SECTORAL INTERACTION IN A MACROECONOMY

by

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Certified that the thesis entitled “Sectoral Interaction in a Macroeconomy” submitted by me for the award of the Degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my work carried out under the supervision of Professor Ambar Nath Ghosh and that neither of this thesis nor any part of it has been submitted before for any degree or diploma anywhere/elsewhere.

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Chapter 1

Interaction between the Real Sector and the Financial Sector: An Alternative to the IS-LM Model

Abstract

The IS-LM model has many flaws. It puts together both stocks and follows and, thereby, creates a serious problem of interpretation of the interest rate it determines. It also does not show how expenditures are financed. It does not incorporate financial intermediaries, which play an important role in mobilizing saving into investment and generating money and credit. This paper develops an alternative model that seeks to resolve all the deficiencies of the IS-LM model mentioned above.

1.1 Introduction

The IS-LM model is yet to lose its relevance. Recent efforts by Blanchard (1981) and Romer (2013, 2000) to extend it bear ample testimony to that. However, one major weakness of the IS-LM model is its financial sector, which it conceives in terms of stocks of supply of money and demand for money. The real sector, however, is characterized in terms of flows. Flows refer to a period of time. Thus the real sector determines output per unit of time such as daily output, weekly output, monthly output or annual output. Stocks on the other hand are defined at every instant of time. At every instant of time there is a stock of supply of money and a stock of demand for money and these determine an interest rate at every instant of time. This obviously raises a problem of interpretation. Suppose the flows in the real sector are quarterly. The real sector thus determines quarterly output, quarterly consumption etc. Stocks of demand for money and supply of money should determine interest rate at every instant. Note that, even if stock of money supply remains the same at every instant during a given period, money holding of the public will vary from one instant to the other. Thus interest rates of different instants during the given period are likely to be different. In the IS-LM, demand for money refers to the average of these instantaneous money holdings during the given period. What does the stock of demand for money defined in the above sense and the stock of supply of money determine in the IS-LM? Do they determine the average of these instantaneous interest rates? Will the average of the interest rates of all the instants during the given period really be equal to the interest rate that the demand for money and supply of money in the IS-LM determine? These issues are obviously unresolved.

Even if we ignore this problem, there are other more serious problems that the characterisation of the financial sector in the IS-LM model gives rise to. Quite a large part of private and public consumption and investment expenditures are financed with credit. Thus the process of generation of credit and that of demand should be closely related to one another. Again, we know that the process of generation of money and that of bank credit occur simultaneously. Thus they are also intimately linked. Again, savers lend out quite a large part of their saving to the financial intermediaries such as banks, insurance companies etc. and also to the government. Thus the process of generation of saving and that of credit are also intimately connected. To sum up, the processes of generation of saving, credit, money, expenditure and income are actually very closely interrelated. In other words, the multiplier process that takes place in the real sector in the IS-LM model and the money multiplier process must occur together. However, the IS-LM model fails to capture these interrelationships. In fact, the IS-LM model does not consider the financial intermediaries. Nor does the IS-LM model show how the expenditures are financed. In this paper, we shall develop a model that seeks to redress the problems noted above. Bernanke and Blinder (1988) and Blinder (1987) addressed some of the above-mentioned issues, but they could not resolve all the major problems of the IS-LM model specified here and present a workable framework that can be applied to explain the major short run macroeconomic events. Bernanke and Blinder (1988), for example, incorporated commercial banks in the IS-LM model. However, it did not seek to resolve the other problems of the IS-LM model. Thus, in the aforementioned paper, the financial sector, just as in the IS-LM model, has been conceived in terms of stocks: supply of aggregate stock of money, demand for aggregate stock of money, supply of aggregate stock of bank credit and demand for aggregate stock of bank credit. But, the commodity market, just as in the IS-LM model, has been presented in terms of flows. Accordingly, it fails to show how different components of aggregate expenditure are financed. As a result, the link between the real sector and the financial sector remains ill-developed. Just as in the IS-LM model, it becomes difficult to interpret the meanings of the interest rates determined in the Bernanke – Blinder paper. In the model we have developed, both the real sector and the financial sector, which includes the commercial banks, have been conceived in terms of flows. Hence, we have succeeded in showing how different components of aggregate expenditure are financed. Since the financial sector has been conceived in terms of flows, the equilibrium interest rate in our model is the one that equates the planned demand for and planned supply of new credit in the period under consideration. Thus, it resolves all the major problems of both the IS-LM and the Bernanke – Blinder model.

1.2 The Model for a Closed Economy

We shall develop first a very simple model that completely resolves the problems noted above. This model is derived from Rakshit (1993). We can easily extend this model to more general cases whenever needed. The model divides the economy into two sectors, the real sector and the financial sector. We shall characterize the financial sector first.

1.2.1 The Financial Sector

The economy consists of the government, central bank, commercial banks, firms and households. The government takes loans only from the central bank and the central bank in its turn lends only to the government. Only firms take loans from the commercial banks and commercial banks receive deposits only from the households who hold their

Table 1.1 Assets and Liabilities of Economic Agents		
	Asset	**Liability**
Government	V_g	L_{gc}
Central Bank	L_{gc}	H_b
Commercial Bank	$L_f + H_b$	D
Firms	V_f	L_f
Households	D	W

$W \equiv$ households' wealth and $V_g \equiv$ government's physical assets, $L_{gc} \equiv$ government's loans from the central bank, $H \equiv$ stock of high-powered money, $H_b \equiv$ reserves of the commercial banks, $L_f \equiv$ loans of the firms from banks, $D \equiv$ aggregate deposits of the commercial banks, $V_f \equiv$ physical assets of firms.

entire wealth or savings in the form of bank deposits. Households are the ultimate lenders and do not take any loans. These assumptions can be easily generalized without any change in the results drawn. The asset-liability structure of the economic agents, given the simplifying assumptions specified above, is presented in Table 1.1. It is assumed in Table 1.1 that the government takes loans from the RBI only to acquire physical assets. Let us now focus on the supply of loans in this economy.

Supply of Loans

Let us first consider the central bank. It extends loans only to the government. Its total outstanding loan to the government is denoted by L_{gc} in Table 1.1. It should be equal to its total outstanding liability, which is the total stock of high-powered money in the economy and it is denoted by *H*. For simplicity, we assume that there is no currency holding by the public. Hence, the whole of this stock of high-powered money is held by the commercial banks as reserves (denoted H_b) in the form of deposits with the central bank. In what follows, we shall refer to the commercial banks as simply banks. We further assume for simplicity that banks do not hold excess reserves and the required reserve ratio (CRR) is denoted by ρ. Households hold their wealth only in the form of bank deposits.

Denoting the total amount of bank deposits by *D*, we have

$$H = \rho D \tag{1.1}$$

$$dD = \frac{dH}{\rho} \tag{1.2}$$

The supply of new loans as planned by the banks in the given period, denoted l_f, is, therefore, given by

$$l_f = (1-\rho)\frac{dH}{\rho} \tag{1.3}$$

1.2.2 The Real Sector

We assume that in the real sector aggregate output is determined by aggregate final demand for goods and services. The price level is fixed and it is taken to be unity. Aggregate planned consumption demand is given by

$$C = C(Y) \qquad 0 < C' < 1 \tag{1.4}$$

We assume for simplicity that consumption is not financed with loans. Aggregate planned investment demand is given by

$$I = I(r) \qquad I' < 0 \tag{1.5}$$

where $r \equiv$ nominal interest rate. We assume, again for simplicity, that investment is financed entirely with loans taken from banks. Government consumption, *G*, is also, as we have already mentioned, financed with loans from the central bank. Thus,

$$\overline{G} = dL_{gc} = dH \tag{1.6}$$

The goods market is in equilibrium when

$$Y = C(Y) + I(r) + \overline{G} \tag{1.7}$$

1.2.3 Interaction between the Real and the Financial Sector

Both government consumption and investment expenditures are financed entirely with loans. Demand for banks' loans comes only from the private investors. Demand for new loans in the given period is therefore given by (1.5). Supply of new bank loans in the given period is given by (1.3). We can work under two alternative assumptions. We can assume that the credit market is competitive and the interest rate clears the market for bank credit. Alternatively, we can assume that the banking sector is oligopolistic so that oligopolistic interdependence as captured in the kinked oligopoly demand curve model makes interest rates charged by banks rigid at a level at which there is excess demand for credit. In the former case where interest rate clears credit market, credit market is in equilibrium when demand for loans and supply of loans are equal, i.e., when the following condition is satisfied:

$$(1-\rho)\frac{dH}{\rho} = (1-\rho)\frac{\overline{G}}{\rho} = I(r) \tag{1.8}$$

In the latter case, as there is excess demand for credit at the fixed interest rate, investment is determined by the supply of credit. In equilibrium, therefore, investment will be given by the supply of new loans from the banks in the given period. Thus,

$$I = (1-\rho)\frac{\overline{G}}{\rho} \tag{1.9}$$

We consider here only the former case. In this case, equilibrium of the economy is given by (1.7) and (1.8), which contain two endogenous variables, Y and r . We may solve (1.7) and (1.8) as follows: We can solve (1.8) for the equilibrium value of *r*.

Substituting (1.8) into (1.7), we get

$$Y = C(Y) + (1-\rho)\frac{\overline{G}}{\rho} + \overline{G} \tag{1.10}$$

We can solve (1.10) for the equilibrium value of *Y*. The solution of *r* and *Y* are shown in Figures 1.1a and 1.1b. In Figure 1.1a, *r* is measured on the vertical axis, while supply of new loans of banks and demand for new loans from banks denoted by l_f and l_d respectively are measured on the horizontal axis. The vertical LS schedule gives the value of l_f, as given by the LHS of (1.8), corresponding to different values of *r*. The LD schedule on the other hand gives the value of l_d, as given by the RHS of (1.8),

Derivation of the Equilibrium Values of *Y* and *r*

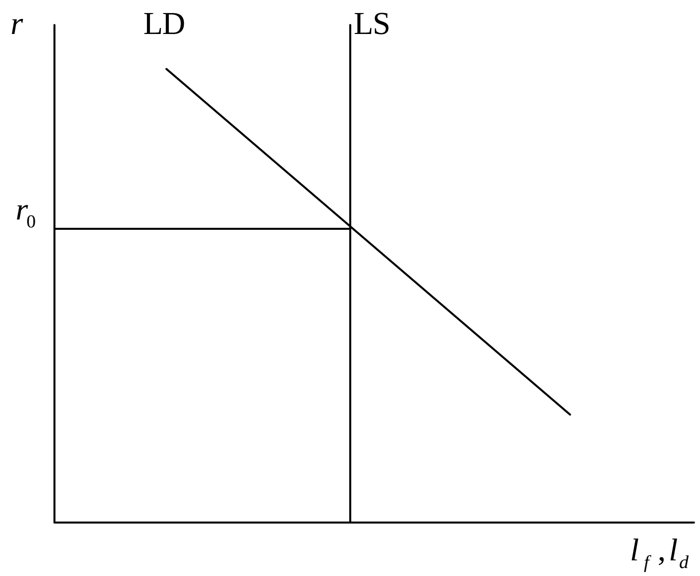

Figure 1.1a

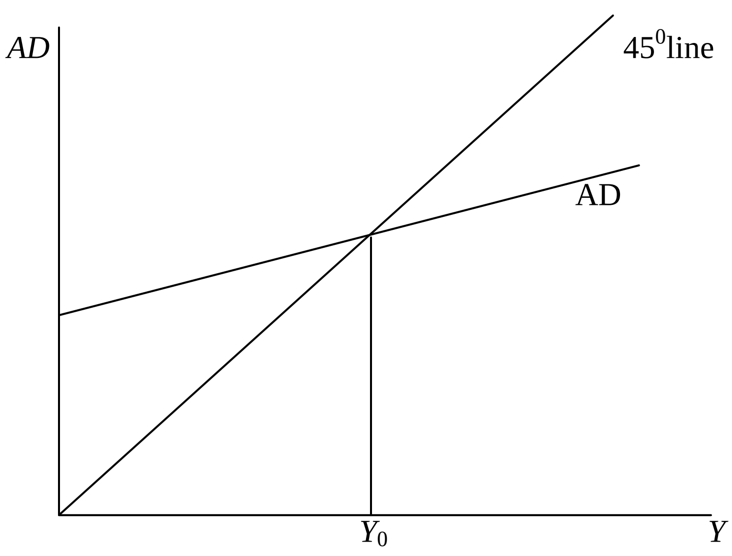

Figure 1.1b

corresponding to different values of r. The equilibrium value of r corresponds to the point of intersection of LD and LS schedules. The equilibrium value of r is labeled r_0 in Figure 1.1a. In Figure 1.1b, the AD schedule represents the RHS of (1.10). It gives the value of aggregate planned demand for goods and services (AD) corresponding to different values of Y. The equilibrium Y corresponds to the point of intersection of the AD schedule and the 45^0 line. We shall now carry out a few comparative static exercises to explain the working of the model.

1.2.4 Fiscal Policy: An Increase in Government Expenditure Financed by Borrowing from the Central Bank

We shall here examine how an increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank affects Y and r. We shall first derive the results diagrammatically using Figures 1.2a and 1.2b, where initial equilibrium values of Y and r, which correspond to the points of intersection of the AD schedule and the 45^0 line in Figure 1.2b and the LD and LS schedules in Figure 1.2a respectively. These initial equilibrium values of Y and r are labeled Y_0 and r_0. Following an increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank, the supply of high-powered money and the reserves of the banks increase by dG. This raises aggregate planned supply of new loans of banks by $(1-\rho)\frac{d\overline{G}}{\rho}$, whatever be the level of r. Thus, the LS schedule in Figure 1.2a shifts to the right by $(1-\rho)\frac{d\overline{G}}{\rho}$. The new LS schedule is labeled LS_1. The LD schedule, however, remains unaffected. Hence, the equilibrium r goes down. Let us now focus on the AD schedule in Figure 1.2b. Corresponding to every Y, investment demand and G are larger by

Effect of an Increase in $\overline{G}$ on Y and r

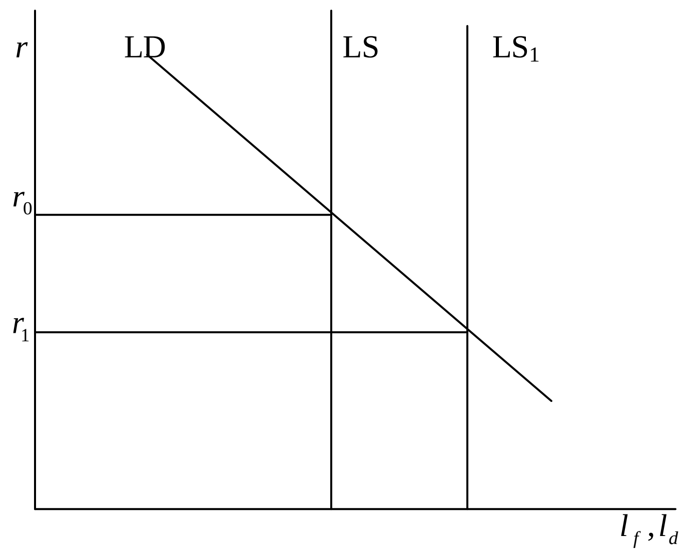

Figure 1.2a

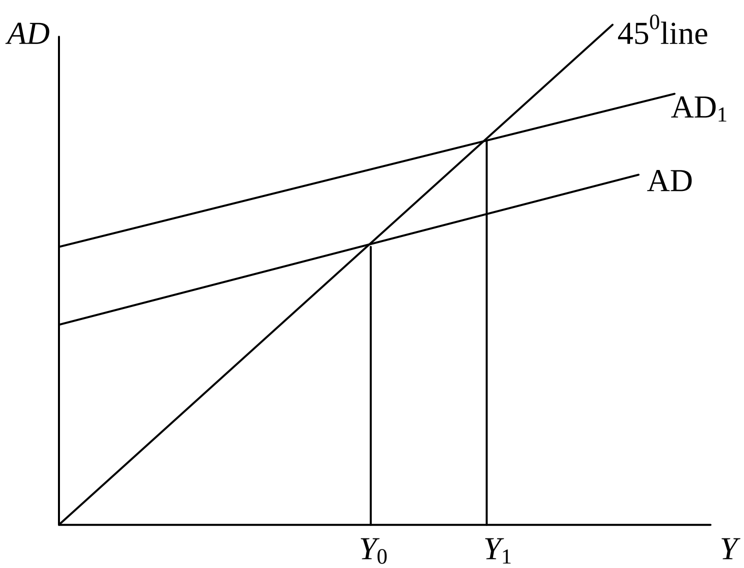

Figure 1.2b

$(1-\rho)\frac{d\overline{G}}{\rho}$ and *dG* respectively – see (1.10). The AD schedule, therefore, shifts upward by $(1-\rho)\frac{d\overline{G}}{\rho}+d\overline{G}=\frac{1}{\rho}d\overline{G}$. The new AD schedule is labeled AD_1. The equilibrium value of *Y* will, accordingly, be larger.

Mathematical Derivation of the Results

Taking total differential of (1.8) and (1.10) treating all exogenous variables other than *G* as fixed, we get

$$(1-\rho)\frac{d\overline{G}}{\rho}=I'dr \qquad (1.11)$$

$$dY=C'dY+\frac{d\overline{G}}{\rho} \qquad (1.12)$$

Solving (1.11), we get the equilibrium value of *dr*. It is given by

$$dr=\frac{(1-\rho)\frac{d\overline{G}}{\rho}}{I'}<0 \qquad (1.13)$$

Again, solving (1.12), we get the equilibrium value of *dY*. It is given by

$$dY=\frac{\frac{d\overline{G}}{\rho}}{(1-C')}>0 \qquad (1.14)$$

It is quite easy to explain (1.13) and (1.14). Focus on (1.13) first. The numerator of the expression on the RHS of (1.13) gives the increase in the supply of new loans by the banks at the initial equilibrium *r*. This gives rise to excess supply of new loans at the initial equilibrium *r* of the same amount. *r*, therefore, has to fall to clear the loan market. Per unit decline in *r*, demand for loans increases by $-I'$. Hence, to raise demand for loans by $\frac{d\overline{G}}{\rho}$, r has to fall by $\frac{(1-\rho)\frac{d\overline{G}}{\rho}}{-I'}$. This explains (1.13). Now consider (1.14). Following an increase in $\overline{G}$ by $d\overline{G}$, aggregate planned supply of new loans of banks increases by $(1-\rho)\frac{d\overline{G}}{\rho}$ and this depresses r to raise investment demand by the same amount. Therefore, at the initial equilibrium Y, there emerges an excess demand of $d\overline{G}+(1-\rho)\frac{d\overline{G}}{\rho}=\frac{d\overline{G}}{\rho}$. This is given by the numerator of the expression on the RHS of (1.14). Y will, therefore, have to increase to remove the excess demand. Per unit increase in Y, excess demand for goods and services falls by $(1-C')$. Accordingly, excess demand for goods and services will fall by $\frac{d\overline{G}}{\rho}$, when Y increases by $\frac{\frac{d\overline{G}}{\rho}}{1-C'}$. This explains (1.14).

Adjustment Process

Let us now describe how economic agents behave to bring about the changes in the equilibrium values of r and Y derived above. Following an increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank, the familiar multiplier process operates and raises GDP by $\frac{d\overline{G}}{(1-C')}$. From this additional income of $\frac{d\overline{G}}{(1-C')}$, people will save $(1-C')\frac{d\overline{G}}{(1-C')}=d\overline{G}$, which they will deposit with the banks, since, by assumption, people hold all their savings in the form of bank deposits. Out of these new deposits of $d\overline{G}$, banks will plan to lend out $(1-\rho)d\overline{G}$ giving rise to an excess supply of loans of

$(1-\rho)d\overline{G}$. This will lower r by $\frac{(1-\rho)d\overline{G}}{I'}$ so that investment and, therefore, demand for bank loans increases by $(1-\rho)d\overline{G}$. This is the end of the first round of expansion. In the first round, Y increases by $dY_1 = \frac{d\overline{G}}{1-C'}$ and r falls by $dr_1 = \frac{(1-\rho)d\overline{G}}{I'}$.

Now, there is an excess demand of $(1-\rho)d\overline{G}$ due to the increase in investment demand in the first round. This will set into motion the second round of expansion. The multiplier process will begin to operate and Y will increase by $dY_2 = \frac{(1-\rho)d\overline{G}}{1-C'}$. This will accrue as additional factor income to the people. The whole of this additional factor income will add to their disposable income. Out of this additional disposable income, people will save $(1-C')\frac{(1-\rho)d\overline{G}}{(1-C')} = (1-\rho)d\overline{G}$. They will deposit their savings in banks. Out of these new deposits banks will lend out $(1-\rho)^2 d\overline{G}$. This will, as before, lower r by $\frac{(1-\rho)^2 d\overline{G}}{I'}$ so that investment demand and, therefore, demand for new loans from banks increases by $(1-\rho)^2 d\overline{G}$. This is the end of the second round. In the second round, changes in Y and r are given by $dY_2 = \frac{(1-\rho)d\overline{G}}{1-C'}$ and $dr_2 = \frac{(1-\rho)^2 d\overline{G}}{I'}$ respectively. This is how expansion in Y and fall in r will continue until the additional saving generated in each round eventually falls to zero. Thus, the total increase in Y and the total decline in r are given by

$$dY = \frac{d\overline{G}}{(1-C')} + \frac{(1-\rho)d\overline{G}}{(1-C')} + \frac{(1-\rho)^2 d\overline{G}}{(1-C')} + \dots\dots\dots\dots\dots\dots = \frac{d\overline{G}}{\rho(1-C')} \tag{1.15}$$

$$dr = \frac{(1-\rho)d\overline{G}}{I'} + \frac{(1-\rho)^2 d\overline{G}}{I'} + \dots\dots\dots\dots\dots\dots = \frac{(1-\rho)d\overline{G}}{\rho I'} \tag{1.16}$$

(1.15) and (1.16) tally with (1.14) and (1.13) respectively.

The model presented above clearly shows how the processes of generation of money credit, spending, income and saving are closely interwoven. More precisely, it shows how creation of high-powered money and credit by the central bank leads to spending on goods and services. This expenditure in turn generates income. The saving made out of that income leads to creation of more money and credit, which leads to another round of generation of spending, income and saving and this process goes on until the additional income that is generated in each round eventually falls to zero.

1.2.5 Monetary Policy

To examine the impact of monetary policy we make the following extension to our simple model. We assume that the central bank gives loans not only to the government, but also to the banks at a pre-specified interest rate denoted by r_c. Demand for new central bank loans of the banks is a decreasing function of r_c and it is given by $l\left(\underset{-}{r_c}\right)$. The central bank meets all the loan demand of the banks. Obviously, the new loan given by the central bank to the banks constitutes a part of the additional stock of high-powered money created in the economy. Thus, we rewrite (1.6) as

$$\overline{G} + l(r_c) = dL_{gc} + l\left(\underset{-}{r_c}\right) = dH \qquad (1.17)$$

Since banks get $l\left(\underset{-}{r_c}\right)$ directly from the central bank, it can use the whole of it to extend loans. Therefore, total amount of new loans the banks can extend using $l\left(\underset{-}{r_c}\right)$ is $\dfrac{l\left(\underset{-}{r_c}\right)}{\rho}$.

Effect of a Cut in r_c on Y and r

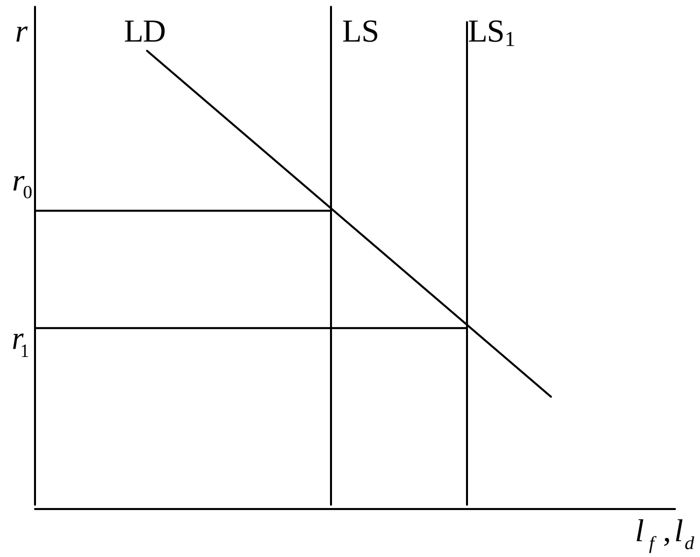

Figure 1.3a

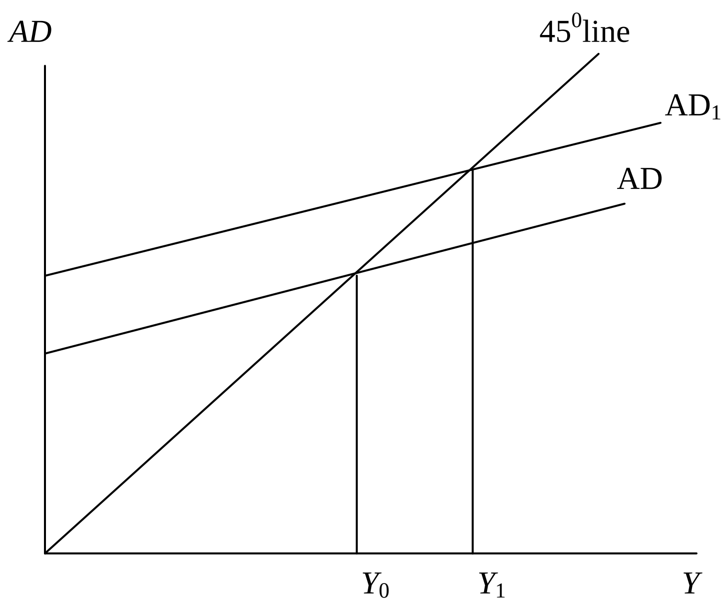

Figure 1.3b

In case of G, however, it accrues as new deposits with the banks. Hence, they can extend only $\frac{1-\rho}{\rho}G$ amount of new loans using G. Hence, we rewrite the credit market equilibrium condition (1.8) as

$$\frac{1-\rho}{\rho}\overline{G}+\frac{l\left(\underset{-}{r_c}\right)}{\rho}=I(r) \tag{1.18}$$

Substituting (1.18) into (1.8), we rewrite (1.10) as

$$Y=C(Y)+\frac{1}{\rho}\overline{G}+\frac{l(r_c)}{\rho} \tag{1.19}$$

We shall use (1.18) and (1.19) examine the impact of monetary policy, consisting in a reduction in r_c, on r and Y. (1.18) and (1.19) yield the equilibrium values of r and Y respectively. The solution is shown in Figures 1.3a and 1.3b respectively, where the initial equilibrium values of Y and r are indicated by Y_0 and r_0 respectively. Following a cut in r_c, the LS schedule representing the LHS of (1.18) in Figure 1.3a shifts to the right. The new LS is labeled LS_1. The LD schedule representing the RHS of (1.18) remains unaffected. Thus, the equilibrium r falls. The new equilibrium r is labeled r_1. The AD schedule representing the RHS of (1.19) shifts upward following a cut in r_c raising the equilibrium Y.

We can derive the same results mathematically also. Taking total differential of (1.18) and (1.19) treating all exogenous variables other than r_c as fixed, and, then, solving for dr and dY, we get

$$dr=\frac{l'dr_c}{\rho I'}<0 \qquad \because dr_c<0 \tag{1.20}$$

$$dY = \frac{l'dr_c}{\rho(1-C')} > 0 \qquad \because dr_c < 0 \tag{1.21}$$

Adjustment Process

Let us now describe how the changes in *r* and *Y* derived above come about. As r_c is cut by dr_c, banks take an additional loan of $l'dr_c$, which they lend out creating an excess supply of loans. *r* will fall by $\frac{l'dr_c}{I'}$ raising *I* by $l'dr_c$. Hence, *Y* will increase by $\frac{l'dr_c}{1-C'}$. Out of this additional *Y*, people save $l'dr_c$ and deposit it with the banks. Banks lend out $(1-\rho)l'dr_c$ lowering *r* by $\frac{(1-\rho)l'dr_c}{I'}$ so that *I* rises by $(1-\rho)l'dr_c$. *Y* will, therefore, increase again by $\frac{(1-\rho)l'dr_c}{1-C'}$. This expansionary process will go on until the additional loan generated in each round eventually falls to zero. Thus the total fall in *r* and total increase in *Y* are given by

$$dr = \frac{l'dr_c}{I'} + \frac{(1-\rho)l'dr_c}{I'} + \frac{(1-\rho)^2 l'dr_c}{I'} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots = \frac{1}{\rho}\frac{l'dr_c}{I'} \tag{1.22}$$

$$dY = \frac{l'dr_c}{1-C'} + \frac{(1-\rho)l'dr_c}{1-C'} + \frac{(1-\rho)^2 l'dr_c}{1-C'} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots = \frac{1}{\rho}\frac{l'dr_c}{(1-C')} \tag{1.23}$$

(1.22) and (1.23) tally with (1.20) and (1.21) respectively.

1.2.6 Irrelevance of the Money Market

The model**,** as it is couched in terms of only flows, brings out clearly the irrelevance of money demand and money supply as conceived in the IS-LM model or the quantity theory tradition. Here, people make their spending and saving out of their income, which they receive in the form of money. So the issue of people being unable to make their purchases of goods and services or financial assets on account of inadequate money holding does not arise. People decide on the allocation of the part of their income that is saved. They may hold it in the form of currency or other financial assets or physical assets. Purchase of financial assets amounts to extending new loans. In case they decide to hold a part of their saving, which they initially own in the form of either currency or bank deposits or both, in the form of currency, the issue of demand for currency being unequal to the supply of currency is irrelevant. If necessary, they can always withdraw the required amount of currency from their bank deposits. The only point is that, if people decide to hold a part of their saving in the form of currency, banks will not be able to supply as much new loans as they otherwise could. Again, if people decide to hold a part of their saving in the form of physical goods, it will give rise to additional demand for goods. If people plan to spend more than their income, it will generate additional demand for new credit. Thus, we have to consider only the loan market and the goods market. Similarly, firms make their purchases using the money they get by selling (supplying) goods and services or by taking new loans. So, the issue of the firms being unable to purchase as much as they want to on account of less money holding is irrelevant. The only problem that can emerge here is the following. If interest rate is rigid, the amount of new credit that banks plan to supply at the given interest rate may exceed the amount of demand for new bank credit. This is, again, a problem of the credit market. We have not considered this problem for simplicity. Thus, the only markets that we have to consider here are the goods market and the loan market. We shall now extend our model to the case of an open economy.

The irrelevance of the money market comes out clearly from the equilibrium condition (1.10). Here, people want to hold all their saving in the form of bank deposits or money. Saving constitutes the only source of demand for new money (or additional money). From (1.10) we get $Y - C(Y) = \frac{G}{\rho} = \frac{dH}{\rho P}$. The LHS of the above equation gives aggregate planned saving of the households. Since there are no taxes or undistributed corporate profit, Y also gives aggregate disposable income of the households. Thus, the LHS of the above equation gives aggregate planned demand for new money. The RHS on the other hand gives aggregate supply of new money. It is, accordingly, clear that the equilibrium condition (1.10) also implies equality of demand for new money and supply of new money. As demand for money and supply of money were equal at the beginning of the period (since the whole of the initial supply of money was willingly held by the households as wealth), equality of demand for new money and supply of new money implies that of demand for money and supply of money.

1.3 The Model for an Open Economy

We consider here a small open economy. For the present, we abstract from capital mobility or cross-border capital flows. We shall first focus on the fixed exchange rate regime:

1.3.1 The Fixed Exchange Rate Regime

The goods market equilibrium condition is given by

$$Y = C\Big(\underset{+}{Y}\Big) + I\Big(\underset{-}{r}\Big) + \overline{G} + X\left(\underset{+}{\frac{P^* e}{P}}; Y^*\right) - M\left(\underset{-}{\frac{P^* e}{P}}, \underset{+}{Y}\right) \tag{1.17}$$

In (1.17), $X \equiv$ exports, $M \equiv$ the value of imports in terms of domestic goods, $P^* \equiv$ the average price of foreign goods in foreign currency, $P \equiv$ the average price of domestic goods in domestic currency, $Y^* \equiv$ foreign GDP and $e \equiv$ nominal exchange rate. As the economy is small, P^* is given. *P*, as before, is taken to be fixed. We first focus on the fixed exchange rate regime. The exchange rate is pegged at $\bar{e}$. Incorporating this pegged value of e into (1.17), we have

$$Y = C\left(\underset{+}{Y}\right) + I\left(\underset{-}{r}\right) + \overline{G} + X\left(\underset{+}{\frac{P^*\bar{e}}{P}}, \underset{+}{Y^*}\right) - M\left(\underset{-}{\frac{P^*\bar{e}}{P}}, \underset{+}{Y}\right) \qquad (1.18)$$

The central bank intervenes in the foreign exchange market to keep the exchange rate fixed at $\bar{e}$. $\left\{X\left(\frac{P^*\bar{e}}{P}; Y^*\right) - M\left(\frac{P^*\bar{e}}{P}, Y\right)\right\}\frac{P}{\bar{e}}$ gives the excess supply of foreign currency at the given exchange rate. The central bank buys up this excess supply with domestic currency at the price $\bar{e}$ creating high-powered money to keep *e* at $\bar{e}$. We further assume for the purpose of illustration that the government borrows from the central bank to finance the whole of its consumption expenditure. We assume that high-powered money is created only on account of government's and banks' borrowings from the central bank and central bank's intervention in the foreign exchange market to keep the exchange rate fixed. Thus, the increase in the stock of high-powered money in the period under consideration is given by

$$dH = P\overline{G} + Pl\left(\underset{-}{r_c}\right) + \bar{e}.\frac{P}{\bar{e}}\left[X\left(\frac{P^*\bar{e}}{P}, Y^*\right) - M\left(\frac{P^*\bar{e}}{P}, Y\right)\right] \qquad (1.19)$$

From (1.19) it follows that the stock of real balance created in the period under consideration is given by

$$\frac{dH}{P} = \overline{G} + l\left(\underset{-}{r_c}\right) + \left[X\left(\frac{P^*\overline{e}}{P}, Y^*\right) - M\left(\frac{P^*\overline{e}}{P}, Y\right)\right] \tag{1.20}$$

Again, as before, we assume that households do not take any loans, hold all their wealth in the form of bank deposits and banks are the only source of loans to the firms. These are all simplifying assumptions. We can easily incorporate other financial assets and currency. Given the assumptions stated above, the whole of the high-powered money created will be held by the banks as reserve. Accordingly, the amount of new loans in real terms the banks will plan to supply to the firms in the given period, which we denote by l_f, is given by (see (1.3) and (1.20))

$$l_f = (1-\rho)\frac{\overline{G} + X\left(\frac{P^*\overline{e}}{P}\right) - M\left(\frac{P^*\overline{e}}{P}, Y\right)}{\rho} + \frac{l(r_c)}{\rho} \tag{1.21}$$

where ρ denotes CRR. We ignore excess reserves for simplicity.

We have assumed in this paper that investors finance their investment entirely with bank loans, which is, by assumption, the only source of loans to the private sector. There is no other source of demand for bank loans. Equilibrium in the loan market is therefore given by the following equation

$$(1-\rho)\frac{\overline{G} + X\left(\frac{P^*\overline{e}}{P}; Y^*\right) - M\left(\frac{P^*\overline{e}}{P}, Y\right)}{\rho} + \frac{l(r_c)}{\rho} = I(r) \tag{1.22}$$

where $I(r)$ is the investment function of the firms. The specification of our model is now complete. It contains three key equations (1.18), (1.20) and (1.22) in three unknowns $Y, \frac{dH}{P}$ and r. We can solve them as follows: We can solve (1.18) and (1.22) for the equilibrium values of Y and r. Putting the equilibrium value of Y into (1.20), we get the

Derivation of the Equilibrium Values of $Y, \dfrac{dH}{P}$ and r

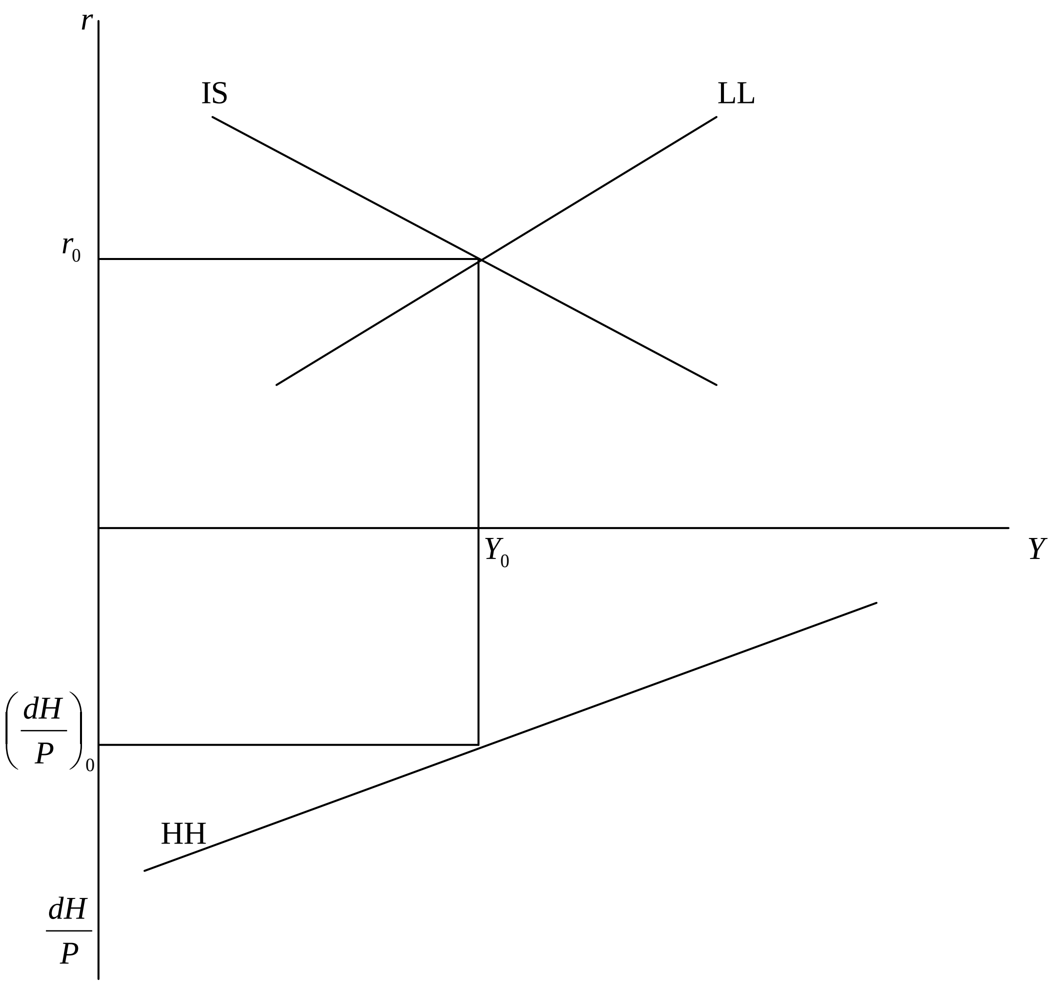

Figure 1.4

equilibrium value of $\frac{dH}{P}$. We show the solution in Figure 1.4, where in the upper panel the IS and LL schedules represent (1.18) and (1.22) respectively in the (Y, r) plane. The equilibrium values of Y and r correspond to the point of intersection of the IS and LL schedules. These equilibrium values of Y and r are labeled Y_0 and r_0 respectively. In the lower panel, where positive values of $\frac{dH}{P}$ are measured in the downward direction, the schedule HH represents (1.20). It gives corresponding to every Y the value of $\frac{dH}{P}$, as given by (1.20). The equilibrium value of $\frac{dH}{P}$ corresponds to the equilibrium value of Y on the HH schedule. We shall now illustrate the working of the model using a comparative static exercise.

Fiscal policy: The Effect of an Increase in Government Expenditure Financed by Borrowing from the Central Bank

Suppose the government raises G and finances it by borrowing from the central bank. How will it affect $Y, \frac{dH}{P}$ and r? We shall examine this question first diagrammatically using Figure 1.5, where the initial equilibrium values of $Y, \frac{dH}{P}$ and r are labeled $Y_0, \left(\frac{dH}{P}\right)_0$ and r_0 respectively. Y_0 and r_0 correspond to the point of intersection of IS and LL schedules in the upper panel, while $\left(\frac{dH}{P}\right)_0$ corresponds to Y_0 on the HH schedule in the lower panel. First, focus on the IS curve. Take any (Y, r) on the initial IS. Following

The Effect of an Increase in $\overline{G}$ on $Y, \dfrac{dH}{P}$ and r

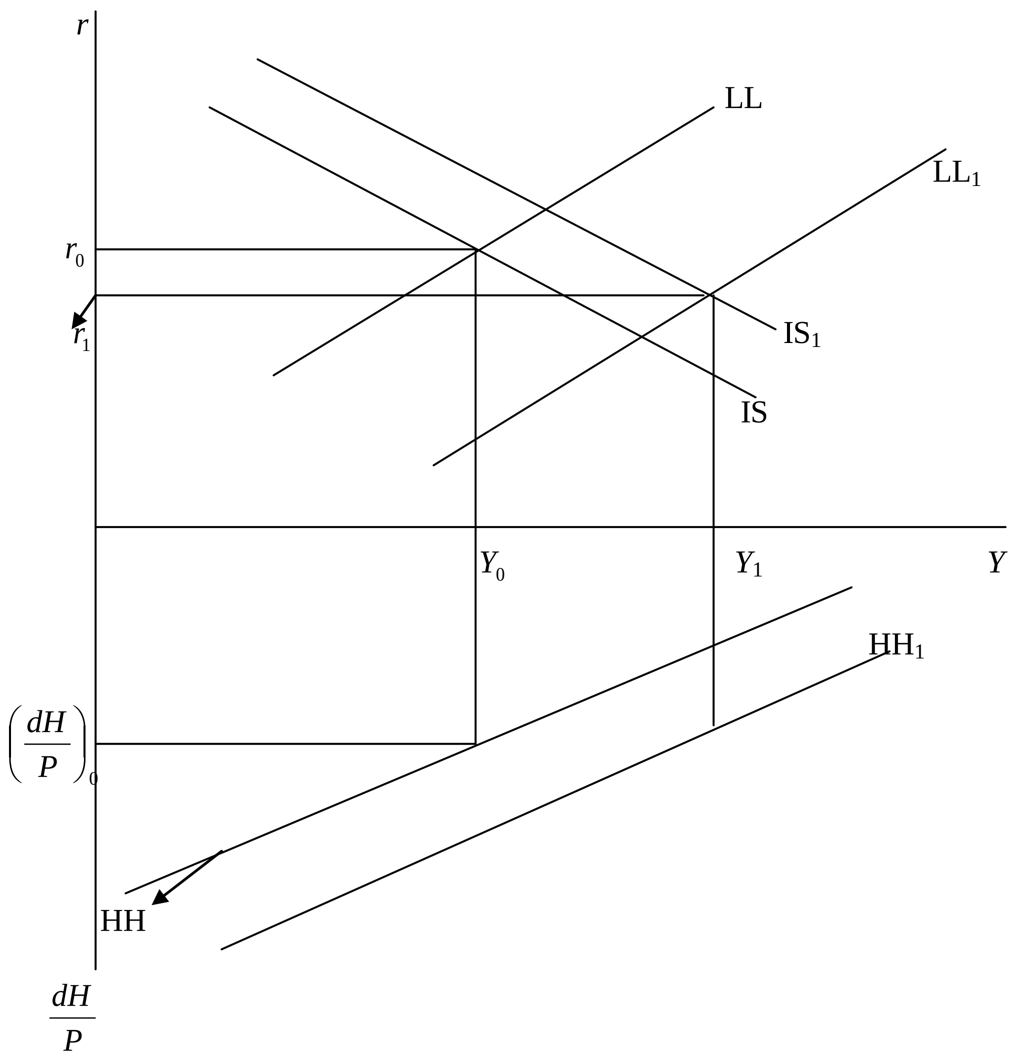

Figure 1.5

an increase in G by dG financed by borrowing from the central bank, there emerges an excess demand of dG for domestic goods at the given (Y, r). At the given r, therefore, the goods market will be in equilibrium at a larger Y, or at the given Y, the goods market will be in equilibrium at a higher r. Hence, the IS curve will shift upward or to the right. The new IS is labeled IS_1 in Figure 1.5. Now, focus on the LL curve. Take any (Y, r) on the initial LL. Following the increase in G by dG financed by borrowing from the central bank, there now emerges at the given (Y, r) an increase in the supply of new loans by the banks – see the LHS of (1.22), while demand for new loans from banks as given by the RHS of (1.22) remains unaffected. Therefore, it follows from (1.22) that the loan market at the given r will be in equilibrium at a larger Y or at a lower r at the given Y. Thus, the LL shifts to the right or downward. The new LL is labeled LL_1. Hence, in the new equilibrium, Y will be larger unambiguously, but r may change in either direction. However, we shall show shortly that r will actually fall. Let us now focus on the HH schedule representing (1.20). Following an increase in G by dG, supply of $\frac{H}{P}$, as given by the RHS of (1.20), increases by dG corresponding to every Y. Hence, the HH schedule will shift southward. The new HH schedule is labeled HH_1. Accordingly, the direction of change in the equilibrium value of $\left(\frac{dH}{P}\right)$ is ambiguous. However, we have derived below that $\left(\frac{dH}{P}\right)$ will actually increase.

Mathematical Derivation of the Results

To derive the results mathematically, we first substitute (1.22) into (1.18) to write it as

$$Y = C\left(\underset{+}{Y}\right) + \frac{1}{\rho}\left[\overline{G} + l\left(r_c\right) + X\left(\underset{+}{\frac{P^*\overline{e}}{P}}, \underset{+}{Y^*}\right) - M\left(\underset{-}{\frac{P^*\overline{e}}{P}}, \underset{+}{Y}\right)\right] \tag{1.23}$$

Taking total differential of (1.23) treating all exogenous variables other than $\overline{G}$ as fixed, we have

$$dY = C'dY + \frac{1}{\rho}\left(d\overline{G} - M_Y dY\right)$$

Solving the above equation for dY, we get

$$dY = \frac{d\overline{G}}{\rho\left(1 - C'\right) + M_Y} \tag{1.24}$$

Again, taking total differential of (1.22) treating all exogenous variables other than $\overline{G}$ as fixed and using (1.20) and (1.21), we get

$$dr = \frac{\frac{1-\rho}{\rho}\left[d\overline{G} - M_Y dY\right]}{I'} = \frac{\frac{1-\rho}{\rho} d\left(dH\right)}{I'} = \frac{dl_f}{I'}$$

Substituting (1.24) into the above equation, we get

$$dr = \frac{\frac{1-\rho}{\rho}\left[1 - \frac{M_Y}{\rho\left(1-C'\right) + M_Y}\right] d\overline{G}}{I'} < 0 \tag{1.25}$$

From (1.20) and (1.24) we get

$$d\left(dH\right) = d\overline{G} - M_Y dY = d\overline{G}\left[1 - \frac{M_Y}{\rho\left(1-C'\right) + M_Y}\right] = d\overline{G}\left[\frac{\rho\left(1-C'\right)}{\rho\left(1-C'\right) + M_Y}\right] > 0 \tag{1.26}$$

Again, from (1.21) and (1.26) we get

$$dl_f = \frac{1-\rho}{\rho}\left[\frac{\rho\left(1-C'\right)}{\rho\left(1-C'\right) + M_Y}\right] d\overline{G} = \left(1-\rho\right)\left[\frac{\left(1-C'\right)}{\rho\left(1-C'\right) + M_Y}\right] d\overline{G} \tag{1.27}$$

Adjustment Process

We shall now explain below how these changes come about. Following the increase in $\overline{G}$ by $d\overline{G}$, Y through the multiplier process increases by $\frac{d\overline{G}}{1-(C'-M_Y)}$. From this additional income people save $(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$ and they hold this in the form of bank deposits. Banks receive an additional deposit of $(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$. Accordingly, their reserves and, therefore, the stock of high-powered money increases by $(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$. Let us explain this point a little more. When the government borrows from the central bank dG amount, the stock of high-powered money in the economy rises by the same amount. But following the increase in Y by $\frac{d\overline{G}}{1-(C'-M_Y)}$, import demand rises by $M_Y.\left[\frac{d\overline{G}}{1-(C'-M_Y)}\right]$ generating an excess demand for foreign currency (in terms of domestic goods) by the same amount. The central bank has to buy up $M_Y.\left[\frac{d\overline{G}}{1-(C'-M_Y)}\right]$ amount of domestic currency (in terms of domestic goods) with foreign currency. Thus, at the end of the multiplier process the stock of high-powered money in the domestic economy rises by $d\overline{G}-M_Y.\left[\frac{d\overline{G}}{1-(C'-M_Y)}\right]=(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$. Banks get this, as we have already explained, in the form of additional deposits and reserve. Let us make this point clearer.

As Y increases by $dY_1 = \frac{d\overline{G}}{1-(C'-M_Y)}$, people's saving increases by $(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$. Besides this, they also have in their hands $M_y \frac{d\overline{G}}{1-(C'-M_Y)}$ part of their income, which they do not spend on domestic goods. Note that $(1-C')\frac{d\overline{G}}{1-(C'-M_Y)} + M_y \frac{d\overline{G}}{1-(C'-M_Y)} = d\overline{G}$. However, they will not deposit $M_Y \frac{d\overline{G}}{1-(C'-M_Y)}$ amount of income with the banks. They will sell it to the central bank for foreign currency. So, the banks will get an additional deposit of $(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$. In the central bank's balance sheet, the following changes will occur. On the asset side, central bank's credit to the government will increase by $d\overline{G}$ and its stock of foreign exchange will go down by $M_Y \frac{d\overline{G}}{1-(C'-M_Y)}$ so that, in the net, central bank's total asset increases by $d\overline{G} - M_Y \frac{d\overline{G}}{1-(C'-M_Y)} = (1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$. On the liabilities side banks' reserve rises by $(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$.

Banks will not want to keep this whole of this additional reserve idle. They will plan to extend an additional credit of $(1-\rho)(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$. r will, therefore, fall by $\left[\left\{(1-\rho)(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}\right\}/I'\right]$ to raise investment by the amount of the additional supply of bank credit. This will bring about the second round of expansion in Y. At the end of the first round, increases in Y, dH and l_f and the decline in r are given respectively by $\frac{d\overline{G}}{1-(C'-M_Y)}, (1-C')\frac{d\overline{G}}{1-(C'-M_Y)}, (1-\rho)(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$ and $\left[\left\{(1-\rho)(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}\right\}/I'\right]$.

In the second round, the increase in investment by $(1-\rho)(1-C')\frac{d\overline{G}}{1-(C'-M_Y)}$ will lead through the multiplier process to an increase in Y by $(1-\rho)(1-C')\frac{d\overline{G}}{[1-(C'-M_Y)]^2} \equiv dY_2$. Out of this additional income of dY_2, people will save $(1-C')dY_2$ and will not spend $M_Y dY_2$ on domestic goods. Note that $(1-C')dY_2 + M_Y dY_2 = (1-\rho)(1-C')dY_1$, which is the amount of new credit extended by the banks at the end of the first round. However, the banks will not get back the whole of this credit as new deposit. People will deposit $(1-C')dY_2$ with the banks and sell $M_Y dY_2$ to the central bank. In the balance sheet of the central bank, following changes will occur. On the asset side, central banks' stock of foreign exchange will fall by $M_Y dY_2$ and on the liabilities side, banks' reserve will go down by the same amount. In the second round, therefore, the stock of high-powered money will decline by $M_Y dY_2$. In the second round, aggregate saving increases by $(1-\rho)(1-C')^2\frac{d\overline{G}}{[1-(C'-M_Y)]^2}$, which the households will hold in the form of bank deposits. Banks will receive additional deposits of $(1-\rho)(1-C')^2\frac{d\overline{G}}{[1-(C'-M_Y)]^2}$, which will induce them to extend additional credit of

$(1-\rho)^2(1-C')^2 \dfrac{d\overline{G}}{[1-(C'-M_Y)]^2}$. This will increase investment by the same amount through the decline in r by $\left[\left\{(1-\rho)^2(1-C')^2 \dfrac{d\overline{G}}{[1-(C'-M_Y)]^2}\right\}/I'\right]$. Thus another round of expansion will begin. This process will go on until the amount of additional investment generated falls to zero. When that happens, the economy achieves a new equilibrium. Thus the total increases in Y, dH and l_f and the decline in r are given respectively by

$$\begin{aligned} dY &= \frac{d\overline{G}}{[1-(C'-M_Y)]} + (1-\rho)(1-C')\frac{d\overline{G}}{[1-(C'-M_Y)]^2} + \\ &(1-\rho)^2(1-C')^2 \frac{d\overline{G}}{[1-(C'-M_Y)]^3} + \ldots\ldots = \frac{d\overline{G}}{\rho(1-C')+M_Y} \end{aligned} \tag{1.28}$$

$$\begin{aligned} d(dH) &= d\overline{G} - M_Y \frac{d\overline{G}}{[1-(C'-M_Y)]} - M_Y(1-\rho)(1-C')^2 \frac{d\overline{G}}{[1-(C'-M_Y)]^2} - \\ &M_Y(1-\rho)^2(1-C')^3 \frac{d\overline{G}}{[1-(C'-M_Y)]^3} - \ldots\ldots = \frac{\rho(1-C')d\overline{G}}{\rho(1-C')+M_Y} \end{aligned} \tag{1.29}$$

$$\begin{aligned} dl_f &= (1-\rho)(1-C')\frac{d\overline{G}}{[1-(C'-M_Y)]} + (1-\rho)^2(1-C')^2 \frac{d\overline{G}}{[1-(C'-M_Y)]^2} + \\ &(1-\rho)^3(1-C')^3 \frac{d\overline{G}}{[1-(C'-M_Y)]^3} + \ldots\ldots = \frac{(1-\rho)(1-C')d\overline{G}}{\rho(1-C')+M_Y} \end{aligned} \tag{1.30}$$

$$\begin{aligned} dr &= (1-\rho)(1-C')\frac{d\overline{G}}{[1-(C'-M_Y)]}\frac{1}{I'} + (1-\rho)^2(1-C')^2 \frac{d\overline{G}}{[1-(C'-M_Y)]^2}\frac{1}{I'} + \\ &(1-\rho)^3(1-C')^3 \frac{d\overline{G}}{[1-(C'-M_Y)]^3}\frac{1}{I'} + \ldots\ldots = \frac{(1-\rho)(1-C')d\overline{G}}{\rho(1-C')+M_Y}\frac{1}{I'} \end{aligned} \tag{1.31}$$

Clearly, (1.28), (1.29), (1.30) and (1.31) tally with the values of $dY, d(dH), dl_f$ and dr derived mathematically earlier and given by (1.24), (1.26), (1.27) and (1.25) respectively.

Monetary Policy

We shall examine here the impact of an expansionary monetary policy, which consists in the central bank reducing its policy rate r_c so that the banks take more loans from the central bank. We shall examine the impact of a cut in r_c by dr_c diagrammatically first using Figure 1.6, where the initial equilibrium values of Y, r and $\frac{dH}{P}$ are denoted by Y_0, r_0 and $\left(\frac{dH}{P}\right)_0$ respectively. Following a cut in r_c, the IS representing (1.18) remains unaffected, but the LL representing (1.22) shifts rightward. The new LL is labeled LL_1 in Figure 1.6. Thus, *Y* will increase and *r* will fall. The HH schedule representing (1.20) in the lower panel shifts southward following a cut in r_c. The new HH schedule is labeled HH_1. Hence, $\left(\frac{dH}{P}\right)$ may change in either direction. However, $\left(\frac{dH}{P}\right)$ must be larger in the new equilibrium since *r* is less and, therefore, demand for new credit is larger. These results can be easily derived mathematically. Substituting (1.22) into (1.18), we rewrite it as

$$Y = C\Big(\underset{+}{Y}\Big) + \frac{1}{\rho}\left[\bar{G} + l(r_c) + X\left(\underset{+}{\frac{P^*\bar{e}}{P}}, \underset{+}{Y^*}\right) - M\left(\underset{-}{\frac{P^*\bar{e}}{P}}, \underset{+}{Y}\right)\right] \qquad (1.32)$$

Taking total differential of (1.32) treating all exogenous variables other than r_c as fixed, we get $dY = C'dY + \frac{1}{\rho} M_y dY + \frac{l'}{\rho} dr_c \Rightarrow$

$$dY = \frac{\frac{l'}{\rho} dr_c}{1 - \left(C' - \frac{1}{\rho} M_y \right)} > 0 \tag{1.33}$$

Again, taking total differential of (1.22) treating all exogenous variables other than r_c as fixed, and, then, solving for *dr*, we get

$$dr = \frac{\frac{l'}{\rho} dr_c}{I'} < 0 \tag{1.34}$$

Thus, monetary policy is effective in the fixed exchange rate regime. The adjustment process is very similar to the one described in the case of fiscal policy.

Irrelevance of the Money Market

We shall now show that the equilibrium conditions (1.18), (1.20) and (1.22) imply equality of demand for money and supply of money. Substituting (1.22) and (1.20) into (1.18), we get

$$Y = C\left(\underset{+}{Y}\right) + \frac{1-\rho}{\rho} \frac{dH}{P} + \frac{dH}{P} \Rightarrow$$
$$Y - C\left(Y\right) = \frac{1}{\rho} \frac{dH}{P}$$

The LHS of the above equation constitutes households' saving. It, therefore, represents households' demand for additional money, as they hold their entire saving in the form of money. The RHS gives the supply of additional money. This ensures equality of demand for money and supply of money. Thus, when (1.18), (1.20) and (1.22) are satisfied,

The Effect of a Cut in r_c on $Y, \frac{dH}{P}$ and r

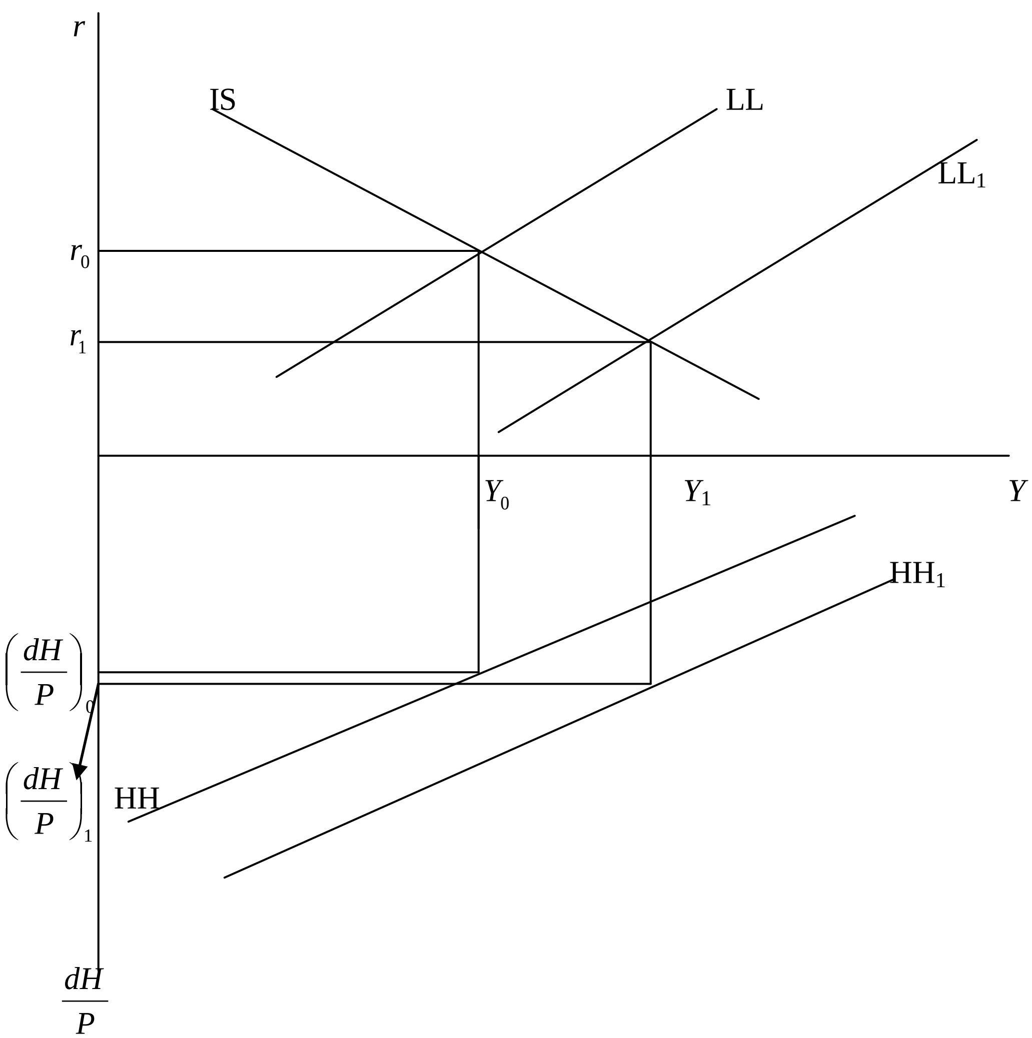

Figure 1.6

money demand and money supply become automatically equal.

1.3.2 The Flexible Exchange Rate Regime

We now focus on the flexible exchange rate regime. The goods market equilibrium in this case is given by

$$Y = C\underset{+}{(Y)} + I\underset{-}{(r)} + \overline{G} + X\left(\underset{+}{\frac{P^{*}e}{P}}; Y^{*}\right) - M\left(\underset{-}{\frac{P^{*}e}{P}}, \underset{+}{Y}\right) \tag{1.35}$$

The stock of high-powered money in this economy can increase, by assumption, if and only if the government or the commercial banks borrow from the central bank. We assume here as before that the government finances the whole of its expenditure by borrowing from the central bank and it is the only reason why it borrows from the central bank. Thus, we get

$$\frac{dH}{P} = \overline{G} + l(r_c) \tag{1.36}$$

The supply of new loans by the commercial banks, just as in the earlier case, is given by

$$l = (1-\rho)\frac{\overline{G}}{\rho} + \frac{l(r_c)}{\rho} \tag{1.37}$$

Since the whole of private investment is financed with loans from commercial banks, the loan market is in equilibrium, when the following equation is satisfied:

$$(1-\rho)\frac{\overline{G}}{\rho} + \frac{l(r_c)}{\rho} = I(r) \tag{1.38}$$

Finally, the balance of payments (BOP) is in equilibrium, and, therefore, the foreign currency market is in equilibrium, when the following condition is satisfied:

$$X\left(\frac{P^{*}e}{P}; Y^{*}\right) - M\left(\frac{P^{*}e}{P}, Y\right) = 0 \tag{1.39}$$

Determination of Y, r and e in the Flexible Exchange Rate Regime

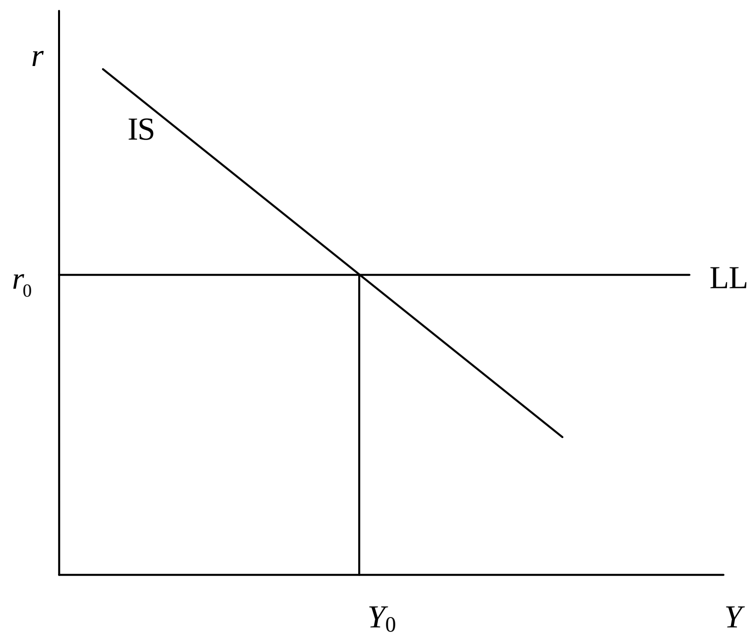

Figure 1.7a

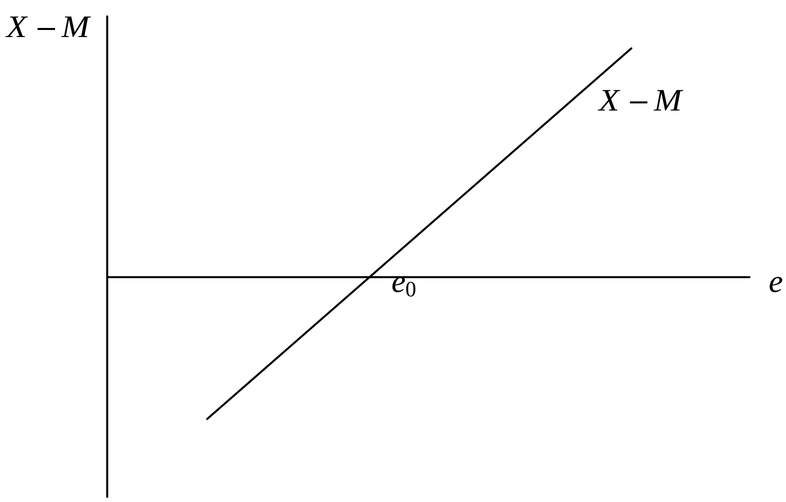

Figure 1.7b

The specification of the model is now complete. The key equations of the model are (1.35), (1.38) and (1.39). They contain 3 unknowns: Y, r and e. We can, therefore, solve them for the equilibrium values of the three endogenous variables. We solve them as follows: Substituting (1.39) into (1.35), we get

$$Y = C(\underset{+}{Y}) + I(\underset{-}{r}) + \overline{G} \tag{1.40}$$

We can solve (1.38) and (1.40) for Y and r. The solution is shown in Figure 1.7a, where the IS and LL schedule represent (1.40) and (1.38) respectively. The equilibrium values of Y and r correspond to the point of intersection of the two schedules. We label them Y_0 and r_0 respectively. Substituting the equilibrium value of Y in (1.39) and, then, solving it, we get the equilibrium value of *e*. The solution of *e* is shown in Figure 1.7b where the $X - M$ line represents the LHS of (1.39), when Y is fixed at its initial equilibrium value. We assume here that both export and import demands are sufficiently price elastic so that the $X - M$ line is positively sloped. The equilibrium *e* corresponds to the point of intersection of the $X - M$ line and the horizontal axis.

Fiscal policy: The Effect of an Increase in Government Expenditure Financed by Borrowing from the Central Bank

We shall explain the working of the model by carrying out a comparative static exercise. Suppose $\overline{G}$ increases by $d\overline{G}$, which the government finances by borrowing from the central bank. To derive how it will affect the endogenous variables of the model, we shall take total differential of (1.40), (1.38) and (1.39) treating all exogenous variables other than $\overline{G}$ as fixed. This yields the following equations:

$$dY = C'dY + I'dr + d\overline{G} \tag{1.41}$$

$$(1-\rho)\frac{d\overline{G}}{\rho} = I'dr \tag{1.42}$$

$$X_p \frac{P^*}{P} de - M_p \frac{P^*}{P} de - M_Y dY = 0 \tag{1.43}$$

Substituting (1.42) into (1.41) and solving for *dY*, we get

$$dY = \frac{d\overline{G}}{\rho(1-C')} \tag{1.44}$$

Again, from (1.42), we get

$$dr = (1-\rho)\frac{d\overline{G}}{\rho I'} \tag{1.45}$$

Substituting (1.44) into (1.43) and solving for *de*, we get

$$de = \frac{M_Y}{(X_p - M_p)\frac{P^*}{P}} \frac{d\overline{G}}{\rho(1-C')} \tag{1.46}$$

Adjustment Process

We shall now explain how these changes come about. As the government spends $d\overline{G}$ on goods and services, producers face an excess demand of $d\overline{G}$. They raise production by the same amount. Owners of factors of production get this $d\overline{G}$ amount of factor income. Out of this, they spend $(C' - M_Y)d\overline{G}$ on domestic goods and try to use $M_Y d\overline{G}$ to buy foreign currency to spend on foreign consumption goods. This gives rise to an excess demand for foreign currency of $\frac{P}{e}M_Y d\overline{G}$ at the initial equilibrium exchange rate. So, *e* will rise so that $\frac{P}{e}(X-M)$, which declined by $\frac{P}{e}M_Y d\overline{G}$, rises by $\frac{P}{e}M_Y d\overline{G}$ restoring equilibrium in the foreign currency market. Per unit increase in *e*, $\frac{P}{e}(X-M)$ increases by $\frac{P}{-e^2}(X-M)+\frac{P}{e}(X_p-M_p)\frac{P^*}{P}=\frac{P}{e}(X_p-M_p)\frac{P^*}{P}$, since $X-M=0$. Therefore, $\frac{P}{e}(X-M)$ will increase by $\frac{P}{e}M_Y d\overline{G}$, when e rises by $\frac{\frac{P}{e}M_Y d\overline{G}}{\frac{P}{e}(X_p-M_p)\frac{P^*}{P}}=\frac{M_Y d\overline{G}}{(X_p-M_p)\frac{P^*}{P}}$. Let us now examine by how much demand for domestic goods given by $C+I+\overline{G}+(X-M)$ increases following the increase in Y (or aggregate factor income) by $d\overline{G}$. C rises by $C'd\overline{G}$, while all other components of aggregate demand including $(X-M)$ remains unaffected. Hence aggregate demand for domestic goods will increase by $C'd\overline{G}$. This multiplier process will go on and finally, Y will increase by $\frac{d\overline{G}}{1-C'}$. Out of this additional factor income of $\frac{d\overline{G}}{1-C'}$, people will save $(1-C')\frac{d\overline{G}}{1-C'}=d\overline{G}$. This is the end of Round 1. As people save only in the form of bank deposits, they will deposit their saving of $d\overline{G}$ with the banks. The banks will, of course, not hold the whole of this additional bank deposits in the form of reserve. They will want to lend out $(1-\rho)d\overline{G}$ giving rise to excess supply of bank credit. So, r will fall by $\frac{(1-\rho)d\overline{G}}{I'}$ so that investment demand goes up by $(1-\rho)d\overline{G}$. This will again set off the multiplier process, which will raise Y further by $\frac{(1-\rho)d\overline{G}}{1-C'}$. This will again raise saving by $(1-\rho)d\overline{G}$, which the savers will again deposit with the banks. The banks, in turn, will lend out again $(1-\rho)^2 d\overline{G}$ raising I and Y by $(1-\rho)^2 d\overline{G}$ and $\frac{(1-\rho)^2 d\overline{G}}{1-C'}$

respectively. This process of expansion will go on until the additional saving generated falls to zero. Thus, total increase in Y, total increase in l, total decrease in r and total increase in e are given by

$$dY = \frac{d\overline{G}}{1-C'} + \frac{(1-\rho)d\overline{G}}{1-C'} + \frac{(1-\rho)^2 d\overline{G}}{1-C'} + \ldots\ldots\ldots\ldots\ldots\ldots = \frac{d\overline{G}}{\rho(1-C')} \tag{1.47}$$

$$dl = d\overline{G} + (1-\rho)d\overline{G} + (1-\rho)^2 d\overline{G} + \ldots\ldots\ldots\ldots\ldots = \frac{d\overline{G}}{\rho} \tag{1.48}$$

$$dr = \frac{(1-\rho)d\overline{G}}{I'} + \frac{(1-\rho)^2 d\overline{G}}{I'} + \ldots\ldots\ldots\ldots\ldots = \frac{(1-\rho)d\overline{G}}{\rho I'} \tag{1.49}$$

$$de = \left(\frac{d\overline{G}}{1-C'}\right)\frac{M_Y}{\left(X_p - M_p\right)\frac{P^*}{P}} + \frac{(1-\rho)d\overline{G}}{1-C'}\,\frac{M_Y}{\left(X_p - M_p\right)\frac{P^*}{P}} + \frac{(1-\rho)^2 d\overline{G}}{1-C'}\,\frac{M_Y}{\left(X_p - M_p\right)\frac{P^*}{P}} +$$

$$\ldots\ldots\ldots\ldots\ldots\ldots = \frac{d\overline{G}}{\rho(1-C')}\,\frac{M_Y}{\left(X_p - M_p\right)\frac{P^*}{P}} \tag{1.50}$$

It is clear that (1.47), (1.49) and (1.50) tally with (1.44), (1.45) and (1.46).

Monetary Policy

We shall examine here how expansionary monetary policy, which consists in a cut in the central bank's policy rate r_c, affects Y, r and e. Substituting (1.38) and (1.39) into (1.35), we rewrite it as

$$Y = C(Y) + \frac{1}{\rho}\left(\overline{G} + l(r_c)\right) \tag{1.51}$$

Taking total differential of (1.51) treating all exogenous variables other than r_c as fixed and, then, solving for dY, we get

$$dY = \frac{\frac{l'}{\rho} dr_c}{1 - C'} > 0 \tag{1.52}$$

Again, taking total differential of (1.38) treating all exogenous variables other than r_c as fixed, we get

$$dr = \frac{l' dr_c}{\rho I'} < 0 \tag{1.53}$$

Substituting (1.52) into (1.43) and solving for *de*, we get

$$de = \frac{M_Y}{\left(X_p - M_p\right)\frac{P^*}{P}} \frac{l' dr_c}{\rho\left(1 - C'\right)} > 0 \tag{1.54}$$

The adjustment process is very similar to the one of the fiscal policy delineated above.

Irrelevance of the Money market

We shall now show that the equilibrium conditions (1.32), (1.33), (1.35) and (1.36) imply equality of demand for money and supply of money. Substituting (1.33), (1.35) and (1.36) into (1.32), we get

$$Y = C\left(\underset{+}{Y}\right) + \frac{1-\rho}{\rho} \frac{dH}{P} + \frac{dH}{P} \Rightarrow$$
$$Y - C\left(Y\right) = \frac{dH}{P}$$

The LHS of the above equation constitutes households' saving, which represents households' demand for additional money, while the RHS represents supply of additional money. Thus, the equilibrium conditions of the model automatically imply equality of demand for money and supply of money.

1.4 Conclusion: Evaluation of the Model

This simple model redresses all the problems mentioned in the introduction regarding the deficiencies of the characterization of the financial sector in the IS-LM . The model brings out clearly the interrelationships that exist among the processes that generate income, saving, new credit and expenditure. It shows that the multiplier process that occurs in the real sector and the money or credit multiplier process that occur in the financial sector take place simultaneously reinforcing each other. It brings to the fore the process through which savings are used by the financial intermediaries to extend credit**.**

This model also shows that the money market is completely unnecessary and irrelevant. Here people hold their entire wealth in the form of deposits of the banks, i.e., in the form of money. Stock demand for money of the households is their entire wealth. The flow demand for money is their saving. This is, obviously, a special case. We can easily generalize this model to the situation where households hold their wealth and saving in the form of not only bank deposits but also government and corporate securities and currency. This model shows that the issue of demand for money being unequal to the supply of money is irrelevant. People receive their income in the form of money. They want to hold a part of it, the part that they do not spend to buy goods and services or non-money assets, in the form of money. This, obviously, they will always be able to do. The part of their income, which they do not want to hold as money, they will always be able to spend on goods and services and non-money assets. Hence, demand for money will always be equal to supply of money. Accordingly, there is no need to consider the money market.

Unlike the IS-LM model, which cannot handle the situation where interest rates are rigid, this model can handle the situation where the interest rates are flexible as well as the one where interest rates are fixed, even though we have not considered the latter case here. The present model can easily be extended to accommodate that case.

Here we have kept P unchanged. We can easily drop this assumption, and explicitly consider the process that determines P. This is a part of our future research agenda.

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Chapter 2

An Alternative to the IS–LM Model: Extension to the Case of Perfect Capital Mobility

Abstract

In this chapter, we extend the model developed in the previous chapter to consider cross-border capital flows. Here, however, we shall only focus on the case of perfect capital mobility. The model will seek to capture the behaviour of a small open economy in both the fixed and flexible exchange rate regimes under conditions of perfect capital mobility.

2.1 Introduction

In this chapter, we shall extend the model developed in chapter 2 to incorporate perfect capital mobility. We incorporate capital mobility in the following way for simplicity. As before, here also the households hold all their savings in the form of bank deposits with the domestic banks. So, here households do not allocate their savings between deposits of domestic banks and those of foreign banks. Similarly, government seeks loans only from the domestic central bank. Domestic firms, however, can secure loans from domestic banks as well as from the world credit market at the interest rate prevailing in the world credit market. Domestic banks can lend not only to domestic firms but also in the world credit market at interest rates prevailing in the world credit market. Both the domestic banks and domestic firms are assumed to be risk-neutral. Since the domestic economy is assumed to be small, the world interest rate in foreign currency is given to the domestic economic agents. As there is perfect capital mobility, borrowing from the domestic banks and the world market are equivalent to domestic borrowers if the interest rates in domestic currency on the two types of loans are equal. Again, lending to domestic firms and in the world market are equivalent to the domestic banks if the interest rates in domestic currency on the two types of loans are equal. For simplicity, we have ignored for the present households' allocation of savings between domestic and foreign assets. We are now in a position to develop a model to determine domestic NDP, interest rate and exchange rate. We first focus on the flexible exchange rate regime, where the central bank does not intervene in the foreign exchange market to keep the exchange rate under control.

2.2 The Model under Flexible Exchange Rate Regime

The world interest rate is denoted by r^*. Domestic firms can borrow as much as they want from the world credit market at r^*. Domestic banks can also lend as much as they want at r^*. In keeping with the assumption of the Mundell-Flemming model, we assume that the expected rate of depreciation of domestic currency is zero. Hence, to domestic firms and domestic banks, interest rate on borrowing from and lending to the world credit market in domestic currency is also r^*. Interest rate in domestic currency on loans from domestic banks and interest rate in domestic currency on deposits of domestic banks is *r*. Here, for simplicity, we do not distinguish between deposit rate and lending rate of domestic banks. Thus, in equilibrium, we shall have

$$r = r^* \tag{2.1}$$

If *r* exceeds r^*, domestic firms will want to borrow only from the world credit market, while domestic banks will want to lend only to domestic firms bringing about an excess supply in the domestic bank credit market. Hence, *r* will go on falling until it becomes equal to r^*. Similarly, if r is less than r^*, domestic firm will want to borrow only from the domestic banks, but the latter will want to lend only in the world market. Thus, there will emerge an excess demand for domestic bank credit. It will be corrected only when *r* rises and becomes equal to r^*.

The goods market equilibrium condition, as before, is given by

$$Y = C(Y) + I(r) + \bar{G} + X\left(\frac{P^*e}{P}; Y^*\right) - M\left(\frac{P^*e}{P}, Y\right) \tag{2.2}$$

Substituting (2.1) into (2.2), we rewrite it as

$$Y = C(Y) + I(r^*) + \overline{G} + X\left(\frac{P^*e}{P}; Y^*\right) - M\left(\frac{P^*e}{P}; Y\right) \tag{2.3}$$

We assume for simplicity that the whole of $\overline{G}$ is financed with new loans from the central bank. Banks also borrow from the central bank at the central bank specified interest rate r_c. The central bank meets the banks' entire demand for central bank loans given by $l(r_c)$. We further assume that, these are the only two ways high-powered money is created in the economy. Accordingly, the increase in the stock of high-powered money in real terms in the period under consideration, denoted by $\frac{dH}{P}$, is given by $\frac{dH}{P} = \overline{G} + l(r_c)$. Thus, as in the previous chapter, the planned supply of new loans by the banks is given by

$$l_f = (1-\rho)\frac{\overline{G}}{\rho} + \frac{l(r_c)}{\rho} \tag{2.4}$$

where l_f denotes the supply of new loans by the banks, and ρ denotes CRR,. We get (2.4) under the assumption that the domestic agents do not hold any currency. They hold all their savings in the form of bank deposits only. The entire investment is financed with loans and it is the only source of demand for loans of the banks. Thus, the domestic credit market is in equilibrium when

$$(1-\rho)\frac{\overline{G}}{\rho} + \frac{l(r_c)}{\rho} = I(r) - K \tag{2.5}$$

where *K* denotes net inflow of capital from abroad. To explain (2.5), we first substitute (2.1) into it to get

$$(1-\rho)\frac{\overline{G}}{\rho}+\frac{l(r_c)}{\rho}=I(r^*)-K \tag{2.6}$$

(2.6) may be explained as follows. If $I(r^*)$ exceeds the supply of loans given by the LHS of (2.6), the firms will meet their excess demand for loans by securing loans from the world credit market. In this case, there will take place an inflow of capital to the domestic excess supply of loans and the banks will lend this excess supply of loans to the world market. There will thus take place outflow of capital and the value of *K* will be given by

$$K=I(r^*)-(1-\rho)\frac{(dH/P)}{\rho}-\frac{l(r_c)}{\rho}<0$$

Finally, the balance of payments (BOP) will be in equilibrium, when

$$X\left(\frac{P^*e}{P};Y^*\right)-M\left(\frac{P^*e}{P},Y\right)+K=0 \tag{2.7}$$

economy by the amount $I(r^*)-(1-\rho)\frac{(dH/P)}{\rho}-\frac{l(r_c)}{\rho}$ and, therefore,

$K=I(r^*)-(1-\rho)\frac{(dH/P)}{\rho}-\frac{l(r_c)}{\rho}>0$. Again, if $(1-\rho)\frac{(dH/P)}{\rho}+\frac{l(r_c)}{\rho}>I(r^*)$, there is

The specification of our model is complete. It consists of three key equations (2.3), (2.6) and (2.7) in three unknowns Y, e and K. We may solve the three equations for their equilibrium values as follows: (2.6) directly gives the equilibrium value of *K*. It is given by $K=I(r^*)-(1-\rho)\frac{\overline{G}}{\rho}-\frac{l(r_c)}{\rho}$. We denote this equilibrium value of *K* by K_0. We show the diagrammatic derivation of the equilibrium value of K in Figure 2.1a, where we plot supply of credit by domestic banks and demand for credit net of net inflow of capital given by the LHS and RHS of (2.6) respectively and denoted by l^s and l^d against *K*. The

Derivation of the Equilibrium Value of *K, Y* and *e*

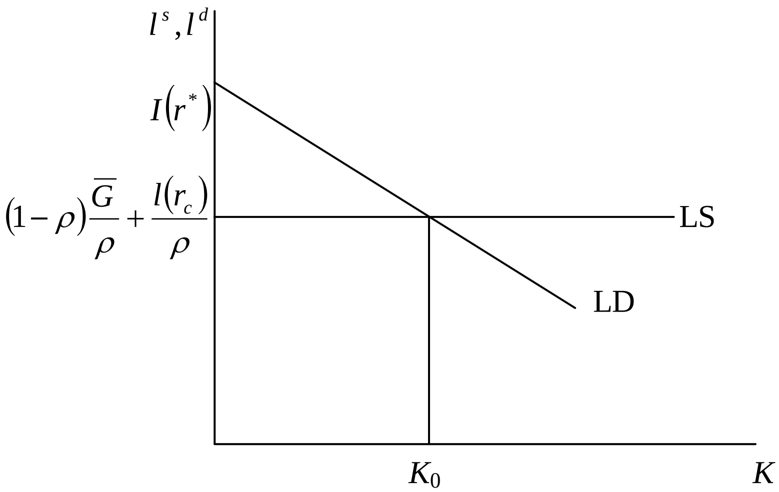

Figure 2.1a

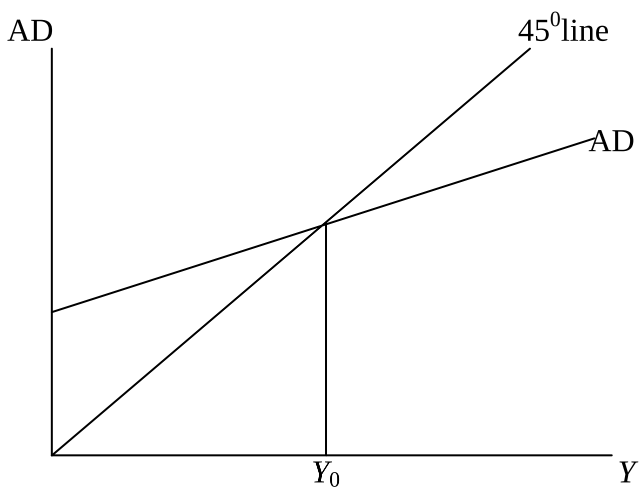

Figure 2.1b

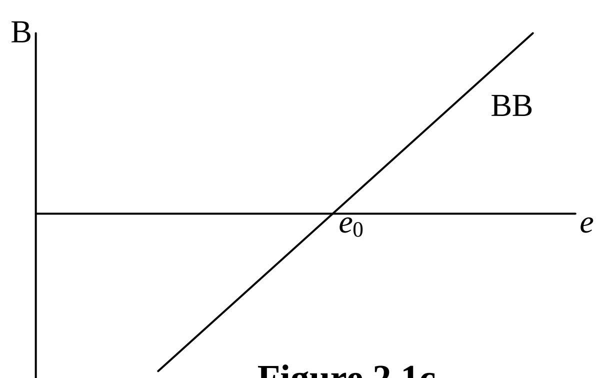

Figure 2.1c

l^s and l^d schedules are labeled LS and LD respectively. The equilibrium K corresponds to the point of intersection of the two schedules. Substituting the equilibrium value of K into (2.7), we rewrite it as

$$X\left(\frac{P^*e}{P};Y^*\right)-M\left(\frac{P^*e}{P},Y\right)+\left[I\left(r^*\right)-\left(1-\rho\right)\frac{\overline{G}}{\rho}-\frac{l\left(r_c\right)}{\rho}\right]=0 \tag{2.8}$$

Eqs. (2.3) and (2.8) can be solved for the equilibrium values of Y and e. We do it as follows: Substituting (2.8) in (2.3), we rewrite it as

$$Y=C\left(Y\right)+I\left(r^*\right)+\overline{G}+\frac{1-\rho}{\rho}\overline{G}+\frac{l\left(r_c\right)}{\rho}-I\left(r^*\right)=C\left(Y\right)+\frac{\overline{G}}{\rho}+\frac{l\left(r_c\right)}{\rho} \tag{2.9}$$

We can solve (2.9) for the equilibrium value of Y. The solution of (2.9) is illustrated in Figure 2.1b, where the AD schedule gives the value of aggregate demand for Y as given by the RHS of (2.9). The equilibrium value of Y, labeled Y_0, corresponds the point of intersection of the AD schedule and the 45^0 line. Substituting this equilibrium value of Y into (2.8), we can solve it for the equilibrium value of e. The solution is illustrated in Figure 2.1c where the BB schedule plots the value of the LHS of (2.8) against e. The schedule is positively sloped by assumption made earlier. The equilibrium e corresponds to the point of intersection of the BB schedule and the horizontal axis. It is labeled e_0. We shall now explain the working of the model with the help of a comparative static exercise.

2.2.1 Fiscal Policy: An Increase in Government Expenditure Financed by Borrowing from the Central Bank

Let us examine the impact of an increase in $\overline{G}$ financed by borrowing from the central bank. We shall first do this diagrammatically using Figures 2.2a, 2.2b and 2.2c, where initial equilibrium values of K,Y and e are labeled K_0,Y_0 and e_0 respectively. First, focus on Figure 2.2a. Following the increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the

Effect of an Increase in $\overline{G}$ on *K, Y* and *e*

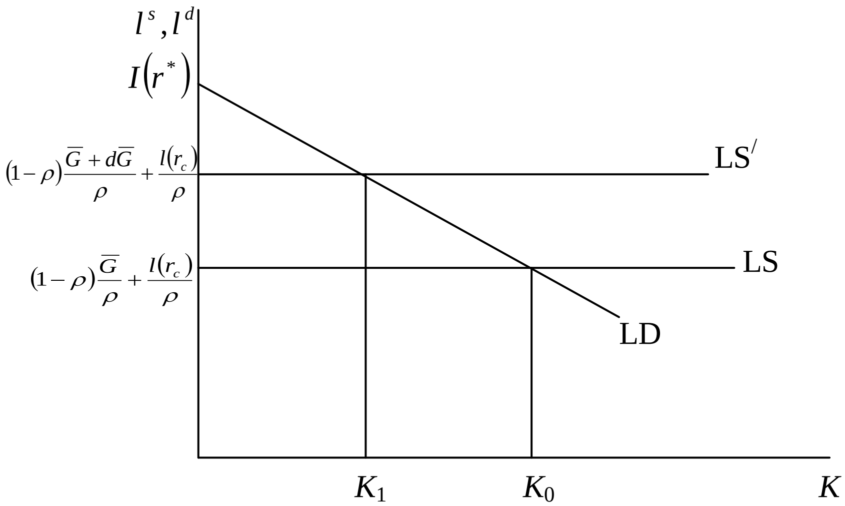

Figure 2.2a

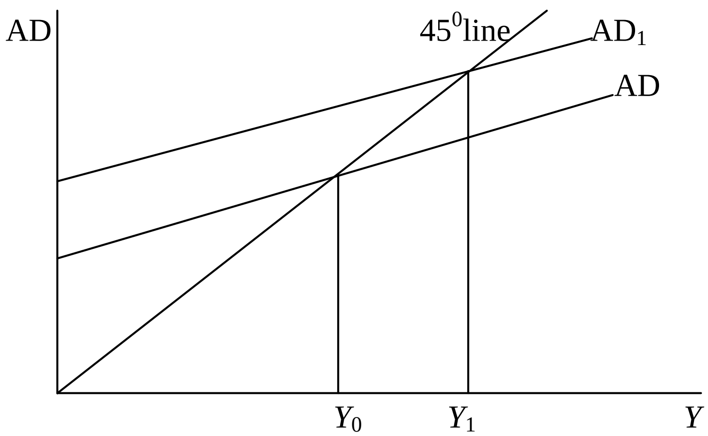

Figure 2.2b

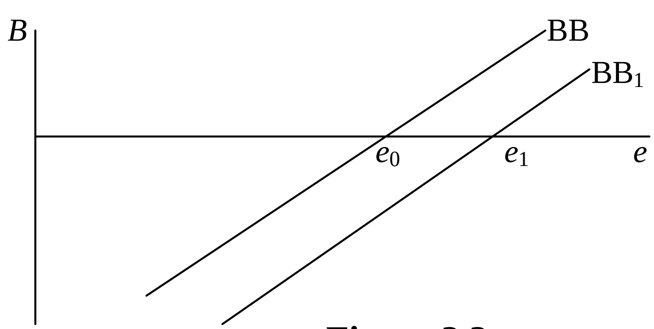

Figure 2.2c

Central bank, the value of planned supply of loan by domestic banks, as given by the LHS of (2.6), increases by $(1-\rho)\frac{d\overline{G}}{\rho}$ irrespective of the value of *K*. Hence, the LS schedule in Figure 2.2a shifts upward. The new LS schedule is labeled LS$^{/}$. The value of demand for loans net of the net inflow of capital, as given by the RHS of (2.6), remains unchanged corresponding to every value of *K*. The LD schedule, thus, remains unaffected. The equilibrium value of *K*, therefore, falls. The new equilibrium *K* is labeled K_1. Let us now focus on Figure 2.2b, where the AD schedule represents the RHS of (2.9). Following the increase in $\overline{G}$ by $d\overline{G}$, the RHS of (2.9) increases by $\frac{d\overline{G}}{\rho}$. Hence, the AD schedule shifts upward by $\frac{d\overline{G}}{\rho}$. The new equilibrium *Y* is, therefore, higher. It is labeled Y_1. Finally, focus on Figure 2.2c where the BB schedule plots the value of the LHS of (2.8) against *e*, when *Y* is fixed at its initial equilibrium value, Y_0. Following the increase in $\overline{G}$ by $d\overline{G}$, equilibrium *Y* rises. The value of the LHS of (2.8) corresponding to every *e* will be less, when *Y* is fixed at its new equilibrium value. Thus, the BB schedule corresponding to the new equilibrium *Y* will be below the initial BB schedule. The new BB schedule is labeled BB_1 in Figure 2.2c. The new equilibrium *e* will, therefore, be higher. The new equilibrium *e* is labeled e_1 in Figure 2.2c.

Mathematical Derivation of the Results

Let us now derive these results mathematically. Taking total differential of (2.6) treating all exogenous variables other than $\overline{G}$ as fixed, we get

$$dK = -(1-\rho)\frac{d\overline{G}}{\rho} \tag{2.10}$$

Again, taking total differential of (2.9) treating all exogenous variables other than $\overline{G}$ as fixed, and, then, solving for dY, we get

$$dY = \frac{d\overline{G}}{\rho(1-C')} \tag{2.11}$$

Finally, taking total differential of (2.8) treating all exogenous variables other than $\overline{G}$ as fixed, we get

$$X_p \frac{P^*}{P} de - M_p \frac{P^*}{P} de - M_Y dY - (1-\rho)\frac{d\overline{G}}{\rho} = 0 \tag{2.12}$$

Substituting (2.11) into (2.12), and, then, solving for de, we get

$$de = \frac{M_Y \dfrac{d\overline{G}}{(1-C')\rho} + \left(\dfrac{1-\rho}{\rho}\right) d\overline{G}}{(X_p - M_p)\dfrac{P^*}{P}} \tag{2.13}$$

Adjustment Process

The adjustment process may be explained as follows. The government borrows $d\overline{G}$ from the central bank and spends it for purchasing goods and services. The multiplier process operates and *Y* goes up by $\frac{d\overline{G}}{1-C'}$. Note that, all through the multiplier process, *e* rises to keep net export, which declines on account of the increase in *Y*, unchanged so that the BOP remains in equilibrium. Out of this additional income of $\frac{d\overline{G}}{1-C'}$, people save $(1-C')\frac{d\overline{G}}{1-C'} = d\overline{G}$. They will put it in banks as deposit. Clearly, the banks will not want to hold these deposits in the form of reserve. They will plan to lend out $(1-\rho)d\overline{G}$ giving rise to excess supply of loans at the interest rate r^*. The banks will, therefore, plan to lend it out at r^* in the world credit market. For this, they will try to sell $P(1-\rho)d\overline{G}$ amount of domestic currency for foreign currency giving rise to excess demand for foreign currency of $\frac{P}{e}(1-\rho)d\overline{G}$ in the foreign currency market at the prevailing exchange rate. The net supply of foreign currency is given by $\left[X\left(\frac{P^*e}{P},Y^*\right)-M\left(\frac{P^*e}{P},Y\right)+K\right]\frac{P}{e}$. The exchange rate will rise to equilibrate the foreign currency market. Per unit increase in *e*, net supply of foreign currency increases by $\left\{\left(X_p-M_p\right)\frac{P^*}{P}\right\}\frac{P}{e}$. Therefore, to raise net supply of foreign currency by $\frac{P}{e}(1-\rho)d\overline{G}$, and, thereby, equilibrate the foreign currency market, *e* has to increase by $\frac{\frac{P}{e}(1-\rho)d\overline{G}}{\left\{\left(X_p-M_p\right)\frac{P^*}{P}\right\}\frac{P}{e}}=\frac{(1-\rho)d\overline{G}}{\left\{\left(X_p-M_p\right)\frac{P^*}{P}\right\}}$. This will raise net export by $(1-\rho)d\overline{G}$, since per unit increase in *e*, net export increases by $\left\{\left(X_p-M_p\right)\frac{P^*}{P}\right\}$. This will again create an excess demand for domestic goods of $(1-\rho)d\overline{G}$ setting off another round of multiplier process. *Y* in this second round will increase by $\frac{(1-\rho)d\overline{G}}{1-C'}$. Out of this additional income, people will save $(1-\rho)d\overline{G}$ and deposit it with banks. Out of these new deposits, banks will try to lend out $(1-\rho)^2 d\overline{G}$. This will again, through the process described above raise net export by $(1-\rho)^2 d\overline{G}$. This in turn will again raise *Y* by $\frac{(1-\rho)^2 d\overline{G}}{1-C'}$. Note that, in the second round banks lend out in the world credit market $(1-\rho)d\overline{G}$. So net inflow of capital, K, changes by $-(1-\rho)d\overline{G}$. In the third round, banks again lend out $(1-\rho)^2 d\overline{G}$. So, K in the third round changes by $-(1-\rho)^2 d\overline{G}$. This process will continue until the additional saving created in each round eventually falls to zero. Thus, the total change in Y and K are give respectively by

$$dY = \frac{d\overline{G}}{1-C'} + (1-\rho)\frac{d\overline{G}}{1-C'} + (1-\rho)^2 \frac{d\overline{G}}{1-C'} + \dots\dots\dots\dots = \frac{d\overline{G}}{\rho(1-C')} \tag{2.14}$$

$$dK = -(1-\rho)d\overline{G} - (1-\rho)^2 d\overline{G} - \dots\dots\dots\dots = -\frac{(1-\rho)d\overline{G}}{\rho} \tag{2.15}$$

We find that (2.14) and (2.15) tally with (2.11) and (2.10) respectively. This explains the working of the model.

2.2.2 Monetary Policy

We shall examine here the effect of an expansionary monetary policy, which consists in a cut in the central bank's policy rate r_c. We shall derive the results mathematically. Taking total differential of (2.9) treating all exogenous variables other than r_c as fixed, and, then solving for dY, we get

$$dY = \frac{l' dr_c}{\rho(1-C')} > 0 \tag{2.16}$$

Again, taking total differential of (2.6) treating all exogenous variables other than r_c as fixed, we get

$$dK = -\frac{l' dr_c}{\rho} < 0 \tag{2.17}$$

Finally, taking total differential of (2.8) treating all exogenous variables other than r_c as fixed, we get

$$X_p \frac{P^*}{P} de - M_p \frac{P^*}{P} de - M_Y dY - \frac{l' dr_c}{\rho} = 0$$

Substituting (2.16) into the above equation and solving for *de*, we get

$$de = \frac{M_Y \dfrac{l' dr_c}{(1-C')\rho} + \dfrac{l' dr_c}{\rho}}{\left(X_p - M_p\right)\dfrac{P^*}{P}} \tag{2.18}$$

The adjustment process of this case is very similar to that of the previous case.

2.3 The Model under Fixed Exchange Rate Regime

Let us now focus on the case of perfect capital mobility, with fixed exchange rate. In the fixed exchange rate regime, the central bank intervenes in the foreign exchange market to keep the exchange rate fixed at a target rate, say, $\bar{e}$. If there emerges an excess supply of foreign currency at $\bar{e}$, the central bank has to buy up this excess supply of foreign currency at $\bar{e}$ with domestic currency so that *e* does not fall from $\bar{e}$. This clearly brings about an increase in the supply of high-powered money. Similarly, if there emerges an excess demand for foreign currency at $\bar{e}$, the central bank has to meet this excess demand for foreign currency by selling foreign currency from its stock in exchange for domestic currency so that *e* does not rise above $\bar{e}$. In this case, obviously, the stock of high-powered money goes down. The amount of excess supply of foreign currency at $\bar{e}$ is given by $\left[X\left(\frac{P^*\bar{e}}{P};Y^*\right) - M\left(\frac{P^*\bar{e}}{P},Y\right) + K\right]\frac{P}{\bar{e}}$, which may be positive or negative. When it is negative, it represents excess demand. The change in the stock of high-powered money is, therefore, given by

$$dH = \frac{P}{\bar{e}}\left[X\left(\frac{P^*\bar{e}}{P};Y^*\right) - M\left(\frac{P^*\bar{e}}{P},Y\right) + K\right].\bar{e} + P\overline{G} + Pl\left(r_c\right) \tag{2.19}$$

We write (2.16) as

$$\frac{dH}{P} = \left[X\left(\frac{P^{*}\bar{e}}{P};Y^{*}\right) - M\left(\frac{P^{*}\bar{e}}{P},Y\right) + K \right] + \bar{G} + l(r_c) \tag{2.20}$$

In the present regime, therefore, besides r being equal to r^{*} because of perfect capital mobility, e is also equal to $\bar{e}$ on account of the fixed exchange rate policy of the central bank.

In the flexible exchange rate case considered earlier, $\frac{dH}{P} = \bar{G} + l(r_c)$. In the present case, however, $\frac{dH}{P}$ is given by (2.20). Hence, using (2.20), we rewrite the credit market equilibrium condition (2.6) as

$$\frac{1-\rho}{\rho}\left\{\left[X\left(\frac{P^{*}\bar{e}}{P};Y^{*}\right) - M\left(\frac{P^{*}\bar{e}}{P},Y\right) + K \right] + \bar{G}\right\} + \frac{l(r_c)}{\rho} = I(r^{*}) - K \tag{2.21}$$

Again, substituting $\bar{e}$ into (2.3), we write the goods market equilibrium condition for the present regime as

$$Y = C(Y) + I(r^{*}) + \bar{G} + X\left(\frac{P^{*}\bar{e}}{P};Y^{*}\right) - M\left(\frac{P^{*}\bar{e}}{P},Y\right) \tag{2.22}$$

The specification of our model is now complete. It consists of two key equations (2.21) and (2.22) in two unknowns Y and K. We can, therefore, solve (2.21) and (2.22) for the equilibrium values of Y and K. (2.22) can be solved for the equilibrium value of Y, while (2.21) can be solved for the equilibrium value of K after substituting for Y its equilibrium value. The solutions are illustrated in Figures 2.3a and 2.3b. In Figure 2.3a, the AD schedule plots the value of aggregate planned demand for domestic goods and services given by the RHS of (2.22) against Y. The equilibrium value of Y corresponds to the point

Derivation of the Equilibrium Value of *Y* and *K*

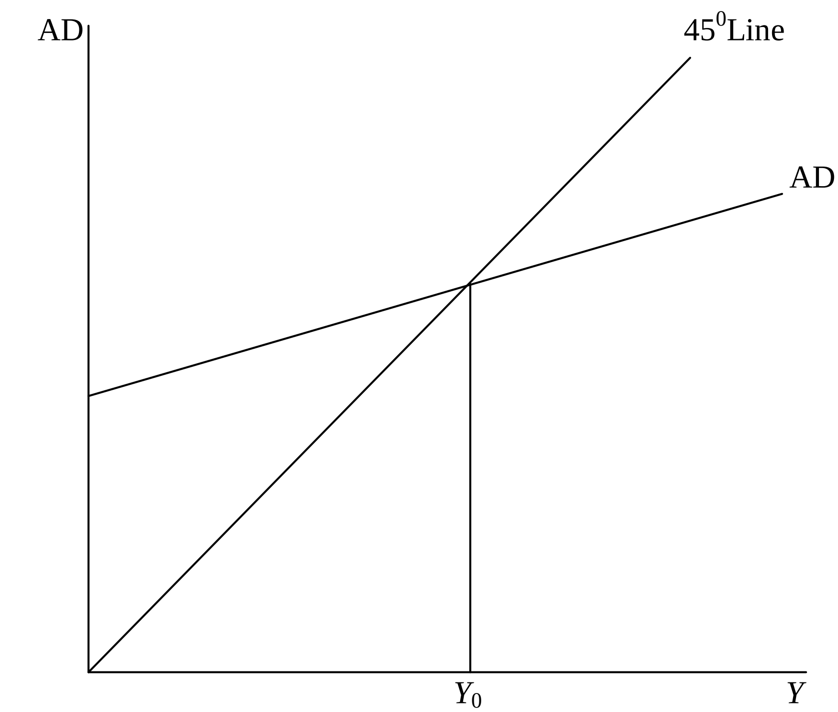

Figure 2.3a

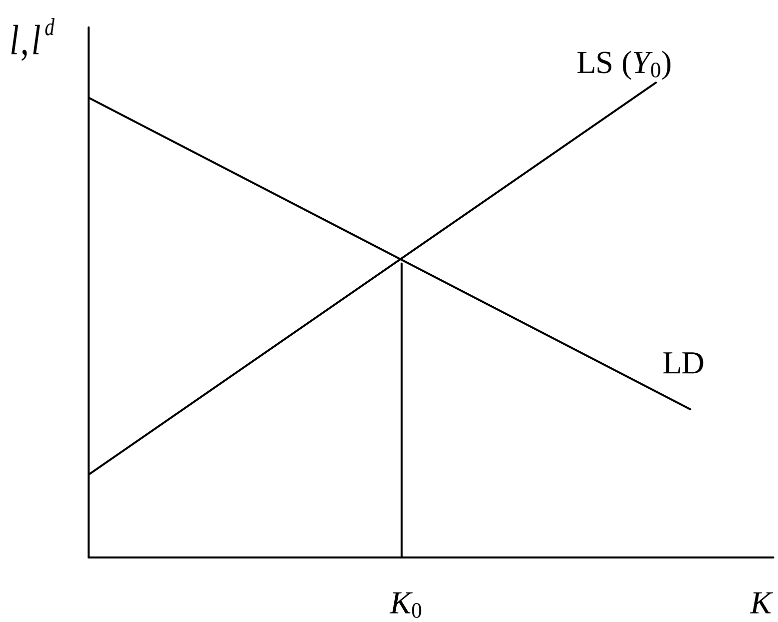

Figure 2.3b

of intersection of the AD schedule and the 45^0 line. The equilibrium value of Y is labeled Y_0. In Figure 2.3b, supply of loans by domestic banks denoted l and demand for loans from the domestic banks denoted l^d are measured on vertical axis, while K is measured on the horizontal axis. Values of l and l^d are given by the LHS and RHS of (2.21) respectively. The LS and LD schedules plot the values of l and l^d against K, with Y fixed at its equilibrium value, Y_0. The equilibrium value of K, labeled K_0, corresponds to the point of intersection of the two schedules.

2.3.1 Fiscal Policy: An Increase in Government Expenditure Financed by Borrowing from the Central Bank

Here we shall examine how an increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank affects Y and K. This we shall do first diagrammatically using Figures 2.4a and 2.4b, where initial equilibrium values of Y and K are labeled Y_0 and K_0 respectively. Focus on Figure 2.4a first. Following an increase in $\overline{G}$ by $d\overline{G}$, the AD schedule representing the RHS of (2.22), shifts upward by $d\overline{G}$. The new AD schedule is labeled AD_1. As a result, the equilibrium Y will be higher. The new equilibrium Y is labeled Y_1. Now, focus on Figure 2.4b. Since the increase in $\overline{G}$ is financed by borrowing from the central bank, the stock of high-powered money in real terms increases by $d\overline{G}$. Hence, planned supply of credit by the domestic banks given by the LHS of (2.21) increases by $\frac{(1-\rho)}{\rho}d\overline{G}$. The equilibrium Y has, however, gone up. This lowers the supply of credit. The ls schedule representing the LHS of (2.21), therefore, may shift either way. However, as we have shown below, the LS schedule will shift upward. The new LS schedule is labeled as LS_1. The LD schedule, representing the RHS of (2.21), remains unaffected.

The Effect of an Increase in $\bar{G}$ on Y and K

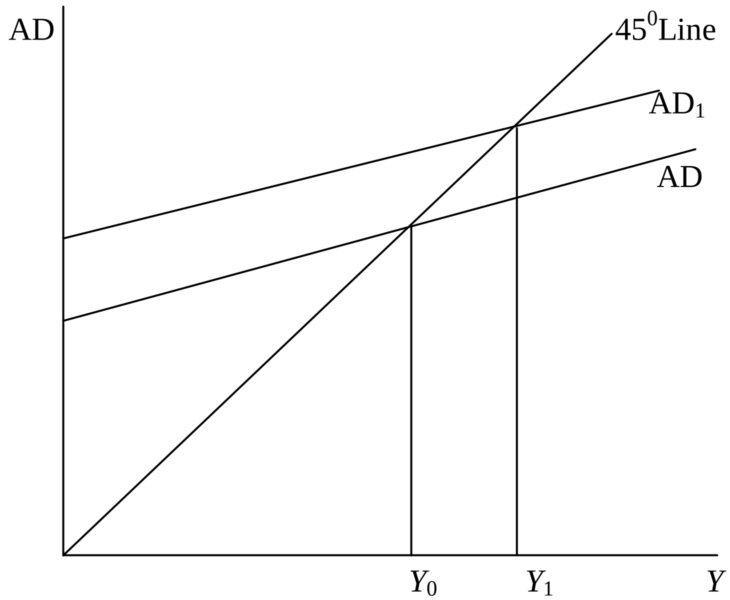

Figure 2.4a

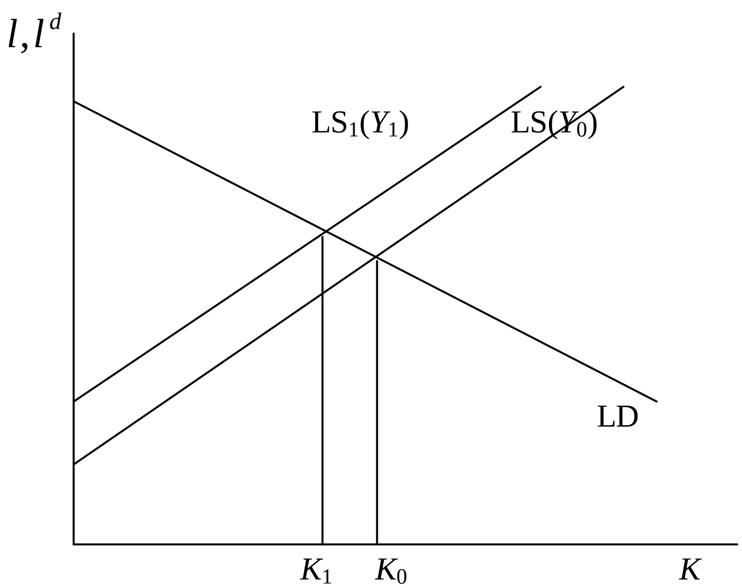

Figure 2.4b

Hence, K falls in the new equilibrium. The new equilibrium K is denoted by K_1.

Mathematical Derivation of the Result

We shall now derive the results mathematically. Taking total differential of (2.22) treating all exogenous variables other than $\overline{G}$ as fixed, and, then, solving for dY, we get

$$dY = \frac{d\overline{G}}{1-(C'-M_Y)} \tag{2.23}$$

Taking total differential of (2.21) treating all exogenous variables other than $\overline{G}$ as fixed, we get

$$\begin{aligned} &-\frac{(1-\rho)}{\rho}M_Y dY + \frac{(1-\rho)}{\rho}dK + \frac{(1-\rho)}{\rho}d\overline{G} = -dK \Rightarrow \\ &dK = -(1-\rho)\frac{(1-C')}{1-(C'-M_Y)}d\overline{G} \end{aligned} \tag{2.24}$$

Adjustment Process

Following an increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank, the multiplier process begins to work and Y goes up by $\frac{d\overline{G}}{1-(C'-M_Y)}$. Out of every unit of additional income, domestic households spend $(C'-M_Y)$ on domestic goods. So, form every additional unit of income, $1-(C'-M_Y)$ is not spent on domestic goods. Out of this remaining part of $1-(C'-M_Y)$, M_Y is spent on foreign goods. This means that the households try to sell PM_Y amount of domestic currency to secure foreign currency creating excess demand for foreign currency. The central bank, therefore, has to buy up this PM_Y of domestic currency with $\frac{P}{\overline{e}}M_Y$ amount of foreign currency so that e remains at $\bar{e}$. Domestic households buy with this $\frac{P}{P^*\bar{e}}M_Y$ amount of foreign goods. From the above it follows that from $\frac{d\overline{G}}{1-(C'-M_Y)}$ amount of additional income, the part that was not spent on domestic goods is given by $\left[\frac{d\overline{G}}{1-(C'-M_Y)}\right]\{1-(C'-M_Y)\} = d\overline{G}$. From $d\overline{G}$, domestic households used $M_Y \frac{d\overline{G}}{1-(C'-M_Y)}$ to secure foreign currency to buy foreign goods. So, from $\frac{d\overline{G}}{1-(C'-M_Y)}$ amount of additional income, domestic households saved $\left(d\overline{G} - M_Y \frac{d\overline{G}}{1-(C'-M_Y)}\right)$ and this amount was deposited with domestic banks. Domestic banks in their turn tried to lend out from these new deposits $(1-\rho)\left(1-\frac{M_Y}{1-(C'-M_Y)}\right)d\overline{G}$. As it would tend to lower domestic interest rate below r^*, domestic banks would lend it out to foreigners in the world credit market. They will sell $P(1-\rho)\left(1-\frac{M_Y}{1-(C'-M_Y)}\right)d\overline{G}$ amount of domestic currency to the central bank and secure, thereby, $\frac{P}{\bar{e}}(1-\rho)\left(1-\frac{M_Y}{1-(C'-M_Y)}\right)d\overline{G}$ amount of foreign currency, which they will lend out in the world market. In terms of domestic goods, whose price in terms of foreign currency is $\frac{P}{\bar{e}}$, they will lend out $\frac{\frac{P}{\bar{e}}(1-\rho)\left(1-\frac{M_Y}{1-(C'-M_Y)}\right)d\overline{G}}{\frac{P}{\bar{e}}}$ in the world market. Hence *K* will go down by $(1-\rho)\left(1-\frac{M_Y}{1-(C'-M_Y)}\right)d\overline{G}=(1-\rho)\left(\frac{1-C'}{1-(C'-M_Y)}\right)d\overline{G}$. This tallies with (2.24).

2.3.2 Monetary Policy

We shall examine here the impact of expansionary monetary policy, which consists in a cut in the central bank's policy rate r_c. We shall derive the results mathematically. Taking total differential of (2.21) and (2.22) treating all exogenous variables other than r_c as fixed, we get

$$\frac{1-\rho}{\rho}dK+\frac{l'}{\rho}dr_c=-dK \tag{2.25}$$

And

$$dY=C'dY-M_y dY \tag{2.26}$$

We can solve (2.25) and (2.26) for the equilibrium values of *dY* and *dK*. They are given by

$$dY=\frac{0}{1-(C'-M_y)}=0 \tag{2.27}$$

$$dK=-l'dr_c \tag{2.28}$$

From (2.28) it is clear that expansionary monetary policy does not produce any impact on output and employment. The result is quite easy to explain. Following a cut in r_c, banks will secure more loans from the central bank. The additional loan they are able to extend as a result will not be lent out domestically, as it will tend to depress domestic interest rate. The will convert their additional loan supply into foreign currency and lend it out in the world market. Hence, net capital inflow will go down by the amount given by the RHS of (2.28). It will produce no other impact.

2.4 Conclusion

Here we have extended the model developed in the previous chapter to incorporate cross-border capital flows. However, we have focused only on the situation of perfect capital mobility. The present model is, therefore, an alternative to the Mundell-Fleming model. We consider this model better than the Mundell-Fleming model as it explicitly considers the operations of the financial sector and financing of all the different kinds of expenditure.

This model also brings out clearly the irrelevance of the money market. In the models developed here, it is shown explicitly that economic agents spend only out of the money they receive by selling factor services or produced goods and services or by way of loan. Firms and government, which receive money by selling produced goods and services and by way of loan, spend all the money. Only households save a part of the money, which they receive as factor income. Here, by assumption, they save only in the form of bank deposits (money). Since economic agents can keep whatever portion of the money at their disposal they want to in the form of money and spend whatever portion of the money at their disposal they do not want to keep in the form of money on goods and services and non-money assets, demand for money will always be equal to supply of money. It is, therefore, not necessary to consider the money market or demand for money and supply of money. This is also clear from the equilibrium conditions. The equilibrium in the flexible exchange rate regime is given by eqs. (2.3), (2.6) and (2.7). Substituting (2.7) into (2.3), we rewrite it as $Y = C(Y) + I(r^*) - K + \overline{G}$. Again, substituting (2.6) into the above equation, we get $Y = C(Y) + \frac{\overline{G}}{\rho} \Rightarrow Y - C(Y) = \frac{\overline{G}}{\rho}$. Now $Y - C(Y)$ is the saving of the households, which they want to hold in the form of money, while $\frac{\overline{G}}{\rho}$ is the supply of new money in the period under consideration. Thus, equilibrium conditions imply equality of demand for and supply of money.

Again, the equilibrium conditions in the fixed exchange rate regime are given by (2.17), (2.18) and (2.19). Substituting (2.17) into (2.19), we write it as $Y = C(Y) + I(r^*) + \overline{G} + \frac{dH}{P} - K - \overline{G} = C(Y) + I(r^*) + \frac{dH}{P} - K$. Again, substituting (2.18) into the above equation, we get $Y = C(Y) + \frac{1-\rho}{\rho}\frac{dH}{P} + \frac{dH}{P} \Rightarrow Y - C(Y) = \frac{\frac{dH}{P}}{\rho}$. Thus, here also the equilibrium conditions imply that the demand for additional money given by the saving of the households, $(Y - C(Y))$, equals the supply of new money $\frac{\frac{dH}{P}}{\rho}$. Thus, as we already argued, it is not necessary to consider the money market explicitly.

Chapter 3

Perfect Versus Imperfect Capital Mobility: The Micro-Foundation of Imperfect Capital Mobility

Abstract

The objective of this chapter is to develop a micro-foundation of imperfect mobility of capital and argue thereby that the imperfect capital mobility is the general case, while perfect capital mobility is a special one. This hypothesis is corroborated by the following fact. Under perfect capital mobility the central bank of a small open economy such as India does not have any control over the interest rate. But central banks in almost all the countries in the world including India use the interest rate as the main policy instrument for stabilisation.

3.1 Introduction

In the Mundell-Fleming model presented in the previous chapter, all economic agents have identical expectations regarding the future rate of depreciation of domestic currency. Normally, individuals' tastes and preferences, perceptions, views etc. vary substantially and that should hold in case of their expectation regarding the future course of the exchange rate as well. Many of the modern text books justify Mundell-Fleming model's assumption that all individuals have the same expected rate of depreciation on the ground that they have rational expectations. When individuals have rational expectations, they use all the available information including those regarding which of the existing models is the best one for predicting the future rate of depreciation of the domestic currency. They use this best model to derive the mathematical expectation of the future rate of depreciation of the domestic currency, which is the expected rate of depreciation of domestic currency of the economic agents with rational expectations. Thus, to domestic investors with rational expectations, expected rate of return on foreign bonds in domestic currency is $r^* + E(\hat{e})$, where $E(\hat{e})$ is the mathematical expectation of $\hat{e}\left(\equiv \frac{\frac{de_t}{dt}}{e_t}\right)$, which gives the future rate of depreciation of domestic currency. Domestic investors will compare r and $r^* + E(\hat{e})$. However, there is one caveat. While r is certain, $r^* + E(\hat{e})$ is the expected return, which is uncertain, i.e., the actual return from foreign bonds can differ from its expected return. If domestic investors are risk-neutral, then certainty equivalent of the expected return is the same as the expected return. This means that a risk-neutral individual will be indifferent between certain income and uncertain income, if they are equal. Thus, a risk-neutral domestic investor will be indifferent between *r* and $r^* + E(\hat{e})$, if they are equal. On the other hand, if domestic investors are risk-averse, their certainty equivalent of the expected return will be less than the expected return and the amount by which the latter exceeds the former is referred to as the risk-premium, which we shall denote by ρ. This means that, to a risk-averse individual a given amount of uncertain income is equivalent to a smaller amount of certain income. The latter is the certainty equivalent of the former and the difference between the given amount of uncertain income and its certainty equivalent is referred to as the risk premium. Thus, when economic agents have rational expectations, are risk averse and their attitudes towards risk (i.e., their degrees of risk-aversion) are identical, every domestic agent is indifferent between the uncertain income $r^* + E(\hat{e})$ and a given amount of certain income which is less than $r^* + E(\hat{e})$ by ρ. From the above it follows that if all individuals have rational expectations, are risk averse and their degree of risk-aversion is identical, they will be indifferent between domestic bonds and foreign bonds if $r - \rho = r^* + E(\hat{e})$. If domestic economic agents are all risk-neutral, $\rho = 0$.

The Mundell-Fleming model is based on the assumption that individuals are identical. Theory of rational expectations assumes that individuals are identical; their views as regards which the best model is for predicting the future course of the exchange rate are identical. In reality, people's opinions in this regard vary widely. There are people who harbor serious doubts as to whether there at all exists any reliable model for predicting the future movement of any variable. In general, people differ in their tastes and preferences, in their attitudes towards risk, in their perceptions and expectations. Even in a single family, different members may be vastly different from one another in all the different aspects mentioned above. In what follows, we shall assume that individuals are different and show that in such a situation we shall have imperfect capital mobility.

3.2 Micro-Foundation of Imperfect Capital Mobility

Here we shall show that imperfect capital mobility may stem from two sources: divergence of individuals' expected rate of depreciation of domestic currency and the difference in the degrees of riskiness of domestic and foreign bonds. We shall explore the implications of both these factors below:

3.2.1 Individuals Having Different Expected Rates of Depreciation

Mundell- Fleming model is concerned with risk-free bonds, i.e., bonds which are free from default risk. Examples of such bonds are bonds issued by domestic and foreign governments denominated in their respective currencies. However, to the domestic economic agents, safe domestic bonds are safe, but safe foreign bonds are not. Even though foreign bonds are default-risk-free, they involve exchange rate risk to the domestic economic agents. So, domestic bonds and foreign bonds are not perfect substitutes. (We shall show in the next section that this feature will also lead to imperfect capital mobility). Here, however, we shall focus on the divergence in individuals' expectations as regards the future rate of depreciation of domestic currency and derive its implications. We thus assume here that the value of the expected rate of depreciation of domestic currency (ε^E) varies from one individual to another. Under these conditions, the choice between domestic and foreign bonds will not be all or nothing on the aggregate, i.e., if r exceeds r^*, everyone will not prefer domestic bonds to foreign bonds and vice versa. We shall develop this argument following Keynes' line of explanation of

The i^{th} Domestic Agent's Demand for Domestic Bonds

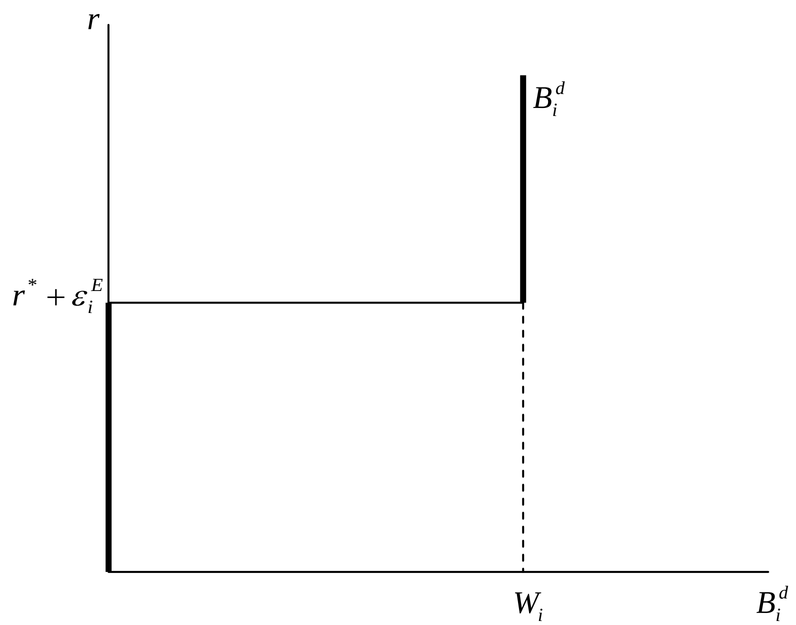

Figure 3.1a

Aggregate Demand for Domestic Bonds

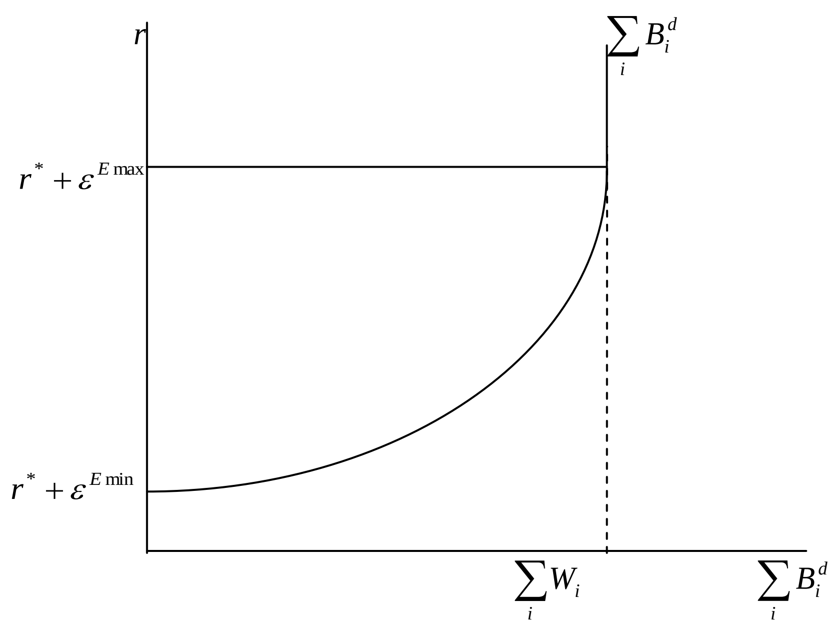

Figure 3.1b

speculative demand for money. Consider the ith domestic wealth holder who has a given amount of wealth W_i to allocate between domestic bonds and foreign bonds. His expected rate of depreciation of domestic currency is denoted by ε_i^E. He will prefer domestic bonds to foreign bonds, if $r \geq r^* + \varepsilon_i^E$. Otherwise, he will prefer foreign bonds to domestic bonds. His demand for domestic bonds is shown in Figure 3.1a, where for $r \geq r^* + \varepsilon_i^E$, his demand for domestic bonds is equal to his wealth W_i and for $r \leq r^* + \varepsilon_i^E$, his demand for domestic bonds is zero. The bold lines show his demand for domestic bond schedule labeled as B_i^d.

Since different individuals have different ε^Es, there will be a maximum and a minimum value of ε^E. We denote them by $\varepsilon^{E\max}$ and $\varepsilon^{E\min}$ respectively. Clearly, for $r < r^* + \varepsilon^{E\min}$, every domestic economic agent prefers foreign bonds to domestic bonds. Hence, aggregate demand for domestic bonds is zero at such low values of *r*. As *r* rises above $r^* + \varepsilon^{E\min}$, domestic agents for whom $r \geq r^* + \varepsilon^E$ will plan to switch from foreign bonds to domestic bonds. Others will prefer foreign bonds to domestic bonds. Thus, as *r* rises above $r^* + \varepsilon^{E\min}$, demand for domestic bonds becomes positive. The more *r* rises above $r^* + \varepsilon^{E\min}$, the larger is the number of domestic agents who plan to switch from foreign to domestic bonds. Thus, aggregate demand for domestic bonds increases with an increase in r for $r \geq r^* + \varepsilon^{E\min}$. When $r = r^* + \varepsilon^{E\max}$, all the domestic economic agents plan to switch from foreign bonds to domestic bonds and aggregate demand for domestic bonds equals the total financial wealth of the domestic economic agents. The aggregate demand for domestic bond schedule labeled $\sum_i B_i^d$ is shown in Figure 3.1b.

From the above it follows that, even if $r > r^*$, all domestic agents may not prefer domestic bonds to foreign bonds. Only some domestic agents may. Others may prefer foreign bonds to domestic bonds. In all the models we shall consider in this book, foreigners do not enter as players in the domestic bond market. Their holding of domestic bonds is infinitesimally small relative to their total bond holding and they are content with whatever domestic bonds they are holding. So, domestic agents are the only players in the domestic bond market. When domestic agents want to switch from domestic bond or domestic money to foreign bonds, there takes place planned outflow of capital. Again, when they want to switch from foreign bonds to domestic bonds or domestic money, there takes place planned inflow of capital. Domestic agents in the aggregate have in their portfolio some foreign bonds and some domestic bonds. Corresponding to any given r and r^*, some domestic agents will want to hold only foreign bonds, while others will want to hold only domestic bonds. If the former are holding any domestic bonds, they will want to sell off their entire holding of domestic bonds to buy foreign bonds. The latter, on the other hand, will want to sell off their entire holding of foreign bonds, if they have any, to buy domestic bonds. So, there will be a unique value of the planned net inflow of capital. With a rise in r, given r^*, more domestic agents will want to hold only domestic bonds, i.e., more domestic agents will want to sell off their foreign bond holding and use the sales proceeds to invest in domestic bonds. Hence, aggregate net planned inflow of capital will increase. Thus, the larger the value of $(r - r^*)$, the greater is the number of domestic agents who want to sell off their foreign bond holding to buy domestic bonds. So, aggregate planned net inflow of capital becomes an increasing function of $(r - r^*)$. Thus, we have

$$K = K\left(\underset{+}{r - r^*}\right)$$

(3.1)

This is the case of imperfect capital mobility.

3.2.2 Difference in the Degrees of Riskiness of Domestic and Foreign Bonds

Domestic bonds, as we have mentioned above, are safe to domestic economic agents, but foreign bonds, even though free from default risk, are risky to the domestic economic agents as they involve exchange rate risk. In this situation, if a domestic economic agent holds all his wealth in domestic bonds, he assumes no risk. But, if the foreign bond yields a higher expected return, then by allocating a part of his wealth to foreign bonds he will be able to enjoy higher expected return from his portfolio, though the portfolio will involve some risk. The larger the fraction of his wealth he allocates to foreign bonds, the greater will be the expected return from the portfolio and the higher will be the risk. In these circumstances, a domestic economic agent instead of putting all his wealth in the form of domestic bonds may decide to allocate his wealth between both types of bonds and thereby choose a combination of risk and return that he considers optimum. This situation is formally shown below using Tobin's model of speculative demand for money.

The Model

The model considers a domestic economic agent with a given amount of wealth, which is assumed to be unity for simplicity. The model assumes that the individual does not have just one expected rate of depreciation of domestic currency, but has a subjective probability distribution over many possible values of the expected rate of depreciation of domestic currency. Under these circumstances, as we shall presently show, the choice between domestic and foreign bonds even for an individual wealth holder is unlikely to be an all-or-nothing one. Even when r and r^* are different, individuals instead of putting all their wealth in the form of the bond that yields higher return/expected return will allocate their wealth between both types of bonds. We shall now establish this point. Consider a domestic wealth holder. Suppose he has a given amount of wealth in domestic currency, which we denote by $\overline{W}$. For simplicity we assume that it is unity. He will have to decide how he will allocate this given amount of wealth between domestic bonds and foreign bonds. Here we consider only risk-free (i.e., default-risk free) domestic and foreign bonds. Domestic bonds are safe to him. But foreign bonds, though default-risk free, are risky to domestic investors as they involve exchange rate risk. Thus, to a domestic investor, the return on domestic bonds denoted by r is fully certain. Expected return on risk-free foreign bonds to a domestic investor in terms of domestic currency, as we have already explained above, is $r^* + \varepsilon^E$, where ε^E is the expected rate of depreciation of domestic currency. In our earlier discussion we assumed that every wealth holder has a unique ε^E, which differs across wealth holders. But, now we relax this assumption and postulate that every wealth holder has many possible values of ε^E and every wealth holder has a subjective probability distribution defined over the possible values of ε^E. For the domestic wealth holder under consideration, the mean of his probability distribution is defined as the mathematical expectation of ε^E, $E(\varepsilon^E)$. We shall denote $E(\varepsilon^E)$ by μ. Again, the standard deviation of his probability distribution is given by $\sqrt{E(\varepsilon^E - \mu)^2}$. We denote this standard deviation by σ. We denote the fraction of the given wealth that the domestic investor invests in foreign bonds by $A_{1.}$ Since $\overline{W}$ is taken to be unity, A_2 also gives the amount of domestic currency invested by the domestic investor in foreign bonds. Accordingly, he invests $(1-A_2)$ amount of domestic currency in domestic bonds. Every unit of domestic currency invested in domestic bonds yields after one year an additional income of r in domestic currency. Hence $(1-A_2)$ amount of domestic currency invested in domestic bonds will yield an additional income of $(1-A_2)r$ in the next instant/period in domestic currency. Similarly, every unit of domestic currency invested in foreign bonds yields in the next instant/period $r^* + \varepsilon$ in domestic currency. Hence A_2 amount of domestic currency invested in foreign bonds will yield an additional income of $A_2(r^* + \varepsilon)$ in the instant/period in domestic currency. Thus, the income that a domestic investor earns from his portfolio containing A_2 amount of wealth invested in foreign bonds and $(1-A_2)$ amount of wealth invested in domestic bonds is given by

$$\tilde{R} = (1-A_2)r + A_2(r^* + \varepsilon) \tag{3.2}$$

At the time of making the choice regarding A_2, the value of ε is not known. He has to make his choice on the basis of his expected values of ε, ε^E over which he has a probability distribution. Thus, while making the choice regarding A_2, the individual has to take into reckoning, after substituting ε^E for ε in the expression of $\tilde{R}$, the mathematical expectation of $\tilde{R}$, $E(\tilde{R})$, which we shall denote by R. It gives the domestic wealth holder's expected mean return from his portfolio. Thus

$$R \equiv E(\tilde{R}) = (1-A_2)r + A_2(r^* + E(\varepsilon^E)) = (1-A_2)r + A_2 r^* + A_2\mu \qquad E(\varepsilon^E) = \mu \tag{3.3}$$

The Budget Line of the Domestic Investor

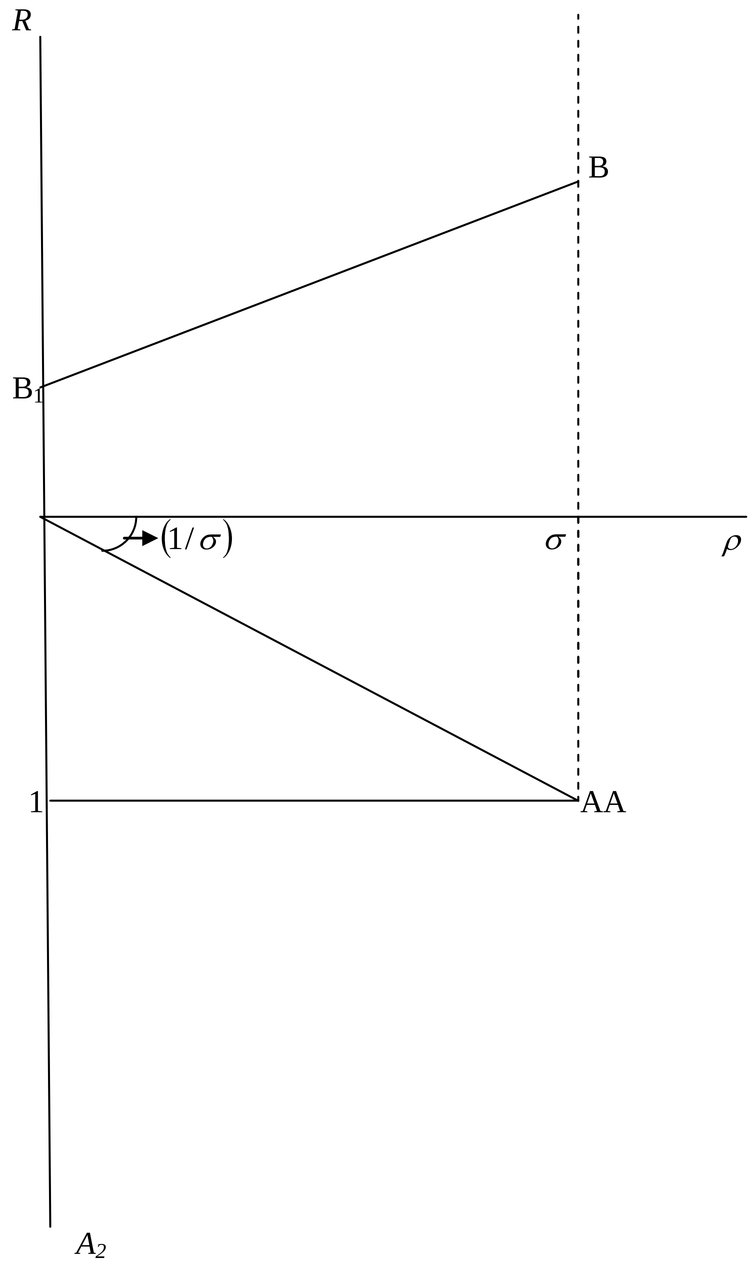

Figure 3.2

The risk involved in the portfolio is measured, as standard, by the standard deviation of $\tilde{R}$. It is given by

$$\rho \equiv \sqrt{E\left(\tilde{R}-R\right)^2} = \sqrt{E\left(A_2\varepsilon^E - A_2\mu\right)^2} = A_2\sigma \qquad \sigma \equiv \sqrt{E\left(\varepsilon^E-\mu\right)^2} \tag{3.4}$$

From (3.3) and (3.4) it follows that corresponding to any given A_2, there is a unique value of R and ρ. By choosing different values of A_2, the domestic investor can choose different combinations of R and ρ, given r, r_* and the mean and standard deviation of his subjective probability distribution over ε^E. All the different combinations of R and ρ that the domestic investor can choose from by varying A_2 may be derived as follows. Solving (3.4) for A_2, we get

$$A_2 = \frac{\rho}{\sigma} \tag{3.5}$$

Substituting (3.5) into (3.4), we get

$$R = r + \frac{\rho}{\sigma}\left(r^* + \mu - r\right) \tag{3.6}$$

(3.6) gives all the combinations of R and ρ the domestic investor can assume by varying $A_2 \in [0,1]$. (3.6) is referred to as the budget line of the domestic investor. The budget line is a straight line. In Figure 3.2, in the upper panel, the straight line B_1B represents the budget line. Note that, the maximum value of ρ, as follows from (3.4), is σ, since the maximum value that A_2 can assume is 1. As the budget line is a straight line, it is defined by its vertical intercept and slope. The vertical intercept of the budget line is r and its slope is $\frac{1}{\sigma}\left(r^* + \mu - r\right)$. Let us now explain them. The vertical incept gives the value of R, when $\rho = 0$. If the domestic investor does not want to assume any risk, i.e., if he wants to set $\rho = 0$, he has to make A_2, as follows from (3.4), zero. This means that the domestic investor has to invest all his wealth, which is unity, in domestic bonds. So, additional income from his portfolio in domestic currency in the next instant/period is r, i.e., $R = r$. This explains the vertical intercept of the budget line.

Let us now explain the slope of the budget line. Starting from a (ρ, R) on the budget line, the slope of the budget line gives the amount of increase in R that is required to satisfy (3.6) following a unit increase in ρ from the given (ρ, R). Let us explain. Take any (ρ, R) on the budget line. If the domestic investor wants to raise ρ by one unit, he has to raise A_2 by $(1/\sigma)$ - see (3.4). One unit of domestic currency invested in foreign bonds yields in the next instant/period a mean expected income of $(r^* + \mu)$. Hence, $(1/\sigma)$ amount of domestic currency invested in foreign bonds yields an expected mean income of $(1/\sigma)(r^* + \mu)$. As A_2 rises by $(1/\sigma)$, the amount of domestic currency invested in domestic bonds falls by $(1/\sigma)$. Hence, additional income from domestic bonds falls by $(1/\sigma)r$. Therefore, when ρ rises by unity, the expected mean income from the portfolio rises by $(1/\sigma)(r^* + \mu) - (1/\sigma)r = (1/\sigma)(r^* + \mu - r)$. This explains the slope of the budget line. We shall henceforth refer to this slope as the actual marginal rate of compensation for risk-taking. It gives us the amount by which R of the individual's portfolio will increase if he takes one unit more risk, i.e., if he raises ρ by 1 unit.

In the lower panel of Figure 3.2, we measure positive values of A_2 on the vertical axis in the downward direction. In the lower panel, the line AA represents (3.5). It gives the value of A_2, as given by (3.5), corresponding to every different value of ρ.

Risk-Aversion and Preference Ordering

Let us now focus on the individual's preference ordering or his utility function defined over the set of all possible combinations of R and ρ. This preference ordering is represented by a set of indifference curves. For risk-averse individuals, these indifference curves are positively sloped. Let us explain. Given the portfolio risk, ρ, an increase in R makes every individual better-off. However, if an individual is risk-averse, an increase in ρ, given R, makes him worse-off. Therefore, starting from a (ρ, R) on a given indifference curve of a risk-averse individual, an increase in ρ, with R remaining unchanged, will take him over to a lower indifference curve. If the risk-averse individual is to be kept on the initial indifference curve with this higher value of ρ, R has to be raised commensurately. This makes indifference curves of risk-averse individuals positively sloped in the (ρ, R) plane. Corresponding to any given ρ, value of R is higher on a higher indifference curve. Hence, a higher indifference curve represents a higher level of utility.

Risk-Aversion and Choice

We consider it sensible to assume that most of the individuals are risk-averse. We shall, therefore, consider a domestic economic agent who is risk-averse. His indifference curves, as we have already pointed out, are positively sloped. His budget line as given by (3.6) may be positively sloped or negatively sloped. We shall first focus on his choice when his budget line is negatively sloped. In such a situation, he will invest all his wealth in domestic bonds. The reason is quite obvious. If he invests all his wealth in domestic bonds, i.e., if he sets A_2 equal to 0, he does not take any risk, with $\rho = 0$ and $R = r$ - see

Choice of the Portfolio by the Domestic Investor

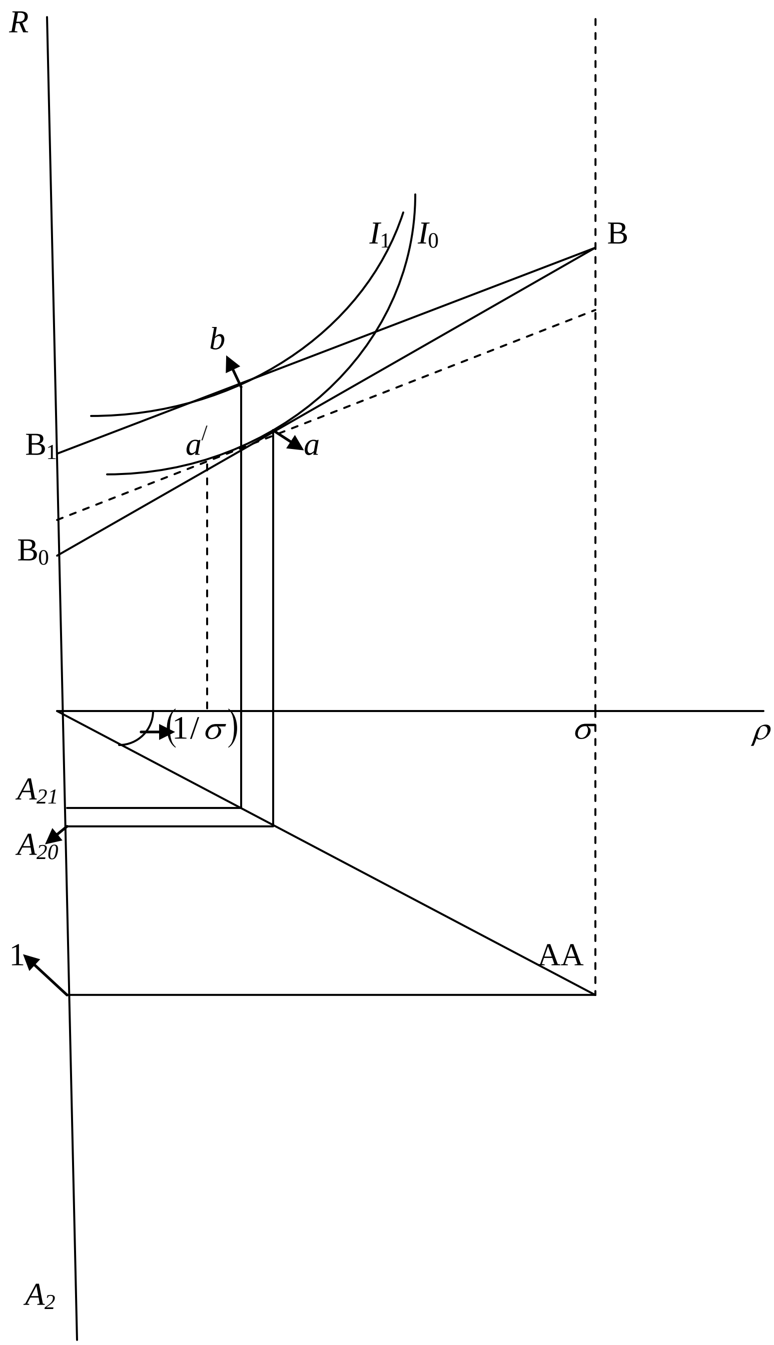

Figure 3.3

(3.4) and (3.3). If he raises A_2 and, thereby, ρ, R will decline making him worse-off.

Here we focus on a domestic agent for whom $r^* + \mu$ exceeds r so that his budget line is positively sloped. We further assume that his indifference curves are not only positively sloped but also strictly convex downward. This means that the slope of such an indifference curve rises as ρ increases along the given indifference curve. These indifference curves are represented by I_0 and I_1 in Figure 3.3. The slope of an indifference curve gives us the amount of increase in R that is required to keep the domestic agent on the same indifference curve as before following a unit increase in ρ from a (ρ, R) on the given indifference curve. We shall refer to the slope of an indifference curve as the required marginal rate of compensation for risk-taking. Along a strictly convex downward indifference curve, the required marginal rate of compensation for risk-taking rises with an increase in ρ along the indifference curve. The domestic agent will choose from the budget line given by (3.4) and represented by the line B_0B in Figure 3.3, the point on the highest indifference curve. The chosen point is labeled '*a*' in Figure 3.3. Why does the domestic agent choose '*a*' from the budget line? Let us explain that. At '*a*' an indifference curve is tangent to the budget line. Therefore, at '*a*' the slope of the budget line equals that of the indifference curve. In other words, at '*a*' the actual marginal rate of compensation for risk-taking equals the required marginal rate of compensation for risk-taking. Consider any point to the left of '*a*' on the budget line. The indifference curve that passes through the point intersects the budget line from above. At such a point, therefore, the slope of the indifference curve passing through the point is less than that of the budget line, i.e., the required marginal rate of compensation for risk-taking is less than the actual marginal rate of compensation for risk-taking. This means that, if from the given point the domestic agent raises ρ by unity, the increase in *R* that will take place will be larger than the increase in *R* that is required to keep him on the same indifference curve. Hence, from the given point by taking one unit more risk he will be able to move over to a higher indifference curve. Similarly, explain why the domestic agent will not choose a point to the right of '*a*' on his budget line.

In the lower panel of Figure 3.3, just as in the lower panel of Figure 3.2, the line AA representing (3.5) gives the value of A_2 corresponding to every given value of ρ. The value of A_2 corresponding to the chosen point '*a*' is denoted by A_{20}. This has the following implication. Note that μ may be positive or negative and its value may be small or large. Thus, even if $r^* + \mu > r$, *r* may be substantially higher than r^* and even at $r > r^*$, the value of A_2 chosen by the domestic agent may be substantially greater than zero as long as $r < r^* + \mu$. This means that, even when $r > r^*$, a risk-averse individual mat not want to hold the whole of his wealth in the form of domestic bonds. He may want to hold just a fraction of his wealth in the form of domestic bonds.

Let us now examine how an increase in *r* will affect the domestic agent's choice. We shall do this with the help of Figure 3.3. Focus on the budget line BB_0 representing (3.6) at the initial value of *r* first. To ascertain how it will shift following a given increase in *r*, we rewrite (3.6) as follows:

$$R = r\left(1 - \frac{\rho}{\sigma}\right) + \frac{\rho}{\sigma}\left(r^* + \mu\right) \tag{3.7}$$

Note that ρ rises from zero to σ, as A_2 goes up from zero to unity – see (3.4). Therefore, as we find from (3.7), for any $\rho < \sigma$, *R* rises following an increase in *r*. However, for $\rho = \sigma$, an increase in *r* will leave *R* unaffected at $r^* + \mu$. Thus, the budget line in Figure 3.3 will shift upward corresponding to every $\rho < \sigma$. The magnitude of this shift is given by $dR = \left(1 - \frac{\rho}{\sigma}\right)dr$. Thus the magnitude of the vertical shift is dr at $\rho = 0$; it decreases as ρ rises and becomes equal to zero when ρ assumes its maximum value, σ. The vertical shift of the budget line can be explained easily. From (3.5) we find that $A_2 = \frac{\rho}{\sigma}$. Thus, given ρ, the amount of wealth invested in domestic bonds is $\left(1 - \frac{\rho}{\sigma}\right)$. Following an increase in *r* by *dr*, income from every unit of wealth invested in domestic bonds goes up by *dr*. Hence income from $\left(1 - \frac{\rho}{\sigma}\right)$ amount of wealth invested in domestic bonds will go up by $\left(1 - \frac{\rho}{\sigma}\right)dr$. Expected income from $\frac{\rho}{\sigma}$ amount of wealth invested in foreign bonds remains unchanged as r^* is unaffected. Thus, following the increase in *r* by *dr*, given ρ, expected income from the portfolio, *R*, increases by $\left(1 - \frac{\rho}{\sigma}\right)dr$. This explains the vertical shift of the budget line. In Figure 3.3, B_1B is the new budget line. Its vertical intercept is larger by *dr* and its slope is less by $\frac{1}{\sigma}dr$. Denoting the new *r* by r_1, we can write the slope of the new budget line as $\frac{1}{\sigma}\left(r^* + \mu - r_1\right)$. The domestic agent will choose a new optimum (ρ, R) from B_1B. This new optimum bundle is labeled '*b*' in Figure 3.3. We cannot say a priori whether '*b*' will be to the left or right of '*a*', i.e., whether it will contain a smaller or a larger ρ than '*a*'. To comprehend the conditions under which the domestic investor will assume more or less risk, we have to decompose the change from '*a*' to '*b*' into substitution and income effect. We do this as follows.

There takes place two changes following an increase in *r*. First, as we find from (3.6), a unit increase in ρ brings about a smaller increase in R, i.e., risk-taking becomes less rewarding. The rate at which risk-taking is compensated for is given by $\frac{1}{\sigma}\left(r^* + \mu - r\right)$. An increase in *r*, given everything else, reduces it. The new actual marginal rate of compensation for risk-taking, as we have already specified, is given by $\frac{1}{\sigma}\left(r^* + \mu - r_1\right)$. Second, the ceteris paribus increase in *r* raises *R* corresponding to any given ρ enabling the domestic agent to choose from a higher indifference curve, which is labeled I_1 in Figure 3.3. This movement to a higher indifference curve signifies an increase in the real income of the domestic agent. In fact, real income of the domestic agents is measured by the highest indifference curve he is able to attain. Thus, his initial real income is given by I_0, while his new real income is given by I_1. The change in the domestic agent's choice due to the change in the actual marginal rate of compensation for risk-taking alone is called the substitution effect, while the change in his choice due to the change in his real income alone is the income effect. To separate the effect of the change in the actual marginal rate of compensation for risk-taking from that of the change in the domestic economic agent's real income, we can do the following. We can consider the hypothetical situation where the investor's mean income from his portfolio, *R*, is taxed in such a way (through a lump sum tax, say) that the new budget line shifts downward with its slope, which gives the new actual marginal rate of compensation for risk-taking, unchanged and becomes tangent to the initial indifference curve, I_0 – see Figure 3.3. The situation is shown in Figure 3.3 where the dashed line represents this hypothetical post-tax budget line, which is parallel to the new budget line and tangent to the initial indifference curve I_0. The point of tangency is labeled $a^{/}$. Obviously, from this dashed budget line the domestic agent will choose $a^{/}$. The real income of the investor is indicated by the highest indifference curve the investor is able to attain, given his budget line. Therefore, the choice of the investor from the dashed budget line gives his choice when his real income is the same as what it was before the increase in r had taken place, but the actual marginal rate of compensation for risk-taking that he faces is the new one. Thus the change in the domestic agent's choice from a to $a^{/}$ is due to the change in the actual marginal rate of compensation for risk-taking only. Hence this change is the substitution effect. We shall now show that $a^{/}$ will be to the left of a on the initial indifference curve I_0. At $a^{/}$ the actual marginal rate of compensation for risk-taking is equal to the new actual marginal rate of compensation for risk-taking. Hence, it is less than that at a. By assumption, the actual marginal rate of compensation for risk-taking rises as ρ increases along an indifference curve. Hence, $a^{/}$ has to be to the left of a on I_0. Thus, substitution effect discourages risk-taking.

Obviously, the change in the domestic agent's choice from $a^{/}$ to 'b' in Figure 3.3 is due to the increase in the domestic agent's real income alone. He faces the same actual marginal rate of compensation for risk-taking, when he chooses $a^{/}$ and b. The only difference when he makes the two choices is in the level of the domestic agent's real income. Therefore, the change in the choice of the domestic agent from $a^{/}$ to b is the income effect. If R and ρ are kind of normal goods, demand for both R and ρ will go up following the increase in the domestic agent's real income. In this case, therefore, income effect encourages risk-taking. In general, therefore, substitution effect and income effect work in opposite directions. What happens to risk-taking, then, depends upon the relative strengths of the two effects. Normally, it is assumed that the substitution effect is stronger than the income effect so that, as shown in Figure 3.3, risk-taking falls following an increase in r. In Figure 3.3, A_2 falls from A_{20} to A_{21} following the increase in r.

From the above discussion it follows that for any given $r < r^* + \mu$ the value of A_2 chosen by the investor is such that $0 < A_2 < 1$. For $r \geq r^* + \mu$, the budget line of the investor is horizontal or negative in the (ρ, R) plane. Hence the optimum A_2 for the risk-averse investor, as we have already explained, is zero. Since μ may be positive and large, even at r substantially higher than r^* the value of A_2 may be positive. Similarly, at $r < r^*$, the value of A_2 may be less than unity.

From the above it follows that over a wide range of values of r, given r^*, domestic economic agents instead of preferring one kind of bonds to another, will want to allocate their wealth between the two kinds of bonds. At any such r those who are holding more foreign bonds than what they want to (i.e., those for whom actual A_2 is greater the optimum A_2), will desire to switch from foreign bonds to domestic bonds and those who are holding less foreign bonds than what they want to (i.e., those for whom the actual A_2 is less than the optimuim A_2) will want to switch from domestic bonds to foreign bonds. Thus, corresponding to any given r, with r^* fixed at a given level, the net inflow of capital, K, is finite. In fact, at any such r, individuals whose actual A_2 is greater than their optimum A_2 will want to buy a finite amount of domestic bonds by selling foreign bonds. Again, those individuals whose actual A_2 is less than the optimum A_2 will offer to sell a finite amount of domestic bonds for purchasing foreign bonds. Therefore, even at a $r > r^*$, demand for purchase of domestic bonds may be less than the amount of domestic bonds on offer for sale putting an upward pressure on *r*. The higher the *r* relative to r^*, the less will be the optimum A_2 relative to the actual A_2 for the domestic people. Hence, demand for purchase of domestic bonds by selling foreign bonds will increase, while the amount of domestic bonds offered for sale for purchasing foreign bonds will fall and *K* will increase. From the above discussion it follows that, given expectations (captured by the subjective probability distributions over the possible values of ε^E), we may write *K* as

$$K = K\left(\underset{+}{r - r^*}\right) \tag{3.8}$$

This is the case of imperfect capital mobility. Here, even at a $r > r^*$, there may be excess supply of domestic bonds (matched by an excess demand for foreign bonds) putting upward pressure on *r*. Here, unlike what happens in the perfect mobility case, the domestic bond market may be in equilibrium with $r > r^*$ or $r < r^*$.

3.3 Conclusion

This chapter shows that perfect capital mobility is a special case, while imperfect capital mobility is the general one. The case of perfect capital mobility obtains when domestic bonds and foreign bonds are perfect substitutes, switching from one kind of bond to another is costless, individuals have identical expectations regarding the future rate of depreciation of domestic currency and they are risk neutral. Obviously, these conditions are seldom met in reality. To the domestic economic agents, risk-free domestic bonds are completely risk-free, but risk-free foreign bonds (i.e., foreign bonds that are free from default risk) are risky as they involve exchange rate risk. Thus, domestic bonds and foreign bonds can never be perfect substitutes to the domestic economic agents. It is also unrealistic to assume that individuals' expectations are identical. Usually, people including the economists differ widely in their perception as regards how the economic events including the exchange rate are going to change in future. Under these conditions, we have shown, at any r, given r^*, some domestic agents will prefer foreign bonds to domestic bonds, while others will prefer domestic bonds to foreign bonds, it does not matter whether $r > r^*$ or $r < r^*$. Therefore, at any r, given r^*, some domestic agents will want to switch from domestic bonds to foreign bonds, while others will want to switch from foreign bonds to domestic bonds. Thus, the net inflow of capital, K, may be positive, zero or negative. The higher the r, given r^*, the larger will be the number of domestic agents who will want to switch from foreign bonds to domestic bonds. Hence K will rise. Thus, K becomes an increasing function of the interest rate differential $(r - r^*)$.

So far, we stuck to the assumption of risk-neutrality. If we drop the assumption and assume instead that most of the individuals are risk-averse, we shall get imperfect capital mobility, even when individuals' expectations do not diverge. If expected return on foreign bonds, $(r^* + \mu)$, exceeds r, domestic agents can increase expected income from his wealth by allocating a larger part of his wealth to foreign bonds. But, foreign bonds are risky. The more the investment in foreign bonds, the greater is the risk to the domestic agents. A domestic economic agent can increase expected income from his wealth by investing a larger part of his wealth in foreign bonds and thereby taking more risk. Thus, risk-averse domestic economic agents may allocate their wealth between foreign and domestic bonds in such a way that risk and return associated with the portfolio become optimum. In this case also, at any r, given r^*, some domestic agents will want to switch from domestic bonds to foreign bonds, while others will want to switch from foreign bonds to domestic bonds. As a result, net inflow of capital, *K*, may be positive, negative or zero, it does not matter whether $r > r^*$ or $r < r^*$. The discussion in this chapter shows that an increase in r, given r^*, will induce domestic agents to allocate more of their wealth to domestic bonds raising *K*. Thus, we have imperfect capital mobility with *K* an increasing function of the interest rate differential $\left(r - r^*\right)$. The mainstream open economy macroeconomics recognizes the generality of imperfect capital mobility – see, for example, Romer (1996, 2013).

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Chapter 4

Imperfect Capital Mobility

Abstract

The objective of this chapter is to extend the model developed in chapter 2 to the case of a small open economy, with imperfect capital mobility across borders. We consider both the fixed and flexible exchange rate regimes. The endeavour is worthwhile in the light of our discussion in Chapter 4. Chapter 4 shows that imperfect capital mobility is the general case, while perfect capital mobility is a special one.

4.1 Introduction

The objective of this chapter is to extend the model developed in chapters 2 and 3 to the case of imperfect capital mobility. The endeavour is important for the following reasons. In chapter 4 we have argued that in general capital is imperfectly mobile across sectors. Hence, it is imperative that we extend the model developed in chapters 2 and 3 to capture the case of imperfect capital mobility.

We shall first focus on the flexible exchange rate regime. In this case, the central bank does not intervene in the foreign exchange market to regulate the exchange rate.

4.2 Imperfect Capital Mobility, with Flexible Exchange Rate Regime

The goods market equilibrium condition, as before, is given by

$$Y = C(Y) + I(r) + \overline{G} + X\left(\frac{P^{*}e}{P}; Y^{*}\right) - M\left(\frac{P^{*}e}{P}; Y\right) \tag{4.1}$$

Under imperfect capital mobility, r may differ from r^{*} and the former is determined in the domestic loan market. As before, we assume that the entire government consumption expenditure is financed by borrowing from the domestic central bank. The central bank also lends to the banks at a pre-specified policy rate r_c. banks' demand for central bank loans at r_c is given by $l(r_c)$. The central bank meets banks' entire demand for central bank loans. Central bank's loans to the government and the banks constitute the only source of high-powered money in the economy. Thus,

$$\frac{dH}{P} = \overline{G} + l(r_c) \tag{4.2}$$

Again, given the assumption that firms do not save and households save in the form of domestic bank deposits only, total planned supply of new loans by the domestic banks, denoted l_b is given by (for reasons we have already explained in the previous chapters)

$$l_b = \frac{(1-\rho)}{\rho} d\overline{G} + \frac{l(r_c)}{\rho} \tag{4.3}$$

Let us now focus on capital flows across borders. We consider here a small open economy. Since the economy is small, domestic economic agents can borrow from and lend to the world credit market as much as they want at the interest rate prevailing in the world credit market, which is denoted by r^*. This implies that savers can hold their saving in the form of either domestic bank deposits or loans in the world market or both. Similarly, domestic banks can secure deposits from domestic households as well as from foreigners. They can also lend either to domestic firms or in the world credit market or both. Domestic firms can also borrow from either domestic banks or the world credit market or both. However, for simplicity, we shall make the following assumptions. Savers hold their saving in the form of domestic bank deposits only. Domestic banks lend to both domestic firms and in the world credit market, even though they receive their deposits from domestic savers only. Domestic borrowers borrow from both domestic banks and the world credit market. Since domestic economic agents can borrow from and lend to the world market as much as they want at the given interest rate r^*, total net supply of loans to domestic borrowers, denoted *l*, is given by $l_b + K$, where *K* denotes net inflow of capital. Under imperfect capital mobility, *K* is an increasing function of the interest rate differential, given domestic agents' expectations regarding the future course of the exchange rate. Let us explain this point a little more. Domestic banks can lend to domestic borrowers or they can lend to foreigners at the given interest rate r^*. Lending to foreigners, however, involves exchange rate risk. Hence, given r and r^* and their expectations, domestic banks, in accordance with the models developed in chapter 3, will plan to allocate their total lending between domestic borrowers and foreigners. The higher the r relative to r^*, the larger is the domestic banks' planned supply of loans to domestic borrowers. Therefore, the higher the r relative to r^*, domestic banks' planned supply of loans to domestic borrowers will be larger or the outflow of capital on account of domestic banks' decisions will be less. Similarly, domestic borrowers can borrow from either domestic banks at the interest rate r or foreigners at the given interest rate r^*. However, borrowing from foreigners involves exchange rate risk. We can easily modify the models developed in chapter 3 to the case of borrowers and apply these models to domestic borrowers. These modified models, as one can easily deduce, suggest that they will plan to allocate their total loan demand between domestic and foreign sources on the basis of the given values of r and r^*, given their expectations. Borrowing from foreigners means capital inflow. The higher the r relative to r^*, the less will be their planned demand from domestic sources and, hence, the larger will be their planned demand from foreign sources, i.e., the larger will be capital inflow on account of domestic borrowers' decisions. Thus, given the expectations of domestic banks and domestic borrowers, the higher the r relative to r^*, the larger will be the net inflow of loans or capital. The aggregate net supply of new loans to domestic borrowers is, therefore, given by total planned supply of loans by domestic banks, $\frac{(1-\rho)}{\rho}d\overline{G}+\frac{l(r_c)}{\rho}$, minus the planned outflow of capital (i.e, the planned supply of new loans to foreigners by domestic banks) plus the planned inflow of capital (i.e., the amount of new loans the domestic borrowers plan to secure from abroad). Accordingly, the total supply of new loans to domestic firms denoted *l*, is given by

$$l = \frac{(1-\rho)}{\rho}\overline{G} + \frac{l(r_c)}{\rho} + K\left(r - r^*\right) + \overline{K} \tag{4.4}$$

In (4.4), the net inflow of capital given by $K\left(r - r^*\right) + \overline{K}$ includes the autonomous component $\overline{K}$. It captures that part of the net inflow of capital which is determined by people's expectations regarding the future course of the exchange rate. Since we do not know how these expectations are formed, it is best to regard them as exogenously given.

Demand for loans, denoted l^d, comes from the domestic borrowers who finance their entire investment expenditure with loans. Domestic borrowers do not require loans for any other purposes. Domestic loan market will, therefore, be in equilibrium when

$$\frac{(1-\rho)}{\rho}\overline{G} + \frac{l(r_c)}{\rho} + K\left(r - r^*\right) + \overline{K} = I(r) \tag{4.5}$$

Finally, the foreign currency market will be in equilibrium, when the excess supply of foreign currency given by $\left[X\left(\frac{P^* e}{P}; Y^*\right) - M\left(\frac{P^* e}{P}; Y\right) + K\left(r - r^*\right) + \overline{K}\right]\frac{P}{e}$ is zero, i.e., when the following condition is satisfied:

$$\left[\left\{X\left(\frac{P^* e}{P}; Y^*\right) - M\left(\frac{P^* e}{P}; Y\right)\right\} + K\left(r - r^*\right) + \overline{K}\right]\frac{P}{e} = 0 \Rightarrow$$

$$\left[X\left(\frac{P^* e}{P}; Y^*\right) - M\left(\frac{P^* e}{P}, Y\right)\right] + K\left(r - r^*\right) + \overline{K} = 0 \tag{4.6}$$

The specification of our model is now complete. It consists of three key equations (4.1), (4.5) and (4.6) in three endogenous variables: Y, r and e. We may solve them as follows. Substituting (4.6) into (4.1), we may rewrite it as

$$Y = C(Y) + I(r) + \overline{G} - K(r - r^*) - \overline{K} \tag{4.7}$$

We can solve (4.5) for the equilibrium value of *r*. The solution is shown diagrammatically in Figure 4.1a, where ls schedule represents the LHS of (4.5) and gives the value of net aggregate supply of loans to domestic borrowers corresponding to different values of *r*. The LD schedule represents the RHS of (4.5) and gives the value of demand for loans of domestic borrowers at different values of *r*. The equilibrium value of *r*, labeled r_0, corresponds to the point of intersection of the LD and LS schedules. Putting the equilibrium value of *r* in (4.7), we get the equilibrium value of *Y*. We show the solution in Figure 4.1b, where the AD(r_0) schedule gives the value of aggregate demand for domestic goods, given by the RHS of (4.7), corresponding to different values of *Y*, when *r* is fixed at its equilibrium value, r_0. The equilibrium value of *Y* corresponds to the point of intersection of the AD schedule and the 45^0 line. The equilibrium *Y* is labeled Y_0. Putting the equilibrium values of *Y* and *r* in (4.6), we get the equilibrium value of *e*. The solution is shown in Figure 4.1c, where the $TK(Y_0, r_0)$ schedule plots the value of the LHS of (4.6) against *e*, when *Y* and *r* are fixed at their equilibrium values Y_0 and r_0 respectively. The equilibrium value of *e* corresponds to the point of intersection of the $TK(Y_0, r_0)$ schedule and the horizontal axis. It is labeled e_0.

Determination of Equilibrium Value of *Y*, *r* and *e*

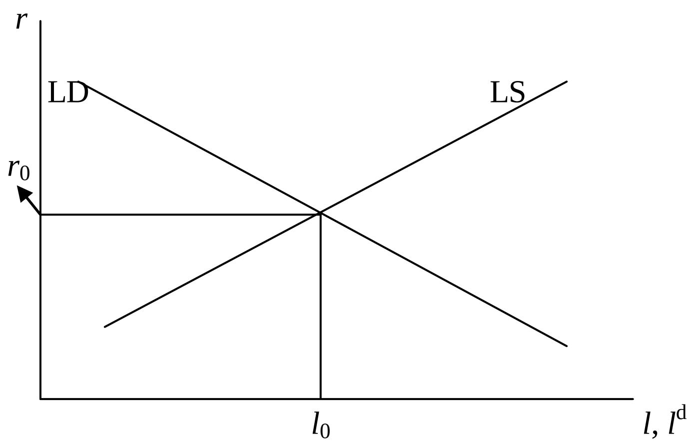

Figure 4.1a

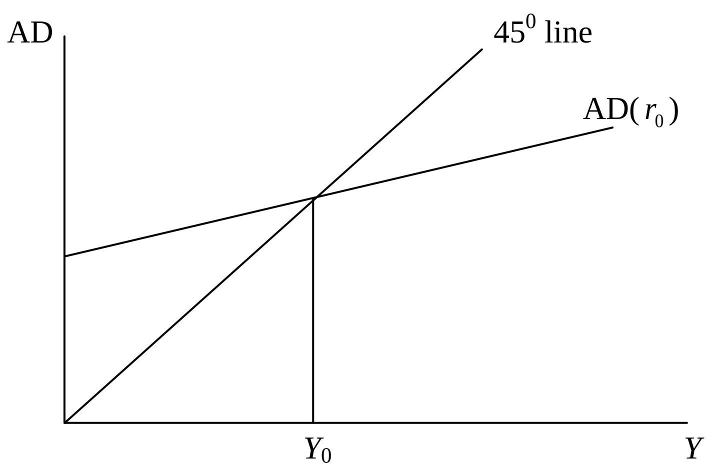

Figure 4.1b

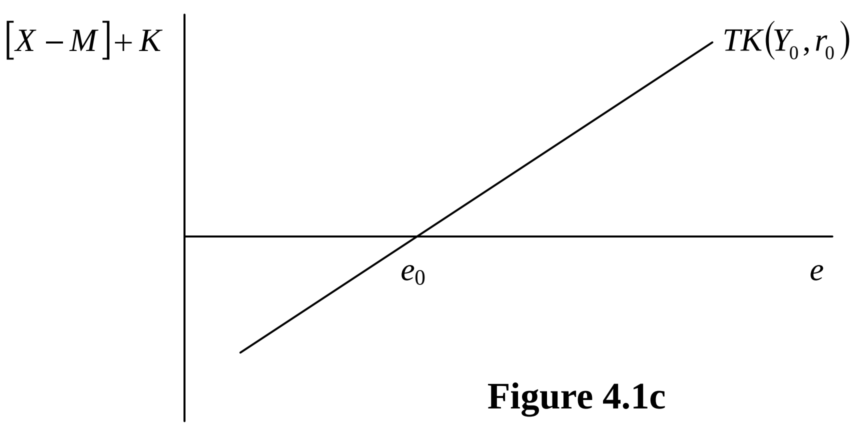

Figure 4.1c

4.2.1 Fiscal Policy: An Increase in Government Consumption Financed by Borrowing from the Central Bank

We shall now examine how an increase in $\overline{G}$ financed by borrowing from the central bank affects *Y*, *r* and *e*. Let us do it diagrammatically first. We shall do it using Figures 4.2a, 4.2b and 4.2c, where the initial equilibrium values of *Y*, *r* and *e* are labeled Y_0, r_0 and e_0 respectively. Following an increase in $\overline{G}$ by $d\overline{G}$, the net supply of new loans to domestic borrowers as given by the LHS of (4.5) increases by $\frac{d\overline{G}(1-\rho)}{\rho}$ corresponding to every *r*. So, ls schedule in Figure 4.2a shifts to the right by $\frac{d\overline{G}(1-\rho)}{\rho}$. The new ls schedule is labeled $\text{ls}^{/}$. The ld schedule as given by the RHS of (4.5), however, remains unaffected. Therefore, the equilibrium *r* falls. The new equilibrium *r* is denoted by r_1. It is also clear from the RHS of (4.7) that the aggregate demand for goods and services corresponding to every *Y* will be larger following a fall in *r*. So, $\text{AD}(r_1)$ schedule will lie above the $\text{AD}(r_0)$ schedule in Figure 4.2b. Hence, equilibrium *Y* will increase. The new equilibrium *Y* is labeled Y_1. It follows from the LHS of (4.6) that the value of $(X-M)+K$ corresponding to every *Y* will fall following an increase in *Y* and a decline in *r*. Therefore, $TK(Y_1, r_1)$ schedule will lie below $TK(Y_0, r_0)$ schedule in Figure 4.2c. Hence, *e* will rise in the new equilibrium. The new equilibrium value of *e* is labeled e_1 in Figure 4.2c.

Mathematical Derivation of the Results

We shall now derive these results mathematically. Taking total differential of (4.5), (4.7) and (4.6) treating all exogenous variables other than $\overline{G}$ as fixed, we get

Effect of an Increase in $\overline{G}$ on *Y*, *r* and *e*

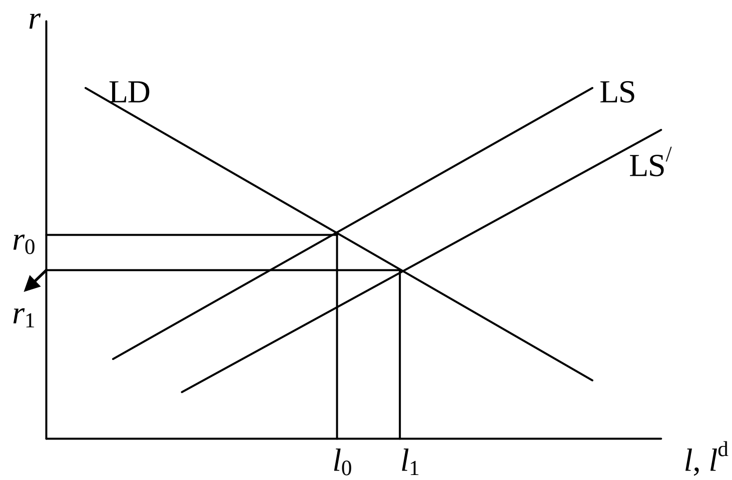

Figure 4.2a

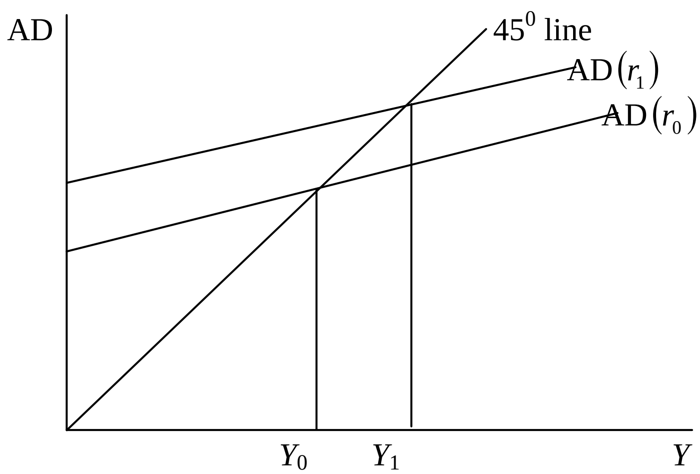

Figure 4.2b

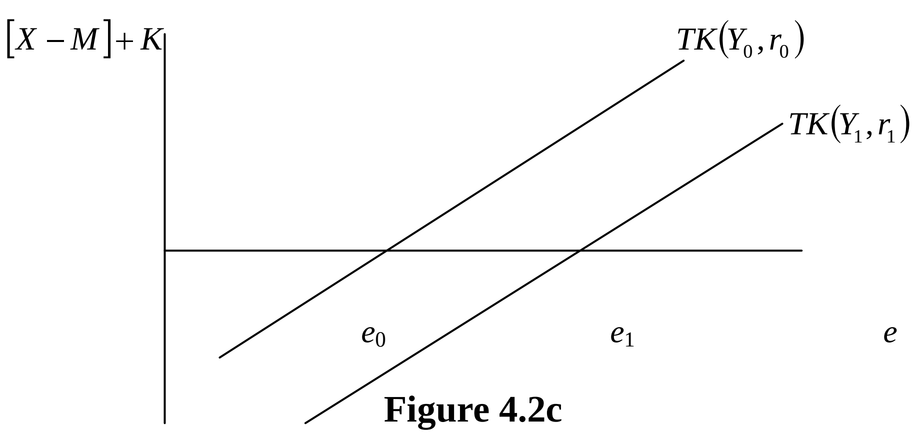

Figure 4.2c

$$\frac{(1-\rho)}{\rho}d\overline{G}+K_{\tilde{r}}dr=I'dr \qquad\qquad K_{\tilde{r}}\equiv\frac{\partial K}{\partial(r-r^*)} \tag{4.8}$$

$$dY=C'dY+I'dr+d\overline{G}-K_{\tilde{r}}dr \tag{4.9}$$

and

$$(X_p-M_p)\frac{P^*}{P}de-M_YdY+K_{\tilde{r}}dr=0 \qquad\qquad p\equiv\frac{P^*e}{P} \tag{4.10}$$

Solving (4.8) for *dr*, we get

$$dr=\frac{\frac{d\overline{G}(1-\rho)}{\rho}}{I'-K_{\tilde{r}}}<0 \tag{4.11}$$

Explanation of (4.11) is quite simple. Following an increase in $\overline{G}$ by $d\overline{G}$, there emerges an excess supply of loans of $\frac{d\overline{G}(1-\rho)}{\rho}$ in the domestic loan market at the initial equilibrium *r*. So, *r* will fall to clear the loan market. Per unit decline in *r* supply of loan goes down by $K_{\tilde{r}}$, while demand for loan goes up by $-I'$. Hence, excess supply of loans falls by $K_{\tilde{r}}+(-I')$. Accordingly, excess supply of loans will fall by $\frac{d\overline{G}(1-\rho)}{\rho}$ to zero, when *r* declines by $\frac{\frac{d\overline{G}(1-\rho)}{\rho}}{-I'+K_{\tilde{r}}}$, i.e., when *r* changes by the RHS of (4.11). Substituting (4.11) into (4.9), we can solve it for dY. It is given by

$$dY=\frac{d\overline{G}}{\rho(1-C')} \tag{4.12}$$

Substituting (4.11) and (4.12) into (4.10), we can solve it for de. It is given by

$$de = \frac{M_Y \frac{d\overline{G}}{\rho(1-C')} + K_{\tilde{r}} \frac{\frac{d\overline{G}(1-\rho)}{\rho}}{-I' + K_{\tilde{r}}}}{\left(X_p - M_p\right)\frac{P^*}{P}} > 0 \tag{4.13}$$

It is quite easy to explain (4.13). From the initial equilibrium to the new one, *Y* has risen by $\frac{d\overline{G}}{\rho(1-C')}$ raising import by $M_Y \frac{d\overline{G}}{\rho(1-C')}$. Again, *r* has fallen by $\frac{\frac{d\overline{G}(1-\rho)}{\rho}}{-I' + K_{\tilde{r}}}$ lowering *K* by $K_{\tilde{r}}\left(\frac{\frac{d\overline{G}(1-\rho)}{\rho}}{-I' + K_{\tilde{r}}}\right)$. The above mentioned changes create a BOP deficit of $M_Y \frac{d\overline{G}}{\rho(1-C')} + K_{\tilde{r}} \frac{\frac{d\overline{G}(1-\rho)}{\rho}}{-I' + K_{\tilde{r}}}$ at the initial equilibrium *e*. So, *e* has to rise to restore BOP equilibrium. Per unit increase in *e*, $[(X-M)+K]$ rises by $\left(X_p - M_p\right)\frac{P^*}{P}$. Hence, $[(X-M)+K]$ will rise by $M_Y \frac{d\overline{G}}{\rho(1-C')} + K_{\tilde{r}} \frac{\frac{d\overline{G}(1-\rho)}{\rho}}{-I' + K_{\tilde{r}}}$, when *e* increases by $\frac{M_Y \frac{d\overline{G}}{\rho(1-C')} + K_{\tilde{r}} \frac{\frac{d\overline{G}(1-\rho)}{\rho}}{-I' + K_{\tilde{r}}}}{\left(X_p - M_p\right)\frac{P^*}{P}}$. This explains (4.13).

Adjustment Process

We shall now describe the adjustment process, i.e, we shall now explain how different economic agents behave following the increase in $\overline{G}$ by $d\overline{G}$ to bring about the changes in

Y, r and e derived above. Following an increase in $\overline{G}$ by $d\overline{G}$, Y goes up by $d\overline{G}$. Out of this additional income of $d\overline{G}$, people spend $(C' - M_Y)d\overline{G}$ on domestic goods. They also spend $PM_Y d\overline{G}$ in the foreign currency market to buy foreign currency to purchase foreign consumption goods. Hence, excess demand emerges in the foreign currency market raising *e*. *e* will rise until $(X - M)$ rises by $M_Y d\overline{G}$ and restores BOP equilibrium. To raise $(X - M)$ by $M_Y d\overline{G}$, *e* will have to rise by $\dfrac{M_Y d\overline{G}}{(X_p - M_p)\frac{P^*}{P}}$. Therefore, the additional income of $d\overline{G}$ creates an additional demand for domestic goods of $(C' - M_Y)d\overline{G} + M_Y d\overline{G} = C'd\overline{G}$. This will raise *Y* by $C'd\overline{G}$. This increase in *Y* will create an additional consumption demand for domestic goods of $(C' - M_Y)C'd\overline{G}$ and raise import demand by $M_Y C'd\overline{G}$. The latter will induce an increase in *e* by $\dfrac{M_Y C'd\overline{G}}{(X_p - M_p)\frac{P^*}{P}}$ so that $(X - M)$ rises by $M_Y C'd\overline{G}$ and restores BOP equilibrium. Thus demand for domestic goods will increase by $(C' - M_Y)C'd\overline{G} + C'M_Y d\overline{G} = C'^2 d\overline{G}$. This is how the multiplier process will operate and raise *Y* at the end of the process by $\dfrac{d\overline{G}}{1 - C'}$ and *e* by $\dfrac{d\overline{G}}{(1 - C')} \cdot \dfrac{M_Y}{(X_p - M_p)\frac{P^*}{P}}$. This is the end of the first round of change.

Out of the additional income of $\dfrac{d\overline{G}}{1 - C'}$ generated in the first round, people will save $\dfrac{d\overline{G}}{(1 - C')}(1 - C') = d\overline{G}$. They will deposit this amount in domestic banks, which in turn will extend out of these new deposits new loans of $(1-\rho)d\overline{G}$ creating an excess supply in the domestic loan market. *r* will, therefore, fall to clear the loan market. Per unit fall in *r*, demand for new loans of domestic borrowers rises by $-I'$, while net supply of new loans from abroad falls by $K_{\tilde{r}}$. Hence, per unit fall in *r*, excess supply of new loans to domestic borrowers falls by $-I'+K_{\tilde{r}}$. Therefore, *r* will fall by $\dfrac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}$ and reduce excess supply of new loans by $(1-\rho)d\overline{G}$ to zero and, thereby, restore equilibrium in the domestic loan market. This fall in *r* will raise *I* by $\dfrac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}(-I')$. It will also lower *K* by $K_{\tilde{r}}\dfrac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}$ creating BOP deficit. *e* will, therefore, rise by $\left[K_{\tilde{r}}\dfrac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}\right]\left[\dfrac{1}{(X_p-M_p)\frac{P^*}{P}}\right]$ to raise $(X-M)$ by $K_{\tilde{r}}\dfrac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}$. Thus, aggregate planned investment and net export increase by $\dfrac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}(-I')+K_{\tilde{r}}\dfrac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}=(1-\rho)d\overline{G}$. This, just as in the first round, sets into motion the multiplier process and *Y* at the end of the multiplier process goes up by $\dfrac{(1-\rho)d\overline{G}}{1-C'}$ in the second round. This increase in *Y*, as before, will raise *e* by $\dfrac{(1-\rho)d\overline{G}}{1-C'}\left[\dfrac{M_Y}{(X_p-M_p)\frac{P^*}{P}}\right]$. Thus, in the second round, in the net *e* goes up by

$$\left[K_{\tilde{r}}\frac{(1-\rho)d\overline{G}}{-I'+K_{\tilde{r}}}\right]\left[\frac{1}{\left(X_p-M_p\right)\frac{P^*}{P}}\right]+\left[\frac{(1-\rho)d\overline{G}}{1-C'}\right]\left[\frac{M_Y}{\left(X_p-M_p\right)\frac{P^*}{P}}\right]=\left(\overline{\theta}+\theta\right)(1-\rho)d\overline{G},$$

where $\theta\equiv\left[\frac{K_{\tilde{r}}}{-I'+K_{\tilde{r}}}\right]\left[\frac{1}{\left(X_p-M_p\right)\frac{P^*}{P}}\right]$ and $\overline{\theta}\equiv\left[\frac{M_Y}{(1-C')}\right]\left[\frac{1}{\left(X_p-M_p\right)\frac{P^*}{P}}\right]$

The increase in Y in the second round, as before, will create an additional saving of $(1-C')\frac{(1-\rho)d\overline{G}}{1-C'}=(1-\rho)d\overline{G}$, which the households will deposit with the domestic banks. The banks will plan to extend out of these new deposits new loans of $(1-\rho)^2 d\overline{G}$, which, as before, will lower r by $\frac{(1-\rho)^2 d\overline{G}}{-I'+K_{\tilde{r}}}$. This, in turn, will raise I by $\frac{(1-\rho)^2 d\overline{G}}{-I'+K_{\tilde{r}}}(-I')$ and lower K by $\frac{(1-\rho)^2 d\overline{G}}{-I'+K_{\tilde{r}}}K_{\tilde{r}}$. The fall in K will create BOP deficit.

This will raise e by $\left[K_{\tilde{r}}\frac{(1-\rho)^2 d\overline{G}}{-I'+K_{\tilde{r}}}\right]\left[\frac{1}{\left(X_p-M_p\right)\frac{P^*}{P}}\right]$ so that $(X-M)$ rises by $K_{\tilde{r}}\frac{(1-\rho)^2 d\overline{G}}{-I'+K_{\tilde{r}}}$. Aggregate planned investment and net export together will, therefore, go up by $\frac{(1-\rho)^2 d\overline{G}}{-I'+K_{\tilde{r}}}(-I')+K_{\tilde{r}}\frac{(1-\rho)^2 d\overline{G}}{-I'+K_{\tilde{r}}}=(1-\rho)^2 d\overline{G}$. This will at the end of the multiplier process raise Y by $\frac{(1-\rho)^2 d\overline{G}}{1-C'}$. This increase in Y will raise e by

$\left[(1-\rho)^2 d\overline{G}\right]\left[\dfrac{M_Y}{\left(X_p - M_p\right)\dfrac{P^*}{P}}\right]$. Thus, in the net e will go up by $\left(\theta + \overline{\theta}\right)(1-\rho)^2 d\overline{G}$ in the third round. This process of expansion will continue until the additional demand that is created at the beginning of each round eventually falls to zero. The total increase in Y and e and the total fall in r brought about by the increase in $\overline{G}$ by $d\overline{G}$ is, therefore, given by

$$dY = \frac{d\overline{G}}{1-C'} + \frac{(1-\rho)d\overline{G}}{1-C'} + \frac{(1-\rho)^2 d\overline{G}}{1-C'} + \dots\dots\dots = \frac{d\overline{G}}{\rho(1-C')} \qquad (4.14)$$

$$de = \overline{\theta} d\overline{G} + \left(\theta + \overline{\theta}\right)(1-\rho)d\overline{G} + \left(\theta + \overline{\theta}\right)(1-\rho)^2 d\overline{G} + \dots\dots\dots = \overline{\theta}\frac{d\overline{G}}{\rho} + \theta\frac{(1-\rho)d\overline{G}}{\rho} \qquad (4.15)$$

$$dr = -\frac{(1-\rho)d\overline{G}}{-I' + K_{\tilde{r}}} - \frac{(1-\rho)^2 d\overline{G}}{-I' + K_{\tilde{r}}} - \frac{(1-\rho)^3 d\overline{G}}{-I' + K_{\tilde{r}}} - \dots\dots\dots = -\frac{\dfrac{(1-\rho)}{\rho} d\overline{G}}{-I' + K_{\tilde{r}}} \qquad (4.16)$$

It is clear that (4.16), (4.14) and (4.15) tally with (4.11), (4.12) and (4.13) respectively.

4.2.2 Monetary Policy

Her we shall examine how an expansionary monetary policy consisting in a cut in r_c will affect *r*, *Y*, *e* in our model. We derive the results mathematically. Taking total differential of (4.5) treating all exogenous variables other than r_c as fixed, and solving for *dr*, we get

$$dr = \frac{\dfrac{l' dr_c}{\rho}}{-I' + K_{\tilde{r}}} < 0 \qquad (4.17)$$

Taking total differential of (4.7) treating all exogenous variables as fixed, substituting for *dr* its value given by (4.17) and, finally, solving for *dY*, we get

$$dY = \frac{l' dr_c}{\rho(1 - C')} > 0 \tag{4.18}$$

Again, taking total differential of (4.6) treating all exogenous variables as fixed, substituting for *dY* and *dr* their values given by (4.17) and (4.18) respectively and, finally, solving for *de*, we get

$$de = \frac{M_y \dfrac{l' dr_c}{\rho(1 - C')} + \dfrac{l' dr_c}{\rho(-I' + K_{\tilde{r}})}}{\left(X_p - M_p\right)\dfrac{P^*}{P}} > 0 \tag{4.19}$$

From the above it follows that monetary policy is effective in influencing output and employment in the flexible exchange rate regime, with imperfect capital mobility. The intuition is quite simple. Following a cut in r_c, the banks take more loans from the central bank. This raises supply of loans in the market depressing the interest rate. Investment demand as a result goes up raising *Y*. The fall in *r* and the increase in *Y* create BOP deficit pushing up the interest rate.

The detailed adjustment process is very similar to that in the case of fiscal policy.

4.2.3 Irrelevance of the Money Market

We shall show here that the equilibrium conditions (4.1), (4.2), (4.5) and (4.6) imply equality of demand for money and supply of money. It means that it is not necessary to consider the money market separately. Substituting (4.6) into (4.10, we get (4.7). Substituting (4.2) and (4.5) into (4.7), we get

$$Y = C\left(Y - \bar{T}\right) + \frac{1-\rho}{\rho}\frac{dH}{P} + \frac{dH}{P} \Rightarrow$$

$$Y - C\left(Y - \bar{T}\right) = \frac{1}{\rho}\frac{dH}{P}$$

The LHS of the above equation gives households' saving, which constitutes demand for additional money, while the RHS gives the supply of additional money. Thus, when the equilibrium conditions of the model are satisfied, demand for money and supply of money become equal automatically.

4.3 Imperfect Capital Mobility, with Fixed Exchange Rate

We shall examine here how Y, r and H are determined under imperfect capital mobility, when the central bank seeks to keep e at a target level to be denoted by $\bar{e}$. In this case, the goods market equilibrium condition is given by

$$Y = C(Y - \bar{T}) + I(r) + \bar{G} + X\left(\frac{P^*\bar{e}}{P}; Y^*\right) - M\left(\frac{P^*\bar{e}}{P}; Y\right) \tag{4.20}$$

The central bank intervenes in the foreign currency market to keep the exchange rate at $\bar{e}$. If there emerges excess supply of foreign currency at $\bar{e}$, the central bank has to buy up this excess supply at $\bar{e}$ with domestic currency so that the stock of high-powered money increases by the value of the excess supply of foreign currency valued at $\bar{e}$. Again, if there emerges excess demand for foreign currency at $\bar{e}$, the central bank has to meet this excess demand for foreign currency by selling foreign currency at $\bar{e}$ in exchange for domestic currency. Clearly, in this case, the stock of high-powered money will go down by the value of the excess demand for foreign currency valued at $\bar{e}$. Therefore, given the assumption that the entire government consumption expenditure is financed by borrowing from the central bank, and the central bank lends to the banks at the policy rate r_c, the increase in the stock of high-powered money in the given period in the economy is given by the following equation:

$$\frac{dH}{P}=\overline{G}+l(r_c)+\left[X\left(\frac{P^*\overline{e}}{P};Y^*\right)-M\left(\frac{P^*\overline{e}}{P},Y\right)+K(r-r^*)+\overline{K}\right] \tag{4.21}$$

Note that $\frac{P}{\overline{e}}\left[X\left(\frac{P^*\overline{e}}{P};Y^*\right)-M\left(\frac{P^*\overline{e}}{P},Y\right)+K(r-r^*)+\overline{K}\right]$ gives the excess supply of foreign currency at $\overline{e}$, which may be positive or negative. If it is negative, it represents excess demand. The domestic central bank has to buy up this excess supply of foreign currency with $\overline{e}.\frac{P}{\overline{e}}\left[X\left(\frac{P^*\overline{e}}{P};Y^*\right)-M\left(\frac{P^*\overline{e}}{P},Y\right)+K(r-r^*)+\overline{K}\right]$ amount of domestic currency raising the stock of high-powered money by $P\left[X\left(\frac{P^*\overline{e}}{P};Y^*\right)-M\left(\frac{P^*\overline{e}}{P},Y\right)+K(r-r^*)+\overline{K}\right]$ and that of real balance by $\left[X\left(\frac{P^*\overline{e}}{P};Y^*\right)-M\left(\frac{P^*\overline{e}}{P},Y\right)+K(r-r^*)+\overline{K}\right]$. This explains (4.21).

Since economic agents hold their savings only in the form of domestic bank deposits, as we have explained in the previous chapters, total planned supply of new loans by domestic banks is given by $\frac{(1-\rho)}{\rho}\left\{\overline{G}+\left[X\left(\frac{P^*\overline{e}}{P};Y^*\right)-M\left(\frac{P^*\overline{e}}{P},Y\right)+K(r-r^*)\right]\right\}+\frac{l(r_c)}{\rho}$. As explained above in the context of the flexible exchange rate regime, total net supply of new loans from abroad is given by $\overline{K}+K(r-r^*)$. To recall, $\overline{K}+K(r-r^*)$ is made up of the total amount of new loans secured by domestic borrowers from abroad net of the total amount of new loans extended by domestic banks to foreigners. Therefore, as before, total supply of new loans to domestic borrowers denoted l is given by

$$l = \frac{(1-\rho)}{\rho}\left[\overline{G} + X\left(\frac{P^*\overline{e}}{P};Y^*\right) - M\left(\frac{P^*\overline{e}}{P},Y\right)\right] + \frac{1}{\rho}l(r_c) + \overline{K} + K(r-r^*) =$$
$$\frac{(1-\rho)}{\rho}\left[\overline{G} + X\left(\frac{P^*\overline{e}}{P};Y^*\right) - M\left(\frac{P^*\overline{e}}{P},Y\right)\right] + \frac{1}{\rho}l(r_c) + \frac{1}{\rho}\left(K(r-r^*) + \overline{K}\right) \tag{4.22}$$

Demand for loans comes only from domestic investors, who finance their entire investment demand with new loans. Thus, demand for new loans of domestic borrowers denoted by l^d is given by

$$l^d = I(r) \tag{4.23}$$

Domestic loan market is in equilibrium when

$$\frac{(1-\rho)}{\rho}\left[\overline{G} + X\left(\frac{P^*\overline{e}}{P};Y^*\right) - M\left(\frac{P^*\overline{e}}{P},Y\right)\right] + \frac{1}{\rho}l(r_c) + \frac{1}{\rho}\left(K(r-r^*) + \overline{K}\right) = I(r) \tag{4.24}$$

The specification of our model is complete. It consists of three key equations, (4.20), (4.21) and (4.24) in three endogenous variables, Y, r and $\frac{dH}{P}$. We solve them as follows. We solve (4.20) and (4.24) for the equilibrium values of Y and r. The solution is shown in Figure 4.3 where equilibrium values of Y and r , labeled Y_0 and r_0, correspond to the point of intersection of the IS and LL curves representing (4.20) and (4.24) respectively. Substituting the equilibrium values of Y and r in (4.21), we get the equilibrium value of $\frac{dH}{P}$. We can show the equilibrium value of $\frac{dH}{P}$ in a diagram as follows. Solving (4.24), we get the equilibrium value of r as a function of Y, given $\overline{G}$ and other parameters of (4.24). Thus,

$$r = r\left(\underset{+}{Y};\underset{-}{\overline{G}}\right) \tag{4.25}$$

Determination of Equilibrium Value of *Y*, *r* and $\frac{dH}{P}$

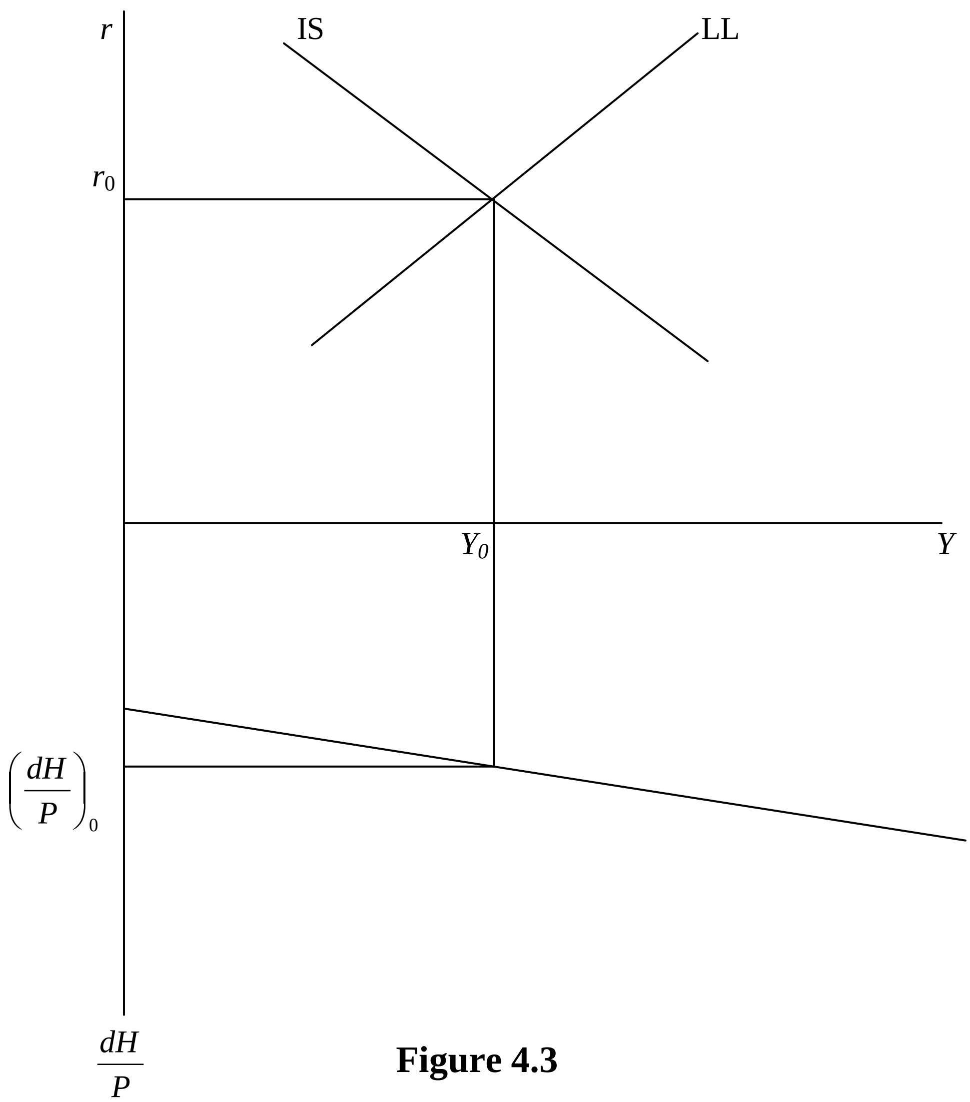

Figure 4.3

Signs of partial derivatives of (4.25) can be easily derived from (4.24). Substituting (4.25) into (4.21), we rewrite it as

$$\frac{dH}{P} = \overline{G} + l(r_c) + \left[X\left(\frac{P^* \overline{e}}{P}; Y^*\right) - M\left(\frac{P^* \overline{e}}{P}, Y\right) + K\left(r\left(\underset{+}{Y}; \underset{-}{\overline{G}}\right) - r^*\right) + \overline{K} \right] \tag{4.26}$$

We measure positive values of $\frac{dH}{P}$ in the downward direction on the vertical axis in the lower panel of Figure 4.4, where HH represents (4.26). Its slope is clearly ambiguous. We have drawn it as positively sloped. The equilibrium value of $\frac{dH}{P}$ corresponds to the equilibrium value of Y on the HH line. The equilibrium value of $\frac{dH}{P}$ is labeled $\left(\frac{dH}{P}\right)_0$.

4.3.1 Fiscal Policy: An Increase in Government Expenditure Financed by Borrowing from the Central Bank

We shall here examine how an increase in $\overline{G}$ financed by borrowing from the central bank affects the endogenous variables of the model. We shall first do it diagrammatically using Figure 4.4, where the initial equilibrium values of Y and r, which correspond to the point of intersection of IS and LL schedules representing (4.20) and (4.24) respectively, are labeled Y_0 and r_0. The initial equilibrium value of $\frac{dH}{P}$, which corresponds to Y_0 on the HH schedule in the lower panel, is labeled $\left(\frac{dH}{P}\right)_0$. Following an increase in $\overline{G}$ by $d\overline{G}$, the IS shifts to the right by $\frac{d\overline{G}}{1 - C' + M_Y}$. The new IS is labeled IS_1 in Figure 4.4. The increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank raises the stock of high-powered money, which, in turn, raises the supply of new loans. Hence, as follows

Effect of an Increase in $\overline{G}$ on Y, r and $\frac{dH}{P}$

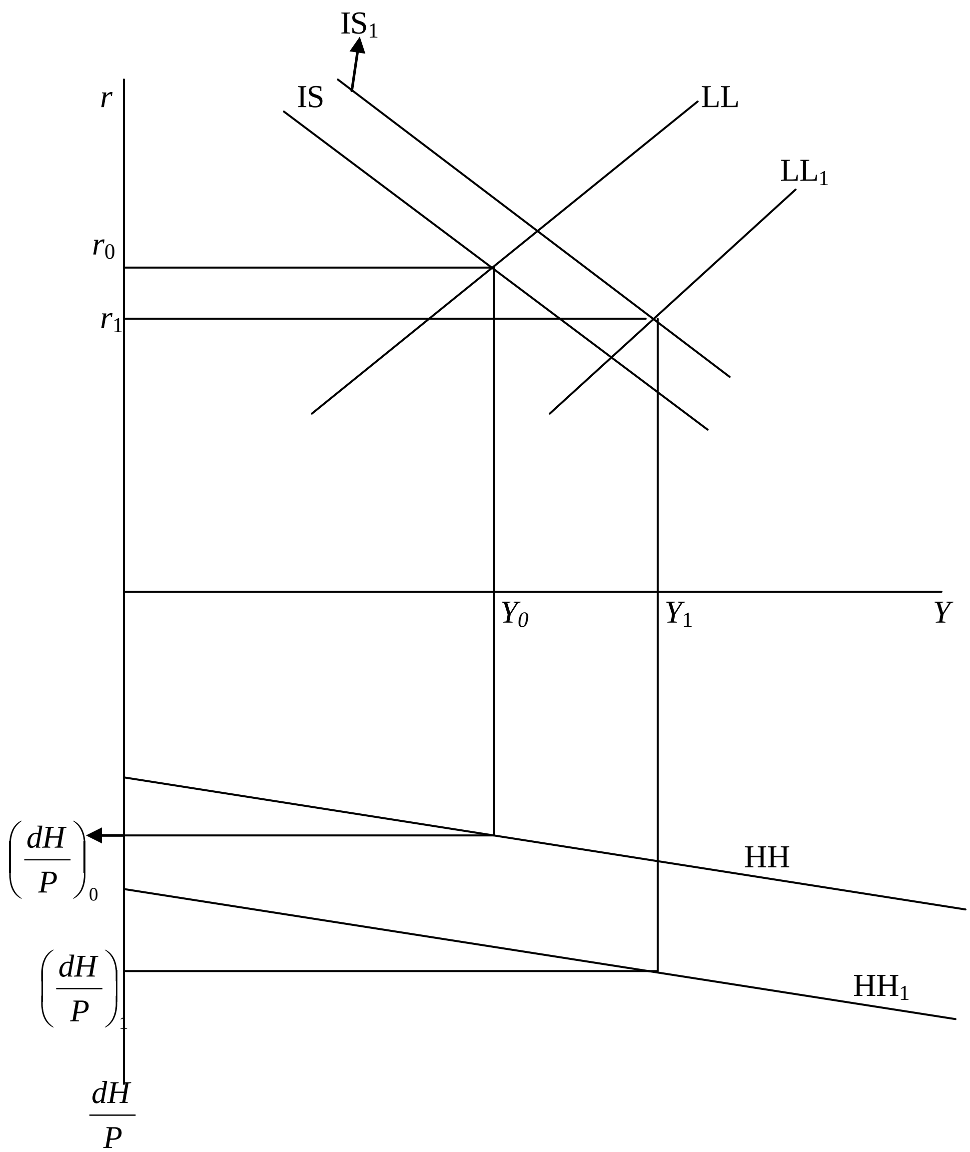

Figure 4.4

from (4.21), the LL schedule also shifts to the right by $\frac{d\overline{G}}{M_Y}$. The new LL is labeled LL_1. Since $(1-C')$ is positive, the rightward shift in the IS is less than that in the LL. Hence, Y goes up and r falls. The new equilibrium values of Y and r are labeled Y_1 and r_1 respectively. Let us now focus on the HH schedule representing (4.26). An increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank directly raises $\frac{H}{P}$ by $d\overline{G}$ corresponding to any given Y. However, the increase in the supply of high-powered money and the consequent increase in the planned supply of loans lowers r. That, in turn, lowers K and, thereby, lowers the supply of high-powered money corresponding to any given Y. However, $\frac{H}{P}$ must increase in the net, otherwise r cannot be less. This may be proved as follows. Using (4.21), we can rewrite (4.24) as $\left(\frac{1}{\rho}\right)\frac{dH}{P} = I(r) + \rho\left(\overline{G} + X\left(\frac{P^*\overline{e}}{P};Y^*\right) - M\left(\frac{P^*\overline{e}}{P},Y\right)\right)$. It is clear from this equation that, if r is less and the value of $\overline{G}$ higher, $\frac{dH}{P}$ has to be larger corresponding to any given Y. Therefore, HH schedule shifts southward. The new HH schedule is labeled HH_1. So, the supply of high-powered money will increase, if HH is positively sloped. If HH is negatively sloped, the direction of change in $\frac{dH}{P}$ becomes ambiguous.

Mathematical Derivation of the Result

Taking total differential of (4.20) and (4.24) treating all exogenous variables other than $\overline{G}$ as fixed, we get

$$dY = C'dY + I'dr + d\overline{G} - M_Y dY \tag{4.27}$$

$$\frac{(1-\rho)}{\rho}d\overline{G} - \frac{(1-\rho)}{\rho}M_Y dY + \frac{1}{\rho}K_{\tilde{r}}dr = I'dr \tag{4.28}$$

We can solve (4.27) and (4.28) for dY and dr.

Solving (4.28), we get

$$dr = \frac{\frac{(1-\rho)}{\rho}\left(d\overline{G} - M_Y dY\right)}{-\left[(-I') + \frac{1}{\rho}K_{\tilde{r}}\right]} \tag{4.29}$$

Substituting (4.29) into (4.27), we get

$$dY = C'dY + (-I')\frac{\frac{(1-\rho)}{\rho}\left(d\overline{G} - M_Y dY\right)}{\left[(-I') + \frac{1}{\rho}K_{\tilde{r}}\right]} + d\overline{G} - M_Y dY \Rightarrow$$

$$dY = \frac{d\overline{G} + (-I')\dfrac{\frac{(1-\rho)}{\rho}d\overline{G}}{\left[(-I') + \frac{1}{\rho}K_{\tilde{r}}\right]}}{1 - (C' - M_Y) - (-I')\dfrac{\frac{(1-\rho)}{\rho}M_Y}{\left[(-I') + \frac{1}{\rho}K_{\tilde{r}}\right]}} \tag{4.30}$$

Adjustment Process

We may describe the adjustment process in the present case as follows. Following an increase in $\overline{G}$ by $d\overline{G}$ financed by borrowing from the central bank, demand for domestic goods rises by $d\overline{G}$. Demand for domestic goods rises because of another reason also. As the government spends $d\overline{G}$ for purchasing domestic goods, the amount accrues to the sellers. Since no one holds currency, the whole of this amount gets deposited with the domestic banks. This will start the money multiplier process and create an excess supply of $\frac{(1-\rho)}{\rho}d\overline{G}$ in the credit market. Interest rate r will, therefore, fall and clear the credit market. Per unit fall in r, as one can easily check from (4.19), excess supply of credit falls by $(-I')+\frac{1}{\rho}K_{\tilde{r}}$. Hence r will fall by $\frac{\frac{1-\rho}{\rho}d\overline{G}}{(-I')+\frac{1}{\rho}K_{\tilde{r}}}$ raising investment demand by $(-I')\frac{\frac{1-\rho}{\rho}d\overline{G}}{(-I')+\frac{1}{\rho}K_{\tilde{r}}}$. Thus, aggregate demand for domestic goods increases by $d\overline{G}+(-I')\frac{\frac{1-\rho}{\rho}d\overline{G}}{(-I')+\frac{1}{\rho}K_{\tilde{r}}}$. Hence, Y goes up by $d\overline{G}+(-I')\frac{\frac{1-\rho}{\rho}d\overline{G}}{(-I')+\frac{1}{\rho}K_{\tilde{r}}}(\equiv dY_1)$. This is the end of the first round. The increase in Y in the first round raises aggregate factor income and, therefore, aggregate disposable income by dY_1. As a result, aggregate demand for domestic goods rises by $(C'-M_Y)dY_1$ and import demand increases by $M_Y dY_1$. The latter lowers bank reserves by the same amount reducing supply of bank credit by $\frac{(1-\rho)}{\rho}M_Y dY_1$. The resulting excess demand for credit will raise r by $\frac{\frac{1-\rho}{\rho}M_Y dY_1}{(-I')+\frac{1}{\rho}K_{\tilde{r}}}$, which, in turn, will lower investment by $(-I')\frac{\frac{1-\rho}{\rho}M_Y dY_1}{(-I')+\frac{1}{\rho}K_{\tilde{r}}}$. Thus, aggregate demand for domestic goods will increase by

$\left[\left(C'-M_Y\right)-\left(-I'\right)\dfrac{\frac{1-\rho}{\rho}M_Y}{\left(-I'\right)+\frac{1}{\rho}K_{\tilde{r}}}\right]dY_1$. Y will, accordingly, go up by $\left[\left(C'-M_Y\right)-\left(-I'\right)\dfrac{\frac{1-\rho}{\rho}M_Y}{\left(-I'\right)+\frac{1}{\rho}K_{\tilde{r}}}\right]dY_1\left(\equiv dY_2\right)$. From the above it follows that in the third round, Y will increase by $\left[\left(C'-M_Y\right)-\left(-I'\right)\dfrac{\frac{1-\rho}{\rho}M_Y}{\left(-I'\right)+\frac{1}{\rho}K_{\tilde{r}}}\right]^2 dY_1\left(\equiv dY_3\right)$. This multiplier process will continue until the additional demand that is created eventually falls to zero. Thus the total increase in Y is given by

$$dY = dY_1 + \left[\left(C'-M_Y\right)-\left(-I'\right)\frac{\frac{1-\rho}{\rho}M_Y}{\left(-I'\right)+\frac{1}{\rho}K_{\tilde{r}}}\right]dY_1 + \left[\left(C'-M_Y\right)-\left(-I'\right)\frac{\frac{1-\rho}{\rho}M_Y}{\left(-I'\right)+\frac{1}{\rho}K_{\tilde{r}}}\right]^2 dY_1 + \ldots\ldots\ldots$$
$$= \frac{dY_1}{1-\left[\left(C'-M_Y\right)-\left(-I'\right)\dfrac{\frac{1-\rho}{\rho}M_Y}{\left(-I'\right)+\frac{1}{\rho}K_{\tilde{r}}}\right]} \tag{4.31}$$

(4.31) tallies with (4.30).

4.3.2 Monetary Policy

We shall examine here the impact of expansionary monetary policy, which consists in the central bank lowering its policy rate r_c. We shall derive the impact mathematically.

Taking total differential of (4.20) and (4.24) treating all exogenous variables other than r_c as fixed, we get

$$dY = C'dY + I'dr - M_Y dY \tag{4.32}$$

and

$$\frac{1}{\rho} l' dr_c - \frac{(1-\rho)}{\rho} M_Y dY + \frac{1}{\rho} K_{\tilde{r}} dr = I'dr \tag{4.33}$$

We can solve (4.32) and (4.33) for dY and dr.

Solving (4.33), we get

$$dr = \frac{\frac{1}{\rho} l' dr_c - \frac{(1-\rho)}{\rho} M_Y dY}{-\left[(-I') + \frac{1}{\rho} K_{\tilde{r}}\right]} \tag{4.34}$$

Substituting (4.34) into (4.32), we get

$$dY = C'dY + (-I')\frac{\frac{1}{\rho} l' dr_c - \frac{(1-\rho)}{\rho} M_Y dY}{\left[(-I') + \frac{1}{\rho} K_{\tilde{r}}\right]} - M_Y dY \Rightarrow$$

$$dY = \frac{(-I')\dfrac{\frac{1}{\rho} l' dr_c}{\left[(-I') + \frac{1}{\rho} K_{\tilde{r}}\right]}}{1 - (C' - M_Y) - (-I')\dfrac{\frac{(1-\rho)}{\rho} M_Y}{\left[(-I') + \frac{1}{\rho} K_{\tilde{r}}\right]}} > 0 \tag{4.35}$$

Thus monetary policy is also effective in influencing output and employment. The interpretation of (4.35) and the adjustment process are very similar to those in the case of fiscal policy.

4.3.3 Irrelevance of the Money Market

We shall now show that the equilibrium conditions (4.17), (4.18) and (4.21) imply equality of demand for money and supply of money so that it is not necessary to consider the money market separately. Substituting (4.18) into (4.17), we rewrite it as

$$Y - C(Y) = \frac{dH}{P} + I(r) - K(r - r^*) \tag{4.29}$$

Again, substituting (4.18) into (4.21), we get

$$\frac{(1-\rho)}{\rho}\frac{dH}{P} - \left[\frac{(1-\rho)}{\rho}K(r - r^*) - \frac{1}{\rho}K(r - r^*)\right] = \frac{(1-\rho)}{\rho}\frac{dH}{P} + K(r - r^*) = I(r) \tag{4.30}$$

Substituting (4.30) into (4.29), we get

$$Y - C(Y) = \frac{dH}{P} + \frac{1-\rho}{\rho}\frac{dH}{P} = \frac{1}{\rho}\frac{dH}{P} \tag{4.31}$$

The LHS of (4.31) is the households' saving, which constitutes demand for additional money, while the RHS gives the supply of additional money. Hence, the equilibrium conditions of the model imply equality of demand for money and supply of money.

4.4 Conclusion

The model presented here resolves almost all the problems of the IS-LM model for an open economy, with imperfect capital mobility. The model is spelt out in terms of flows only. There is a full-fledged financial sector, with the central bank and the banks. Financing of every kind of expenditure is explicitly considered here. It brings out clearly the close connection between the generation of income, saving, credit and expenditure. Interest rate is determined, as it should be, in the credit market. Equilibrium conditions of the model also ensure equality of demand for money and supply of money. This model considers only the banks: the central bank and the banks. It can be easily extended to consider other kinds of financial institutions and assets.