Lecture Note: Income Determination in the Open Economy

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1. Introduction

We have examined the determination of exchange rates in the short run and in the long run using the asset approach. We have learned how interest rates, expected inflation, and even productivity growth impacts on exchange rates. But all of this analysis was conducted with the level of output treated as an exogenous variable. We did not consider how changes in exchange rates and interest rates impact on national income. We now must remedy this problem. We turn to the determination of income, the current account, and the exchange rate in the open economy. The workhorse model in international finance is the Mundell-Fleming model. This model focuses on flows of spending, rather than on stocks of assets as we previously analyzed.

The M-F model incorporates the current account into the standard IS-LM model. We see how changes in exchange rates affect spending flows and how the current account fits into macroeconomic balance. The IS-LM model is a static model, that is a limitation. But it makes an important contribution.

How can we deal with these two approaches separately, when both seem to focus on important matters? The basic reason is easy to see if we recall the equation for the balance of payments:

$$CA_t + KO_t = \Delta IR_t \tag{1.1}$$

In equilibrium $\Delta IR = 0$,[1] so we have:

$$CA_t + KO_t = 0. \tag{1.2}$$

[1] Notice that this is a very weak notion of external balance. It boils down to no need to ster-

Now it immediately follows from (1.2) that if the current account is in balance so is the current account, and vice versa. Hence, we can focus on either balance. If we know combinations of income, interest rates, and exchange rates that keep the current account at some level, we know that in equilibrium the capital account will equal the negative of that at these same parameter values. Hence, we can follow the flow approach and look at CA_t, of we can look at asset approaches focussing on KO_t.

2. Aggregate Demand and the Open Economy

It is useful to begin with a fix-price economy. This makes the analysis simpler. We can later extend to flexible prices. Hence, we can let the price level, P, be a shift variable for now. It is also useful to begin by assuming that the current account is equivalent to the trade balance, T.[2] Because the current account is equal to the difference between income and absorption, we have:

$$CA = T = Y - A = Y - C - I - G \tag{2.1}$$

Notice that the trade balance in nominal terms can be written as:

$$\begin{aligned} T_N &= X_N - M_N & (2.2) \\ &= PM^* - eP^*M. & (2.3) \end{aligned}$$

Hence, the trade balance in real terms is given by

$$\begin{aligned} T &= M^* - \frac{eP^*}{P}M \\ &= M^* - qM & (2.4) \end{aligned}$$

where q is the real exchange rate.

ilize. But a country could satisfy this condition while increasing its indebtedness dramatically. This external balance condition tells us nothing about inter-temporal balance. It is interesting because it tells us what is happening to monetary policy. So it is a very short-term notion of equilibrium.

[2] The difference between the current account and the trade balance – interest income on foreign assets, tourism, other invisibles – are relatively small and more importantly, unlikely to be related strongly to movements in domestic income. Nonetheless, we only ignore them for simplicity.

2.1. Real Exchange Rate and the Trade Balance

Now we explain how the q affects the trade balance. Let us write the demand for domestic exports as

$$M^* = M^*(q, Y^*) \tag{2.5}$$

where $\frac{\partial M^*}{\partial q} > 0$, because a rise in the real exchange rate increases the relative price of foreign goods. Similarly, $\frac{\partial M^*}{\partial Y^*} > 0$, because a rise in foreign income increases their imports which are our exports.

We can write the domestic demand for import function as

$$M = M(q, Y) \tag{2.6}$$

where $\frac{\partial M}{\partial q} < 0$, because a rise in the relative price of foreign goods switches expenditure to domestic goods. And we have $\frac{\partial M}{\partial Y} > 0$, because a rise in domestic income raises imports. We can thus write the trade balance as

$$\begin{aligned} T &= M^*(q, Y^*) - qM(q, Y) && (2.7) \\ &= \overline{T}(q, Y^*, Y) && (2.8) \end{aligned}$$

It is useful to write this in the separable linear form:

$$T = \overline{T}(Y^*) - mY + \phi q \tag{2.9}$$

where m is the marginal propensity to import and $\overline{T}(Y^*)$ represents the autonomous component of exports. The real question, however, is over the sign of ϕ, which measures the effect of the real exchange rate on the trade balance. It is important to note that in theory ϕ could be positive or negative. This follows from (2.7) because q increases exports and reduces imports, but it causes the cost of imports to increase.

2.2. The Marshall-Lerner Condition

It is important to know whether an appreciation of the exchange rate improves the trade balance or not. Notice that in our model, with the price level fixed, the real exchange rate and the nominal exchange rate move together. Thus let us find the condition when the trade balance will improve if the real exchange rate appreciates.

Recall the question. An appreciation of the exchange rate will increase exports and reduce imports, but it will increase the cost of imports. Hence, the outcome depends on *how sensitive* are exports and imports to changes in the real exchange rate. In other words, to the elasticity of exports and imports with respect to the real exchange rate. These are defined, respectively as $\eta^* = \frac{\Delta M^*/M^*}{\Delta q/q}$, and $\eta = -\frac{\Delta M/M}{\Delta q/q}$. Notice that a rise in the real exchange rate reduces the demand for imports, and it is useful to define elasticities as positive numbers.

Notice that we can write the change in the value of the trade balance as

$$\Delta T = \Delta M^* - q\Delta M - M\Delta q \tag{2.10}$$

hence, dividing by Δq

$$\frac{\Delta T}{\Delta q} = \frac{\Delta M^*}{\Delta q} - \frac{q\Delta M}{\Delta q} - \frac{M\Delta q}{\Delta q}.$$

Now let us assume that we start from a position of trade balance, i.e., $M^* = qM$. Then, we obtain:

$$\begin{aligned} \phi &\equiv \frac{\Delta T}{\Delta q} = \frac{M^*}{q}\left(\frac{\Delta M^*}{\Delta q}\frac{q}{M^*} - \frac{\Delta M}{\Delta q}\frac{q}{M} - 1\right) \\ &= \frac{M^*}{q}\left(\eta^* + \eta - 1\right). \end{aligned} \tag{2.11}$$

From this last expression we obtain what is known as the Marshall-Lerner condition by noting that $\frac{M^*}{q}$ must be positive. Hence, the trade balance will improve iff $\eta^* + \eta - 1 > 0$. In other words, the condition for the trade balance to improve in response to an appreciation in the real exchange rate is that the sum of these elasticities exceed unity.

The Marshall-Lerner condition makes intuitive sense. When exports and imports are very sensitive to the real exchange rate, then a change in the latter will cause exports to rise and imports to decrease sufficiently to offset the higher cost of imports. Clearly, if exports and imports were insensitive to prices, then the trade balance would not improve. Whether the Marshall-Lerner condition is satisfied or not in the real world is an empirical condition. For the most part we will assume that it is satisfied, so that $\phi > 0$.

2.2.1. The J-Curve

We can derive an important relationship between the time path of the trade balance in response to exchange rate changes by noting that elasticities are larger in the long run than in the short run. It takes time for quantities to adjust to prices. This means that at *impact* we would expect the only effect of a change in q to be a worsening of T. Over time, exports will rise an imports will fall. Eventually, the trade balance will improve. Hence, we derive the *J-curve*.

Why does T worsen before improving? First, elasticities are always higher in the long run than in the short run, because it takes time for behavior and production to adjust to changes in prices. Second, in the short run agents may not be sure that a change in the exchange rate is permanent – they may only start to adjust once they see that the change is not temporary.

For most purposes, however, we are doing comparative statics, so our concern is what happens to equilibrium levels of T.

2.3. Goods Market Equilibrium

We now derive the goods market equilibrium condition in the open economy. We continue to treat prices as fixed. Let $\overline{A} \equiv \overline{C} + \overline{I} + \overline{G}$ be autonomous absorption.[3] Then we can write domestic absorption as

$$A = \overline{A} + aY - br \tag{2.12}$$

where a is the marginal propensity to spend out of income, and b is the elasticity of spending with respect to the interest rate. The signs follow from assumption about consumption and investment spending.

Equilibrium in the goods market requires that income equal absorption plus the trade balance, $Y = A + T$. Hence using (2.9) we have:

$$Y = \overline{A} + aY - br + \overline{T} - mY + \phi q \tag{2.13}$$

and solving for Y:

$$\begin{aligned} Y &= \frac{\overline{A} - br + \overline{T} + \phi q}{1 - a + m} && (2.14) \\ &\equiv \alpha(\overline{A} - br + \overline{T} + \phi q). && (2.15) \end{aligned}$$

Expression (2.15) is the equation for the IS curve in the open economy. The IS curve represents combinations of income and the rate of interest that keep the

[3] For simplicity we are going to assume that all government spending is autonomous, and that taxes are lump sum.

goods market in equilibrium. The slope of the IS curve is equal to $-\frac{1-a+m}{b} = -\frac{1}{\alpha b}$. Because $\alpha > 0$, the slope of the IS curve is negative. An increase in b, meaning that investment is more sensitive to interest rates makes the IS curve flatter. Increases in autonomous expenditure shift it to the right.

We also deduce from (2.15) that an increase in $\overline{T}$ causes the IS curve to shift to the right. Aggregate demand is higher at every interest rate. This makes sense. An increase in $\overline{T}$ means that spending is higher than before. To keep the goods market in equilibrium the interest rate must be higher at every level of income.

2.3.1. Graphically

It is useful to see this graphically. The equilibrium condition can be written as $Y - A = T$. The left-hand side is national savings minus investment, the right-hand side is the current account. For the graphs I will label the left-hand side as $NS - I$. We know that $NS - I$ is increasing in income. How? Because $a < 1$, which means that as income rises $Y - A$ must increase. So the curve $NS - I$ must increase with Y, and its slope is $1 - a$. If $Y = 0$, then $NS - I = -[\overline{A} - br]$, which is the intercept. Notice that a fall in the rate of interest will shift the curve down. You can also figure out what happens when $\overline{A}$ changes.

How about the trade balance. Clearly, this falls with higher income. When $Y = 0$, then $T = \overline{T} + \phi q$, which is the intercept. We refer to this as the TB locus. So we have figure (2.1). Notice that at point A the goods market is in equilibrium and the trade balance is in surplus. You can examine the impact of changes in various policies on goods market equilibrium. Expenditure *switching* policies shift the TB locus up or down. For example, imposing a tariff or devaluing the currency. These policies raise the value of the trade balance at every level of income. Expenditure *changing* policies shift the $NS - I$ locus – they impact on the level of expenditures. For example, government spending or autonomous investment may increase. Or taxes may decrease.

Suppose that $T < 0$, and that this causes q to rise. What happens? If we assume that the Marshall-Lerner condition holds then $\phi > 0$ and the TB locus shifts up. Given that $a < 1$, we can see that income must rise and the trade balance must improve. The rise in q shifts the composition of expenditure towards domestic goods. This causes income to rise, but some of the increased income is saved, hence we reach a new equilibrium. Notice, however, that as $a \to 1$ the slope of the $NS - I$ locus gets flatter and flatter. This implies that changes in income will have less impact on the trade balance. It stands to reason that if

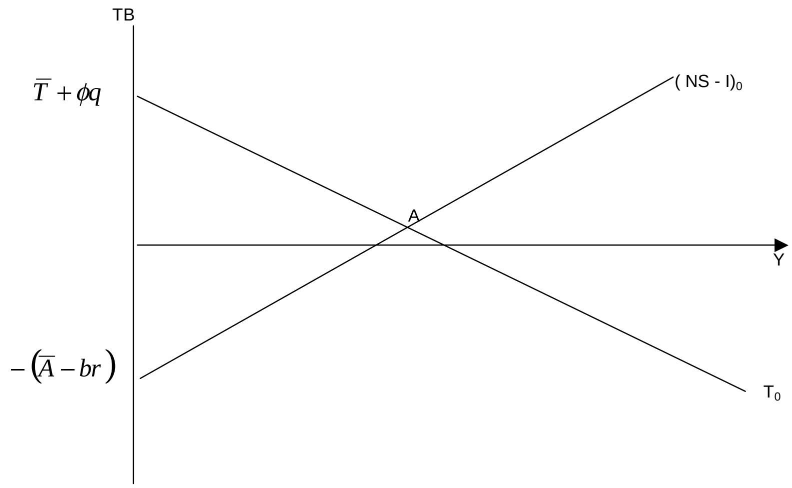


Figure 2.1: Goods Market Equilibrium

changes in Y cannot change the balance between national savings and investment it cannot affect the trade balance, since we know that the two are essentially the same thing! If national savings is less than investment at any level of income then no amount of real exchange rate appreciation can reduce the trade deficit. Only a change in some other policies will do it.[4]

The IS curve represents goods market equilibrium. But we have two endogenous variables, Y and i with one equation. We need another condition.

2.4. Money Market Equilibrium

To close the model we need a relationship that defines equilibrium in asset holding. We suppose that there are two assets, money and bonds, that people hold their wealth in. Thus:

$$\frac{W}{P} = \frac{M^s}{P} + V^s \tag{2.16}$$

[4] It is important to note that we have assumed that changes in q do not affect $NS-I$. This is a standard assumption. But see the discussion on the Laursen-Metzler-Harberger effect, below (section 3.3.4). We might also consider whether a change in the real exchange rate might impact balance sheets and therefore savings. But for the most part we will assume that A is unaffected by changes in q.

where V^s is the real supply of bonds. The demand for assets must some up to the total amount of wealth, hence we must also have:

$$\frac{W}{P} = L^d + V^d \tag{2.17}$$

where L^d is the demand for real money balances. It is clear from these two expressions that

$$\frac{M^s}{P} + V^s = L^d + V^d \tag{2.18}$$

Another way to write this expression is Walras' Law for assets:

$$\left(L^d - \frac{M^s}{P}\right) + \left(V^d - V^s\right) = 0 \tag{2.19}$$

where we have used parentheses to separate the money market and the bond market.

The important point about (2.19) is that it means we need only study the conditions that determine equilibrium in one of the two markets. We will focus on the money market.

What does the demand for money depend on? Notice that our concern is with real money balances. What agents demand is the means to buy goods. Real money balances are assumed to depend on the quantity of purchases people plan to make and the opportunity cost of holding money. The latter is just the nominal interest rate, i. The alternative to holding money is to hold bonds. Holding money means that interest is foregone. Hence, real money demand is inversely related to i. As for the transactions demand for money, we use real income as a proxy. Hence, we can write:

$$\begin{aligned} L^d &= l(Y, i) \\ &= kY - hi \end{aligned} \tag{2.20}$$

where we have linearized money demand for convenience.

Equilibrium in the money market requires that money demand equal money supply. Denoting the latter by $\frac{M^s}{P}$ we have:

$$\frac{M^s}{P} = kY - hi \tag{2.21}$$

or

$$i = \frac{1}{h}\left(kY - \frac{M^s}{P}\right) \tag{2.22}$$

which is the equation of the LM curve. Notice that we have not specified how the nominal money supply is determined. As we shall see, this will differ depending on the exchange rate regime.

To see more clearly how we derive the LM curve and why it is positively sloped we plot condition (2.21) in figure 2.2: Suppose that income rises. Then money

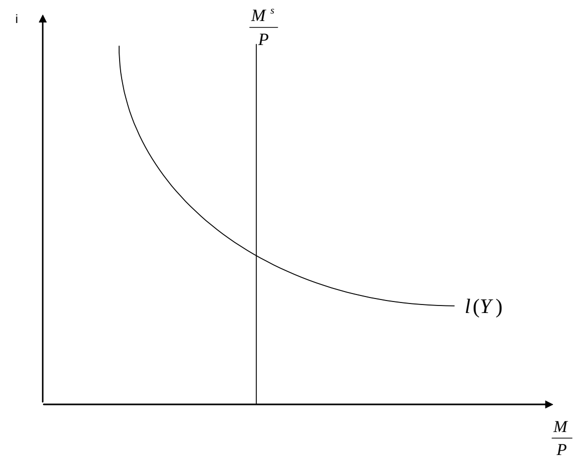


Figure 2.2: Money Market Equilibrium

demand will increase. This means that the interest rate must rise to keep the money market in equilibrium. So the LM curve is positively sloped: higher i is associated with higher Y. Similarly, we can see that a rise in the money stock or a fall in the price level must cause the LM curve to shift to the right: higher income is associated with any given interest rate.

We can thus plot the LM curve in figure 2.3

Fisher Equation It is also important to note that we have used two different notions of the rate of interest in the IS and LM equations. In the IS curve the appropriate interest rate is the real rate, r, which measures the premium of present over future consumption. It is this measure which is relevant for savings and investment decisions. But the LM equation contains the nominal interest rate, i, which is the opportunity cost of holding money.

Fortunately, there is an important relation that connects the two. The Fisher equation is given by

$$i = r + \pi^e \tag{2.23}$$

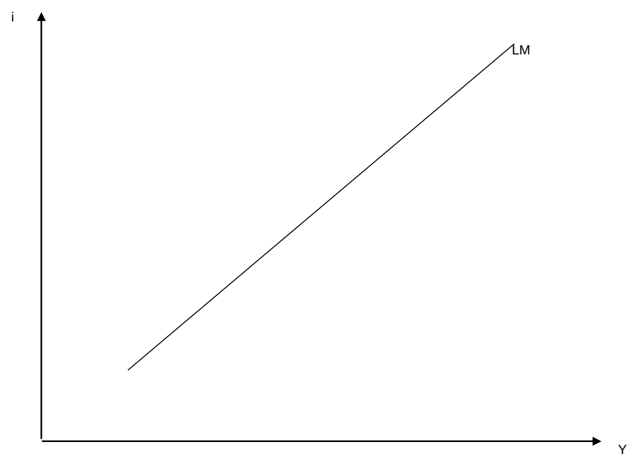


Figure 2.3: The LM Curve

where π^e is expected inflation. For any given real interest rate, a rise in expected inflation causes the nominal rate to fall; hence, it causes the LM curve to shift to the left. This follows, because a fall in the nominal rate of interest increases money demand, so a decrease in income is needed to keep money demand unchanged. Alternatively, if we draw the IS-LM diagram in $i - Y$ space, then a rise in π^e represents a decrease in real interest rates, and thus causes the IS curve to shift to the right.

If we ignore inflation, and set $\pi^e = 0$, then we can use r and i interchangeably. It is best, however, to be more careful (despite the text).

2.5. IS-LM

We now put the two relations together. Equilibrium in both markets is given by the intersection of IS and LM. At this point, the bond market is also in equilibrium, by virtue of Walras Law.

We can solve for the equilibrium level of output by substituting expression (2.22) into (2.15):

$$\begin{aligned} Y &= \frac{\overline{A} - b(i - \pi^e) + \overline{T} + \phi q}{1 - a + m} \\ &= \frac{\overline{A} - b\left(\left[\frac{1}{h}\left(kY - \frac{M^s}{P}\right)\right] - \pi^e\right) + \overline{T} + \phi q}{1 - a + m} \end{aligned}$$

so

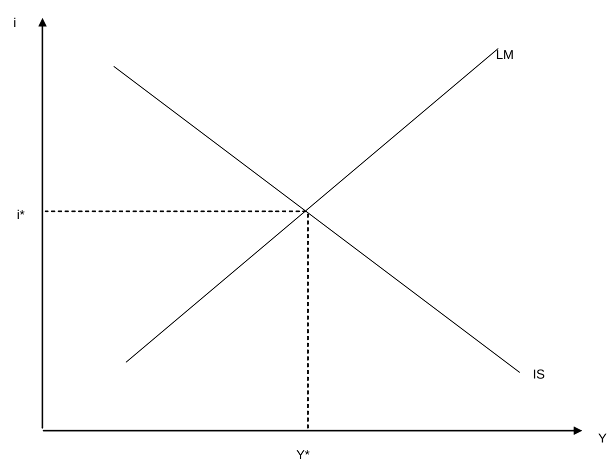
$$Y\left(1+\frac{\frac{bk}{h}}{1-a+m}\right)=\frac{\overline{A}+\frac{b}{h}\left(\frac{M^s}{P}\right)-b\pi^e+\overline{T}+\phi q}{1-a+m}$$

or

$$Y=\frac{\overline{A}+\frac{b}{h}\left(\frac{M^s}{P}\right)-b\pi^e+\overline{T}+\phi q}{1-a+m+\frac{bk}{h}} \tag{2.24}$$

which confirms that increases in the nominal money stock, autonomous absorption, and the autonomous trade balance increase equilibrium income, while increases in expected inflation and decreases in the real exchange rate decrease equilibrium income.

We can see the equilibrium level of income and the interest rate graphically. It is where the IS and LM curves intersect, in figure 2.5. Notice that we can see what happens when any of the parameters change. For example, a rise in the real exchange rate shifts the IS curve to the right, so equilibrium i and Y must rise. Similarly, an increase in the demand for money shifts the LM curve to the left, so i must rise while Y falls. We now have equilibrium in the goods market and the



money market. We have a model for the closed economy. The last piece to add is external equilibrium.

3. Flexible Exchange Rates and the Balance of Payments

We know that under a regime of flexible exchange rates central banks do not intervene in exchange markets. Hence, changes in the reserve settlements balance is always equal to zero. If we ignore the differences between the current account and the trade balance, then we can write:

$$B = T + K = 0 \tag{3.1}$$

where B is the reserve settlements balance and K are capital inflows. In practice, of course, central banks do intervene, but we will ignore this until later.

3.1. The BB Curve

What determines the balance of payments, B? We now derive the BB curve which shows how interest rates and income effect the balance of payments.

Recall that the trade balance depends on domestic and foreign income and the real exchange rate. We are treating foreign income as exogenous, so we will simply write $T = T(q, Y)$, or use the linear approximation of before: $T = \overline{T} - mY + \phi q$.

What about capital flows? From our previous analysis we know that interest differentials and expectations about future exchange rates are key variables. For now we are going to ignore the latter and focus on interest differentials. If we let i^* be the foreign interest rate, we can write $K = \beta(i - i^*)$, where β is a measure of the sensitivity of capital inflows to interest differentials.[5] If β is high, then small interest differentials cause massive capital inflows, and vice versa.

Now put the elements together into equation (3.1) we get the BB curve, the combinations of i and Y that maintain external balance:

$$B = \overline{T} - mY + \phi q + \beta(i - i^*) = 0 \tag{3.2}$$

So, solving for i we get:

$$i = \frac{1}{\beta}\left(mY - \overline{T} - \phi q\right) + i^* \tag{3.3}$$

Hence, the slope of the BB curve is $\frac{m}{\beta}$.

Two special cases are immediate:

[5]Notice that we are assuming that the exchange rate is expected to remain constant, i.e., $\delta = 0$. Later, we will allow δ to vary. When we do, capital flows depend on the difference between i and $i^* + \delta$.

- *Perfect capital mobility* ($\beta = \infty$) means that domestic residents can borrow or lend as much as they want at the world interest rate. This represents a perfectly integrated capital market. In this case the domestic interest rate can never differ from the world rate, because this would cause infinite capital inflows. If we draw combinations of i and Y that keep the balance of payments in equilibrium, we see that the BB curve is horizontal (its slope is zero) at the world interest rate. From (3.3) if $\beta \longrightarrow \infty$, $i \rightarrow i^*$. All points above the BB curve represent capital inflows and $B > 0$, so the currency is appreciating, and vice versa.

- *Zero capital mobility* ($\beta = 0$) occurs when there are prohibitive restrictions on capital flows. It is hard to think about this now, but in the earlier post-WW2 period restrictions on capital flows were quite common. In fact, France still had such restrictions till the early 1980's, and the communist world always had such barriers. In this case, balance of payments equilibrium depends only on the trade balance. The interest rate has no effect since K always equals 0. The BB curve is vertical in $i - Y$ space, at the level of income such that $T = 0$.[6] All points to the left of the BB curve represent a trade surplus, so this is the region of currency appreciation.

  - This is just the monetary approach to the exchange rate, with prices fixed rather than with PPP. Suppose there is an IS expansion. This causes the IS to shift right, raising income and worsening the trade balance. The currency depreciates (there is no incipient capital inflow, even though interest rates rise, because there *are no capital flows!*). How do we get to equilibrium? Notice that the real exchange rate increasing means that both the IS curve and the vertical BB curve will shift to the right. By how much. We have $mY = \overline{T} - \phi q$ which implies that $\Delta Y = \frac{\phi}{m}\Delta q$. From (2.14) the shift in the IS curve is $\frac{\phi}{1-a+m}\Delta q$, so as long as $1 - a > 0$ the IS curve shift is less than the BB curve shift, so the trade balance returns to equilibrium at a lower value of the domestic currency.
  - A monetary expansion shifts the LM curve to the right. The adjustment is left to the reader.

[6] If there are no capital flows then the balance of payments corresponds to the trade balance, and setting $B = 0$, we can solve for the unique level of income, $\widehat{Y} = -\frac{1}{m}(\overline{T} + mq)$. The BB curve is vertical at this level of income.

– Under fixed exchange rates and zero capital mobility we have the monetary approach to the balance of payments. A monetary expansion causes the trade balance to worsen. Reserves fall, this causes the money stock to decrease and we return to the initial equilibrium. Notice that monetary policy is ineffective under fixed exchange rates.

There is also an intermediate case: *imperfect capital mobility*. In this case capital flows are present, but not perfect. Hence, capital flows are finite when there are interest differentials, leading to a trade-off between i and Y and an upward sloping BB curve. The reason why is clear. Higher income means a larger trade deficit. To keep $B = 0$, higher interest rates are needed to induce capital inflows. Hence the slope of the BB curve will depend on β and on $\frac{\partial T}{\partial Y}(\equiv m)$. Linearizing the balance of payments equation yields:

$$B = \overline{T} - mY + \phi q + \beta(i - i^*) = 0$$

so

$$i = \frac{1}{\beta}\left(mY - \overline{T} - \phi q\right) + i^*. \tag{3.4}$$

which is the equation of the BB curve. It is apparent from expression (3.4) that the slope of the BB curve is $\frac{m}{\beta}$. Greater sensitivity to interest rates thus makes BB more flat, while a higher marginal propensity to import increases its slope.

3.2. Capital Mobility

The growth of international financial transactions and international capital flows is one of the most far-reaching economic developments of the late twentieth century and one that is likely to extend into the early twenty-first century. Net flows to developing countries tripled, from roughly \$50 billion a year in 1987-89 to more than \$150 billion in 1995-97, before declining in the wake of the Asian crisis. Gross flows to developing countries and more generally have grown even more dramatically, rising by 1,200 percent between 1984-88 and 1989-94. An increasing number of countries have removed restrictions on capital account transactions in an effort to take advantage of the opportunities afforded by this remarkable rise in international financial flows.

Capital mobility has important benefits. In particular, it creates valuable opportunities for portfolio diversification, risk sharing, and intertemporal trade. By holding claims on that is, lending to foreign countries, households and firms can protect themselves against the effects of disturbances that impinge on the home country alone. A negative shock to domestic income need not be fully absorbed by consumption and investment if the country has access to world capital markets. Companies can protect themselves against cost and productivity shocks in their home countries by investing in branch plants in several countries. Capital mobility can thereby enable investors to achieve higher risk-adjusted rates of return. In turn, higher rates of return can encourage increases in saving and investment that deliver faster rates of growth.

What has causes the tremendous increase in capital mobility in recent years? Increased capital mobility has been due to both policy regime changes and changes in the nature of international transactions and technological changes. Prominent among these are:

- the removal of statutory restrictions on capital account transactions, which is a concomitant of economic liberalization and deregulation in both industrial and developing countries;
- macroeconomic stabilization and policy reform in the developing world, which have created a growing pool of commercial issuers of debt instruments;
- the multilateralization of trade, which has encouraged international financial transactions designed to hedge exposure to currency and commercial risk;
- and the growth of derivative financial instruments such as swaps, options, and futures which has permitted international investors to assume some risks while limiting their exposure to others.

Above all, technology has played a role. Revolutionary changes in information and communications technologies have transformed the financial services industry worldwide. Computer links enable investors to access information on asset prices at minimal cost on a real-time basis, while increased computer power enables them rapidly to calculate correlations among asset prices and between asset prices and other variables. Improvements in communications technologies enable investors to follow developments affecting foreign countries and companies much more efficiently. At the same time, new technologies make it increasingly difficult for governments to control either inward or outward international capital flows when they wish to do so. All this means that the liberalization of capital markets and, with it, likely increases in the volume and the volatility of international capital flows is an ongoing and, to some extent, irreversible process with far-reaching implications for the policies that governments will find it feasible and desirable to follow.[7]

It is important to recognize that financial innovation and liberalization are domestic, as well as international, phenomena. Not only have restrictions on international financial transactions been relaxed, but regulations constraining the operation of domestic financial markets have been removed as countries have moved away from policies of financial repression. Domestic and international financial liberalization have generally gone hand in hand. Both respond to many of the same incentives and pressures.

How can we analyze increased capital mobility in terms of the Mundell-Fleming model? It is simplest perhaps to think about a movement from zero capital mobility to perfect capital mobility, though such a stark change is not necessary. We also assume that before liberalization the domestic interest rate is higher than the world interest rate. If the economy is small, capital market liberalization does not change the world rate.

Notice that with zero capital mobility the balance of payments condition required that the trade balance equal zero in the initial equilibrium. Liberalization of the capital market implies that interest rates will now decrease. What happens next depends on the exchange rate regime.

3.3. Putting the Parts Together

Our model consists of three basic relations: the IS curve, the LM curve, and the BB curve, which determine goods market equilibrium, money market equilibrium, and external balance, respectively. Actually, we have several other implicit expressions.

First, we have the Fisher relation. $i = r + \pi^e$, which relates the nominal and real interest rates. For much of the analysis we are assuming that $\Delta\pi^e = 0$, so we can normalize $\pi^e = 0$. Moreover, as we assume that the price level is fixed for

[7] It is not necessarily an unmixed blessing, however. Financial liberalization, both domestic and international, appears to have been associated with costly financial crises. This association may be somewhat deceptive, given that financial crises are complex events with multiple causes and have occurred in less liberalized as well as more liberalized financial systems. Still, there have been enough cases where financial liberalization, including capital account liberalization, has played a significant role in crises to raise serious questions about whether and under what conditions such liberalizationparticularly capital account liberalization will be beneficial rather than harmful.

short-run analysis, the latter assumption seems quite straightforward.

Second, we have the uncovered interest parity condition:

$$i - i^* = \delta_t \tag{3.5}$$

where $\delta_t \equiv \frac{s^e_{t+1} - s_t}{s_t}$ is the expected appreciation of the exchange rate. For short-run comparative statics analysis it is useful to assume that $\delta_t = 0$. That is why we write the balance of payments condition as $K = \beta(i - i^*)$. This is useful because we do not have enough structure in the model (yet) to determine how expectations about the exchange rate change with exogenous disturbances in the model. A typical comparative statics exercise involves a one-time change in an exogenous variable (such as government spending, the money stock, or foreign output). The future spot rate depends on the value of these variables in the next period. It is most convenient to assume that $\Delta s^e_{t+1} = \Delta s_t$, so that there is no change in expected appreciation.

Finally, we also are making an implicit assumption about aggregate supply. In the short run model we are assuming that $P = \overline{P}$, in other words, the aggregate supply curve is horizontal. It is also possible to consider the long-run, when prices are flexible and output is determined by full employment conditions.[8] In that case, we have $Y = \overline{Y}$, and prices adjust to maintain this relationship.

3.3.1. Perfect Capital Mobility

In this case the BB curve is horizontal. The equilibrium is as given in figure 3.1 Notice that at Y^* the goods market, the money market, and the balance of payments are all in equilibrium.

We can easily see that with perfect mobility fiscal policy is impotent; equilibrium output is fully determined by the intersection of the LM curve and the BB curve. To see this simply note that under Perfect Capital Markets $i = i^*$. Hence, there is only one level of income that will satisfy equation (2.22):

$$i^* = \frac{1}{h}\left(kY - \frac{M^s}{P}\right)$$

or

$$\overline{Y} = \frac{1}{k}\frac{M^s}{P} + \frac{h}{k}i^*. \tag{3.6}$$

[8] For long run analysis it is best to think of output as *per-capita* output.

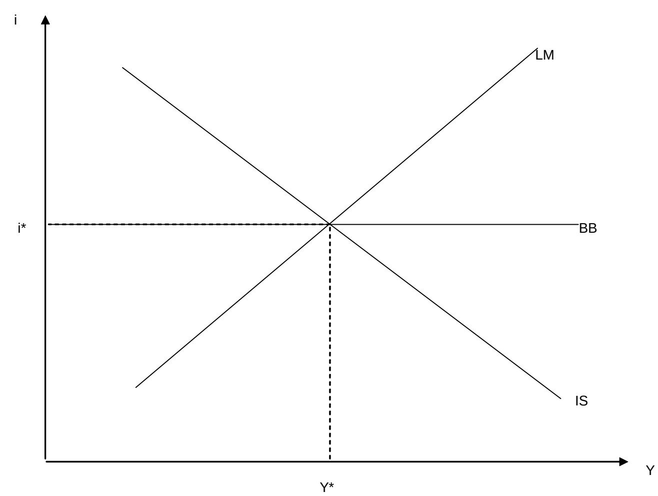


Figure 3.1: The Full Model: Perfect Capital Mobility

From this expression, it is apparent that an increase in the real money stock raises equilibrium income as does an increase in the world interest rate. The latter follows, because higher i^* reduces money demand so that higher income is needed to keep the money market in equilibrium. Hence, combinations of e and Y that keep the money market in equilibrium is vertical in $e-Y$ space. Call this the LL curve.

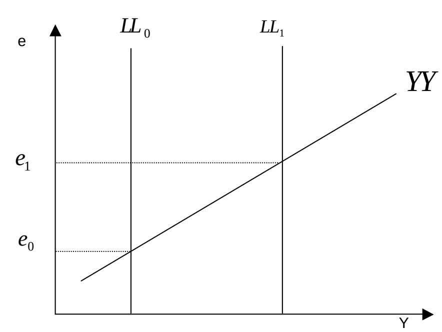


Figure 3.2: Output and the Exchange Rate

What about those combinations of e and Y that keep the goods market in equilibrium? Recall that an appreciation of the real exchange rate causes the IS curve to shift to the right. The reason is that a higher real exchange rate switches demand from foreign to domestic goods, thus requiring increased income to keep the goods market in equilibrium. The equation of the IS curve under Perfect Capital Markets is:

$$Y = \alpha(\overline{A} - b(i^* - \pi^e) + \overline{T} + \phi q). \tag{3.7}$$

Since we are assuming that price levels are fixed, an appreciation of q is equivalent to an appreciation of e. Consequently, combinations of e and Y that keep the goods market in equilibrium will be upward sloping in $e - Y$ space. Call this the YY curve.

The intersection of LL and YY determines the equilibrium exchange rate. It is apparent that an increase in the real money supply will cause the exchange rate to appreciate. The rightward shift in LM causes $\overline{Y}$ to rise, causing the trade balance to deteriorate. To keep the balance of payments in equilibrium (recall that the interest rate cannot change), the exchange rate must appreciate. Hence, YY is upward sloping.

Fiscal policy changes shift the IS curve, and thus the YY curve. But output does not change. So shifts in fiscal policy will only result in movements in the exchange rate. Suppose government spending increases (a change in $\overline{T}$ or π^e would have similar effects). The IS and YY shift to the right. In a closed economy the interest rate would increase, but this cannot happen with Perfect Capital Markets. Instead, a positive interest differential causes capital inflows and currency depreciation. This decrease in e and thus q causes expenditure to switch away from exports and toward imports. The increase in government spending does not change income; that is given at $\overline{Y}$. So some other component of aggregate demand must decrease, and this can only happen via the depreciation in the exchange rate (appreciation of the domestic currency). Hence, fiscal policy under Perfect Capital Markets can only affect the *composition* of spending, not its volume.

Given this analysis it is useful to consider the effects of increases in protectionism on the trade balance. This would cause a rise in $\overline{T}$ with no change in income or the exchange rate. But we have seen that the exchange rate will depreciate in this case. Hence, trade policy is offset by currency movements under flexible exchange rates when there is capital mobility.[9]

[9] It is left to the reader to consider how this result would change with zero capital mobility.

3.3.2. Dutch Disease

This model allows us to re-examine the phenomenon of Dutch Disease. Suppose that the UK (or Netherlands in the East Indies, I suppose) discovers oil, and let the exchange rate be flexible. Exports of oil will increase. We can interpret this as an increase in $\overline{T}$, and thus a shift to the right of the IS curve. With flexible exchange rates this leads to an incipient capital inflow, depreciation of the exchange rate (a rightward shift of the YY curve) and thus real exchange rate depreciation. This causes the IS curve to shift back to its initial point.

At the new equilibrium (which has the same income and interest rate as the old one) oil exports have increased but other exports have fallen. The real depreciation of the exchange rate has caused manufactured exports to become less profitable. This can be interpreted as a process of deindustrialization.[10]

3.3.3. Insulation

The analysis to this point suggests the *insulation* properties of flexible exchange rates. Shocks to foreign income or the money supply to not affect domestic income.[11] If foreign income increases this merely leads to a depreciation of the real exchange rate, leaving income unaffected. A rise in the foreign money supply has no effect in this setting.

Notice that this has positive as well as negative aspects. While the domestic economy does not benefit from an expansion in foreign income, nor does it suffer when the rest of the world goes into recession. The decline in Y^* does cause the demand for domestic exports to decrease, but this is offset by the increase in the value of the exchange rate.

The only foreign change that has serious effects on the domestic economy under Perfect Capital Markets and flexible exchange rates is a change in the world interest rate. The small economy is a price taker with respect to interest rates. A rise in i^* would lead to a rise in income and an appreciation of the real exchange rate. For example, suppose that there was a coordinated expansion in aggregate

[10] It would be incorrect, however, to think that fixing the exchange rate insulates the economy against Dutch Disease. The export boom under fixed rates would cause upward pressure on prices. If real wages in manufacturing do not fall then competitive exports would still decrease. One way to think about this is that the export boom is going to cause the real exchange rate to depreciate (our prices rise faster than foreign prices). In the case of flexible exchange rates this occurs via real appreciation of the currency. In the fixed exchange rate case this occurs via domestic inflation.

[11] In a flex-price model this statement would apply to the price level.

demand in Europe. If many economies simultaneously expand this would cause i^* to increase, the BB curve shifts up, and domestic income increases.

3.3.4. Laursen-Metzler-Harberger Effect

The sharp result on insulation must be modified by the *LMH* effect. In the standard model we assumed that the marginal propensity to absorb, a, is a constant fraction of domestic income Y. So a change in the real exchange rate does not impact savings directly. Then the Marshall-Lerner conditions were sufficient to guarantee that a devaluation improved the trade balance. But if agents spend on domestic and foreign goods a change in the real exchange rate will affect their purchasing power, and hence their consumption and savings will depend on the terms of trade. If the real exchange rate rises imports are more expensive, so real income measured in terms of the actual basket that domestic residents consume goes down. If consumption and savings are proportional to income, as in the permanent income hypothesis, then this does not matter. In the textbook Keynesian model, however, the marginal propensity to consume is a decreasing function of income, that is

$$\frac{\Delta C/\Delta Y}{C/Y} = \frac{c}{C/Y} = \frac{c}{\frac{\overline{C}+cY}{Y}} < 1,$$

which implies that consumers reduce their consumption less than proportionately to a fall in income. Hence, the rise in the real exchange rate will, in addition to the effect on net exports, lead to an decrease in savings relative to investment, as households, because households save a smaller fraction of their incomes when they are poorer. This means that $Y - A$ (or national savings minus investment) goes down measured in domestic terms.

Consider then a fall in foreign income for example. In the standard case, devaluation improves the terms of trade and offsets the impact of Y^*. In terms of figure 2.1 the fall in Y^* causes the TB locus to shift down but the rise in q causes it to shift up. So if $\Delta q = \frac{1}{\phi}\Delta Y^*$ there is no shift in the TB locus and so complete insulation. But the LMH effect implies that domestic spending will also fall. This means that the $NS - I$ locus will shift down, as well. Hence, further devaluation is needed to restore the trade balance.[12] So a fall in Y^* would not be fully absorbed in the exchange rate alone. Income would have to rise as well to offset the effect of the devaluation on savings.

[12] The Marshall Lerner condition is no longer sufficient. The new condition is that $\eta^* + \eta - 1 > m + m^*$.

Notice that the LMH effect would not occur for changes in permanent income. In that case consumption is proportional to income and the savings rate is independent of the level of income. Changes in permanent income do not change the balance national savings and investment. .

3.4. Large Country

So far we have assumed that the economy is a small one. What if a large country like the US undertakes an expansionary fiscal policy. Here we can no longer assume that i^* is unaffected. If the US undertakes a fiscal expansion, with output unchanged, this causes the current account to worsen. This would cause an excess demand for current consumption worldwide. We know from the two-country model that this would cause the world interest rate to rise. Hence, the expansionary fiscal policy would cause US output to rise as well.

3.5. Imperfect Capital Mobility

What happens if there is imperfect capital mobility? This, after all, seems a more realistic case for many countries. Consider a monetary expansion. We know that the impact effect is that the interest rate will decrease. With Perfect Capital Mobility the depreciation in the currency would cause the IS curve to shift to the right until $i = i^*$. With Imperfect Capital Mobility the same shift in LM will cause a smaller capital inflow, and thus a smaller depreciation in the currency. Hence, the IS curve will shift to the right by a smaller amount than with Perfect Capital Mobility. The key point is that with Imperfect Capital Mobility interest rates will be lower with a monetary expansion: the full effect is not offset. Hence, the LL curve shifts to the right by a smaller amount than with Perfect Capital Mobility.

To analyze the effects of policy under flexible exchange rates when there is less than perfect capital mobility it is difficult to operate with the IS and BB curves. The reason is that there is now a trade-off between movements in the rate of interest and the exchange rate that keeps the goods market in equilibrium. Whenever the exchange rate changes we know that the IS curve shifts. But so does the BB curve if there is less than perfect capital markets. Why? The reason is perhaps easiest to see if we think about zero capital mobility. In that case the BB curve is given by:

$$B = \overline{T} - mY + \phi q = 0 \tag{3.8}$$

which we can solve for $\widehat{Y}$, the level of income at which we have external balance:

$$\widehat{Y} = \frac{1}{m}\left(\overline{T} + \phi q\right) \tag{3.9}$$

Now the important point to notice from (3.9) is that there is a given level of income which maintains external balance *for any given value of the exchange rate*. Changes in the rate of interest do not affect capital flows because of zero capital mobility. But interest rate changes may result in changes in the exchange rate. An appreciation in the real exchange rate means that $\widehat{Y}$ would increase; in effect, the BB curve shifts to the right. This shift will also occur under imperfect capital mobility – it is only under perfect capital mobility that we do not have to worry about this, because a horizontal line cannot shift to the right!

The fact that BB shifts when there is less than perfect capital mobility makes it cumbersome. Too many curves are shifting around to make the model useful. Fortunately, there is a simpler way to analyze the operation of flexible exchange rates when there is less than perfect capital mobility.

What we will do is simply use the external balance condition in combination with the goods market equilibrium condition. In effect, we will combine the BB curve and the IS curve together. We will eventually see that the horizontal BB curve is just a special case of what we obtain. We know that capital flows depend on interest differentials, $K = \beta(i - i^*)$.[13] Notice that the world interest rate is still an exogenous variable; the country is still small.

Now we know that $B = T + K = 0$, hence:

$$T = -\beta(i - i^*) \tag{3.10}$$

Because goods market equilibrium requires $Y = A$, we can write:

$$Y = \overline{A} + aY - b(i - \pi^e) - \beta(i - i^*) \tag{3.11}$$

Compare this to equation (2.13).

Hence,

$$Y = \frac{\overline{A} - (b + \beta)i - \beta i^* + b\pi^e}{1 - a} \tag{3.12}$$

which is the equation of the XX curve, in figure 3.3: Notice that the slope of the

[13] It is useful assume that i^* does not change, but not necessary. Hence, we can without loss of generality simply assume $K = \beta i$, by setting $i^* = 0$. This reduces notation without altering the analysis.

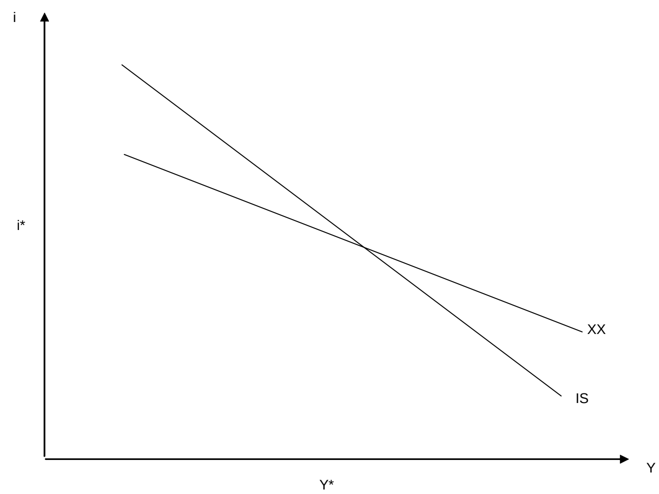


Figure 3.3: The XX curve

XX curve is less than that of the IS curve:

$$\text{slope of IS: } \frac{1-a+m}{b} > \text{slope of XX: } \frac{1-a}{b+\beta} \tag{3.13}$$

The XX curve takes into account the effects of exchange rate depreciation on goods market equilibrium. Notice that points above the XX curve indicate that the balance of payments is in surplus – the interest rate is too high given the level of income – and vice versa.

Notice that the XX curve is a general tool which we can use to analyze changes under any degree of capital mobility. If we have perfect capital mobility, then $\beta \to \infty$, so the slope of the XX curve goes to zero (this is just the BB curve then, and the IS curve is superfluous). There is only one interest rate at which the goods market is in equilibrium and external balance is maintained.

The case of zero capital mobility, $\beta = 0$, is also easy to analyze. In this case the XX curve becomes steeper than before. But from (3.13) it is clear that it is still flatter than the IS curve, as

$$\frac{1-a+m}{b} > \frac{1-a}{b} > \frac{1-a}{b+\beta} \tag{3.14}$$

In figure 3.4 there are two XX curves: XX_1 refers to the case of low (zero) capital mobility, and XX_0 refers to greater but still imperfect capital mobility.

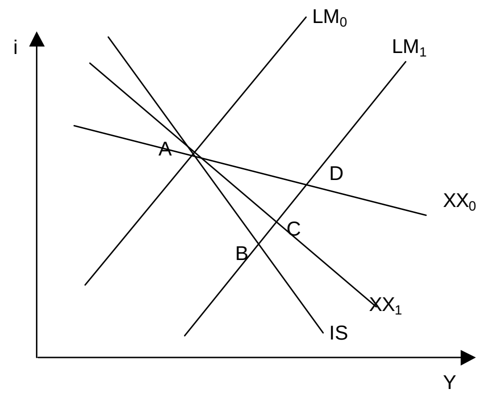


Figure 3.4: Monetary expansion with imperfect capital mobility

In 3.4 the monetary expansion shifts the LM curve to the right. At point B the external balance condition is not satisfied; we are below the XX curve. The depreciation of the currency at that point causes the IS curve to shift to the right, and we end up at point C. Notice that even with zero capital mobility the currency depreciates at point B. The reason is that higher income worsens the trade balance. In order to satisfy the expression for external balance $B = \overline{T} - mY + \phi q = 0$, the exchange rate must appreciate to offset the rise in income. This moves us from point B to point C.

If there is imperfect capital mobility, the depreciation of the currency is larger. This follows because at point B there will be a capital outflow; we now have an external imbalance due to the negative interest differential in addition to the trade balance. So the appreciation in the exchange rate is greater, and we end up at point D. Notice that as capital mobility increases the XX curve will be flatter. In the limit it is horizontal at i^*; monetary policy has its greatest impact.

What about a change in fiscal policy. With perfect capital mobility there is no effect on income, only on the exchange rate.[14] With less than perfect capital mobility, however, fiscal policy will impact on income and the interest rate as well as the exchange rate.

Consider an expansionary fiscal policy. The IS curve shifts to the right. Notice that the rightward shift of the XX curve is greater than the rightward shift of the

[14] A horizontal line cannot shift to the right or left!

IS curve. With zero capital mobility higher income will cause the exchange rate to appreciate: higher income raises imports, so to maintain external balance the exchange rate must appreciate. The IS curve thus shifts further to the right. This is because with zero capital mobility the XX curve is steep (though still less than the IS curve).

Now suppose we have imperfect capital mobility. This means that the fiscal expansion causes a capital inflow as well as a trade balance deterioration. If capital mobility is great enough the former effect overcomes the latter and the exchange rate depreciates. This causes IS to shift left. This weakens the effect of the fiscal expansion. This is hardly surprising; we know that with perfect capital mobility the effect is fully offset.

3.5.1. Some Experiences of Monetary and Fiscal Policy Under Flexible Exchange Rates

It is perhaps useful to discuss two policy episodes under flexible rates to get a feel for the operation of this regime. We consider the US in the early 1980's and Japan in the late 80's-early 90's.

In the late 1970's the US suffered from very high inflation. The Fed, under Paul Volcker attacked inflation with tight monetary policy. The subsequent recession was followed by a recovery led by fiscal expansion. This is a useful episode to consider.

Tight monetary policy can be characterized by a leftward shift of the LM curve. This led to higher interest rates, as the US is a large country and can impact the world interest rate. Notice that tight money in the US tends to induce a capital inflow (due both to the high interest rates and the fall in income). This causes the dollar to appreciate. The brunt of the recession that resulted was felt mainly by investment and the trade balance. Export industries were especially effected. The capital inflows induced by high interest rates results in a current account deficit under flexible exchange rates.

The fiscal expansion that led to recovery in 1983 can be thought of in terms of a rightward shift of IS. This also induced interest rates to increase due to the large country effect on i^*. By the mid-80's we had a situation where the LM curve had shifted to the left and the IS curve had shifted to the right. Income was close to where it started but interest rates were higher.[15] But while the *level* of

[15] And real interest rates were much higher, because the decline in inflation had led to decreases in π^e.

income had not changed its *composition* had. Investment and the trade balance had worsened, due to higher interest rates and the higher value of the dollar. Government spending and consumption had risen relative to the 1980 levels.

Was there any benefit to this change in stance of monetary and fiscal policy? Notice that the stronger value for the dollar meant that imports were cheaper than before. This certainly helped with disinflation. Lower import prices put pressure on domestic industry not to raise prices. This may have been a short-run advantage given the public's hostility to high inflation. But the long-run costs should also be mentioned. Lower investment results in lower economic growth. And the deterioration in the trade balance can lead to protectionist pressures that reduce economic efficiency. The current account deficits are also the reason why the US went from being a net foreign creditor to a net foreign debtor. This is not so bad as long as people are willing to invest in the US. But sudden reversals in such preferences can be very costly.

Japan in the late 1980's presents another interesting case. The yen was appreciating against the dollar, which was a problem for exporters. The Bank of Japan responded by expansionary monetary policy, purchasing dollars and selling yen. The rightward shift of the LM curve reduced real interest rates in Japan and let to a capital outflow and an exchange rate appreciation. This helped exporters, but the low interest rates also led to a boom in asset prices, especially real estate. To prick the bubble, the Bank of Japan raised interest rates. This caused a recession in Japan and a sharp fall in asset prices. It also led to an appreciation of the yen.

To a great extent Japan still suffers from the effects of the bursting of this bubble. The strong yen continued to hurt exporters, but the decline in asset prices weakened the banking system. With household wealth dramatically lower, savings increased. This made it very hard for the Bank of Japan to further lower interest rates.

3.6. Fear of Floating

How many countries actually let their exchange rates float? Calvo and Reinhart showed that there is a "fear of floating." Although it *appears* that flexible exchange rates are replacing fixed or managed rates. This is not really the case. The self-described picture shows a secular increase in flexibility (table 3.5)

What Calvo and Reinhart do is examine how volatile are exchange rates, interest rates, and reserves in various economies relative to the US and Japan. Why? We know that the US and Japan are floaters, relatively purely. And we know that

Year	Percent of countries in the sample which were classified by the IMF as having a:			
	Peg	Limited flexibility	Managed	Flexible
1970	97.2	0.0	0.0	2.8
1975	63.9	11.1	13.9	11.1
1980	38.9	5.6	47.2	8.3
1985	33.3	5.6	36.1	25.0
1990	19.4	13.9	30.6	36.1
1995	13.9	8.3	38.9	38.9
1999	11.1	11.1	33.3	44.5

Figure 3.5: Self -Classification of Exchange Rate Regimes (Calvo & Reinhart, p32).

the US and Japanese economies are relatively less volatile than other economies, partly due to their size. So, if countries are floating their exchange rates ought to fluctuate more than the dollar or the yen if they are subject to more shocks that would cause the exchange rate to move. But this does not appear to be the case.

In table 3.6 self-described floaters are examined for how often their exchange rates fluctuate within narrow bands. The interesting fact is that most of the countries listed demonstrate much less volatility than in the US or Japan. In the US and Japan less than one-third of the time (approximately) the exchange rate – observed at monthly frequencies – stays within a one-percent band. But for many countries this happens much more often; for example, 82% of the time in India and 79% of the time in Norway. Are these economies really more stable?

It could be that other economies are more stable than the US and Japan. One way to examine that would be to see how volatile are reserves and interest rates. If the countries are really intervening then reserves will be more volatile than in the US. Or nominal interest rates may be fluctuating considerably to maintain the stability in the exchange rate. Think, for example of the impact of a shock to the IS curve. If there is true floating the exchange rate changes but interest rates and reserves are unaffected. But if the country wants to prevent the exchange rate from moving it either has to intervene by adjusting reserves, interest rates, or both.

Country	Period	Probability that the monthly percent change in nominal exchange rate falls within:	
		+/- 1 percent band	+/- 2.5 percent band
United States $/DM	**February 1973-April 1999**	**26.8**	**58.7**
Japan	**February 1973-April 1999**	**33.8**	**61.2**
Australia	January 1984-April 1999	28	70.3
Bolivia	September 1985-December 1997	72.8	93.9
Canada	June 1970-April 1999	68.2	93.6
India	March 1993-April 1999	82.2	93.4
Kenya	October 1993-December 1997	50	72.2
Mexico	December 1994-April 1999	34.6	63.5
New Zealand	March 1985-April 1999	39.1	72.2
Nigeria	October 1986-March 1993	36.4	74.5
Norway	December 1992-December 1994	79.2	95.8
Peru	August 1990-April 1999	45.2	71.4
Philippines	January 1988-April 1999	60.7	74.9
South Africa	January 1983-April 1999	32.8	66.2
Spain	January 1984-May 1989	57.8	93.8
Sweden	November 1992-April 1999	35.1	75.5
Uganda	January 1992-April 1999	52.9	77.9
Average, excluding U.S. and Japan		51.67	79.27
Standard deviation, excluding U.S. and Japan		17.83	11.41
Memorandum: The Post-Asian-crisis “floaters”			
Indonesia	July 1997-April 1999	9.5	14.3
Korea	November 1997-April 1999	5.9	17.7
Thailand	July 1997-April 1999	14.3	38.1

Figure 3.6: Volatility of Exchange Rates Among Self-Described Floaters

Country	Period	Probability that the monthly change in nominal interest rate falls within:	
		+/- 0.25 percent (25 basis points)	+/- 0.5 percent (50 basis points)
United States	**February 1973-April 1999**	59.7	80.7
Japan	**February 1973-April 1999**	67.9	86.4
Australia	January 1984-April 1999	28.1	53.9
Bolivia	September 1985-December 1997	16.3	25.9
Canada	June 1970-April 1999	36.1	61.9
India	March 1993-April 1999	6.4	15.9
Kenya	October 1993-December 1997	19.6	25.5
Mexico	December 1994-April 1999	5.7	9.4
New Zealand	March 1985-April 1999	40	59.4
Nigeria	October 1986-March 1993	89.7	91
Norway	December 1992-December 1994	32.1	51.9

Figure 3.7: Interest Rate Volatility in Self-Described Floaters

If self-described floaters were really floating, one would suspect that interest rates would be relatively stable. When there are shocks these should be absorbed by the exchange rate. But in table 3.6 we can see that this is not the case. Similarly with regard to reserves as in figure 3.8. This evidence shows that these countries fear floating. The question we need to ask is why? But first we need to look a bit at fixed exchange rates.

4. Fixed Exchange Rates

When exchange rates are fixed we have pre-determined a variable that was previously endogenous. The exchange rate cannot now adjust to maintain external equilibrium. Another variable must now become endogenous. But we know what that is: the money stock. The reason is that maintaining fixed exchange rates requires central banks to engage in reserve operations to prevent movements in currency values. These operations also effect the supply of money.

To see this it is useful to think of a simple version of the central bank's balance sheet:

Country	Period	Probability that the monthly percent change in foreign exchange reserves falls within:	
		+/- 1 percent band	+/- 2.5 percent band
United States	**February 1973-April 1999**	**28.6**	**62.2**
Japan	**February 1973-April 1999**	**44.8**	**74.3**
Australia	January 1984-April 1999	23.9	50
Bolivia	September 1985-December 1997	8.1	19.6
Canada	June 1970-April 1999	15.9	36.6
India	March 1993-April 1999	21.6	50
Kenya	October 1993-December 1997	13.7	27.4
Mexico	December 1994-April 1999	13.2	28.3
New Zealand	March 1985-April 1999	11.8	31.4
Nigeria	October 1986-March 1993	7.7	12.8
Norway	December 1992-December 1994	36.1	51.9

Figure 3.8: Reserves Volatility for Self-Described Floaters

assets	*liabilities*
Foreign reserves (IR)	Currency in circulation
Domestic securities (DS)	Bank reserves

Because assets must equal liabilities, we can note that the assets of the central bank, IR+DS sum to equal to the monetary base (MB) (or high-powered money). Note that the money stock is equal to the product of the monetary base and the money multiplier, μ:

$$M = \mu MB = \mu(IR + DS) \tag{4.1}$$

Now let us consider what happens when the Federal Reserve purchases foreign exchange with dollars. There are four cases to consider:

1. purchase from home-country banks: in this case alongside the increase in IR is an increase in bank reserves.

2. purchase from home-country non-bank residents: in this case, residents would receive payment in the form of currency in circulation.

3. purchase from foreign banks or central banks : in these cases currency in circulation rises immediately if the payment is made in cash.

4. purchase from foreign banks or central banks via changes in the foreign bank's deposit at the Fed. In this case, once the bank uses this deposit to purchase some interest-bearing security from a domestic bank, bank reserves will rise.

The key point, in any case, is that reserve transactions must result in simultaneous changes in the money base. This makes the stock of money endogenous. If foreign reserves are increasing so is the domestic money stock, and vice versa.

Sterilization There is one way that the domestic money stock can be insulated from reserve changes. Suppose that at the same time the Fed purchases foreign exchange it also sells domestic securities; that is, it engages in an open market operation. The latter transaction will decrease the money stock, and total central bank assets will be unaffected. This action is called *sterilization* because the domestic economy is insulated from the foreign reserve transaction.

In practice, however, it turns out that sterilization is very difficult to achieve. To sterilize, the Central Bank must change the stock of domestic securities to maintain unchanged the stock of high-powered money. That is,

$$\Delta H = \Delta IR + \Delta DS = 0. \tag{4.2}$$

Thus, if the Central Bank is purchasing foreign exchange, so that reserves are increasing, it must simultaneously sell domestic securities; i.e., $\Delta IR = -\Delta DS$. Notice that to persist in sterilized intervention requires large stocks of both foreign reserves and domestic securities. The reason for the former (that of a "deficit" country) is obvious. But consider the case of a surplus country. It is accumulating reserves. Presumably it can do this forever. But to sterilize such a flow it must be selling domestic securities. But this requires that the Central Bank have a very large stock of debt to sell. This condition is unlikely to be satisfied in most economies.

For now, we will assume that sterilization does not take place.

4.1. Capital Market Liberalization and Fixed Exchange Rates

Assume that capital mobility increases so that the BB curve now has a flatter slope, and the domestic interest rate decreases. The BB curve now intersects the IS curve to the right of the initial equilibrium. We can see this in figure 4.1, where we start at point A and then the BB curve becomes flatter and we reach point B. This means that equilibrium income increases, so that the trade balance necessarily worsens. This coincides with observed effects on the current account. This is not surprising. If liberalization results in lower interest rates, the domestic economy will shift consumption towards the present.

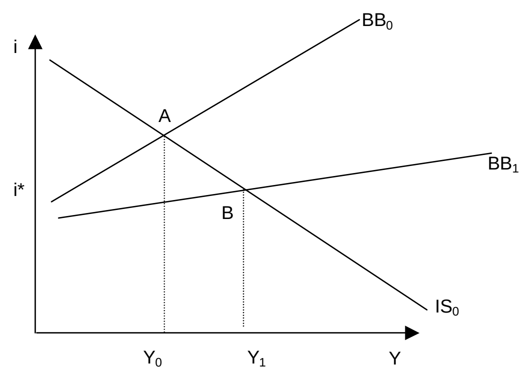


Figure 4.1: Capital Market Liberalization

Of course once a currency comes under crisis we can no longer analyze the situation with comparative statics. Expectations become crucial. Once investors believed that Thailand was in trouble they were no longer willing to invest in Thailand for infinitesimal interest differentials. Rather they required very large risk premia to invest in Thailand. This reversed the pattern of capital flows. To maintain the exchange rate required the central bank to intervene massively to offset the reversal in capital flows. Even after the exchange rate collapsed, however, the problem of capital outflow persists, due to expectations about the ability to service debt. Hence, capital flows have not reversed again, and current account surpluses are needed to offset capital outflows.

4.2. The Effectiveness of Policies Under Fixed Exchange Rates

How are our conclusions about monetary and fiscal policy changes under fixed exchange rates? The easiest case to consider is Perfect Capital Markets. Suppose that there is an expansionary fiscal policy. Under flexible rates, we observed that the incipient capital inflow causes the exchange rate to depreciate so that the IS curve shifted back to its original position. There was no effect on output, only on

e. But with fixed rates, none of this can happen. Instead, the incipient capital inflow forces the central bank to purchase the excess supply of foreign exchange. Reserves and thus the money base increases. Hence, the LM curve shifts to the right. This causes income to rise until external balance is achieved ($i = i^*$). Fiscal policy is now effective. Output increases with expansionary fiscal policy.

With imperfect capital mobility we have figure 4.2. We start at point A and let the fiscal expansion cause the IS curve to shift right. There are two cases. If the LM curve is steep we go initially to point C, where interest rates are above that needed for external balance. The incipient capital inflow causes the monetary base to increase shifting the LM curve down till we reach point D. The alternative case is where the LM curve is flat. We initially move to point B. Now with higher income the trade balance has worsened but the rise in interest rates does not cause a sufficient capital inflow to produce external balance. Hence, reserves fall and the LM curve shifts back to the left until we reach point D. The ultimate outcome is the same in terms of income and the interest rate. The only difference is what happened to the monetary base and international reserves.

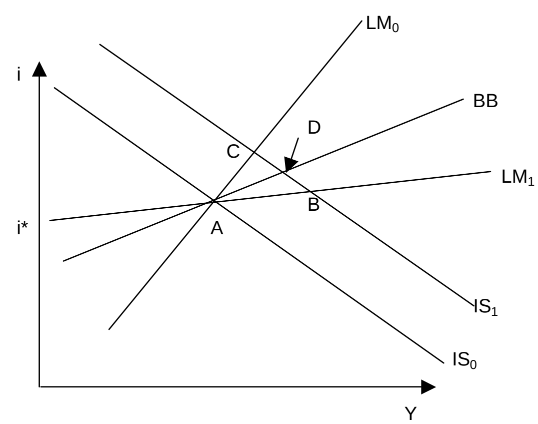


Figure 4.2: Fiscal Expansion Under Fixed Exchange Rates and Imperfect Capital Mobility

What about monetary policy? Suppose that the Central Bank undertakes to reduce the stock of money. A contractionary open market operation would shift the LM curve to the left in a closed economy or in an economy with a flexible exchange rate. With fixed exchange rates, however, the incipient capital inflow that this would induce causes an increase in foreign reserves, and hence the monetary base. The LM curve shifts back to its original position. Hence, under fixed exchange rates monetary policy is ineffective.

Are these results the consequence of prices being fixed? Not really. Consider fiscal policy. Were prices flexible, the increase in output above $\overline{Y}$ would cause prices to increase. This would shift the LM curve to the left as the real money stock decreased. But a rise in P would also cause q to fall, inducing the IS curve to also shift left. We would end up where we started with output at full employment, $i = i^*$, and prices now higher. The effect of fiscal policy would show up on prices rather than output.

Monetary policy, on the other hand, would not have an effect on the price level because it cannot effect output. We have seen that any LM shift is offset by reserve transactions. This is important. It means that a country under fixed exchange rates cannot undertake an independent monetary policy. Suppose that the price level in the rest of the world was increasing (due to rising world money supply). The central bank may wish to prevent domestic inflation by keeping the domestic money supply constant. But this will not work under fixed rates. For the rise in P^* means that q increases, causing the IS curve to shift to the right. This causes an incipient capital inflow and an increase in the domestic money supply. If prices are fixed output rises; the domestic economy is not insulated against the change in the foreign price level.

What if prices were flexible. Again there is no insulation. Now inflation is imported. To see this assume that $\Delta P = \gamma(Y - \overline{Y})$. Now suppose that P^*, and hence q increase. The IS curve shifts to the right, and the capital inflow causes a monetary expansion under fixed exchange rates. But now with $Y > \overline{Y}$, the price level will start to increase. This will cause the LM curve to shift to the left because $\frac{M}{P}$ will be decreasing. It will also cause the IS curve to shift back, because the rise in P will cause q to fall.

This latter result is one reason why many countries found fixed exchange rates problematic. It make it hard for small countries to avoid *importing* inflation as the world money supply increases. Many blame the onset of inflation in the late 1960's on the combination of fixed exchange rates and an increasing world money supply that resulted from persistent US balance of payments deficits. Since the US is a large country, increases in the US money supply causes increases in the world money supply.

4.3. The Impossible Trinity

We have noted that economies can choose to fix interest rates or monetary policy but not both. This is especially true with high capital mobility. A modern economy that can engage in sterilization may be able to run an independent monetary policy if it has capital controls, but with capital market liberalization there is an *impossible trinity*: a country can have any two of financial openness, fixed exchange rates, and independent monetary policy, but not all three. This became quite apparent in the crisis of the ERM in the early 1990's.

In the 1979 the European Monetary System was formed by Germany, France, Italy and other members of the EEC to stabilize their exchange rates. They minimized exchange rate fluctuations among themselves, but floated against the dollar and yen. The idea was to increase economic integration. Initially, France and Italy retained capital controls, so they were not violating the impossible trinity.

By the late 1980's, however, capital controls had been eliminated, and the UK and Spain joined the ERM. Given limited exchange rate flexibility and high capital mobility the ability to pursue independent monetary policy was no longer possible.[16] This became apparent when Germany tightened monetary policy after reunification.[17] Other members of the ERM were not in favor of higher interest rates, but they would have to also tighten if they wanted to stay in the ERM. France and some other members followed suit, giving up their own monetary policy to Germany. Others, like the British, tried to persuade the Germans to relent.

Notice that reunification caused an increase in the price of German goods. To restore equilibrium, either German inflation had to rise or the rest of Europe's had to fall. The Bundesbank sought the latter, and interest rates increased. This raised the cost, mostly in the form of unemployment, for those pursuing austerity policies to reach Maastricht guidelines. This caused the classic situation of conflict between domestic and external balance. For the benefit of EMU these countries were pursuing austerity at the cost of domestic employment. Willingness to continue with this policy stance clearly depended on the likelihood that EMU

[16] France learned this lesson in the early 1980's. The Socialists came to power in 1981 and were set on fiscal and monetary expansion. But capital controls had been greatly reduced, though mobility was still imperfect. The attempt to peg to the DM while pursuing an expansionary policy led to downward pressure on the franc. Capital inflows were insufficient to offset the worsening trade balance. To maintain the peg France had to tighten monetary and fiscal policy.

[17] Monetary reunification had led to an increase in German inflation. The Bundesbank sought to fight this with tight monetary policy.

would actually come about.

The ratification of the Maastricht Treaty, which created the European Monetary System and the eventual Euro, complicated matters. Danish voters rejected the treaty in 1992,[18] and polls showed that France would likely follow (they didn't, barely). If the treaty was rejected, there would be no reason for countries like Italy to exert dramatic fiscal discipline in order to join EMU. Hence, investors speculated that the ERM would unravel, and started selling the currencies of those countries least appreciative of high interest rates. Italy and the UK were forced to leave the system and let their currencies float, as did Sweden even after letting their overnight interest rates rise to 540% in an attempt to defend their krone.[19] George Soros bet heavily against sterling in this episode, earning the enmity of the Bank of England, and profiting from the investment by more than a billion dollars.

There is a problem with this explanation of the ERM crisis of 1992. This has to do with forward exchange rates. In July of 1992 one year ahead forward rates of the attacked currencies were not outside of their ERM bands. This suggests, perhaps, that fundamentals were not out of line. Had observers expected a policy shift would not these forward rates have reflected the realignment that was expected?

This suggest that perhaps the crisis was due to a speculative attack. Suppose that a country has a balanced budget and balance in external accounts and is thus happy to maintain current policies indefinitely. Imagine that speculators attack the currency. To defend the peg the authorities raise interest rates to prevent capital outflows. This raises the costs of maintaining the current fiscal policies. The effects on domestic absorption and unemployment may now be excessive compared with the benefits of EMU. The costs of acquiring a reputation for austerity may no longer be less than the expected benefits. This may make the crisis *self-fulfilling*. This runs counter to the standard theory of currency crises, where attacks are only successful if determined by fundamentals. Notice that the rules of EMU required that the country maintain exchange rate stability to qualify. An attack that causes a devaluation may prevent the country from having the benefits of EMU, so it relents quicker. Even if in the absence of a speculative attack policies were sustainable, the rules for joining EMU may have made speculative attacks more likely. We will return to this topic.

In any event, the result of the ERM crisis was a split among the countries.

[18] Although they later reversed that decision in May 1993.

[19] It is estimated that Sweden spent $26 billion dollars defending the krone in the six days prior to devaluation, on the order of 10% of GDP, or about $3600 per Swede!

Those that stayed in the system, like Netherlands, gave up monetary sovereignty. Others, like the UK opted to let their currencies float.

With the introduction of the *euro*, the countries in the system chose to cede monetary sovereignty to the European Central Bank. It remains to be seen, however, whether politicians will be able to live with this arrangement.

5. Varieties

We talk of fixed and floating rates, but there really are quite a variety of exchange rate regimes. Corden's diagram (figure 5.1) neatly summarizes them. Here $FBAR$ stands for fixed but adjustable, as in Bretton Woods. One can think of absolutely fixed as the gold standard. Managed floating means that the central bank is free to intervene in the currency market, and it actually does. But there is no commitment to any rate. A target zone is a band within which the exchange rate can float, but there are upper and lower limits where the rate is pegged. Pegged rates come in two types: a flexible peg where the rate is fixed at a point in time but can be altered regularly,[20] and a crawling peg where there the peg depreciates steadily over time, either according to schedule or passively.

[20] And with less commitment to the rate than with the FBAR.

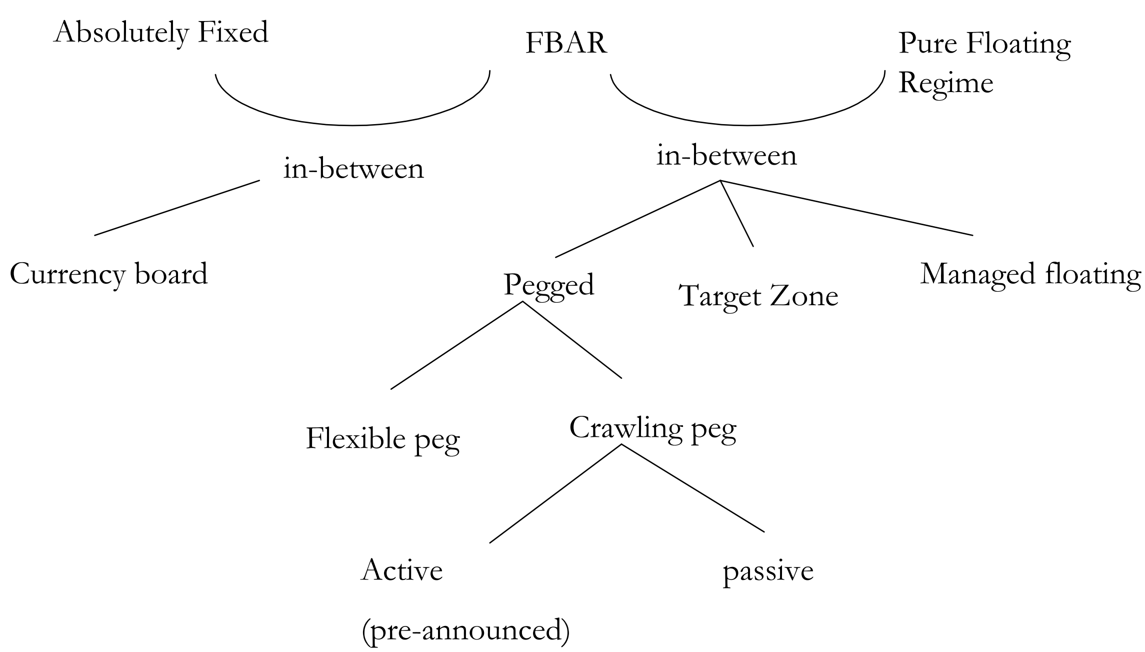


Figure 5.1: Corden's Varieties of Exchange Rate Regimes