Chapter 12: Income, Money and Interest Rates under Fixed and Partially Fixed Exchange Rates

In November 2013, in the face of capital outflows and a weakening currency, the Russian central bank raised interest rates, and intervened in the foreign exchange market, buying up rubles with their holdings of US dollars.

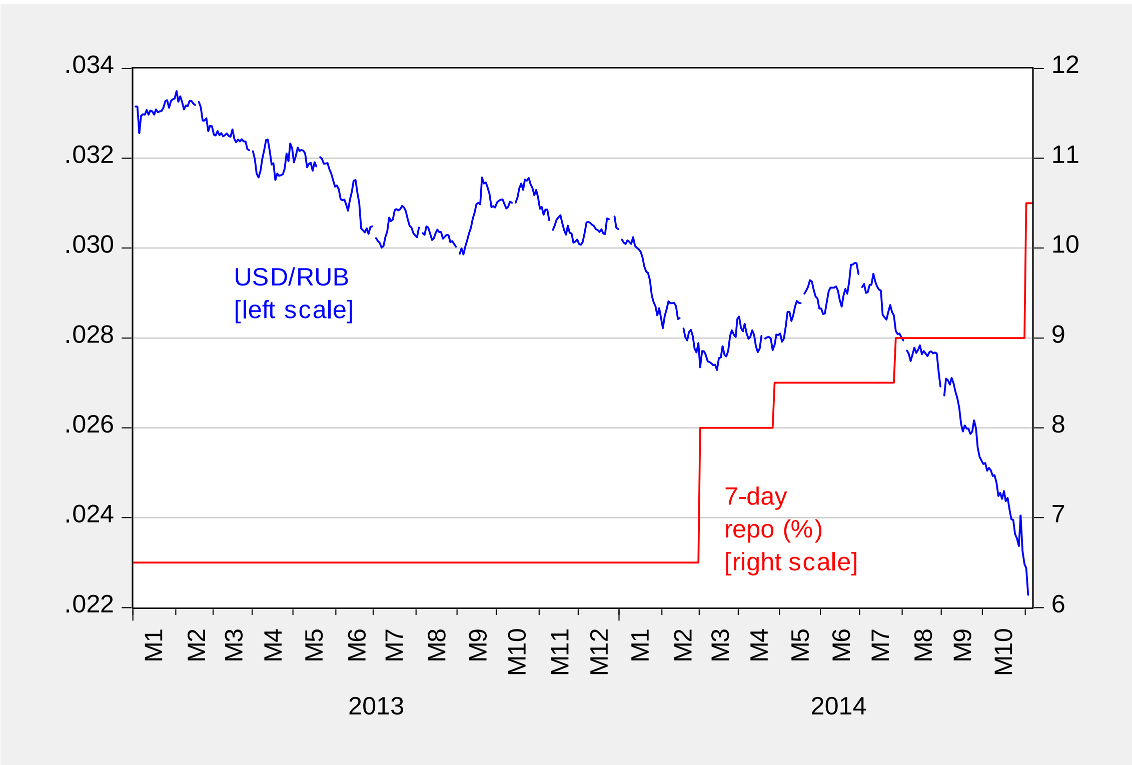

Chart 12.1: The US dollar/Russian ruble exchange rate (1/S) (blue, down is a depreciation), and the Russian overnight interest rate (red).

Why did policymakers think these actions would work to stem the flow of capital out of the country? What were the consequences of these measures? We can't answer that question without a model of why and how interest rates are determined, and how higher interest rates affect capital flows.

In this chapter and the next, we develop an integrated model of how the economy interacts with the rest of the world, where savings can move across borders, and the value of the currency can change. To begin with, we examine how the economy behaves when the central bank commits to keeping the exchange rate pegged at a certain value (or close to a certain value).

12.1 Describing an Economy with Money and Interest Rates: IS-LM

In order to analyze the role of the financial sector, we modify the model discussed in Chapter 11.

That requires that at least one component of aggregate demand depends on a financial sector variable. What we'll do is to let investment in physical capital (factories and equipment) depend on the interest rate. Hence, on the real side of the economy, everything remains the same as in Chapter 11, except for the investment function.

(12.1) $$I = \bar{I} - bi$$

The parameter -*b* is the interest sensitivity of investment, and indicates the change in investment spending for a one percentage point change in the interest rate. This equation indicates that firms always undertake a certain amount of investment ($\bar{I}$) which changes in ways that are determined by factors outside of the model. For instance, a sudden increase in optimism regarding future sales by firm owners might spur greater purchases of plant and equipment in anticipation of these greater sales. The other part of the equation indicates that the higher the interest rate on paper assets, the lower the rate of investment.

Why does investment spending have this relationship with the interest rate? One can think of the choices facing the owner of a firm. She has two options: either put the firm's savings in a bank, or spend on new factories or machinery. Each investment option yields a rate of return – one is the interest rate received from the bank and the other the rate of return on the new piece of machinery or new factory. The higher the interest rate, the higher the opportunity cost of investment spending, and hence the less investment spending undertaken.

This might be easier to see if one considered all the projects a firm *k* faces. Let's rank the projects from the highest rate of return (*RoR*) to lowest rate of return.

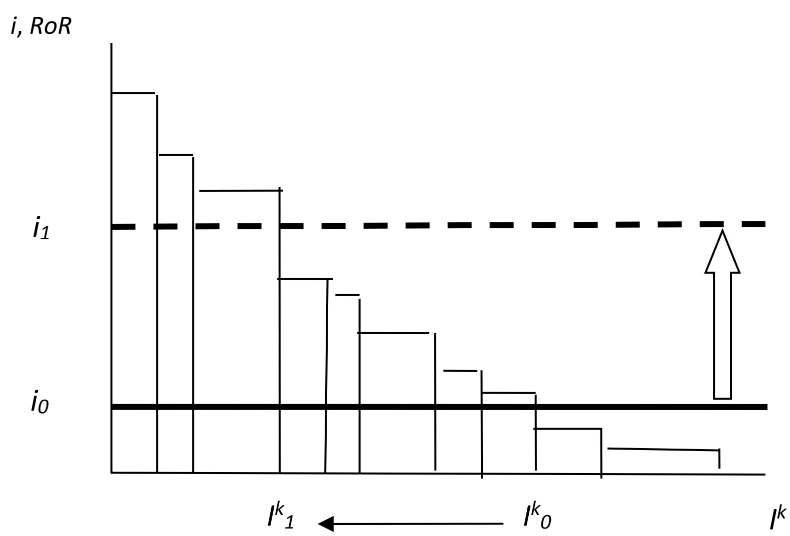

Figure 12.1: Investment projects and rates of return facing firm k, and interest rates

To understand the motivation for equation 12.1, consider the choices facing firm k. It has to determine the amount of investment to undertake. When the interest rate it faces is i_0, then the projects from 0 to the eight, totaling an amount of $I^k{}_0$, provide a rate of return in excess of the interest rate -- the return the firm would gain from putting the funds in the bank. The firm will therefore find it to its advantage to invest in all the projects up to $I^k{}_0$.

When the interest rate facing the firm rises to i_1 (the white arrow) but the firm faces the same set of investment projects to decide amongst, then only the top three projects exceed the interest rate. The firm will now only proceed on these projects totaling $I^k{}_1$, which is less than the original amount of $I^k{}_0$. Investment spending by the firm declines (the thin arrow).

To summarize, there is a negative relationship between interest rates and investment spending in plant and equipment at the firm level. The same holds true when one aggregates up to the economy level, since all the firms face a similar decision.

Now we turn to incorporating this negative relationship into the solution for equilibrium income in Chapter 11. But because investment depends on the interest rate, rather than taking a single value, the resulting expression will be a combination of points.

Solving out for income leads to the following expression, relating the income to the interest rate.

(12.2) $$Y = \bar{\alpha}[\bar{A} + \bar{X} - \overline{IM} + (n + v)\bar{q} - bi]$$ <IS curve>

Notice that this looks very similar to equation (11.12), except that now there is a "-*bi*" term. This seems like a small difference, but conceptually, it's very important. This expression, called the IS curve, means that for lower levels of interest rates, investment, a component of aggregate demand, is higher, and thus income is also higher. The IS curve is also drawn for a given level of autonomous spending and a given level of the exchange rate (which is why there is a bar over the real exchange rate). Since the interest rate is free to move, there is a different equilibrium income for each given interest rate. Thus (12.2) is an expression for a line, rather than a specific value (that's why there is no "0" subscript on Y).

Now to introducing money. It's useful to spend a moment discussing how money differs from income, even though in everyday discussion we use the terms interchangeably. Essentially, what we are doing is to decompose the economy into a real sector (what we spent Chapter 11 and the preceding part of this chapter discussing) and a financial sector.

To model the financial sector, we make a big simplification by assuming there are only two assets: money and bonds.[1] Then, under the proper assumptions, the financial sector equilibrium can be characterized by the money market, so that we don't need to separately keep track of the bond market as well.[2]

[1] We also make the assumption that all the private sector liabilities net out with the private sector assets. For instance, the corporate bond (liability) issued by General Motors and held by Citibank (an asset) wash out, so we don't need to keep track of them.

[2] If the price elasticity of bonds is infinite, so that all government bonds issued are demanded at a given price, then the only market that has to be tracked in order to know if the financial sector is in equilibrium is the money market.

The two assets are distinguished in the following way. Money is an asset that is useful for transactions, but yields no returns. Bonds, in contrast, are not useful for transactions, but provide a return, in this case the interest rate *i*. In reality, there is not a sharp dividing line between money and bonds – savings accounts pay interest, but are pretty easy to convert to cash that can be used to make purchases.

Equilibrium in the money market is described by the standard quantity demanded equals quantity supplied condition:

(12.3) $$\frac{M^d}{P} = \frac{M^s}{P}$$

Money supply is assumed to be given exogenously, set by the central bank. That means that the number of pieces of paper called money is a fixed number (which changes when the central bank decides to increase or decrease the number of pieces of paper). That's why we put an overbar over the M.[3]

(12.4) $$\frac{M^d}{P} = \frac{\bar{M}}{\bar{P}}$$

Money demand is a positive function of income and a negative function of the interest rate.

(12.5) $$\frac{M^d}{P} = kY - hi$$

Money demand rises with income because it is assumed that the number of transactions rises with income. Recall, the only way one can make transactions is using money, hence the positive relationship. The parameter *k* is the income sensitivity of money demand, the change in dollars of money demanded for a one unit change in real income.

The parameter -*h* is the interest sensitivity, the change in dollars demanded when the interest rate rises by one percentage point. Why does money demand depend negatively on the interest rate? It's because the interest rate is the return on the alternative asset (bonds), and so it serves as the opportunity cost of holding money. As the return on bonds goes up, one holds less money.

Substitute (12.4) and (12.5) and solve for the interest rate yields:

(12.6) $$i = -\left(\frac{1}{h}\right)\left(\frac{\bar{M}}{\bar{P}}\right) + \left(\frac{k}{h}\right)Y$$ <LM curve>

The LM curve represents the combinations of income levels and interest rates such that the money market (and hence the bond market) is in equilibrium. It's a positive relationship because higher income levels are associated with higher money demand levels which, with a given

[3] Since we are holding the price level constant, an overbar is also placed over the variable P as well.

money supply, implies a higher interest rate to equilibrate the market.

There are two unknowns, and two equations. To determine equilibrium income and interest rates, we can solve the system by substituting one equation into the other. The answer is given in equation (12.7):

$$(12.7) \qquad Y_0 = \hat{\alpha}[\bar{A} + \bar{X} - \overline{IM} + (n+v)\bar{q} + \left(\frac{b}{h}\right)\left(\frac{\bar{M}}{\bar{P}}\right)] \text{ where } \hat{\alpha} \equiv \left(\frac{1}{1-c+m+\frac{bk}{h}}\right)$$

Notice that equilibrium income now depends on the level of autonomous spending, the real exchange rate, and the money stock (in real terms). The equilibrium interest rate is a complicated function of autonomous spending, real exchange rate and the money stock.

The equilibrium income level and interest rate is depicted in Figure 12.1:

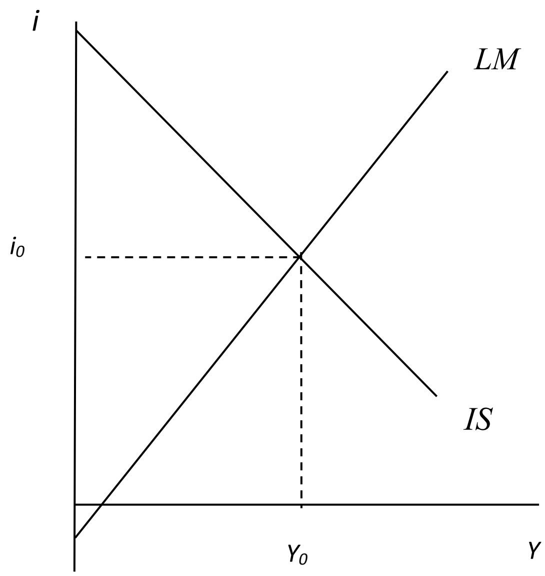

Figure 12.1: IS-LM equilibrium

Equilibrium income and interest rates are determined by the intersection of the two curves. Note the following aspects of these curves:

- The position of the IS curve depends upon $\bar{A}, \bar{X}, \overline{IM}, \bar{q}$. Increases in $\bar{A}, \bar{X}, \bar{q}$ shift out the IS curve, while an increase in $\overline{IM}$ shifts in the curve.

- The position of the LM curve depends upon the real money stock, $(\bar{M}/\bar{P})$. An increase in $\bar{M}$shifts down (or out) the LM curve.

Only at the combination of i_0 and Y_0 is it true that both the goods market and the money market are in equilibrium.

It's easiest to explain the intuition for the IS-LM model by showing how policy works in model. First we'll consider fiscal policy (as discussed in Chapter 11), second, monetary policy and finally, exchange rate policy.

The increase in government spending increases autonomous spending (remember $\bar{G}$ is part of $\bar{A}$); initially GDP rises by $\Delta G = \Delta A$. But the increase in GDP means that more goods have to be produced, and production requires that the factors of production have to be paid. With the resulting income, households have higher disposable income, a portion of which they consume. In the absence of any other effects, the multiplier chain described in Chapter 11 would occur – each real dollar increase in government spending, yields a stream of increases in spending of $1+c+c^2+c^3+c^4+\ldots > 1$ (ignoring imports and investment). In Figure 12.2, the government spending increase shows up as the outward shift of the IS curve (gray arrow); if interest rates were to stay constant, income would rise to Y'_0.

However, we can't just ignore what happens to investment spending. In particular, we know that investment depends on the interest rate, and it's possible that the interest rate could change in response to the increase in government spending. In fact, it's very likely that interest rates will change.

Recall that money demand depends on income. As GDP and income rises (due to the above mechanism), the quantity of money demanded rises. However, the central bank is assumed to hold the money supply constant. If at the beginning, the quantity of money demanded equaled the quantity of money supplied (i.e., the economy was on the LM curve), then under new conditions and the old interest rate, the quantity of money demanded would have to exceed the quantity of money supplied. Hence, the interest rate would have to be higher in order to re-equilibrate the quantity of money demanded to the (fixed) quantity of money supplied.

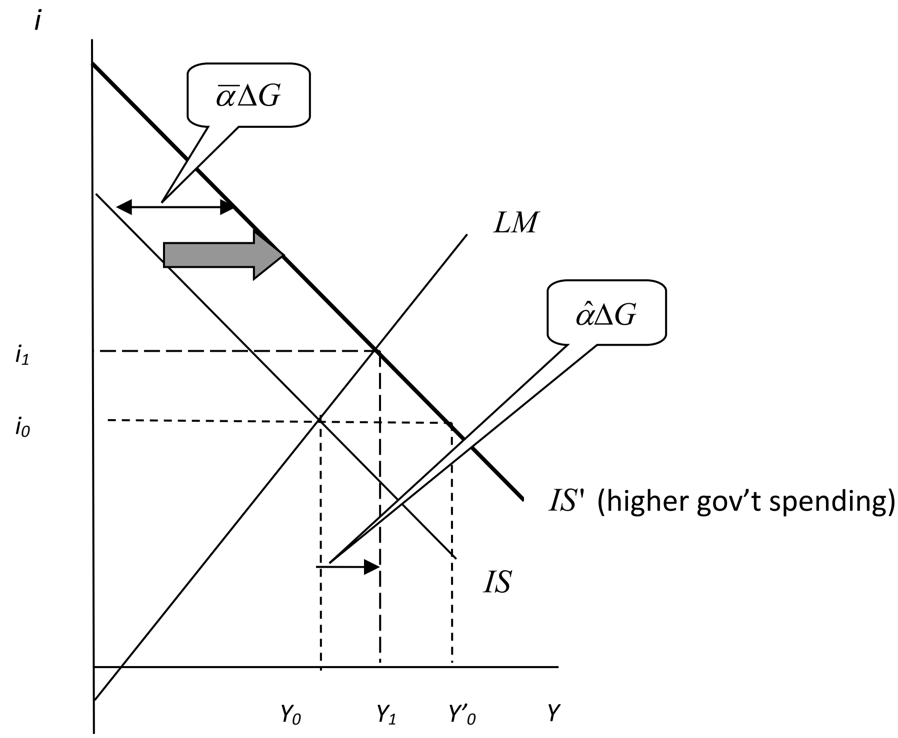

Figure 12.2: Expansionary fiscal policy in IS-LM

Due to the higher interest rate, income does not rise to Y'_0 (which would have been the case using the model in Chapter 11) but only to Y_1. Equivalently, the increase in output $\hat{\alpha}\Delta G$ is smaller than that which would have been implied by the simple Keynesian multiplier ($\bar{\alpha}\Delta G$).

The reason the increase in output is less in this model is because of "crowding out" due to the heightened transactions demand for money. Let's trace out the chain of events: Higher output (due to higher government spending) leads to higher money demand which, given a constant money supply, results in a higher interest rate. The higher interest rate depresses investment spending, thereby offsetting in part the increase in output. Notice that, unless the LM curve is vertical, or the IS curve is perfectly flat, the output increases.

Now we turn to monetary policy. In this model, monetary policy involves changes in money supply.[4] If *M* increased when *P* is constant, then *M*/*P* rises, and the LM shifts out rightward (shown by the gray arrow in Figure 12.3).

[4] In the real world, monetary policy is often described as a change in the interest rate that the central bank controls. An increase in the money supply, holding everything else constant, is the same as a decrease in that interest rate.

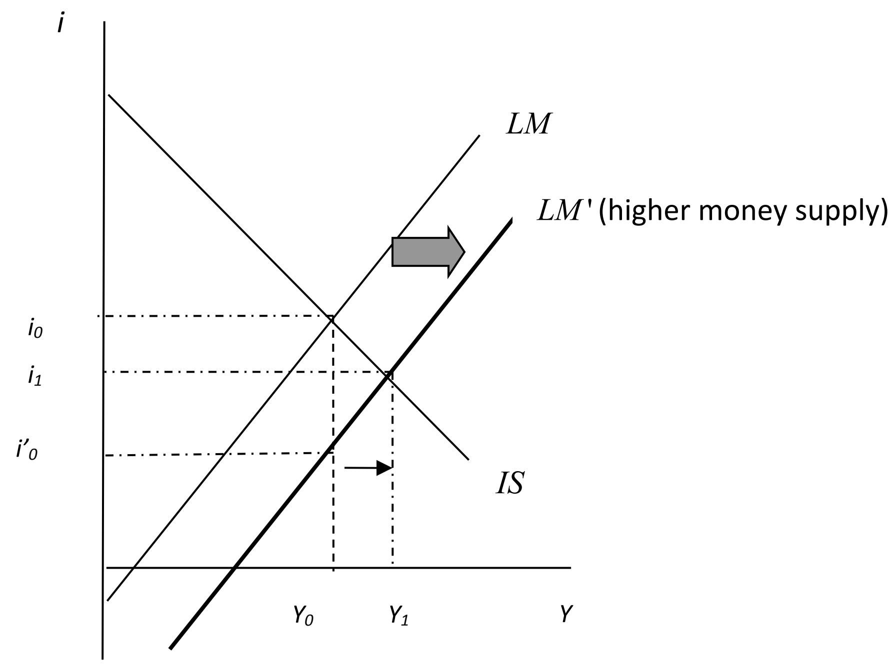

Figure 12.3: Expansionary monetary policy in IS-LM

When the quantity of money supplied increases, at the original income levels and interest rates, an excess quantity of money supplied occurs (remember, before the change in monetary policy, the quantity of money demanded equals quantity of money supplied, since the economy was on the LM curve). That means that interest rate has to change in order to induce households and firms to hold the additional dollars that are now circulating. Since the interest rate is the opportunity cost of holding money, the interest rate must decline to re-equilibrate the money market. Holding income constant, the interest rate would have to fall to i'_0. That however, is not the end of the story. The lower interest rate results in a higher level of investment spending, thus a higher level of aggregate demand and hence output (which in turn induces some additional money demand). Interest rates end up at i_2, and income at Y_1.

To sum up, expansionary monetary policy works by driving down interest rates and hence spurring investment which, by the multiplier process, increases income.

Finally, we examine the impact of exchange rate policy. Consider a devaluation of the exchange rate. This spurs net exports (an increase in exports and a decrease in imports), which results in an increase in aggregate demand. This shifts out the IS curve in Figure 12.4 (gray arrow), resulting in an increase in output.

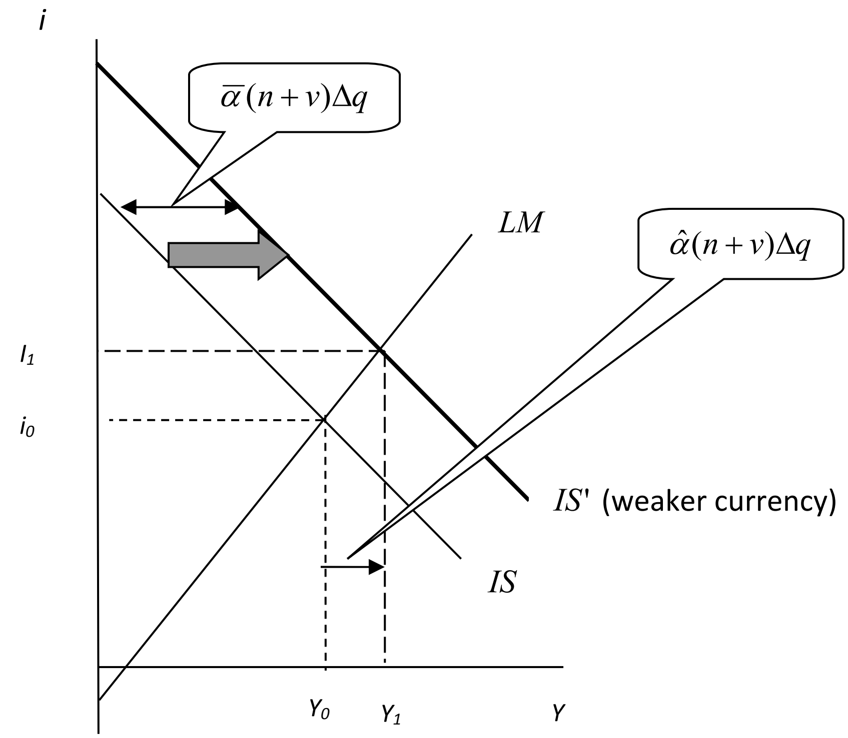

Figure 12.4: Exchange rate devaluation in IS-LM

A way to quantitatively determine the magnitude of output changes is to relate the change to changes in the policy variables. Take equation (12.7), and break it up into the constituent changes (i.e., take a total differential):

(12.8) $$\Delta Y = \hat{\alpha}[\Delta A + \Delta X - \Delta IM + (n+v)\Delta q + \left(\frac{b}{h}\right)\Delta\left(\frac{M}{P}\right)]$$

The change in income or GDP can be attributed to changes in the amount of autonomous spending (like the part of investment that doesn't depend on interest rates, or government spending on goods and services), changes in the amount of money supply, or changes in the real exchange rate.

To determine the impact of changes in government spending *only*, one sets all the other changes to zero, so that after re-arranging, one obtains the following expression for a change in government spending:

$$\frac{\Delta Y}{\Delta G} = \hat{\alpha} \geq 0$$

For a change in the real money supply *only*, the impact on income is:

$$\frac{\Delta Y}{\Delta(M/P)} = \hat{\alpha}(b/h) \geq 0$$

The final policy tool in this economy is exchange rate devaluation/revaluation. For a change in exchange rates *only*, the impact on income is:

$$\frac{\Delta Y}{\Delta q} = \hat{\alpha}(n + v) \geq 0$$

This indicates that if the exchange rate rises (devalues or depreciates), then exports increase and imports decrease, leading to a boost in income by way of the usual multiplier process.

Thus far, we haven't incorporated any restrictions on how exchange rates or financial flows might be affected by the country's interaction with the rest of the world. In order to account for this dimension, we need to include some sort of equilibrium condition related to the external balance.

12.2 Introducing an External Balance Condition

The external balance condition is built upon the Balance of Payments identity, outlined in Chapter 9. Recall the identity states that the current account and the financial account and official reserves transactions has to sum to zero:

(12.9) $$CA + FA + ORT \equiv 0$$

In words, this means that if there is a deficit on the current account, either the financial account must be in surplus, FA>0 (foreigners are lending enough to finance the deficit), or foreign exchange reserves are declining (ORT > 0).

The equilibrium concept of the balance of payments is one where official reserves transactions are zero. This can be written as:

(12.10) $$TB + FA = 0$$

where we have assumed the current account can be approximated by the trade balance.

In words, our definition of external equilibrium is one where foreign exchange reserves are unchanged, neither increasing nor decreasing. This is a reasonable condition, since it's sustainable.

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We have already described how the trade balance behaves in Chapter 11. However, we have yet to describe what the financial account depends upon.

(12.11) $$FA = \overline{FA} + \kappa(i - \bar{\imath}^{*})$$

Where κ is the sensitivity of financial flows to interest differential, or the change in dollars of inflow for a one percentage change in the interest rate (relative to the foreign country's interest rate).

The higher the home interest rate, the more financial capital flows to the home country, holding all else constant. The intuition is that the higher the return on home assets, the more attractive those assets are, and the more likely they are to be purchased. (For instance, a foreign purchase of a US government bond is the same as lending to the United States.)

Substituting in the expressions for the trade balance (exports minus imports) and the financial account into (12.10), and re-arranging to solve for the interest rate yields:

(12.12) $$i = -\left(\frac{1}{\kappa}\right)[(\bar{X} - \overline{IM} + \overline{FA}) + (n+v)q] + \bar{\imath}^{*} + \left(\frac{m}{\kappa}\right)Y$$ <BP=0 curve>

The overbar over i^* indicates that the foreign interest rate is taken as given (or exogenous). Notice that the slope of this curve is positive (m/κ), and that anything that changes the autonomous components of exports, imports and financial flows will shift the position of the schedule. So too will changes in q.

The BP=0 schedule is the combination of all points for which the trade balance and financial flows are such that the overall balance of payments (in an economic sense) equals zero, so that official foreign exchange reserves do not change. The slope of the BP=0 schedule is positive because higher income is associated with higher imports and a lower trade balance; hence financial inflows must be higher, and this occurs when the interest rate is higher, holding foreign interest rates constant.

The IS and LM and BP=0 schedules are all shown in Figure 12.5. The figure is drawn assuming equilibrium internally and externally, with equilibrium at i_0 interest rate and Y_0 income level. This model combining the IS-LM model and an external balance condition is also called the Mundell-Fleming model.[5]

[5] The original references are Mundell (1961) and Fleming (1962).

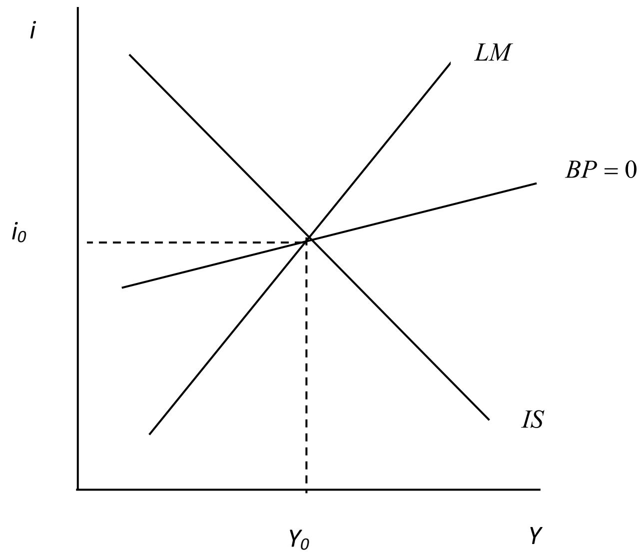

Figure 12.5: IS-LM-BP=0 in equilibrium

12.3 Fiscal and Monetary Policies under Fixed Exchange Rates

In the fixed exchange rate situation, q does not change unless the government devalues or revalues the currency. This simplifies the mechanics of the model, and so we examine this situation in this chapter. To denote the fact that the real exchange rate is controlled by the central bank, and is changed exogenously, we will put a bar over q, hence $\bar{q}$.

Shifts in the IS and LM curves occur for the same reasons as before. Consider what happens if one increases government spending, as shown in Figure 12.6. The IS curve shifts out (denoted by the gray arrow).

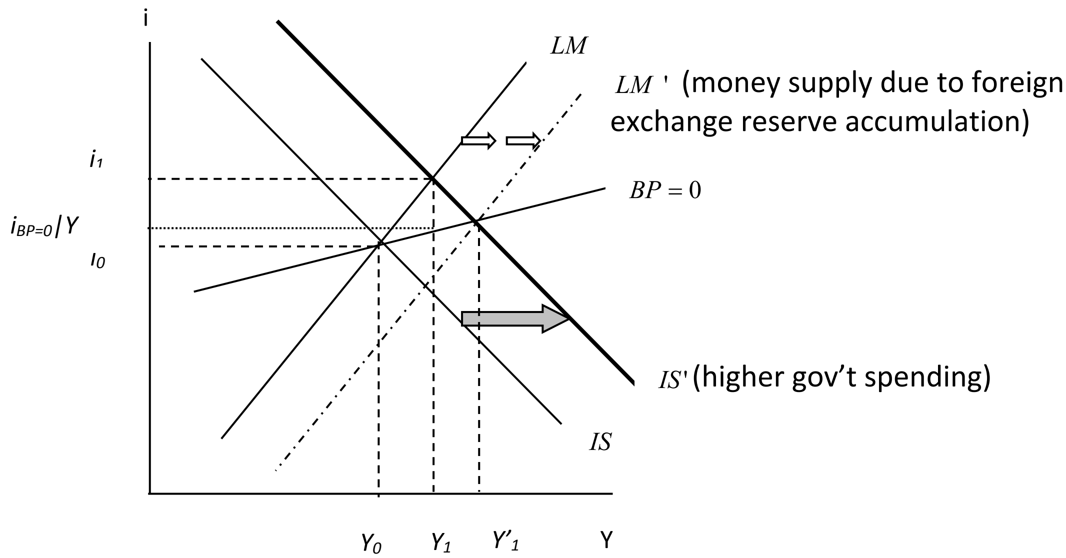

Figure 12.6: Expansionary fiscal policy under fixed exchange rates, high capital mobility

In this case, equilibrium income and interest rates rise. Notice that the equilibrium interest rate i_1 is higher than that consistent with external equilibrium (i.e., BP=0). As a consequence, the balance of payments is in surplus, so ORT < 0, and foreign exchange reserves are increasing. In the absence of sterilized intervention, the LM curve will shift out to the new LM (white arrows), setting income at level Y'_1). However, if the central bank sterilizes the inflow, then the LM curve remains at Y_1.

To show why a net financial inflow causes an LM shift in the absence of sterilization, we have to digress in order to examine the workings of the central bank. A central bank issues currency and credits banks with bank reserves, and purchases domestic assets (such as government bonds) and foreign exchange. The balance sheet reflects the outcomes of these operations cumulatively:

Central Bank
Balance Sheet

Assets	Liabilities
Domestic Assets (DA)	Currency (CU)
Foreign exchange reserves (FXRes)	Bank reserves (Res)

The sum of central bank liabilities (currency and bank reserves) is termed the money *base*. This is different from the money supply, which determines the position of the LM curve. For our purposes, we'll just assume that when the money base increases, the money supply increases.[6]

The central bank increases or decreases the money supply typically through conducting "open market operations". For instance, in Section 12.1, the central bank would increase the money supply by buying domestic assets (*DA*, e.g. government bonds) from the private banks, and paying with currency.

Suppose that there is a financial flow that more than offsets a trade deficit; then foreign exchange reserves (*FXRes*) would rise. Notice that when *FXRes* rises on asset side of the balance sheet, then the money base also rises, unless the central bank reduces *DA* by the same amount. The central bank could do this by selling *DA* in exchange for currency. The process of exactly offsetting the increase in *FXRes* with decreases in *DA* is termed a "sterilization of reserve accumulation".

There is nothing that guarantees that the BP=0 line is flatter than the LM curve. Recall the slope of the LM curve is (k/h), while that of the BP=0 curve is (m/κ), and one can imagine that for a small, developing country, international investors might not wish to place their financial capital in the country without a very high rate of return; in other words financial flows might not be very sensitive to interest differentials, so that κ is small. Then the slope of the BP=0 curve will be steep, perhaps steeper than the LM curve.

As depicted below in Figure 12.7, the fiscal expansion shifts out the IS curve (gray arrow), output and interest rates rise as before. Now, however, the equilibrium interest rate is not as high as that required for external equilibrium. Hence, BP < 0, ORT > 0, and foreign exchange

[6] The money supply is composed of currency and checking deposits; the former is a liability of the central bank, while the latter is a liability of the private banking system. If banks are forced to hold a minimum amount of bank reserves as a share of total checking deposits (say 10%, so $100 deposits requires $10 bank reserves), then there will be a fixed relationship between money supply and money base. (This assumes the private banks do not hold any reserves above the required minimum.)

reserves decline. If the central bank does not sterilize the foreign reserves decline, then the LM curve will shift in, until external equilibrium is restored. If the central bank does sterilize, then the LM remains where it was. Of course, this must come to an end when foreign exchange reserves are depleted.

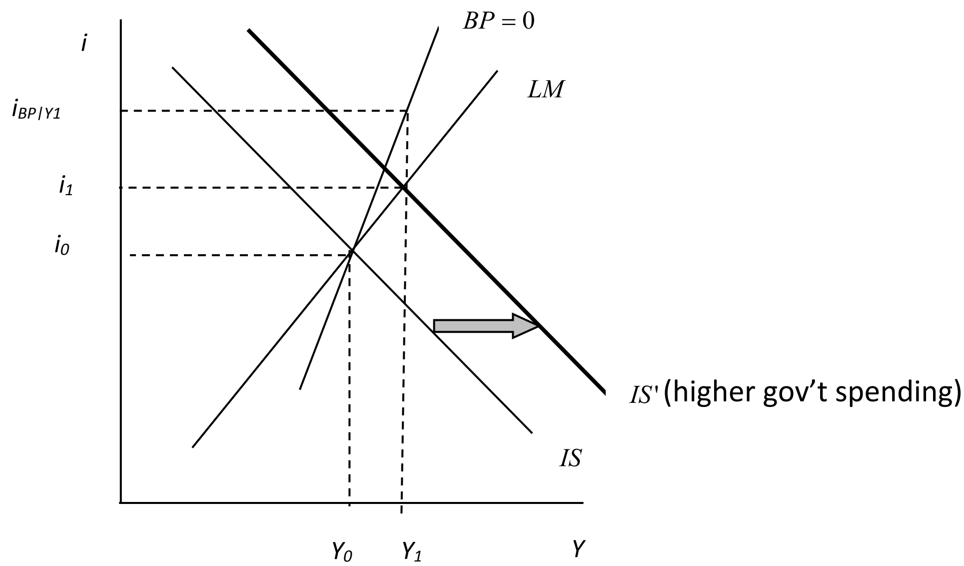

Figure 12.7: Expansionary fiscal policy under fixed exchange rates, low capital mobility

Since the expansionary fiscal policy induces a trade deficit, then *FXRes* will decline over time. In the absence of offsetting increases in DA (sterilization), then the money base will decline, reducing the money supply ($\Delta M < 0$), and shifting the LM curve in, until the original level of income is restored. However, if the central bank does sterilize the inflow, then the LM remains shifted out, and income at Y_1 – at least until foreign exchange reserves are exhausted.

It is instructive to consider what happens if a monetary expansion is undertaken. Examine the high capital mobility case, shown in Figure 12.8 (the low capital mobility case has the same result). The LM curve shifts out, driving the interest rate down to i_1.

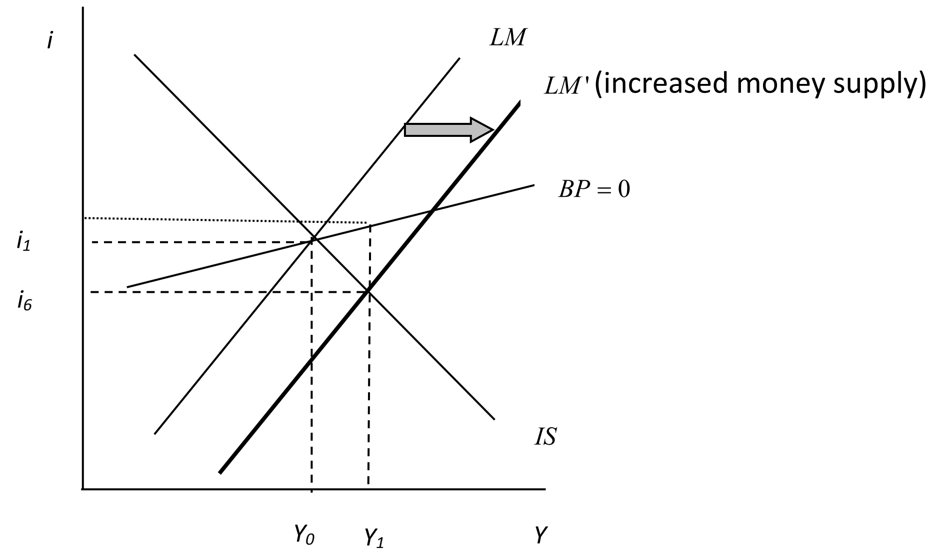

Figure 12.8: Expansionary monetary policy under fixed exchange rates, high capital mobility

In this case, the resulting equilibrium interest rate i_1 is less than required for external equilibrium. As a consequence, there is a balance of payments deficit, ORT > 0, and foreign exchange reserves are run down. In the absence of offsetting sterilization by the central bank, the money supply shrinks, and the LM curve shifts back. This process stops only when the interest rate is back at i_0. In other words, the monetary policy is undone. This happens because monetary policy is subordinated to the pegging of the exchange rate.

Another way of putting this is that a country loses monetary autonomy when it enters into a fixed exchange rate system. Since the loss of foreign exchange reserves is faster when capital mobility is high, then the higher the degree of capital mobility, the greater the loss in monetary autonomy under a fixed exchange rate system. (This applies when countries use market forces to set the equilibrium exchange rate at the official pegged rate; sometimes countries use capital controls and other exchange restrictions to set the rate at the official rate, as in the case of China).

12.4 Exchange Rate Policy under Fixed Rates: Devaluation and the Interest Rate Defense

In this model, the government exerts control over the economy through three levers: fiscal policy, monetary policy, and the value of the currency. By changing the value of the currency (by altering the value of the currency the central bank commits to exchanging home currency for foreign), the government can affect the level of economic activity, primarily by changing the relative price of home and foreign goods.

Suppose a country faces a balance of payments deficit, as shown in Figure 12.9. Notice that initially, the equilibrium interest rate is below that consistent with equilibrium. Under these conditions, a devaluation could be a particularly useful policy. Notice that q enters into the BP=0 equation and in the IS equation; hence a devaluation would shift both curves (gray arrows).

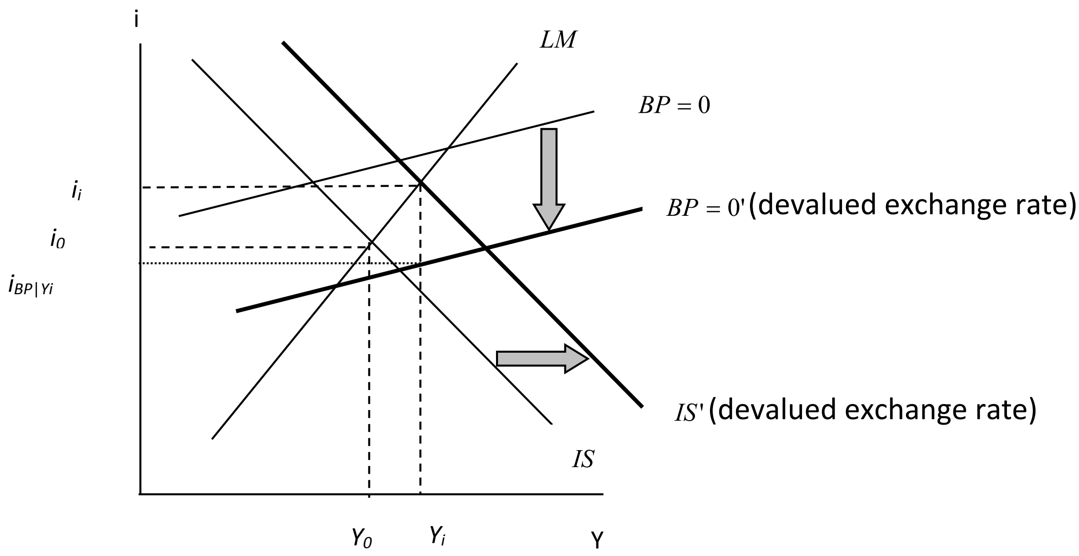

Figure 12.9: Devaluation from an initial balance of payments deficit

At the new equilibrium, the balance of payments is now in surplus, since the interest rate i_1 is greater than $i_{BP|Y1}$. The balance of payments problem has been remedied, and in fact foreign exchange reserves will now accumulate.

The balance of payments surplus will be undone over time if the central bank does not sterilize the reserve accumulation. As foreign exchange reserves rise, the money base increases, shifting out the LM curve. Eventually, the interest rate will fall to the level consistent with external balance, and reserve accumulation ceases.

Now, let's return to the question raised at the beginning of the chapter. Why would raising the interest rate defend against a balance of payments deficit? We start with the same conditions as in Figure 12.9, but now the central bank raises the interest rate by tightening monetary policy so the LM curve shifts inward (gray arrow).

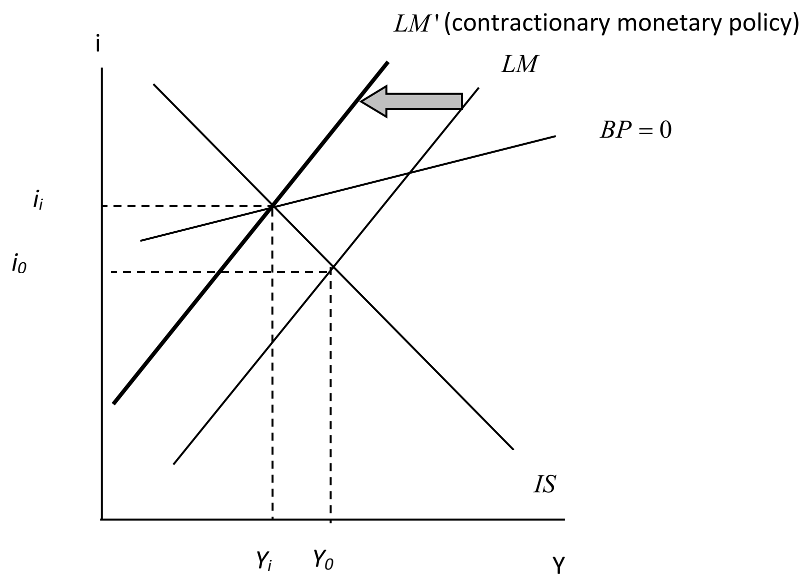

Figure 12.10: Interest rate defense in a balance of payments deficit

The resulting equilibrium is sustainable in terms of the balance of payments, but, as depicted in Figure 12.9, would result in a lower level of income. Hence, the interest rate defense brings with it serious costs.

Rarely do countries pursue solely one policy or another. In 2014, Russia implemented a combination of both policies – raising interest rates and allowing the currency to weaken.

12.5 Application: China's Surpluses and Reserve Accumulation

One of the best illustrations of the impact of the fixed exchange rate is China. Beginning in 2004, China began running significant current account surpluses. These surpluses arose from a variety of factors, including the accession of China to the World Trade Organization that could be interpreted as an exogenous increase in net exports.

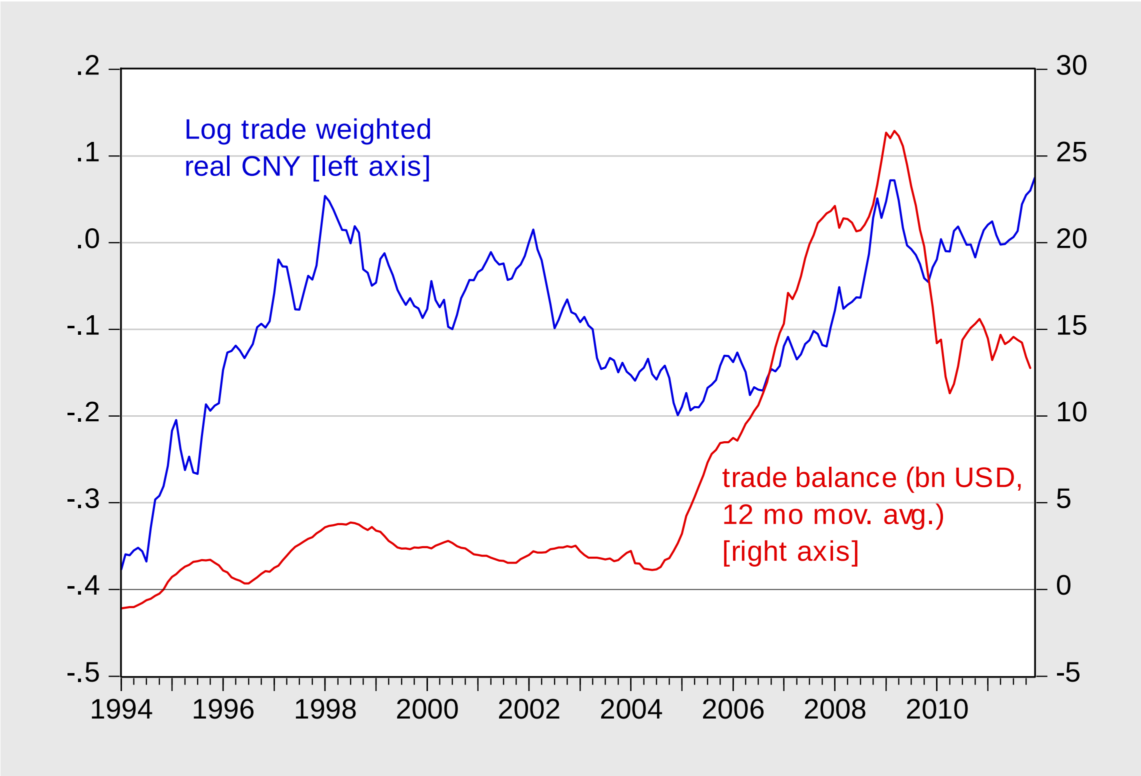

Chart 12.1: Log trade weighted value of the Chinese yuan (blue, left scale), and 12 month moving average of Chinese trade balance, in billions of USD.

In addition, rapid productivity growth can be interpreted as a depreciation in the real exchange rate. Both of these effects result in an outward shift in the IS and a downward shift in the BP=0 curves. The resulting equilibrium is illustrated in Figure 12.11. Notice that the equilibrium interest rate i_0 exceeded that necessary for external equilibrium, $i_{BP|Y0}$.

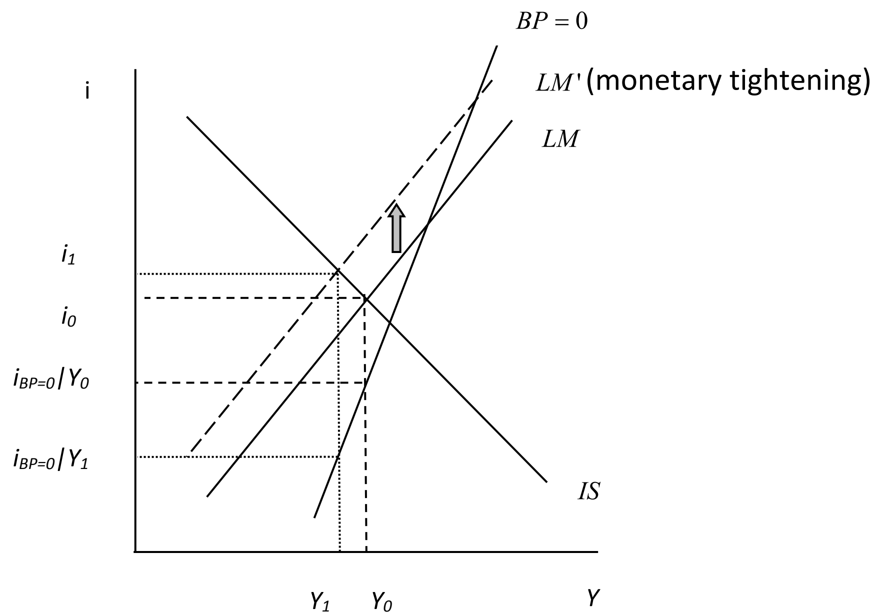

Figure 12.11: China 2004-05.

In the next two years, the current account surplus increased, resulting in accelerating reserve accumulation. Notice that in order to prevent the LM shifting out (which would have increased GDP and reduced the current account), the central bank had to sterilize the reserve accumulation. Instead of selling Chinese government bonds (reducing *DA* on the central bank balance sheet), the People's Bank of China (PBoC) relied mostly upon forcing the banking sector to hold more bank reserves. This served to reduce the money supply relative to what it otherwise would have been.

In the years leading up to 2005, the PBoC tried to offset the expansionary effect of a weak currency by tightening money policy (gray arrow). This shifted the LM curve upward, raising the interest rate, and widening the gap between the equilibrium interest rate i_1 and the interest rate consistent with external balance, $i_{BP|Y1}$. In other words, government policy exacerbated reserve accumulation. Chinese foreign exchange reserves surge starting in 2004, as shown in Chart 12.2.

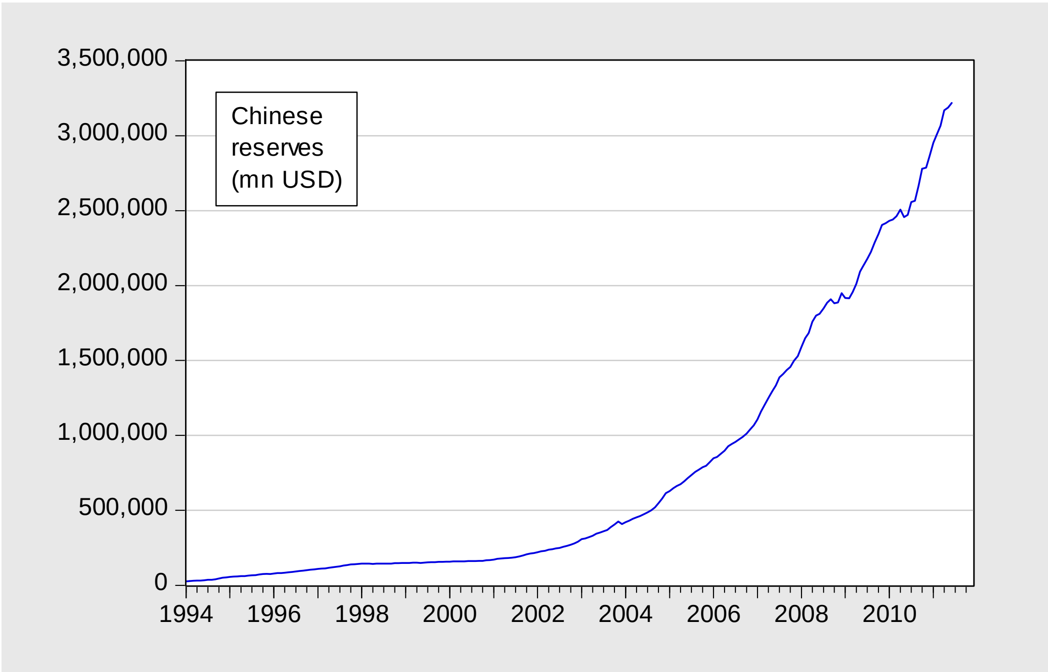

Chart 12.2: International reserves, in millions of USD. Source: IMF, *International Financial Statistics.*

A much more reasonable approach would have been to revalue the Chinese currency, the *yuan*. This would have shifted the IS curve inward (achieving the goal of reducing GDP) and shifted up the BP=0 curve (shown as gray arrows). This policy is shown in Figure 12.12.

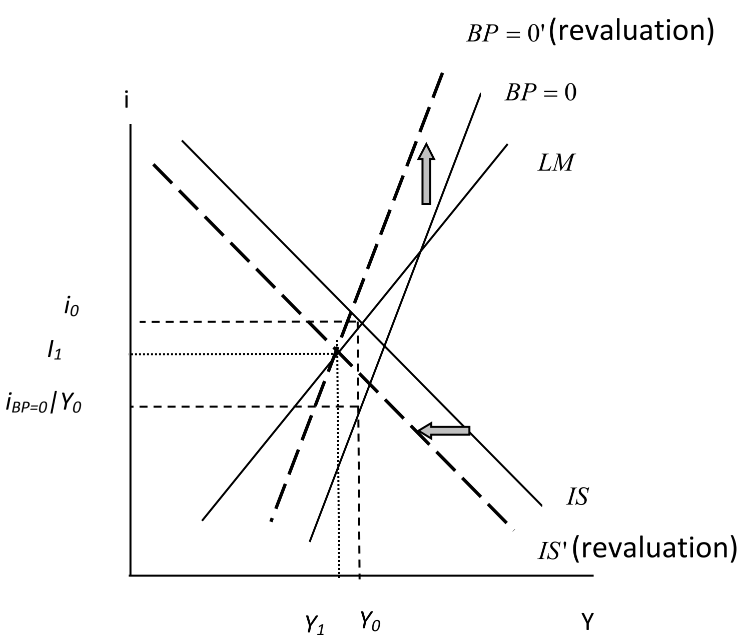

Figure 12.12: China, 2005-2008.

A currency revaluation could have accomplished the dual aims of cooling off the economy, and reducing the current account surplus and pace of reserve accumulation. This is essentially the policy China finally undertook, under pressure from the international community, since China went off its de facto peg against the US dollar in July 2005. By 2015, after years of yuan appreciation, Chinese foreign exchange reserves stabilized, at *over $4 trillion*.

Summary Points

1. A model that dichotomizes the economy into real and financial sides is developed. The real side is linked to the financial side by way of investment sensitivity to interest rates.

2. Fiscal policy is less powerful than in the simple Keynesian model, because higher income induces higher interest rates that depress investment.

3. Monetary policy works by changing interest rates, thereby affecting investment and total aggregate demand.

4. In an economy on a fixed exchange rate, the central bank is committed to buying and selling foreign exchange to peg the currency at a certain value.

5. Both monetary and fiscal policy are effective in affecting output, but they are only effective over time if foreign exchange changes are sterilized.

6. The degree of capital mobility is important to determining the effectiveness of either fiscal or monetary policy, when foreign exchange changes are sterilized.

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