Chapter 15
Exchange Rate Determination

"'Suppose four fifths of all the money in Great Britain to be annihilated in one night,' David Hume speculated in 1752, '...must not the price of all labor and commodities sink in proportion,' giving England a competitive advantage in trade which must quickly 'bring back the money we had lost, and raise us to the level (of prices) of all the neighboring nations?'"
Michael Connolly, "The Monetary Approach to an Open Economy: The Fundamental Theory", in Putnam and Wilford, eds. The Monetary Approach to International Adjustment.

I. Chapter Outline

II. Chapter Summary and Review

The **Purchasing Power Parity (PPP) Theory** of exchange rates takes two forms: **Absolute PPP** and **Relative PPP**. Both forms originate from the idea that in equilibrium a dollar should be able to buy the same amount of goods anywhere in

the world. If it could not, then substitution will cause the exchange rates and/or prices to change to equalize the purchasing power. Suppose, for example, that one U.S. dollar purchased more goods in Europe than in the United States. The resulting high demand for the euro and European goods would cause the price of the euro to increase and/or the price of European goods to increase (and the price of U.S. goods to decrease), until the purchasing power of the dollar was the same in both Europe and the U.S.

Absolute PPP starts with the **law of one price**. If P_g^* is the price of gold (or any commodity) in Europe in euros and R is the dollar cost of the euro ($/euro), then the dollar cost of gold in Europe is

$$P_g^*(R).$$

By the law of one price, the dollar cost of gold in the U.S., P_g, will equal this. If, for example, the price of gold in Europe is Pg*=€800 and the exchange rate R=$1.20/€1, then by the law of one price, the cost of gold in the US will be $960. If it differed, say $P_g > P_g^*(R)$, then gold would be purchased in Europe and sold in the U.S., causing P_g to fall and both P_g^* and R to increase until there was equality. Thus, the law of one price states that

$$P_g = P_g^*(R) \text{ or } R = P_g/P_g^*.$$

Thus, the exchange rate, the dollar cost of the euro, will equal the ratio of dollar prices to euro prices.

When this is extended to all goods, whose prices are measured by price indices (like the consumer price index), then we have absolute PPP, i.e.,

$$R = P/P^*,$$

where P is the price index in the United States and P* is the price index in Europe.

There are two basic problems with PPP. First, PPP to the market for traded goods and services. The exchange rate is influenced not only by the supply and demand for goods and services, but also by movements of capital. The exchange rate will change in response to increased or reduced demand for foreign assets, and not necessarily reflect just relative goods' and services' prices. The second problem is transportation costs. Some goods and services are so expensive to transport, e.g., land, houses, and haircuts that they are not traded internationally so

substitution cannot cause the law of one price to hold for these goods, and so not for collections of goods whose average price is represented by a price index. Those with high transportation costs may be trade, but their but prices will differ by the cost of transportation.

Relative PPP recognizes that R may differ from P/P* due to the above considerations, but if the difference between R and P/P* is relatively constant, then *changes* in R should reflect *changes* in P and P*. Stated algebraically,

$$\%\Delta R = \%\Delta P - \%\Delta P^*.$$

(The *International Economics* text presents a more precise version of relative PPP. The two versions can be shown to be the same except for, in most cases, a very small difference.) This says that if the U.S. has a higher rate of inflation than Europe ($\%\Delta P > \%\Delta P^*$), then the euro will appreciate ($\%\Delta R>0$). The cause of this is the substitution out of U.S. goods and services and into European goods and services. As the demand for European goods and services increases, the demand for the euro increases and the euro will appreciate.

Empirically, PPP is a reasonable description of price levels and exchange rates for only very long periods of time, perhaps because the markets for goods and services are not highly integrated or exhibit price stickiness. It may take considerable time for goods to be substituted internationally and their prices to reflect changes in supply and demand. PPP also works best to describe inflationary periods, and not for periods in which the price of non-traded goods change relative to the price of trade goods. (Recall that it is the existence of non-traded goods that will cause deviations from PPP.)

PPP, although important in itself, is also an element in other exchange rate theories. The **monetary approach to the balance of payments**, developed in the early 1960s, recognizes that the balance of payments can be viewed not only as the sum of its constituent parts, e.g., goods, services, financial capital, etc., but also as the movement of money internationally. A balance of payments deficit (for autonomous transactions) means that, net, money flows out of a country, and a balance of payments surplus means, net, money flows into a country. A deficit, therefore, implies that the **demand for money** in the domestic market is less than the **supply of money** in the domestic market. This excess supply of domestic money means that money will flow out of the country—a deficit. A surplus implies excess domestic money demand (domestic money demand exceeds domestic money supply) which domestics try to satisfy by producing an inflow of money—a

surplus.

More formally, suppose that the amount of money demanded is some stable fraction of nominal GDP:

$$M_d = k(PY),$$

where M_d is the amount of money demanded, P is the domestic price level, Y is real GDP (PY is nominal GDP) and k is the stable fraction of nominal GDP that domestics want to hold in money balances. If PY = 100 and k = 1/5, then domestics require money balances of $20 in order to conduct transactions. (Note that a k = 1/5 means that money is used, on average, five times, so velocity = 1/k.)

The supply of money is determined by the product of the **monetary base** and the money multiplier, i.e,

$$M_s = mB,$$

where M_s is the money supply, m is the money multiplier, and B is the monetary base. The monetary base can be changed by the domestic authorities through the use of monetary policy tools, such as open market operations. The monetary base can also be changed through international transactions. In a fixed exchange-rate system, a country's monetary authority agrees to buy its currency if its value threatens to fall and sell its currency if its value threatens to increase. If the monetary authority buys its own currency (retiring it, so to speak) then the monetary base is reduced and the domestic money supply is decreased. If the monetary authorities sell its own currency, then the monetary base is increased and domestic money supply is increased.

In equilibrium, money supply equals money demand, or $M_d=M_s$. Suppose now that there is an increase in the supply of money through an open market purchase by the central bank with no corresponding change in domestic money demand. This excess domestic supply of money in the domestic market will flow out of the country, producing an appreciation of foreign currencies (depreciation of the domestic currency) and a deficit in the (autonomous) balance of payments. The downward pressure on the country's exchange rate will initiate a purchase of the country's currency by the domestic monetary authorities, which reduces the domestic money supply. Although the initial open market operation has increased the money supply, the intervention to keep the exchange rate fixed has decreased the money supply by the same amount.

The mechanism can also be run in reverse. A reduction in the domestic money supply, with no corresponding change in the domestic demand for money, will cause an excess domestic demand for money, which will be satisfied by domestics selling, net, goods, services, and assets abroad. The threatened appreciation of the exchange rate will initiate sales of the domestic currency by the monetary authorities, which increases the domestic money supply.

Notice that in both of the above cases, after all foreign repercussions occurred, there was no change in the money supply. In a fixed exchange rate system, a country cannot control its money supply. The money supply automatically adjusts to correct any imbalance in the balance of payments, with imbalances (balance of payments deficits and surpluses) being caused by excess money supply or money demand.

In a flexible rate system, the monetary authority of a nation does not commit to buying or selling its own currency to maintain a particular exchange rate, so the monetary authority can control the nation's money supply. The adjustment to balance-of-payments surpluses and deficits in a flexible exchange rate system occurs through the effect of exchange-rate changes on domestic prices. Consider a balance-of-payments surplus. As with the monetary approach in general, a balance-of-payments surplus represents an excess domestic demand for money. In an attempt to satisfy the excess demand for money, there is a net sale of goods, services, and assets abroad. With flexible exchange rates, this leads to an appreciation of the domestic currency. Domestic currency appreciation leads to lower prices directly through reducing import prices, as measured in the local currency, and through substitution, a reduction in domestic prices. A reduction in prices reduces money demand ($M_d = k(PY)$) until it is consistent with the money supply. The balance-of-payments surplus does not change the money supply when exchange rates are free to change. The balance-of-payments surplus changes exchange rates, which affect prices and money demand. A balance-of-payments deficit from an excess supply of money will cause depreciation of the currency, which will cause prices to increase which restores equilibrium by increasing money demand.

The exchange rate in the monetary approach is based on PPP. If the conditions for PPP are met, as discussed above, then dollar cost of a unit of foreign exchange is

$$R = P/P^*.$$

From monetary equilibrium, $M_s = M_d = k(PY)$,

$$P = M_s/kY.$$

Using the same expression for the foreign country, and substituting it into the PPP expression produces

$$R = M_s k^*Y^*/M_s^*kY.$$

If k and k* are constant, and Y and Y* are constant at their full employment levels, then the exchange rate, R, is proportional to M_s and inversely proportional to M_s^*. A country's exchange rate reflects the quantity of domestic money relative to foreign money. Very simply, R will increase (a depreciation of the domestic currency) if a country increases its money supply relative to other countries. A higher money supply for a country relative to other countries will cheapen the currency on the foreign exchange market. If the exchange rate is flexible, therefore, the exchange rate reflects relative money supplies. If the exchange rate is fixed, however, then the supply of money cannot be controlled, and it is the price levels that is determined by the exchange rate.

The monetary approach also recognizes that changes in inflationary expectations and changes in the expected future exchange rate can affect the current exchange rate in a floating-rate system. The effect of changes in expected inflation on the exchange rate can be seen through the PPP relationship. If, for example, foreign inflation is expected to increase relative to domestic inflation (a decrease in P/P*), then by PPP (R = P/P*) it must also be the case that R is expected to fall. If R is expected to fall (expected depreciation of the foreign currency), then sales of the foreign currency by speculators in anticipation of its decrease will cause it to decrease in the current period.

This effect of changes in the expected exchange rate can be seen from the uncovered interest parity condition of Chapter 14. Interest parity was expressed as

$$i = i^* + [E(SR)-SR]/SR.$$

The term [E(SR)-SR]/SR is the expected appreciation of the foreign currency as a percentage of the current exchange rate and is denoted by “EA” in Chapter 15 of the *International Economics* text. Substituting EA for the expected appreciation and rearranging,

$$i - i^* = EA.$$

Given interest rates, EA must equal the difference between domestic and foreign interest rates. If, for example, the domestic interest rate is 8% and the foreign interest rate is 5%, then EA must be 3%. If EA now increases to 4%, then the return on foreign investment is 9% (i*+EA). This will cause a flow of funds to the foreign market, causing an immediate appreciation of the exchange rate (SR), which will restore EA to 3%. (There may also be affects on the interest rates, as explained in Chapter 14 that will restore equality.) Thus, the exchange will appreciate by 1% (given interest rates), exactly equal to the change in expectations. The assumption in the monetary approach that uncovered interest parity applies is equivalent to the assumption that investors care only about the rate of return, implying that foreign currency is not seen as riskier than domestic currency.

The **portfolio balance approach** (also called the asset market approach) to exchange rates views money as just one asset of many and views the exchange rate as that which equates the supply and demand for assets. In the portfolio balance approach, domestic and foreign assets are not perfect substitutes due to the currency risk associated with foreign assets, as well as the possibility of higher default risk. Due to these risks, uncovered interest parity does not hold precisely because of a **risk premium**. If the risk premium, RP, is 1% on foreign assets, then 1% would be subtracted from the return on foreign assets in calculating the net rate of return, so

$$i = i^* + EA - RP.$$

For RP = 1%, there would be equilibrium if, say, i = 7%, i* = 6%, and EA = 2%. The *total* expected return of 8% from the foreign bond exceeds the return of 7% on the domestic bond by 1%, in order to compensate for a risk premium of 1% on the foreign bond.

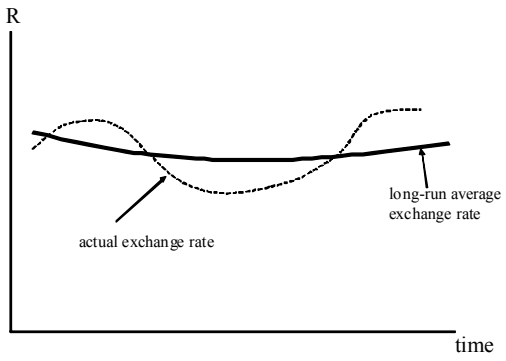
In the portfolio balance approach, each wealth owner distributes wealth in some way between domestic money, domestic bonds, and foreign bonds. Money will be held in order to conduct ongoing transactions, but there is a cost to do so in the form of foregone interest that could be earned on bonds. Thus, wealth will be balanced between money for transactions and interest-bearing bonds. Some of those bonds may be foreign bonds due to a higher return and due to possible diversification benefits. (Two assets can often produce lower risk than any one of them if their returns are not perfectly correlated. If the return on one asset falls, then

there is some probability that the return on the other asset will increase, offsetting that loss. Thus, an asset with a lower return can still be valuable if there are significant diversification benefits.) The split between money, domestic bonds, and foreign bonds depends upon wealth, relative interest rates, expected appreciation (or depreciation) of the foreign currency, and the risk premium. A change in any of these factors will cause a portfolio reallocation, and to the degree that foreign bond holdings change (buying or selling), the exchange rate will change. In the portfolio balance approach, equilibrium occurs when the market for each asset (money, domestic bonds, and foreign bonds) is in equilibrium.

Because there is substitution between money, domestic bonds, and foreign bonds in the portfolio balance approach, a disturbance in any one of the markets can affect the exchange rate. For example, if real domestic income increases, then the demand for money will increase in order to conduct a higher volume of real transactions. Given the money supply, the increased desire for money balances will lead to sales of domestic and foreign bonds. The sale of foreign bonds in an attempt to increase domestic money balances will cause a depreciation of the foreign currency. Of course, the mechanism is more complicated than this because a change in Y could also produce a change in prices, interest rates, and other variables that affect asset demand. The interesting aspect of the portfolio approach is that it focuses attention on the relationship between all the sectors of the economy.

In the early 1970s, the major industrial nations (e.g., Canada, European nations, Japan, and the U.S.) moved from a relatively fixed exchange-rate system to a floating-rate system. One notable characteristic of the floating-rate system is volatile exchange rates in which the exchange moves more than is necessary to reach its long-run average value, as shown in Fig. 15.1. Thus the exchange rate appears to move more than its long-run value moves. The monetary approach to exchange rates provides one explanation of what is called **exchange rate overshooting**.

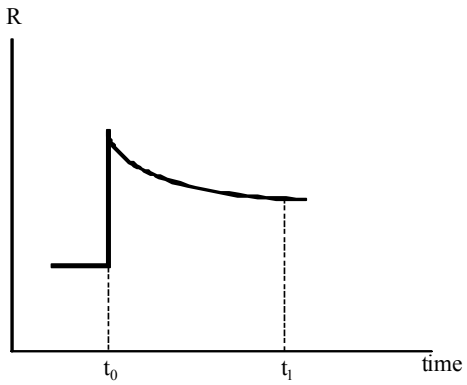
Figure 15.1



In monetary equilibrium, $M_s=M_d$, or $M_s=k(PY)$. If k and Y are taken to be constant, then an increase in the domestic money supply, M_s, will lead to an increase in P by the same proportion. The increase in P increases money demand, restoring monetary equilibrium ($M_s=M_d$). The increased money supply will also cause an appreciation of the foreign exchange rate, as explained in the monetary approach to exchange rates above ($R= M_s k^* Y^* / M_s^* kY$). Thus, R will increase (foreign currency appreciation) as a result of an increased money supply.

The next few steps are crucial in the exchange rate overshooting argument. The price level, P, does not necessarily increase immediately because it takes time for the increased money supply to produce an increase in spending and time for producers to raise prices. In the period in which P does not increase, there will be an excess supply of money. This excess supply of domestic money will cause domestic interest rates to fall. *But*, if the domestic interest rate is lower, then by uncovered interest parity, the foreign currency must be *expected* to depreciate—not expected to appreciate. (If initially $i = i^*+EA$ and $EA = 0$, then a decrease in i, given i^* must mean EA becomes negative, given i*.) How can the exchange rate appreciate (see the last sentence in the previous paragraph) and be expected to depreciate? This can occur only if the exchange rate initially moves in excess of its new higher level, as shown in Fig. 15.2. The exchange rate does appreciate from its value just before time period t_o to time period t_1, but at time period t_o it jumps up by more than its eventual increase so that at time period t_o there is an expected depreciation.

Figure 15.2



Interestingly, the monetary approach to exchange rates does not do very well in predicting exchange rates, except over very long time periods. In fact, these models are outperformed in the short run by simply assuming that exchange rates move randomly. (If exchange rates move randomly, then exchange rates will not, on average, change from the previous period. The changes that do occur are random, which means that changes are unpredictable.) Similarly, there is little empirical support for the portfolio balance model of exchange rates. This inability of the monetary approach to explain exchange rates may be due to the admitted failure of PPP to hold in the short run and from the likelihood of short-run movements of exchange rates to be dominated by day-to-day "news," which by its very nature is random. There may also be bandwagon effects, in which foreign exchange speculators fulfill their own expectations, causing exchange rates to move simply because they believe that others expect the exchange rate to move. Such behavior will produce movements of exchange rates quite independent of the underlying fundamental factors identified by the monetary and portfolio approaches.

III. Questions

1. Explain the effect each of the events listed below on the balance of payments (autonomous payments) and the pressure each event will produce on the exchange rate according to the monetary approach.

a) An exogenous decrease in the domestic demand for money. Exogenous means a decrease in the domestic demand for money for reasons other than a change in P or Y

b) An increase in domestic Y

c) An increase in the domestic money supply due to actions by the central bank

2. Each of the events listed in Question 1 creates disequilibrium in the balance of payments. For each event, describe the adjustment to a new equilibrium assuming that the exchange rate is fixed.

3. For each event listed in Question 1, describe the adjustment to a new equilibrium assuming that the exchange rate floats freely.

4. Using the monetary approach, explain the following statements:

a) In a fixed exchange rate system, the monetary authorities must "accommodate" any increases in real income by increasing the money supply in order to keep the exchange rate fixed.

b) In a floating rate system the monetary authorities must "accommodate" an increase in real income in order to avoid deflation (a decrease in the average price level).

c) Given k, P, and Y in both countries, a fixed exchange rate system restricts a country to a fixed supply of money.

5. The relative average price of goods in two countries, when expressed in a common currency, e.g., dollars, is called the **real exchange rate**. For example, the real exchange rate for the yen is $(P^{¥})(R)/P^{\$}$, where $P^{¥}$ is the price level in yen, R is the dollar cost of the yen (\$/¥), and $P^{\$}$ is the price level in dollars.

a) If absolute PPP holds, then what is the numerical value of the real exchange rate?

b) If absolute PPP holds, then how many candy bars will $10 buy in the United States relative to Japan?

c) Can the law of one price hold for all traded goods and absolute PPP not hold?

d) If absolute PPP does not hold, but relative PPP does, then what should happen to the real exchange rate over time?

6. Although the portfolio balance approach to exchange rates can be rather complicated, the first round of effects on exchange rates is straightforward. Describe the effect of the following events on the exchange rate, according to the portfolio balance approach:

a) An expected appreciation of foreign currencies

b) An increase in the risk associated with foreign currencies

c) An increase in domestic income

d) An increase in foreign interest rates

7. a) Draw the time path of the exchange rate if an increase in the money supply is accompanied by a simultaneous and proportionately equal increase in the price level.

b) Draw the time path of the exchange rate if an increase in the money supply produces a delayed increase in the price level.