MODULE 7

The Foreign Exchange Market

This module uses the concepts developed in the lessons entitled *Interest Rates and Asset Values* and *Asset Markets* to analyze the foreign exchange market. First, the terms foreign exchange and foreign exchange market are explained. Attention then turns to the concepts of spot and forward exchange, particularly to the purpose of forward markets and to the meanings of the terms, forward discount, hedging, arbitrage, forward cover and speculation. Then efficient markets and interest parity conditions are developed and the relationship between domestic and foreign market interest rates is explained. Using the relationship between real and nominal interest rates and expected inflation, this analysis is then extended to consider the relationship between domestic and foreign real interest rates and the constraint it imposes on domestic government policy. Finally, some data on forward and spot exchange rates, interest rates and inflation rates for several countries are plotted and analyzed.

1. Foreign Exchange Markets

Foreign exchange markets exist because most countries have their own monetary units in which business is done within their own borders. Trade between countries in goods and securities therefore requires the exchange of national moneys. The foreign exchange market is where this occurs. We define the exchange rate as the domestic currency price of foreign currency, denoted by Π.

Since each country or currency area has an exchange rate with every other currency area there are many more exchange rates than there are currencies. Internal consistency of this network of exchange rates is maintained by *arbitrage*. The latter is defined as a set of simultaneous transactions at existing exchange rates from which a sure profit can be made as a result of discrepancies between those rates. For example, if the exchange rates between the dollar, yen and pound were such that one could make a profit by converting dollars to yen, yen to pounds, and pounds back into dollars, foreign exchange traders will make these trades and quickly create market pressures that will restore consistency between the rates.

It is customary for traders to use certain currencies, like the U.S. dollar, the British Pound, the Euro and the Japanese yen as *vehicle currencies* or international moneys. This means that trade between countries other than vehicle-currency countries is conducted in a vehicle currency with the local moneys being exchanged for the vehicle currency rather than for each other.

2. Forward Exchange

Forward exchange contracts arise because exchange rates can change between the time that goods are purchased and sold and final payment is made. A German importer committed to pay an invoice in yen in 90 days will lose if the Deutschmark price of the yen increases during that period. Changing the invoice to specify payment in D-marks merely shifts the potential loss to the Japanese exporter. By contracting to purchase yen with Deutschmarks in 90 days at a price agreed upon now, these traders can pass this risk of foreign exchange rate change onto someone else.

The *forward exchange rate* is the exchange rate, agreed upon now, at which the parties to a *forward exchange contract* agree to exchange currencies at a specific future date. The *spot exchange rate* is the rate at which two currencies can be exchanged now. Intermediaries are essential in the forward exchange market—they operate, for example, by in selling forward

yen in return for dollars to some traders while buying forward yen in return for dollars from others.

Covering oneself against future exchange rate changes by entering into a forward contract is called *hedging*. Allowing oneself to remain uncovered or deliberately taking an uncovered position is called *speculating*. Speculation differs from arbitrage in that one can gain or lose from speculating, depending upon which way the exchange rate moves and by how much, while one always gains from arbitrage if one can make the appropriate set of transactions at existing exchange rates.

3. The Relationship Between Spot and Forward Exchange Rates

The *forward discount* on domestic currency is defined as the excess of the forward price of foreign currency in terms of domestic currency over its current spot price, taken as a fraction or percentage of the current spot price.

$$\Phi = (\Pi' - \Pi)/\Pi \tag{1}$$

where Π is the spot price of foreign currency in terms of domestic currency, Π' is the forward price, and Φ is the forward discount.

A speculator who thinks that the future spot price of foreign currency at the time a forward contract matures will be less than the forward price, can expect to gain by selling the foreign currency forward—or taking a short position in it—and then purchasing it spot for delivery under the contract when the forward contract comes due. This assumes, of course, that the speculator is willing to bear the risk involved. The possibility of profit results from a difference between the forward rate and the spot rate expected at the maturity date in excess of any allowance for risk—the current spot rate is irrelevant. Tabular examples for a speculator who is indifferent to risk are shown in Figure 3.1 and Figure 3.2.

Figure 3.1:

SITUATION:	TODAY	3 MONTHS HENCE
SPOT RATE		¥ XXX = $1
FORWARD RATE	¥ 355 = $1	
EXPECTED SPOT RATE		¥ 360 = $1

SPECULATIVE ACTION:

SELL YEN FOR DELIVERY IN 3 MONTHS AT 355 PER DOLLAR.
ON DELIVERY DATE, BUY YEN SPOT FOR DELIVERY.

RESULT:

GAIN IF XXX > 355, LOSE IF XXX < 355.
GAIN EQUALS [XXX − 355] YEN OR [1/(XXX − 355)] DOLLARS.

Figure 3.2:

SITUATION:	TODAY	3 MONTHS HENCE
SPOT RATE		¥ XXX = $1
FORWARD RATE	¥ 355 = $1	
EXPECTED SPOT RATE		¥ 350 = $1

SPECULATIVE ACTION:

CONTRACT TO BUY YEN FORWARD IN 3 MONTHS AT 355 PER DOLLAR THEN SELL THEM SPOT ON THE DELIVERY DATE.

RESULT:

GAIN IF XXX < 355, LOSE IF XXX > 355.
GAIN EQUALS [355 − XXX] YEN OR [1/(355 − XXX)] DOLLARS.

Action by all speculators will drive the forward price of the foreign currency in terms of domestic currency into equality with their expected future spot price, plus or minus an allowance for *foreign exchange risk*. The latter is defined as the risk of loss through changes in the exchange rate when taking an uncovered position. If the foreign exchange risk premium is zero

the forward exchange rate will equal the market's expectation of the spot rate that will hold on the due date of the forward contract.

Let $\hat{\Pi}$ be the expected future price of foreign currency in terms of domestic currency. Adding and subtracting it within the brackets in equation (1) and rearranging the terms, we obtain

$$\begin{aligned} \Phi &= (\Pi' - \hat{\Pi} + \hat{\Pi} - \Pi)/\Pi \\ &= (\Pi' - \hat{\Pi})/\Pi + (\hat{\Pi} - \Pi)/\Pi \\ &= \theta_T + E_\Pi \end{aligned} \tag{2}$$

where θ_T is a premium to cover foreign exchange risk and E_Π is the expected rate of change in the domestic currency price of foreign currency.

The condition for equation (2) to hold is that market participants form their expectations rationally in the sense that they use all information available to them in making buy and sell decisions. This also implies that the foreign exchange market is efficient. Equation (2) can thus be called the *efficient markets condition.*

4. Interest Rate Parity

Ignoring risk considerations, an arbitrage opportunity will exist whenever the domestic interest rate exceeds the foreign interest rate by more or less than the forward discount on the domestic currency. If the interest rate differential is greater than the forward discount it pays to shift funds from foreign securities to domestic securities and cover oneself by purchasing foreign currency forward to guarantee return of the funds at the exchange rate indicated by the forward discount. If the interest rate differential is less than the forward discount it pays to shift funds in the other direction, covering oneself by selling foreign currency forward. The widespread attempt to take advantage of discrepancies between the interest rate differential and the forward discount will eliminate them. As a result

$$i_d - i_f = \Phi \tag{1}$$

where i_d and i_f are the domestic and foreign interest rates and Φ is the forward discount on domestic currency.

Since there is no reason to assume that securities in the two countries are equally risky, this equation has to be modified by including a risk premium.

$$i_d - i_f = \Phi + \theta_X \tag{2}$$

where θ_X is a premium for political or country-specific risk. Note that this risk is different from foreign exchange risk because it will exist even if the exchange rate is immutably fixed and Φ is therefore zero. The condition (2) is called the *interest rate parity condition.*

5. Domestic Interest Rate Determination

The two conditions, efficient markets and interest rate parity can be combined by substituting the efficient markets equation

$$\Phi = \theta_T + E_\Pi \tag{1}$$

into the interest parity equation

$$i_d - i_f = \Phi + \theta_X \tag{2}$$

to obtain

$$i_d - i_f = \theta_T + \theta_X + E_\Pi \tag{3}$$

where θ_T and θ_X are the foreign exchange and country-specific risk premia and E_Π is the expected rate of depreciation of the domestic currency in terms of foreign currency. The two risk premia can be consolidated to express equation (3) as

$$i_d - i_f = \theta + E_\Pi \tag{4}$$

which can be rearranged to yield an equation determining the domestic interest rate,

$$i_d = i_f + \theta + E_\Pi \tag{5}$$

This equation reveals a fundamental constraint on domestic macroeconomic policy—the only way the domestic government can alter the domestic interest rate (assuming that it cannot affect the interest rate in the rest of the world) is to induce a change in the risk of holding domestic assets or induce an expected change in the domestic exchange rate.

This constraint can be developed further by introducing the relationship between nominal interest rates and real interest rates developed in the lesson entitled *Interest Rates and Asset Values*,

$$r = i - \tau^e \tag{6}$$

where τ^e is the rate of inflation expected during the term of the loan, r is the real interest rate on which people base their decisions and the nominal interest rate is given by i. Using this relationship, we can express domestic and foreign interest rates as

$$r_d = i_d - \tau_d^e \tag{7}$$

$$r_f = i_f - \tau_f^e \tag{8}$$

and then subtract (8) from (7) to obtain

$$r_d - r_f = (i_d - i_f) - (\tau_d^e - \tau_f^e) \tag{9}$$

which upon substitution of equation (4) gives

$$\begin{aligned} r_d - r_f &= \theta + E_\Pi - (\tau_d^e - \tau_f^e) \\ &= \theta - (\tau_d^e - E_\Pi - \tau_f^e) \end{aligned} \tag{10}$$

The expression $(\tau_d^e - E_\Pi - \tau_f^e)$ equals the expected rate of change of the real exchange rate where the latter is defined as

$$\frac{P_d}{\Pi P_f} = q. \tag{11}$$

P_d and P_f are the price levels of domestic and foreign output. The real exchange rate q is the relative price of domestic output in terms of foreign output where both prices are measured in domestic currency. Equation (10) can thus be rewritten as

$$r_d - r_f = \theta - E_q \tag{12}$$

where E_q is the expected rate of change in the domestic real exchange rate.

The domestic real interest rate is thus constrained in relation to the foreign real interest rate by

$$r_d = r_f + \theta - E_q \tag{13}$$

An expected rise in the real exchange rate (increase in the relative price of domestic output in terms of foreign output) lowers the domestic real interest rate because it implies an increasing value of domestic output in terms of foreign output and thus a future capital gain on domestic capital relative to foreign capital. This makes domestically employed capital more valuable as

compared to foreign capital, raising its price and lowering the interest rate at which the future (non-capital-gains) income from it is discounted.

Equation (13) implies a constraint on the real interest rate similar to the constraint on the nominal interest rate implied by equation (5). This constraint says that the domestic authorities can affect the domestic real interest rate in two ways—by inducing a change in the risk of holding domestic capital, or by inducing a change in people's expectations about the future course of the real exchange rate. This assumes, of course, that the domestic authorities have no control over the foreign interest rate.

Finally, the relationships between the nominal and real interest rates in the domestic and foreign economies, given by the two countries' Fisher equations,

$$i_d = r_d + \tau_d^e \tag{14}$$

$$i_f = r_f + \tau_f^e \tag{15}$$

obtained by rearranging equations (7) and (8) implies that

$$i_d - i_f = (r_d - r_f) + (\tau_d^e - \tau_f^e) \tag{16}$$

A change in the domestic relative to the foreign expected inflation rate will lead to an equal change in the domestic relative to the foreign nominal interest rate, assuming that real interest rates are unaffected.

6. Some Empirical Evidence

Figure 6.1 shows the spot and 90 day forward prices of the U.S. dollar in terms of the Canadian dollar—these exchange rates follow each other so closely that the difference between them hardly shows up on the chart. A similar closeness holds between the spot and forward rates of other pairs of currencies.

Figure 6.1:

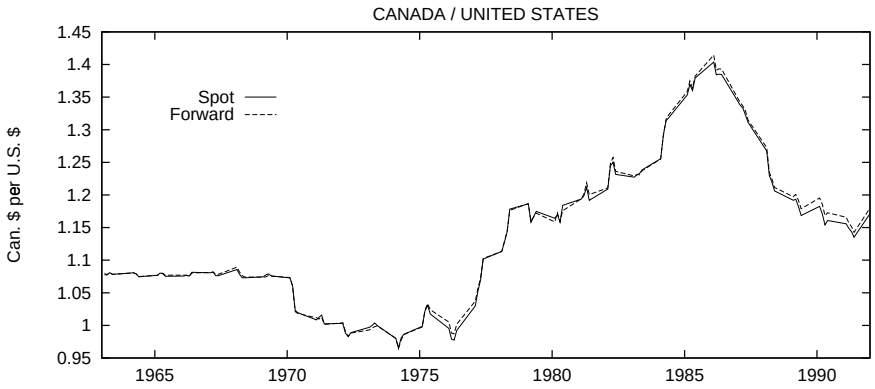


Figure 6.2:

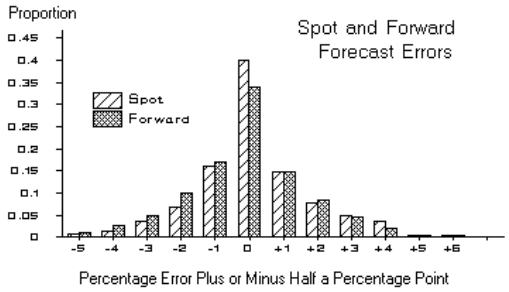


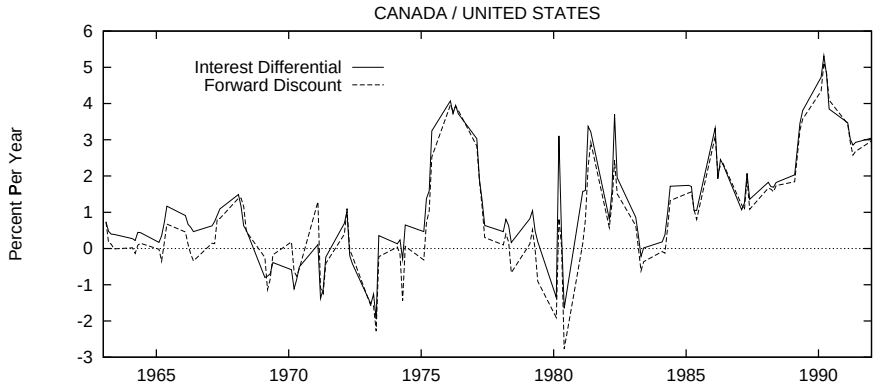
Figure 6.2 shows the forecast errors from two different forecasts of the future spot exchange rate: 1) that the spot rate three months hence will be the same as the spot rate today (shown in the chart as the spot forecast); 2) that the spot rate three months from now will equal today's 3 month forward rate (shown in the chart as the forward forecast). The horizontal axis gives the percentage forecast errors, with each interval containing the forecast error lying within a half-percentage point of the number of percentage points stated for the interval. The vertical axis gives the proportions of the time the forecast error fell in the intervals. Monthly data for Canada vs. the U.S. from January 1963 to August 1993 are used. The conclusions are that small forecast errors are much more likely than large ones and that the forward rate forecast is out by more than one-half percentage point more often than

is the naive forecast that the spot rate in 3 months will be the same as today's spot rate.

As Figure 6.2 indicates, forward rates do a poor job of predicting future spot rates. This would suggest that observed forward discounts primarily represent foreign exchange risk in this case.

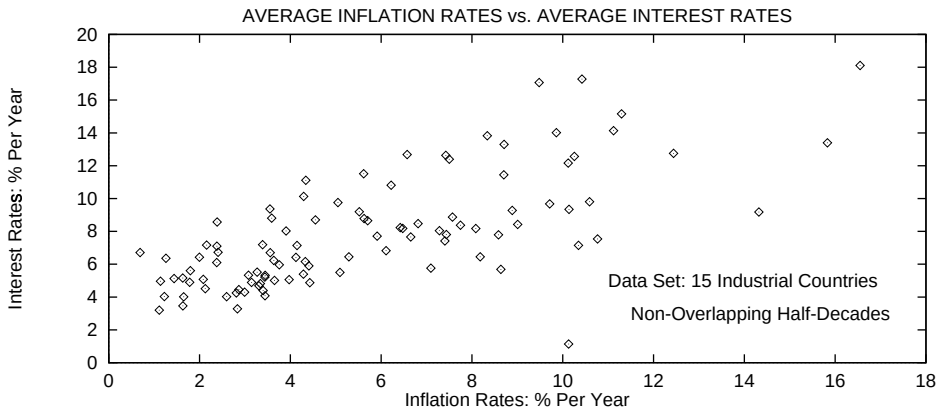
Figure 6.3 plots the difference between the interest rate on 90-day commercial paper in Canada and the 90-day commercial paper rate in the U.S. together with the 90-day forward discount on the Canadian dollar in terms of the U.S. dollar. The close correspondence of the two series suggests that the country-specific risks in the two countries have been similar. A similar close correspondence holds for other countries.

Figure 6.3:



One reason why the forward price of the U.S. dollar in terms of the Canadian dollar does a poor job of predicting the future spot price is that Canadian and U.S. inflation rates have been very similar. We would expect substantial ongoing differences in inflation rates between countries to be reflected in differences in their nominal interest rates and forward discounts on the currencies of the high-inflation rate countries. Evidence of a positive relationship between five-year average inflation rates and the average interest rate on long-term government bonds during the same periods is presented in Figure 6.4.

Figure 6.4:



The five-year periods taken were the non-overlapping half decades 1955-59, 1960-64, 1965-69, 1970-74, 1975-79, 1980-84, and 1985-89. The data are for fifteen countries—Austria, Belgium, Denmark, France, Germany, Italy, Norway, Sweden, Switzerland, United Kingdom, Japan, Australia, New Zealand, Canada and the United States. The data are consistent with rough similarity of real interest rates across industrial countries and with differences of nominal interest rates that reflect the substantial differences in inflation rates both across countries and through time.

Study Questions

Consider a world with two countries, domestic and foreign, in both of which five units of output are produced for every unit of capital stock, broadly defined to include human capital, physical capital, technology, knowledge, etc. Suppose that the domestic (and foreign) real exchange rate is an immutable constant equal to 1.0. Suppose further that the residents of both the domestic and foreign economies choose to hold one unit of nominal money balances for every two units of nominal output, regardless of market interest rates. Finally, assume that no one in either economy requires any premium to bear risk.

What will be the effect on the nominal exchange rate, the forward discount on the domestic currency and the domestic market interest rate of

- An unanticipated (by the private sector) one-shot increase in the domestic nominal money supply of 10 percent, brought about by the actions of the domestic government?
- A sudden and not previously predicted increase in the public's desired ratio of nominal money to nominal income from 0.5 to 0.6?
- An increase in the rate of growth of the domestic money supply, brought about by pre-announced actions of the domestic government, from 0 percent per year to 10 percent per year?

How would your answers above change if it were the case that the public's desired ratio of money to income falls in both countries when the nominal interest rate increases?

In the above cases, does the forward discount adjust to equal the domestic/foreign interest rate differential or does the domestic/foreign interest rate differential adjust to equal the forward discount?

References

Michael Melvin, *International Money and Finance*, Sixth Edition, Addison-Wesley, 2000, Chapters 1, 4, 5 and 6, including Appendices.

Michael Mussa, "Empirical Regularities in the Behavior of Exchange Rates and Theories of the Foreign Exchange Market," in Karl Brunner and Allan Meltzer, eds., *Policies for Employment, Prices and Exchange Rates*, Carnegie-Rochester Conference Series on Public Policy, 11, Amsterdam: North Holland, 1979, pp. 9-57.