Understanding International Finance, the Global Economy, and Exchange Rates

Lecture 8: Currency Exchange Rates II
Solnik and McLeavey (2013): Chapter 1

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Foward Quotes

- **Spot exchange rates** are quoted for immediate currency transactions, although in practice the settlement takes place 48 hours later. Spot transactions are used extensively to settle commercial purchases of goods as well as for investments.
- Foreign exchange dealers also quote **forward exchange rates**. These are rates contracted today but with delivery and settlement in the future, usually 30 or 90 days hence. As with spot rates, forward rates are quoted by a bank with a bid and an ask price.
  - For example, a bank may quote the one-month €:$ exchange rate as 1.24688–1.24719.
  - This means that the bank is willing to commit itself today to buy euros for 1.24688 dollars or to sell them for 1.24695 dollars in one month.
- In a forward contract (or futures contract), a commitment is irrevocably made on the transaction date, but the exchange of currency takes place later on a date set in the contract.
- The origins of the forward currency market may be traced back to the Middle Ages, when merchants from all over Europe met at major trade fairs and made forward contracts for the next fair.

- Forward exchange rates are commonly used by asset managers to manage their foreign currency positions. By investing in foreign assets, an investor takes a currency position that can suffer (or benefit) from exchange rate movements.
- For example, a German investor might wish to invest in attractive American stocks but fear a depreciation of the U.S. dollar. In order to hedge the dollar risk, the German investor will sell dollars forward against euros.
- It is important first to get an understanding of the pricing of the forward exchange rate and its relation to the spot exchange rate.

- Forward exchange rates are often quoted as a premium, or discount, to the spot exchange rate.
- With the convention of giving the value of the quoted currency (the first currency) in terms of units of the second currency, *there is a premium on the quoted currency when the forward exchange rate is higher than the spot rate and a discount otherwise*. Clearly, a negative premium is a discount.
- If the one-month forward exchange rate is €:$ $=$ 1.24688 (1.24688 dollars per euro) and the spot rate is €:$ $=$ 1.25000, the euro quotes with a discount of 0.00312 dollar per euro. In the language of currency traders, the euro is "weak" relative to the dollar, as its forward value is lower than its spot value. Conversely, the dollar is traded at a premium, as the forward value of one dollar ($:€ $= 1/1.24688 = 0.80200$) is higher than its spot value ($:€ $= 0.80000$).
- When a trader announces that a currency quotes at **a premium**, the premium should be added to the spot exchange rate to obtain the value of the forward exchange rate. If a currency quotes at **a discount**, the discount should be subtracted from the spot exchange rate to obtain the value of the forward rate.

- The forward discount, or premium, is often calculated as an annualized percentage deviation from the spot rate.
- Given an exchange rate of $a : b$, the annualized forward premium (discount) on the quoted currency a is equal to

$$\left(\frac{\text{Forward rate} - \text{Spot rate}}{\text{Spot rate}}\right)\left(\frac{12}{\text{No. months forward}}\right)100\%. \quad (1)$$

- If (Spot rate – Forward rate) replaces (Forward rate – Spot rate) in Formula 1, we have the forward discount (premium) on the measurement currency in which the price is expressed.
- The percentage premium (discount) is annualized by multiplying by 12 and dividing by the length of the forward contract in months. For example, the annualized forward premium on the dollar as quoted above is

$$\left(\frac{0.802 - 0.800}{0.800}\right)\left(\frac{12}{1}\right)100\% = 3.0\%.$$

- Spot and forward dollar exchange rates can be found in newspapers around the world, such as the London-based Financial Times.
- For example, the spot \$:SFr exchange rate could be \$:SFr = 1.2932–1.2939. The midpoint is equal to 1.2936.
- At the same time, \$:SFr for delivery three months later could be quoted at a midpoint of 1.2823.
- The dollar (the quoted currency) quotes at a **discount** and the Swiss franc at a **premium**.
- The annualized percentage premium of the Swiss franc would then be equal to 3.5 percent. Because the Swiss franc is the measurement currency in the quote, this premium is obtained by taking the difference between the spot and the forward rate and dividing it by the spot rate:

$$\left(\frac{1.2936 - 1.2823}{1.2936}\right)\left(\frac{12}{3}\right)100\% = 3.5\%.$$

Interest Rate Parity

- **Arbitrage** plays an important role in the worldwide currency market. Spot exchange rates, forward exchange rates, and interest rates are technically linked for all currencies that are part of the free international market.
- **Interest rate parity (IRP)** is a relationship linking spot exchange rates, forward exchange rates, and interest rates.
- For two currencies, the IRP relationship is that the forward discount/premium equals the discounted interest rate differential between the two currencies.
- Stated more simply, the product of the forward rate multiplied by one plus the risk-free rate for the quoted currency equals the product of the spot exchange rate multiplied by one plus the risk-free rate for the measurement currency in which the price is expressed.

- The relation is driven by arbitrage as illustrated here. Assume that the following data exist for the dollar (quoted currency) and the euro:

  Spot exchange rate: \$:€= 0.8000
  One-year forward exchange rate: \$:€= 0.8080

- One-year interest rates (purposely unrealistic at present to show numerical effects) are $r_{€} = 14\%$ and $r_{\$} = 10\%$.

- To take advantage of the interest rate differential, a speculator could borrow dollars at 10 percent, convert them immediately into euros at the rate of 0.8 euros per dollar, and invest the euros at 14 percent. This action is summarized in Exhibit 1.

- The speculator makes a profit of 4 percent on the borrowing/lending position but runs the risk of a large depreciation of the euro.

Currency Exchange Rates

EXHIBIT 1

Currency Speculation

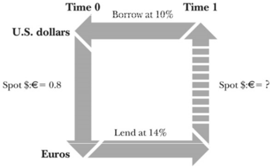

EXHIBIT 2

Covered Interest Rate Arbitrage

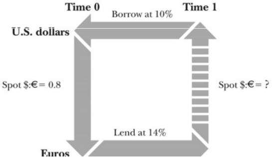

Figure: Interest Rate Parity

- In **Exhibit 1**, borrowing dollars means bringing money from the future to the present.
- Lending euros means the reverse.
- At the end of the period, at time 1, the speculator must convert euros into dollars at an unknown rate to honor the claim in dollars borrowed.

- This position may be transformed into a covered (riskless) interest rate arbitrage by simultaneously buying a forward exchange rate contract to convert the euros into dollars in one year at a known forward exchange rate of $\$:€ = 0.808$.

- In the process shown in **Exhibit 2**, the investor still benefits on the interest rate differential (a gain of 4 percent) but loses on the conversion of euros to dollars.

- In one year, the rate of change in the exchange rate will be equal to

$$\frac{0.800 - 0.808}{0.800} = -0.01 \text{ for a loss of } 1\%.$$

- Per dollar borrowed, the net gain on the position is 3 percent. This gain is certain at time 0 because all interest rates and exchange rates are fixed at that time.

- No capital is invested in the position, which is a pure swap with simultaneous borrowing and lending.
- If such rates were quoted in reality, banks would arbitrage to exploit this riskless profit opportunity. Enormous swaps could occur, because no capital needs to be invested.
- To prevent this obvious arbitrage (riskless profit), the forward discount (premium) must exactly equal the interest rate differential. The various rates must adjust so that interest rate parity holds.
- Note that if the forward discount (premium) were larger than the interest rate differential, the arbitrage would simply go the other way. Arbitrageurs would borrow euros and swap them for dollars.

- The exact mathematical relationship is slightly more complicated, because one must buy a forward contract covering both the principal and the accrued interest in order to achieve a perfect arbitrage. In the previous example, for every dollar borrowed, the forward hedge should cover 0.8 euros plus the interest rate of 14 percent, that is, $0.80\ (1.14) = 0.912$.

- The interest rate parity relationship is that the forward discount (premium) equals the discounted interest rate differential between two currencies:

$$(F - S)/S = (r_b - r_a)/(1 + r_a) \tag{2}$$

where

r_a is the interest rate of the quoted currency
r_b is the interest rate of the measured currency
S and F are the spot and forward exchange rates.

- Equivalently, we have the relation

$$F(1 + r_a) = S(1 + r_b) \text{ or } F = S(1 + r_b)/(1 + r_a). \tag{3}$$

Example (INTEREST RATE PARITY)

If the U.S. dollar is the quoted currency against the euro, arbitrage ensures that

$$F(1 + r_{\$}) = S(1 + r_{€})$$

where S and F are the spot and forward exchange rates (euro price of one U.S. dollar) and $r_{€}$ and $r_{\$}$ are the interest rates in euros and U.S. dollars. This relation implies that the forward premium (discount) will be

$$\frac{F - S}{S} = \frac{r_{€} - r_{\$}}{1 + r_{\$}}$$

If the spot exchange rate is $\$$:€ $= 1.05$ and the dollar and euro interest rates are 1.76 percent and 3.39 percent, what is the forward exchange rate, and what is the forward premium (discount)?

SOLUTION

Using equation (3), we have

$$F = S(1 + r_b)/(1 + r_a) = 1.05(1.0339/1.0176) = 1.0668$$

and

$$\frac{F - S}{S} = \frac{r_{€} - r_{\$}}{1 + r_{\$}} = \frac{0.0339 - 0.0176}{1.0176} = 1.6\%.$$

- When the U.S. dollar trades with a forward premium relative to the euro – for example, as in the case above, in which the forward rate is €1.0668 and the spot rate is €1.0500 - the dollar trades at a forward premium relative to the euro;
- Conversely, the euro trades at a forward discount relative to the U.S. dollar.
- Notice that a forward premium is associated with a lower interest rate.

- A similar arbitrage relation holds for maturities of less than a year, provided that the right interest rates are used.
- Whatever the maturity, the convention for interest rates and yields is to quote annualized rates.
- To perform the forward exchange rate calculations, annualized interest rates must first be converted into rates over the investment period.
- For a contract with n months' maturity, the quoted interest rate must be divided by 12 and multiplied by n. This is because short-term interest rates are quoted using a linear convention for annualization.

Example (INTEREST RATE PARITY WITH MATURITIES OF LESS THAN ONE YEAR)

Consider the following data: Spot exchange rate is

$$\$:€ = 1.058.$$

Annual risk-free interest rates (three-month maturity)

3.39% for the euro
1.76% for the U.S. dollar

What is the three-month forward exchange rate $:€?

SOLUTION

Three-month interest rates over the period are

$$r_{€}\ 3.39\%(3/12) = 0.8475\%$$
$$r_{\$}\ 1.76\%(3/12) = 0.4400\%$$

The three-month forward exchange rate is equal to

$$\begin{aligned} F &= S \times \frac{1 + r_{€}}{1 + r_{\$}} \\ &= 1.058(1.008475/1.0044) = 1.0623 \end{aligned}$$

Thus, the three-month forward rate is €1.0623 per dollar, or \$:€ = 1.0623.

Foward Exchange Rate Calculations with Bid-Ask Spreads

- When an investor calls a bank to get a forward exchange rate quote, the bank will quote a bid and ask price.
- As with spot exchange rates, bid?ask spreads differ as a result of market conditions, bank/dealer positions, and trading volume.
- Unique to forward transactions is the feature that liquidity decreases with the increasing maturity of the forward contract. Consequently, bid-ask spreads increase with the increasing maturity of the contract.

- A bank will usually construct a forward contract by doing the three transactions outlined above: a spot foreign exchange transaction, coupled with borrowing and lending in the two currencies.
- The spread on a forward rate is derived from the spreads on the spot rate and on the two interest rates.
- Banks quote interest rates with a bid-ask spread. The **bid interest rate** is the rate at which the bank is willing to borrow money from the client, and the **ask interest rate** is the rate at which the bank is willing to lend money to a client.
- The bid interest rate is lower than the ask interest rate.
- In what follows, we calculate the ask forward \$:€ and then the bid forward \$:€.

- For example, a transaction in which an investor is buying forward dollars (having to pay the ask forward \$:€) with euros is equivalent to \$:€.
    1. Borrowing euros (and hence having to pay the ask interest rate, ask $r_{€}$)
    2. Using these euros to buy dollars spot (and hence having to pay the ask spot exchange rate, ask spot \$:€)
    3. Lending those dollars (and hence receiving the bid interest rate, bid $r_{\$}$)

- To obtain the bid forward exchange rate, we perform the reverse calculations:
    1. Borrowing dollars (and hence having to pay the ask interest rate, ask $r_{\$}$)
    2. Selling these dollars to buy euros spot (and hence receiving the bid spot exchange rate, bid spot $:€)
    3. Lending those euros (and hence receiving the bid interest rate, bid $r_{€}$)
- The result will constitute the bid price of the forward exchange rate, bid forward $:€.

Example (FORWARD QUOTATIONS WITH BID-ASK SPREADS)

Consider the following data:

$$\text{Spot exchange rate} \qquad \$:\text{Sfr} = 1.2932\text{–}1.2939$$

Annual risk-free interest rate (one-year maturity) are

Swiss francs	1.42%–1.44%
U.S. dollar	4.50%–4.52%

What should be the bid-ask quote for the one-year forward exchange rate \$:Sfr?

SOLUTION

Let's first make sure we calculate the forward rate in the proper direction. The one-year forward rate \$:Sfr is given by equation (3), where the dollar is the quoted currency measured in Swiss francs:

$$\text{Forward exchange rate} = \text{Spot exchange rate } \times (1 + r_{Sfr})(1 + r_{\$}).$$

A bank will quote bid-ask forward rates, where the bid is lower than the ask. The ask forward rate (ask forward \$:Sfr) is the Sfr price at which an investor can buy dollars forward, and the bid forward rate is the price that an investor can obtain for dollars. Buying dollars forward (paying the ask forward) is equivalent to

1. Borrowing Swiss francs (and hence having to pay the ask interest rate, ask r_{Sfr})
2. Using these Swiss francs to buy dollars spot (and hence having to pay the ask exchange rate, ask spot \$:Sfr)
3. Lending those dollars (and hence receiving the bid interest rate, bid $r_{\$}$

The resulting ask forward exchange rate (\$:Sfr) is

Ask forward (\$:Sfr) = 1.2939(1+1.44%)/(1+4.50%) = 1.2560

The bid forward exchange rate (\$:Sfr) is

Fid forward (\$:Sfr) = 1.2932(1+1.42%)/(1+4.52%) = 1.2548

Thus, the one-year forward rate should be \$:Sfr = 1.2548–1.2560.

- We note that interest rate parity is sometimes called **covered interest rate parity** (covered by a forward contract) to distinguish it from **uncovered interest rate parity**.
- Uncovered interest rate parity is based on economic theory rather than on arbitrage and involves expected exchange rates rather than forward rates.
- Uncovered interest rate parity is an economic theory that links interest rate differentials and the difference between the spot and expected exchange rate.
- On the other hand, interest rate parity, discussed in this chapter, is a **pure arbitrage condition** imposed by efficient markets.