



7: International Arbitrage and Interest Rate Parity

If discrepancies occur within the foreign exchange market, with quoted prices of currencies varying from what the market prices should be, certain market forces will realign the rates. The realignment occurs as a result of international arbitrage. Financial managers of MNCs must understand how international arbitrage realigns exchange rates because it has implications for how they should use the foreign exchange market to facilitate their international business.

The specific objectives of this chapter are to:

- explain the conditions that will result in various forms of international arbitrage, along with the realignments that will occur in response to various forms of international arbitrage, and
- explain the concept of interest rate parity and how it prevents arbitrage opportunities.

International Arbitrage

Arbitrage can be loosely defined as capitalizing on a discrepancy in quoted prices by making a riskless profit. In many cases, the strategy does not require an investment of funds to be tied up for a length of time and does not involve any risk.

EXAMPLE Two coin shops buy and sell coins. If Shop A is willing to sell a particular coin for \$120, while Shop B is willing to buy that same coin for \$130, a person can execute arbitrage by purchasing the coin at Shop A for \$120 and selling it to Shop B for \$130. The prices at coin shops can vary because demand conditions may vary among shop locations. If two coin shops are not aware of each other's prices, the opportunity for arbitrage may occur. ■

The act of arbitrage will cause prices to realign. In our example, arbitrage would cause Shop A to raise its price (due to high demand for the coin). At the same time, Shop B would reduce its bid price after receiving a surplus of coins as arbitrage occurs. The type of arbitrage discussed in this chapter is primarily international in scope; it is applied to foreign exchange and international money markets and takes three common forms:

- Locational arbitrage
- Triangular arbitrage
- Covered interest arbitrage

Each form will be discussed in turn.

Locational Arbitrage

Commercial banks providing foreign exchange services normally quote about the same rates on currencies, so shopping around may not necessarily lead to a more

favorable rate. If the demand and supply conditions for a particular currency vary among banks, the banks may price that currency at different rates, and market forces will force realignment.

When quoted exchange rates vary among locations, participants in the foreign exchange market can capitalize on the discrepancy. Specifically, they can use **locational arbitrage**, which is the process of buying a currency at the location where it is priced cheap and immediately selling it at another location where it is priced higher.

EXAMPLE Akron Bank and Zyn Bank serve the foreign exchange market by buying and selling currencies. Assume that there is no bid/ask spread. The exchange rate quoted at Akron Bank for a British pound is \$1.60, while the exchange rate quoted at Zyn Bank is \$1.61. You could conduct locational arbitrage by purchasing pounds at Akron Bank for \$1.60 per pound and then selling them at Zyn Bank for \$1.61 per pound. Under the condition that there is no bid/ask spread and there are no other costs to conducting this arbitrage strategy, your gain would be \$.01 per pound. The gain is risk free in that you knew when you purchased the pounds how much you could sell them for. Also, you did not have to tie your funds up for any length of time. ■

Locational arbitrage is normally conducted by banks or other foreign exchange dealers whose computers can continuously monitor the quotes provided by other banks. If other banks noticed a discrepancy between Akron Bank and Zyn Bank, they would quickly engage in locational arbitrage to earn an immediate risk-free profit. Since banks have a bid/ask spread on currencies, this next example accounts for the spread.

EXAMPLE The information on British pounds at both banks is revised to include the bid/ask spread in Exhibit 7.1. Based on these quotes, you can no longer profit from locational arbitrage. If you buy pounds from Akron Bank at \$1.61 (the bank's ask price) and then sell the pounds at Zyn Bank at its bid price of \$1.61, you just break even. As this example demonstrates, even when the bid or ask prices of two banks are different, locational arbitrage will not always be possible. To achieve profits from locational arbitrage, the bid price of one bank must be higher than the ask price of another bank. ■

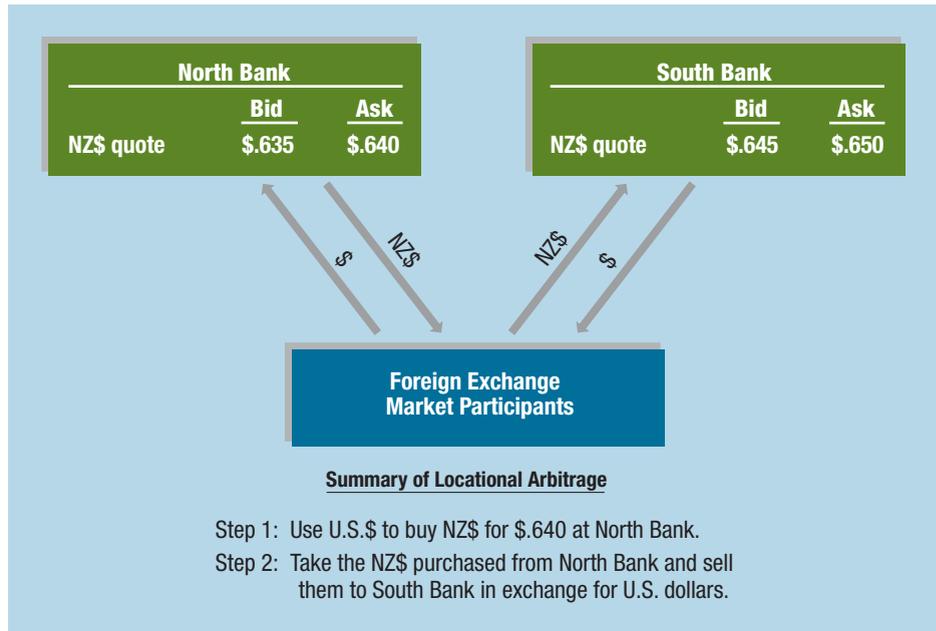
Gains from Locational Arbitrage. Your gain from locational arbitrage is based on the amount of money that you use to capitalize on the exchange rate discrepancy, along with the size of the discrepancy.

EXAMPLE The quotations for the New Zealand dollar (NZ\$) at two banks are shown in Exhibit 7.2. You can obtain New Zealand dollars from North Bank at the ask price of \$.640 and then sell New Zealand dollars to South Bank at the bid price of \$.645. This represents one "round-trip" transaction in locational arbitrage. If you start with \$10,000 and conduct one round-trip transaction, how many U.S. dollars will you end up with? The \$10,000 is initially exchanged for NZ\$15,625 ($\$10,000 / \$.640$ per New Zealand dollar) at North Bank. Then the NZ\$15,625 are sold for \$.645 each, for a total of \$10,078. Thus, your gain from locational arbitrage is \$78. ■

Your gain may appear to be small relative to your investment of \$10,000. However, consider that you did not have to tie up your funds. Your round-trip transaction could

Exhibit 7.1 Currency Quotes for Locational Arbitrage Example

	Akron Bank			Zyn Bank	
	Bid	Ask		Bid	Ask
British pound quote	\$1.60	\$1.61	British pound quote	\$1.61	\$1.62

Exhibit 7.2 Locational Arbitrage

take place over a telecommunications network within a matter of seconds. Also, if you could use a larger sum of money for the transaction, your gains would be larger. Finally, you could continue to repeat your round-trip transactions until North Bank's ask price is no longer less than South Bank's bid price.

This example is not intended to suggest that you can pay for your education through part-time locational arbitrage. As mentioned earlier, foreign exchange dealers compare quotes from banks on computer terminals, which immediately signal any opportunity to employ locational arbitrage.

Realignment due to Locational Arbitrage. Quoted prices will react to the locational arbitrage strategy used by you and other foreign exchange market participants.

EXAMPLE

In the previous example, the high demand for New Zealand dollars at North Bank (resulting from arbitrage activity) will cause a shortage of New Zealand dollars there. As a result of this shortage, North Bank will raise its ask price for New Zealand dollars. The excess supply of New Zealand dollars at South Bank (resulting from sales of New Zealand dollars to South Bank in exchange for U.S. dollars) will force South Bank to lower its bid price. As the currency prices are adjusted, gains from locational arbitrage will be reduced. Once the ask price of North Bank is not any lower than the bid price of South Bank, locational arbitrage will no longer occur. Prices may adjust in a matter of seconds or minutes from the time when locational arbitrage occurs. ■

The concept of locational arbitrage is relevant in that it explains why exchange rate quotations among banks at different locations normally will not differ by a significant amount. This applies not only to banks on the same street or within the same city but to all banks across the world. Technology allows banks to be electronically connected to foreign exchange quotations at any time. Thus, banks can ensure that their quotes are in line with those of other banks. They can also immediately detect any discrepancies among quotations as soon as they occur, and capitalize on

HTTP://

<http://finance.yahoo.com/currency?u>

Currency converter for over 100 currencies with frequent daily foreign exchange rate updates.

those discrepancies. Thus, technology enables more consistent prices among banks and reduces the likelihood of significant discrepancies in foreign exchange quotations among locations.

Triangular Arbitrage

Cross exchange rates represent the relationship between two currencies that are different from one's base currency. In the United States, the term *cross exchange rate* refers to the relationship between two nondollar currencies.

EXAMPLE

If the British pound (£) is worth \$1.60, while the Canadian dollar (C\$) is worth \$.80, the value of the British pound with respect to the Canadian dollar is calculated as follows:

$$\text{Value of } \pounds \text{ in units of C\$} = \$1.60 / \$.80 = 2.0$$

The value of the Canadian dollar in units of pounds can also be determined from the cross exchange rate formula:

$$\text{Value of C\$ in units of } \pounds = \$.80 / \$1.60 = .50$$

Notice that the value of a Canadian dollar in units of pounds is simply the reciprocal of the value of a pound in units of Canadian dollars. ■

If a quoted cross exchange rate differs from the appropriate cross exchange rate (as determined by the preceding formula), you can attempt to capitalize on the discrepancy. Specifically, you can use **triangular arbitrage** in which currency transactions are conducted in the spot market to capitalize on a discrepancy in the cross exchange rate between two currencies.

EXAMPLE

Assume that a bank has quoted the British pound (£) at \$1.60, the Malaysian ringgit (MYR) at \$.20, and the cross exchange rate at £1 = MYR8.1. Your first task is to use the pound value in U.S. dollars and Malaysian ringgit value in U.S. dollars to develop the cross exchange rate that should exist between the pound and the Malaysian ringgit. The cross rate formula in the previous example reveals that the pound should be worth MYR8.0.

When quoting a cross exchange rate of £1 = MYR8.1, the bank is exchanging too many ringgit for a pound and is asking for too many ringgit in exchange for a pound. Based on this information, you can engage in triangular arbitrage by purchasing pounds with dollars, converting the pounds to ringgit, and then exchanging the ringgit for dollars. If you have \$10,000, how many dollars will you end up with if you implement this triangular arbitrage strategy? To answer the question, consider the following steps illustrated in Exhibit 7.3:

1. Determine the number of pounds received for your dollars: $\$10,000 = \pounds 6,250$, based on the bank's quote of \$1.60 per pound.
2. Determine how many ringgit you will receive in exchange for pounds: $\pounds 6,250 = \text{MYR}50,625$, based on the bank's quote of 8.1 ringgit per pound.
3. Determine how many U.S. dollars you will receive in exchange for the ringgit: $\text{MYR}50,625 = \$10,125$ based on the bank's quote of \$.20 per ringgit (5 ringgit to the dollar). The triangular arbitrage strategy generates \$10,125, which is \$125 more than you started with. ■

Like locational arbitrage, triangular arbitrage does not tie up funds. Also, the strategy is risk free since there is no uncertainty about the prices at which you will buy and sell the currencies.

Accounting for the Bid/Ask Spread. The previous example is simplified in that it does not account for transaction costs. In reality, there is a bid and ask quote for each currency, which means that the arbitrageur incurs transaction costs

that can reduce or even eliminate the gains from triangular arbitrage. The following example illustrates how bid and ask prices can affect arbitrage profits.

E X A M P L E

Using the quotations in Exhibit 7.4, you can determine whether triangular arbitrage is possible by starting with some fictitious amount (say, \$10,000) of U.S. dollars and estimating the number of dollars you would generate by implementing the strategy. Exhibit 7.4 differs from the previous example only in that bid/ask spreads are now considered.

Recall that the previous triangular arbitrage strategy involved exchanging dollars for pounds, pounds for ringgit, and then ringgit for dollars. Apply this strategy to the bid and ask quotations in Exhibit 7.4. The steps are summarized in Exhibit 7.5.

Step 1. Your initial \$10,000 will be converted into approximately £6,211 (based on the bank’s ask price of \$1.61 per pound).

Step 2. Then the £6,211 are converted into MYR50,310 (based on the bank’s bid price for pounds of MYR8.1 per pound, $£6,211 \times 8.1 = MYR50,310$).

Step 3. The MYR50,310 are converted to \$10,062 (based on the bank’s bid price of \$.200).

The profit is $\$10,062 - \$10,000 = \$62$. The profit is lower here than in the previous example because bid and ask quotations are used. ■

Exhibit 7.3 Example of Triangular Arbitrage

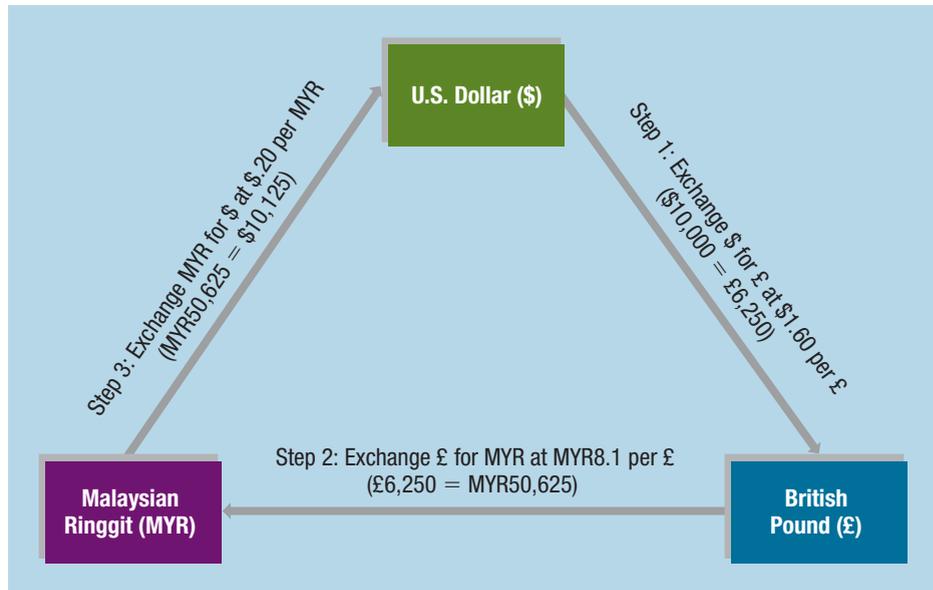


Exhibit 7.4 Currency Quotes for a Triangular Arbitrage Example

	Quoted Bid Price	Quoted Ask Price
Value of a British pound in U.S. dollars	\$1.60	\$1.61
Value of a Malaysian ringgit (MYR) in U.S. dollars	\$.200	\$.201
Value of a British pound in Malaysian ringgit (MYR)	MYR8.10	MYR8.20

Realignment Due to Triangular Arbitrage. The realignment that results from the triangular arbitrage activity is summarized in the second column of Exhibit 7.6. The realignment will likely occur quickly to prevent continued benefits from triangular arbitrage. The discrepancies assumed here are unlikely to occur within a single bank. More likely, triangular arbitrage would require three transactions at three separate banks.

If any two of these three exchange rates are known, the exchange rate of the third pair can be determined. When the actual cross exchange rate differs from the appropriate cross exchange rate, the exchange rates of the currencies are not in equilibrium. Triangular arbitrage would force the exchange rates back into equilibrium.

Like locational arbitrage, triangular arbitrage is a strategy that few of us can ever take advantage of because the computer technology available to foreign exchange dealers can easily detect misalignments in cross exchange rates. The point of this discussion is that triangular arbitrage will ensure that cross exchange rates are usually aligned correctly. If cross exchange rates are not properly aligned, triangular arbitrage will take place until the rates are aligned correctly.

Exhibit 7.5 Example of Triangular Arbitrage Accounting for Bid/Ask Spreads

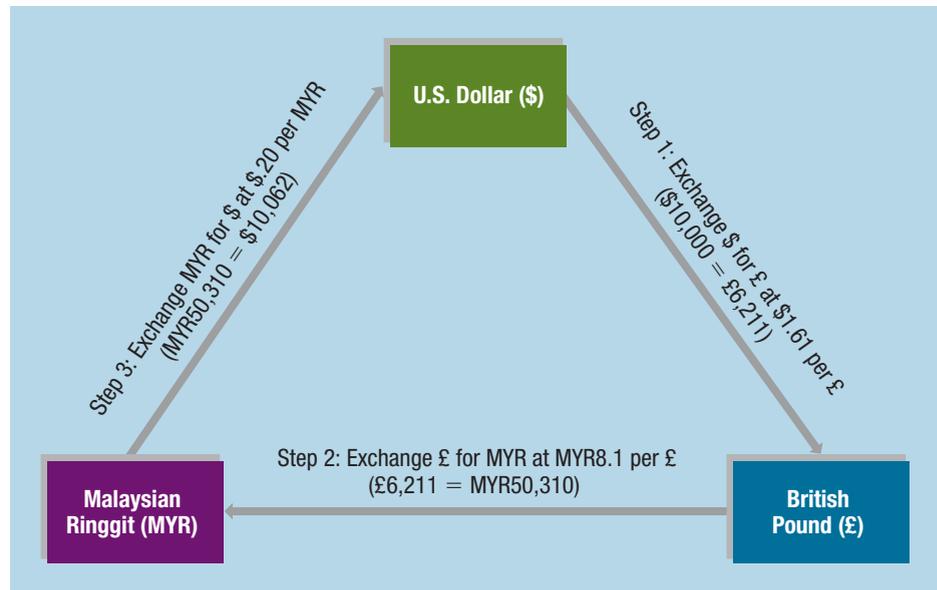


Exhibit 7.6 Impact of Triangular Arbitrage

Activity	Impact
1. Participants use dollars to purchase pounds.	Bank increases its ask price of pounds with respect to the dollar.
2. Participants use pounds to purchase Malaysian ringgit.	Bank reduces its bid price of the British pound with respect to the ringgit; that is, it reduces the number of ringgit to be exchanged per pound received.
3. Participants use Malaysian ringgit to purchase U.S. dollars.	Bank reduces its bid price of ringgit with respect to the dollar.

Covered Interest Arbitrage

The forward rate of a currency for a specified future date is determined by the interaction of demand for the contract (forward purchases) versus the supply (forward sales). Forward rates are quoted for some widely traded currencies (just below the respective spot rate quotation) in the *Wall Street Journal*. Financial institutions that offer foreign exchange services set the forward rates, but these rates are driven by the market forces (demand and supply conditions). In some cases, the forward rate may be priced at a level that allows investors to engage in arbitrage. Their actions will affect the volume of orders for forward purchases or forward sales of a particular currency, which in turn will affect the equilibrium forward rate. Arbitrage will continue until the rate is aligned where it should be, and at that point arbitrage will no longer be feasible. This arbitrage process and its effects on the forward rate are described next.

Covered interest arbitrage is the process of capitalizing on the interest rate differential between two countries while covering your exchange rate risk with a forward contract. The logic of the term *covered interest arbitrage* becomes clear when it is broken into two parts: “interest arbitrage” refers to the process of capitalizing on the difference between interest rates between two countries; “covered” refers to hedging your position against exchange rate risk.

Covered interest arbitrage is sometimes interpreted to mean that the funds to be invested are borrowed locally. In this case, the investors are not tying up any of their own funds. In another interpretation, however, the investors use their own funds. In this case, the term *arbitrage* is loosely defined since there is a positive dollar amount invested over a period of time. The following discussion is based on this latter meaning of covered interest arbitrage; under either interpretation, however, arbitrage should have a similar impact on currency values and interest rates.

EXAMPLE

You desire to capitalize on relatively high rates of interest in the United Kingdom and have funds available for 90 days. The interest rate is certain; only the future exchange rate at which you will exchange pounds back to U.S. dollars is uncertain. You can use a forward sale of pounds to guarantee the rate at which you can exchange pounds for dollars at a future point in time. This actual strategy is as follows:

1. On day 1, convert your U.S. dollars to pounds and set up a 90-day deposit account in a British bank.
2. On day 1, engage in a forward contract to sell pounds 90 days forward.
3. In 90 days when the deposit matures, convert the pounds to U.S. dollars at the rate that was agreed upon in the forward contract. ■

If the proceeds from engaging in covered interest arbitrage exceed the proceeds from investing in a domestic bank deposit, and assuming neither deposit is subject to default risk, covered interest arbitrage is feasible. The feasibility of covered interest arbitrage is based on the interest rate differential and the forward rate premium. To illustrate, consider the following numerical example.

EXAMPLE

Assume the following information:

- You have \$800,000 to invest.
- The current spot rate of the pound is \$1.60.
- The 90-day forward rate of the pound is \$1.60.
- The 90-day interest rate in the United States is 2 percent.
- The 90-day interest rate in the United Kingdom is 4 percent.

Based on this information, you should proceed as follows:

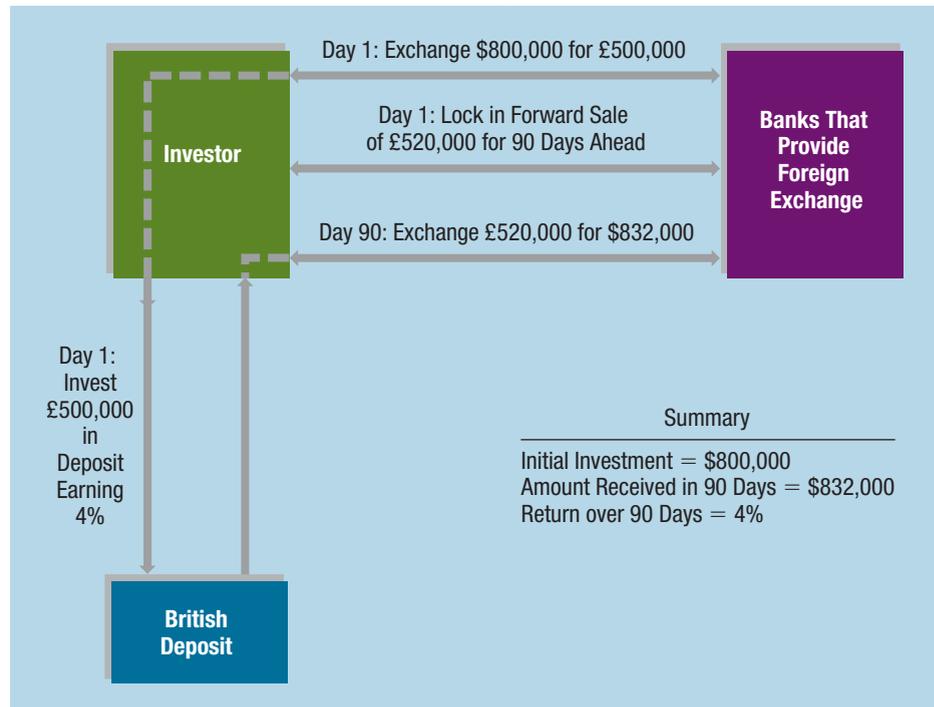
1. On day 1, convert the \$800,000 to £500,000 and deposit the £500,000 in a British bank.
2. On day 1, sell £520,000 90 days forward. By the time the deposit matures, you will have £520,000 (including interest).
3. In 90 days when the deposit matures, you can fulfill your forward contract obligation by converting your £520,000 into \$832,000 (based on the forward contract rate of \$1.60 per pound). ■

This act of covered interest arbitrage is illustrated in Exhibit 7.7. It results in a 4 percent return over the 3-month period, which is 2 percent above the return on a U.S. deposit. In addition, the return on this foreign deposit is known on day 1, since you know when you make the deposit exactly how many dollars you will get back from your 90-day investment.

Recall that locational and triangular arbitrage do not tie up funds; thus, any profits are achieved instantaneously. In the case of covered interest arbitrage, the funds are tied up for a period of time (90 days in our example). This strategy would not be advantageous if it earned 2 percent or less, since you could earn 2 percent on a domestic deposit. The term *arbitrage* here suggests that you can guarantee a return on your funds that exceeds the returns you could achieve domestically.

Realignment Due to Covered Interest Arbitrage. As with the other forms of arbitrage, market forces resulting from covered interest arbitrage will cause a market realignment. As many investors capitalize on covered interest arbitrage, there is upward pressure on the spot rate and downward pressure on the 90-day forward rate. Once the forward rate has a discount from the spot rate that is about equal to the interest rate advantage, covered interest arbitrage will no longer be feasible. Since the interest rate advantage of the British interest rate over the U.S.

Exhibit 7.7 Example of Covered Interest Arbitrage



interest rate is 2 percent, the arbitrage will no longer be feasible once the forward rate of the pound exhibits a discount of about 2 percent.

EXAMPLE

Assume that as a result of covered interest arbitrage, the market forces caused the spot rate of the pound to rise to \$1.62 and that the 90-day forward rate of the pound declined to \$1.5888. Consider the results from using \$800,000 (as in the previous example) to engage in covered interest arbitrage.

1. Convert \$800,000 to pounds:

$$\$800,000 / \$1.62 = \pounds 493,827$$

2. Calculate accumulated pounds over 90 days at 4 percent:

$$\pounds 493,827 \times 1.04 = \pounds 513,580$$

3. Reconvert pounds to dollars (at the forward rate of \$1.5888) after 90 days:

$$\pounds 513,580 \times \$1.5888 = \$815,976$$

4. Determine the yield earned from covered interest arbitrage:

$$(\$815,976 - \$800,000) / \$800,000 = .02, \text{ or } 2\%$$

As this example shows, those individuals who initially conduct covered interest arbitrage cause exchange rates and possibly interest rates to move in such a way that future attempts at covered interest arbitrage provide a return that is no better than what is possible domestically. Due to the market forces from covered interest arbitrage, a relationship between the forward rate premium and interest rate differentials should exist. This relationship is discussed shortly. ■

Consideration of Spreads. One more example is provided to illustrate the effects of the spread between the bid and ask quotes and the spread between deposit and loan rates.

EXAMPLE

The following exchange rates and one-year interest rates exist.

	Bid Quote	Ask Quote
Euro spot	\$1.12	\$1.13
Euro one-year forward	1.12	1.13
	Deposit Rate	Loan Rate
Interest rate on dollars	6.0%	9.0%
Interest rate on euros	6.5%	9.5%

You have \$100,000 to invest for one year. Would you benefit from engaging in covered interest arbitrage?

Notice that the quotes of the euro spot and forward rates are exactly the same, while the deposit rate on euros is .5 percent higher than the deposit rate on dollars. So it may seem that covered interest arbitrage is feasible. However, U.S. investors would be subjected to the ask quote when buying euros (€) in the spot market, versus the bid quote when selling the euros through a one-year forward contract.

1. Convert \$100,000 to euros (ask quote):

$$\$100,000 / \$1.13 = \text{€}88,496$$

2. Calculate accumulated euros over one year at 6.5 percent:

$$€88,496 \times 1.065 = €94,248$$

3. Sell euros for dollars at the forward rate (bid quote):

$$€94,248 \times \$1.12 = \$105,558$$

4. Determine the yield earned from covered interest arbitrage:

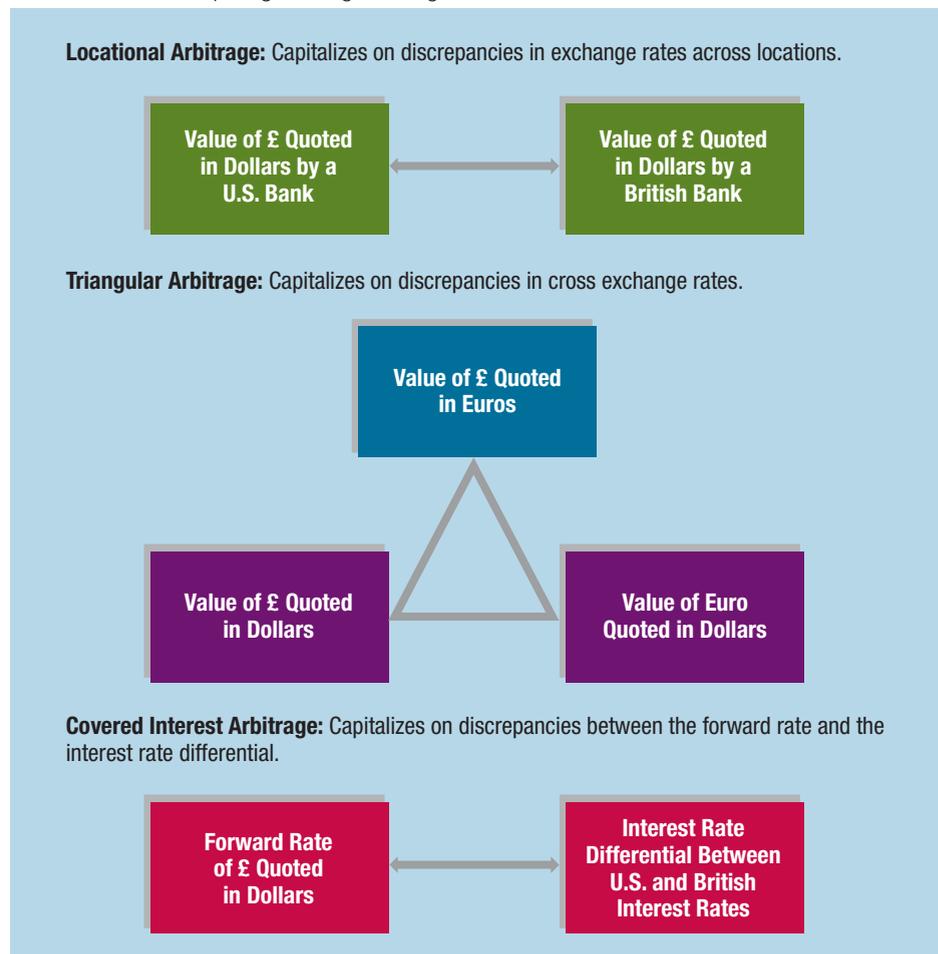
$$(\$105,558 - \$100,000)/\$100,000 = .05558, \text{ or } 5.558\%$$

The yield is less than you would have earned if you had invested the funds in the United States. Thus, covered interest arbitrage is not feasible. ■

Comparison of Arbitrage Effects

Exhibit 7.8 provides a comparison of the three types of arbitrage. The threat of locational arbitrage ensures that quoted exchange rates are similar across banks in different locations. The threat of triangular arbitrage ensures that cross exchange rates are properly set. The threat of covered interest arbitrage ensures that forward exchange rates are properly set. Any discrepancy will trigger arbitrage, which should eliminate the discrepancy. Thus, arbitrage tends to allow for a more orderly foreign exchange market.

Exhibit 7.8 Comparing Arbitrage Strategies



Interest Rate Parity (IRP)

Once market forces cause interest rates and exchange rates to adjust such that covered interest arbitrage is no longer feasible, there is an equilibrium state referred to as **interest rate parity (IRP)**. In equilibrium, the forward rate differs from the spot rate by a sufficient amount to offset the interest rate differential between two currencies. In the previous example, the U.S. investor receives a higher interest rate from the foreign investment, but there is an offsetting effect because the investor must pay more per unit of foreign currency (at the spot rate) than is received per unit when the currency is sold forward (at the forward rate). Recall that when the forward rate is less than the spot rate, this implies that the forward rate exhibits a discount.

Derivation of Interest Rate Parity

The relationship between a forward premium (or discount) of a foreign currency and the interest rates representing these currencies according to IRP can be determined as follows. Consider a U.S. investor who attempts covered interest arbitrage. The investor's return from using covered interest arbitrage can be determined given the following:

- The amount of the home currency (U.S. dollars in our example) that is initially invested (A_b).
- The spot rate (S) in dollars when the foreign currency is purchased.
- The interest rate on the foreign deposit (i_f).
- The forward rate (F) in dollars at which the foreign currency will be converted back to U.S. dollars.

The amount of the home currency received at the end of the deposit period due to such a strategy (called A_n) is:

$$A_n = (A_b/S)(1 + i_f)F$$

Since F is simply S times one plus the forward premium (called p), we can rewrite this equation as:

$$\begin{aligned} A_n &= (A_b/S)(1 + i_f)[S(1 + p)] \\ &= A_b(1 + i_f)(1 + p) \end{aligned}$$

The rate of return from this investment (called R) is as follows:

$$\begin{aligned} R &= \frac{A_n - A_b}{A_b} \\ &= \frac{[A_b(1 + i_f)(1 + p)] - A_b}{A_b} \\ &= (1 + i_f)(1 + p) - 1 \end{aligned}$$

If IRP exists, then the rate of return achieved from covered interest arbitrage (R) should be equal to the rate available in the home country. Set the rate that can be achieved from using covered interest arbitrage equal to the rate that can be achieved from an investment in the home country (the return on a home investment is simply the home interest rate called i_b):

$$R = i_b$$

By substituting into the formula the way in which R is determined, we obtain:

$$(1 + i_f)(1 + p) - 1 = i_b$$

By rearranging terms, we can determine what the forward premium of the foreign currency should be under conditions of IRP:

$$\begin{aligned}(1 + i_f)(1 + p) - 1 &= i_b \\(1 + i_f)(1 + p) &= 1 + i_b \\1 + p &= \frac{1 + i_b}{1 + i_f} \\p &= \frac{1 + i_b}{1 + i_f} - 1\end{aligned}$$

Thus, given the two interest rates of concern, the forward rate under conditions of IRP can be derived. If the actual forward rate is different from this derived forward rate, there may be potential for covered interest arbitrage.

Determining the Forward Premium

Using the information just presented, the forward premium can be measured based on the interest rate differential under conditions of IRP.

EXAMPLE

Assume that the Mexican peso exhibits a 6-month interest rate of 6 percent, while the U.S. dollar exhibits a 6-month interest rate of 5 percent. From a U.S. investor's perspective, the U.S. dollar is the home currency. According to IRP, the forward rate premium of the peso with respect to the U.S. dollar should be:

$$\begin{aligned}p &= \frac{1 + .05}{1 + .06} - 1 \\&= -.0094, \text{ or } -.94\% \text{ (not annualized)}\end{aligned}$$

Thus, the peso should exhibit a forward discount of about .94 percent. This implies that U.S. investors would receive .94 percent less when selling pesos 6 months from now (based on a forward sale) than the price they pay for pesos today at the spot rate. Such a discount would offset the interest rate advantage of the peso. If the peso's spot rate is \$.10, a forward discount of .94 percent means that the 6-month forward rate is as follows:

$$\begin{aligned}F &= S(1 + p) \\&= \$.10(1 - .0094) \\&= \$.09906\end{aligned}$$

Relationship between Forward Premium and Interest Rate Differential. The relationship between the forward premium (or discount) and the interest rate differential according to IRP is simplified in an approximated form as follows:

$$p = \frac{F - S}{S} \cong i_b - i_f$$

where

- p = forward premium (or discount)
- F = forward rate in dollars
- S = spot rate in dollars
- i_b = home interest rate
- i_f = foreign interest rate

This approximated form provides a reasonable estimate when the interest rate differential is small. The variables in this equation are not annualized. In our previous example, the U.S. (home) interest rate is less than the foreign interest rate, so the

forward rate contains a discount (the forward rate is less than the spot rate). The larger the degree by which the foreign interest rate exceeds the home interest rate, the larger will be the forward discount of the foreign currency specified by the IRP formula.

If the foreign interest rate is less than the home interest rate, the IRP relationship suggests that the forward rate should exhibit a premium.

Implications. If the forward premium is equal to the interest rate differential as explained above, covered interest arbitrage will not be feasible.

EXAMPLE

Use the information on the spot rate, the 6-month forward rate of the peso, and Mexico's interest rate from the preceding example to determine a U.S. investor's return from using covered interest arbitrage. Assume the investor begins with \$1,000,000 to invest.

Step 1. On the first day, the U.S. investor converts \$1,000,000 into Mexican pesos (MXP) at \$.10 per peso:

$$\text{\$1,000,000}/\text{\$.10 per peso} = \text{MXP10,000,000}$$

Step 2. On the first day, the U.S. investor also sells pesos 6 months forward. The number of pesos to be sold forward is the anticipated accumulation of pesos over the 6-month period, which is estimated as:

$$\text{MXP10,000,000} \times (1 + .06) = \text{MXP10,600,000}$$

Step 3. After 6 months, the U.S. investor withdraws the initial deposit of pesos along with the accumulated interest, amounting to a total of 10,600,000 pesos. The investor converts the pesos into dollars in accordance with the forward contract agreed upon 6 months earlier. The forward rate was \$.09906, so the number of U.S. dollars received from the conversion is:

$$\text{MXP10,600,000} \times (\text{\$.09906 per peso}) = \text{\$1,050,036}$$

In this case, the investor's covered interest arbitrage achieves a return of about 5 percent. Rounding the forward discount to .94 percent causes the slight deviation from the 5 percent return. The results suggest that, in this instance, using covered interest arbitrage generates a return that is about what the investor would have received anyway by simply investing the funds domestically. This confirms that covered interest arbitrage is not worthwhile if IRP exists. ■

Graphic Analysis of Interest Rate Parity

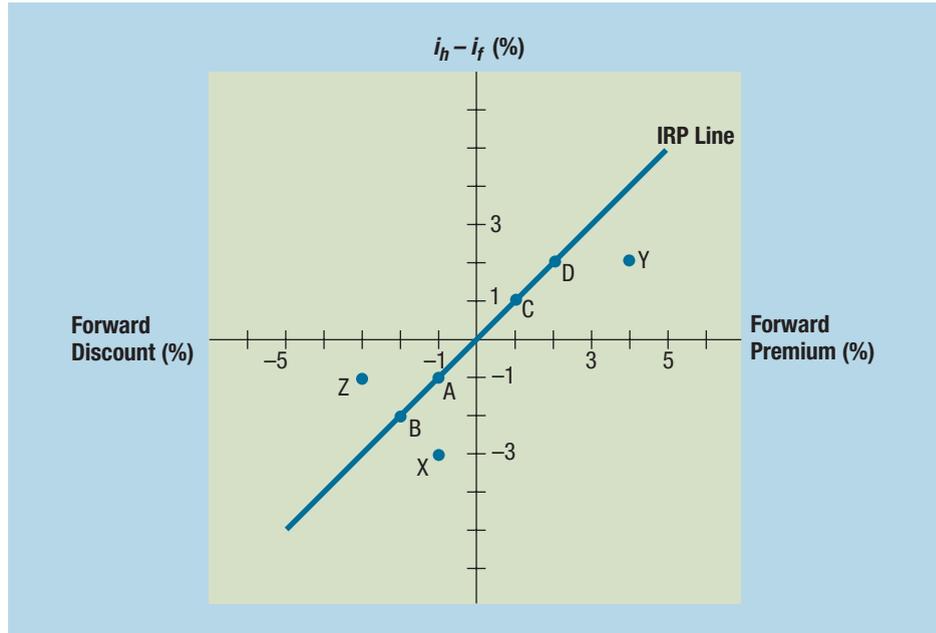
The interest rate differential can be compared to the forward premium (or discount) with the use of a graph. All the possible points that represent interest rate parity are plotted on Exhibit 7.9 by using the approximation expressed earlier and plugging in numbers.

Points Representing a Discount. For all situations in which the foreign interest rate exceeds the home interest rate, the forward rate should exhibit a discount approximately equal to that differential. When the foreign interest rate (i_f) exceeds the home interest rate (i_h) by 1 percent ($i_h - i_f = -1\%$), then the forward rate should exhibit a discount of 1 percent. This is represented by point A on the graph. If the foreign interest rate exceeds the home rate by 2 percent, then the forward rate should exhibit a discount of 2 percent, as represented by point B on the graph, and so on.

Points Representing a Premium. For all situations in which the foreign interest rate is less than the home interest rate, the forward rate should exhibit a premium approximately equal to that differential. For example, if the home interest

HTTP://

<http://www.bloomberg.com>
Latest information from
financial markets around
the world.

Exhibit 7.9 Illustration of Interest Rate Parity

rate exceeds the foreign rate by 1 percent ($i_h - i_f = 1\%$), then the forward premium should be 1 percent, as represented by point C. If the home interest rate exceeds the foreign rate by 2 percent ($i_h - i_f = 2\%$), then the forward premium should be 2 percent, as represented by point D, and so on.

Points Representing IRP. Any points lying on the diagonal line cutting the intersection of the axes represent IRP. For this reason, that diagonal line is referred to as the **interest rate parity (IRP) line**. Covered interest arbitrage is not possible for points along the IRP line.

An individual or corporation can at any time examine all currencies to compare forward rate premiums (or discounts) to interest rate differentials. From a U.S. perspective, interest rates in Japan are usually lower than the home interest rates. Consequently, the forward rate of the Japanese yen usually exhibits a premium and may be represented by points such as C or D or even points above D along the diagonal line in Exhibit 7.9. Conversely, the United Kingdom often has higher interest rates than the United States, so the pound's forward rate often exhibits a discount, represented by point A or B.

Exhibit 7.9 can be used whether or not you annualize the rates, as long as you are consistent. That is, if you annualize the interest rates to determine the interest rate differential, you should also annualize the forward premium or discount.

Points below the IRP Line. What if a 3-month deposit represented by a foreign currency offers an annualized interest rate of 10 percent versus an annualized interest rate of 7 percent in the home country? Such a scenario is represented on the graph by $i_h - i_f = -3\%$. Also assume that the foreign currency exhibits an annualized forward discount of 1 percent. The combined interest rate differential and forward discount information can be represented by point X on the graph. Since point X is not on the IRP line, we should expect that covered interest arbitrage will be beneficial for some investors. The investor attains an additional 3 percentage points for the

foreign deposit, and this advantage is only partially offset by the 1 percent forward discount.

Assume that the annualized interest rate for the foreign currency is 5 percent, as compared to 7 percent for the home country. The interest rate differential expressed on the graph is $i_h - i_f = 2\%$. However, assume that the forward premium of the foreign currency is 4 percent (point Y in Exhibit 7.9). Thus, the high forward premium more than makes up what the investor loses on the lower interest rate from the foreign investment.

If the current interest rate and forward rate situation is represented by point X or Y, home country investors can engage in covered interest arbitrage. By investing in a foreign currency, they will earn a higher return (after considering the foreign interest rate and forward premium or discount) than the home interest rate. This type of activity will place upward pressure on the spot rate of the foreign currency, and downward pressure on the forward rate of the foreign currency, until covered interest arbitrage is no longer feasible.

Points above the IRP Line. Now shift to the left side of the IRP line. Take point Z, for example. This represents a foreign interest rate that exceeds the home interest rate by 1 percent, while the forward rate exhibits a 3 percent discount. This point, like all points to the left of the IRP line, represents a situation in which U.S. investors would achieve a lower return on a foreign investment than on a domestic one. This lower return normally occurs either because (1) the advantage of the foreign interest rate relative to the U.S. interest rate is more than offset by the forward rate discount (reflected by point Z), or because (2) the degree by which the home interest rate exceeds the foreign rate more than offsets the forward rate premium.

For points such as these, however, covered interest arbitrage is feasible from the perspective of foreign investors. Consider British investors in the United Kingdom, whose interest rate is 1 percent higher than the U.S. interest rate, and the forward rate (with respect to the dollar) contains a 3 percent discount (as represented by point Z). British investors will sell their foreign currency in exchange for dollars, invest in dollar-denominated securities, and engage in a forward contract to purchase pounds forward. Though they earn 1 percent less on the U.S. investment, they are able to purchase their home currency forward for 3 percent less than what they initially sold it forward in the spot market. This type of activity will place downward pressure on the spot rate of the pound and upward pressure on the pound's forward rate, until covered interest arbitrage is no longer feasible.

How to Test Whether Interest Rate Parity Exists

An investor or firm can plot all realistic points for various currencies on a graph such as that in Exhibit 7.9 to determine whether gains from covered interest arbitrage can be achieved. The location of the points provides an indication of whether covered interest arbitrage is worthwhile. For points to the right of the IRP line, investors in the home country should consider using covered interest arbitrage, since a return higher than the home interest rate (i_h) is achievable. Of course, as investors and firms take advantage of such opportunities, the point will tend to move toward the IRP line. Covered interest arbitrage should continue until the interest rate parity relationship holds.

Interpretation of Interest Rate Parity

Interest rate parity does not imply that investors from different countries will earn the same returns. It is focused on the comparison of a foreign investment and a domestic investment in risk-free interest-bearing securities by a particular investor.

EXAMPLE

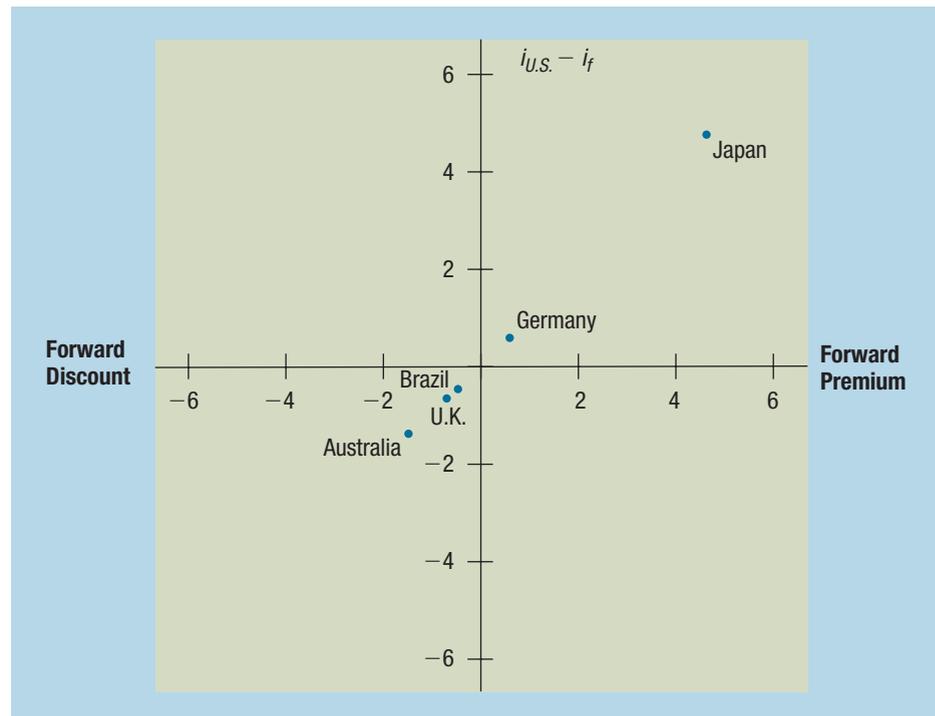
Assume that the United States has a 10 percent interest rate, while the United Kingdom has a 14 percent interest rate. U.S. investors can achieve 10 percent domestically or attempt to use covered interest arbitrage. If they attempt covered interest arbitrage while IRP exists, then the result will be a 10 percent return, the same as they could achieve in the United States. If British investors attempt covered interest arbitrage while IRP exists, then the result will be a 14 percent return, the same as they could achieve in the United Kingdom. Thus, U.S. investors and British investors do *not* achieve the same nominal return here, even though IRP exists. An appropriate summary explanation of IRP is that if IRP exists, investors cannot use covered interest arbitrage to achieve higher returns than those achievable in their respective home countries. ■

Does Interest Rate Parity Hold?

To determine conclusively whether interest rate parity holds, it is necessary to compare the forward rate (or discount) with interest rate quotations occurring at the same time. If the forward rate and interest rate quotations do not reflect the same time of day, then results could be somewhat distorted. Due to limitations in access to data, it is difficult to obtain quotations that reflect the same point in time.

A comparison of annualized forward rate premiums and annualized interest rate differentials for five widely traded currencies as of April 13, 2007, is provided in Exhibit 7.10 from a U.S. perspective. At this time, the U.S. interest rate was higher than the Japanese and German interest rates and lower than the interest rates in the other countries. The exhibit shows that the yen and euro (Germany's currency) exhibited a forward premium, while all other currencies exhibited a discount. The Australian dollar exhibited the most pronounced forward discount, which is attributed to its

Exhibit 7.10 Forward Rate Premiums and Interest Rate Differentials for Five Currencies



Note: The data are as of April 13, 2007. The forward rate premium is based on the 6-month forward rate and is annualized. The interest rate differential represents the difference between the 6-month annualized U.S. interest rate and the 6-month foreign interest rate.

relatively high interest rate. The forward premium or discount of each currency is in line with the interest rate differential and therefore reflects IRP.

At different points in time, the position of a country may change. For example, if Brazil's interest rate increased while other countries' interest rates stayed the same, Brazil's position would move down along the y axis. Yet, its forward discount would likely be more pronounced (farther to the left along the x axis) as well, since covered interest arbitrage would occur otherwise. Therefore, its new point would be farther to the left but would still be along the 45-degree line.

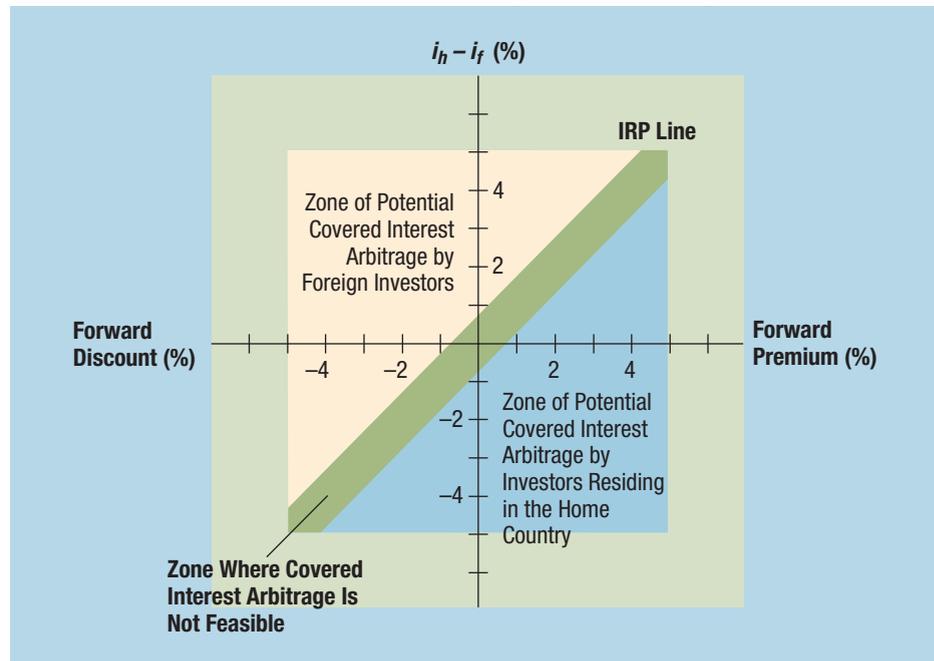
Numerous academic studies have conducted empirical examination of IRP in several periods. The actual relationship between the forward rate premium and interest rate differentials generally supports IRP. Although there are deviations from IRP, they are often not large enough to make covered interest arbitrage worthwhile, as we will now discuss in more detail.

Considerations When Assessing Interest Rate Parity

If interest rate parity does not hold, covered interest arbitrage deserves consideration. Nevertheless, covered interest arbitrage still may not be worthwhile due to various characteristics of foreign investments, including transaction costs, political risk, and differential tax laws.

Transaction Costs. If an investor wishes to account for transaction costs, the actual point reflecting the interest rate differential and forward rate premium must be farther from the IRP line to make covered interest arbitrage worthwhile. Exhibit 7.11 identifies the areas that reflect potential for covered interest arbitrage *after* accounting for transaction costs. Notice the band surrounding the IRP line. For points not on the IRP line but within this band, covered interest arbitrage is not worthwhile (because the excess return is offset by costs). For points to the right of (or below) the band, investors residing in the home country could gain through covered

Exhibit 7.11 Potential for Covered Interest Arbitrage When Considering Transaction Costs



interest arbitrage. For points to the left of (or above) the band, foreign investors could gain through covered interest arbitrage.

Political Risk. Even if covered interest arbitrage appears feasible after accounting for transaction costs, investing funds overseas is subject to political risk. Though the forward contract locks in the rate at which the foreign funds should be reconverted, there is no guarantee that the foreign government will allow the funds to be reconverted. A crisis in the foreign country could cause its government to restrict any exchange of the local currency for other currencies. In this case, the investor would be unable to use these funds until the foreign government eliminated the restriction.

Investors may also perceive a slight default risk on foreign investments such as foreign Treasury bills, since they may not be assured that the foreign government will guarantee full repayment of interest and principal upon default. Therefore, because of concern that the foreign Treasury bills may default, they may accept a lower interest rate on their domestic Treasury bills rather than engage in covered interest arbitrage in an effort to obtain a slightly higher expected return.

Differential Tax Laws. Because tax laws vary among countries, investors and firms that set up deposits in other countries must be aware of the existing tax laws. Covered interest arbitrage might be feasible when considering before-tax returns but not necessarily when considering after-tax returns. Such a scenario would be due to differential tax rates.

Forward Premiums across Maturity Markets

The yield curve represents the relationship between the annualized yield of risk-free debt and the time to maturity at a given point in time. The shape of the yield curve in the United States commonly has an upward slope, implying that the annualized interest rate is higher for longer terms to maturity. The yield curve of every country has its own unique shape. Consequently, the annualized interest rate differential between two countries can vary among debt maturities, and so will the annualized forward premiums.

To illustrate, review Exhibit 7.12, which shows today's quoted interest rates for various times to maturity. If you plot a yield curve with the time to maturity on the horizontal axis and the U.S. interest rate on the vertical axis, the U.S. yield curve today is upward sloping. If you repeat the exercise for the interest rate of the euro, the yield curve is flat, as the annualized interest rate in the euro zone is the same regardless of the maturity. For times to maturity of less than 180 days, the euro interest rate is higher than the U.S. interest rate, so the forward rate of the euro would exhibit a discount if IRP holds. For the time to maturity of 180 days, the euro interest rate is equal to the U.S. interest rate, which means that the 180-day forward rate of the euro

Exhibit 7.12 Quoted Interest Rates for Various Times to Maturity

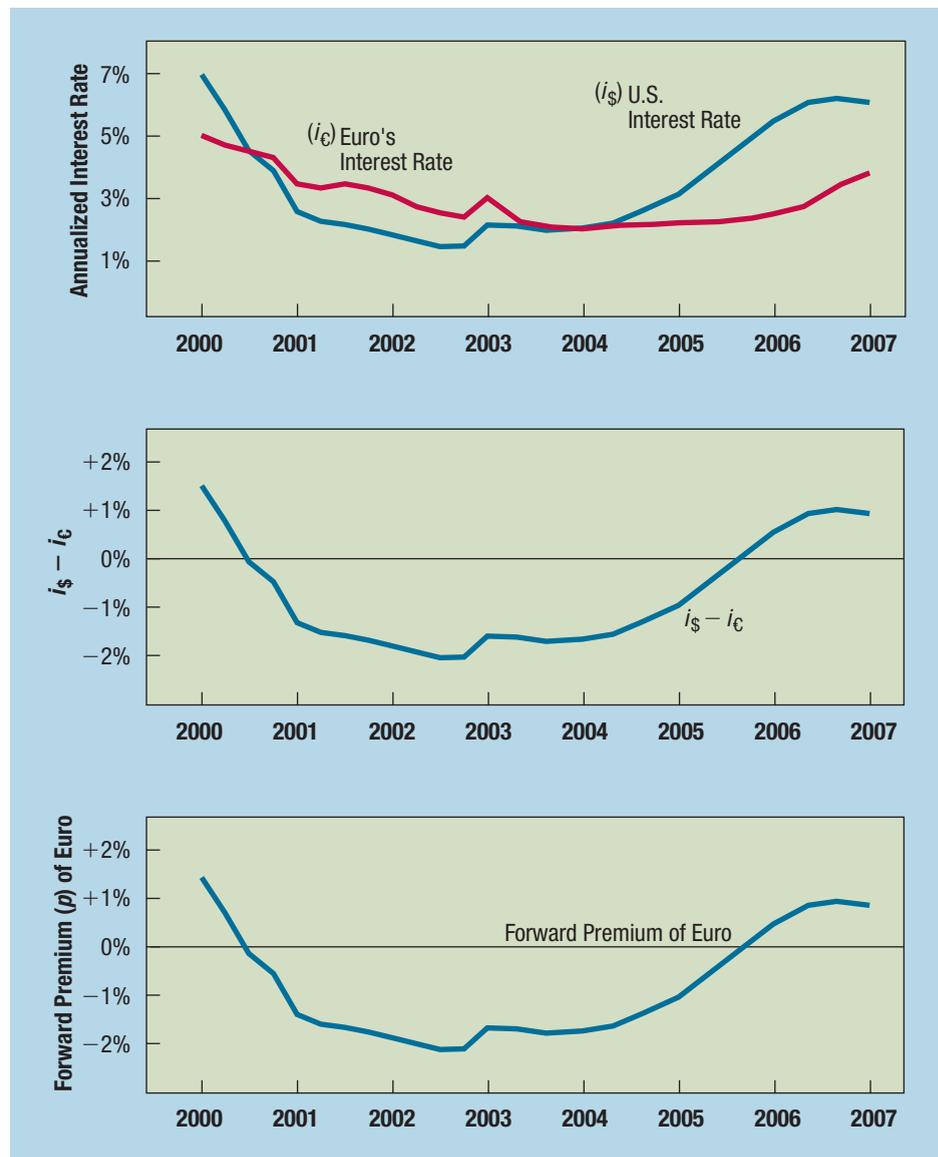
Time to Maturity	U.S. Interest (Annualized) Quoted Today	Euro Interest (Annualized) Quoted Today	Interest Rate Differential (Annualized) Based on Today's Quotes	Approximate Forward Rate Premium (Annualized) of Euro as of Today if IRP Holds
30 days	4.0%	5.0%	-1.0%	-1.0%
90 days	4.5	5.0	-.5	-.5
180 days	5.0	5.0	.0	.0
1 year	5.5	5.0	+5	+5
2 years	6.0	5.0	+1.0	+1.0

should be equal to its spot rate (no premium or discount). For times to maturity beyond 180 days, the euro interest rate is lower than the U.S. interest rate, which means that the forward rate of the euro would exhibit a premium if IRP holds. Consider the implications for U.S. firms that hedge future euro payments. A firm that is hedging euro outflow payments for a date of less than 180 days from now will lock in a forward rate for the euro that is lower than the existing spot rate. Conversely, a firm that is hedging euro outflow payments for a date beyond 180 days from now will lock in a forward rate that is above the existing spot rate.

Changes in Forward Premiums

Exhibit 7.13 illustrates the relationship between interest rate differentials and the forward premium over time. In the fourth quarter of 2000, the U.S. interest rate was

Exhibit 7.13 Relationship between Interest Rate Differentials and Forward Rate Premiums over Time



HTTP://

<http://www.bmonesbittburns.com/economics/fxrates>

Forward rates of the Canadian dollar, British pound, euro, and Japanese yen for various periods.

higher than the interest rate on euros, and the forward rate of the euro exhibited a premium. During the next 2 years, the U.S. interest rate declined to a greater degree than the euro's interest rate. As the U.S. interest rate declined below the euro's interest rate in 2001, the euro's forward rate exhibited a discount, as the forward rate was lower than the prevailing spot rate. The larger the degree to which the euro's interest rate exceeded the U.S. interest rate, the more pronounced was the euro's forward discount.

In 2005, the U.S. interest rate increased and rose above the euro's interest rate, which caused the euro's forward rate to exhibit a forward premium at that time. Since the U.S. interest rate remained above the euro's interest rate during the 2005–2007 period, the euro consistently exhibited a forward premium during that period.

GOVERNANCE**How Arbitrage Reduces the Need to Monitor Transaction Costs**

Many MNCs engage in transactions amounting to more than \$100 million per year. Since the foreign exchange market is over-the-counter, there is not one consistently transparent set of exchange quotations. Consequently, managers of an MNC could incur large transaction costs if they consistently paid too much for the currencies that they needed. However, the arbitrage process limits the degree of differentials among currencies. Locational arbitrage limits the differences in a spot exchange rate quotation across locations, while covered interest arbitrage ensures that the forward rate is properly priced. Thus, an MNC's managers should be able to avoid excessive transaction costs. ■

SUMMARY

■ Locational arbitrage may occur if foreign exchange quotations differ among banks. The act of locational arbitrage should force the foreign exchange quotations of banks to become realigned, and locational arbitrage will no longer be possible.

■ Triangular arbitrage is related to cross exchange rates. A cross exchange rate between two currencies is determined by the values of these two currencies with respect to a third currency. If the actual cross exchange rate of these two currencies differs from the rate that should exist, triangular arbitrage is possible. The act of triangular arbitrage should force cross exchange rates to become realigned, at which time triangular arbitrage will no longer be possible.

■ Covered interest arbitrage is based on the relationship between the forward rate premium and the interest rate differential. The size of the premium or discount exhibited by the forward rate of a currency should be about the same as the differential between the interest rates of the two countries of concern. In general terms, the forward rate of the foreign currency will contain a discount (premium) if its interest rate is higher (lower) than the U.S. interest rate.

If the forward premium deviates substantially from the interest rate differential, covered interest arbitrage is possible. In this type of arbitrage, a foreign short-term investment in a foreign currency is covered by a forward sale of that foreign currency in the future. In this manner, the investor is not exposed to fluctuation in the foreign currency's value.

■ Interest rate parity (IRP) is a theory that states that the size of the forward premium (or discount) should be equal to the interest rate differential between the two countries of concern. When IRP exists, covered interest arbitrage is not feasible because any interest rate advantage in the foreign country will be offset by the discount on the forward rate. Thus, the act of covered interest arbitrage would generate a return that is no higher than what would be generated by a domestic investment.

POINT COUNTER-POINT

Does Arbitrage Destabilize Foreign Exchange Markets?

Point Yes. Large financial institutions have the technology to recognize when one participant in the foreign exchange market is trying to sell a currency for a higher price than another participant. They also recognize when the forward rate does not properly reflect the interest rate differential. They use arbitrage to capitalize on these situations, which results in large foreign exchange transactions. In some cases, their arbitrage involves taking large positions in a currency and then reversing their positions a few minutes later. This jumping in and out of currencies can cause abrupt price adjustments of currencies and may create more volatility in the foreign exchange market. Regulations should be created that would force financial institutions to maintain their currency positions for at least one month. This would result in a more stable foreign exchange market.

Counter-Point No. When financial institutions engage in arbitrage, they create pressure on the price of a currency that will remove any pricing discrepancy. If arbitrage did not occur, pricing discrepancies would become more pronounced. Consequently, firms and individuals who use the foreign exchange market would have to spend more time searching for the best exchange rate when trading a currency. The market

would become fragmented, and prices could differ substantially among banks in a region, or among regions. If the discrepancies became large enough, firms and individuals might even attempt to conduct arbitrage themselves. The arbitrage conducted by banks allows for a more integrated foreign exchange market, which ensures that foreign exchange prices quoted by any institution are in line with the market.

Who Is Correct? Use the Internet to learn more about this issue. Which argument do you support? Offer your own opinion on this issue.

SELF TEST

Answers are provided in Appendix A at the back of the text.

1. Assume that the following spot exchange rates exist today:

$$£1 = \$1.50$$

$$C\$ = \$.75$$

$$£1 = C\$2$$

Assume no transaction costs. Based on these exchange rates, can triangular arbitrage be used to earn a profit? Explain.

2. Assume the following information:

$$\text{Spot rate of } £ = \$1.60$$

$$\text{180-day forward rate of } £ = \$1.56$$

$$\text{180-day British interest rate} = 4\%$$

$$\text{180-day U.S. interest rate} = 3\%$$

Based on this information, is covered interest arbitrage by U.S. investors feasible (assuming that U.S. investors use their own funds)? Explain.

3. Using the information in the previous question, does interest rate parity exist? Explain.
4. Explain in general terms how various forms of arbitrage can remove any discrepancies in the pricing of currencies.
5. Assume that the British pound's one-year forward rate exhibits a discount. Assume that interest rate parity continually exists. Explain how the discount on the British pound's one-year forward discount would change if British one-year interest rates rose by 3 percentage points while U.S. one-year interest rates rose by 2 percentage points.

QUESTIONS AND APPLICATIONS

- Locational Arbitrage.** Explain the concept of locational arbitrage and the scenario necessary for it to be plausible.
- Locational Arbitrage.** Assume the following information:

	Beal Bank	Yardley Bank
Bid price of New Zealand dollar	\$.401	\$.398
Ask price of New Zealand dollar	\$.404	\$.400

Given this information, is locational arbitrage possible? If so, explain the steps involved in locational arbitrage, and compute the profit from this arbitrage if you had \$1 million to use. What market forces would occur to eliminate any further possibilities of locational arbitrage?

- Triangular Arbitrage.** Explain the concept of triangular arbitrage and the scenario necessary for it to be plausible.
- Triangular Arbitrage.** Assume the following information:

	Quoted Price
Value of Canadian dollar in U.S. dollars	\$.90
Value of New Zealand dollar in U.S. dollars	\$.30
Value of Canadian dollar in New Zealand dollars	NZ\$3.02

Given this information, is triangular arbitrage possible? If so, explain the steps that would reflect triangular arbitrage, and compute the profit from this strategy if you had \$1 million to use. What market forces would occur to eliminate any further possibilities of triangular arbitrage?

- Covered Interest Arbitrage.** Explain the concept of covered interest arbitrage and the scenario necessary for it to be plausible.
- Covered Interest Arbitrage.** Assume the following information:

Spot rate of Canadian dollar	= \$.80
90-day forward rate of Canadian dollar	= \$.79
90-day Canadian interest rate	= 4%
90-day U.S. interest rate	= 2.5%

Given this information, what would be the yield (percentage return) to a U.S. investor who used covered interest arbitrage? (Assume the investor invests \$1 million.) What market forces would occur to eliminate any further possibilities of covered interest arbitrage?

- Covered Interest Arbitrage.** Assume the following information:

Spot rate of Mexican peso	= \$.100
180-day forward rate of Mexican peso	= \$.098
180-day Mexican interest rate	= 6%
180-day U.S. interest rate	= 5%

Given this information, is covered interest arbitrage worthwhile for Mexican investors who have pesos to invest? Explain your answer.

- Effects of September 11.** The terrorist attack on the United States on September 11, 2001, caused expectations of a weaker U.S. economy. Explain how such expectations could have affected U.S. interest rates and therefore have affected the forward rate premium (or discount) on various foreign currencies.
- Interest Rate Parity.** Explain the concept of interest rate parity. Provide the rationale for its possible existence.
- Inflation Effects on the Forward Rate.** Why do you think currencies of countries with high inflation rates tend to have forward discounts?
- Covered Interest Arbitrage in Both Directions.** Assume that the existing U.S. one-year interest rate is 10 percent and the Canadian one-year interest rate is 11 percent. Also assume that interest rate parity exists. Should the forward rate of the Canadian dollar exhibit a discount or a premium? If U.S. investors attempt covered interest arbitrage, what will be their return? If Canadian investors attempt covered interest arbitrage, what will be their return?
- Interest Rate Parity.** Why would U.S. investors consider covered interest arbitrage in France when the interest rate on euros in France is lower than the U.S. interest rate?
- Interest Rate Parity.** Consider investors who invest in either U.S. or British one-year Treasury bills. Assume zero transaction costs and no taxes.

- a. If interest rate parity exists, then the return for U.S. investors who use covered interest arbitrage will be the same as the return for U.S. investors who invest in U.S. Treasury bills. Is this statement true or false? If false, correct the statement.
- b. If interest rate parity exists, then the return for British investors who use covered interest arbitrage will be the same as the return for British investors who invest in British Treasury bills. Is this statement true or false? If false, correct the statement.
14. **Changes in Forward Premiums.** Assume that the Japanese yen's forward rate currently exhibits a premium of 6 percent and that interest rate parity exists. If U.S. interest rates decrease, how must this premium change to maintain interest rate parity? Why might we expect the premium to change?
15. **Changes in Forward Premiums.** Assume that the forward rate premium of the euro was higher last month than it is today. What does this imply about interest rate differentials between the United States and Europe today compared to those last month?
16. **Interest Rate Parity.** If the relationship that is specified by interest rate parity does not exist at any period but does exist on average, then covered interest arbitrage should not be considered by U.S. firms. Do you agree or disagree with this statement? Explain.
17. **Covered Interest Arbitrage in Both Directions.** The one-year interest rate in New Zealand is 6 percent. The one-year U.S. interest rate is 10 percent. The spot rate of the New Zealand dollar (NZ\$) is \$.50. The forward rate of the New Zealand dollar is \$.54. Is covered interest arbitrage feasible for U.S. investors? Is it feasible for New Zealand investors? In each case, explain why covered interest arbitrage is or is not feasible.
18. **Limitations of Covered Interest Arbitrage.** Assume that the one-year U.S. interest rate is 11 percent, while the one-year interest rate in Malaysia is 40 percent. Assume that a U.S. bank is willing to purchase the currency of that country from you one year from now at a discount of 13 percent. Would covered interest arbitrage be worth considering? Is there any reason why you should not attempt covered interest arbitrage in this situation? (Ignore tax effects.)
19. **Covered Interest Arbitrage in Both Directions.** Assume that the annual U.S. interest rate is currently 8 percent and Germany's annual interest rate is currently 9 percent. The euro's one-year forward rate currently exhibits a discount of 2 percent.
- a. Does interest rate parity exist?
- b. Can a U.S. firm benefit from investing funds in Germany using covered interest arbitrage?
- c. Can a German subsidiary of a U.S. firm benefit by investing funds in the United States through covered interest arbitrage?
20. **Covered Interest Arbitrage.** The South African rand has a one-year forward premium of 2 percent. One-year interest rates in the United States are 3 percentage points higher than in South Africa. Based on this information, is covered interest arbitrage possible for a U.S. investor if interest rate parity holds?
21. **Deriving the Forward Rate.** Assume that annual interest rates in the United States are 4 percent, while interest rates in France are 6 percent.
- a. According to IRP, what should the forward rate premium or discount of the euro be?
- b. If the euro's spot rate is \$1.10, what should the one-year forward rate of the euro be?
22. **Covered Interest Arbitrage in Both Directions.** The following information is available:
- You have \$500,000 to invest.
 - The current spot rate of the Moroccan dirham is \$.110.
 - The 60-day forward rate of the Moroccan dirham is \$.108.
 - The 60-day interest rate in the United States is 1 percent.
 - The 60-day interest rate in Morocco is 2 percent.
- a. What is the yield to a U.S. investor who conducts covered interest arbitrage? Did covered interest arbitrage work for the investor in this case?
- b. Would covered interest arbitrage be possible for a Moroccan investor in this case?

Advanced Questions

23. **Economic Effects on the Forward Rate.** Assume that Mexico's economy has expanded significantly, causing a high demand for loanable funds there by local firms. How might these conditions affect the forward discount of the Mexican peso?
24. **Differences among Forward Rates.** Assume that the 30-day forward premium of the euro is -1 percent, while the 90-day forward premium of the euro is 2 percent. Explain the likely interest rate conditions that would cause these premiums. Does this ensure that covered interest arbitrage is worthwhile?
25. **Testing Interest Rate Parity.** Describe a method for testing whether interest rate parity exists. Why are transaction costs, currency restrictions, and differential tax laws important when evaluating whether covered interest arbitrage can be beneficial?

26. **Deriving the Forward Rate.** Before the Asian crisis began, Asian central banks were maintaining a somewhat stable value for their respective currencies. Nevertheless, the forward rate of Southeast Asian currencies exhibited a discount. Explain.
27. **Interpreting Changes in the Forward Premium.** Assume that interest rate parity holds. At the beginning of the month, the spot rate of the Canadian dollar is \$.70, while the one-year forward rate is \$.68. Assume that U.S. interest rates increase steadily over the month. At the end of the month, the one-year forward rate is higher than it was at the beginning of the month. Yet, the one-year forward discount is larger (the one-year premium is more negative) at the end of the month than it was at the beginning of the month. Explain how the relationship between the U.S. interest rate and the Canadian interest rate changed from the beginning of the month until the end of the month.
28. **Interpreting a Large Forward Discount.** The interest rate in Indonesia is commonly higher than the interest rate in the United States, which reflects a high expected rate of inflation there. Why should Nike consider hedging its future remittances from Indonesia to the U.S. parent even when the forward discount on the currency (rupiah) is so large?
29. **Change in the Forward Premium.** At the end of this month, you (owner of a U.S. firm) are meeting with a Japanese firm to which you will try to sell supplies. If you receive an order from that firm, you will obtain a forward contract to hedge the future receivables in yen. As of this morning, the forward rate of the yen and spot rate are the same. You believe that interest rate parity holds.
- This afternoon, news occurs that makes you believe that the U.S. interest rates will increase substantially by the end of this month, and that the Japanese interest rate will not change. However, your expectations of the spot rate of the Japanese yen are not affected at all in the future. How will your expected dollar amount of receivables from the Japanese transaction be affected (if at all) by the news that occurred this afternoon? Explain.
30. **Testing IRP.** The one-year interest rate in Singapore is 11 percent. The one-year interest rate in the United States is 6 percent. The spot rate of the Singapore dollar (S\$) is \$.50 and the forward rate of the S\$ is \$.46. Assume zero transaction costs.
- Does interest rate parity exist?
 - Can a U.S. firm benefit from investing funds in Singapore using covered interest arbitrage?
31. **Implications of IRP.** Assume that interest rate parity exists. You expect that the one-year nominal interest rate in the United States is 7 percent, while the one-year nominal interest rate in Australia is 11 percent. The spot rate of the Australian dollar is \$.60. You will need 10 million Australian dollars in one year. Today, you purchase a one-year forward contract in Australian dollars. How many U.S. dollars will you need in one year to fulfill your forward contract?
32. **Triangular Arbitrage.** You go to a bank and are given these quotes:
- You can buy a euro for 14 pesos.
The bank will pay you 13 pesos for a euro.
- You can buy a U.S. dollar for .9 euros.
The bank will pay you .8 euros for a U.S. dollar.
- You can buy a U.S. dollar for 10 pesos.
The bank will pay you 9 pesos for a U.S. dollar.
- You have \$1,000. Can you use triangular arbitrage to generate a profit? If so, explain the order of the transactions that you would execute and the profit that you would earn. If you cannot earn a profit from triangular arbitrage, explain why.

Discussion in the Boardroom

This exercise can be found in Appendix E at the back of this textbook.

Running Your Own MNC

This exercise can be found on the Xtra! website at <http://maduraxtra.swlearning.com>.

BLADES, INC. CASE

Assessment of Potential Arbitrage Opportunities

Recall that Blades, a U.S. manufacturer of roller blades, has chosen Thailand as its primary export target for “Speedos,” Blades’ primary product. Moreover, Blades’ primary customer in Thailand, Entertainment Products, has committed itself to purchase 180,000 Speedos

annually for the next 3 years at a fixed price denominated in baht, Thailand’s currency. Because of quality and cost considerations, Blades also imports some of the rubber and plastic components needed to manufacture Speedos.

Lately, Thailand has experienced weak economic growth and political uncertainty. As investors lost confidence in the Thai baht as a result of the political uncertainty, they withdrew their funds from the country. This resulted in an excess supply of baht for sale over the demand for baht in the foreign exchange market, which put downward pressure on the baht's value. As foreign investors continued to withdraw their funds from Thailand, the baht's value continued to deteriorate. Since Blades has net cash flows in baht resulting from its exports to Thailand, a deterioration in the baht's value will affect the company negatively.

Ben Holt, Blades' CFO, would like to ensure that the spot and forward rates Blades' bank has quoted are reasonable. If the exchange rate quotes are reasonable, then arbitrage will not be possible. If the quotations are not appropriate, however, arbitrage may be possible. Under these conditions, Holt would like Blades to use some form of arbitrage to take advantage of possible mispricing in the foreign exchange market. Although Blades is not an arbitrageur, Holt believes that arbitrage opportunities could offset the negative impact resulting from the baht's depreciation, which would otherwise seriously affect Blades' profit margins.

Ben Holt has identified three arbitrage opportunities as profitable and would like to know which one of them is the most profitable. Thus, he has asked you, Blades' financial analyst, to prepare an analysis of the arbitrage opportunities he has identified. This would allow Holt to assess the profitability of arbitrage opportunities very quickly.

1. The first arbitrage opportunity relates to locational arbitrage. Holt has obtained spot rate quotations from two banks in Thailand: Minzu Bank and Sobat Bank, both located in Bangkok. The bid and ask prices of Thai baht for each bank are displayed in the table below:

	Minzu Bank	Sobat Bank
Bid	\$.0224	\$.0228
Ask	\$.0227	\$.0229

Determine whether the foreign exchange quotations are appropriate. If they are not appropriate, determine the profit you could generate by withdrawing \$100,000 from Blades' checking account and engaging in arbitrage before the rates are adjusted.

2. Besides the bid and ask quotes for the Thai baht provided in the previous question, Minzu Bank has

provided the following quotations for the U.S. dollar and the Japanese yen:

	Quoted Bid Price	Quoted Ask Price
Value of a Japanese yen in U.S. dollars	\$.0085	\$.0086
Value of a Thai baht in Japanese yen	¥2.69	¥2.70

Determine whether the cross exchange rate between the Thai baht and Japanese yen is appropriate. If it is not appropriate, determine the profit you could generate for Blades by withdrawing \$100,000 from Blades' checking account and engaging in triangular arbitrage before the rates are adjusted.

3. Ben Holt has obtained several forward contract quotations for the Thai baht to determine whether covered interest arbitrage may be possible. He was quoted a forward rate of \$.0225 per Thai baht for a 90-day forward contract. The current spot rate is \$.0227. Ninety-day interest rates available to Blades in the United States are 2 percent, while 90-day interest rates in Thailand are 3.75 percent (these rates are not annualized). Holt is aware that covered interest arbitrage, unlike locational and triangular arbitrage, requires an investment of funds. Thus, he would like to be able to estimate the dollar profit resulting from arbitrage over and above the dollar amount available on a 90-day U.S. deposit.

Determine whether the forward rate is priced appropriately. If it is not priced appropriately, determine the profit you could generate for Blades by withdrawing \$100,000 from Blades' checking account and engaging in covered interest arbitrage. Measure the profit as the excess amount above what you could generate by investing in the U.S. money market.

4. Why are arbitrage opportunities likely to disappear soon after they have been discovered? To illustrate your answer, assume that covered interest arbitrage involving the immediate purchase and forward sale of baht is possible. Discuss how the baht's spot and forward rates would adjust until covered interest arbitrage is no longer possible. What is the resulting equilibrium state called?

SMALL BUSINESS DILEMMA

Assessment of Prevailing Spot and Forward Rates by the Sports Exports Company

As the Sports Exports Company exports footballs to the United Kingdom, it receives British pounds. The check (denominated in pounds) for last month's exports just arrived. Jim Logan (owner of the Sports Exports Company) normally deposits the check with his local bank and requests that the bank convert the check to dollars at the prevailing spot rate (assuming that he did not use a forward contract to hedge this payment). Jim's local bank provides foreign exchange services for many of its business customers who need to buy or sell widely traded currencies. Today, however, Jim decided to check the quotations of the spot rate at other banks before converting the payment into dollars.

1. Do you think Jim will be able to find a bank that provides him with a more favorable spot rate than his local bank? Explain.
2. Do you think that Jim's bank is likely to provide more reasonable quotations for the spot rate of the British pound if it is the only bank in town that provides foreign exchange services? Explain.
3. Jim is considering using a forward contract to hedge the anticipated receivables in pounds next month. His local bank quoted him a spot rate of \$1.65 and a one-month forward rate of \$1.6435. Before Jim decides to sell pounds one month forward, he wants to be sure that the forward rate is reasonable, given the prevailing spot rate. A one-month Treasury security in the United States currently offers a yield (not annualized) of 1 percent, while a one-month Treasury security in the United Kingdom offers a yield of 1.4 percent. Do you believe that the one-month forward rate is reasonable given the spot rate of \$1.65?

INTERNET/EXCEL EXERCISE

The Bloomberg website provides quotations in foreign exchange markets. Its address is <http://www.bloomberg.com>.

Use this web page to determine the cross exchange rate between the Canadian dollar and the Japanese yen.

Notice that the value of the pound (in dollars) and the value of the yen (in dollars) are also disclosed. Based on these values, is the cross rate between the Canadian dollar and the yen what you expected it to be? Explain.