PART II

Corporate Foreign-Exchange Risk Management

In 1997, two American finance professors – Robert Merton of Harvard University and Myron Scholes of Stanford University – received the Nobel Prize in economics for their groundbreaking work on option pricing that helped spawn the present $100 trillion derivatives industry. In the early 1970s, Professor Scholes invented an insightful method of pricing options and warrants at a time when investors and traders still relied on educated guesses to determine the value of various stock market products. Professor Merton later demonstrated the broad applicability of this options-pricing formula, which led to the incredible growth in the derivatives market.

Part II (chapters 5–10) explains relationships between exchange rates and economic variables, with an emphasis on foreign-exchange risk management. This part covers not only the spot market but also the derivatives market. Currency derivatives – forwards, futures, options, futures options, and swaps – are contracts whose values are derived from the prices of underlying currencies. They are offered through two channels: organized exchanges and over-the-counter markets. Organized exchanges such as the Chicago Mercantile Exchange and similar exchanges around the world have expanded their menu of products. Over-the-counter (OTC) markets, such as banks and some other financial institutions, also offer and are willing to tailor make these products for their customers. Before we consider currency derivatives separately in coming chapters, we will describe the key derivatives terminology below.

Derivatives and Terminology

cap An option that protects the buyer from a rise in a particular interest rate above a certain level.

collar The simultaneous purchase of a cap and sale of a floor, with the objective of maintaining interest rates within a defined range.

dealer A counterparty that enters into a swap in order to earn fees or trading profits, serving customers as an intermediary.

derivative A contract whose value depends on, or is derived from, the value of an underlying asset.

end-user A counterparty that engages in a swap to manage its interest rate or currency exposure.

exercise (strike) price The price at which some currency underlying a derivative instrument can be purchased or sold on or before the contract's maturity date.

floor An option that protects the buyer from a decline in a particular interest rate below a certain level.

forward An OTC contract obligating a buyer and a seller to trade a fixed amount of a particular asset at a set price on a future date.

future A highly standardized forward contract traded on an exchange.

futures option A contract giving the holder the right, but not the obligation, to buy or sell a futures contract at a set price during a specified period.

hedging The reduction of risk by eliminating the possibilities of foreign-exchange gains or losses.

notional value The principal value upon which interest and other payments in a transaction are based.

option A contract giving the holder the right, but not the obligation, to buy or sell a fixed amount of an asset at a set price during a specified period.

over-the-counter (OTC) market The market in which currency transactions are conducted through a telephone and computer network connecting currency dealers, rather than on the floor of an organized exchange.

swap A forward-type contract in which two parties agree to exchange a series of cash flows in the future according to a predetermined rule.

swaption An option giving the holder the right to enter or cancel a swap transaction.

underlying The asset, reference rate, or index whose price movement determines the value of the derivative.

CHAPTER 5

The Foreign-Exchange Market and Parity Conditions

Opening Case 5: The Volume of Foreign-Exchange Trading

Can you figure out which one is larger: the volume of foreign-exchange trading or the volume of world trade? The single statistic that perhaps best illustrates the dramatic expansion of international financial markets is the volume of trading in the world's 48 foreign-exchange markets. The volume of foreign-exchange trading in these markets in April 2001 was $1.2 trillion per day. In comparison, the global volume of exports of goods and services for all of 2001 was $6 trillion, or about $16.5 billion per day. In other words, foreign-exchange trading was about 73 times as great as trade in goods and services. Derivatives market transactions (67 percent) exceeded spot market transactions (33 percent). The market for foreign exchange is the largest financial market in the world by any standard. It is open somewhere in the world 365 days a year, 24 hours a day.

Interestingly, this number actually represents a drop in overall trading levels. The volume of foreign-exchange trading had grown by 26 percent from 1995 to 1998 and by 46 percent from 1992 to 1995. From 1998 to 2001, however, this trend was reversed and the volume of foreign-exchange trading decreased by 19 percent. The main causes for this decrease were the worldwide economic problems caused by the recession in the United States, the September 11 attacks, and the bursting of the technological stock bubble. Additionally, the switch to the euro lowered the volume of trading, because Europe's common currency eliminates the need to trade one eurozone currency for another.

Figure 5.1 shows that in 2001, the largest amount of foreign-exchange trading took place in the United Kingdom (33 percent). Indeed, the trading volume in London was so large that a larger share of currency trading in US dollars occurred in the UK

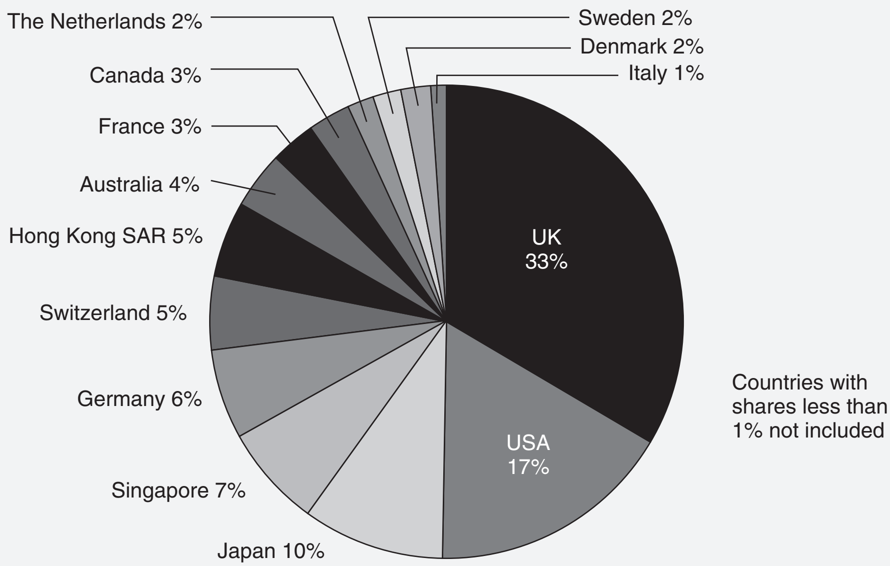

Figure 5.1 Shares of the reported foreign-exchange trading volume, 2001
Source: The Federal Reserve Bank of New York, www.ny.frb.org

than in the USA. The USA had the second-largest exchange market (17 percent), followed by Japan (10 percent) and Singapore (7 percent). This means that 67 percent of all global currency trading occurred in just four countries – the UK, the USA, Japan, and Singapore.

The introduction of the euro affected the major centers for currency trading. While London and New York were by far the most important cities for currency trading, Frankfurt, Germany, closed its gap with Tokyo and Singapore and jumped past Hong Kong, Paris, and Zurich in the volume of foreign-exchange trading. This was largely due to the prominent role that Frankfurt, the host city of the European Central Bank, plays in euro trading.

Sources: www.wto.org and www.bis.org/publ/rpfx02.htm.

The efficient operation of the international monetary system has necessitated the creation of an institutional structure, usually called the foreign-exchange market. This is a market where one country's currency can be exchanged for that of another country. Contrary to what the term might suggest, the foreign-exchange market actually is not a geographical location. It is an informal network of telephone, telex, satellite, facsimile, and computer communications between banks, foreign-exchange dealers, arbitrageurs, and speculators. The market operates simultaneously at three tiers:

1 Individuals and corporations buy and sell foreign exchange through their commercial banks.
2 Commercial banks trade in foreign exchange with other commercial banks in the same financial center.
3 Commercial banks trade in foreign exchange with commercial banks in other financial centers.

The first type of the foreign-exchange market is called the retail market, and the last two are known as the interbank market.

We must first understand the organization and dynamics of the foreign-exchange market in order to understand the complex functions of global finance. This chapter explains the roles of the major participants in the exchange market, describes the spot and forward markets, discusses theories of exchange rate determination (parity conditions), and examines the roles of arbitrageurs.

5.1 Major Participants in the Exchange Market

The foreign-exchange market consists of a spot market and a forward market. In the spot market, foreign currencies are sold and bought for delivery within two business days after the day of a trade. In the forward market, foreign currencies are sold and bought for future delivery.

There are many types of participants in the foreign-exchange market: exporters, governments, importers, multinational companies (MNC), tourists, commercial banks, and central banks. But large commercial banks and central banks are the two major participants in the foreign-exchange market. Most foreign-exchange transactions take place in the commercial banking sector.

5.1.1 Commercial banks

Commercial banks participate in the foreign-exchange market as intermediaries for customers such as MNCs and exporters. These commercial banks also maintain an interbank market. In other words, they accept deposits of foreign banks and maintain deposits in banks abroad. Commercial banks play three key roles in international transactions:

1 They operate the payment mechanism.
2 They extend credit.
3 They help to reduce risk.

Operating the payment mechanism The commercial banking system provides the mechanism by which international payments can be efficiently made. This mechanism is a collection system through which transfers of money by drafts, notes, and other means are made internationally. In order to operate an international payments mechanism, banks maintain deposits in banks abroad and accept deposits of foreign banks. These accounts are debited and credited when payments are made. Banks can make international money transfers very quickly and efficiently by using telegraph, telephones, and computer services.

Extending credit Commercial banks also provide credit for international transactions and for business activity within foreign countries. They make loans to those engaged in international trade and foreign investments on either an unsecured or a secured basis.

Reducing risk The letter of credit is used as a major means of reducing risk in international transactions. It is a document issued by a bank at the request of an importer. In the document, the bank agrees to honor a draft drawn on the importer if the draft accompanies specified documents. The letter of credit is advantageous to exporters. Exporters sell their goods abroad against the promise of a bank rather than a commercial firm. Banks are usually larger, better known, and better credit risks than most business firms. Thus, exporters are almost completely assured of payment if they meet specific conditions under letters of credit.

Exchange trading by commercial banks Most commercial banks provide foreign-exchange services for their customers. For most US banks, however, currency trading is not an important activity and exchange transactions are infrequent. These banks look to correspondents in US money centers to execute their orders.

A relatively small number of money-center banks conduct the bulk of the foreign-exchange transactions in the United States. Virtually all the big New York banks have active currency trading operations. Major banks in Chicago, San Francisco, Los Angeles, Boston, Detroit, and Philadelphia also are active through head office operations as well as affiliates in New York and elsewhere. Thus, all commercial banks in the USA are prepared to buy or sell foreign-currency balances for their commercial customers as well as for the international banking activities of their own institutions.

Bank trading rooms share common physical characteristics. All are equipped with modern communications equipment to keep in touch with other banks, foreign-exchange brokers, and corporate customers around the world. Over 30 US banks have direct telephone lines with the Federal Reserve Bank of New York. Traders subscribe to the major news services to keep current on financial and political developments that might influence exchange trading. In addition, the banks maintain extensive "back office" support staffs to handle routine operations such as confirming exchange contracts, paying and receiving dollars and foreign currencies, and keeping general ledgers. These operations generally are kept separate from the trading room itself to assure proper management and control.

In other important respects, however, no two trading rooms are alike. They differ widely according to the scale of their operations, the roster of their corporate customers, and their overall style of trading. The basic objectives of a bank's foreign-exchange trading policy are set by senior management. That policy depends upon factors such as the size of the bank, the scope of its international banking commitments, the nature of trading activities at its foreign branches, and the availability of resources.

The global market and national markets Banks throughout the world serve as market makers in foreign exchange. They comprise a global market in the sense that a bank in one country can trade with another bank almost anywhere. Banks are linked by telecommunications equipment that allows instantaneous communication and puts this "over-the-counter" market as close as the telephone or the telex machine.

Because foreign exchange is an integral part of the payment mechanism, local banks may benefit from closer access to domestic money markets. They usually have an advantage in trading

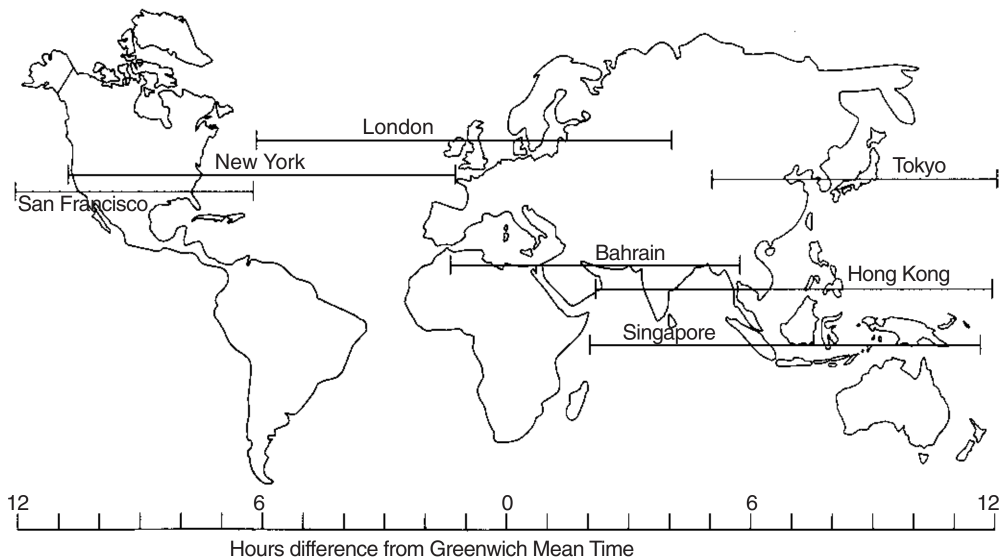

Figure 5.2 A map of major foreign-exchange markets with time zones

their local currency. For instance, the buying and selling of pounds sterling for dollars is most active among the banks in London. Similarly, the major market for Swiss francs is in Zurich; and that for Japanese yen, in Tokyo. But the local advantage is by no means absolute. Hence, dollar–euro trading is active in London and dollar–sterling trading is active in Zurich. Furthermore, New York banks trade just as frequently with London, German, or Swiss banks in all major currencies as they do with other New York banks.

Foreign exchange is traded in a 24-hour market. Somewhere in the world, banks are buying and selling dollars for, say, euros at any time during the day. Figure 5.2 shows a map of major foreign-exchange markets around the globe, with time zones included for each major market. This map should help readers understand the 24-hour operation of major foreign-exchange markets around the world. Banks in Australia and the Far East begin trading in Hong Kong, Singapore, Tokyo, and Sydney at about the time most traders in San Francisco go home for supper. As the Far East closes, trading in Middle Eastern financial centers has been going on for a couple of hours, and the trading day in Europe has just begun. Some of the large New York banks have an early shift to minimize the time difference of 5–6 hours with Europe. By the time New York trading gets going in full force around 8 a.m., it is lunch time in London and Frankfurt. To complete the circle, West Coast banks also extend "normal banking hours" so they can trade with New York or Europe, on one side, and with Hong Kong, Singapore, or Tokyo, on the other.

One implication of a 24-hour currency market is that exchange rates may change at any time. Bank traders must be light sleepers so that they can be ready to respond to a telephone call in the middle of the night, which may alert them to an unusually sharp exchange rate movement on another continent. Many banks permit limited dealing from home by senior traders to contend with just such a circumstance.

5.1.2 *Central banks*

Central banks, such as the Federal Reserve System of the USA and the Bank of Japan, attempt to control the growth of the money supply within their jurisdictions. They also strive to maintain the value of their own currency against any foreign currency. In other words, central bank operations reflect government transactions, transactions with other central banks and various international organizations, and intervention to influence exchange rate movements.

Central banks serve as their governments' banker for domestic and international payments. They handle most or all foreign-exchange transactions for the government as well as for important public-sector enterprises. They may also pay or receive a foreign currency not usually held in official reserves. For example, the Federal Reserve Bank of New York handles a substantial volume of foreign-exchange transactions for its correspondents who wish to buy or sell dollars for other currencies. Moreover, most central banks frequently enter into exchange transactions with international and regional organizations that need to buy or sell the local currency. The most important role of central banks in exchange market operations is their intervention in the exchange market to influence market conditions or the exchange rate. They carry out intervention operations either on behalf of the country's treasury department or for their own account.

In a system of fixed exchange rates, central banks usually absorb the difference between supply of and demand for foreign exchange in order to maintain the par value system. Under this system, the central banks agree to maintain the value of their currencies within a narrow band of fluctuations. If pressures such as huge trade deficits and high inflation develop, the price of a domestic currency approaches the lower limit of the band. At this point, a central bank is obliged to intervene in the foreign-exchange market. This intervention is designed to counteract the forces prevailing in the market.

In a system of flexible exchange rates, central banks do not attempt to prevent fundamental changes in the rate of exchange between their own currency and any other currency. However, even within the flexible exchange rate system, they intervene in the foreign-exchange market to maintain orderly trading conditions rather than to maintain a specific exchange rate (see Global Finance in Action 5.1).

Global Finance in Action 5.1
Is Official Exchange Intervention Effective?

Many governments have intervened in foreign-exchange markets to try to dampen volatility and to slow or reverse currency movements. Their concern is that excessive short-term volatility and long-term swings in exchange rates may hurt their economy, particularly sectors heavily involved in international trade. And the foreign-exchange market certainly has been volatile recently. For example, one euro cost about $1.15 in January 1999, dropped to only $0.85 by the end of 2000, and climbed to over $1.18 by March 2003. Over this same period, one US dollar bought as much as 133 Japanese yen and as little as ¥102, a 30 percent fluctuation. Many other currencies have also experienced similarly large price swings in recent years.

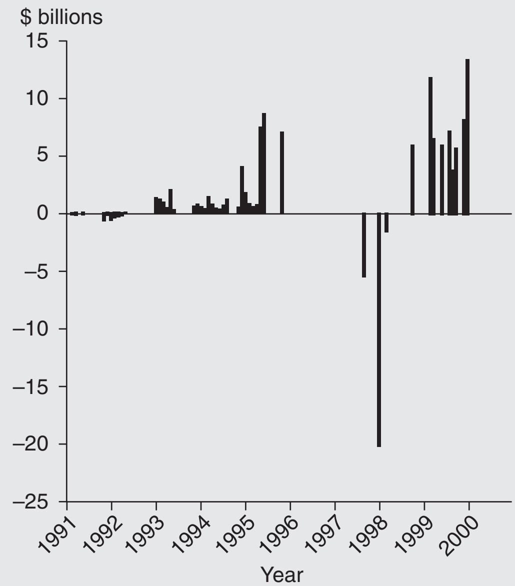

Figure 5.3 Bank of Japan intervention

Conventional academic wisdom holds that "sterilized" interventions have little impact on the exchange rate and are a waste of time and of the government's foreign-exchange reserves. In a sterilized intervention, the central bank offsets the purchase or sale of foreign exchange by selling or purchasing domestic securities to keep the domestic interest rates at its target. Because the domestic interest rate usually is considered the main determinant of the value of the domestic currency, many argue, it must change in order to influence the exchange rate.

Despite academic skepticism, many central banks intervene in foreign-exchange markets. The largest player is Japan (see figure 5.3). Between 1991 and December 2000, for example, the Bank of Japan bought US dollars on 168 occasions for a cumulative amount of $304 billion and sold US dollars on 33 occasions for a cumulative amount of $38 billion. A typical case: on Monday, April 2, 2000, the Bank of Japan purchased $13.2 billion in US dollars in the foreign-exchange market in an attempt to stop the 4 percent depreciation of the dollar against the yen that had occurred during the previous week.

Source: Michael Hutchinson, "Is Official Exchange Rate Intervention Effective?" *FRBSF Economic Letter*, Federal Reserve Bank of San Francisco, July 18, 2003, pp. 1–3.

5.2 Spot Exchange Quotation: The Spot Exchange Rate

The foreign-exchange market employs both spot and forward exchange rates. The **spot rate** is the rate paid for delivery of a currency within two business days after the day of the trade. The forward exchange rate is discussed in the following section.

Practically all major newspapers in the world, such as *The Wall Street Journal* and *The Financial Times* (London) print a daily list of exchange rates. Table 5.1 shows cross rates for seven currencies, spot rates for most currencies, and forward rates for major currencies that appeared in *The Wall Street Journal* on July 1, 2004. These quotes apply to transactions among banks in amounts of $1 million or more. When interbank trades involve dollars, these rates will be expressed in either American terms (dollars per unit of foreign currency) or European terms (units of foreign currency per dollar).

As shown in the bottom half of table 5.1, *The Wall Street Journal* quotes in both American and European terms are listed side by side. Column 2 (or 3) of table 5.1 shows the amount of US dollars required to buy one unit of foreign currency. Given this amount, one can determine the number of foreign currency units required to buy one US dollar. This conversion can be achieved by simply taking the reciprocal of the given quotation. In other words, the relationship between US dollars and British pounds can be expressed in two different ways, but they have the same meaning. Column 4 (or 5) presents the reciprocals of the exchange rates in column 2 (or 3). Column 4 (or 5) equals 1.0 divided by column 2 (or 3).

Some currencies, such as the Uruguayan new peso, have different rates for financial or commercial transactions. For some major currencies, such as the British pound and the Swiss franc, rates also are given for future delivery. Foreign-exchange risk can be minimized by purchasing or selling foreign currency for future delivery at a specified exchange rate. For large amounts, this can be accomplished through banks in what is called the forward market; the 30-, 90-, and 180-day rates in table 5.1 reflect this.

The conversion rate for the SDR near the bottom of table 5.1 represents the rate for special drawing rights, which is a reserve asset created by the International Monetary Fund for settlements among central banks. It is also used as a unit of account in international bond markets and by commercial banks. Based 45 percent on the US dollar, 29 percent on the euro, 15 percent on the Japanese yen, and 11 percent on the British pound, the SDR's value fluctuates less than any single component currency. At the bottom of table 5.1 is the euro, the European common currency that replaced the national currencies of eurozone countries on March 1, 2002.

5.2.1 *Direct and indirect quotes for foreign exchange*

Foreign-exchange quotes are frequently given as a direct quote or as an indirect quote. In this pair of definitions, the home or reference currency is critical. A **direct quote** is a home currency price per unit of a foreign currency, such as $0.2300 per Saudi Arabian riyal (SR) for a US resident. An **indirect quote** is a foreign-currency price per unit of a home currency, such as SR4.3478 per US dollar for a US resident. In Saudi Arabia, the foreign-exchange quote, "$0.2300," is an indirect quotation, while the foreign-exchange quote, "SR4.3478," is a direct quotation. In the USA, both quotes are reported daily in *The Wall Street Journal* and other financial press.

Table 5.1 Currency cross rates and exchange rates

Key currency cross rates — Late New York Trading Friday, July 9, 2004

	Dollar	*Euro*	*Pound*	*SFranc*	*Peso*	*Yen*	*CdnDlr*
Canada	1.3184	1.6364	2.4513	1.0775	.11474	.01217	. . .
Japan	108.33	134.46	201.42	88.539	9.428	. . .	82.169
Mexico	11.4903	14.2617	21.364	9.3910	. . .	.10607	8.7154
Switzerland	1.2235	1.5187	2.2749	. . .	.10648	.01129	.9281
UK	.53780	.6676	. . .	.4396	.04681	.00496	.40795
Euro	.80570	. . .	1.4980	.65848	.07012	.00744	.61110
USA	. . .	1.2412	1.8593	.81730	.08703	.00923	.75850

Source: Reuters.

Exchange rates — July 9, 2004

The foreign exchange mid-range rates below apply to trading among banks in amounts of $1 million and more, as quoted at 4 p.m. Eastern time by Reuters and other sources. Retail transactions provide fewer units of foreign currency per dollar.

	US$ EQUIVALENT		*CURRENCY PER US$*	
Country	*Fri.*	*Thu.*	*Fri.*	*Thu.*
Argentina (Peso)-y	.3390	.3384	2.9499	2.9551
Australia (Dollar)	.7228	.7196	1.3835	1.3897
Bahrain (Dinar)	2.6525	2.6526	.3770	.3770
Brazil (Real)	.3287	.3272	3.0423	3.0562
Canada (Dollar)	.7585	.7595	1.3184	1.3167
1-month forward	.7580	.7590	1.3193	1.3175
3-months forward	.7574	.7584	1.3203	1.3186
6-months forward	.7569	.7579	1.3212	1.3194
Chile (Peso)	.001575	.001575	634.92	634.92
China (Renminbi)	.1208	.1208	8.2781	8.2781
Colombia (Peso)	.0003747	.0003741	2,668.80	2,673.08
Czech. Rep. (Koruna)				
Commercial rate	.03941	.03935	25.374	25.413
Denmark (Krone)	.1669	.1667	5.9916	5.9988
Ecuador (US Dollar)	1.0000	1.0000	1.0000	1.0000
Egypt (Pound)-y	.1604	.1604	6.2364	6.2364
Hong Kong (Dollar)	.1282	.1282	7.8003	7.8003
Hungary (Forint)	.004918	.004937	203.33	202.55
India (Rupee)	.02192	.02188	45.620	45.704
Indonesia (Rupiah)	.0001124	.0001113	8,897	8,985
Israel (Shekel)	.2231	.2229	4.4823	4.4863
Japan (Yen)	.009231	.009191	108.33	108.80
1-month forward	.009241	.009202	108.21	108.67
3-months forward	.009268	.009229	107.90	108.35
6-months forward	.009317	.009290	107.33	107.64
Jordan (Dinar)	1.4104	1.4104	.7090	.7090
Kuwait (Dinar)	3.3920	3.3921	.2948	.2948
Lebanon (Pound)	.0006627	.0006614	1,508.98	1,511.94
Malaysia (Ringgit)-b	.2632	.2632	3.7994	3.7994
Malta (Lira)	2.9097	2.9031	.3437	.3445
Mexico (Peso)				
Floating rate	.0870	.0868	11.4903	11.5221
New Zealand (Dollar)	.6579	.6557	1.5200	1.5251
Norway (Krone)	.1466	.1463	6.8213	6.8353
Pakistan (Rupee)	.01718	.01718	58.207	58.207
Peru (new Sol)	.2898	.2893	3.4507	3.4566
Philippines (Peso)	.01792	.01789	55.804	55.897
Poland (Zloty)	.2743	.2740	3.6456	3.6496
Russia (Ruble)-a	.03435	.03436	29.112	29.104
Saudi Arabia (Riyal)	.2666	.2667	3.7509	3.7495
Singapore (Dollar)	.5875	.5862	1.7021	1.7059
Slovak Rep. (Koruna)	.03111	.03103	32.144	32.227
South Africa (Rand)	.1643	.1657	6.0864	6.0350
South Korea (Won)	.0008700	.0008692	1,149.43	1,150.48
Sweden (Krona)	.1350	.1349	7.4074	7.4129
Switzerland (Franc)	.8173	.8166	1.2235	1.2246
1-month forward	.8180	.8173	1.2225	1.2235
3-months forward	.8196	.8188	1.2201	1.2213
6-months forward	.8220	.8213	1.2165	1.2176
Taiwan (Dollar)	.02982	.02980	33.535	33.557
Thailand (Baht)	.02455	.02451	40.733	40.800
Turkey (Lira)	.00000069	.00000069	1,449,275	1,449,275
UK (Pound)	1.8593	1.8494	.5378	.5407
1-month forward	1.8542	1.8443	.5393	.5422
3-months forward	1.8445	1.8345	.5422	.5451
6-months forward	1.8308	1.8235	.5462	.5484
United Arab (Dirham)	.2723	.2723	3.6724	3.6724
Uruguay (Peso)				
Financial	.03400	.03400	29.412	29.412
Venezuela (Bolivar)	.000521	.000521	1,919.39	1,919.39
SDR	1.4810	1.4780	.6752	.6766
Euro	1.2412	1.2393	.8057	.8069

Special Drawing Rights (SDR) are based on exchange rates for the US, British, and Japanese currencies. Source: International Monetary Fund.
a, Russian Central Bank rate; b, government rate; y, floating rate.

Source: *The Wall Street Journal*, July 12, 2004, p. C13.

5.2.2 Cross rates

A **cross rate** is an exchange rate between two nonhome currencies. In just about every country, foreign currencies are quoted against the home currency, but there are instances in which MNCs should know the exchange rate between two nonhome currencies. For example, a US company may want to know the exchange rate between the Mexican peso and the British pound. Because foreign currencies are quoted against the dollar in the USA, their exchange rate is determined through their relationship to the US dollar. The type of exchange rate desired here is known as the cross rate because it reflects the value of one foreign currency against another foreign currency.

Once we understand how two currencies in an exchange quote can be converted into each other, we can learn how the relationships among three or more currencies are reflected in exchange quotes. For example, if the Australian dollar (A$) is selling for $0.60 and the buying rate for the South African rand (R) is $0.15, then the A$ and R cross rate is R4 per A$, and the R and A$ cross rate is A$0.25 per rand.

Example 5.1

A somewhat more complicated cross rate calculation may be necessary for some foreign-exchange users. Let us assume that the dollar price of the British pound is $1.6000 per pound and that the Mexican peso price of the dollar is Mex$4 per dollar.

To determine the price of pounds in terms of Mexican pesos or the price of Mexican pesos in terms of pounds, one must convert both quotations to a common denominator – in other words, the US dollar:

$$\text{£}0.6250/\$ = \$1.6000/\text{£}: \text{£}1/\$1.6000$$
$$\text{Mex\$}4.0000/\$ \text{ (as initially given)}$$

Because the prices of dollars are now quoted in terms of both pounds and pesos, we can obtain the price of pounds in terms of pesos:

$$\text{Mex\$}/\text{£} = \frac{4.0000}{0.6250} = \text{Mex\$}6.4000/\text{£}$$

Similarly, we can determine the price of pesos in terms of pounds:

$$\text{£}/\text{Mex\$} = \frac{0.6250}{4.0000} = \text{£}0.1563/\text{Mex\$}$$

The exchange rate between two currencies is called the cross rate if it is obtained from the rates of these two currencies in terms of a third currency. The top portion of table 5.1 shows cross rates for seven major currencies that appeared in *The Wall Street Journal* on July 9, 2004.

5.2.3 *Measuring a percentage change in spot rates*

MNCs frequently measure the percentage change in the exchange rate between two specific points in time: for example, the current spot rate and the forecasted spot rate 1 year ahead. For example, if the Australian dollar appreciates from $0.6400 to $0.6800 over a 1-year period, US MNCs are likely to raise questions such as: What is the percentage increase in the dollar value of the Australian dollar? What is the percent increase in the dollar value of Australian dollar-denominated accounts receivable or accounts payable held by Americans?

DIRECT QUOTATIONS When the home currency price for a foreign currency (direct quote) is used, the percentage change in the value of the foreign currency is computed by the following formula:

$$\text{percentage change} = \frac{\text{ending rate} - \text{beginning rate}}{\text{beginning rate}} \tag{5.1}$$

Example 5.2

Assume that the spot rate changes from $0.6400 per A$ (Australian dollar) to $0.6800 per A$ over a 1-year period. The percentage change in the Australian dollar spot rate using direct quotes for a US company is calculated as follows:

$$\text{percentage change} = \frac{\$0.6800 - \$0.6400}{\$0.6400} = 0.0625$$

In this case, the Australian dollar has become 6.25 percent stronger than the US dollar over the 1-year period.

INDIRECT QUOTATIONS When the foreign-currency price of a home currency (indirect quote) is used, the formula to compute the percentage change in the spot rate for a foreign currency becomes:

$$\text{percentage change} = \frac{\text{beginning rate} - \text{ending rate}}{\text{ending rate}} \tag{5.2}$$

Example 5.3

Converting example 5.2 into indirect quotations, we can assume that the Australian dollar appreciates from A\$1.5625 per dollar to A\$1.4706 per dollar. The percentage change in the Australian dollar spot rate using indirect quotes for a US company is computed as follows:

$$\text{percentage change} = \frac{\text{A\$1.5625} - \text{A\$1.4706}}{\text{A\$1.4706}} = 0.0625$$

In both methods of computation, the Australian dollar has appreciated by 6.25 percent against the US dollar over the 1-year period.

5.2.4 *The bid–ask spread*

Up to this point, we have ignored bid–ask spreads in our discussion of foreign-exchange transactions. International banks serve as foreign-exchange dealers who stand ready to quote bid and ask prices on major currencies for their customers. A bank's **bid price** is the price at which the bank is ready to buy a foreign currency. A bank's **ask price** is the price at which the bank is ready to sell a foreign currency. The **bid–ask spread** is the spread between bid and ask rates for a currency; this spread is the bank's fee for executing the foreign-exchange transaction:

$$\text{bid–ask spread} = \frac{\text{ask price} - \text{bid price}}{\text{ask price}} \tag{5.3}$$

Example 5.4

The bid price is \$1.5000 for the British pound and \$0.0130 for the Japanese yen. The ask price is \$1.6000 for the pound and \$0.0140 for the yen.

Applying equation 5.3 to the bid–ask spread for the pound, we obtain:

$$\text{bid–ask spread} = \frac{\$1.6000 - \$1.5000}{\$1.6000} = 0.0625 \text{ or } 6.25\%$$

Applying equation 5.3 to the bid–ask spread for the yen, we obtain:

$$\text{bid–ask spread} = \frac{\$0.0140 - \$0.0130}{\$0.0140} = 0.0714 \text{ or } 7.14\%$$

5.3 Forward Exchange Quotation: The Forward Exchange Rate

The **forward rate** is the rate to be paid for delivery of a currency at some future date. The exchange rate is established at the time the contract is made, but payment and delivery are not required until maturity. Forward rates are usually quoted for fixed periods of 30, 90, or 180 days from the day of the contract. In some instances, actual contracts in major currencies can be arranged for delivery at any specified date up to 1 year.

Table 5.1 shows the forward rates for only four major currencies: British pounds, Canadian dollars, Japanese yen, and Swiss francs. The current spot rate and the forward rate may be the same during a period of foreign-exchange stability. However, there usually is a difference between the spot rate and the forward rate; this difference is known as the spread.

Example 5.5

Forward quotations are made either "outright" or in terms of the spread on the spot rate. Suppose that the 90-day outright forward quotation is $0.7900 per Can$ for Canadian dollars and $0.6000 per SFr for Swiss francs, and that the spot rate is $0.8000 per Can$ and $0.5800 per SFr. The spread between the forward rate and the spot rate is stated in terms of points; one point equals 0.01 percent or $0.0001. Point quotations for the two 90-day forward rates are determined as follows:

Spot or forward rate	Canadian dollars	Swiss francs
90-day forward rate	$0.7900	$0.6000
Less: spot rate	0.8000	0.5800
90-day forward quote in points	–100	+200

In giving a forward quote for the Canadian dollar, a trader might say "minus 100" or "a discount of 100." For the Swiss franc, the trader would say "plus 200" or "a premium of 200." Thus, when the forward rate is less than the spot rate, it is said to be at a discount. When the forward rate is greater than the spot rate, it is said to be at a premium. Outright quotations are normally used for retail customers of the bank, while point quotations are usually employed for traders.

A forward premium or discount is sometimes expressed in terms of the annualized percentage deviation from the spot rate. The premium or discount is computed using the following formula:

$$\text{premium (discount)} = \frac{n\text{-day forward rate} - \text{spot rate}}{\text{spot rate}} \times \frac{360}{n} \tag{5.4}$$

Applying equation 5.4 to the 90-day forward quote for Canadian dollars given in example 5.5, we obtain:

$$\text{forward discount} = \frac{\$0.7900 - \$0.8000}{\$0.8000} \times \frac{360}{90} = -0.05 \text{ or } -5.00\%$$

Applying equation 5.4 to the 90-day forward quote for Swiss francs given in example 5.5, we obtain:

$$\text{forward premium} = \frac{\$0.6000 - \$0.5800}{\$0.5800} \times \frac{360}{90} = +0.1379 \text{ or } +13.79\%$$

5.3.1 *Key reasons for forward exchange transactions*

Actual exchange market participants are banks, companies, individuals, governments, and other financial institutions. However, these participants are called arbitrageurs, traders, hedgers, or speculators, depending on the purpose of their participation in the exchange market. Arbitrageurs seek to earn riskless profits by taking advantage of differences in interest rates among countries. Traders use forward contracts to eliminate possible exchange losses on export or import orders denominated in foreign currencies. Hedgers, mostly MNCs, engage in forward contracts to protect the home-currency value of foreign currency denominated assets and liabilities. Speculators deliberately expose themselves to exchange risk by engaging in forward contracts in order to make a profit from exchange rate fluctuations.

Individuals and corporations buy and sell forward currencies to provide protection against future changes in exchange rates. So long as we do not have a single world currency, some degree of exchange risk exists in any system. We cannot eliminate some possibility of foreign-exchange losses in either the fixed exchange rate system or the flexible exchange rate system.

Example 5.6

Assume that an American firm purchases machinery through its UK branch for £10,000 with terms of 90 days. Let us also assume that the spot rate for pounds is $1.70 per pound and the 90-day forward rate for pounds is $1.80 per pound. Payment should be made in British pounds 90 days from the day of the shipment.

Actually, there are two alternative methods of payment available to the American firm. First, the firm could buy pounds in the spot market 90 days from the day of the shipment to pay the credit. If the spot rate for pounds rises to $2.00 during this time, the American firm should spend $20,000 to buy the sum of £10,000. Second, it could also buy £10,000 in the forward market for $18,000 to pay the credit on the due date. By so doing, the American firm would avoid the risk of a $2,000 loss ($20,000–$18,000). However, if the spot rate for pounds declines to $1.50 during this period, the American firm would lose $3,000 ($15,000–$18,000) under the forward contract.

5.3.2 *Speculation in the foreign-exchange market*

Foreign-exchange markets facilitate both commercial and private transactions such as foreign trade, loans, and investments. In addition, they give rise to exchange speculation. The purpose of speculation in the foreign-exchange market is to make a profit from exchange rate fluctuations by deliberately taking an uncovered position. Speculation can be undertaken in both the spot market and the forward market.

Speculating in the spot market Suppose that a speculator anticipates that the spot rate of the Swiss franc will appreciate in 90 days. The speculator will purchase francs at today's spot rate, will hold them for 90 days, and will resell them at a higher rate.

Example 5.7

The present spot rate for francs is $0.4000 per SFr. A speculator's expectation of the spot rate for francs in 90 days is $0.4500. If the speculator's expectation proves correct, what would be his dollar profit from speculating $10,000 in the spot market?

With $10,000, the speculator could buy SFr25,000 ($10,000/$0.4000) in the spot market, hold them for 90 days, and resell them at $0.4500 per SFr for a gross of $11,250 (SFr25,000 × $0.4500). As a result, the speculator would earn a net profit of $1,250, or 12.50 percent, on the original $10,000 of capital. But spot speculation is risky. If the spot rate were to decline to $0.3500 during this period, the SFr25,000 would have an ending value of $8,750 (SFr25,000 × $0.3500) for a net loss of $1,250. Theoretically speaking, no limit exists to the potential profit, but the maximum loss would be $10,000.

A speculator is not locked into an absolute 90-day terminal date but may simply hold the currency until a date that seems to be most profitable. This is possible because the speculator could close out the position before 90 days or hold it longer than 90 days if his expectation changes after the spot purchase.

Speculating in the forward market Suppose that a speculator anticipates that the Swiss franc's spot rate in 90 days will exceed its 90-day forward rate as quoted today. The speculator buys francs for 90-day future delivery at today's forward rate, waits for 90 days, and then sells the francs spot to close the position.

Example 5.8

The present 90-day forward rate for francs is $0.4300. A speculator's expectation of the spot rate for francs in 90 days is $0.4500. If the speculator's expectation proves correct, what would be his dollar profit from speculating $10,000 in the forward market?

The speculator could buy SFr23,256 forward for $10,000 at the forward quotation of $0.4300, receive them in 90 days, and then sell them at the spot rate of $0.4500 for a gross of $10,465. Profit would be $465. The profit of $465 in this case cannot be related to any investment base to determine a rate of return, because no capital was invested at the time the contract was entered.

Clearly, there is greater risk for a speculator in forward transaction than in spot transaction. Forward market speculation involves a more remote payment date and a greater chance of unfavorable fluctuations. There are two types of risk here. The first risk is the possibility that foreign-exchange rates will fluctuate. The second risk is the possibility that the forward contract will not be carried out. The first risk will affect the speculator only if he carries an open position in the forward contract. The speculator can eliminate this risk by purchasing an offsetting forward contract. Although the speculator has a net position of zero, he still carries the second risk because he stands in the middle.

5.4 International Parity Conditions

In this section, specific attention is paid to the theory of foreign-exchange rate determination. This theory is based on a relationship between the money market and the foreign-exchange market; this relationship prevails without restrictions imposed by government policy on the extent to which rates can move. Such a free market situation will establish the nature of interrelationships among the money markets and the foreign-exchange markets. In other words, we can postulate a simple set of parity conditions that should hold among inflation rates, interest rates, spot rates, and forward rates. This idea, commonly known as the law of one price, is enforced by arbitrageurs who, by following the famous dictum of "buy low, sell high," prevent all but minor deviations from equality.

There are five major theories of exchange rate determination:

1 The theory of purchasing power parity.
2 The Fisher effect.
3 The international Fisher effect.
4 The theory of interest rate parity.
5 The forward rate as an unbiased predictor of the future spot rate.

It is important to remember that the economic relationships of these five theories result from arbitrage activities.

5.4.1 Efficient exchange markets

Investors make risk–return decisions in the framework of available exchange markets. We will base our discussion of the theories of exchange rate determination on the assumption of efficient exchange markets. **Efficient exchange markets** exist when exchange rates reflect all available information and adjust quickly to new information. Because exchange markets are highly competitive in such a situation, the market participants buy and sell foreign exchange in a way that eliminates all profits in excess of the minimum required to sustain their continued participation. In other words, the concept of efficient exchange markets depends on three hypotheses:

1 Market prices such as product prices, interest rates, spot rates, and forward rates should reflect the market's consensus estimate of the future spot rate.
2 Investors should not earn unusually large profits in forward speculation. Because exchange rate forecasts based on market prices are accurate, publicly available forecasts of the future spot rate do not lead to unusual profits in forward speculation.
3 It is impossible for any market analyst to beat the market consistently.

Certainly, these conditions are not completely met in practice. Thus, exchange markets are assumed efficient if the conditions are only reasonably met. There are many indications that support the efficient market assumption for international money and exchange markets. First, foreign currencies and other financial assets are traded by companies and individuals who have broad market contacts, sophisticated analytic capabilities, and modern communications. Because new information is widely, quickly, and cheaply disseminated to investors, market prices are rapidly adjusted to reflect significant developments. Second, since 1973 the major trading countries of the world have adopted the system of freely floating rates, and their governmental interference in exchange markets has been minimal.

5.4.2 The theory of purchasing power parity

The **theory of purchasing power parity** (PPP) explains why the parity relationship exists between inflation rates and exchange rates. The PPP theory has an absolute version and a relative version. The absolute version of the PPP theory maintains that the equilibrium exchange rate between domestic and foreign currencies equals the ratio between domestic and foreign prices. For example, if one American dollar can buy one bushel of wheat and one British pound can buy two bushels of wheat, the exchange rate between the two currencies is $0.50 per pound.

Specifically, the PPP theory in its simplest form holds that the exchange rate must change in terms of a single currency to equate the prices of goods in both countries. For example, if the prices of British goods rise relative to the prices of US goods, the British pound should depreciate to keep the dollar price of goods in the United Kingdom the same as the dollar prices of identical goods in the United States. Otherwise, arbitrageurs would have an incentive to purchase goods in the USA and sell them in the UK until these prices were again equalized.

Unfortunately for this analysis, the world is more complex than this simple example. The real world is characterized by transportation costs, tariffs, quotas, and all sorts of impediments to the equalization of prices for identical goods worldwide. Thus, it is not difficult to understand why the absolute PPP relationship does not hold very well for any pair of countries.

The relative version of the PPP doctrine states that in the long run, the exchange rate between the home currency and the foreign currency will adjust to reflect changes in the price levels of the two countries. In other words, it relates equilibrium changes in the exchange rate to changes in the ratio of domestic and foreign prices:

$$\frac{e_t}{e_0} = \frac{(1+I_d)^t}{(1+I_f)^t} \tag{5.5}$$

where e_t is the dollar price of one unit of foreign currency in period t, e_0 is the dollar price of one unit of foreign currency in period 0, I_d is the domestic inflation rate, and I_f is the foreign inflation rate. If we solve equation 5.5 for the new exchange rate (e_t), we obtain:

$$e_t = e_0 \times \frac{(1+I_d)^t}{(1+I_f)^t} \tag{5.6}$$

Example 5.9

This time, let us assume that the exchange rate between US dollars and British pounds is \$2 per pound. Let us further accept the fact that the USA will have an inflation rate of 10 percent for the coming year and that the UK will have an inflation rate of 20 percent over the same period.

The new exchange rate of \$1.83 per pound is obtained in this way:

$$e_1 = \$2 \times \frac{(1+0.10)}{(1+0.20)} = \$1.83/£$$

Example 5.9 indicates that the US dollar price of the pound should decrease in value by about 10 percent from \$2 per pound to \$1.83 per pound to equalize the dollar price of goods in two countries. If the exchange rate does not fall by the amount suggested by the PPP theory, then we could say that the US dollar is undervalued or the British pound is overvalued.

The main justification for the PPP theory is that if the exchange rate stays the same at \$2 per pound, British exports of goods and services will become less competitive with comparable products produced in the USA. British imports from the USA will also become more price-competitive with higher-priced British products.

An appraisal of the PPP theory The PPP theory not only explains how relative inflation rates between two countries can influence their exchange rate, but it can also be used to forecast exchange rates. It is important to remember that the PPP doctrine is supposed to work well under a freely floating exchange rate system. With the termination of the fixed exchange rate system in 1973, the relative price levels and exchange rates in most industrial countries have fluctuated widely. The experience of 1975–98 indicates that, while movements in dollar exchange rates for some major currencies reflected differences in inflation rates, that was not the case for sharp short-period fluctuations in these rates. In addition, the PPP theory did not work that well for some other currencies.

There are some obvious weaknesses of the PPP theory. First, it assumes that goods are easily traded. This is not the case for such goods as housing and medical services. The PPP theory, moreover, relies on an index of prices such as the consumer price index. Such an index may be misleading because only traded goods directly affect the balance on goods and services. However, even nontraded goods indirectly affect the price of traded goods through their impact on the overall cost of living and on wage demands.

Second, the PPP theory assumes that tradable goods are identical across countries. However, even tradable goods are not always identical when they are produced in different countries. For example, some Americans prefer Japanese cars, and others prefer American cars. Moreover, customer preferences for automobiles change over time. If Japanese cars suddenly become more popular, the increase in demand will drive up the price of Japanese cars. But despite the price differential between the two markets, there might be no opportunity for profitable arbitrage, because customers do not view the Japanese and American cars as equivalent.

Third, we must compare a similar basket of goods in each country with its trading partners in order to test the PPP theory. If we try to compare the prices of dissimilar goods, we have to rely on price indexes. It then becomes a question of which index is most reflective of goods traded between countries.

Fourth, many other factors influence exchange rates besides relative prices. These include relative interest rates, relative income levels, and government interference in the foreign-exchange market. Thus, it is difficult to measure the precise magnitude of exchange rate movements attributable to differences in inflation rates.

In spite of these limitations, the PPP theory is quite useful and seems to be valid over the long run. If a country's inflation rate remains higher than that of its trading partners for a long period, that country's currency will tend to depreciate in order to prevent the country from being forced out of the export market. According to many empirical studies, this fact exists whether it is caused by the PPP theory alone or by a combination of factors.

5.4.3 *The Fisher effect*

The **Fisher effect**, named after economist Irving Fisher, assumes that the nominal interest rate in each country is equal to a real interest rate plus an expected rate of inflation:

$$\text{nominal rate} = \text{real rate} + \text{inflation} \tag{5.7}$$

The real interest rate is determined by the productivity in an economy and a risk premium commensurate with the risk of a borrower. The nominal interest rate embodies an inflation premium sufficient to compensate lenders or investors for an expected loss of purchasing power. Consequently, nominal interest rates are higher when people expect higher rates of inflation and are lower when people expect lower rates of inflation.

The real interest rate is thought to be relatively stable over time. Moreover, in a free market where investors can buy any interest-bearing securities, real interest rates are identical everywhere, but nominal interest rates will vary by the difference in expected rates of inflation. The Fisher effect asserts that real interest rates are equalized across countries through arbitrage. For example, if expected real rates of interest were higher in Switzerland than in the USA, capital would flow from the USA to Switzerland. On the other hand, if real rates of interest were higher in the USA than in Switzerland, capital would flow from Switzerland to the USA. This process of arbitrage would continue, in the absence of government intervention, until the expected real rates of interest are equalized in both countries.

AN APPRAISAL OF THE FISHER EFFECT Empirical studies have found that most of the variation in nominal interest rates, particularly for short-term government securities, can be attributed to changing inflationary expectations. The hypothesis of the Fisher effect, based on long-term securities, suffers from an increased financial risk inherent in fluctuations of a bond market value prior to maturity. Comparisons of corporate securities are influenced by unequal creditworthiness of the issuers. In addition, changes in long-term interest rates and changes in inflation rates are not concurrent, because long-term rates relative to short-term rates are not that sensitive to changes in prices. However, the Fisher effect based on long-term maturities has worked fairly well in recent years. First, long-term interest rates, adjusted for inflation, have been relatively stable in most industrial countries since 1980. Second, long-term real rates of interest in most countries have been relatively close together since 1980.

5.4.4 *The international Fisher effect*

The **international Fisher effect** states that the future spot rate should move in an amount equal to, but in the opposite direction from, the difference in interest rates between two countries. A future spot rate of a currency with a higher interest rate would depreciate in the long run; a future spot rate of a currency with a lower interest rate would appreciate in the long run. For example, if the interest rate over the next year is 4 percent in the USA and 10 percent in Switzerland, the franc would depreciate against the dollar by 6 percent.

When investors purchase the currency of a country to take advantage of higher interest rates abroad, they must also consider any possible losses due to fluctuations in the value of the foreign currency prior to maturity of their investment. To clarify this point, assume that interest rates are higher in Switzerland than in the USA. In this case, US investors in Swiss securities must be rewarded with a higher interest rate to offset the expected depreciation of a spot rate for the franc when they convert the principal and interest into dollars. Swiss investors in US securities must be rewarded with a higher future spot rate for the dollar to offset the lower interest rate in the USA. In other words, the international Fisher effect holds that the interest differential between two countries should be an unbiased predictor of the future change in the spot rate.

SHORT-RUN BEHAVIOR The relationship between interest rates and exchange rates is a complex one, which incorporates numerous behavioral parameters. The short-run behavior of interest and exchange rates, quite contrary to their long-run behavior, shows that a rise in interest rates in a given country is expected to raise the value of that country's currency, and vice versa. In other words, currencies of countries with higher interest rates than the USA tend to appreciate in value against the dollar. Higher interest rates in a given country would raise the value of its currency because higher interest rates could attract capital from investors in other countries. By the same token, currencies of countries with lower interest rates than the USA tend to depreciate in value against the dollar because investors in other countries would sell their currencies in exchange for the dollar. Hence, the exchange rate moves in the same direction as the difference in interest rates between two countries.

5.4.5 *The theory of interest rate parity*

The movement of short-term funds between two countries to take advantage of interest differentials is a major determinant of the spread between forward and spot rates. According to the interest parity theory, the spread between a forward rate and a spot rate should be equal but opposite in sign to the difference in interest rates between two countries. In a free market, the currency with the higher interest rate would sell at a discount in the forward market, while the currency with the lower interest rate would sell at a premium in the forward market. In fact, the forward discount or premium is closely related to the interest differential between the two currencies.

The interest rate parity theory holds that the difference between a forward rate and a spot rate equals the difference between a domestic interest rate and a foreign interest rate:

$$\frac{n\text{-day } F - S}{S} \times \frac{360}{n} = i_d - i_f \tag{5.8}$$

where n-day F is the n-day forward rate, S is the spot rate, i_d is the domestic interest rate, and i_f is the foreign interest rate.

Example 5.10

Let us assume four things: (1) the Swiss interest rate is 9 percent; (2) the US interest rate is 7 percent; (3) the spot rate for the Swiss franc is \$0.4000; and (4) the 180-day forward rate for the Swiss franc is \$0.3960.

In this case, the percentage discount on the 180-day forward rate is equal to the interest rate differential:

$$\frac{\$0.3960 - \$0.4000}{\$0.4000} \times \frac{360}{180} = 0.07 - 0.09$$

$$-0.02 = -0.02$$

Swiss securities would earn 2 percent more than American securities, but Swiss francs would sell in the forward market at a 2 percent discount.

This outcome is brought about by arbitrageurs who enter into forward contracts to avoid the exchange rate risk. If interest rates are higher in Switzerland than in the USA, arbitrageurs in search of a higher yield could move their funds from the USA to Switzerland. In order to avoid the exchange rate risk at maturity, the arbitrageurs would sell the francs in exchange for dollars in the forward market. Consequently, the forward rate for the Swiss franc with the higher interest rate would depreciate, while the forward rate for the US dollar with the lower interest rate would appreciate. Such transactions would continue until the interest differential in favor of Switzerland was equal to the forward discount for the Swiss franc. Under this condition, there is no incentive for capital to move in either direction, because the interest differential is offset by the forward discount.

5.4.6 *The forward rate and the future spot rate*

If speculators think that a forward rate is higher than their prediction of a future spot rate, they will sell the foreign currency forward. This speculative transaction will bid down the forward rate until it equals the expected future spot rate. By the same token, if speculators believe that a forward rate is lower than an expected future spot rate, they will buy a foreign currency forward. This speculative transaction will bid up the forward rate until it reaches the expected future spot rate. Under this condition, there is no longer any incentive to buy or sell a foreign currency forward, because forward rates are unbiased predictors of future spot rates.

5.4.7 *A synthesis of international parity conditions*

In the absence of predictable exchange market intervention by central banks, an expected rate of change in a spot rate, differential rates of national inflation and interest, and forward premiums or discounts are all directly proportional to each other. Because money, capital, and exchange markets are efficient, these variables adjust very quickly to changes in any one of them. Consequently, the forward rate is the best possible forecaster of the future spot rate. Example 5.11 and figure 5.4 illustrate all of the fundamental parity relations simultaneously with the aid of a two-currency model: the US dollar and the Swiss franc.

Example 5.11

Let us assume the following:

1 The current spot rate for the Swiss franc: SFr1 = $0.5000.
2 The 1-year forward rate for the Swiss franc: SFr1 = $0.4750.
3 The expected spot rate in 1 year for the Swiss franc: SFr1 = $0.4750.
4 The expected rate of inflation for 1 year: Switzerland = 10 percent; US = 5 percent.
5 Interest rates on 1-year government securities: Switzerland = 12 percent; US = 7 percent.

Discuss international parity relationships among spot rates, forward rates, inflation rates, and interest rates, using these five assumptions.

First, the PPP theory holds that any change in the differential rate of inflation between two countries tends to be offset by an equal but opposite change in the spot rate. A 5 percent higher rate of inflation in Switzerland is offset by a 5 percent depreciation in the spot rate for the franc. This 5 percent depreciation in the spot rate for the franc is computed by equation 5.1:

$$\text{percentage change} = \frac{\text{ending rate} - \text{beginning rate}}{\text{beginning rate}}$$

$$\text{percentage change} = \frac{0.4750 - 0.5000}{0.5000} = -0.05 \text{ or } -5\%$$

Second, the Fisher effect suggests that real interest rates are identical everywhere and that nominal interest rates will vary by the difference in expected rates of inflation. The real inflation-adjusted interest rate in both countries is computed by equation 5.7: nominal rate = real rate + inflation.

The US: 7% = real rate + 5%; real rate = 2%

Switzerland: 12% = real rate + 10%; real rate = 2%

The nominal interest rate in Switzerland (12 percent) is 5 percent higher than the nominal interest rate in the USA (7 percent). This difference is identical to the 5 percent difference in expected rates of inflation between Switzerland (10 percent) and the USA (5 percent).

Third, the international Fisher effect states that a future spot rate should move in an amount equal to, but in the opposite direction from, the difference in interest rates between two countries. The 5 percent interest differential in favor of Switzerland is equal to the 5 percent depreciation in the future spot rate for the franc (remember that the 5 percent franc depreciation was computed in relation to the PPP theory).

Fourth, the Interest Parity Theory assumes that the spread between the forward rate and the spot rate should be equal but opposite in sign to the difference in interest rates between the two countries. The 5 percent higher rate of interest in Switzerland is consistent with the 5 percent forward discount for the Swiss franc. The 5 percent forward discount for the franc is computed by equation 5.4:

$$\text{premium (discount)} = \frac{n\text{-day forward rate} - \text{spot rate}}{\text{spot rate}} \times \frac{360}{n}$$

$$\text{forward discount} = \frac{0.4750 - 0.5000}{0.5000} = \frac{360}{360} = -0.05 \text{ or } -5\%$$

Finally, under a freely floating exchange rate system, the forward rate is an unbiased predictor of the future spot rate. The 1-year forward rate of \$0.4750 for the franc is identical to the expected spot rate in 1 year of \$0.4750 for the franc. This means that the 5 percent 1-year forward discount for the franc is an unbiased predictor that the franc will depreciate by 5 percent over the next year.

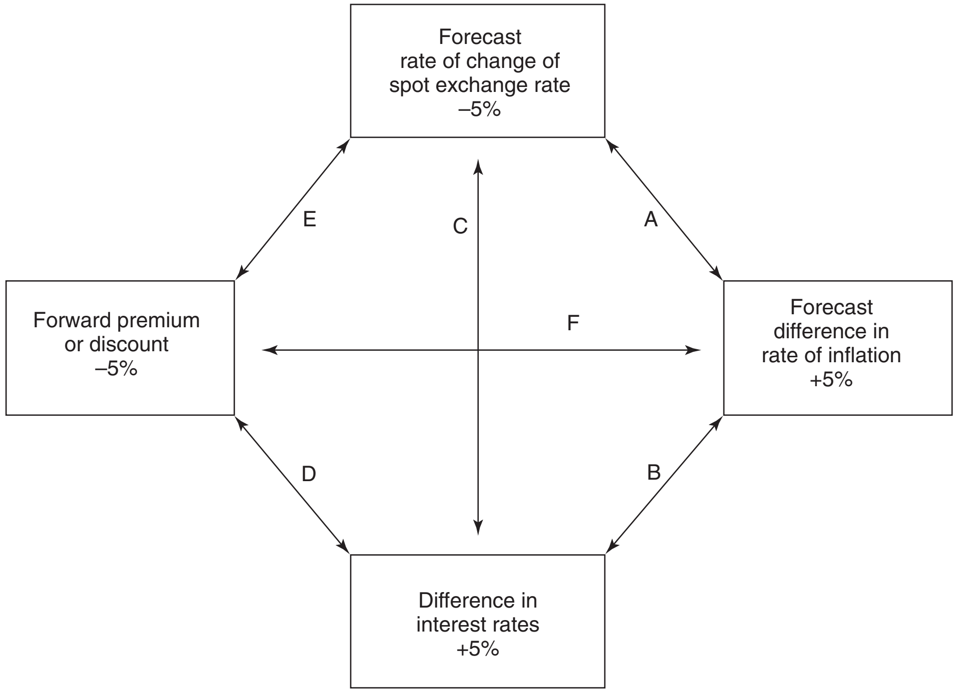

Figure 5.4 Relationships among various financial rates

Figure 5.4 illustrates these five key theories of exchange rate determination and their relationships on the basis of example 5.11: the theory of purchasing power parity (relationship A), the Fisher effect (relationship B), the international Fisher effect (relationship C), the theory of interest rate parity (relationship D), and the forward rate as an unbiased predictor of the future spot rate (relationship E). Relationship F does not represent any particular theory, but it has to be true by definition if relationships A–E are all true. This framework emphasizes the links that exist among spot exchange rates, forward rates, interest rates, and inflation rates.

5.5 Arbitrages

Arbitrage is the purchase of something in one market and its sale in another market to take advantage of a price differential. Professional arbitrageurs quickly transfer funds from one currency to another in order to profit from discrepancies between exchange rates in different markets. The process of arbitrage also works through the foreign-exchange market to bring interest rates in national markets closer together. Even small discrepancies between the exchange rates and interest rates in different markets would motivate enough arbitrage to eliminate these discrepancies quickly.

5.5.1 *Geographical arbitrage*

In principle, the exchange rate for a given currency should be the same in every geographical market. However, geographical arbitrage could arise when local demand-and-supply conditions might create temporary discrepancies among various markets. Arbitrage specialists would buy the currency in a market where its price is lower and then sell the currency where its price is higher. If the exchange rate differential is larger than the transaction cost, an arbitrage profit would be made.

TWO-POINT ARBITRAGE The arbitrage transaction between two currencies is called a **two-point arbitrage**. Suppose, for example, that the quotes of the South African rand against the US dollar are $0.20 in New York and $0.25 in Johannesburg. The price of rands in terms of dollars is higher in Johannesburg than in New York. An arbitrageur could benefit by buying rands with dollars in New York and then selling the rands in exchange for dollars in Johannesburg. Arbitrage tends to wipe out the exchange rate differential that originally triggered it. The purchase of rands in New York would drive the price of rands against the dollar up toward the Johannesburg rate. The sale of rands in Johannesburg would drive the price of rands against the dollar down toward the New York rate. This arbitrage process would continue until the price of rands in terms of the dollar was the same in both markets.

The basic economic principle of "buy low and sell high" dominates the arbitrage transaction of buying and selling currencies in two national money markets. Exchange rates in two different locations must be stated in a given currency if this principle is to be applied in foreign exchange. Thus, the arbitrage process becomes slightly more difficult to understand if exchange rates are quoted in different currencies. Let us restate our previous example in a slightly different way. The price of rands against the dollar is $0.20 in New York. The price of dollars against the rand is R4 in Johannesburg. The quotes in both locations in terms of $/R are as follows:

New York	*Johannesburg*
$0.20/R (as initially given)	$0.25/R (1 ÷ 4)

The rand enjoys a higher price against the dollar in Johannesburg than in New York. This price differential would lead to the following transactions in each market:

1 In New York, investors would buy rands and sell dollars.
2 In Johannesburg, investors would sell rands and buy dollars.

THREE-POINT ARBITRAGE An arbitrage transaction among three currencies is called a **three-point arbitrage** and is also commonly known as a triangle arbitrage. This type of arbitrage can occur if any of the three cross rates is out of line. Consider the possibility that the cross rates of exchange are Rs60/$, Rs10/HK$, and HK$3/$. An arbitrageur could make a profit of $1. She would buy 60 Indian rupees for $1, then purchase six Hong Kong dollars for 60 Indian rupees, and finally buy $2 for the six Hong Kong dollars. A large volume of such transactions would strengthen the rupee against the dollar, strengthen the Hong Kong dollar against the rupee, and strengthen the dollar against the Hong Kong dollar. This arbitrage process causes some consistent patterns of rates to emerge at which no further arbitrage would be profitable. In other words, the arbitrage will continue until dollars can no longer be bought more cheaply in one market than the price at which they are sold in another market. Currency cross rates such as those given in table 5.1 can be prepared to ensure that the exchange rates are consistent with each other in all markets.

5.5.2 Covered-interest arbitrage

Covered-interest arbitrage is the movement of short-term funds between countries to take advantage of interest differentials with exchange risk covered by forward contracts. When investors purchase the currency of a foreign country to take advantage of higher interest rates abroad, they must also consider any losses or gains. Such losses or gains might occur due to fluctuations in the value of the foreign currency prior to the maturity of their investment. Generally, investors cover against such potential losses by contracting for the future sale or purchase of a foreign currency in the forward market.

Their actions, aimed at profits from interest rate differentials between countries, lead, in equilibrium, to the condition of so-called interest parity. The interest rate parity theory says that any exchange gains or losses incurred by a simultaneous purchase and sale in the spot and forward markets are offset by the interest rate differential on similar assets. Under these conditions, there is no incentive for capital to move in either direction, because the effective returns on foreign and domestic assets have been equalized.

Figure 5.5 presents a graphic representation of the theoretical relationship between the forward premium or discount and the interest rate differential. The vertical axis represents the interest differential in favor of the foreign currency and the horizontal axis shows the forward premium or discount on that currency. The interest parity line shows the equilibrium state. This chapter ignores transaction costs for simplicity. However, it is important to recognize the fact that transaction costs cause the interest parity line to be a band rather than a thin line. Transaction costs include the foreign-exchange brokerage costs on spot and forward contracts as well as the investment brokerage cost on buying and selling securities.

Point A of figure 5.5 shows that the forward discount for foreign exchange is 1 percent and that the foreign interest rate is 2 percent higher than the domestic interest rate. In this case, the arbitrageur could employ the so-called covered-interest arbitrage to make a profit. Specifically, the arbitrageur would earn 2 percent more on her investment in foreign securities and lose 1 percent on the repurchase of the domestic currency in the forward market by taking the following actions: (1) buying spot foreign currency with domestic currency; (2) investing the foreign currency in foreign securities; and (3) selling the foreign currency in the forward market. The net result is that the arbitrageur would make a profit of 1 percent from this covered-interest arbitrage transaction.

The arbitrageur would have to convert the foreign currency to domestic currency at the end of maturity. The exchange rate may fall before the arbitrageur has returned her funds to her home country. For that reason, the arbitrage transaction involves foreign-exchange risks. To avoid these risks, she will cover the transaction by selling forward the same amount of the foreign currency at 1 percent discount. The investment protected by forward sales is called covered-interest arbitrage.

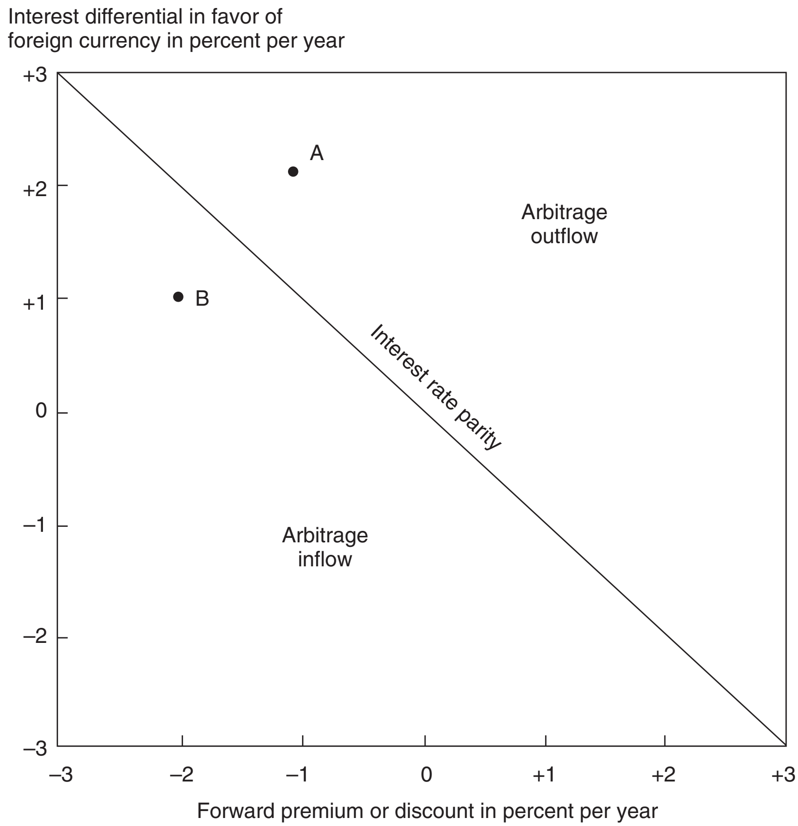

Figure 5.5 Covered-interest arbitrage

Example 5.12

Suppose: (1) the Swiss interest rate is 10 percent; (2) the US interest rate is 8 percent; (3) the spot rate for Swiss francs is \$0.5000; and (4) the 180-day forward rate for Swiss francs is \$0.4975.

The forward discount for the franc is obtained by using equation 5.4:

$$\text{forward discount} = \frac{\$0.4975 - \$0.5000}{\$0.5000} \times \frac{360}{180} = -0.01 \text{ or } -1\%$$

The interest differential is 2 percent (10 percent – 8 percent) in favor of the Swiss franc. The covered-interest arbitrage would work as follows:

1	Borrow dollars in the USA	–8%
	Buy francs spot with the dollars	
2	Invest the francs in Swiss securities	+10%
3	Sell francs forward against dollars at a discount	–1%
	Net profit	+1%

These transactions would cause four tendencies in foreign-exchange markets and money markets:

1 The spot rate of the franc against the dollar would tend to appreciate as investors bought francs against dollars.
2 The forward rate of the franc against the dollar would tend to depreciate as investors sold francs against dollars.
3 The US interest rate would tend to rise as investors borrowed dollars.
4 The Swiss interest rate would tend to fall as investors lent francs.

The first two tendencies would increase the original forward discount of 1 percent toward the initial interest differential of 2 percent. The last two tendencies would reduce the initial interest differential of 2 percent toward the original forward discount of 1 percent. These four tendencies would continue until the forward discount for the franc equaled the interest rate differential in favor of the franc.

At point B of figure 5.5, the foreign interest rate is 1 percent higher than the domestic interest rate. The cost of forward cover (forward discount) is 2 percent. In this case, the arbitrageur would sell the foreign currency for the domestic currency, invest this domestic currency in home-country securities, and repurchase the foreign currency in the forward market at a discount. She would lose 1 percent on this investment in home-country securities, but she would earn 2 percent on the repurchase of the foreign currency. Hence, the arbitrageur would make a profit of 1 percent.

Example 5.13

Suppose: (1) the Canadian interest rate is 10 percent; (2) the US interest rate is 9 percent; (3) the spot rate for Canadian dollars is \$0.8500; and (4) the 180-day forward rate for Canadian dollars is \$0.8415.

The forward discount for the Canadian dollar is obtained by using equation 5.4:

$$\text{forward discount} = \frac{\$0.8415 - \$0.8500}{\$0.8500} \times \frac{360}{180} = -0.02 \text{ or } -2\%$$

The interest differential is 1 percent (10 percent – 9 percent) in favor of the Canadian dollar. The covered-interest arbitrage would work as follows:

1	Borrow Canadian dollars in Canada	–10%
	Buy US dollars with the Canadian dollars	
2	Invest the US dollars in US securities	+9%
3	Sell US dollars forward at a premium	+2%
	Net profit	+1%

These transactions would cause four tendencies in foreign exchange and money markets:

1 The spot rate of the Canadian dollar against the US dollar would tend to depreciate as investors sold Canadian dollars against US dollars.
2 The forward rate of the Canadian dollar against the US dollar would tend to appreciate as investors bought Canadian dollars against US dollars.
3 The US interest rate would tend to fall as investors lent US dollars.
4 The Canadian interest rate would tend to rise as investors borrowed Canadian dollars.

The first two tendencies would reduce the original forward discount of 2 percent toward the initial interest differential of 1 percent. The last two tendencies would increase the initial interest differential of 1 percent toward the original forward discount of 2 percent. These forces would work until the interest rate differential equaled the forward discount.

Any point above the interest parity line, such as point A, has the following two features: (1) the first step of the arbitrage process would be to borrow money in the home country; and (2) funds would move from the home country to the foreign country (arbitrage outflow). Any point below the interest parity line, such as point B, has the following two features: (1) the first step of the arbitrage process would be to borrow money in the foreign country, and (2) funds would move from the foreign country to the home country (arbitrage inflow).

The interest parity line of figure 5.5 identifies the equilibrium position for the relationship between interest rate differentials and forward premiums or discounts. Every point on this line represents a situation in which the interest rate differential equals the forward premium or discount. In this case, arbitrageurs would have no incentive to transfer funds from one country to the other. However, at any point off the line, there should be an incentive to move funds from one country to another. Such transfers of funds would cause interest differentials or forward premiums (discounts) to move toward the interest parity line.

The theoretical equilibrium position exists only under a free market system. Because there are a variety of artificial barriers and intervention by government authorities in both foreign exchange and money markets, this equilibrium condition hardly ever exists in practice.

SUMMARY

Exchange rates represent prices of one currency in terms of another currency. They are determined by the forces of supply and demand under a free market system. The primary function of the foreign-exchange market is to transfer purchasing power denominated in one currency to another, thereby facilitating foreign trade and investment. The foreign-exchange market consists of two tiers: the interbank market, in which banks trade with each other, and the retail market, in which banks deal with their nonbank customers.

A major problem of multinational corporations is the fact that cash flows must cross national boundaries. These flows are subject to various constraints imposed by government authorities and exchange rate fluctuations. Trades in currencies take place in the foreign-exchange markets for immediate delivery (spot market) and future delivery (forward market). The foreign-exchange market is a worldwide network of telephone and computer communications between banks.

The five major theories of exchange rate determination are (1) the theory of purchasing power parity, (2) the Fisher effect, (3) the international Fisher effect, (4) the interest rate parity theory, and (5) the forward rate as an unbiased predictor of the future spot rate. These five theories illustrate the links that exist among spot rates, interest rates, inflation rates, and forward rates. In efficient exchange markets, spot exchange rates are theoretically determined by the interplay of differential national rates of inflation and interest, and the forward premium or discount.

Essentially, the PPP doctrine and the interest parity theory explain why, in the long run, exchange rates move toward positions of equilibrium in which prices in different countries and their interest rates are the same. This is because arbitrageurs buy currencies in one market and sell them in another market in order to take advantage of price or interest differentials prevailing at differential national markets. Thus, the process of arbitrage works through the foreign-exchange market to bring inflation and interest rates in different markets closer together.

Questions

1 What are the major roles that commercial banks play in international transactions?
2 What is the cross rate? Why do we have to compute the cross rate?
3 When will a forward exchange contract backfire?
4 List the hypotheses on which the concept of efficient exchange markets depends.
5 Assume that the inflation rate is higher in the USA than in Japan. How should this affect the US demand for Japanese yen, the supply of the yen for sale, and the equilibrium value of the yen?
6 Discuss some causes of deviations from purchasing power parity.
7 Assume that the interest rate is higher in the UK than in the USA. How should this affect the US demand for British pounds, the supply of pounds for sale, and the equilibrium value of the pound?

8 Under what conditions will a higher inflation rate of a country lead to a corresponding increase of its interest rate for that country?
9 If the US trade balance with the UK is expected to improve next year, what is the likely relationship between the forward rate on the British pound and its current spot rate?
10 Assume that the difference between the US interest rate and the Mexican interest rate is 11 percent in favor of Mexico, but the forward discount rate for the Mexican peso is 20 percent. The discrepancy between the interest differential and the forward discount seem to open incentives for arbitrage. Could it be possible to take advantage of the opportunity for covered-interest arbitrage?

Problems

1 If the Swiss franc is selling for \$0.5618 and the Japanese yen is selling for \$0.0077, what is the cross rate between these two currencies?
2 (a) If the spot rate changes from \$0.11 per peso to \$0.10 per peso over a 1-year period, what is the percentage change in the value of the Mexican peso?
(b) If the spot rate changes from Mex\$10.00 per dollar to Mex\$9.00, what is the percentage change in the value of the Mexican peso?
3 If a bank's bid price is \$1.60 for the British pound and its ask price is \$1.65, what is the bid–ask spread for the pound?
4 Assume: (1) the spot rate for Canadian dollars is \$0.8089; (2) the 180-day forward rate for Canadian dollars is \$0.8048; (3) the spot rate for Swiss francs is \$0.4285; and (4) the 180-day forward rate for Swiss francs is \$0.4407. Determine the 180-day forward discount or premium on both the Canadian dollar and the Swiss franc.
5 Fill in the following blank spaces:

	British pounds	Swiss francs
Direct (outright)		
Spot	\$2.0787	\$0.4108
30-day forward		0.4120
90-day forward		0.4144
Points (spread)		
30-day forward	–13	
90-day forward	–60	
Percentage discount or premium a year		
30-day forward		
90-day forward		

6 Assume that the current exchange rate is $2.00 per pound, the US inflation rate is 10 percent for the coming year, and the British inflation rate is 5 percent over the same period. What is the best estimate of the pound future spot rate 1 year from now?

7 Assume that you can buy a particular basket of goods for $108 in the USA and ¥14,000 in Japan.
   (a) What should the ¥/$ exchange rate be according to the absolute purchasing power parity?
   (b) If the actual exchange rate were ¥120 per dollar, would the dollar be considered undervalued or overvalued?

8 The following quotations and expectations exist for the Swiss franc:

Present spot rate	$0.5000
90-day forward rate	0.5200
Your expectation of the spot rate in 90 days	0.5500

   (a) What is the premium or discount on the forward Swiss franc?
   (b) If your expectation proves correct, what would be your dollar profit or loss from investing $4,000 in the spot market? How much capital would you need now to carry out this operation? What are the major risks associated with this speculation?
   (c) If your expectation proves correct, what would be your dollar profit or loss from investing $4,000 in the forward market? How much capital would you need now to speculate in the forward market? What are the major risks associated with the speculation?

9 An American firm purchases $4,000 worth of perfume (Mex$20,000) from a Mexican firm. The American distributor must make the payment in 90 days, in Mexican pesos. The following quotations and expectations exist for the Mexican peso:

Present spot rate	$0.2000
90-day forward rate	0.2200
Your expectation of the spot rate in 90 days	0.2500
US interest rate	15%
Mexican interest rate	10%

   (a) What is the premium or discount on the forward Mexican peso? What is the interest differential between the USA and Mexico? Is there an incentive for covered-interest arbitrage?
   (b) If there is an incentive for covered-interest arbitrage, how can an arbitrageur take advantage of the situation? Assume: (1) the arbitrageur is willing to borrow $4,000 or Mex$20,000; and (2) there are no transaction costs.
   (c) If transaction costs are $100, would an opportunity still exist for covered-interest arbitrage?
   (d) What alternatives are open to the importer if she wants to cover her transaction against the foreign-exchange risk?

(e) Assume that your expectation proves correct and that the importer decides to cover this transaction. What would be the opportunity cost of each alternative? Which alternative is more attractive and why?

(f) Would you advise the American firm to cover its foreign transaction? Why or why not?

10 You must make a \$100,000 domestic payment in Los Angeles in 90 days. You have \$100,000 now and decide to invest it for 90 days either in the USA or in the UK. Assume that the following quotations and expectations exist:

Present spot rate per pound	\$1.8000
90-day forward rate per pound	\$1.7800
US interest rate	8%
UK interest rate	10%

(a) Where should you invest your \$100,000 to maximize your yield with no risk?

(b) Given the US interest rate, the UK interest rate, and the spot rate, what would be an equilibrium forward exchange quotation? This equilibrium situation should provide you with no advantage or disadvantage associated with investing in one country or the other.

(c) Given the spot rate, the forward rate, and the US interest rate, what is the equilibrium UK interest rate?

11 Assume that ¥1 = \$0.0077 in New York, \$1 = SKr2.00 in London, and SKr1 = ¥65 in Tokyo.

(a) If you have ¥10,000 on hand, how could you use a triangle arbitrage to earn a profit?

(b) If you ignore transaction costs, what is the arbitrage profit per yen initially traded?

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Case Problem 5: The Big Mac Hamburger Standard: February 2003

The theory of purchasing power parity (PPP) is one of the oldest theories in international economics. The theory states that, in the long run, the exchange rates between two currencies should move toward the rate that would equalize the prices of an identical basket of goods and services in the two countries. As a theoretical proposition, it serves as a solid foundation for thinking about the conditions under which prices in international markets adjust to attain long-term equilibrium. As a practical matter, however, PPP has been a more puzzling concept.

The Economist, a monthly business publication, has established another, yet somewhat more recent, tradition: the Big Mac PPP. Since 1986, *The Economist* has evaluated prevailing exchange rates on the basis of Big Mac price differentials in various countries around the world. A similar index has also been developed by the Union Bank of Switzerland in its annual comparison of prices and incomes around the globe. These light-hearted studies of international burger prices have predictably stimulated the passion of the popular media and the financial press. The Big Mac index was devised as an enjoyable guide to whether currencies are at their "correct" level. As *The Economist* puts it, "the index is not intended to be a predictor of exchange rates, but a tool to make economic theory more digestible." An identical basket of goods and services in this particular case is a McDonald's Big Mac, which is made to roughly the same recipe in more than 100 countries. The Big Mac PPP is the exchange rate that would make a burger cost the same in America as it does abroad. Comparing Big Mac PPPs with actual exchange rates is one test of whether a currency is undervalued or overvalued.

The second column of table 5.2 shows the local-currency prices of a Big Mac: the third converts them into dollars. The fourth column shows Big Mac PPPs. For example, dividing the Swiss price by the American gives a dollar PPP of SFr2.48. The actual rate on February 11, 2003, was SFr1.37, implying that the Swiss franc is 81 percent overvalued against the dollar. The average American price is $2.54. Argentina is a place for bargain hunters: a Buenos Aires Big Mac costs only $0.80. At the other extreme, the Swiss price of $4.61 is enough to make Big Mac fans choke on their all-beef patties. This implies that the Argentinean peso is the most undervalued currency (by 69 percent), and the Swiss franc is the most overvalued (by 81 percent). In general, the dollar is undervalued against the currencies of most big industrial countries, but overvalued against the currencies of developing countries.

Case Questions

1 Name the currencies of the 15 countries listed in table 5.2 and write down their traditional symbols.

Table 5.2 The hamburger standard

Country	In local currency	In dollars	Implied PPP of dollar	Actual exchange rate	Local currency under(–)/over(+) valuation
USA	2.54	2.54	–	–	–
Switzerland	6.30	4.61	2.48	1.37	+81
Denmark	24.75	3.57	9.74	6.92	+40
UK	1.99	3.24	1.28	1.63	+27
Sweden	24.0	2.81	9.45	9.45	+11
Eurozone	2.57	2.76	0.99	0.93	+6
South Korea	3,000	2.51	1,181	1,196.70	–1
Japan	294	2.42	116	121.30	–4
Taiwan	70.0	2.01	27.6	34.90	–21
Hong Kong	10.2	1.31	4.02	7.80	–48
China	9.9	1.19	3.90	8.29	–53
South Africa	9.70	1.13	3.82	8.57	–55
Russia	35.00	1.10	13.80	31.82	–57
Brazil	3.30	1.00	1.52	3.59	–58
Argentina	2.50	0.80	0.98	3.13	–69

2 Calculate the dollar price of a Big Mac (column 3), the implied PPP of the dollar (column 4), and the local currency under(–)/over(+)valuation (column 6) for Denmark and Hong Kong.

3 In 2003, it cost \$0.80 to buy a Big Mac in Argentina, \$2.54 to buy a Big Mac in the USA, and \$4.61 to buy a Big Mac in Switzerland. How do we explain these deviations from PPP?

4 A web page of OANDA.com (see www.oanda.com/products/bigmac/bigmac.shtml) provides exchange rate trends of various currencies. Use this web page to obtain the latest version of the hamburger standard shown in table 5.2.

Sources: www.oanda.com/products/bigmac/bigmac.shtml as of Feb. 11, 2003; R. E. Cumby, "Forecasting Exchange Rates and Relative Prices With the Hamburger Standard: Is What You Want What You Get With McParity?" Manuscript, Georgetown University, 1995; and M. R. Pakko and P. S. Pollard, "For Here or To Go? Purchasing Power Parity and the Big Mac," *Review*, Federal Reserve Bank of St. Louis, Jan./Feb. 1996, pp. 3–21.