chapter

14

Foreign Exchange Markets and Exchange Rates

LEARNING GOALS:

After reading this chapter, you should be able to:

- Understand the meaning and functions of the foreign exchange market
- Know what the spot, forward, cross, and effective exchange rates are
- Understand the meaning of foreign exchange risks, hedging, speculation, and interest arbitrage

14.1 Introduction

The foreign exchange market is the market in which individuals, firms, and banks buy and sell foreign currencies or foreign exchange. The foreign exchange market for any currency—say, the U.S. dollar—is comprised of all the locations (such as London, Paris, Zurich, Frankfurt, Singapore, Hong Kong, Tokyo, and New York) where dollars are bought and sold for other currencies. These different monetary centers are connected electronically and are in constant contact with one another, thus forming a single international foreign exchange market.

Section 14.2 examines the functions of foreign exchange markets. Section 14.3 defines foreign exchange rates and arbitrage, and examines the relationship between the exchange rate and the nation's balance of payments. Section 14.4 defines spot and forward rates and discusses foreign exchange swaps, futures, and options. Section 14.5 then deals with foreign exchange risks, hedging, and speculation. Section 14.6 examines uncovered and covered interest arbitrage, as well as the efficiency of the foreign exchange market. Finally, Section 14.7 deals with the Eurocurrency, Eurobond, and Euronote markets. In the appendix, we derive the formula for the precise calculation of the covered interest arbitrage margin.

14.2 Functions of the Foreign Exchange Markets

By far the principal function of foreign exchange markets is the transfer of funds or purchasing power from one nation and currency to another. This is usually accomplished by an electronic transfer and increasingly through the Internet. With it, a domestic bank instructs its correspondent bank in a foreign monetary center to pay a specified amount of the local currency to a person, firm, or account.

The demand for foreign currencies arises when tourists visit another country and need to exchange their national currency for the currency of the country they are visiting, when a domestic firm wants to import from other nations, when an individual or firm wants to invest abroad, and so on. Conversely, a nation's supply of foreign currencies arises from foreign tourist expenditures in the nation, from export earnings, from receiving foreign investments, and so on. For example, suppose a U.S. firm exporting to the United Kingdom is paid in pounds sterling (the U.K. currency). The U.S. exporter will exchange the pounds for dollars at a commercial bank. The commercial bank will then sell these pounds for dollars to a U.S. resident who is going to visit the United Kingdom, to a U.S. firm that wants to import from the United Kingdom and pay in pounds, or to a U.S. investor who wants to invest in the United Kingdom and needs the pounds to make the investment.

Thus, a nation's commercial banks operate as *clearinghouses* for the foreign exchange demanded and supplied in the course of foreign transactions by the nation's residents. In the absence of this function, a U.S. importer needing British pounds, for instance, would have to locate a U.S. exporter with pounds to sell. This would be very time-consuming and inefficient and would essentially be equivalent to reverting to barter trade. Those U.S. commercial banks that find themselves with an oversupply of pounds will sell their excess pounds (through the intermediary of *foreign exchange brokers*) to commercial banks that happen to be short of pounds needed to satisfy their customers' demand. In the final analysis, then, a nation pays for its tourist expenditures abroad, its imports, its investments abroad, and so on with its foreign exchange earnings from tourism, exports, and the receipt of foreign investments.

If the nation's total demand for foreign exchange in the course of its foreign transactions exceeds its total foreign exchange earnings, the rate at which currencies exchange for one another will have to change (as explained in the next section) to equilibrate the total quantities demanded and supplied. If such an adjustment in the exchange rates were not allowed, the nation's commercial banks would have to borrow from the nation's central bank. The nation's central bank would then act as the "lender of last resort" and draw down its foreign exchange reserves (a balance-of-payments deficit of the nation). On the other hand, if the nation generated an excess supply of foreign exchange in the course of its business transactions with other nations (and if adjustment in exchange rates were not allowed), this excess supply would be exchanged for the national currency at the nation's central bank, thus increasing the nation's foreign currency reserves (a balance-of-payments surplus).

Thus, four *levels* of transactors or participants can be identified in foreign exchange markets. At the bottom, or at the first level, are such traditional users as tourists, importers, exporters, investors, and so on. These are the immediate users and suppliers of foreign currencies. At the next, or second, level are the commercial banks, which act as clearinghouses between users and earners of foreign exchange. At the third level are foreign exchange brokers, through whom the nation's commercial banks even out their foreign exchange inflows and outflows among themselves (the so-called *interbank or wholesale market*). Finally, at the fourth and highest level is the nation's central bank, which acts as the seller or buyer of last resort when the nation's total foreign exchange earnings and expenditures are unequal. The central bank then either draws down its foreign exchange reserves or adds to them.

Because of the special position of the U.S. dollar as an international currency as well as the national currency of the United States, U.S. importers and U.S. residents wishing to make investments abroad could pay in dollars. Then it would be U.K. exporters and investment recipients who would have to exchange dollars for pounds in the United Kingdom. Similarly, U.S. exporters and U.S. recipients of foreign investments may require payment in dollars. Then it would be U.K. importers or investors who would have to exchange pounds for dollars in London. This makes *foreign* monetary centers relatively larger than they otherwise might have been.

But the U.S. dollar is more than an international currency. It is a vehicle currency; that is, the dollar is also used for transactions that do not involve the United States at all, as, for example, when a Brazilian importer uses dollars to pay a Japanese exporter (see Case Study 14-1). The same is true of the euro, the newly established currency of the European Monetary Union or EMU. The United States receives a seignorage benefit when the dollar is used as a vehicle currency. This arises from and amounts to an interest-free loan from foreigners to the United States on the amount of dollars held abroad. More than 60 percent of the U.S. currency is now held abroad.

The Bank for International Settlements (BIS) in Basel, Switzerland, estimated that the total of foreign exchange trading or "turnover" for the world as a whole averaged $4.0 trillion *per day* in 2010, up from $3.3 trillion in 2007, $1.9 trillion in 2004, and $1.2 trillion in 2001. This is about 27 percent of the average *yearly* volume of world trade and of the U.S. gross domestic product (GDP) in 2010. Banks located in the United Kingdom

CASE STUDY 14-1 The U.S. Dollar as the Dominant International Currency

Today the U.S. dollar is the dominant international currency, serving as a unit of account, medium of exchange, and store of value not only for domestic transactions but also for private and official international transactions. The U.S. dollar replaced the British pound sterling after World War II as the dominant vehicle currency because of its more stable value, the existence of large and well-developed financial markets in the United States, and the very large size of the U.S. economy. Since its creation at the beginning of 1999, the euro (the common currency of 17 of the 27-member countries of the European Union) has become the second most important vehicle international currency (see Case Study 14-2).

Table 14.1 shows the relative importance of the dollar, the euro, and other major currencies in the world economy in 2010. The table shows that 42.5 percent of foreign exchange trading was in dollars, as compared with 19.6 percent in euro, 9.5 percent in Japanese yen, and smaller percentages in other currencies. Table 14.1 also shows that 58.2 percent of international bank loans, 38.2 percent of international bond offerings, and 52.0 percent of international trade invoicing were denominated in U.S. dollars. Also, 61.5 percent of foreign exchange reserves were held in U.S. dollars, as compared with 26.2 percent in euro, and much smaller percentages for the yen and other currencies. Although the U.S. dollar has gradually lost its role as the *sole* vehicle currency that it enjoyed since the end of World War II, it still remains the dominant vehicle currency in the world today.

(continued)

■ CASE STUDY 14-1 **Continued**

■ **TABLE 14.1. Relative International Importance of Major Currencies in 2010 (in Percentages)**

	Foreign Exchange Trading[a]	International Bank Loans[a]	International Bond Offering[a]	Trade Invoicing[b]	Foreign Exchange Reserves[c]
U.S. dollar	42.5	58.2	38.2	52.0	61.5
Euro	19.6	21.4	45.1	24.8	26.2
Japanese yen	9.5	3.0	3.8	4.7	3.8
Pound sterling	6.5	5.5	8.0	5.4	4.0
Swiss franc	3.2	2.1	1.5	*na*	0.1
Other currencies	18.7	9.8	4.4	13.1	4.4

[a] Bank of International Settlements, *Triennial Central Bank Survey* (Basel, Switzerland: BIS, March 2010) and BIS data set.
[b] P. Bekx, ''The Implications of the Introduction of the Euro for Non-EU Countries,'' *Euro Paper No. 26*, July 1998. Data are for 1995. More recent data are not available.
[c] International Monetary Fund, *Annual Report* (Washington, D.C.: IMF, 2011).

accounted for nearly 37 percent of all foreign exchange market turnover, followed by the United States with about 18 percent, Japan with about 6 percent, Singapore, Switzerland, and Hong Kong SAR each with about 5 percent, Australia with about 4 percent, and the rest with other smaller markets. Most of these foreign exchange transactions take place through debiting and crediting bank accounts rather than through actual currency exchanges. For example, a U.S. importer will pay for EMU goods by debiting his or her account at a U.S. bank. The latter will then instruct its correspondent bank in an EMU country to credit the account of the EMU exporter with the euro value of the goods.

Another function of foreign exchange markets is the credit function. Credit is usually needed when goods are in transit and also to allow the buyer time to resell the goods and make the payment. In general, exporters allow 90 days for the importer to pay. However, the exporter usually discounts the importer's obligation to pay at the foreign department of his or her commercial bank. As a result, the exporter receives payment right away, and the bank will eventually collect the payment from the importer when due. Still another function of foreign exchange markets is to provide the facilities for hedging and speculation (discussed in Section 14.5). Today, about 90 percent of foreign exchange trading reflects purely financial transactions and only about 10 percent trade financing.

With electronic transfers, foreign exchange markets have become truly global in the sense that currency transactions now require only a few seconds to execute and can take place 24 hours per day. As banks end their regular business day in San Francisco and Los Angeles, they open in Singapore, Hong Kong, Sydney, and Tokyo; by the time the latter banks wind down their regular business day, banks open in London, Paris, Zurich, Frankfurt, and Milan; and before the latter close, New York and Chicago banks open.

Case Study 14-1 examines the U.S. dollar as the dominant vehicle currency, whereas Case Study 14-2 discusses the birth of the euro, which has quickly become the second most important vehicle currency.

CASE STUDY 14-2 The Birth of a New Currency: The Euro

On January 1, 1999, the euro (€) came into existence as the single currency of 11 of the then 15 member countries of the European Union (Austria, Belgium, Germany, Finland, France, Ireland, Italy, Luxembourg, Spain, Portugal, and the Netherlands). Greece was admitted at the beginning of 2001, Slovenia in 2007, Cyprus and Malta in 2008, Slovakia in 2009, and Estonia in 2011—making the number of EMU countries in the *Eurozone* equal to 17 (out of the 27 members of the European Union or EU in 2011). Britain, Sweden, and Denmark chose not to participate, but reserved the right to join later. This was the first time that a group of sovereign nations voluntarily gave up their currency in favor of a common currency, and it ranks as one of the most important economic events of the postwar period.

From the start, the euro became an important international currency because the European Monetary Union or EMU (1) is as large an economic and trading unit as the United States; (2) has a large, well-developed, and growing financial market, which is increasingly free of controls; and (3) has a good inflation performance that will keep the value of the euro stable. But it is not likely that the euro will displace the U.S. dollar as the leading international or vehicle currency any time soon because (1) most primary commodities are priced in dollars, and this is likely to remain the case for some time to come; (2) most non-EMU countries are likely to continue to use the dollar for most of their international transactions for the foreseeable future, with the exception of the former communist nations in Central and Eastern Europe (which are candidates for admission into the European Monetary Union and may even adopt the euro before then) and the former French colonies in West and Central Africa; and (3) sheer inertia favors the incumbent (the dollar).

The most likely situation will be that the euro will share the leading position with the dollar during this decade and also with the renminbi or yuan, the currency of China, after that. Although still officially inconvertible, China has already started rapidly "internationalizing" its currency by developing an offshore market in the currency and encouraging the use of renminbi in settling and invoicing international trade transactions. The World Bank predicted that by 2025 the euro and the renminbi will become as important international or vehicle currencies as the dollar in a new "multi-currency" international monetary system.

Sources: D. Salvatore, "The Euro: Expectations and Performance," *Eastern Economic Journal*, Winter 2002, pp. 121–136; D. Salvatore, "Euro," *Princeton Encyclopedia of the World Economy* (Princeton, N.J.: Princeton University Press, 2008), pp. 350–352; World Bank, *Multipolarity: The New Global Economy* (Washington, D.C., 2011), pp. 139–142; and D. Salvatore, "Exchange Rate Misalignments and the International Monetary System," *Journal of Policy Modeling*, July/August 2012, pp. 594–604.

14.3 Foreign Exchange Rates

In this section, we first define exchange rates and show how they are determined under a flexible exchange rate system. Then we explain how exchange rates between currencies are equalized by arbitrage among different monetary centers. Finally, we show the relationship between the exchange rate and the nation's balance of payments.

14.3A Equilibrium Foreign Exchange Rates

Assume for simplicity that there are only two economies, the United States and the European Monetary Union (EMU), with the dollar ($) as the domestic currency and the euro (€) as

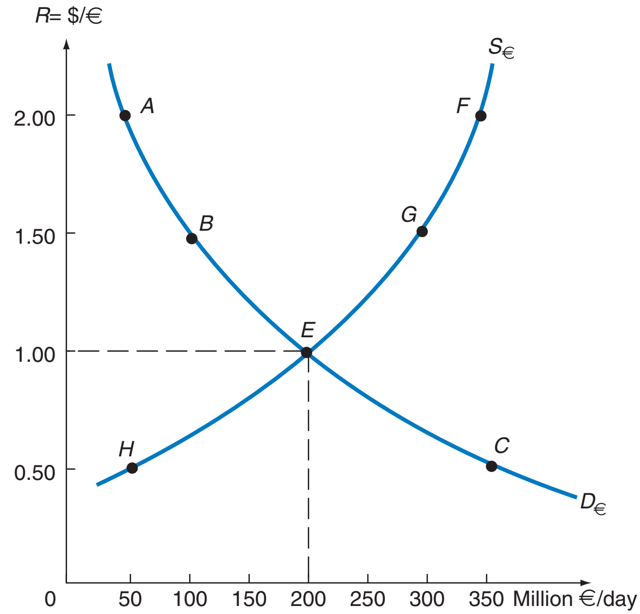

FIGURE 14.1. The Exchange Rate under a Flexible Exchange Rate System.
The vertical axis measures the dollar price of the euro (R = $/€), and the horizontal axis measures the quantity of euros. With a flexible exchange rate system, the equilibrium exchange rate is $R = 1$, at which the quantity demanded and the quantity supplied are equal at €200 million per day. This is given by the intersection at point E of the U.S. demand and supply curves for euros. At a higher exchange rate, a surplus of euros would result that would tend to lower the exchange rate toward the equilibrium rate. At an exchange rate lower than $R = 1$, a shortage of euros would result that would drive the exchange rate up toward the equilibrium level.

the foreign currency. The exchange rate (R) between the dollar and the euro is equal to the number of dollars needed to purchase one euro. That is, R = $/€. For example, if R = $/€ = 1, this means that one dollar is required to purchase one euro.

Under a flexible exchange rate system of the type we have today, the dollar price of the euro *(R)* is determined, just like the price of any commodity, by the intersection of the market demand and supply curves for euros. This is shown in Figure 14.1, where the vertical axis measures the dollar price of the euro, or the exchange rate, R = $/€, and the horizontal axis measures the quantity of euros. The market demand and supply curves for euros intersect at point E, defining the equilibrium exchange rate of $R = 1$, at which the quantity of euros demanded and the quantity supplied are equal at €200 million per day. At a higher exchange rate, the quantity of euros supplied exceeds the quantity demanded, and the exchange rate will fall toward the equilibrium rate of $R = 1$. At an exchange rate lower than $R = 1$, the quantity of euros demanded exceeds the quantity supplied, and the exchange rate will be bid up toward the equilibrium rate of $R = 1$. If the exchange rate were not allowed to rise to its equilibrium level (as under the fixed exchange rate system that prevailed until March 1973), then either restrictions would have to be imposed on the demand for euros of U.S. residents or the U.S. central bank (the Federal Reserve System) would have to fill or satisfy the excess demand for euros out of its international reserves.

The U.S. demand for euros is negatively inclined, indicating that the lower the exchange rate *(R)*, the greater the quantity of euros demanded by U.S. residents. The reason is that the lower the exchange rate (i.e., the fewer the number of dollars required to purchase a euro), the cheaper it is for U.S. residents to import from and to invest in the European Monetary Union, and thus the greater the quantity of euros demanded by U.S. residents. On the other hand, the U.S. supply of euros is usually positively inclined (see Figure 14.1), indicating that the higher the exchange rate *(R)*, the greater the quantity of euros earned by U.S. residents and supplied to the United States. The reason is that at higher exchange rates, EMU residents receive more dollars for each of their euros. As a result, they find U.S. goods and investments cheaper and more attractive and spend more in the United States, thus supplying more euros to the United States.

If the U.S. demand curve for euros shifted up (for example, as a result of increased U.S. tastes for EMU goods) and intersected the U.S. supply curve for euros at point G (see Figure 14.1), the equilibrium exchange rate would be $R = 1.50$, and the equilibrium quantity of euros would be €300 million per day. The dollar is then said to have depreciated since it now requires \$1.50 (instead of the previous \$1) to purchase one euro. Depreciation thus refers to an increase in the domestic price of the foreign currency. Conversely, if the U.S. demand curve for euros shifted down so as to intersect the U.S. supply curve for euros at point H (see Figure 14.1), the equilibrium exchange rate would fall to $R = 0.5$ and the dollar is said to have appreciated (because fewer dollars are now required to purchase one euro). Appreciation thus refers to a decline in the domestic price of the foreign currency. An appreciation of the domestic currency means a depreciation of the foreign currency and vice versa. Shifts in the U.S. supply curve for euros would similarly affect the equilibrium exchange rate and equilibrium quantity of euros (these are left as end-of-chapter problems).

The exchange rate could also be defined as the foreign currency price of a unit of the domestic currency. This is the inverse, or reciprocal, of our previous definition. Since in the case we examined previously, the dollar price of the euro is $R = 1$, its inverse is also 1. If the dollar price of the euro were instead $R = 2$, then the euro price of the dollar would be $1/R = 1/2$, or it would take half a euro to purchase one dollar. Although this definition of the exchange rate is sometimes used, we will use the previous one, or the dollar price of the euro *(R)*, unless clearly stated to the contrary. In the real world, the particular definition of the exchange rate being used is generally spelled out to avoid confusion (see Case Study 14-3).

Finally, while we have dealt with only two currencies for simplicity, in reality there are numerous exchange rates, one between any pair of currencies. Thus, besides the exchange rate between the U.S. dollar and the euro, there is an exchange rate between the U.S. dollar and the British pound (£), between the U.S. dollar and the Swiss franc, the Canadian dollar and the Mexican peso, the British pound and the euro, the euro and the Swiss franc, and between each of these currencies and the Japanese yen. Once the exchange rate between each of a pair of currencies with respect to the dollar is established, however, the exchange rate between the two currencies themselves, or cross-exchange rate, can easily be determined. For example, if the exchange rate *(R)* were 2 between the U.S. dollar and the British pound and 1.25 between the dollar and the euro, then the exchange rate between the pound and the euro would be 1.60 (i.e., it takes €1.6 to purchase 1£). Specifically,

$$R = €/£ = \frac{\$ \text{ value of } £}{\$ \text{ value of } €} = \frac{2}{1.25} = 1.60$$

CASE STUDY 14-3 Foreign Exchange Quotations

Table 14.2 gives the exchange or spot rate for various currencies with respect to the U.S. dollar for Friday May 25, 2012—defined first as the dollar price of the foreign currency (often referred to as in *direct* or "American" terms) and then as the foreign currency price of the dollar (i.e., in *indirect* or "European" terms). For example, next to the Euro area, we find that the direct spot rate was $1.2518/€1. On the same line, we find that the indirect or euro price of the dollar was €0.7988/$1. The last column of the table, headed "U.S. $ vs. YTD chg (%)," shows the percentage change in the exchange rate, year to date (YTD)—that is, from the beginning of the year. For example, the table shows that the dollar appreciated by 3.5 percent vis-à-vis the euro from the beginning of 2012 to May 25, 2012. Note that the main exchange rate table also gives the one-month, three-month, and six-month forward rate for the Australian dollar, the Japanese yen, the Swiss franc, and the British pound. These are discussed in Section 14.4A.

TABLE 14.2. Foreign Exchange Quotation, May 25, 2012

Currencies

U.S.-dollar foreign-exchange rates in late New York trading

Country/currency	—Thurs— in US$	—Thurs— per US$	US$ vs, YTD chg (%)
Americas			
Argentina peso*	.2239	4.4668	3.7
Brazil real	.5031	1.9877	6.5
Canada dollar	.9716	1.0293	0.8
Chile peso	.001965	509.00	−2.1
Colombia peso	.0005462	1831.00	−5.6
Ecuador US dollar	1	1	unch
Mexico peso*	.0713	14.0238	0.6
Peru new sol	.3711	2.695	−0.1
Uruguay peso†	.04975	20.1005	1.5
Venezuela b.fuerte	.229885	4.3500	unch
Asia-Pacific			
Australian dollar	.9759	1.0247	4.6
1-mos forward	.9730	1.0278	4.3
3-mos forward	.9681	1.0330	4.2
6-mos forward	.9618	1.0398	4.1
China yuan	.1578	6.3372	0.3
Hong Kong dollar	.1288	7.7634	unch
India rupee	.01806	55.375	4.4
Indonesia rupiah	.0001058	9450	4.6
Japan yen	.012549	79.68	3.6
1-mos forward	.012552	79.67	3.5
3-mos forward	.012561	79.61	3.6
6-mos forward	.012581	79.48	3.6
Malaysia ringglt	.3171	3.1532	−0.8
New Zealand dollar	.7537	1.3267	3.2
Pakistan rupee	.01086	92.055	2.5
Philippines peso	.0228	43.770	−0.2
Singapore dollar	.7804	1.2814	−1.2
South Korea won	.0008432	1185.90	2.2
Taiwan dollar	.03374	29.640	−2.1
Thailand baht	.03157	31.676	0.2
Vietnam dong	.00004796	20850	−0.9

Country/currency	—Thurs— in US$	—Thurs— per US$	US$ vs, YTD chg (%)
Europe			
Czech Rep. koruna**	.04933	20.273	2.6
Denmark krone	.1685	5.9355	3.5
Euro area euro	1.2518	.7988	3.5
Hungary forint	.004176	239.44	−1.5
Norway krone	.1662	6.0162	0.7
Poland zloty	.2868	3.4869	1.2
Russia ruble‡	.03119	32.064	−0.3
Sweden krona	.1393	7.1766	4.3
Switzerland franc	1.0422	.9595	2.4
1-mos forward	1.0427	.9590	2.3
3-mos forward	1.0443	.9576	2.3
6-mos forward	1.0472	.9549	2.3
Turkey lira**	.5407	1.8494	−3.5
UK pound	1.5660	.6386	−0.8
1-mos forward	1.5657	.6387	−0.8
3-mos forward	1.5652	.6389	−0.8
6-mos forward	1.5647	.6391	−0.9
Middle East/Africa			
Bahrain dinar	2.6532	.3769	unch
Egypt pound*	.1656	6.0372	−0.2
Israel shekel	.2593	3.8559	1.2
Jordan dinar	1.4119	.7083	−0.2
Kuwait dinar	3.5677	.2803	0.8
Lebanon pound	.0006651	1503.45	−0.1
Saudi Arabia riyal	.2666	3.7509	unch
South Africa rand	.1190	8.4028	3.9
UAE dirham	.2723	3.6730	unch

Source : *ICAPplc*.

*Floating rate † Financial §Government rate ‡Russian Central Bank rate **Commercial rate

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Since over time a currency can depreciate with respect to some currencies and appreciate against others, an effective exchange rate is calculated. This is a weighted average of the exchange rates between the domestic currency and that of the nation's most important trade partners, with weights given by the relative importance of the nation's trade with each of these trade partners (see Section 14.5A). Finally, we must also distinguish between the nominal exchange rate (the one we have been discussing) and the real exchange rate (to be discussed in Chapter 15).

14.3B Arbitrage

The exchange rate between any two currencies is kept the same in different monetary centers by arbitrage. This refers to the purchase of a currency in the monetary center where it is cheaper, for immediate resale in the monetary center where it is more expensive, in order to make a profit.

For example, if the dollar price of the euro was \$0.99 in New York and \$1.01 in Frankfurt, an arbitrageur (usually a foreign exchange dealer of a commercial bank) would purchase euros at \$0.99 in New York and immediately resell them in Frankfurt for \$1.01, thus realizing a profit of \$0.02 per euro. While the profit per euro transferred seems small, on €1 million the profit would be \$20,000 for only a few minutes work. From this profit must be deducted the cost of the electronic transfer and the other costs associated with arbitrage. Since these costs are very small, we shall ignore them here.

As arbitrage takes place, however, the exchange rate between the two currencies tends to be equalized in the two monetary centers. Continuing our example, we see that arbitrage increases the demand for euros in New York, thereby exerting an upward pressure on the dollar price of euros in New York. At the same time, the sale of euros in Frankfurt increases the supply of euros there, thus exerting a downward pressure on the dollar price of euros in Frankfurt. This continues until the dollar price of the euro quickly becomes equal in New York and Frankfurt (say at \$1 = €1), thus eliminating the profitability of further arbitrage.

When only two currencies and two monetary centers are involved in arbitrage, as in the preceding example, we have *two-point arbitrage*. When three currencies and three monetary centers are involved, we have *triangular*, or *three-point, arbitrage*. While triangular arbitrage is not very common, it operates in the same manner to ensure *consistent indirect*, or *cross, exchange rates* between the three currencies in the three monetary centers. For example, suppose exchange rates are as follows:

$$\$1 = €1 \text{ in New York}$$
$$€1 = £0.64 \text{ in Franfurt}$$
$$£0.64 = \$1 \text{ in London}$$

These cross rates are consistent because

$$\$1 = €1 = £0.64$$

and there is no possibility of profitable arbitrage. However, if the dollar price of the euro were \$0.96 in New York, with the other exchange rates as indicated previously, then it would pay to use \$0.96 to purchase €1 in New York, use the €1 to buy £0.64 in Frankfurt, and exchange the £0.64 for \$1 in London, thus realizing a \$0.04 profit on each euro so transferred. On the other hand, if the dollar price of the euro was \$1.04 in New York, it would pay to do just the opposite—that is, use \$1 to purchase £0.64 in London, exchange the £0.64 for €1 in Frankfurt, and exchange the €1 for \$1.04 in New York, thus making a profit of \$0.04 on each euro so transferred.

As in the case of two-point arbitrage, triangular arbitrage increases the demand for the currency in the monetary center where the currency is cheaper, increases the supply of the currency in the monetary center where the currency is more expensive, and quickly eliminates inconsistent cross rates and the profitability of further arbitrage. As a result, arbitrage quickly equalizes exchange rates for each pair of currencies and results in consistent cross rates among all pairs of currencies, thus unifying all international monetary centers into a single market.

14.3c The Exchange Rate and the Balance of Payments

We can examine the relationship between the exchange rate and the nation's balance of payments with Figure 14.2, which is identical to Figure 14.1 except for the addition of the new demand curve for euros labeled $D'_€$. We have seen in Chapter 13 that the U.S. demand for euros ($D_€$) arises from the U.S. demand for imports of goods and services from the European Union, from U.S. unilateral transfers to the European Union, and from U.S.

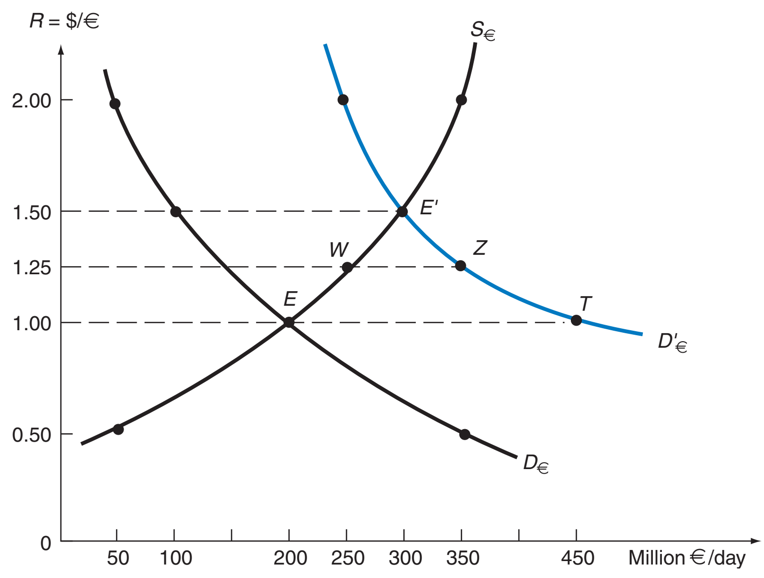


FIGURE 14.2. Disequilibrium under a Fixed and a Flexible Exchange Rate System.
With $D_€$ and $S_€$, equilibrium is at point E at the exchange rate of $R = \$/€ = 1$, at which the quantities of euros demanded and supplied are equal at €200 million per day. If $D_€$ shifted up to $D'_€$, the United States could maintain the exchange rate at $R = 1$ by satisfying (out of its official euro reserves) the excess demand of €250 million per day (*TE* in the figure). With a freely flexible exchange rate system, the dollar would depreciate until $R = 1.50$ (point E' in the figure). If, on the other hand, the United States wanted to limit the depreciation of the dollar to $R = 1.25$ under a managed float, it would have to satisfy the excess demand of €100 million per day (*WZ* in the figure) out of its official euro reserves.

investments in the European Monetary Union (a capital outflow from the United States). These are the autonomous debit transactions of the United States that involve payments to the European Monetary Union.

On the other hand, the supply of euros ($S_€$) arises from U.S. exports of goods and services to the European Monetary Union, from unilateral transfers received from the European Monetary Union, and from the EMU investments in the United States (a capital inflow to the United States). These are the autonomous credit transactions of the United States that involve payments from the European Monetary Union. (We are assuming for simplicity that the United States and the European Monetary Union are the only two economies in the world and that all transactions between them take place in euros.)

With $D_€$ and $S_€$, the equilibrium exchange rate is $R = \$/€ = 1$ (point E in Figure 14.2), at which €200 million are demanded and supplied per day (exactly as in Figure 14.1). Now suppose that for whatever reason (such as an increase in U.S. tastes for EMU products) the U.S. autonomous demand for euros shifts up to $D'_€$. If the United States wanted to maintain the exchange rate fixed at $R = 1$, U.S. monetary authorities would have to satisfy the excess demand for euros of TE (€250 million per day in Figure 14.2) out of its official reserve holdings of euros. Alternatively, EMU monetary authorities would have to purchase dollars (thus adding to their official dollar reserves) and supply euros to the foreign exchange market to prevent an appreciation of the euro (a depreciation of the dollar). In either case, the U.S. official settlements balance would show a deficit of €250 million ($250 million at the official exchange rate of $R = 1$) per day, or €91.25 billion ($91.25 billion) per year.

If, however, the United States operated under a freely flexible exchange rate system, the exchange rate would rise (i.e., the dollar would depreciate) from $R = 1.00$ to $R = 1.50$, at which the quantity of euros demanded (€300 million per day) exactly equals the quantity supplied (point E' in Figure 14.2). In this case, the United States would not lose any of its official euro reserves. Indeed, international reserves would be entirely unnecessary under such a system. The tendency for an excess demand for euros on autonomous transactions would be completely eliminated by a sufficient depreciation of the dollar with respect to the euro.

However, under a managed floating exchange rate system of the type in operation since 1973, U.S. monetary authorities can intervene in foreign exchange markets to moderate the depreciation (or appreciation) of the dollar. In the preceding example, the United States might limit the depreciation of the dollar to $R = 1.25$ (instead of letting the dollar depreciate all the way to $R = 1.50$ as under a freely fluctuating exchange rate system). The United States could do this by supplying to the foreign exchange market the excess demand for euros of WZ, or €100 million per day, out of its official euro reserves (see the figure). Under such a system, part of the potential deficit in the U.S. balance of payments is covered by the loss of official reserve assets of the United States, and part is reflected in the form of a depreciation of the dollar. Thus, we cannot now measure the deficit in the U.S. balance of payments by simply measuring the loss of U.S. international reserves or by the amount of the net credit balance in the official reserve account of the United States. Under a managed float, the loss of official reserves only indicates the degree of official intervention in foreign exchange markets to influence the level and movement of exchange rates, and not the balance-of-payments deficit.

For this reason, since 1976 the United States has suspended the calculation of the balance-of-payments deficit or surplus. The statement of international transactions does not even show the net balance on the official reserve account (although it can be easily calculated) in order to be neutral and not to focus undue attention on such a balance, in view of the present system of floating but managed exchange rates (see Table 13.1).

The concept and measurement of international transactions and the balance of payments are still very important and useful, however, for several reasons. First, as pointed out in Chapter 13, the flow of trade provides the link between international transactions and the national income. (This link is examined in detail in Chapter 17.) Second, many developing countries still operate under a fixed exchange rate system and peg their currency to a major currency, such as the U.S. dollar and the euro, or to SDRs. Third, the International Monetary Fund requires all member nations to report their balance-of-payments statement annually to it (in the specific format shown in Section A13.1). Finally, and perhaps more important, while not measuring the deficit or surplus in the balance of payments, the balance of the official reserve account gives an indication of the degree of intervention by the nation's monetary authorities in the foreign exchange market to reduce exchange rate volatility and to influence exchange rate levels.

14.4 Spot and Forward Rates, Currency Swaps, Futures, and Options

In this section we distinguish between spot and forward exchange rates and examine their significance. Then we discuss foreign exchange swaps, futures, and options and their uses.

14.4A Spot and Forward Rates

The most common type of foreign exchange transaction involves the payment and receipt of the foreign exchange within two bussiness days after the day the transaction is agreed upon. The two-day period gives adequate time for the parties to send instructions to debit and credit the appropriate bank accounts at home and abroad. This type of transaction is called a *spot transaction*, and the exchange rate at which the transaction takes place is called the spot rate. The exchange rate $R = \$/€ = 1$ in Figure 14.1 is a spot rate.

Besides spot transactions, there are forward transactions. A *forward transaction* involves an agreement today to buy or sell a specified amount of a foreign currency at a specified future date at a rate agreed upon today (the forward rate). For example, I could enter into an agreement today to purchase €100 three months from today at $1.01 = €1. Note that no currencies are paid out at the time the contract is signed (except for the usual 10 percent security margin). After three months, I get the €100 for $101, regardless of what the spot rate is at that time. The typical forward contract is for one month, three months, or six months, with three months the most common (see Case Study 14-3). Forward contracts for longer periods are not as common because of the great uncertainties involved. However, forward contracts can be renegotiated for one or more periods when they become due. In what follows, we will deal exclusively with three-month forward contracts and rates, but the procedure would be the same for forward contracts of different duration.

The equilibrium forward rate is determined at the intersection of the market demand and supply curves of foreign exchange *for future delivery*. The demand for and supply of forward foreign exchange arise in the course of hedging, from foreign exchange speculation, and from covered interest arbitrage. These, as well as the close relationship between the spot rate and the forward rate, are discussed next in Sections 14.5 and 14.6. All that needs to be said here is that, at any point in time, the forward rate can be equal to, above, or below the corresponding spot rate.

If the forward rate is below the present spot rate, the foreign currency is said to be at a forward discount with respect to the domestic currency. However, if the forward rate is above the present spot rate, the foreign currency is said to be at a forward premium. For example, if the spot rate is \$1 = €1 and the three-month forward rate is \$0.99 = €1, we say that the euro is at a three-month forward discount of 1 cent or 1 percent (or at a 4 percent forward discount per year) with respect to the dollar. On the other hand, if the spot rate is still \$1 = €1 but the three-month forward rate is instead \$1.01 = €1, the euro is said to be at a forward premium of 1 cent or 1 percent for three months, or 4 percent per year.

Forward discounts *(FD)* or premiums *(FP)* are usually expressed as percentages per year from the corresponding spot rate and can be calculated formally with the following formula:

$$FD \text{ or } FP = \frac{FR - SR}{SR} \times 4 \times 100$$

where FR is the forward rate and SR is the spot rate (what we simply called R in the previous section). The multiplication by 4 is to express the $FD(-)$ or $FP(+)$ on a yearly basis, and the multiplication by 100 is to express the FD or FP in percentages. Thus, when the spot rate of the pound is $SR = \$1.00$ and the forward rate is $FR = \$0.99$, we get

$$FD = \frac{\$0.99 - \$1.00}{\$1.00} \times 4 \times 100 = \frac{-\$0.01}{\$1.00} \times 4 \times 100$$
$$= -0.01 \times 4 \times 100 = -4\%$$

the same as found earlier without the formula. Similarly, if $SR = \$1$ and $FR = \$1.01$:

$$FP = \frac{\$1.01 - \$1.00}{\$1.00} \times 4 \times 100 = \frac{\$0.01}{\$1.00} \times 4 \times 100$$
$$= 0.01 \times 4 \times 100 = +4\%$$

14.4B Foreign Exchange Swaps

A foreign exchange swap refers to a spot sale of a currency combined with a forward repurchase of the same currency—as part of a single transaction. For example, suppose that Citibank receives a \$1 million payment today that it will need in three months, but in the meantime it wants to invest this sum in euros. Citibank would incur lower brokerage fees by swapping the \$1 million into euros with Frankfurt's Deutsche Bank as part of a single transaction or deal, instead of selling dollars for euros in the spot market today and at the same time repurchasing dollars for euros in the forward market for delivery in three months—in two separate transactions. The *swap rate* (usually expressed on a yearly basis) is the difference between the spot and forward rates in the currency swap.

Most interbank trading involving the purchase or sale of currencies for future delivery is done not by forward exchange contracts alone but combined with spot transactions in the form of foreign exchange swaps. In April 2010, there were $1,765 billion worth of foreign exchange swaps outstanding. These represented 44 percent of total interbank currency trading. Spot transactions were $1,490 billion or 37 percent of the total. Thus, the foreign exchange market is dominated by the foreign exchange swap and spot markets.

14.4c Foreign Exchange Futures and Options

An individual, firm, or bank can also purchase or sell foreign exchange futures and options. Trading in foreign exchange futures was initiated in 1972 by the International Monetary Market (IMM) of the Chicago Mercantile Exchange (CME). A foreign exchange futures is a forward contract for standardized currency amounts and selected calendar dates traded on an organized market (exchange). The currencies traded on the IMM are the Japanese yen, the Canadian dollar, the British pound, the Swiss franc, the Australian dollar, the Mexican peso, and the euro.

International Monetary Market trading is done as contracts of standard size. For example, the IMM Japanese yen contract is for ¥12.5 million, the Canadian dollar contract is for C$100,000, the pound contract is for £62,500, and the euro contract is for €125,000. Only four dates per year are available: the third Wednesday in March, June, September, and December (see Case Study 14-4). The IMM imposes a daily limit on exchange rate fluctuations. Buyers and sellers pay a brokerage commission and are required to post a security deposit or margin (about 4 percent of the value of the contract). A market similar to the IMM is the NYSE Euronext Liffe and the Frankfurt-based Eurex.

The *futures market* differs from a forward market in that in the futures market only a few currencies are traded; trades occur in standardized contracts only, for a few specific delivery dates, and are subject to daily limits on exchange rate fluctuations; and trading takes place only in a few geographical locations, such as Chicago, New York, London, Frankfurt, and Singapore. Futures contracts are usually for smaller amounts than forward contracts and thus are more useful to small firms than to large ones but are somewhat more expensive. Futures contracts can also be sold at any time up until maturity on an organized futures market, while forward contracts cannot. While the market for currency futures is small compared with the forward market, it has grown very rapidly, especially in recent years. (The value of currency futures outstanding was about $475 billion in April 2010). The two markets are also connected by arbitrage when prices differ.

Since 1982, individuals, firms, and banks have also been able to buy foreign exchange options (in Japanese yen, Canadian dollars, British pounds, Swiss francs, and euros) on the Philadelphia Stock Exchange, the Chicago Mercantile Exchange (since 1984), or from a bank. A foreign exchange option is a contract giving the purchaser the right, but not the obligation, to buy (a *call option*) or to sell (a *put option*) a standard amount of a traded currency on a stated date (the *European option*) or at any time before a stated date (the *American option*) and at a stated price (the *strike* or *exercise price*). Foreign exchange options are in standard sizes equal to those of futures IMM contracts. The buyer of the option has the choice to purchase or forego the purchase if it turns out to be unprofitable. The seller of the option, however, must fulfill the contract if the buyer so desires. The buyer pays the seller a premium (the option price) ranging from 1 to 5 percent of the contract's value for this privilege when he or she enters the contract. About $207 billion of currency options were outstanding in April 2010.

CASE STUDY 14-4 Size, Currency, and Geographic Distribution of the Foreign Exchange Market

Table 14.3 gives data on the size, currency, and geographical distribution of the foreign exchange market in 2010. The table shows that average daily spot transactions amounted to $1,490 billion or 37.4 percent of the total market turnover, outright forwards (forward transactions or futures) were $475 billion or 11.9 percent of the total, foreign exchange swaps were $1,765 billion or 44.3 percent, currency swaps (foreign exchange derivatives) were $43 billion or 1.1 percent, and options and other products were $207 billion or 5.2 percent, for a grand total foreign exchange market of $3,981 billion in 2010. The table also shows that the share of the U.S. dollar was more than twice that of the euro and more than four that of the Japanese yen and more than six times that of the British pound (the two currencies most used after the dollar and the euro). The United Kingdom (mostly London) had the largest share of the market with 36.7 percent followed by the United States (mostly New York, Chicago, and Philadelphia) with 17.9 percent share.

TABLE 14.3. Average Daily Global Foreign Exchange Market Turnover, Currency, and Geographic Distribution in 2010

Market Turnover[a]			Currency Distribution		Geographic Distribution	
	Value (billion $)	% of Total	Currency	% Share[b]	Nation	% Share
Spot transactions	1,490	37.4	U.S. dollar	84.9	United Kingdom	36.7
Outright forwards	475	11.9	Euro	39.1	United States	17.9
Foreign exchange swaps	1,765	44.3	Japanese yen	19.0	Japan	6.2
Currency swaps	43	1.1	British pound	12.9	Singapore	5.3
Options and other products	207	5.2	Australian dollar	7.6	Switzerland	5.2
Total	3,981	100.0	Swiss franc	6.4	Hong Kong	4.7
			Canadian dollar	5.3	Australia	3.8
			Hong Kong dollar	2.4	France	3.0
			Other	22.4	Other	17.2
			Total	200.0	Total	100.0

[a]Daily averages in April, in billions of U.S. dollars; total does not add up because of rounding.
[b]Total market shares sum to 200 percent rather than to 100 percent because each transaction involves two currencies.
Source: Bank for International Settlements, *Triennial Central Bank Survey* (Basel: BIS), December 2010.

In contrast, neither forward contracts nor futures are options. Although forward contracts can be reversed (e.g., a party can sell a currency forward to neutralize a previous purchase) and futures contracts can be sold back to the futures exchange, both must be exercised (i.e., both contracts must be honored by both parties on the delivery date). Thus, options are less flexible than forward contracts, but in some cases they may be more useful. For example, an American firm making a bid to take over an EMU firm may be required to promise to pay a specified amount in euros. Since the American firm does not know if its bid will be successful, it will purchase an option to buy the euros that it would need and will exercise the option if the bid is successful. Case Study 14-4 gives the average daily distribution of global foreign exchange market turnover by instrument, by currency, and by geographical location.

14.5 Foreign Exchange Risks, Hedging, and Speculation

In this section, we examine the meaning of foreign exchange risks and how they can be avoided or covered by individuals and firms whose main business is not speculation. We then discuss how speculators attempt to earn a profit by trying to anticipate future foreign exchange rates.

14.5A Foreign Exchange Risks

Through time, a nation's demand and supply curves for foreign exchange shift, causing the spot (and the forward) rate to vary frequently. A nation's demand and supply curves for foreign exchange shift over time as a result of changes in tastes for domestic and foreign products in the nation and abroad, different growth and inflation rates in different nations, changes in relative rates of interest, changing expectations, and so on.

For example, if U.S. tastes for EMU products increase, the U.S. demand for euros increases (the demand curve shifts up), leading to a rise in the exchange rate (i.e., a depreciation of the dollar). On the other hand, a lower rate of inflation in the United States than in the European Monetary Union leads to U.S. products becoming cheaper for EMU residents. This tends to increase the U.S. supply of euros (the supply curve shifts to the right) and causes a decline in the exchange rate (i.e., an appreciation of the dollar). Or simply the expectation of a stronger dollar may lead to an appreciation of the dollar. In short, in a dynamic and changing world, exchange rates frequently vary, reflecting the constant change in the numerous economic forces simultaneously at work.

Figure 14.3 shows the great variation in exchange rates of the U.S. dollar with respect to the Japanese yen, the euro, the British pound, and the Canadian dollar from 1971 to 2005. Note that the exchange rate is here defined from the foreign nation's point of view (i.e., it is the foreign-currency price of the U.S. dollar), so that an increase in the exchange rate refers to a depreciation of the foreign currency (it takes more units of the foreign currency to purchase one dollar), while a reduction in the exchange rate refers to an appreciation of the foreign currency (and depreciation of the dollar).

The first panel of Figure 14.3 shows the sharp appreciation of the Japanese yen with respect to the U.S. dollar from about 360 yen per dollar in 1971 to 180 yen in fall 1978. The yen exchange rate then rose (i.e., the yen depreciated) to 260 yen per dollar in fall 1982 and again in spring 1985, but then it declined almost continuously until only slightly above 80 yen per dollar in spring of 1995; it stayed in the range 109 to 125 yen per dollar between 1996 and 2007, and it averaged 82 yen per dollar in March 2012.

The second panel of Figure 14.3 shows that the euro depreciated sharply from \$1.17/€, the value at which it was introduced on January 1, 1999, to \$0.85/€ in October 2000, but then it appreciated just as sharply from the beginning of 2002 to reach the high of \$1.36/€ in December 2004. The euro then depreciated to an average of \$1.25/€ in 2005, it rose to the all-time peak of \$1.58/€ in July 2008, but then it depreciated to \$1.32/€ in March 2012. Note that the euro dollar exchange rate in Figure 14.3 is defined as the dollar price of the euro (rather than the other way around, as for the exchange rate of the other currencies shown in Figure 14.3). Note also the sharp depreciation of the British pound with respect to the U.S. dollar from 1980 to 1985 (and in 2008) and the sharp appreciation of the Canadian dollar with respect to the U.S. from 2002 to the beginning of 2008 (and depreciation in fall 2008, followed by appreciation).

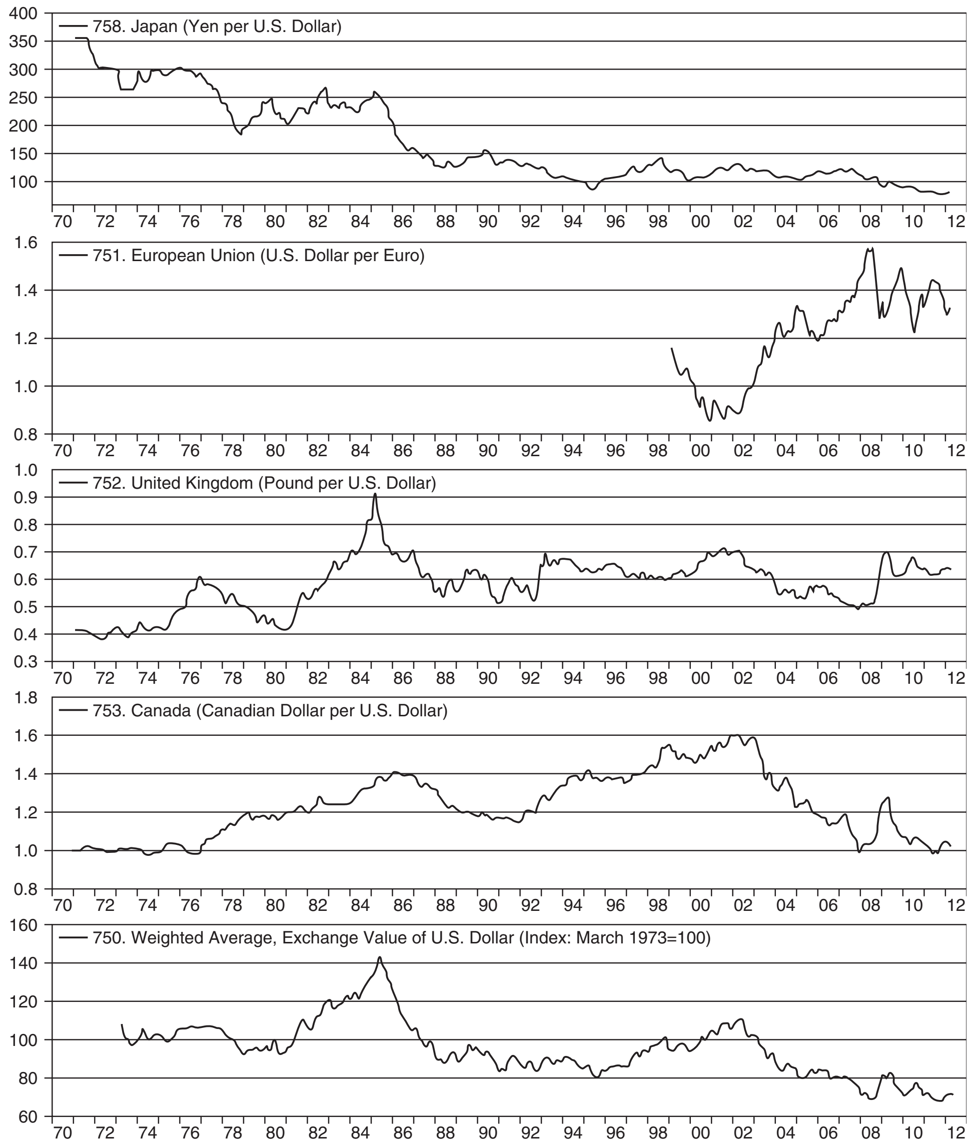


FIGURE 14.3. The Exchange Rate of Major Currencies and the Dollar Effective Exchange Rate, 1970–2012.

The top four panels of the figure show the fluctuations of the exchange rate of the Japanese yen, the euro, the British pound, and the Canadian dollar with respect to the dollar from 1970 to 2009 (the euro only from its creation at the beginning of 1999). The exchange rate used is the foreign-currency value of the dollar (so that an increase in the exchange rate refers to a depreciation of the foreign currency and appreciation of the dollar), except for the euro. The bottom panel shows the effective exchange rate of the dollar defined as the weighted average of the foreign-currency value of the dollar, with March 1973 = 100. The figure shows the wide fluctuations of exchange rates from 1970 to 2012.

Source: The Conference Board, *Business Cycle Indicators*, April 2012, p. 23.

The bottom panel of Figure 14.3 shows the effective exchange rate of the dollar (defined as the weighted average foreign-currency value of the dollar, with March 1973 = 100). The index is useful because the exchange rate between the U.S. dollar and the various currencies changed by different amounts and sometimes in different directions over time. The sharp depreciation of the other currencies and appreciation of the dollar from the beginning of 1980 until the beginning of 1985, as well as the appreciation of the other currencies and depreciation of the dollar from the beginning of 1985 until the end of 1987, are clearly shown in the figure. Although less spectacularly, the effective exchange rate of the dollar has also fluctuated a great deal since 1987, and it was 75 in March 2012 (see Figure 14.3).

The frequent and relatively large fluctuations in exchange rates shown in Figure 14.3 impose foreign exchange risks on all individuals, firms, and banks that have to make or receive future payments denominated in a foreign currency. For example, suppose a U.S. importer purchases €100,000 worth of goods from the European Monetary Union and has to pay in three months in euros. If the present spot rate of the pound is $SR = \$1/€1$, the current dollar value of the payment that he or she must make in three months is $100,000. However, in three months the spot rate might change to $SR = \$1.10/€1$. Then the importer would have to pay $110,000, or $10,000 more, for the imports. Of course, in three months the spot rate might be $SR = \$0.90/€1$, in which case the importer would have to pay only $90,000, or $10,000 less than anticipated. However, the importer has enough to worry about in the import business without also having to deal with this exchange risk. As a result, the importer will usually want to insure against an increase in the dollar price of the euro (i.e., an increase in the spot rate) in three months.

Similarly, a U.S. exporter who expects to receive a payment of €100,000 in three months will receive only $90,000 (instead of the $100,000 that he or she anticipates at today's spot rate of $SR = \$1/€1$) if the spot rate in three months is $SR = \$0.90/€1$. Once again, the spot rate could be higher in three months than it is today so that the exporter would receive more than anticipated. However, the exporter, like the importer, will usually want to avoid (at a small cost) the exchange risk that he or she faces. Another example is provided by an investor who buys euros at today's spot rate in order to invest in three-month EMU treasury bills paying a higher rate than U.S. treasury bills. However, in three months, when the investor wants to convert euros back into dollars, the spot rate may have fallen sufficiently to wipe out most of the extra interest earned on the EMU bills or even produce a loss.

These three examples clearly show that whenever a future payment must be made or received in a foreign currency, a foreign exchange risk, or a so-called open position, is involved because spot exchange rates vary over time. In general, businesspeople are risk averse and will want to avoid or insure themselves against their foreign exchange risk. (Note that arbitrage does not involve any exchange risk since the currency is bought at the cheaper price in one monetary center to *be resold immediately* at the higher price in another monetary center.) A foreign exchange risk arises not only from transactions involving future payments and receipts in a foreign currency (the *transaction exposure*), but also from the need to value inventories and assets held abroad in terms of the domestic currency for inclusion in the firm's consolidated balance sheet (the *translation* or *accounting exposure*), and in estimating the domestic currency value of the future profitability of the firm (the *economic exposure*). In what follows, we concentrate on the transaction exposure or risk.

14.5B Hedging

Hedging refers to the avoidance of a foreign exchange risk, or the covering of an open position. For example, the importer of the previous example could borrow €100,000 at the present spot rate of $SR = \$1/€1$ and leave this sum on deposit in a bank (to earn interest) for three months, when payment is due. By so doing, the importer avoids the risk that the spot rate in three months will be higher than today's spot rate and that he or she would have to pay more than $100,000 for the imports. The cost of insuring against the foreign exchange risk in this way is the positive difference between the interest rate the importer has to pay on the loan of €100,000 and the lower interest rate he or she earns on the deposit of €100,000. Similarly, the exporter could borrow €100,000 today, exchange this sum for $100,000 at today's spot rate of $SR = \$1/€1$, and deposit the $100,000 in a bank to earn interest. After three months, the exporter would repay the loan of €100,000 with the payment of €100,000 he or she receives. The cost of avoiding the foreign exchange risk in this manner is, once again, equal to the positive difference between the borrowing and deposit rates of interest.

Covering the foreign exchange risk in the spot market as indicated above has a very serious disadvantage, however. The businessperson or investor must borrow or tie up his or her own funds for three months. To avoid this, hedging usually takes place in the forward market, where no borrowing or tying up of funds is required. Thus, the importer could buy euros forward for delivery (and payment) in three months at today's three-month forward rate. If the euro is at a three-month forward premium of 4 percent per year, the importer will have to pay $101,000 in three months for the €100,000 needed to pay for the imports. Therefore, the hedging cost will be $1,000 (1 percent of $100,000 for the three months). Similarly, the exporter could sell pounds forward for delivery (and payment) in three months at today's three-month forward rate, in anticipation of receiving the payment of €100,000 for the exports. Since no transfer of funds takes place until three months have passed, the exporter need not borrow or tie up his or her own funds now. If the euro is at a three-month forward discount of 4 percent per year, the exporter will get only $99,000 for the €100,000 he or she delivers in three months. On the other hand, if the euro is at a 4 percent forward premium, the exporter will receive $101,000 in three months with certainty by hedging.

A foreign exchange risk can also be hedged and an open position avoided in the futures or options markets. For example, suppose that an importer knows that he or she must pay €100,000 in three months and the three-month forward rate of the pound is $FR = \$1/€1$. The importer could either purchase the €100,000 forward (in which case he or she will have to pay $100,000 in three months and receive the €100,000) or purchase an option to purchase €100,000 in three months, say at $1/€1, and pay now the premium of, say, 1 percent (or $1,000 on the $100,000 option). If in three months the spot rate of the pound is $SR = \$0.98/€1$, the importer would have to pay $100,000 with the forward contract, but could let the option expire unexercised and get the €100,000 at the cost of only $98,000 on the spot market. In that case, the $1,000 premium can be regarded as an insurance policy and the importer will save $2,000 over the forward contract.

In a world of foreign exchange uncertainty, the ability of traders and investors to hedge greatly facilitates the international flow of trade and investments. Without hedging there would be smaller international capital flows, less trade and specialization in production, and smaller benefits from trade. Note that a large firm, such as a multinational corporation, that has to make and receive a large number of payments in the same foreign currency at the same time in the future need only hedge its net open position. Similarly, a bank has an open position only in the amount of its net balance on contracted future payments and receipts in each foreign currency at each future date. The bank closes as much of its open positions as possible by dealing with other banks (through foreign exchange brokers), and it may cover the remainder in the spot, futures, or options markets.

14.5c Speculation

Speculation is the opposite of hedging. Whereas a hedger seeks to cover a foreign exchange risk, a speculator accepts and even seeks out a foreign exchange risk, or an open position, in the hope of making a profit. If the speculator correctly anticipates future changes in spot rates, he or she makes a profit; otherwise, he or she incurs a loss. As in the case of hedging, speculation can take place in the spot, forward, futures, or options markets—usually in the forward market. We begin by examining speculation in the spot market.

If a speculator believes that the spot rate of a particular foreign currency will rise, he or she can purchase the currency now and hold it on deposit in a bank for resale later. If the speculator is correct and the spot rate does indeed rise, he or she earns a profit on each unit of the foreign currency equal to the spread between the previous lower spot rate at which he or she purchased the foreign currency and the higher subsequent spot rate at which he or she resells it. If the speculator is wrong and the spot rate falls instead, he or she incurs a loss because the foreign currency must be resold at a price lower than the purchase price.

If, on the other hand, the speculator believes that the spot rate will fall, he or she borrows the foreign currency for three months, immediately exchanges it for the domestic currency at the prevailing spot rate, and deposits the domestic currency in a bank to earn interest. After three months, if the spot rate on the foreign currency is lower, as anticipated, the speculator earns a profit by purchasing the currency (to repay the foreign exchange loan) at the lower spot rate. (Of course, for the speculator to earn a profit, the new spot rate must be sufficiently lower than the previous spot rate to also overcome the possibly higher interest rate paid on a foreign currency deposit over the domestic currency deposit.) If the spot rate in three months is higher rather than lower, the speculator incurs a loss.

In both of the preceding examples, the speculator operated in the spot market and either had to tie up his or her own funds or had to borrow to speculate. It is to avoid this serious shortcoming that speculation, like hedging, usually takes place in the forward market. For example, if the speculator believes that the spot rate of a certain foreign currency will be higher in three months than its present three-month forward rate, the speculator purchases a specified amount of the foreign currency forward for delivery (and payment) in three months. After three months, if the speculator is correct, he or she receives delivery of the foreign currency at the lower agreed forward rate and immediately resells it at the higher spot rate, thus realizing a profit. Of course, if the speculator is wrong and the spot rate in three months is lower than the agreed forward rate, he or she incurs a loss. In any event, no currency changes hands until the three months are over (except for the normal 10 percent security margin that the speculator is required to pay at the time he or she signs the forward contract).

As another example, suppose that the three-month forward rate on the euro is $FR =$ \$1.01/€1 and the speculator believes that the spot rate of the euro in three months will be

SR = \$0.99/€1. The speculator then sells euros forward for delivery in three months. After three months, if the speculator is correct and the spot rate is indeed as anticipated, he or she purchases euros in the spot market at *SR* = \$0.99/€1 and immediately resells them to fulfill the forward contract at the agreed forward rate of \$1.01/€1, thereby earning a profit of 2 cents per euro. If the spot rate in three months is instead *SR* = \$1.00/€1, the speculator earns only 1 cent per euro. If the spot rate in three months is \$1.01/€1, the speculator earns nothing. Finally, if the spot rate in three months is higher than the forward rate at which the speculator sold the forward euros, the speculator incurs a loss on each euro equal to the difference between the two rates.

As an alternative, the speculator (who believes that the euro will depreciate) could have purchased an option to sell a specific amount of euros in three months at the rate of, say, \$1.01/€1. If the speculator is correct and the spot rate of the euro in three months is indeed \$0.99/€1 as anticipated, he or she will exercise the option, buy euros in the spot market at \$0.99/€1, and receive \$1.01/€1 by exercising the option. By so doing, the speculator earns 2 cents per euro (from which he or she deducts the premium or the option price to determine the net gain). In this case, the result will be the same as with the forward contract, except that the option price may exceed the commission on the forward contract so that his or her net profit with the option may be a little less. On the other hand, if the speculator is wrong and the spot rate of the euro is much higher than expected after three months, he or she will let the option contract expire unexercised and incur only the cost of the premium or option price. With the forward contract, the speculator would have to honor his or her commitment and incur a much larger loss.

When a speculator buys a foreign currency on the spot, forward, or futures market, or buys an option to purchase a foreign currency in the expectation of reselling it at a higher future spot rate, he or she is said to take a *long position* in the currency. On the other hand, when the speculator borrows or sells forward a foreign currency in the expectation of buying it at a future lower price to repay the foreign exchange loan or honor the forward sale contract or option, the speculator is said to take a *short position* (i.e., the speculator is now selling what he or she does not have).

Speculation can be stabilizing or destabilizing. Stabilizing speculation refers to the *purchase* of a foreign currency when the domestic price of the foreign currency (i.e., the exchange rate) falls or is low, in the expectation that it will soon rise, thus leading to a profit. Or it refers to the sale of the foreign currency when the exchange rate rises or is high, in the expectation that it will soon fall. Stabilizing speculation moderates fluctuations in exchange rates over time and performs a useful function.

On the other hand, destabilizing speculation refers to the *sale* of a foreign currency when the exchange rate falls or is low, in the expectation that it will fall even lower in the future, or the purchase of a foreign currency when the exchange rate is rising or is high, in the expectation that it will rise even higher in the future. Destabilizing speculation thus magnifies exchange rate fluctuations over time and can prove very disruptive to the international flow of trade and investments. Whether speculation is primarily stabilizing or destabilizing is a very important question, to which we return in Chapter 16, when we analyze in depth the operation of a flexible exchange rate system, and in Chapter 20, when we compare the operation of a flexible exchange rate system with that of a fixed exchange rate system. In general, it is believed that under "normal" conditions speculation is stabilizing, and we assume so here.

Speculators are usually wealthy individuals or firms rather than banks. However, anyone who has to make a payment in a foreign currency in the future can speculate by speeding up payment if he or she expects the exchange rate to rise and delaying it if he or she expects the exchange rate to fall, while anyone who has to receive a future payment in a foreign currency can speculate by using the reverse tactics. For example, if an importer expects the exchange rate to rise soon, he or she can anticipate the placing of an order and pay for imports right away. On the other hand, an exporter who expects the exchange rate to rise will want to delay deliveries and extend longer credit terms to delay payment. These are known as *leads* and *lags* and are a form of speculation.

In recent years, a number of huge losses have been incurred by speculating on the movement of exchange rates. One of the most spectacular was the case of Showaka Shell Sekiyu, a Japanese oil refiner and distributor 50 percent owned by Royal Dutch Shell. From 1989 until 1992, the finance department of Showaka bet $6.44 billion worth in the futures market that the dollar would appreciate. When the dollar depreciated (and the yen appreciated—see Figure 14.3) instead, Showaka lost $1.37 billion. More recently, there was the five-year $750 million cumulative foreign exchange loss by John Rusnak of Allfirst Bank, the U.S. subsidiary of Allied Irish Banks, Ireland's largest bank, on trading the U.S. dollar against the Japanese yen discovered in February 2002. And in January 2004, four foreign currency dealers at the National Australia Bank incurred losses of $360 million in three months of unauthorized foreign exchange trades. Yes, speculation in foreign exchange is very risky and can lead to huge losses.

14.6 Interest Arbitrage and the Efficiency of Foreign Exchange Markets

Interest arbitrage refers to the international flow of short-term liquid capital to earn higher returns abroad. Interest arbitrage can be covered or uncovered. These are discussed in turn. We will then examine the covered interest parity theory and the efficiency of foreign exchange markets.

14.6A Uncovered Interest Arbitrage

Since the transfer of funds abroad to take advantage of higher interest rates in foreign monetary centers involves the conversion of the domestic to the foreign currency to make the investment, and the subsequent reconversion of the funds (plus the interest earned) from the foreign currency to the domestic currency at the time of maturity, a foreign exchange risk is involved due to the possible depreciation of the foreign currency during the period of the investment. If such a foreign exchange risk is covered, we have covered interest arbitrage; otherwise, we have uncovered interest arbitrage. Even though interest arbitrage is usually covered, we begin by examining the simpler uncovered interest arbitrage.

Suppose that the interest rate on three-month treasury bills is 6 percent at an annual basis in New York and 8 percent in Frankfurt. It may then pay for a U.S. investor to exchange dollars for euros at the current spot rate and purchase EMU treasury bills to earn the extra 2 percent interest at an annual basis. When the EMU treasury bills mature, the U.S. investor may want to exchange the euros invested plus the interest earned back into dollars. However, by that time, the euro may have depreciated so that the investor would get back fewer dollars per euro than he or she paid. If the euro depreciates by 1 percent at an annual basis during the three months of the investment, the U.S. investor nets only about 1 percent from this foreign investment (the extra 2 percent interest earned minus the 1 percent lost from the depreciation of the euro) at an annual basis (¼ of 1 percent for the three months or quarter of the investment). If the euro depreciates by 2 percent at an annual basis during the three months, the U.S. investor gains nothing, and if the euro depreciates by more than 2 percent, the U.S. investor loses. Of course, if the euro *appreciates*, the U.S. investor gains both from the extra interest earned and from the appreciation of the euro.

Related to uncovered interest arbitrage is carry trade. Carry trade refers to the strategy in which an investor borrows low-yielding currencies and lends (invest in) high-yielding currencies. That is, an investor borrows a currency with a relatively low interest rate and uses the funds to purchase another currency yielding a higher interest rate. If the higher-yielding currency depreciates during the period of the investment, however, the investor runs the risk of losing money (see Case Study 14-5).

CASE STUDY 14-5 Carry Trade

Earlier defined, carry trade is the strategy in which an investor borrows a low-yielding currency and lends (invests in) a higher-yielding currency. The risk is that if during the investment period the higher-yielding currency depreciates vis-à-vis the lower-yielding currency by a higher percentage than the positive interest differentials, the investor would lose money.

For example, suppose that in a "yen carry trade" the investor borrows yens from a Japanese bank at 1 percent interest, exchanges the yens for U.S. dollars at the prevailing dollar/yen exchange rate, and then buys a U.S. bond paying, say, 4 percent interest. The investor would earn 3 percent net on her or his investment—so long as the dollar/yen exchange rate does not change during the period of the investment. If the dollar appreciated with respect to the yen, the investor would earn that much more. If, on the other hand, the dollar depreciated with respect to the yen during the investment period, the investor would earn less, break even, or incur a loss. Specifically, if the dollar depreciated by less than 3 percent with respect to the yen during the investment period, the investor would earn that much less. If the dollar depreciated by exactly 3 percent, the investor would break even (assuming no transaction costs). If, on the other hand, the dollar depreciated by more than 3 percent, the investor's loss would equal the difference between the rate of the dollar depreciation and the positive interest differential in favor of the dollar. Thus, the big risk in carry trade is the uncertainty of exchange rates.

Actually, the gains or losses from carry trade will be much greater than indicated above because of leveraging (i.e., because the investor buys the U.S. bond on margin—puts down only a small fraction, usually 10 percent, of the bond price). In this case, the gains or losses would be amplified tenfold.

In theory, according to *uncovered interest rate parity,* carry trades should not yield a predictable profit because the difference in interest rates between two currencies should equal the rate at which investors expect the low-interest-rate currency to appreciate with respect to the high-interest-rate one. Carry trades, however, tend to weaken the currency that is borrowed, because investors sell the borrowed money by converting it to other currencies. In fact, the carry trade is often blamed for rapid depreciation of the low-yielding currency and appreciation of the higher-yielding currency, thus increasing exchange rate volatility.

(continued)

CASE STUDY 14-5 Continued

The U.S. dollar and the yen have been the currencies most heavily used in carry trade transactions since the 1990s, with the yen being the low-rate currency and U.S. dollar bonds being the higher-yielding asset. At its peak, in early 2007, the yen carry trade was estimated to be about $1 trillion. That trade largely collapsed in 2008 as a result of the rapid appreciation of the yen. This created pressure to cover debts denominated in yen by converting foreign assets into yen—which led to further yen appreciation. Exchange rate volatility often leads to carry trade unwinds, the largest of which was the 2008 one, and that contributed substantially to the credit crunch that caused the 2008 global financial crisis.

Source: C. Burnside, M. Eichenbaum, and S. Rebelo, "Carry Trade and Momentum in Currency Markets," *Annual Review of Financial Economics*, December 2011, pp. 511–535.

14.6B Covered Interest Arbitrage

Investors of short-term funds abroad generally want to avoid the foreign exchange risk; therefore, interest arbitrage is usually covered. To do this, the investor exchanges the domestic for the foreign currency at the current spot rate in order to purchase the foreign treasury bills, and at the same time the investor sells forward the amount of the foreign currency he or she is investing plus the interest he or she will earn so as to coincide with the maturity of the foreign investment. Thus, covered interest arbitrage refers to the spot purchase of the foreign currency to make the investment and the offsetting simultaneous forward sale *(swap)* of the foreign currency to cover the foreign exchange risk. When the treasury bills mature, the investor can then get the domestic currency equivalent of the foreign investment plus the interest earned without a foreign exchange risk. Since the currency with the higher interest rate is usually at a forward discount, the net return on the investment is *roughly* equal to the interest differential in favor of the foreign monetary center minus the forward discount on the foreign currency. This reduction in earnings can be viewed as the cost of insurance against the foreign exchange risk.

As an illustration, let us continue the previous example where the interest rate on three-month treasury bills is 6 percent per year in New York and 8 percent in Frankfurt, and assume that the euro is at a forward discount of 1 percent per year. To engage in covered interest arbitrage, the U.S. investor exchanges dollars for euros at the current exchange rate (to purchase the EMU treasury bills) and at the same time sells forward a quantity of euros equal to the amount invested plus the interest he or she will earn at the prevailing forward rate. Since the euro is at a forward discount of 1 percent per year, the U.S. investor loses 1 percent on an annual basis on the foreign exchange transaction to cover the foreign exchange risk. The net gain is thus the extra 2 percent interest earned minus the 1 percent lost on the foreign exchange transaction, or 1 percent on an annual basis ($\frac{1}{4}$ of 1 percent for the three months or quarter of the investment). Note that we express both the interest differential and the forward discount at an annual basis and then divide by four to get the net gain for the three months or quarter of the investment.

However, as covered interest arbitrage continues, the possibility of gains diminishes until it is completely wiped out. This occurs for two reasons. First, as funds are transferred from New York to Frankfurt, the interest rate rises in New York (since the supply of funds in New

York diminishes) and falls in Frankfurt (since the supply of funds in Frankfurt increases). As a result, the interest differential in favor of Frankfurt diminishes. Second, the purchase of euros in the spot market increases the spot rate, and the sale of euros in the forward market reduces the forward rate. Thus, the forward discount on the euro (i.e., the difference between the spot rate and the forward rate) rises. With the interest differential in favor of Frankfurt diminishing and the forward discount on the euro rising, the net gain falls for both reasons until it becomes zero. Then the euro is said to be at covered interest arbitrage parity (CIAP). Here, the interest differential in favor of the foreign monetary center is equal to the forward discount on the foreign currency (both expressed on an annual basis). In the real world, a net gain of at least ¼ of 1 percent per year is normally required to induce funds to move internationally under covered interest arbitrage. Thus, in the preceding example, the net annualized gain would be ¾ of 1 percent after considering transaction costs or 0.1875 percent for three months.

If the euro is instead at a forward premium, the net gain to the U.S. investor will equal the extra interest earned plus the forward premium on the euro. However, as covered interest arbitrage continues, the interest differential in favor of Frankfurt diminishes (as indicated earlier) and so does the forward premium on the euro until it becomes a forward discount and all of the gains are once again wiped out. Thus, the spot rate and the forward rate on a currency are closely related through covered interest arbitrage.

14.6c Covered Interest Arbitrage Parity

Figure 14.4 illustrates in a more general and rigorous way the relationship, through covered interest arbitrage, between the interest rate differentials between two nations and the forward discount or premium on the foreign currency. The vertical axis of the figure measures the interest rate in the nation's monetary center (i) minus the interest rate in foreign monetary center (i^*), or $(i - i^*)$, in percentages per year. Negative values for $(i - i^*)$ indicate that the interest rate is higher abroad than in the nation, while positive values indicate that the interest rate is higher in the nation than abroad. The horizontal axis measures the forward discount (–) or premium (+) on the foreign currency also expressed in percentages per year.

The solid diagonal line indicates all points of *covered interest arbitrage parity (CIAP)*. Thus, when $(i - i^*)$ equals -1, the foreign currency is at a forward discount of 1 percent per year. A positive interest differential of 1 is associated with a forward *premium* of 1 percent. When the interest differential is zero, the foreign currency is neither at a forward discount nor at a forward premium (i.e., the forward rate on the foreign currency is equal to its spot rate), and we are on the *CIAP line* at the origin.

Below the CIAP line, either the negative interest differential (in favor of the foreign monetary center) exceeds the forward discount on the foreign currency or the forward premium exceeds the positive interest differential (see the figure). In either case, there will be a net gain from a covered interest arbitrage (CIA) *outflow*. For example, at point A, the negative interest differential is 2 percentage points per year in favor of the foreign monetary center, while the foreign currency is at a forward discount of 1 percent per year. Thus, there is a covered interest arbitrage margin of 1 percent per year in favor of the foreign nation, leading to a capital outflow. Similarly, point A' involves a forward premium of 2 percent on the foreign currency and a positive interest differential of only 1 percent in favor of the domestic monetary center. Thus, investors have an incentive to invest abroad because they would gain 2 percent on the exchange transaction and lose only 1 percent in interest in

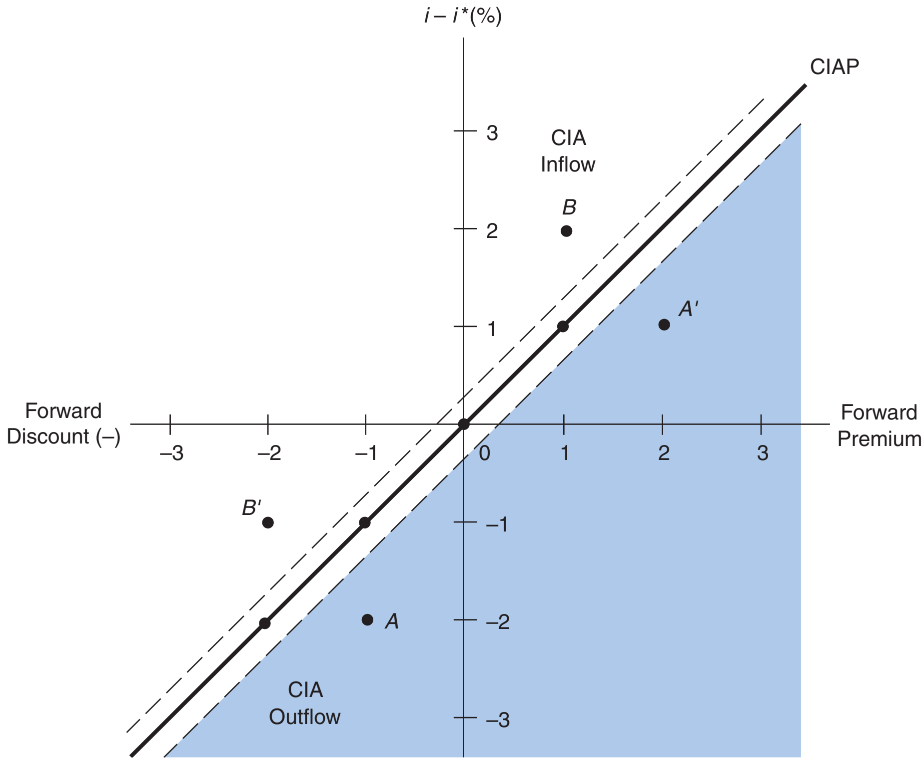


FIGURE 14.4. Covered Interest Arbitrage.
The vertical axis measures the difference in the interest rate in the home nation *(i)* and in the foreign nation (i^*) in percentages per annum. The horizontal axis measures the forward exchange rate, with the minus sign indicating a forward discount and positive values indicating a forward premium on the foreign currency in percent per annum. The solid diagonal line is the covered interest parity (CIAP) line. Below the CIAP line, either the negative interest differential exceeds the forward discount or the forward premium exceeds the positive interest differential. In either case, there will be a capital outflow under covered interest arbitrage. Above the CIAP line, the opposite is true and there will be an arbitrage inflow.

investing abroad. The net gain would then be 1 percent per year or ¼ of 1 percent for the three months or quarter of the investment.

As the arbitrage outflow continues, the net gain diminishes and tends to disappear. Specifically, starting from point *A*, the transfer of funds abroad reduces the interest differential in favor of the foreign monetary center (say, from −2 to −1.5) and increases the forward discount on the foreign currency (say, from −1 to −1.5), as explained in the previous section, so as to reach the CIAP line (see the figure). Starting from point *A*′, the transfer of funds abroad will increase the positive interest differential (say, from 1 to 1.5) and reduce the forward premium (say, from +2 to +1.5) so as to once again reach the CIAP line. Specifically, as funds move abroad, interest rates tend to rise at home and decline abroad. Since interest rates were already higher at home, the positive interest differential increases. On the other hand, as investors purchase the foreign currency to invest abroad, the spot rate rises. As they sell the foreign currency forward to cover their foreign exchange risk, the forward rate declines. Thus, the forward premium (i.e., the excess of the forward rate over the spot rate) diminishes. With the positive interest differential increasing and the forward premium decreasing, the net gain from arbitrage outflow diminishes until it becomes zero when the CIAP line is reached and the arbitrage outflow comes to an end.

Above the interest parity line, either the positive interest differential exceeds the forward premium on the foreign currency (point B in the figure) or the negative interest differential is smaller than the forward discount on the foreign currency (point B'). In either case, it pays for foreigners to invest in our country, and there will be an arbitrage *inflow*. However, as the arbitrage inflow continues, the net gain diminishes and then disappears when the CIAP line is reached. In reality, interest arbitrage (inflow and outflow) will come to an end when the net gain reaches about ¼ of 1 percent per year (1/16 of 1 percent for three months). This range is shown by the white area between the diagonal *dashed* lines in the figure.

14.6D Covered Interest Arbitrage Margin

We have seen that points on the CIAP line indicate either that the negative interest differential (in favor of the foreign monetary center) equals the forward discount *(FD)* on the foreign currency or that the positive interest differential (in favor of the home monetary center) equals the forward premium *(FP)* on the foreign currency. This can be expressed as:

$$i - i^* = FD \text{ if } i < i^* \text{ or}$$
$$i - i^* = FP \text{ if } i > i^*$$

But since the forward rate minus the spot rate divided by the spot rate [i.e., $(FR{-}SR)/SR$] measures the forward discount (if $SR > FR$) or the forward premium (if $FR > SR$), the foregoing condition for CIAP can be rewritten as

$$i - i^* = (FR - SR)/SR \tag{14-1}$$

We can now define the covered interest arbitrage margin (CIAM) or the percentage gain from covered interest arbitrage as

$$\text{CIAM} = (i - i^*) - FD \text{ or } FP$$

or more precisely as

$$\text{CIAM} = (i - i^*)/(1 + i^*) - (FR - SR)/SR \tag{14-2}$$

where $(1 + i^*)$ is a weighting factor. This formula is derived in the appendix to this chapter.

To see how the formula works, let us apply it to the case where the interest rate on a three-month treasury bill is 6 percent on an annual basis in New York and 8 percent in Frankfurt, while the spot rate of the euro is \$1/€1 and the three-month forward rate on the euro is \$0.99/€1 on an annual basis. Applying the CIAM formula, we get:

$$\begin{aligned}\text{CIAM} &= (0.06 - 0.08)/(1 + 0.08) - (\$0.99 - \$1.00)/\$1.00 \\ &= (-0.02)/1.08 - (-\$0.01)/\$1.00 \\ &= -0.01852 + 0.01 \\ &= -0.00852\end{aligned}$$

The negative sign for the CIAM refers to a CIA outflow or investing in Frankfurt. The absolute value of the CIAM indicates that the extra return per dollar invested in Frankfurt is 0.852 percent per year or 0.213 per quarter. (These values are similar to the approximate values obtained in the previous subsection without the weighting factor.) On a $10 million investment, this means an extra return of $21,300 for investing in three-month EMU treasury bills with the foreign exchange risk covered for three months. From this extra return, we would have to deduct the transaction costs. If these are ¼ of 1 percent per year or 1⁄16 of 1 percent per quarter, we get transaction costs of (0.01/16) times $10 million, which are $6,250. Thus, the net gain from investing $10 million in Frankfurt under CIA with the transaction costs taken into consideration is $21,300 minus $6,250, or $15,050 for the three months of the investment.

In the real world, significant covered interest arbitrage margins are sometimes observed. The reason is not that covered interest arbitrage does not work, but it may be the result of other forces at work. For example, higher tax rates abroad may exceed the CIAM in favor of the foreign monetary center so that no arbitrage outflows take place. Similarly, investors may not take advantage of a CIAM in favor of the foreign monetary center if they fear that the foreign government might default or impose exchange restrictions on the repatriation of profits and principal on the foreign investment. Or simply, large and persistent CIAM may exist because of lack of information on foreign investment opportunities in developing countries' financial markets.

14.6E Efficiency of Foreign Exchange Markets

A market is said to be *efficient* if prices reflect all available information. The foreign exchange market is said to be efficient if forward rates accurately predict future spot rates; that is, if forward rates reflect all available information and quickly adjust to any new information so that investors cannot earn consistent and unusual profits by utilizing any available information.

Questions of market efficiency are important because only when markets are efficient do prices correctly reflect the scarcity value of the various resources and result in allocational efficiency. For example, if, for whatever reason, the price of a commodity is higher than its value to consumers, then too many resources flow to the production of the commodity at the expense of other commodities that consumers prefer.

By their very nature, tests of market efficiency are very difficult to formulate and to interpret. Even if foreign exchange markets were efficient, we cannot expect the forward rate of a currency to be identical to the future spot rate of the currency because the latter also depends on unforeseen events. However, if the forward rate exceeds the future spot rate as often as it falls below it, then we could say that the market is efficient in the sense that there is no available information that investors could systematically use to ensure consistent and unusual profits.

Many empirical tests have been conducted on the efficiency of foreign exchange markets by *Levich* (1985) and others (see the references in the Selected Bibliography). Most of these studies seem to indicate that foreign exchange markets are efficient according to this definition of efficiency. For example, several empirical tests show that few opportunities exist for risk-free arbitrage, and deviations from interest rate parity are, for the most part, smaller than transaction costs. Similarly, speculators sometimes earn profits and sometimes incur losses and seldom face opportunities for certain and large profits. *Frankel and MacArthur* (1988) have presented evidence that covered interest arbitrage holds reasonably well for large industrial countries but not for small ones, and *Lewis* (1995) shows that the theory does not hold well for developing countries. *Clarida et al.* (2003) suggest that forward-exchange-rate time series contain valuable information not yet fully utilized for predicting the future path of the spot exchange rates.

Thus, while many studies seem to indicate that foreign exchange markets are fairly efficient, others do not. Exchange rates seem to respond very quickly to news, are very volatile, have defied all attempts at being accurately forecasted, and the variance in their fluctuation has been relatively large, so that even if the forward rate were an unbiased predictor of the future spot rate it would not be an efficient one. We return to this topic in our discussion of foreign exchange forecasting in the next chapter.

As exchange rates have become more volatile, the volume of foreign exchange transactions has grown much faster than the volume of world trade and faster than even the much larger flows of investment capital. Only over the 1998–2001 period has the volume of foreign exchange transactions declined (from $1.5 trillion in 1998 to $1.2 trillion in 2001). This was due to the introduction of the euro (which replaced several important currencies, thus eliminating the need to convert these currencies into one another) and the consolidation of the banking sector (which eliminated a great deal of the interbank foreign exchange market). More recently, the volume of foreign exchange transactions has resumed its growth and reached $4.0 billion in 2012.

14.7 Eurocurrency or Offshore Financial Markets

In this section, we examine the operation and effects of Eurocurrency or offshore financial markets and also discuss Eurobonds and Euronotes.

14.7A Description and Size of the Eurocurrency Market

Eurocurrency refers to commercial bank deposits outside the country of their issue. For example, a deposit denominated in U.S. dollars in a British commercial bank (or even in a British branch of a U.S. bank) is called a Eurodollar. Similarly, a pound sterling deposit in a French commercial bank or in a French branch of a British bank is a Eurosterling, a deposit in euros (the new European currency) in a Swiss bank is simply a Eurodeposit (to avoid the awkward “Euroeuro”), and so on. These balances are usually borrowed or loaned by major international banks, international corporations, and governments when they need to acquire or invest additional funds. The market in which this borrowing and lending takes place is called the Eurocurrency market.

Initially, only the dollar was used in this fashion, and the market was therefore called the Eurodollar market. Subsequently, the other leading currencies (the German mark, the Japanese yen, the British pound sterling, the French franc, and the Swiss franc) began also to be used in this way, and so the market is now called the *Eurocurrency market*. The practice of keeping bank deposits denominated in a currency other than that of the nation in which the deposit is held has also spread to such non-European international monetary centers as Tokyo, Hong Kong, Singapore, and Kuwait, as well as to the Bahamas and the Cayman Islands in the Caribbean, and are appropriately called offshore deposits. Often, however, the name Eurodeposits is also used for such deposits outside Europe. With these geographical extensions, the Eurocurrency market has become an essentially 24-hour-a-day operation. Indeed, any foreign deposit made in a nation's bank (even if in the nation's currency) is Eurocurrency if the deposit is exempted from the regulations that the nation imposes on domestic deposits.

The Eurocurrency market consists mostly of short-term funds with maturity of less than six months. In measuring the size of the Eurocurrency market, we must distinguish between its gross and net size. The first includes interbank deposits. These are the deposits of banks with surplus Eurocurrencies to other banks facing an excess demand for Eurocurrency loans. Thus, interbank deposits represent transfers of Eurocurrency funds from one bank to another and do not involve a net increase in the total amount of Eurocurrency available to be lent to nonbank customers. Since the interbank market is a very important and active part of the Eurocurrency market, however, the gross measure seems more appropriate in measuring the size of the market (see Case Study 14-6).

14.7B Reasons for the Development and Growth of the Eurocurrency Market

There are several reasons for the existence and spectacular growth of the Eurocurrency market during the past four decades. One reason was the higher interest rates often prevailing abroad on short-term deposits. Until it was abolished in March 1986, Federal Reserve System *Regulation Q* put a ceiling on the interest rates that U.S. member banks could pay on deposits to levels that were often below the rates paid by European banks. As a result, short-term dollar deposits were attracted to European banks and became Eurodollars. Another important reason is that international corporations often found it very convenient to hold balances abroad for short periods in the currency in which they needed to make payments. Since the dollar is the most important international and vehicle currency in making and receiving international payments, it is only natural for a large proportion of the currency to be in Eurodollars. Still another reason is that international corporations can overcome domestic credit restrictions by borrowing in the Eurocurrency market.

The Eurocurrency market originated from the desire of communist nations to keep their dollar deposits outside the United States during the early days of the Cold War for fear that they might be frozen in a political crisis. After 1973, the impetus to the growth of the Eurodollar market came from the huge dollar deposits from petroleum-exporting countries arising from the manyfold increases in the price of petroleum. These nations also did not want to keep their dollar deposits in the United States for fear that the U.S. government might freeze them in a political crisis. Indeed, this is exactly what happened to the (small proportion of the) dollar deposits that Iran and Iraq did keep in the United States during the U.S. conflict with these nations in the late 1970s and early 1990s, respectively.

European banks are willing to accept deposits denominated in foreign currencies and are able to pay higher interest rates on these deposits than U.S. banks because they can lend these deposits at still higher rates. In general, the spread between lending and borrowing rates on Eurocurrency deposits is smaller than that of U.S. banks. Thus, European banks are often able to pay higher deposit rates and lend at lower rates than U.S. banks. This is the result of (1) the fierce competition for deposits and loans in the Eurocurrency market, (2) the lower

CASE STUDY 14-6 Size and Growth of Eurocurrency Market

Table 14.4 shows the gross and the net size of Eurocurrency deposits (i.e., international bank deposits denominated in currencies other than the currency of the borrower's or lender's nation) from 1964 to 2011, as well as the percentage of the gross market held in the form of Eurodollars. For comparison purposes, the table also gives the U.S. money supply (broadly defined, or M2) over the same period of time. The table also shows that the gross Eurocurrency market grew extremely rapidly from $19 billion in 1964 to $17.9 trillion in 2007, but then it declined to $15.8 trillion as a result of the global financial crisis, and it was $16.9 trillion in 2011. Gross Eurocurrency deposits thus went from less than 5 percent of the M2 measure of the U.S. money supply in 1964 to 238 percent in 2007, and they were 174 percent in 2011. While the U.S. money supply grew 23 times from 1964 to 2011, gross Eurocurrency deposits grew 890 times! The table also shows that the percentage of Eurodollars in gross Eurocurrency deposits declined from 79 percent in 1968 to 55 percent in 1996 and 2007, and it was 58 percent in 2011.

TABLE 14.4. Size of Eurocurrency Deposit Market (in billions of dollars)

Year	Gross Size	Net Size	Eurodollars as a Percentage of Gross	U.S. Money Stock (M2)
1964	$19	$14	n.a.	$425
1968	46	34	79	567
1972	210	110	78	802
1976	422	199	69	1, 152
1980	839	408	71	1, 599
1984	1, 343	667	78	2, 310
1988	2, 684	1, 083	64	2, 994
1992	3, 806	1, 751	59	3, 431
1996	4, 985	2, 639	55	3, 842
1998	6, 332	3, 122	53	4, 403
2000	6, 077	3, 532	63	4, 949
2002	7, 505	4, 590	61	5, 807
2004	10, 035	6, 952	57	6, 437
2006	14, 168	9, 604	59	7, 094
2007	17, 931	11, 966	55	7, 522
2008	16, 668	10, 928	58	8, 269
2009	15, 817	10, 829	57	8, 552
2010	16, 014	10, 983	58	8, 849
2011	16, 911	11, 374	58	9, 713

Sources: Morgan Guaranty, *World Financial Markets*; BIS, *Quarterly Survey*; and IMF, *International Financial Statistics*; various issues.

operating costs in the Eurocurrency market due to the absence of legal reserve requirements and other restrictions on Eurocurrency deposits (except for U.S. branches of European banks), (3) economies of scale in dealing with very large deposits and loans, and (4) risk diversification. Arbitrage is so extensive in the Eurocurrency market that interest parity is generally maintained.

14.7c Operation and Effects of the Eurocurrency Market

One important question is whether or not Eurocurrencies are money. Since Eurocurrencies are, for the most part, time rather than demand deposits, they are money *substitutes* or *near* money rather than money itself, according to the usual narrow definition of money or M1 (which includes only currency in circulation and demand deposits). Thus, Eurobanks do not, in general, create money, but they are essentially financial intermediaries bringing together lenders and borrowers, and operating more like domestic savings and loan associations (before they established the so-called NOW accounts) than like commercial banks in the United States. Perhaps more significant is that the rapid growth of Eurocurrency deposits since the 1960s has greatly increased world liquidity. They also led to a significant integration of domestic and international financial markets, which greatly increased competition and the efficiency of domestic banking in industrialized nations.

The existence, size, and rapid growth of the Eurocurrency market have created certain problems. One of the most serious is that the Eurocurrency market reduces the effectiveness of domestic stabilization efforts of national governments. For example, large firms that cannot borrow domestically because of credit restrictions often can and do borrow in the Eurocurrency market, thus frustrating the government effort to restrict credit to fight domestic inflationary pressures. This is particularly true for smaller nations where the volume of domestic financial transactions is small in relation to Eurocurrency transactions. A closely related problem is that frequent and large flows of liquid Eurocurrency funds from one international monetary center to another can produce great instability in foreign exchange rates and domestic interest rates.

Another possible problem is that Eurocurrency markets are largely uncontrolled. As a result, a deep worldwide recession could render some of the system's banks insolvent and possibly lead internationally to the type of bank panics that afflicted capitalist nations during the nineteenth century, the first third of the twentieth century, and the latter part of the last decade. Domestic bank panics were more or less eliminated by the creation of national central banks to regulate domestic banking through deposit insurance and by setting themselves up as "lenders of last resort" for domestic banks in a liquidity squeeze. In the Eurocurrency market, however, any attempt on the part of any one nation to regulate it would simply result in the market shifting its activity elsewhere. Thus, in order for regulations and guidelines to be effective, they need to be multilateral. Given the strong competition for Eurobanking business, however, it is unlikely that such multilateral cooperation will be forthcoming in the near future. Indeed, nations seem to go out of their way to provide the necessary infrastructures and eliminate existing restrictions in order to attract business.

A specific example of this is provided by the United States. Since December 1981, international banking facilities (IBFs) have been permitted in the United States. That is, U.S. banks were allowed to accept deposits from abroad and re-invest them overseas, and thus compete directly in the huge Eurodollar market. The new rules exempted foreign deposits in U.S. banks (even if in dollars) from federally imposed reserve and insurance requirements; as such, they are Eurodollars. Several states have also passed complementary legislation exempting profits on international banking transactions from state and local taxes. Almost 200 U.S. banks have entered this market, about half of them in New York, with the rest in Chicago, Miami, New Orleans, and San Francisco. The United States has captured about 20 percent of the huge Eurodollar market, and this has led to the creation of thousands of new jobs in banking, half of them in New York City.

14.7D Eurobond and Euronote Markets

Eurobonds are long-term debt securities that are sold outside the borrower's country to raise long-term capital in a currency other than the currency of the nation where the bonds are sold. An example is provided by a U.S. corporation selling bonds in London denominated in euros or U.S. dollars. Eurobonds have to be distinguished from *foreign bonds*, which refer simply to bonds sold in a foreign country but denominated in the currency of the country in which the bonds are being sold. An example is a U.S. multinational corporation selling bonds in England denominated in pounds sterling. Eurobonds, on the other hand, are bonds sold in a foreign country and denominated in another currency. The leading centers in the international bond market are London, Frankfurt, New York, and Tokyo. Eurobonds differ from most domestic bonds in that the former, as opposed to the latter, are usually unsecured (i.e., they do not require a collateral). Another type of debt security is Euronotes. These are medium-term financial instruments falling somewhat between short-term Eurocurrency bank loans and long-term international bonds. Corporations, banks, and countries make use of international notes to borrow medium-term funds in a currency other than the currency of the nation in which the notes are sold.

In 2010, corporations, banks, and countries raised $1,499 billion in Eurobonds and Euronotes—down from $2,784 billion in 2007 (because of the financial crisis), but up from $200 billion in 1993. The sharp increase from 1993 to 2007 was made possible by the opening up of capital markets in these international debt securities by several countries, including France, Germany, and Japan, and by the elimination of the U.S. interest-equalization tax. The incentive to issue Eurobonds and Euronotes is that they generally represent a lower cost of borrowing long-term funds than available alternatives. In 2010, about 72 percent of Eurobonds and Euronotes were denominated in U.S. dollars, 22 percent in euros, 2 percent in Canadian dollars, 1 percent in Australian dollars and pounds sterling, and the remaining 2 percent in other currencies.

Some Eurobonds are denominated in more than one currency in order to give the lender a choice of the currencies in which to be repaid, thus providing some exchange rate protection to the lender. For this benefit, the lender may be willing to lend at a somewhat lower rate. A large issue of Eurobonds and Euronotes is usually negotiated by a group (called a *syndicate*) of banks so as to spread the credit risk among numerous banks in many countries. Eurobonds and Euronotes usually have floating rates. That is, the interest rates charged are re-fixed, usually every three or six months, in line with changes in market conditions. After an issue of Eurobonds and Euronotes is sold by syndicate, a secondary market in the international note or bond emerges in which investors can sell their holdings. (The market in which the initial issue was sold is appropriately called the *primary market*.)

Interest rates on Eurocredits are expressed as a mark-up or spread over LIBOR (the London Interbank Offer Rate) or EUROBOR (the Brussels-set rate) at which Eurobanks lend funds to one another. The spread varies according to the creditworthiness of the borrower and ranges from 1 percent for best or prime borrowers to 2 percent for borrowers with weak credit ratings. Often, weaker borrowers can negotiate a lower spread by paying various fees up front. These are a management fee for the bank or banks organizing the syndication, a participation fee to all participating banks based on the amount lent by each, as well as a commitment fee on any undrawn portion of the loan. Because of the size and rapid growth of the Eurocurrency, and Eurobond and Euronote markets, and the resulting integration of domestic and international financial markets, we are approaching a truly global banking system.

SUMMARY

1. Foreign exchange markets are the markets where individuals, firms, and banks buy and sell foreign currencies or foreign exchange. The foreign exchange market for any currency, say the U.S. dollar, is comprised of all the locations, such as London, Paris, Zurich, Frankfurt, Singapore, Hong Kong, and Tokyo, as well as New York, where dollars are bought and sold for other currencies. These different monetary centers are connected by a telephone network and video screens, and are in constant contact with one another.

2. The principal function of foreign exchange markets is the transfer of purchasing power from one nation and currency to another. The demand for foreign exchange arises from the desire to import or purchase goods and services from other nations and to make investments abroad. The supply of foreign exchange comes from exporting or selling goods and services to other nations and from the inflow of foreign investments. About 90 percent of all foreign exchange transactions today, however, are undertaken by foreign currency traders and speculators. A nation's commercial banks operate as clearinghouses for the foreign exchange demanded and supplied. Commercial banks then even out their excess supply of or demand for foreign exchange with other commercial banks through the intermediation of foreign exchange brokers. The nation's central bank then acts as the lender or borrower of last resort.

3. The exchange rate (R) is defined as the domestic currency price of the foreign currency. Under a flexible exchange rate system of the type in existence since 1973, the equilibrium exchange rate is determined at the intersection of the nation's aggregate demand and supply curves for the foreign currency. If the domestic currency price of the foreign currency rises, we say that the domestic currency depreciated. In the opposite case, we say that the domestic currency appreciated (and the foreign currency depreciated). Arbitrage refers to the purchase of a currency where it is cheaper for immediate resale where it is more expensive in order to make a profit. This equalizes exchange rates and ensures consistent cross rates in all monetary centers, unifying them into a single market. Under a managed floating exchange rate system (of the type in operation today), the loss of official reserves only indicates the degree of official intervention in foreign exchange markets to influence the level and movement of exchange rates, and not the balance-of-payments deficit.

4. A spot transaction involves the exchange of currencies for delivery within two business days. A forward transaction is an agreement to purchase for delivery at a future date (usually one, three, or six months hence) a specified amount of a foreign currency at a rate agreed upon today (the forward rate). When the forward rate is lower than the spot rate, the foreign currency is said to be at a forward discount of a certain percentage per year. In the opposite case, the foreign currency is said to be at a forward premium. Currency swap is a spot sale of a currency combined with a forward repurchase of the same currency. A foreign exchange futures is a forward contract for standardized currency amounts and selected calendar dates traded on an organized market (exchange). A foreign exchange option is a contract specifying the right to buy or sell a standard amount of a traded currency at or before a stated date.

5. Because exchange rates usually change over time, they impose a foreign exchange risk on anyone who expects to make or receive a payment in a foreign currency at a future date. The covering of such an exchange risk is called hedging. Speculation is the opposite of hedging. It refers to the taking of an open position in the expectation of making a profit. Speculation can be stabilizing or destabilizing. Hedging and speculation can take place in the spot, forward, future, or options markets—usually in the forward market.

6. Interest arbitrage refers to the international flow of short-term liquid funds to earn higher returns abroad. One aspect of this is carry trade. Covered interest arbitrage refers to the spot purchase of the foreign currency to make the investment and an offsetting simultaneous forward sale of the foreign currency to cover the foreign exchange risk. The net return from covered interest arbitrage is usually equal to the interest differential in favor of the foreign monetary center minus the forward discount on the foreign currency. As covered interest arbitrage continues, the net gain is reduced and finally eliminated. When the net gain is zero, the currency is said to be at interest parity. Foreign exchange markets are said to be efficient if forward rates accurately predict future spot rates.

7. Eurocurrency refers to commercial bank deposits outside the country of their issue, or even in the same country, if exempted from regulations imposed on domestic deposits. The Eurocurrency market has grown very rapidly during the past three decades. The reasons for its existence and growth are (1) the higher interest rates paid on Eurocurrency deposits, (2) the convenience it provides for international corporations, and (3) the ability to escape national monetary controls. Eurobanks do not, in general, create money, but they are essentially financial intermediaries bringing together lenders and borrowers. The Eurocurrency market can create great instability in exchange and other financial markets. Eurobonds are long-term debt securities sold outside the borrower's country in a currency other than the currency of the nation where the bonds are sold. Euronotes are medium-term financial instruments falling somewhat between short-term Eurocurrency and Eurobonds.

A LOOK AHEAD

The next chapter examines exchange rate determination, both in the long run and in the short run, and discusses the reasons for the large exchange rate disequilibria and great volatility in foreign exchange markets during the past three decades. We also evaluate the accuracy of exchange rate forecasting in the real world.

KEY TERMS

Appreciation, p. 429
Arbitrage, p. 431
Carry trade, p. 445
Covered interest arbitrage, p. 444
Covered interest arbitrage margin (CIAM), p. 449
Covered interest arbitrage parity (CIAP), p. 447
Cross-exchange rate, p. 429
Depreciation, p. 429
Destabilizing speculation, p. 443
Effective exchange rate, p. 431
Efficiency of foreign exchange markets, p. 450
Euro, p. 427
Eurobonds, p. 455
Eurocurrency, p. 451
Eurocurrency market, p. 451
Euronotes, p. 455
Exchange rate, p. 428
Foreign exchange futures, p. 436
Foreign exchange market, p. 423
Foreign exchange option, p. 436
Foreign exchange risk, p. 440
Foreign exchange swaps, p. 435
Forward discount, p. 435
Forward premium, p. 435
Forward rate, p. 434
Hedging, p. 441
Interest arbitrage, p. 444
Offshore deposits, p. 451
Seignorage, p. 425
Speculation, p. 442
Spot rate, p. 434
Stabilizing speculation, p. 443
Uncovered interest arbitrage, p. 444
Vehicle currency, p. 425

QUESTIONS FOR REVIEW

1. What are foreign exchange markets? What is their most important function? How is this function performed?

2. What are the four different levels of participants in foreign exchange markets? What are the other functions of foreign exchange markets?

3. What is meant by the exchange rate? How is the equilibrium exchange rate determined under a flexible exchange rate system?

4. What is meant by a depreciation of the domestic currency? an appreciation? What is the cross exchange rate? What is the effective exchange rate?

5. What is arbitrage? What is its result? What is triangular arbitrage? What are cross rates?

6. Why is the measure of the balance-of-payments deficit or surplus not strictly appropriate under a flexible exchange rate?

7. What is meant by a spot transaction and the spot rate? a forward transaction and the forward rate? What is meant by a forward discount? forward premium? What is a currency swap? What is a foreign exchange futures? a foreign exchange option?

8. What is meant by foreign exchange risk? How can foreign exchange risks be covered in the spot, forward, futures, or options markets? Why does hedging not usually take place in the spot market?

9. What is meant by speculation? How can speculation take place in the spot, forward, futures, or options markets? Why does speculation not usually take place in the spot market? What is stabilizing speculation? destabilizing speculation?

10. What is interest arbitrage? uncovered interest arbitrage? covered interest arbitrage? How is interest arbitrage covered in the forward market? Why does the net gain from covered interest arbitrage tend to diminish as covered interest arbitrage continues?

11. What is meant by the foreign currency being at covered interest arbitrage parity (CIAP)? What are some of the forces that can prevent the achievement of CIAP?

12. (a) What is a Eurocurrency? (b) Why would *offshore deposits* be a more appropriate term? (c) Why is the spread between lending and borrowing rates lower on Eurocurrencies than on commercial bank dollar deposits in the United States?

13. (a) Are Eurocurrencies money? (b) Do Eurobanks create money? (c) What are the most serious problems created by the existence of Eurocurrencies?

14. What is the difference between Eurocurrencies on the one hand and Eurobonds and Euronotes on the other?

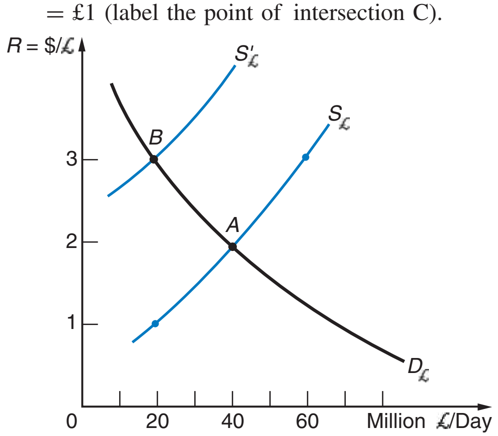
PROBLEMS

1. From the following figure, determine

(a) the equilibrium exchange rate between the dollar and the pound sterling and the equilibrium quantity of pounds with supply curve $S_£$ and $S'_£$ under a flexible exchange rate system.

(b) If the United States wanted to maintain the exchange rate at \$3 = £1 with supply curve $S_£$, how much pound reserves would the U.S. central bank gain or lose per day?

2. **(a)** Redraw demand curve for pounds $D_£$ and supply curve of pounds $S_£$ as in the figure of Problem 1 and draw on it another supply curve for pounds (label it $S^*_£$) that intersects $D_£$ at \$1 = £1 (label the point of intersection C).



(b) Assuming a flexible exchange rate system, determine the equilibrium exchange rate and equilibrium quantity of pounds with $S^*_£$.

(c) If the United States wanted to maintain a fixed exchange rate of $R = 1.5$ with $S^*_£$, indicate the amount of pound reserves that the U.S. central bank would gain or lose per day.

3. Assume the following exchange rates:

\$2 = £1 in New York
¥410 = £1 in London
¥200 = \$1 in Tokyo

Indicate how profitable triangular, or three-point, arbitrage can take place.

4. **(a)** Identify the forces at work that will make the cross exchange rates consistent in currency arbitrage in the previous problem.

(b) What are the consistent cross-rates in Problem 3?

***5.** Calculate the forward discount or premium for the following spot and three-month forward rates:

(a) $SR = \$2.00/£1$ and $FR = \$2.01/£1$

(b) $SR = \$2.00/£1$ and $FR = \$1.96/£1$

6. Calculate the forward discount or premium for the following spot and three-month forward rates:

   (a) SR = SF2/€1 and SF2.02/€1 where SF is the Swiss franc and € is the euro

   (b) SR = ¥200/$1 and FR = ¥190/$1

7. Assume that SR = $2/£1 and the three-month FR = $1.96/£1. How can an importer who will have to pay £10,000 in three months hedge the foreign exchange risk?

8. For the given in Problem 7, indicate how an exporter who expects to receive a payment of £1 million in three months hedges the foreign exchange risk.

*9. Assume that the three month FR = $2.00/£1 and a speculator believes that the spot rate in three months will be SR = $2.05/£1. How can a person speculate in the forward market? How much will the speculator earn if he or she is correct?

10. If the speculator of Problem 9 believes that the spot rate in three months will be SR = $1.95/£1, how can he or she speculate in the forward market? How much will the speculator earn if he or she is correct? What will the result be if in three months SR = $2.05/£1 instead?

*11. If the positive interest rate differential in favor of a foreign monetary center is 4 percent per year and the foreign currency is at a forward discount of 2 percent per year, roughly how much would an interest arbitrageur earn from the purchase of foreign three-month treasury bills if he or she covered the foreign exchange risk?

12. For the given of Problem 11, indicate:

    (a) How much would an interest arbitrageur earn if the foreign currency were at a forward premium of 1 percent per year?

    (b) What would happen if the foreign currency were at a forward discount of 6 percent per year?

13. With reference to Figure 14.4, explain (a) why there will be an arbitrage inflow at points B and B' and (b) the forces that tend to eliminate the net gain as arbitrage inflows continue.

14. Explain why even when CIAP holds, investors in different monetary centers do not necessarily receive the same returns on their financial investments.

*= Answer provided at www.wiley.com/college/salvatore.

APPENDIX

A14.1 Derivation of the Formula for the Covered Interest Arbitrage Margin

In this appendix, we derive the formula for calculating the covered interest arbitrage margin (CIAM). Starting with Formula (14A-1):

$$K(1 + i/4) \underset{<}{\overset{>}{=}} (K/SR)(1 + i^*/4)FR \tag{14A-1}$$

where K = amount of capital invested
i = domestic interest rate per year
i^* = foreign interest rate per year
SR = spot rate
FR = forward rate

The left-hand side of Formula (14A-1) gives the value of the investment (the original capital invested plus the interest earned) when K amount of capital is invested domestically for three months. The right-hand side gives the domestic currency value of the investment (the original capital invested plus the interest earned) when the same amount of capital is invested abroad for three months with the foreign exchange risk covered. Specifically, the right-hand side of the formula gives the foreign currency value of the investment, times one plus the interest earned abroad for three months, times the forward rate (to reconvert the invested capital plus the interest earned back into the domestic currency). Investors will invest domestically if the left-hand side of the formula is larger than the right-hand side; they will invest abroad if the right-hand side of the formula is larger than the left-hand side; and they are indifferent if the two sides are equal.

According to the theory of covered interest arbitrage (CIA), an arbitrage outflow or inflow will proceed until no net gain remains (i.e., until covered interest arbitrage parity or CIAP is reached). Thus, at CIAP the two sides of Formula (14A-1) would be equal. By treating Formula (14A-1) as an equation and manipulating it algebraically, we can derive the formula for the covered interest arbitrage margin (CIAM). In doing this, it is convenient to divide both sides by K and omit, for the moment, the division of i and i^* by 4. This will give us the CIAM per dollar per year. By then multiplying the CIAM obtained by the capital invested (K) and dividing by 4, we get the extra dollar earnings in percentage for the three months of the investment with the foreign exchange risk covered.

Treating Formula (14A-1) as an equation, and dividing both sides by K and omitting the division of i and i^* by 4 as explained previously, we get Equation (14A-2):

$$1 + i = (FR/SR)\ (1 + i^*) \tag{14A-2}$$

Manipulating Equation (14A-2) algebraically, we obtain:

$$(1 + i)/(1 + i^*) = FR/SR$$
$$[(1 + i)/(1 + i^*)] - 1 = [FR/SR] - 1$$
$$(1 + i - 1 - i^*)/(1 + i^*) = (FR - SR)/SR$$
$$(i - i^*)/(1 + i^*) = (FR - SR)/SR$$

Solving for FR, we get Formula (14A-3) to calculate the forward rate at CIAP:

$$FR = [(i - i^*)/(1 + i^*)]SR + SR \tag{14A-3}$$

Thus, the covered interest arbitrage margin (CIAM) is:

$$CIAM = (i - i^*)/(1 + i^*) - (FR - SR)/SR \tag{14A-4}$$

This is Formula (14-2) given in Section 14.6D. The first fraction on the right-hand side of Formula (14A-4) is the domestic-foreign interest rate differential weighted by 1 plus the foreign interest rate. The second fraction is the forward discount on the foreign currency weighted by the spot rate. At CIAP, the value of the two fractions is equal, so that CIAM equals zero. Since Formula (14A-4) refers to a whole year, the CIAM for three months is CIAM/4.

Problem Using the data on i, i^*, SR, and FR in the numerical example at the end of Section 14.6D, determine the dollar amount (principal plus interest) that a U.S. investor will get back by investing $100,000 for three months in (a) U.S. treasury bills or (b) EMU treasury bills with the foreign exchange risk covered. How would your answer to Part (b) differ if you estimated the CIAM as in Section 14.6B?

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