CHAPTER 13

Exchange Rates and the Foreign Exchange Market: An Asset Approach

In the first years of the millennium, Americans flocked to Paris to enjoy French cuisine while shopping for designer clothing and other specialties. When measured in terms of dollars, prices in France were so much lower than a few years before that a shopper's savings could offset the cost of an air ticket from New York or Chicago. Five years later, however, the prices of French goods again looked high to Americans. What economic forces made the dollar prices of French goods swing so widely? One major factor was a sharp fall in the dollar price of France's currency after 1998, followed by an equally sharp rise starting in 2002.

The price of one currency in terms of another is called an **exchange rate.** At 4 P.M. New York time on July 23, 2007, you would have needed 1.3801 dollars to buy one unit of the European currency, the euro, so the dollar's exchange rate against the euro was $1.3801 per euro. Because of their strong influence on the current account and other macroeconomic variables, exchange rates are among the most important prices in an open economy.

Because an exchange rate, as the price of one country's money in terms of another's, is also an asset price, the principles governing the behavior of other asset prices also govern the behavior of exchange rates. As you will recall from Chapter 12, the defining characteristic of an asset is that it is a form of wealth, a way of transferring purchasing power from the present into the future. The price that an asset commands today is therefore directly related to the purchasing power over goods and services that buyers expect it to yield in the future. Similarly, *today's* dollar/euro exchange rate is closely tied to people's expectations about the *future* level of that rate. Just as the price of Google stock rises immediately upon favorable news about Google's future prospects, so do exchange rates respond immediately to any news concerning future currency values.

Our general goals in this chapter are to understand the role of exchange rates in international trade and how exchange rates are determined. To begin, we first learn how exchange rates allow us to compare the prices of different countries' goods and services. Next we describe the international asset market in which currencies are traded and show how equilibrium exchange rates are determined in that market. A final section underlines our asset market approach by showing how today's exchange rate responds to changes in the expected future values of exchange rates.

Learning Goals

After reading this chapter, you will be able to:

- Relate exchange rate changes to changes in the relative prices of countries' exports.
- Describe the structure and functions of the foreign exchange market.
- Use exchange rates to calculate and compare returns on assets denominated in different currencies.
- Apply the interest parity condition to find equilibrium exchange rates.
- Find the effects of interest rates and expectation shifts on exchange rates.

Exchange Rates and International Transactions

Exchange rates play a central role in international trade because they allow us to compare the prices of goods and services produced in different countries. A consumer deciding which of two American cars to buy must compare their dollar prices, for example, $44,000 (for a Lincoln Continental) or $22,000 (for a Ford Taurus). But how is the same consumer to compare either of these prices with the 2,500,000 Japanese yen (¥2,500,000) it costs to buy a Nissan from Japan? To make this comparison, he or she must know the relative price of dollars and yen.

The relative prices of currencies are reported daily in newspapers' financial sections. Table 13-1 shows the dollar exchange rates for currencies traded in New York at 4 P.M. on July 23, 2007, as reported in the *Wall Street Journal*. Notice that an exchange rate can be quoted in two ways: as the price of the foreign currency in terms of dollars (for example, $0.008250 per yen) or as the price of dollars in terms of the foreign currency (for example, ¥121.21 per dollar). The first of these exchange rate quotations (dollars per foreign currency unit) is said to be in *direct* (or "American") terms, the second (foreign currency units per dollar) in *indirect* (or "European") terms.

Households and firms use exchange rates to translate foreign prices into domestic currency terms. Once the money prices of domestic goods and imports have been expressed in terms of the same currency, households and firms can compute the *relative* prices that affect intentional trade flows.

Domestic and Foreign Prices

If we know the exchange rate between two countries' currencies, we can compute the price of one country's exports in terms of the other country's money. For example, how many dollars would it cost to buy an Edinburgh Woolen Mill sweater costing 50 British pounds (£50)? The answer is found by multiplying the price of the sweater in pounds, 50, by the price of a pound in terms of dollars—the dollar's exchange rate against the pound. At an exchange rate of $1.50 per pound (expressed in American terms), the dollar price of the sweater is

$$(1.50\ \$/£) \times (£50) = \$75.$$

TABLE 13-1 **Exchange Rate Quotations**

Currencies

July 23, 2007

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

Country/currency	Mon in US$	Mon per US$	US$ vs. YTD chg (%)
Americas			
Argentina peso*	.3199	3.1260	2.2
Brazil real	.5427	1.8426	-13.7
Canada dollar	.9552	1.0469	-10.2
1-mos forward	.9558	1.0462	-10.2
3-mos forward	.9568	1.0452	-10.1
6-mos forward	.9580	1.0438	-10.0
Chile peso	.001943	514.67	-3.3
Colombia peso	.0005224	1914.24	-14.5
Ecuador US dollar	1	1	unch
Mexico peso*	.0930	10.7550	-0.4
Peru new sol	.3168	3.157	-1.2
Uruguay peso†	.04220	23.70	-2.8
Venezuela bolivar	.000466	2145.92	unch
Asia-Pacific			
Australian dollar	.8827	1.1329	-10.6
China yuan	.1322	7.5620	-3.1
Hong Kong dollar	.1279	7.8215	0.6
India rupee	.02492	40.128	-9.0
Indonesia rupiah	.0001102	9074	0.9
Japan yen	.008250	121.21	1.9
1-mos forward	.008286	120.69	1.8
3-mos forward	.008347	119.80	1.9
6-mos forward	.008440	118.48	1.9
Malaysia ringgit§	.2934	3.4083	-3.4
New Zealand dollar	.8057	1.2412	-12.6
Pakistan rupee	.01653	60.496	-0.5
Philippines peso	.0223	44.803	-8.6
Singapore dollar	.6629	1.5085	-1.6
South Korea won	.0010927	915.16	-1.6
Taiwan dollar	.03048	32.808	0.7
Thailand baht	.03350	29.851	-15.8

Country/currency	Mon in US$	Mon per US$	US$ vs. YTD chg (%)
Europe			
Czech Rep. koruna**	.04892	20.442	-1.9
Denmark krone	.1855	5.3908	-4.6
Euro area euro	1.3801	.7246	-4.3
Hungary forint	.005611	178.22	-6.4
Malta lira	3.2147	.3111	-4.3
Norway krone	.1745	5.7307	-8.1
Poland zloty	.3668	2.7263	-6.1
Russia ruble‡	.03935	25.413	-3.5
Slovak Rep koruna	.04176	23.946	-8.3
Sweden krona	.1502	6.6578	-2.7
Switzerland franc	.8285	1.2070	-1.0
1-mos forward	.8306	1.2039	-1.0
3-mos forward	.8340	1.1990	-0.8
6-mos forward	.8391	1.1918	-0.7
Turkey lira**	.8017	1.2473	-11.9
UK pound	2.0578	.4860	-4.8
1-mos forward	2.0568	.4862	-4.8
3-mos forward	2.0547	.4867	-4.7
6-mos forward	2.0505	.4877	-4.5
Middle East/Africa			
Bahrain dinar	2.6526	.3770	unch
Egypt pound*	.1763	5.6725	-0.7
Israel shekel	.2382	4.1982	-0.4
Jordan dinar	1.4116	.7084	-0.1
Kuwait dinar	3.4854	.2869	-0.8
Lebanon pound	.0006614	1511.94	unch
Saudi Arabia riyal	.2666	3.7509	unch
South Africa rand	.1468	6.8120	-2.6
UAE dirham	.2723	3.6724	unch
SDR††	1.5358	.6511	-2.0

*Floating rate †Financial §Government rate ‡Russian Central Bank rate **Rebased as of Jan 1, 2005
††Special Drawing Rights (SDR); from the International Monetary Fund; based on exchange rates for U.S., British and Japanese currencies.
Note: Based on trading among banks of $1 million and more, as quoted at 4 p.m. ET by Reuters.

Source: Data from "Currencies," *Wall Street Journal,* July 24, 2007, p. C5.

A change in the dollar/pound exchange rate would alter the sweater's dollar price. At an exchange rate of $1.25 per pound, the sweater would cost only

$$(1.25\ \$/£) \times (£50) = \$62.50,$$

assuming its price in terms of pounds remained the same. At an exchange rate of $1.75 per pound, the sweater's dollar price would be higher, equal to

$$(1.75\ \$/£) \times (£50) = \$87.50.$$

Changes in exchange rates are described as depreciations or appreciations. A **depreciation** of the pound against the dollar is a fall in the dollar price of pounds, for example, a change in the exchange rate from $1.50 per pound to $1.25 per pound. The preceding example shows that *all else equal, a depreciation of a country's currency makes its goods cheaper for foreigners*. A rise in the pound's price in terms of dollars—for example, from $1.50 per pound to $1.75 per pound—is an **appreciation** of the pound against the dollar.

All else equal, an appreciation of a country's currency makes its goods more expensive for foreigners.

The exchange rate changes discussed in the example simultaneously alter the prices Britons pay for American goods. At an exchange rate of $1.50 per pound, the pound price of a pair of American designer jeans costing $45 is $(\$45)/(1.50\ \$/£) = £30$. A change in the exchange rate from $1.50 per pound to $1.25 per pound, while a depreciation of the pound against the dollar, is also a rise in the pound price of dollars, an *appreciation* of the dollar against the pound. This appreciation of the dollar makes the American jeans more expensive for Britons by raising their pound price from £30 to

$$(\$45)/(1.25\ \$/£) = £36.$$

The change in the exchange rate from $1.50 per pound to $1.75 per pound—an appreciation of the pound against the dollar but a depreciation of the dollar against the pound—lowers the pound price of the jeans from £30 to

$$(\$45)/(1.75\ \$/£) = £25.71.$$

As you can see, descriptions of exchange rate changes as depreciations or appreciations can be bewildering, because when one currency depreciates against another, the second currency must simultaneously appreciate against the first. To avoid confusion in discussing exchange rates, we must always keep track of which of the two currencies we are examining has depreciated or appreciated against the other.

If we remember that a depreciation of the dollar against the pound is at the same time an appreciation of the pound against the dollar, we reach the following conclusion: *When a country's currency depreciates, foreigners find that its exports are cheaper and domestic residents find that imports from abroad are more expensive. An appreciation has opposite effects: Foreigners pay more for the country's products and domestic consumers pay less for foreign products.*

Exchange Rates and Relative Prices

Import and export demands, like the demands for all goods and services, are influenced by *relative* prices, such as the price of sweaters in terms of designer jeans. We have just seen how exchange rates allow individuals to compare domestic and foreign money prices by expressing them in a common currency unit. Carrying this analysis one step further, we can see that exchange rates also allow individuals to compute the relative prices of goods and services whose money prices are quoted in different currencies.

An American trying to decide how much to spend on American jeans and how much to spend on British sweaters must translate their prices into a common currency to compute the price of sweaters in terms of jeans. As we have seen, an exchange rate of $1.50 per pound means that an American pays $75 for a sweater priced at £50 in Britain. Because the price of a pair of American jeans is $45, the price of sweaters in terms of jeans is ($75 per sweater)/($45 per pair of jeans) = 1.67 pairs of jeans per sweater. Naturally, a Briton faces the same relative price of (£50 per sweater)/(£30 per pair of jeans) = 1.67 pairs of jeans per sweater.

Table 13-2 shows the relative prices implied by exchange rates of $1.25 per pound, $1.50 per pound, and $1.75 per pound, on the assumption that the dollar price of jeans and the pound price of sweaters are unaffected by the exchange rate changes. To test your understanding, try to calculate these relative prices for yourself and confirm that the outcome of the calculation is the same for a Briton and for an American.

TABLE 13-2 $/£ Exchange Rates and the Relative Price of American Designer Jeans and British Sweaters

Exchange rate ($/£)	1.25	1.50	1.75
Relative price (pairs of jeans/sweater)	1.39	1.67	1.94

Note: The above calculations assume unchanged money prices of $45 per pair of jeans and £50 per sweater.

The table shows that if the goods' money prices do not change, an appreciation of the dollar against the pound makes sweaters cheaper in terms of jeans (each pair of jeans buys more sweaters) while a depreciation of the dollar against the pound makes sweaters more expensive in terms of jeans (each pair of jeans buys fewer sweaters). The computations illustrate a general principle: *All else equal, an appreciation of a country's currency raises the relative price of its exports and lowers the relative price of its imports. Conversely, a depreciation lowers the relative price of a country's exports and raises the relative price of its imports.*

The Foreign Exchange Market

Just as other prices in the economy are determined by the interaction of buyers and sellers, exchange rates are determined by the interaction of the households, firms, and financial institutions that buy and sell foreign currencies to make international payments. The market in which international currency trades take place is called the **foreign exchange market.**

The Actors

The major participants in the foreign exchange market are commercial banks, corporations that engage in international trade, nonbank financial institutions such as asset-management firms and insurance companies, and central banks. Individuals may also participate in the foreign exchange market—for example, the tourist who buys foreign currency at a hotel's front desk—but such cash transactions are an insignificant fraction of total foreign exchange trading.

We now describe the major actors in the market and their roles.

1. *Commercial banks*. Commercial banks are at the center of the foreign exchange market because almost every sizable international transaction involves the debiting and crediting of accounts at commercial banks in various financial centers. Thus, the vast majority of foreign exchange transactions involve the exchange of *bank deposits* denominated in different currencies.

   Let's look at an example. Suppose ExxonMobil Corporation wishes to pay €160,000 to a German supplier. First, ExxonMobil gets an exchange rate quotation from its own commercial bank, the Third National Bank. Then it instructs Third National to debit ExxonMobil's dollar account and pay €160,000 into the supplier's account at a German bank. If the exchange rate quoted to ExxonMobil by Third National is $1.2 per euro, $192,000 (= $1.2 per euro × €160,000) is debited from ExxonMobil's account. The final result of the transaction is the exchange of a $192,000 deposit at Third National Bank (now owned by the German bank that supplied the euros) for the €160,000 deposit used by Third National to pay ExxonMobil's German supplier.

   As the example shows, banks routinely enter the foreign exchange market to meet the needs of their customers—primarily corporations. In addition, a bank will also quote to other banks exchange rates at which it is willing to buy currencies from them and sell currencies to them. Foreign currency trading among banks—called **interbank trading**—accounts

A Tale of Two Dollars

Throughout the first half of the 1970s, the U.S. dollar and the Canadian dollar traded roughly at par, that is, at a one-to-one exchange rate. Despite low barriers to mutual trade, proximity, and similarities in language and culture, the U.S. and Canadian economies are quite different—with Canada's more concentrated in production of natural resources—and their governments have at times pursued divergent macroeconomic policies. As a result, the exchange rate of the two dollars for several decades showed a trend, with the Canadian dollar tending to fall against its American cousin until a few years ago. But there have also been some pronounced cycles around that trend, as the figure on the next page shows. For reasons that we will discuss in Chapter 20, the Canadian dollar's downward trend sharply reversed itself in the middle of 2003. In September 2007 the two dollars reached par again for the first time in more than 30 years.

Later chapters of this book will provide the basis for understanding the causes of these exchange rate changes. You can easily understand their effects, however, based on the discussion in the text. When the Canadian dollar slumped (as during 1976–1987 and 1991–2002), Canadian manufacturing exporters were cheered by their ability to sell goods more easily to the United States, while Canadian importers grimaced at the higher prices they had to pay. The tables were turned during the Canadian dollar's appreciation cycles (1987–1991 and, most recently, after 2002), with Canadian exporters facing tougher competition abroad and Canadian importers enjoying improved terms of trade. Not only exporters suffered during the appreciation cycles. Tourism is a big business in Canada, and the influx of foreign visitors rises when the Canadian dollar is weak and falls when it is strong.

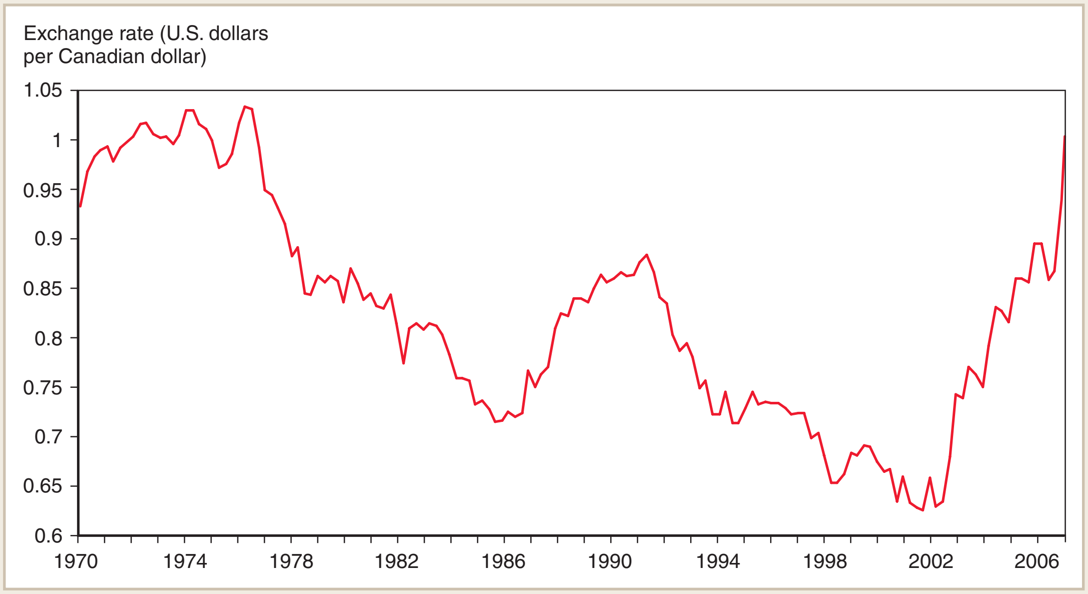
The close interconnections between the U.S. and Canadian economies provide some particularly vivid illustrations of the relative-price effects of exchange rate changes. When the Canadian dollar last hit a peak in 1991, many stores in Canadian border towns shut down as local shoppers sought bargains in the United States. At the same time, shopping malls to serve them sprung up just south of the border.* Niagara Falls, where thousands cross the border going both ways every day, saw Americans, Canadians, and overseas tourists basing their restaurant choices on the exchange rate! The more recent appreciation cycle has had similar effects, with Canadians rushing to buy autos just south of the border.†

*See "Canada's Dollar Is Up a Lot. That's Also the Bad News," *New York Times*, October 8, 2004, p. W1.

†See "Surging Loonie Causes a Flap in U.S.-Canada Border Trade," *Financial Times*, July 16, 2007, p. 3.

for most of the activity in the foreign exchange market. In fact, the exchange rates listed in Table 13-1 are interbank rates, the rates banks charge to each other. No amount less than $1 million is traded at those rates. The rates available to corporate customers, called "retail" rates, are usually less favorable than the "wholesale" interbank rates. The difference between the retail and wholesale rates is the bank's compensation for doing the business.

Because their international operations are so extensive, large commercial banks are well suited to bring buyers and sellers of currencies together. A multinational corporation wishing to convert $100,000 into Swedish kronor might find it difficult and costly to locate other corporations wishing to sell the right amount of kronor. By serving



Exchange Rate of the U.S. and Canadian Dollars, 1970–2007

Source: Global Financial Data.

Currency movements can cause particular problems for firms that have most of their expenses in one country but most of their receipts in the other. Consider the Toronto Blue Jays baseball organization, for example. Because the team competes for free agents in the U.S.-based market for players, it pays U.S. dollar salaries. Yet much of its revenue (including ballpark ticket receipts) is in Canadian dollars. Because a Canadian dollar depreciation therefore raises the Blue Jays' expenses relative to revenues, the team's owners must worry about exchange rates in a way that the owners of the Boston Red Sox or San Francisco Giants need not. As a result, the Blue Jays' maneuvers in the foreign exchange market can be as intricate as a triple play. Its financial managers try to predict future U.S. dollar needs and purchase the American currency in advance, so as to lock in the exchange rate. When exchange rates move sharply, errors in the currency market can be more costly to the Blue Jays than errors in the field.

many customers simultaneously through a single large purchase of kronor, a bank can economize on these search costs.

2. *Corporations*. Corporations with operations in several countries frequently make or receive payments in currencies other than that of the country in which they are headquartered. To pay workers at a plant in Mexico, for example, IBM may need Mexican pesos. If IBM has only dollars earned by selling computers in the United States, it can acquire the pesos it needs by buying them with its dollars in the foreign exchange market.
3. *Nonbank financial institutions*. Over the years, deregulation of financial markets in the United States, Japan, and other countries has encouraged nonbank financial institutions such as mutual funds to offer their customers a broader range of services, many of them indistinguishable from those offered by banks. Among these have been services

involving foreign exchange transactions. Institutional investors such as pension funds often trade foreign currencies. Hedge funds, which cater to very wealthy individuals and are not bound by government regulations that limit mutual funds' trading strategies, trade actively in the foreign exchange market.

4. *Central banks*. In the previous chapter we learned that central banks sometimes intervene in foreign exchange markets. While the volume of central bank transactions is typically not large, the impact of these transactions may be great. The reason for this impact is that participants in the foreign exchange market watch central bank actions closely for clues about future macroeconomic policies that may affect exchange rates. Government agencies other than central banks may also trade in the foreign exchange market, but central banks are the most regular official participants.

Characteristics of the Market

Foreign exchange trading takes place in many financial centers, with the largest volume of trade occurring in such major cities as London (the largest market), New York, Tokyo, Frankfurt, and Singapore. The worldwide volume of foreign exchange trading is enormous, and it has ballooned in recent years. In April 1989, the average total value of global foreign exchange trading was close to $600 billion *per day,* of which $184 billion were traded daily in London, $115 billion in the United States, and $111 billion in Tokyo. Eighteen years later, in April 2007, the daily global value of foreign exchange trading had jumped to around $3.2 trillion, of which $1.36 trillion were traded daily in Britain, $664 billion in the United States, and $238 billion in Japan.[1]

Direct telephone, fax, and Internet links among the major foreign exchange trading centers make each a part of a single world market on which the sun never sets. Economic news released at any time of the day is immediately transmitted around the world and may set off a flurry of activity by market participants. Even after trading in New York has finished, New York-based banks and corporations with affiliates in other time zones can remain active in the market. Foreign exchange traders may deal from their homes when a late-night communication alerts them to important developments in a financial center on another continent.

The integration of financial centers implies that there can be no significant difference between the dollar/euro exchange rate quoted in New York at 9 A.M. and the dollar/euro exchange rate quoted in London at the same time (which corresponds to 2 P.M. London time). If the euro were selling for $1.1 in New York and $1.2 in London, profits could be made through **arbitrage,** the process of buying a currency cheap and selling it dear. At the prices listed above, a trader could, for instance, purchase €1 million in New York for $1.1 million and immediately sell the euros in London for $1.2 million, making a pure profit of $100,000. If all traders tried to cash in on the opportunity, however, their demand for euros in New York would drive up the dollar price of euros there, and their supply of euros in London would drive down the dollar price of euros there. Very quickly, the difference between the New York and London exchange rates would disappear. Since foreign exchange traders carefully watch their computer screens for arbitrage opportunities, the few that arise are small and very short-lived.

[1] April 1989 figures come from surveys carried out simultaneously by the Federal Reserve Bank of New York, the Bank of England, the Bank of Japan, the Bank of Canada, and monetary authorities from France, Italy, the Netherlands, Singapore, Hong Kong, and Australia. The April 2007 survey was carried out by 54 central banks. Revised figures are reported in "Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in April 2007: Preliminary Global Results," Bank for International Settlements, Basle, Switzerland, September 2007. Daily U.S. foreign currency trading in 1980 averaged only around $18 billion.

While a foreign exchange transaction can match any two currencies, most transactions between banks (roughly 86 percent in 2007) are exchanges of foreign currencies for U.S. dollars. This is true even when a bank's goal is to sell one nondollar currency and buy another! A bank wishing to sell Swiss francs and buy Israeli shekels, for example, will usually sell its francs for dollars and then use the dollars to buy shekels. While this procedure may appear roundabout, it is actually cheaper for the bank than the alternative of trying to find a holder of shekels who wishes to buy Swiss francs. The advantage of trading through the dollar is a result of the United States' importance in the world economy. Because the volume of international transactions involving dollars is so great, it is not hard to find parties willing to trade dollars against Swiss francs or shekels. In contrast, relatively few transactions require direct exchanges of Swiss francs for shekels.[2]

Because of its pivotal role in so many foreign exchange deals, the dollar is sometimes called a **vehicle currency.** A vehicle currency is one that is widely used to denominate international contracts made by parties who do not reside in the country that issues the vehicle currency. It has been suggested that the euro, which was introduced at the start of 1999, will evolve into a vehicle currency on a par with the dollar. By April 2007, however, only about 37 percent of foreign exchange trades were against euros. The pound sterling, once second only to the dollar as a key international currency, has declined in importance.[3]

Spot Rates and Forward Rates

The foreign exchange transactions we have been discussing take place on the spot: Two parties agree to an exchange of bank deposits and execute the deal immediately. Exchange rates governing such "on-the-spot" trading are called **spot exchange rates,** and the deal is called a spot transaction.

Foreign exchange deals sometimes specify a *future* transaction date—one that may be 30 days, 90 days, 180 days, or even several years away. The exchange rates quoted in such transactions are called **forward exchange rates.** In a 30-day forward transaction, for example, two parties may commit themselves on April 1 to a spot exchange of £100,000 for $155,000 on May 1. The 30-day forward exchange rate is therefore $1.55 per pound, and it is generally different from the spot rate and from the forward rates applied to different future dates. When you agree to sell pounds for dollars on a future date at a forward rate agreed on today, you have "sold pounds forward" and "bought dollars forward." The future date on which the currencies are actually exchanged is called the *value date*.[4]

Table 13-1 reports forward exchange rates for some heavily traded foreign currencies. (The forward quotations, when available, are listed below the corresponding spot quotations.)

[2] The Swiss franc/shekel exchange rate can be calculated from the dollar/franc and dollar/shekel exchange rates as the dollar/shekel rate divided by the dollar/franc rate. If the dollar/franc rate is $0.80 per franc and the dollar/shekel rate is $0.20 per shekel, then the Swiss franc/shekel rate is (0.20 $/shekel)/(0.80 $/franc) = 0.25 Swiss franc/shekel. Exchange rates between nondollar currencies are called "cross rates" by foreign exchange traders.

[3] For more detailed discussion of vehicle currencies, see Richard Portes and Hélène Rey, "The Emergence of the Euro as an International Currency," *Economic Policy* 26 (April 1998), pp. 307–343. Data on currency shares come from Bank for International Settlements, *op. cit.*, footnote 1. For a progress report on the euro's status, see Harald Hau, William Killeen, and Michael Moore, "How Has the Euro Changed the Foreign Exchange Market?" *Economic Policy* 34 (April 2002), pp. 149–191. Further discussion can be found in a symposium in the October 2002 issue of the journal *Economic Policy.*

[4] In days past, it would take up to two days to settle even spot foreign exchange transactions. In other words, the value date for a spot transaction was actually two days after the deal was struck. Nowadays, most spot trades of major currencies settle on the same day through an electronic system called Continuous Linked Settlement.

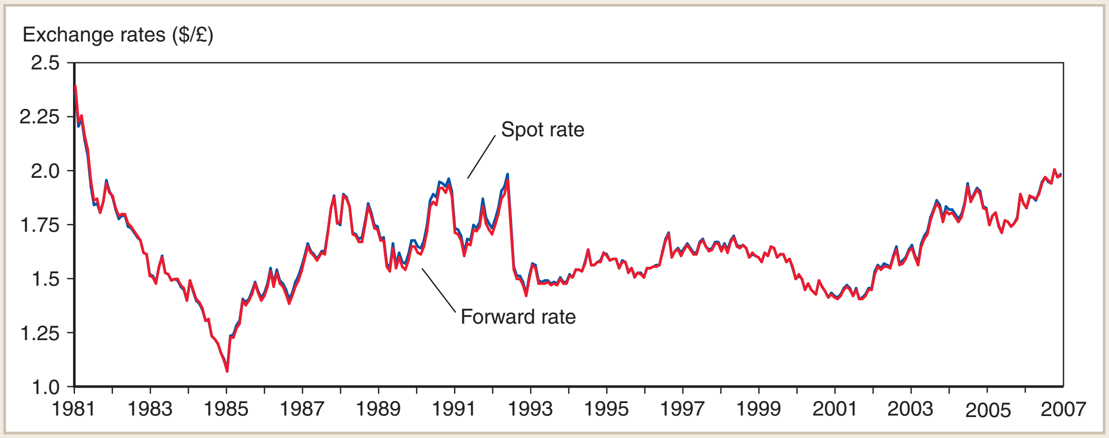


Figure 13-1

Dollar/Pound Spot and Forward Exchange Rates, 1981–2007

Spot and forward exchange rates tend to move in a highly correlated fashion.

Source: *Datastream.* Rates shown are 90-day forward exchange rates and spot exchange rates, at end of month.

Forward and spot exchange rates, while not necessarily equal, do move closely together, as illustrated for monthly data on dollar/pound rates in Figure 13-1. The appendix to this chapter, which discusses how forward exchange rates are determined, explains this close relationship between movements in spot and forward rates.

An example shows why parties may wish to engage in forward exchange transactions. Suppose Radio Shack knows that in 30 days it must pay yen to a Japanese supplier for a shipment of radios arriving then. Radio Shack can sell each radio for $100 and must pay its supplier ¥9,000 per radio; its profit depends on the dollar/yen exchange rate. At the current spot exchange rate of $0.0105 per yen, Radio Shack would pay ($0.0105 per yen) × (¥9,000 per radio) = $94.50 per radio and would therefore make $5.50 on each radio imported. But Radio Shack will not have the funds to pay the supplier until the radios arrive and are sold. If over the next 30 days the dollar unexpectedly depreciates to $0.0115 per yen, Radio Shack will have to pay ($0.0115 per yen) × (¥9,000 per radio) = $103.50 per radio and so will take a $3.50 *loss* on each.

To avoid this risk, Radio Shack can make a 30-day forward exchange deal with Bank of America. If Bank of America agrees to sell yen to Radio Shack in 30 days at a rate of $0.0107, Radio Shack is assured of paying exactly ($0.0107 per yen) × (¥9,000 per radio) = $96.30 per radio to the supplier. By buying yen and selling dollars forward, Radio Shack is guaranteed a profit of $3.70 per radio and is insured against the possibility that a sudden exchange rate change will turn a profitable importing deal into a loss. In the jargon of the foreign exchange market, we would say that Radio Shack has *hedged* its foreign currency risk.

From now on, when we mention an exchange rate without specifying whether it is a spot rate or a forward rate, we will always be referring to the spot rate.

Foreign Exchange Swaps

A foreign exchange *swap* is a spot sale of a currency combined with a forward repurchase of the currency. For example, suppose the Toyota auto company has just received $1 million from American sales and knows it will have to pay those dollars to a California supplier in three months. Toyota's asset-management department would meanwhile like to invest the $1 million in euro bonds. A three-month swap of dollars into euros may result in lower brokers' fees than the two separate transactions of selling dollars for spot euros and selling the euros for dollars on the forward market. Swaps make up a significant proportion of all foreign exchange trading.

Futures and Options

Several other financial instruments traded in the foreign exchange market, like forward contracts, involve future exchanges of currencies. The timing and terms of the exchanges can differ, however, from those specified in forward contracts, giving traders additional flexibility in avoiding foreign exchange risk. Only 25 years ago, some of these instruments were not traded on organized exchanges.

When you buy a *futures contract,* you buy a promise that a specified amount of foreign currency will be delivered on a specified date in the future. A forward contract between you and some other private party is an alternative way to ensure that you receive the same amount of foreign currency on the date in question. But while you have no choice about fulfilling your end of a forward deal, you can sell your futures contract on an organized futures exchange, realizing a profit or loss right away. Such a sale might appear advantageous, for example, if your views about the future spot exchange rate were to change.

A *foreign exchange option* gives its owner the right to buy or sell a specified amount of foreign currency at a specified price at any time up to a specified expiration date. The other party to the deal, the option's seller, is required to sell or buy the foreign currency at the discretion of the option's owner, who is under no obligation to exercise his right.

Imagine that you are uncertain about when in the next month a foreign currency payment will arrive. To avoid the risk of a loss, you may wish to buy a *put option* giving you the right to sell the foreign currency at a known exchange rate at any time during the month. If instead you expect to make a payment abroad sometime in the month, a *call option,* which gives you the right to buy foreign currency to make the payment at a known price, might be attractive. Options can be written on many underlying assets (including foreign exchange futures), and, like futures, they are freely bought and sold. Forwards, swaps, futures, and options are all examples of *financial derivatives,* which we encountered in Chapter 12.

The Demand for Foreign Currency Assets

We have now seen how banks, corporations, and other institutions trade foreign currency bank deposits in a worldwide foreign exchange market that operates 24 hours a day. To understand how exchange rates are determined by the foreign exchange market, we first must ask how the major actors' demands for different types of foreign currency deposits are determined.

The demand for a foreign currency bank deposit is influenced by the same considerations that influence the demand for any other asset. Chief among these considerations is our view of what the deposit will be worth in the future. A foreign currency deposit's future value depends in turn on two factors: the interest rate it offers and the expected change in the currency's exchange rate against other currencies.

Assets and Asset Returns

As you will recall, people can hold wealth in many forms—stocks, bonds, cash, real estate, rare wines, diamonds, and so on. The object of acquiring wealth—of saving—is to transfer

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Nondeliverable Forward Exchange Trading in Asia

In a standard forward exchange contract, two parties agree to exchange two different currencies at an agreed rate on a future date. The currencies of many developing countries are, however, not fully *convertible,* meaning that they cannot be freely traded on international foreign exchange markets. An important example of an inconvertible currency is China's renminbi, which can be traded within China's borders (by residents) but not outside (because China's government does not allow nonresidents unrestricted ownership of renminbi deposits in China). Thus, for currencies such as the renminbi, the customary way of trading forward exchange is not possible.

Developing countries such as China with inconvertible currencies have entered the ranks of the world's largest participants in international trade and investment. Usually, traders use the forward exchange market to hedge their currency risks, but in cases such as China's, as we have seen, a standard forward market cannot exist. Is there no way for foreigners to hedge the currency risk they may take on when they trade with inconvertible-currency countries?

Since the early 1990s, markets in *nondeliverable forward exchange* have sprung up in centers such as Hong Kong and Singapore to facilitate hedging in inconvertible Asian currencies. Among the currencies traded in offshore nondeliverable forward markets are the Chinese renminbi, the Taiwan dollar, and the Indian rupee. By using nondeliverable forward contracts, traders can hedge currency risks without ever actually having to trade inconvertible currencies.

Let's look at a hypothetical example to see how this hedging can be accomplished: General Motors has just sold some car components to China. Its contract with the Chinese importer states that in three months, GM will receive the dollar equivalent of 10 million yuan in payment for its shipment. (The yuan is the unit in which amounts of renminbi are measured, just as British sterling is measured in pounds.) The People's Bank of China (PBC), the central bank, tightly controls its currency's exchange rate by trading dollars that it holds for renminbi with domestic residents.* Today, the PBC will buy or sell a U.S. dollar for 7.6 yuan. But the PBC has been gradually allowing its currency to appreciate against the dollar, and the rate it will quote in three months is uncertain: It could be anywhere between, say, 7.5 and 7.3 yuan per dollar. GM would like to lock in a forward exchange rate of 7.4 yuan per dollar, which the company's chief financial officer might typically do simply by selling the expected 10 million yuan receipts forward for dollars at that rate. Unfortunately, the renminbi's inconvertibility means that GM will actually receive, not renminbi that it can sell forward, but the dollar equivalent of 10 million yuan, dollars that the importer can buy through China's banking system.

Nondeliverable forwards result in a "virtual" forward market, however. They do this by allowing non-Chinese traders to make bets that are *payable in dollars* on the renminbi's value. To lock in a nondeliverable forward exchange rate of 7.4 yuan per dollar, GM can sign a contract requiring it to pay the difference between the number of dollars it actually receives in three months and the amount it would receive if the exchange rate were exactly 7.4 yuan per dollar, equivalent to 1/7.4 dollars per yuan = $0.1351 per yuan

*China's currency regime is an example of a fixed exchange-rate system, which we will study in greater detail in Chapter 17.

purchasing power into the future. We may do this to provide for our retirement years, for our heirs, or simply because we earn more than we need to spend in a particular year and prefer to save the balance for a rainy day.

Defining Asset Returns Because the object of saving is to provide for future consumption, we judge the desirability of an asset largely on the basis of its **rate of return,** that is, the percentage increase in value it offers over some time period. For example, suppose that at the beginning of 2009 you pay $100 for a share of stock issued by Financial

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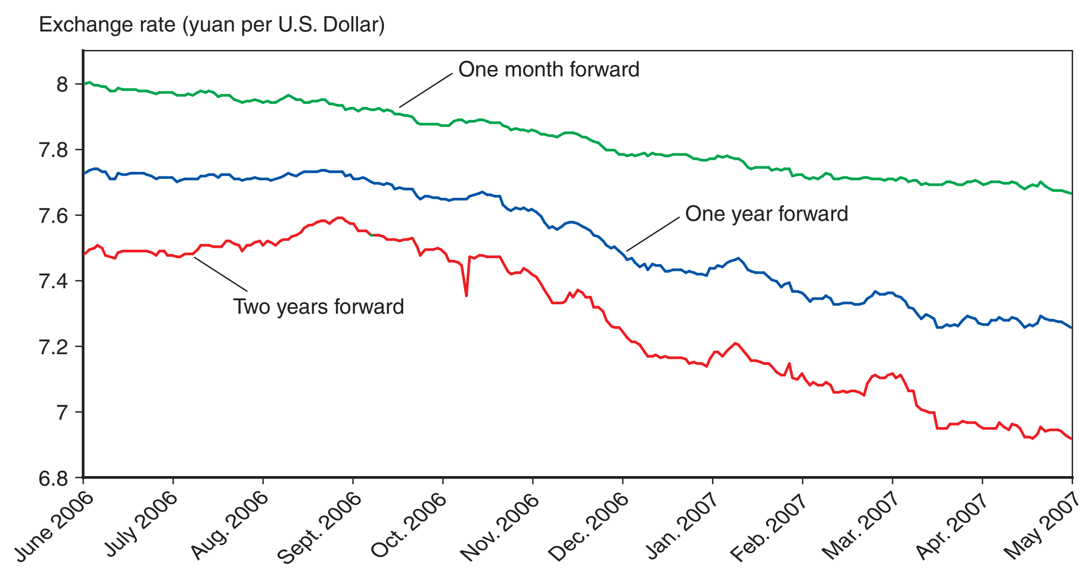


Nondeliverable Forward Exchange Rates, China Yuan per Dollar

Source: *Datastream*.

(after rounding). Thus, if the exchange rate turns out to be 7.3 yuan per dollar (which otherwise would be good luck for GM), GM will have to pay out on its contract (1/7.3 – 1/7.4 dollars per yuan) × (10,000,000 yuan) = ($0.1370 – $0.1351 per yuan) × (10,000,000 yuan) = $19,000.

On the other hand, by giving up the possibility of good luck, GM also avoids the risk of bad luck. If the exchange rate turns out instead to be 7.5 yuan per dollar (which otherwise would be unfavorable for GM), GM will pay the negative amount ($0.1333 –$0.1351 per yuan) × (10,000,000 yuan) = –$18,000, that is, it will receive $18,000 from the other contracting party. The nondeliverable forward contract allows GM to immunize itself from exchange risk, even though the parties to the contract need never actually exchange Chinese currency.

The chart above shows daily data on nondeliverable forward rates of yuan for dollars at maturities of one month, one year, and two years. (Far longer maturities are also quoted.) Changes in these rates are more variable at the longer maturities, and the rates reflect expectations that China will continue its policy of gradually allowing its currency to appreciate against the dollar. China's exchange rate system and policies have been a focus for international controversy in recent years, and we will say more about them in later chapters.

Soothsayers, Inc. If the stock pays you a dividend of $1 at the beginning of 2010, and if the stock's price rises from $100 to $109 per share over the year, then you have earned a rate of return of 10 percent on the stock over 2009—that is, your initial $100 investment has grown in value to $110, the sum of the $1 dividend and the $109 you could get by selling your share. Had Financial Soothsayers stock still paid out its $1 dividend but dropped in price to $89 per share, your $100 investment would be worth only $90 by year's end, giving a rate of return of *negative* 10 percent.

You often cannot know with certainty the return that an asset will actually pay after you buy it. Both the dividend paid by a share of stock and the share's resale price, for example, may be hard to predict. Your decision therefore must be based on an *expected* rate of return. To calculate an expected rate of return over some time period, you make your best forecast of the asset's total value at the period's end. The percentage difference between that expected future value and the price you pay for the asset today equals the asset's expected rate of return over the time period.

When we measure an asset's rate of return, we compare how an investment in the asset changes in total value between two dates. In the previous example, we compared how the value of an investment in Financial Soothsayers stock changed between 2009 ($100) and 2010 ($110) to conclude that the rate of return on the stock was 10 percent per year. We call this a *dollar* rate of return because the two values we compare are expressed in terms of dollars. It is also possible, however, to compute different rates of return by expressing the two values in terms of a foreign currency or a commodity such as gold.

The Real Rate of Return The expected rate of return that savers consider in deciding which assets to hold is the expected **real rate of return,** that is, the rate of return computed by measuring asset values in terms of some broad representative basket of products that savers regularly purchase. It is the expected real return that matters because the ultimate goal of saving is future consumption, and only the *real* return measures the goods and services a saver can buy in the future in return for giving up some consumption (that is, saving) today.

To continue our example, suppose the dollar value of an investment in Financial Soothsayers stock increases by 10 percent between 2009 and 2010 but that the dollar prices of all goods and services *also* increase by 10 percent. Then in terms of output—that is, in *real terms*—the investment would be worth no more in 2009 than in 2010. With a real rate of return of zero, Financial Soothsayers stock would not be a very desirable asset.

Although savers care about expected real rates of return, rates of return expressed in terms of a currency can still be used to *compare* real returns on *different* assets. Even if all dollar prices rise by 10 percent between 2009 and 2010, a rare bottle of wine whose dollar price rises by 25 percent is still a better investment than a bond whose dollar value rises by 20 percent. The real rate of return offered by the wine is 15 percent (= 25 percent – 10 percent) while that offered by the bond is only 10 percent (= 20 percent − 10 percent). Notice that the difference between the dollar returns of the two assets (25 percent – 20 percent) must equal the difference between their real returns (15 percent – 10 percent). The reason for this equality is that, given the two assets' dollar returns, a change in the rate at which the dollar prices of goods are rising changes both assets' real returns by the same amount.

The distinction between real rates of return and dollar rates of return illustrates an important concept in studying how savers evaluate different assets: The returns on two assets cannot be compared unless they are measured in the *same* units. For example, it makes no sense to compare directly the real return on the bottle of wine (15 percent in our example) with the dollar return on the bond (20 percent) or to compare the dollar return on old paintings with the euro return on gold. Only after the returns are expressed in terms of a common unit of measure—for example, all in terms of dollars—can we tell which asset offers the highest expected real rate of return.

Risk and Liquidity

All else equal, individuals prefer to hold those assets offering the highest expected real rate of return. Our later discussions of particular assets will show, however, that "all else" often is not equal. Some assets may be valued by savers for attributes other than the expected real rate of return they offer. Savers care about two main characteristics of an asset other than its return: its **risk,** the variability it contributes to savers' wealth, and its **liquidity,** the ease with which the asset can be sold or exchanged for goods.

1. *Risk*. An asset's real return is usually unpredictable and may turn out to be quite different from what savers expect when they purchase the asset. In our last example, savers found the expected real rate of return on an investment in bonds (10 percent) by subtracting from the expected rate of increase in the investment's dollar value (20 percent) the expected rate of increase in dollar prices (10 percent). But if expectations are wrong and the bonds' dollar value stays constant instead of rising by 20 percent, the saver ends up with a real return of *negative* 10 percent (= 0 percent − 10 percent). Savers dislike uncertainty and are reluctant to hold assets that make their wealth highly variable. An asset with a high expected rate of return may appear undesirable to savers if its realized rate of return fluctuates widely.

2. *Liquidity*. Assets also differ according to the cost and speed at which savers can dispose of them. A house, for example, is not very liquid because its sale usually requires time and the services of brokers and inspectors. In contrast, cash is the most liquid of assets: It is always acceptable at face value as payment for goods or other assets. Savers prefer to hold some liquid assets as a precaution against unexpected pressing expenses that might force them to sell less liquid assets at a loss. They will therefore consider an asset's liquidity as well as its expected return and risk in deciding how much of it to hold.

Interest Rates

As in other asset markets, participants in the foreign exchange market base their demands for deposits of different currencies on a comparison of these assets' expected rates of return. To compare returns on different deposits, market participants need two pieces of information. First, they need to know how the money values of the deposits will change. Second, they need to know how exchange rates will change so that they can translate rates of return measured in different currencies into comparable terms.

The first piece of information needed to compute the rate of return on a deposit of a particular currency is the currency's **interest rate,** the amount of that currency an individual can earn by lending a unit of the currency for a year. At a dollar interest rate of 0.10 (quoted as 10 percent per year), the lender of $1 receives $1.10 at the end of the year, $1 of which is principal and 10 cents of which is interest. Looked at from the other side of the transaction, the interest rate on dollars is also the amount that must be paid to borrow $1 for a year. When you buy a U.S. Treasury bill, you earn the interest rate on dollars because you are lending dollars to the U.S. government.

Interest rates play an important role in the foreign exchange market because the large deposits traded there pay interest, each at a rate reflecting its currency of denomination. For example, when the interest rate on dollars is 10 percent per year, a $100,000 deposit is worth $110,000 after a year; when the interest rate on euros is 5 percent per year, a €100,000 deposit is worth €105,000 after a year. Deposits pay interest because they are really loans from the depositor to the bank. When a corporation or a financial institution deposits a currency in a bank, it is lending that currency to the bank rather than using it for some current expenditure. In other words, the depositor is acquiring an asset denominated in the currency it deposits.

The dollar interest rate is simply the dollar rate of return on dollar deposits. You "buy" the deposit by lending a bank $100,000, and when you are paid back with 10 percent interest at the end of the year your asset is worth $110,000. This gives a rate of return of

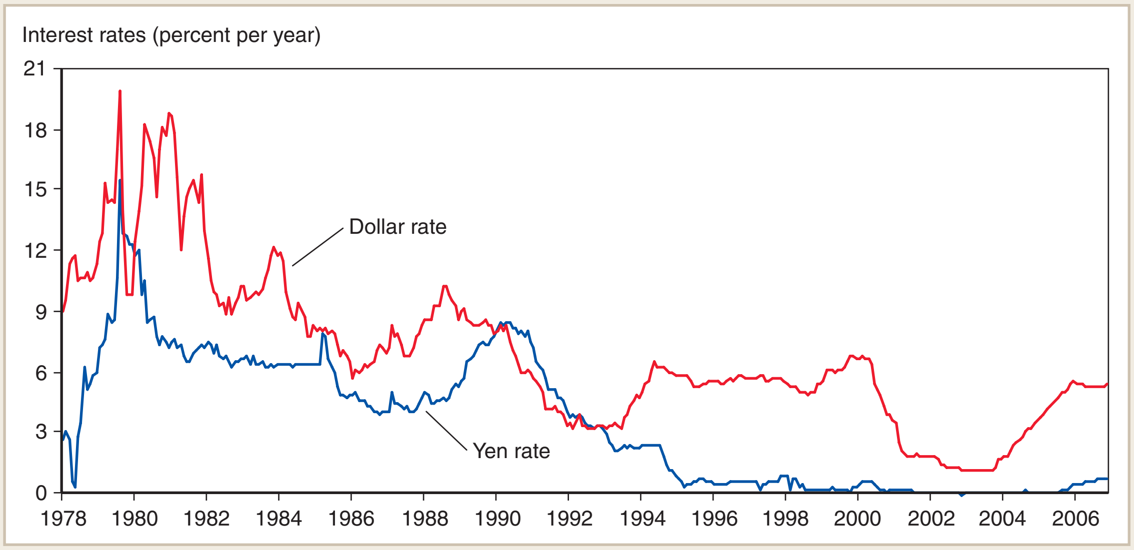


Figure 13-2

Interest Rates on Dollar and Yen Deposits, 1978–2007

Since dollar and yen interest rates are not measured in comparable terms, they can move quite differently over time.

Source: *Datastream*. Three-month interest rates are shown.

(110,000 − 100,000)/100,000 = 0.10, or 10 percent per year. Similarly, a foreign currency's interest rate measures the foreign currency return on deposits of that currency. Figure 13-2 shows the monthly behavior of interest rates on the dollar and the Japanese yen from 1978 to 2007. These interest rates are not measured in comparable terms, so there is no reason for them to be close to each other or to move in similar ways over time.[5]

Exchange Rates and Asset Returns

The interest rates offered by a dollar and a euro deposit tell us how their dollar and euro values will change over a year. The other piece of information we need to compare the rates of return offered by dollar and euro deposits is the expected change in the dollar/euro exchange rate over the year. To see which deposit, euro or dollar, offers a higher expected rate of return, you must ask the question: If I use dollars to buy a euro deposit, how many dollars will I get back after a year? When you answer this question, you are calculating the *dollar* rate of return on a euro deposit because you are comparing its *dollar* price today with its *dollar* value a year from today.

To see how to approach this type of calculation, let's look at the following situation: Suppose that today's exchange rate (quoted in American terms) is \$1.10 per euro, but that you expect the rate to be \$1.165 per euro in a year (perhaps because you expect unfavorable

[5]Chapter 7 defined *real* interest rates, which are simply real rates of return on loans, that is, interest rates expressed in terms of a consumption basket. Interest rates expressed in terms of currencies are called *nominal* interest rates. The connection between real and nominal interest rates is discussed in detail in Chapter 15.

developments in the U.S. economy). Suppose also that the dollar interest rate is 10 percent per year while the euro interest rate is 5 percent per year. This means a deposit of $1.00 pays $1.10 after a year while a deposit of €1 pays €1.05 after a year. Which of these deposits offers the higher return?

The answer can be found in five steps.

Step 1. Use today's dollar/euro exchange rate to figure out the dollar price of a euro deposit of, say, €1. If the exchange rate today is $1.10 per euro, the dollar price of a €1 deposit is just $1.10.

Step 2. Use the euro interest rate to find the amount of euro you will have a year from now if you purchase a €1 deposit today. You know that the interest rate on euro deposits is 5 percent per year. So at the end of a year, your €1 deposit will be worth €1.05.

Step 3. Use the exchange rate you expect to prevail a year from today to calculate the expected dollar value of the euro amount determined in Step 2. Since you expect the dollar to depreciate against the euro over the coming year so that the exchange rate 12 months from today is $1.165 per euro, then you expect the dollar value of your euro deposit after a year to be $1.165 per euro $\times$ €1.05 $=$ $1.223.

Step 4. Now that you know the dollar price of a €1 deposit today ($1.10) and can forecast its value in a year ($1.223), you can calculate the expected *dollar* rate of return on a euro deposit as $(1.223 - 1.10)/1.10 = 0.11$, or 11 percent per year.

Step 5. Since the dollar rate of return on dollar deposits (the dollar interest rate) is only 10 percent per year, you expect to do better by holding your wealth in the form of euro deposits. Despite the fact that the dollar interest rate exceeds the euro interest rate by 5 percent per year, the euro's expected appreciation against the dollar gives euro holders a prospective capital gain that is large enough to make euro deposits the higher-yield asset.

A Simple Rule

A simple rule shortens this calculation. First, define the **rate of depreciation** of the dollar against the euro as the percentage increase in the dollar/euro exchange rate over a year. In the last example, the dollar's expected depreciation rate is $(1.165 - 1.10)/1.10 = 0.059$, or roughly 6 percent per year. Once you have calculated the rate of depreciation of the dollar against the euro, our rule is this: *The dollar rate of return on euro deposits is approximately the euro interest rate plus the rate of depreciation of the dollar against the euro*. In other words, to translate the euro return on euro deposits into dollar terms, you need to add the rate at which the euro's dollar price rises over a year to the euro interest rate.

In our example, the sum of the euro interest rate (5 percent) and the expected depreciation rate of the dollar (roughly 6 percent) is about 11 percent, which is what we found to be the expected dollar return on euro deposits in our first calculation.

We summarize our discussion by introducing some notation:

$R_{€}$ = today's interest rate on one-year euro deposits,

$E_{\$/€}$ = today's dollar/euro exchange rate (number of dollars per euro),

$E^e_{\$/€}$ = dollar/euro exchange rate (number of dollars per euro) expected to prevail a year from today.

(The superscript ^{e} attached to this last exchange rate indicates that it is a forecast of the future exchange rate based on what people know today.)

TABLE 13-3 Comparing Dollar Rates of Return on Dollar and Euro Deposits

Case	Dollar Interest Rate $R_\$$	Euro Interest Rate $R_€$	Expected Rate of Dollar Depreciation Against Euro $\frac{E^e_{\$/€} - E_{\$/€}}{E_{\$/€}}$	Rate of Return Difference Between Dollar and Euro Deposits $R_\$ - R_€ - \frac{(E^e_{\$/€} - E_{\$/€})}{E_{\$/€}}$
1	0.10	0.06	0.00	0.04
2	0.10	0.06	0.04	0.00
3	0.10	0.06	0.08	−0.04
4	0.10	0.12	−0.04	0.02

Using these symbols, we write the expected rate of return on a euro deposit, measured in terms of dollars, as the sum of (1) the euro interest rate and (2) the expected rate of dollar depreciation against the euro:

$$R_€ + (E^e_{\$/€} - E_{\$/€})/E_{\$/€}.$$

This expected return is what must be compared with the interest rate on one-year dollar deposits, $R_\$$, in deciding whether dollar or euro deposits offer the higher expected rate of return.[6] The expected rate of return difference between dollar and euro deposits is therefore equal to $R_\$$ less the above expression,

$$R_\$ - [R_€ + (E^e_{\$/€} - E_{\$/€})/E_{\$/€}] = R_\$ - R_€ - (E^e_{\$/€} - E_{\$/€})/E_{\$/€}. \quad (13\text{-}1)$$

When the difference above is positive, dollar deposits yield the higher expected rate of return; when it is negative, euro deposits yield the higher expected rate of return.

Table 13-3 carries out some illustrative comparisons. In case 1, the interest difference in favor of dollar deposits is 4 percent per year $(R_\$ - R_€ = 0.10 - 0.06 = 0.04)$, and no change in the exchange rate is expected $[(E^e_{\$/€} - E_{\$/€})/E_{\$/€} = 0.00]$. This means that the expected annual real rate of return on dollar deposits is 4 percent higher than that on euro, so that, other things equal, you would prefer to hold your wealth as dollar rather than euro deposits.

In case 2 the interest difference is the same (4 percent), but it is just offset by an expected depreciation rate of the dollar of 4 percent. The two assets therefore have the same expected rate of return.

Case 3 is similar to the one discussed earlier: A 4 percent interest difference in favor of dollar deposits is more than offset by an 8 percent expected depreciation of the dollar, so euro deposits are preferred by market participants.

[6]If you compute the expected dollar return on euro deposits using the exact five-step method we described before introducing the simple rule, you'll find that it actually equals

$$(1 + R_€)(E^e_{\$/€}/E_{\$/€}) - 1.$$

This exact formula can be rewritten, however, as

$$R_€ + (E^e_{\$/€} - E_{\$/€})/E_{\$/€} + R_€ \times (E^e_{\$/€} - E_{\$/€})/E_{\$/€}.$$

The expression above is very close to the formula derived from the simple rule when, as is usually the case, the product $R_€ \times (E^e_{\$/€} - E_{\$/€})/E_{\$/€}$ is a small number.

In case 4, there is a 2 percent interest difference in favor of euro deposits, but the dollar is expected to *appreciate* against the euro by 4 percent over the year. The expected rate of return on dollar deposits is therefore 2 percent per year higher than that on euro.

So far we have been translating all returns into dollar terms. But the rate of return differentials we calculated would have been the same had we chosen to express returns in terms of euro or in terms of some third currency. Suppose, for example, we wanted to measure the return on dollar deposits in terms of euro. Following our simple rule, we would add to the dollar interest rate $R_\$$ the expected rate of depreciation of the euro against the dollar. But the expected rate of depreciation of the euro against the dollar is approximately the expected **rate of appreciation** of the dollar against the euro, that is, the expected rate of depreciation of the dollar against the euro with a minus sign in front of it. This means that in terms of euro, the return on a dollar deposit is

$$R_\$ - (E^e_{\$/€} - E_{\$/€})/E_{\$/€}.$$

The difference between the expression above and $R_€$ is identical to equation (13-1). Thus, it makes no difference to our comparison whether we measure returns in terms of dollars or euros, as long as we measure in terms of a single currency.

Return, Risk, and Liquidity in the Foreign Exchange Market

We observed earlier that a saver deciding which assets to hold may care about assets' riskiness and liquidity in addition to their expected real rates of return. Similarly, the demand for foreign currency assets depends not only on returns but on risk and liquidity. Even if the expected dollar return on euro deposits is higher than that on dollar deposits, for example, people may be reluctant to hold euro deposits if the payoff to holding them varies erratically.

There is no consensus among economists about the importance of risk in the foreign exchange market. Even the definition of "foreign exchange risk" is a topic of debate. For now we will avoid these complex questions by assuming that the real returns on all deposits have equal riskiness, regardless of the currency of denomination. In other words, we are assuming that risk differences do not influence the demand for foreign currency assets. We discuss the role of foreign exchange risk in greater detail, however, in Chapters 17 and 21.[7]

Some market participants may be influenced by liquidity factors in deciding which currencies to hold. Most of these participants are firms and individuals conducting international trade. An American importer of French fashion products or wines, for example, may find it convenient to hold euros for routine payments even if the expected rate of return on euros is lower than that on dollars. Because payments connected with international trade make up a very small fraction of total foreign exchange transactions, we ignore the liquidity motive for holding foreign currencies.

We are therefore assuming for now that participants in the foreign exchange market base their demands for foreign currency assets exclusively on a comparison of those

[7] In discussing spot and forward foreign exchange transactions, some textbooks make a distinction between foreign exchange "speculators"—market participants who allegedly care only about expected returns—and "hedgers"—market participants whose concern is to avoid risk. We depart from this textbook tradition because it can mislead the unwary: While the speculative and hedging motives are both potentially important in exchange rate determination, the same person can be both a speculator and a hedger if she cares about both return and risk. Our tentative assumption that risk is unimportant in determining the demand for foreign currency assets means, in terms of the traditional language, that the speculative motive for holding foreign currencies is far more important than the hedging motive.

assets' expected rates of return. The main reason for making this assumption is that it simplifies our analysis of how exchange rates are determined in the foreign exchange market. In addition, the risk and liquidity motives for holding foreign currencies appear to be of secondary importance for many of the international macroeconomic issues discussed in the next few chapters.

Equilibrium in the Foreign Exchange Market

We now use what we have learned about the demand for foreign currency assets to describe how exchange rates are determined. We will show that the exchange rate at which the market settles is the one that makes market participants content to hold existing supplies of deposits of all currencies. When market participants willingly hold the existing supplies of deposits of all currencies, we say that the foreign exchange market is in equilibrium.

The description of exchange rate determination given in this section is only a first step: A full explanation of the exchange rate's current level can be given only after we examine how participants in the foreign exchange market form their expectations about exchange rates they expect to prevail in the future. The next two chapters look at the factors that influence expectations of future exchange rates. For now, however, we will take expected future exchange rates as given.

Interest Parity: The Basic Equilibrium Condition

The foreign exchange market is in equilibrium when deposits of all currencies offer the same expected rate of return. The condition that the expected returns on deposits of any two currencies are equal when measured in the same currency is called the **interest parity condition.** It implies that potential holders of foreign currency deposits view them all as equally desirable assets, provided their expected rates of return are the same.

Let's see why the foreign exchange market is in equilibrium only when the interest parity condition holds. Suppose the dollar interest rate is 10 percent and the euro interest rate is 6 percent, but that the dollar is expected to depreciate against the euro at an 8 percent rate over a year. (This is case 3 in Table 13-3.) In the circumstances described, the expected rate of return on euro deposits would be 4 percent per year higher than that on dollar deposits. We assumed at the end of the last section that individuals always prefer to hold deposits of currencies offering the highest expected return. This means that if the expected return on euro deposits is 4 percent greater than that on dollar deposits, no one will be willing to continue holding dollar deposits, and holders of dollar deposits will be trying to sell them for euro deposits. There will therefore be an excess supply of dollar deposits and an excess demand for euro deposits in the foreign exchange market.

As a contrasting example, suppose that dollar deposits again offer a 10 percent interest rate but euro deposits offer a 12 percent rate and the dollar is expected to *appreciate* against the euro by 4 percent over the coming year. (This is case 4 in Table 13-3.) Now the return on dollar deposits is 2 percent higher. In this case no one would demand euro deposits, so they would be in excess supply and dollar deposits would be in excess demand.

When, however, the dollar interest rate is 10 percent, the euro interest rate is 6 percent, and the dollar's expected depreciation rate against the euro is 4 percent, dollar and euro deposits offer the same rate of return and participants in the foreign exchange market are equally willing to hold either. (This is case 2 in Table 13-3.)

Only when all expected rates of return are equal—that is, when the interest parity condition holds—is there no excess supply of some type of deposit and no excess demand for another. The foreign exchange market is in equilibrium when no type of deposit is in excess demand or excess supply. We can therefore say that the foreign exchange market is in equilibrium when, and only when, the interest parity condition holds.

To represent interest parity between dollar and euro deposits symbolically, we use expression (13-1), which shows the difference between the two assets' expected rates of return measured in dollars. The expected rates of return are equal when

$$R_{\$} = R_{€} + (E^{e}_{\$/€} - E_{\$/€})/E_{\$/€}. \qquad (13\text{-}2)$$

You probably suspect that when dollar deposits offer a higher return than euro deposits, the dollar will appreciate against the euro as investors all try to shift their funds into dollars. Conversely, the dollar should depreciate against the euro when it is euro deposits that initially offer the higher return. This intuition is exactly correct. To understand the mechanism at work, however, we must take a careful look at how exchange rate changes like these help to maintain equilibrium in the foreign exchange market.

How Changes in the Current Exchange Rate Affect Expected Returns

As a first step in understanding how the foreign exchange market finds its equilibrium, we examine how changes in today's exchange rate affect the expected return on a foreign currency deposit when interest rates and expectations about the future exchange rate do not change. Our analysis will show that, other things equal, depreciation of a country's currency today *lowers* the expected domestic currency return on foreign currency deposits. Conversely, appreciation of the domestic currency today, all else equal, *raises* the domestic currency return expected of foreign currency deposits.

It is easiest to see why these relationships hold by looking at an example: How does a change in today's dollar/euro exchange rate, all else held constant, change the expected return, measured in terms of dollars, on euro deposits? Suppose that today's dollar/euro rate is \$1.00 per euro and the exchange rate you expect for this day next year is \$1.05 per euro. Then the expected rate of dollar depreciation against the euro is $(1.05 - 1.00)/1.00 = 0.05$, or 5 percent per year. This means that when you buy a euro deposit, you not only earn the interest $R_{€}$ but also get a 5 percent "bonus" in terms of dollars. Now suppose that today's exchange rate suddenly jumps up to \$1.03 per euro (a depreciation of the dollar and an appreciation of the euro) but the expected future rate is *still* \$1.05 per euro. What has happened to the "bonus" you expected to get from the euro's increase in value in terms of dollars? The expected rate of dollar depreciation is now only $(1.05 - 1.03)/1.03 = 0.019$, or 1.9 percent instead of 5 percent. Since $R_{€}$ has not changed, the dollar return on euro deposits, which is the sum of $R_{€}$ and the expected rate of dollar depreciation, has *fallen* by 3.1 percentage points per year (5 percent – 1.9 percent).

In Table 13-4 we work out the dollar return on euro deposits for various levels of today's dollar/euro exchange rate $E_{\$/€}$, always assuming that the expected *future* exchange rate remains fixed at \$1.05 per euro and the euro interest rate is 5 percent per year. As you can see, a rise in today's dollar/euro exchange rate (a depreciation of the dollar against the euro) always *lowers* the expected dollar return on euro deposits (as in our example), while a fall in today's dollar/euro rate (an appreciation of the dollar against the euro) always *raises* this return.

It may run counter to your intuition that a depreciation of the dollar against the euro makes euro deposits less attractive relative to dollar deposits (by lowering the expected dollar return on euro deposits) while an appreciation of the dollar makes euro deposits more attractive. This result will seem less surprising if you remember we have assumed that the

TABLE 13-4 Today's Dollar/Euro Exchange Rate and the Expected Dollar Return on Euro Deposits When $E^e_{\$/€}$ = \$1.05 per Euro

Today's Dollar/Euro Exchange Rate	Interest Rate on Euro Deposits	Expected Dollar Depreciation Rate Against Euro	Expected Dollar Return on Euro Deposits
$E_{\$/€}$	$R_€$	$\frac{1.05 - E_{\$/€}}{E_{\$/€}}$	$R_€ + \frac{1.05 - E_{\$/€}}{E_{\$/€}}$
1.07	0.05	−0.019	0.031
1.05	0.05	0.00	0.05
1.03	0.05	0.019	0.069
1.02	0.05	0.029	0.079
1.00	0.05	0.05	0.10

expected future dollar/euro rate and interest rates do not change. A dollar depreciation today, for example, means the dollar now needs to depreciate by a *smaller* amount to reach any given expected future level. If the expected future dollar/euro exchange rate does not change when the dollar depreciates today, the dollar's expected future depreciation against the euro therefore falls, or, alternatively, the dollar's expected future appreciation rises. Since interest rates also are unchanged, today's dollar depreciation thus makes euro deposits less attractive compared with dollar deposits.

Put another way, a current dollar depreciation that affects neither exchange rate expectations nor interest rates leaves the expected future dollar payoff of a euro deposit the same but raises the deposit's current dollar cost. This change naturally makes euro deposits less attractive relative to dollars.

It may also run counter to your intuition that *today's* exchange rate can change while the exchange rate expected for the *future* does not. We will indeed study cases later in this book when both of these rates do change at once. We nonetheless hold the expected future exchange rate constant in the present discussion because that is the clearest way to illustrate the effect of today's exchange rate on expected returns. If it helps, you can imagine we are looking at the impact of a *temporary* change so brief that it has no effect on the exchange rate expected for next year.

Figure 13-3 shows the calculations in Table 13-4 in a graphic form that will be helpful in our analysis of exchange rate determination. The vertical axis in the figure measures today's dollar/euro exchange rate and the horizontal axis measures the expected dollar return on euro deposits. For *fixed* values of the expected future dollar/euro exchange rate and the euro interest rate, the relation between today's dollar/euro exchange rate and the expected dollar return on euro deposits defines a downward-sloping schedule.

The Equilibrium Exchange Rate

Now that we understand why the interest parity condition must hold if the foreign exchange market is in equilibrium and how today's exchange rate affects the expected return on foreign currency deposits, we can see how equilibrium exchange rates are determined. Our main conclusion will be that exchange rates always adjust to maintain interest parity. We continue to assume that the dollar interest rate $R_\$$, the euro interest rate $R_€$, and the expected future dollar/euro exchange rate $E^e_{\$/€}$, are all *given*.

Figure 13-3

The Relation Between the Current Dollar/Euro Exchange Rate and the Expected Dollar Return on Euro Deposits

Given $E^e_{\$/€} = 1.05$ and $R_€ = 0.05$, an appreciation of the dollar against the euro raises the expected return on euro deposits, measured in terms of dollars.

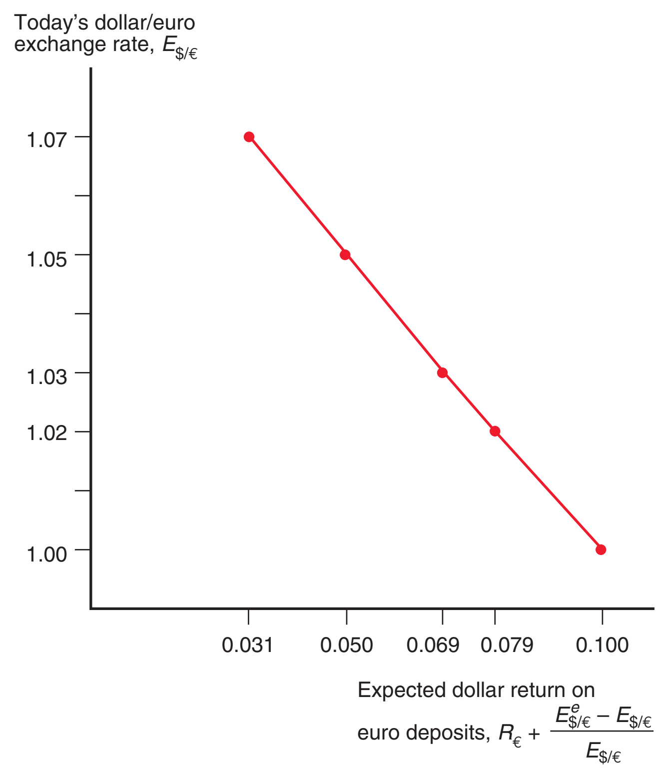


Figure 13-4 illustrates how the equilibrium dollar/euro exchange rate is determined under these assumptions. The vertical schedule in the graph indicates the given level of $R_\$$, the return on dollar deposits measured in terms of dollars. The downward-sloping schedule shows how the expected return on euro deposits, measured in terms of dollars, depends on the current dollar/euro exchange rate. This second schedule is derived in the same way as the one shown in Figure 13-3.

The equilibrium dollar/euro rate is the one indicated by the intersection of the two schedules at point 1, $E^1_{\$/€}$. At this exchange rate, the returns on dollar and euro deposits are equal, so that the interest parity condition (13-2),

$$R_\$ = R_€ + (E^e_{\$/€} - E^1_{\$/€})/E^1_{\$/€},$$

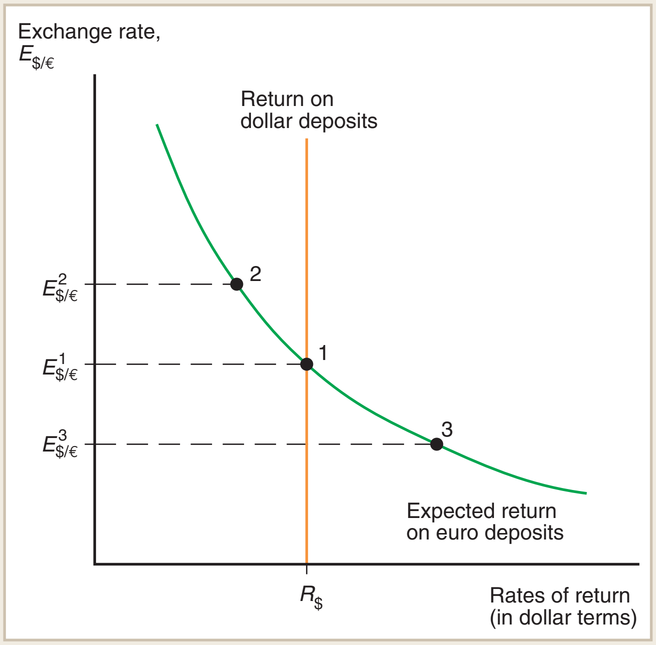
is satisfied.

Let's see why the exchange rate will tend to settle at point 1 in Figure 13-4 if it is initially at a point such as 2 or 3. Suppose first that we are at point 2, with the exchange rate equal to $E^2_{\$/€}$. The downward-sloping schedule measuring the expected dollar return on euro deposits tells us that at the exchange rate $E^2_{\$/€}$, the rate of return on euro deposits is less than the rate of return on dollar deposits, $R_\$$. In this situation anyone holding euro deposits wishes to sell them for the more lucrative dollar deposits: The foreign exchange market is out of equilibrium because participants such as banks and multinational corporations are *unwilling* to hold euro deposits.

Figure 13-4

Determination of the Equilibrium Dollar/Euro Exchange Rate

Equilibrium in the foreign exchange market is at point 1, where the expected dollar returns on dollar and euro deposits are equal.



How does the exchange rate adjust? The unhappy owners of euro deposits attempt to sell them for dollar deposits, but because the return on dollar deposits is higher than that on euro deposits at the exchange rate $E^2_{\$/€}$, no holder of a dollar deposit is willing to sell it for euro at that rate. As euro holders try to entice dollar holders to trade by offering them a better price for dollars, the dollar/euro exchange rate falls toward $E^1_{\$/€}$; that is, euros become cheaper in terms of dollars. Once the exchange rate reaches $E^1_{\$/€}$, euro and dollar deposits offer equal returns and holders of euro deposits no longer have an incentive to try to sell them for dollars. The foreign exchange market is therefore in equilibrium. In falling from $E^2_{\$/€}$ to $E^1_{\$/€}$, the exchange rate equalizes the expected returns on the two types of deposit by increasing the rate at which the dollar is expected to depreciate in the future, thereby making euro deposits more attractive.

The same process works in reverse if we are initially at point 3 with an exchange rate of $E^3_{\$/€}$. At point 3, the return on euro deposits exceeds that on dollar deposits, so there is now an excess supply of the latter. As unwilling holders of dollar deposits bid for the more attractive euro deposits, the price of euros in terms of dollars tends to rise; that is, the dollar tends to depreciate against the euro. When the exchange rate has moved to $E^1_{\$/€}$, rates of return are equalized across currencies and the market is in equilibrium. The depreciation of the dollar from $E^3_{\$/€}$ to $E^1_{\$/€}$ makes euro deposits less attractive relative to dollar deposits by reducing the rate at which the dollar is expected to depreciate in the future.[8]

[8]We could have developed our diagram from the perspective of Europe, with the euro/dollar exchange rate $E_{€/\$}(= 1/E_{\$/€})$ on the vertical axis, a schedule vertical at $R_€$ to indicate the euro return on euro deposits, and a downward-sloping schedule showing how the euro return on dollar deposits varies with $E_{€/\$}$. An exercise at the end of the chapter asks you to show that this alternative way of looking at equilibrium in the foreign exchange market gives the same answers as the method used in the text.

Interest Rates, Expectations, and Equilibrium

Having seen how exchange rates are determined by interest parity, we now take a look at how current exchange rates are affected by changes in interest rates and in expectations about the future, the two factors we held constant in our previous discussions. We will see that the exchange rate (which is the relative price of two assets) responds to factors that alter the expected rates of return on those two assets.

The Effect of Changing Interest Rates on the Current Exchange Rate

We often read in the newspaper that the dollar is strong because U.S. interest rates are high or that it is falling because U.S. interest rates are falling. Can these statements be explained using our analysis of the foreign exchange market?

To answer this question we again turn to a diagram. Figure 13-5 shows a rise in the interest rate on dollars, from $R^1_\$$ to $R^2_\$$, as a rightward shift of the vertical dollar deposits return schedule. At the initial exchange rate $E^1_{\$/€}$, the expected return on dollar deposits is now higher than that on euro deposits by an amount equal to the distance between points 1 and 1′. As we have seen, this difference causes the dollar to appreciate to $E^2_{\$/€}$ (point 2). Because there has been no change in the euro interest rate or in the expected future exchange rate, the dollar's appreciation today raises the expected dollar return on euro deposits by increasing the rate at which the dollar is expected to depreciate in the future.

Figure 13-6 shows the effect of a rise in the euro interest rate $R_€$. This change causes the downward-sloping schedule (which measures the expected dollar return on euro deposits) to shift rightward. (To see why, ask yourself how a rise in the euro interest rate alters the dollar return on euro deposits, given the current exchange rate and the expected future rate.)

At the initial exchange rate $E^1_{\$/€}$, the expected depreciation rate of the dollar is the same as before the rise in $R_€$, so the expected return on euro deposits now exceeds that on

Figure 13-5

Effect of a Rise in the Dollar Interest Rate

A rise in the interest rate offered by dollar deposits from $R^1_\$$ to $R^2_\$$ causes the dollar to appreciate from $E^1_{\$/€}$ (point 1) to $E^2_{\$/€}$ (point 2).

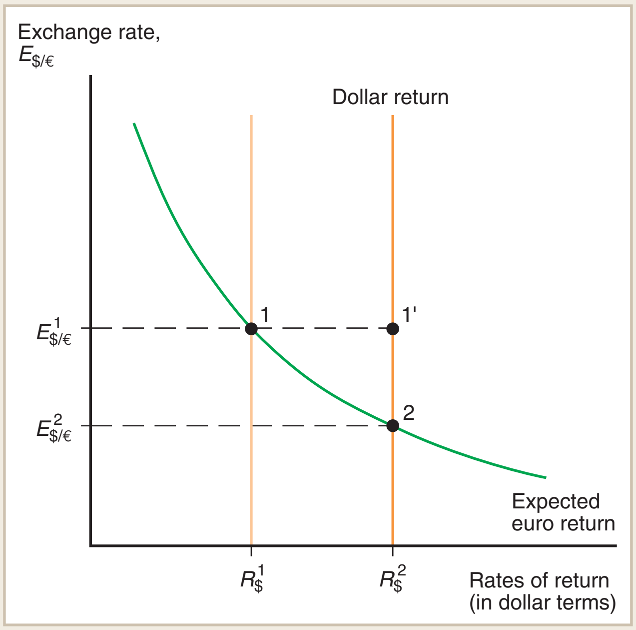
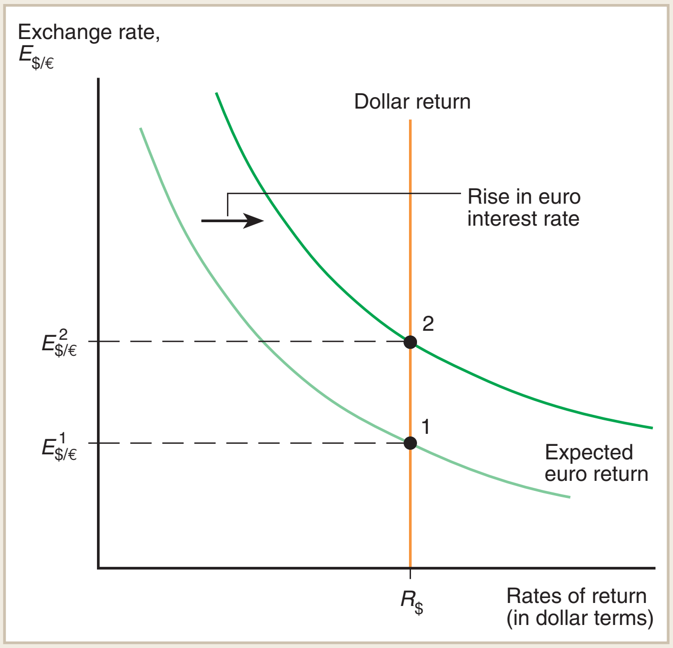


Figure 13-6

Effect of a Rise in the Euro Interest Rate

A rise in the interest rate paid by euro deposits causes the dollar to depreciate from $E^1_{\$/€}$ (point 1) to $E^2_{\$/€}$ (point 2). (This figure also describes the effect of a rise in the expected future $/€ exchange rate.)



dollar deposits. The dollar/euro exchange rate rises (from $E^1_{\$/€}$ to $E^2_{\$/€}$) to eliminate the excess supply of dollar assets at point 1. As before, the dollar's depreciation against the euro eliminates the excess supply of dollar assets by lowering the expected dollar rate of return on euro deposits. A rise in European interest rates therefore leads to a depreciation of the dollar against the euro or, looked at from the European perspective, an appreciation of the euro against the dollar.

Our discussion shows that, all else equal, *an increase in the interest paid on deposits of a currency causes that currency to appreciate against foreign currencies*.

Before we conclude that the newspaper account of the effect of interest rates on exchange rates is correct, we must remember that our assumption of a *constant* expected future exchange rate often is unrealistic. In many cases, a change in interest rates will be accompanied by a change in the expected future exchange rate. This change in the expected future exchange rate will depend, in turn, on the economic causes of the interest rate change. We compare different possible relationships between interest rates and expected future exchange rates in Chapter 15. Keep in mind for now that in the real world, we cannot predict how a given interest rate change will alter exchange rates unless we know *why* the interest rate is changing.

The Effect of Changing Expectations on the Current Exchange Rate

Figure 13-6 may also be used to study the effect on today's exchange rate of a rise in the expected future dollar/euro exchange rate, $E^e_{\$/€}$.

Given today's exchange rate, a rise in the expected future price of euros in terms of dollars raises the dollar's expected depreciation rate. For example, if today's exchange rate is $1.00 per euro and the rate expected to prevail in a year is $1.05 per euro, the expected depreciation rate of the dollar against the euro is $(1.05 - 1.00)/1.00 = 0.05$; if the expected future exchange rate now rises to \$1.06 per euro, the expected depreciation rate also rises, to $(1.06 - 1.00)/1.00 = 0.06$.

Because a rise in the expected depreciation rate of the dollar raises the expected dollar return on euro deposits, the downward-sloping schedule shifts to the right, as in Figure 13-6. At the initial exchange rate $E^1_{\$/€}$ there is now an excess supply of dollar deposits: Euro deposits offer a higher expected rate of return (measured in dollar terms) than do dollar deposits. The dollar therefore depreciates against the euro until equilibrium is reached at point 2.

We conclude that, all else equal, *a rise in the expected future exchange rate causes a rise in the current exchange rate. Similarly, a fall in the expected future exchange rate causes a fall in the current exchange rate.*

SUMMARY

1. An *exchange rate* is the price of one country's currency in terms of another country's currency. Exchange rates play a role in spending decisions because they enable us to translate different countries' prices into comparable terms. All else equal, a *depreciation* of a country's currency against foreign currencies (a rise in the home currency prices of foreign currencies) makes its exports cheaper and its imports more expensive. An *appreciation* of its currency (a fall in the home currency prices of foreign currencies) makes its exports more expensive and its imports cheaper.
2. Exchange rates are determined in the *foreign exchange market*. The major participants in that market are commercial banks, international corporations, nonbank financial institutions, and national central banks. Commercial banks play a pivotal role in the market because they facilitate the exchanges of interest-bearing bank deposits that make up the bulk of foreign exchange trading. Even though foreign exchange trading takes place in many financial centers around the world, modern telecommunication technology links those centers together into a single market that is open 24 hours a day. An important category of foreign exchange trading is *forward* trading, in which parties agree to exchange currencies on some future date at a prenegotiated exchange rate. In contrast, *spot* trades are (for practical purposes) settled immediately.
3. Because the exchange rate is the relative price of two assets, it is most appropriately thought of as being an asset price itself. The basic principle of asset pricing is that an asset's current value depends on its expected future purchasing power. In evaluating an asset, savers look at the expected *rate of return* it offers, that is, the rate at which the value of an investment in the asset is expected to rise over time. It is possible to measure an asset's expected rate of return in different ways, each depending on the units in which the asset's value is measured. Savers care about an asset's expected *real rate of return,* the rate at which its value expressed in terms of a representative output basket is expected to rise.
4. When relative asset returns are relevant, as in the foreign exchange market, it is appropriate to compare expected changes in assets' currency values, provided those values are expressed in the same currency. If *risk* and *liquidity* factors do not strongly influence the demands for foreign currency assets, participants in the foreign exchange market always prefer to hold those assets yielding the highest expected rate of return.
5. The returns on deposits traded in the foreign exchange market depend on *interest rates* and expected exchange rate changes. To compare the expected rates of return offered by dollar and euro deposits, for example, the return on euro deposits must be expressed in dollar terms by adding to the euro interest rate the expected *rate of*

depreciation of the dollar against the euro (or *rate of appreciation* of the euro against the dollar) over the deposit's holding period.

6. Equilibrium in the foreign exchange market requires *interest parity*; that is, deposits of all currencies must offer the same expected rate of return when returns are measured in comparable terms.
7. For given interest rates and a given expectation of the future exchange rate, the interest parity condition tells us the current equilibrium exchange rate. When the expected dollar return on euro deposits exceeds that on dollar deposits, for example, the dollar immediately depreciates against the euro. Other things equal, a dollar depreciation today reduces the expected dollar return on euro deposits by reducing the depreciation rate of the dollar against the euro expected for the future. Similarly, when the expected return on euro deposits is below that on dollar deposits, the dollar must immediately appreciate against the euro. Other things equal, a current appreciation of the dollar makes euro deposits more attractive by increasing the dollar's expected future depreciation against the European currency.
8. All else equal, a rise in dollar interest rates causes the dollar to appreciate against the euro while a rise in euro interest rates causes the dollar to depreciate against the euro. Today's exchange rate is also altered by changes in its expected future level. If there is a rise in the expected future level of the dollar/euro rate, for example, then at unchanged interest rates, today's dollar/euro exchange rate will also rise.

KEY TERMS

appreciation, p. 319
arbitrage, p. 324
depreciation, p. 319
exchange rate, p. 317
foreign exchange market, p. 321
forward exchange rate, p. 325
interbank trading, p. 321
interest parity condition, p. 336
interest rate, p. 331
liquidity, p. 331
rate of appreciation, p. 335
rate of depreciation, p. 333
rate of return, p. 328
real rate of return, p. 330
risk, p. 331
spot exchange rate, p. 325
vehicle currency, p. 325

PROBLEMS

myeconlab

1. In Munich a bratwurst costs 5 euros; a hot dog costs \$4 at Boston's Fenway Park. At an exchange rate of \$1.50/per euro, what is the price of a bratwurst in terms of hot dogs? All else equal, how does this relative price change if the dollar appreciates to \$1.25 per euro? Compared with the initial situation, has a hot dog become more or less expensive relative to a bratwurst?
2. A U.S. dollar costs 7.5 Norwegian kroner, but the same dollar can be purchased for 1.25 Swiss francs. What is the Norwegian krone/Swiss franc exchange rate?
3. Petroleum is sold in a world market and tends to be priced in U.S. dollars. The Nippon Steel Chemical Group of Japan must import petroleum to use in manufacturing plastics and other products. How are its profits affected when the yen depreciates against the dollar?
4. Calculate the dollar rates of return on the following assets:
   a. A painting whose price rises from \$200,000 to \$250,000 in a year.

b. A bottle of a rare Burgundy, Domaine de la Romanée-Conti 1978, whose price rises from \$225 to \$275 between 2010 and 2011.

c. A £10,000 deposit in a London bank in a year when the interest rate on pounds is 10 percent and the \$/£ exchange rate moves from \$1.50 per pound to \$1.38 per pound.

5. What would be the real rates of return on the assets in the preceding question if the price changes described were accompanied by a simultaneous 10 percent increase in all dollar prices?

6. Suppose the dollar interest rate and the pound sterling interest rate are the same, 5 percent per year. What is the relation between the current equilibrium \$/£ exchange rate and its expected future level? Suppose the expected future \$/£ exchange rate, \$1.52 per pound, remains constant as Britain's interest rate rises to 10 percent per year. If the U.S. interest rate also remains constant, what is the new equilibrium \$/£ exchange rate?

7. Traders in asset markets suddenly learn that the interest rate on dollars will decline in the near future. Use the diagrammatic analysis of the chapter to determine the effect on the *current* dollar/euro exchange rate, assuming current interest rates on dollar and euro deposits do not change.

8. We noted that we could have developed our diagrammatic analysis of foreign exchange market equilibrium from the perspective of Europe, with the euro/dollar exchange rate $E_{€/\$}$ $(= 1/E_{\$/€})$ on the vertical axis, a schedule vertical at $R_€$ to indicate the euro return on euro deposits, and a downward-sloping schedule showing how the euro return on dollar deposits varies with $E_{€/\$}$. Derive this alternative picture of equilibrium and use it to examine the effect of changes in interest rates and the expected future exchange rate. Do your answers agree with those we found earlier?

9. The following report appeared in the *New York Times* on August 7, 1989 ("Dollar's Strength a Surprise," p. D1):

> But now the sentiment is that the economy is heading for a "soft landing," with the economy slowing significantly and inflation subsiding, but without a recession.
>
> This outlook is good for the dollar for two reasons. A soft landing is not as disruptive as a recession, so the foreign investments that support the dollar are more likely to continue.
>
> Also, a soft landing would not force the Federal Reserve to push interest rates sharply lower to stimulate growth. Falling interest rates can put downward pressure on the dollar because they make investments in dollar-denominated securities less attractive to foreigners, prompting the selling of dollars. In addition, the optimism sparked by the expectation of a soft landing can even offset some of the pressure on the dollar from lower interest rates.

a. Show how you would interpret the third paragraph of this report using this chapter's model of exchange rate determination.

b. What additional factors in exchange rate determination might help you explain the second paragraph?

10. Suppose the dollar exchange rates of the euro and the yen are equally variable. The euro, however, tends to depreciate unexpectedly against the dollar when the return on the rest of your wealth is unexpectedly high, while the yen tends to appreciate unexpectedly in the same circumstances. As a U.S. resident, which currency, the euro or the yen, would you consider riskier?

11. Does any of the discussion in this chapter lead you to believe that dollar deposits may have liquidity characteristics different from those of other currency deposits? If so, how would the differences affect the interest differential between, say, dollar and Mexican peso deposits? Do you have any guesses about how the liquidity of euro deposits may be changing over time?

12. In October 1979, the U.S. central bank (the Federal Reserve System) announced it would play a less active role in limiting fluctuations in dollar interest rates. After this new policy was put into effect, the dollar's exchange rates against foreign currencies became more volatile. Does our analysis of the foreign exchange market suggest any connection between these two events?

13. Imagine that everyone in the world pays a tax of τ percent on interest earnings and on any capital gains due to exchange rate changes. How would such a tax alter the analysis of the interest parity condition? How does the answer change if the tax applies to interest earnings but *not* to capital gains, which are untaxed?

14. Suppose the one-year forward $/€ exchange rate is $1.26 per euro and the spot exchange rate is $1.2 per euro. What is the forward premium on euros (the forward discount on dollars)? What is the difference between the interest rate on one-year dollar deposits and that on one-year euro deposits (assuming no political risk)?

15. Europe's single currency, the euro, was introduced in January 1999, replacing the currencies of 11 European Union members, including France, Germany, Italy, and Spain (but not Britain; see Chapter 20). Do you think that, immediately after the euro's introduction, the value of foreign exchange trading in euros was greater or less than the euro value of the pre-1999 trade in the 11 original national currencies? Explain your answer.

16. Multinationals generally have production plants in a number of countries. Consequently, they can move production from expensive locations to cheaper ones in response to various economic developments—a phenomenon called *outsourcing* when a domestically based firm moves part of its production abroad. If the dollar depreciates, what would you expect to happen to outsourcing by American companies? Explain and provide an example.

FURTHER READING

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Federal Reserve Bank of New York. *The Basics of Foreign Trade and Exchange,* at http://www.ny.frb.org/education/fx/index.html. Broad-ranging but highly accessible account of exchange markets and their role. Also supplies many useful Web links.

Philipp Hartmann. *Currency Competition and Foreign Exchange Markets: The Dollar, the Yen and the Euro*. Cambridge: Cambridge University Press, 1999. Theoretical and empirical micro-oriented study of the role of international currencies in world trade and asset markets.

John Maynard Keynes. *A Tract on Monetary Reform,* Chapter 3. London: MacMillan, 1923. Classic analysis of the forward exchange market and covered interest parity.

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APPENDIX TO CHAPTER 13

Forward Exchange Rates and Covered Interest Parity

This appendix explains how forward exchange rates are determined. Under the assumption that the interest parity condition always holds, a forward exchange rate equals the spot exchange rate expected to prevail on the forward contract's value date.

As the first step in the discussion, we point out the close connection among the forward exchange rate between two currencies, their spot exchange rate, and the interest rates on deposits denominated in those currencies. The connection is described by the *covered interest parity* condition, which is similar to the (noncovered) interest parity condition defining foreign exchange market equilibrium but involves the forward exchange rate rather than the expected future spot exchange rate.

To be concrete, we again consider dollar and euro deposits. Suppose you want to buy a euro deposit with dollars but would like to be *certain* about the number of dollars it will be worth at the end of a year. You can avoid exchange rate risk by buying a euro deposit and, at the same time, selling the proceeds of your investment forward. When you buy a euro deposit with dollars and at the same time sell the principal and interest forward for dollars, we say you have "covered" yourself, that is, avoided the possibility of an unexpected depreciation of the euro.

The covered interest parity condition states that the rates of return on dollar deposits and "covered" foreign deposits must be the same. An example will clarify the meaning of the condition and illustrate why it must always hold. Let $F_{\$/€}$ stand for the one-year forward price of euros in terms of dollars, and suppose $F_{\$/€} = \$1.113$ per euro. Assume that at the same time, the spot exchange rate $E_{\$/€} = \$1.05$ per euro, $R_{\$} = 0.10$, and $R_{€} = 0.04$. The (dollar) rate of return on a dollar deposit is clearly 0.10, or 10 percent per year. What is the rate of return on a covered euro deposit?

We answer this question as in the chapter. A €1 deposit costs \$1.05 today, and it is worth €1.04 after a year. If you sell €1.04 forward today at the forward exchange rate of \$1.113 per euro, the dollar value of your investment at the end of a year is (\$1.113 per euro) × (€1.04) = 1.158. The rate of return on a covered purchase of a euro deposit is therefore $(1.158 - 1.05)/1.05 = 0.103$. This 10.3 percent per year rate of return exceeds the 10 percent offered by dollar deposits, so covered interest parity does not hold. In this situation, no one would be willing to hold dollar deposits; everyone would prefer covered euro deposits.

More formally, we can express the covered return on euro deposit as

$$\frac{F_{\$/€}(1 + R_{€}) - E_{\$/€}}{E_{\$/€}},$$

which is approximately equal to

$$R_{€} + \frac{F_{\$/€} - E_{\$/€}}{E_{\$/€}}$$

when the product $R_{€} \times (F_{\$/€} - E_{\$/€})/E_{\$/€}$ is a small number. The covered interest parity condition can therefore be written

$$R_{\$} = R_{€} + (F_{\$/€} - E_{\$/€})/E_{\$/€}.$$

The quantity

$$(F_{\$/€} - E_{\$/€})/E_{\$/€}$$

is called the *forward premium* on euros against dollars. (It is also called the *forward discount* on dollars against euros.) Using this terminology, we can state the covered interest parity condition as follows: *The interest rate on dollar deposits equals the interest rate on euro deposits plus the forward premium on euros against dollars (the forward discount on dollars against euros).*

There is strong empirical evidence that the covered interest parity condition holds for different foreign currency deposits issued within a single financial center. Indeed, currency traders often set the forward exchange rates they quote by looking at current interest rates and spot exchange rates and using the covered interest parity formula.[9] Deviations from covered interest parity can occur, however, if the deposits being compared are located in different countries. These deviations occur when asset holders fear that governments may impose regulations which prevent the free movement of foreign funds across national borders. Our derivation of the covered interest parity condition implicitly assumed there was no political risk of this kind.[10]

By comparing the (noncovered) interest parity condition,

$$R_{\$} = R_{€} + (E^{e}_{\$/€} - E_{\$/€})/E_{\$/€},$$

with the *covered* interest parity condition, you will find that both conditions can be true at the same time only if the one-year forward \$/€ rate quoted today equals the spot exchange rate people expect to materialize a year from today:

$$F_{\$/€} = E^{e}_{\$/€}.$$

This makes intuitive sense. When two parties agree to trade foreign exchange on a date in the future, the exchange rate they agree on is the spot rate they expect to prevail on that date. The important difference between covered and noncovered transactions should be kept in mind, however. Covered transactions do not involve exchange rate risk, noncovered transactions do.[11]

The theory of covered interest parity helps explain the close correlation between movements in spot and forward exchange rates shown in Figure 13-1, a correlation typical of all major currencies. The unexpected economic events that affect expected asset returns often have a relatively small effect on international interest rate differences between deposits with

9 Empirical evidence supporting the covered interest parity condition is provided by Frank McCormick in "Covered Interest Arbitrage: Unexploited Profits? Comment," *Journal of Political Economy* 87 (April 1979), pp. 411–417, and by Kevin Clinton in "Transactions Costs and Covered Interest Arbitrage: Theory and Evidence," *Journal of Political Economy* 96 (April 1988), pp. 358–370.

10 For a more detailed discussion of the role of political risk in the forward exchange market, see Robert Z. Aliber, "The Interest Parity Theorem: A Reinterpretation," *Journal of Political Economy* 81 (November/December 1973), pp. 1451–1459. Of course, actual government restrictions on cross-border money movements can also cause covered interest parity deviations.

11 We indicated in the text that the (noncovered) interest parity condition, while a useful simplification, may not always hold exactly if the riskiness of currencies influences demands in the foreign exchange market. Therefore, the forward rate may differ from the expected future spot rate by a risk factor even if *covered* interest parity holds true. As noted earlier, the role of risk in exchange rate determination is discussed more fully in Chapters 17 and 21.

short maturities (for example, three months). To maintain covered interest parity, therefore, spot and forward rates for the corresponding maturities must change roughly in proportion to each other.

We conclude this appendix with one further application of the covered interest parity condition. To illustrate the role of forward exchange rates, the chapter used the example of an American importer of Japanese radios anxious about the $/¥ exchange rate it would face in 30 days when the time came to pay the supplier. In the example, Radio Shack solved the problem by selling forward for yen enough dollars to cover the cost of the radios. But Radio Shack could have solved the problem in a different, more complicated way. It could have (1) borrowed dollars from a bank; (2) sold those dollars immediately for yen at the spot exchange rate and placed the yen in a 30-day yen bank deposit; (3) then, after 30 days, used the proceeds of the maturing yen deposit to pay the Japanese supplier; and (4) used the realized proceeds of the U.S. radio sales, less profits, to repay the original dollar loan.

Which course of action—the forward purchase of yen or the sequence of four transactions described in the preceding paragraph—is more profitable for the importer? We leave it to you, as an exercise, to show that the two strategies yield the same profit when the covered interest parity condition holds.