CHAPTER 8

CURRENCY MARKETS AND EXCHANGE RATE FUTURES

INTRODUCTION

Exchange rate futures contracts were developed in the early 1970s, markets were opened in 1972, and in the U.S., these contracts are traded in the International Monetary Market (IMM) of the Chicago Mercantile Exchange (CME). Exchange rate futures were one of the CME's most successful early series of contracts. Now, many futures exchanges around the world trade exchange rate contracts in which foreign currencies are priced based on the local currency.

Exchange rate futures contracts exist alongside a very large and growing currency market. This currency market does not physically exist in one particular location. Rather, it exists within the communication system connecting the large banks of the world. With growing world trade, large flows of the different world currencies occur between these banks. More than $300 billion flows between the major banks and other financial institutions in Europe, the Far East, and North America. As a consequence, banks trade currencies in which their customers make deposits and require withdrawals. This market is referred to as the interbank currency market. International trade has been a significant portion of the world economy since the 1840s, and there has basically been a currency market for as long as there as been any form of electronic communication. The operation of this currency market improves with any progress in worldwide communications. The growth of this market in the 1970s accompanied improvements in satellite communications and was encouraged by the monetary instability of the time period.

Prior to the advent of exchange rate futures contracts, only large commercial banks transacted in the interbank currency market. The smallest transactions are in tens of millions of dollars, but transactions are more typically in hundreds of millions of dollars. These amounts are generally greater than the wealth of individuals or trading companies that have speculative interests. There is also no clearinghouse for this interbank market, no marking-to-market of currency contracts, and no margin system, so individual banks are very cautious in trading with individuals or other firms that are not other large commercial banks. Collateral is required, but arrangements are more flexible than in futures markets. This limited market access was targeted by the CME when exchange rate futures were introduced.

The interbank currency market is an interesting institution. One of the most interesting characteristics is that it is mainly a forward market. The banks trade currency primarily for future delivery. Currency to be delivered in 30-, 60-, 90-, and 120-day intervals are the most common. There are fewer transactions in currency for immediate delivery. Further, unlike futures contracts, the currency in these forward contracts is actually delivered. The banks trading the forward contracts desire to hold more or less of the transacted currency.

A volume of less than a million exchange rate futures contracts were traded each year between the introduction in 1972 and 1980. However, with the large trade deficits in the early 1980s, more than 15 million contracts per year were traded by 1984. The market volume peaked in 1992 with trade of close to 40 million contracts that year. Since the peak in 1992, this market has seen its volume reduced by half. This is not because of any reduced importance in international trade or currency flows. In part, the cause has been more stable world interest rates led by more stable U.S. interest rates and the resulting more stable exchange rates. Also, banks involved in international currency have reduced transaction costs and are offering more services to clients transacting in world currencies. Previously, firms were taking the do-it-yourself approach to exchange rate risk management. They were hedging and conducting other currency trades on the futures market. These firms generally had to take this approach because of the difficulty in transacting with large commercial banks. Banks are now capturing more of this market and are offering risk management services to smaller clients, but there are fewer small clients. Firms that are involved in international trade, and are successful, are becoming larger. In the face of these trends, volume declined.

Far and away the largest group of currencies traded at the IMM are those of western European countries. These include German marks, Swiss francs, and English pounds. The region is the largest trading partner with the U.S. In terms of individual countries as trading partners, Germany is generally the largest, followed by Japan. Thus, the Japanese yen has significant trading volume on the IMM, but it is generally smaller than the group of currencies from Western Europe. The final well-establish futures contract is for Canadian dollars. Trade in this contract has grown with the passage of the North American Free Trade Agreement (NAFTA). The IMM introduced a contract based on the Mexican peso in 1996, and if trends continue, trade in this contract will likely surpass even the active trade in the Canadian dollar.

CURRENCY AND EXCHANGE RATE BASICS

Every price in the currency market, forward or futures, is a relative price. To say that one U.S. dollar will purchase two German marks (DM), is the same as saying one German mark will purchase one-half a U.S. dollar. This is the exchange rate. The two currencies are expressed as a ratio. We may be interested in DM per U.S. dollar, or U.S. dollars per DM; it is a matter of choosing the denominator in the ratio. For example,

$$DM/\$ = 2 = 1/0.5 = 1/(\$/DM).$$

Exchange rate quotes are reported on many satellite information services that contain financial data. Exchange rates are also quoted in the *Wall Street Journal* and finan-

	Dollar	CdnDlr	D-Mark	Pound	Peso	Yen
U.S.	—	0.72738	0.56402	1.6159	0.12903	0.00822
Canada	1.3748	—	0.77541	2.2215	0.17739	0.01131
Germany	1.7730	1.2896	—	2.8650	0.22877	0.01458
U.K.	0.61885	0.45014	0.34904	—	0.07985	0.00509
Mexico	7.7500	5.6372	4.3711	12.523	—	0.06373
Japan	121.3	88.449	68.584	196.49	15.69	—

Source: *Dow Jones* as reported in the *Wall Street Journal*.

TABLE 8.1
Key Currency Cross Rates at the Close of Trading, 2 October 1997, in New York

cial newspapers in foreign countries. Exchange rate quotes are readily available, but the reader should be cautious in that often quotes are for forward markets—30 days ahead, for example. Spot markets are thinner. Thus, the reader should be careful to relate quotes with the proper time of delivery.

Table 8.1 contains exchange rate quotes from New York banks involved in the interbank market as sourced by *Dow Jones* and reported in the *Wall Street Journal* for October 2, 1997. These are spot market quotes. Deutsche marks were trading for 1.7730 per U.S. dollar because each mark was worth 0.56402 U.S. dollars. Likewise, Japanese yen were trading for 121.65 per U.S. dollar since a yen was worth 0.00822 dollars.

Table 8.2 contains prices for exchange rate futures contracts on the same day. The futures market exchange rates are slightly different from those of the forward market. The IMM operates in the U.S. and all transactions are in U.S. dollars. Thus, all exchange

	Open	High	Low	Settle	Change
JAPANESE YEN (CME) 12.5 million yen; $ per yen (.00)					
Dec	.8360	.8368	.8282	.8300	–.0061
Mr98	.8400	.8418	.8400	.8410	–.0062
June	.8585	.8585	.8530	.8522	–.0063
Est vol 16,019; vol Wed 18,522; open int 76,599, –981					
DEUTSCHE MARK (CME) 125,000 marks; $ per mark					
Dec	.5664	.5689	.5647	.5666	+.0001
Mr98	.5716	.5716	.5692	.5679	+.0001
June	—	—	—	.5726	+.0001
Sept	—	—	—	.5753	+.0001
Est vol 15,160; vol Wed 19,503; open int 60,998, –22					
BRITISH POUND (CME) 62,500 pds.; $ per pound					
Dec	1.6106	1.6140	1.6068	1.6108	+.0004
Mr98	—	—	—	1.6044	+.0004
Est vol 3,726; vol Wed 3,211; open int 28,044, +4					

Source: *Wall Street Journal*.

TABLE 8.2
Exchange Rate Quotes for IMM Futures Contracts on 2 October 1997

TABLE 8.3
IMM Exchange Rate Futures Contract Specifications

Currency	Expiration Months	Size	Price Quote
Deutsche mark	Mar, June, Sept, Dec	DM 125,000	$ / DM
Japanese yen	Mar, June, Sept, Dec	¥ 12.5 million	$ / ¥
Swiss franc	Mar, June, Sept, Dec	SF 125,000	$ / SF
British pound	Mar, June, Sept, Dec	£ 62,500	$ / £
Canadian dollar	Mar, June, Sept, Dec	C$ 100,000	$ / C$
Australian dollar	Mar, June, Sept, Dec	A$ 100,000	$ / A$
French franc	Mar, June, Sept, Dec	FF 500,000	$ / FF
Mexican peso	Mar, June, Sept, Dec	MP 500,000 New	$ / MP

rates are in terms of U.S. dollars per unit of foreign currency. All exchange rate futures contracts are for a fixed amount of the foreign currency. For example, the deutsche mark futures contract is for 125,000 marks and trades in terms of marks per dollar. The Japanese yen contract is for 12.5 million yen and trades in yen per dollar.

Table 8.3 provides a list of the exchange rate contracts trade on the IMM and the sizes of the different contracts.

EXCHANGE RATE TRADING EXAMPLES

Having discussed the size of the different exchange rate contracts and the units with which they are priced in the previous section, it is now relatively easy to work a few trading examples.

Suppose that in October a trader buys one December DM contract for $0.565/DM. In December, the contract is trading for $0.59/DM and the trader offsets the position by selling the contract. The net change in the value of the position is the value at the time of sale less the value at the time of purchase.

$$(\$.59/DM \times DM\ 125{,}000) - (\$.565/DM \times DM\ 125{,}000) =$$
$$\$73{,}750 - \$70{,}625 = +\$3{,}125.$$

The net change in the value of the position can also be calculated using the price change.

$$(\$.59/DM - \$.565/DM) \times DM\ 125{,}000 = \$.025/DM \times DM\ 125{,}000 = +\$3{,}125$$

The value of the dollar relative to the DM decreased or weakened. One DM could be exchanged for fewer dollars through the futures contract in October than in December. Thus, buying DM with dollars in October and then selling DM in return for dollars in December is profitable.

As a second example, suppose that in October a trader sells one December Japanese yen contract for $.0083/¥. In December, the contract is trading for $.0081/¥ and the trader offsets this position by buying the contract. The net change in the value of the position is

$$(\$.0083/¥ \times ¥\ 12{,}500{,}000) - (\$.0081/¥ \times ¥\ 12{,}500{,}000) =$$
$$\$103{,}750 - \$101{,}250 = +\$2{,}500.$$

The net change in the value of the position can also be calculated using the price change.

$$(\$.0083/¥ - \$.0081/¥) \times ¥\ 12{,}500{,}000 = \$.0002/¥ \times 12{,}500{,}000\ ¥ = +\$2{,}500$$

The value of the dollar relative to the yen increased or strengthened. One yen could be exchanged for more dollars through the futures contract in October than in December. Thus, selling yen in return for dollars in October and then buying yen with dollars in December is profitable.

If you have little experience with currencies or exchange rates you need to be careful working the trading or hedge examples in later sections. The common terminology used to explain currency and exchange rate movements is the reverse of the trading position that would seem to be implied by the movement. For example, if the dollar is strengthening, a short exchange rate futures position is profitable. Likewise, if the dollar is weakening a long exchange rate futures position is profitable. This is because the futures contracts are specified as U.S. dollars per unit of foreign currency. A strengthening U.S. dollar implies each dollar can buy more units of the foreign currency, or identically, each unit of foreign currency can buy fewer dollars. Therefore, the exchange rate specified as dollars per unit of foreign currency, like in the futures contract, will fall with the strengthening dollar. You are encouraged to rework the previous examples to obtain a solid understanding of exchange rate directions with respect to a strengthening or weakening U.S. dollar.

IMM futures contracts enable the trader to trade the exchange rate between foreign currencies and the U.S. dollar. To trade an exchange rate between two foreign currencies, the trader needs to trade a spread or to buy one contract and sell the other. For example, suppose that in October a trader buys one December DM contract for \$.565/DM and sells one December yen contract for \$.0083/¥. In December, the trader offsets the DM position at \$.59/DM and the yen position at \$.0081/¥. The gain on the DM position is +\$3,125 and the gain on the yen position is +\$2,500, so the net is a gain of +\$5,625. If, between October and December, the U.S. dollar could be exchanged for fewer DM and more yen, then the DM strengthened relative to the yen or the yen weakened relative to the DM as well. This relationship is known as a cross rate and is expressed as follows:

$$\frac{\$}{DM} \times \frac{1}{\frac{\$}{¥}} = \frac{\$}{DM} \times \frac{¥}{\$} = \frac{¥}{DM}.$$

In October this rate is

$$¥/DM = (1/0.0083)\ 0.565 = 68.072 \text{ or } DM/¥ = (1/0.565)\ 0.0083 = 0.01469$$

and it changed to

$$¥/DM = (1/0.0081)\ 0.59 = 72.840 \text{ or } DM/¥ = (1/0.590)\ 0.0081 = 0.01373$$

by December. Thus, between October and December, one DM can be exchanged for more yen. This implies a stronger DM and a weaker yen. The spread trade is equivalent to buying an exchange rate contract specified as ¥/DM or selling a contract specified as DM/¥.

EXCHANGE RATE HEDGING EXAMPLES

Knowledge of the trading examples in the previous section is a prerequisite for understanding a currency hedge. This section will present some example hedges, in which the futures exchange rate position is combined with a cash currency position. These examples can be confusing. You are probably used to thinking in terms of one currency—most likely U.S. or Canadian dollars. And you are used to asking the question, "Am I long or short the commodity?" But that commodity is priced in one currency. In the following examples, you need to ask the question: Is the trader long or short U.S. dollars? U.S. dollars are used because the exchange rate contract is priced in U.S. dollars. The trader is buying in one currency and selling in the other. They are simultaneously long the currency in which they are buying and short the currency in which they are selling. Thus, if they are buying in U.S. dollars and selling in foreign currency (i.e., exporting), they need to *buy* the IMM exchange rate contract to place a hedge. If they are selling in U.S. dollars and buying in foreign currency (i.e., importing), they need to *sell* the IMM exchange rate contract to hedge. Let's move on to examples for clarification.

The first example is that of an exporter. Suppose a grain trading firm signs a contract to deliver soybeans to a German processing operation in western Europe, and the company has grain purchasing facilities in the central U.S. The firm will be paid in DM per bushel upon delivery in March, will have to purchase the soybeans in dollars per bushel in late February and early March, and it is currently October. The contract written with the German processing firm establishes a price for the soybeans at DM 12.0 per bushel. Exchange rate futures for DM in March are trading at \$.57/DM. The soybean price in U.S. dollars is \$6.84 per bushel (DM 12.0 / bu. × \$.57/DM). From this price, the firm must subtract transportation and other marketing costs and cover its profit margin. The firm will receive DM and pay in U.S. dollars. If the number of dollars that can be purchased with DM falls, the firm will lose money, or it will have its profit margin reduced. This example is illustrated in Table 8.4.

TABLE 8.4
Hedging an Exchange Rate in a Soybean Exporting Example

	Export Hedge for U.S. Firm	
Date	**Cash Market**	**Futures Market**
October	Contract to deliver 250,000 bushels soybeans and receive DM 3.0 million or DM 12.0 per bushel.	Sell 24 March futures contracts at \$.57/DM covering DM 3.0 million.
	Anticipate converting DM 3.0 million to \$1.71 million or \$6.84 per bushel which will cover cost of soybean purchase and delivery.	
March	Deliver 250,000 bushels soybeans and receive DM 3.0 million or DM 12.0 per bushel. Covert DM 3.0 million to \$1.59 million or \$6.36 per bushel.	Buy 24 March futures contracts at \$.53/DM.
	\$120 thousand loss.	\$120 thousand gain.
Net soybean revenue \$1.71 million and price \$6.84 per bushel.		

We will hold the soybean price constant. This is realistic because the grain firm can hedge its future soybean purchases. Thus, we are assuming the net price paid for soybeans plus the marketing costs and profit margin is $6.84 per bushel. Now, suppose the exchange rate decreases from $.57/DM to $.53/DM between October and March. The firm is paid DM 12.0 per bushel as is called for in the contract. However, the contract soybean price in U.S. dollars has fallen to $6.36 per bushel after converting the DM to dollars. This will not cover the soybean purchase cost, marketing costs, and profit margin. The firm is long dollars and short DM in the cash position. The firm can manage the exchange rate risk through selling the exchange rate futures contract. Selling the exchange rate contract makes the firm short dollars and long DM. The cash and futures positions balance each other. Losses in the currency market are recovered in the futures market. Likewise, of course, windfall gains in the currency market would be lost in the futures.

The next example is from the perspective of an importer. Suppose a Japanese firm signs a contract to take delivery of corn from a U.S. grain trading firm. The Japanese firm will purchase the corn in dollars per bushel and will be paid in yen per bushel upon sale of the processed corn. The corn will be delivered, processed, and sold in May, and it is currently December. The contract written with the U.S. firm establishes a price for the corn at $4.00 per bushel. This price includes transportation and marketing costs. The corn will be delivered to Japan by the U.S. firm. Exchange rate futures for Japanese yen in June are trading at $.008/¥. The corn in Japanese yen is ¥500 per bushel ($4.00/bu. ÷ $.008/¥). This is the input cost for the Japanese firm. Suppose the firm has contracted with users of corn products (i.e., starches, sugars, and by-product) and that the net price per bushel to the firm after subtracting processing costs and a normal profit margin is ¥550 per bushel. The firm will receive Japanese yen when selling and pay in U.S. dollars. If the number of dollars that can be purchased with yen falls, the firm will lose money or will have a smaller profit margin. This is illustrated in Table 8.5.

The corn price is not an issue in this hedge because the Japanese firm has fixed both the purchase price and sale price through contracts. However, the firm *is* exposed to exchange rate risk. Suppose the exchange rate decreases from $.008/¥ to $.0075/¥ between December and May. The firm receives ¥500 per bushel to cover the

TABLE 8.5
Hedging an Exchange Rate in a Corn Importing Example

	Import Hedge for Japanese Firm	
Date	**Cash Market**	**Futures Market**
December	Contract to receive 500,000 bushels corn paying $2.0 million or $4.00 per bushel. Anticipate converting ¥250 million or ¥500 per bushel to $2.0 million to cover cost of corn purchase.	Sell 20 June futures contracts at $.008/¥ covering ¥250 million.
May	Receive 500,000 bushels corn and pay $2.0 million or $4.00 per bushel. Convert ¥250 million to $1.875 million.	Buy 20 June futures contracts at $.0075/¥.
	$125 thousand loss.	$125 thousand gain.

Net corn cost $2.0 million and price $4.00 per bushel.

cost of the corn, and they must pay \$4.00 per bushel as specified in the cash contract. However, the corn price received after converting the yen to U.S. dollars has fallen to \$3.75 per bushel. The firm cannot convert the yen received for the corn into enough U.S. dollars to cover the corn purchase price. The firm is operating at a net loss. The firm is long dollars and short yen in the cash position. The firm can manage the exchange rate risk through selling the exchange rate futures contract. Selling the exchange rate contract makes the firm short dollars and long yen. The cash and futures positions balance each other. Losses in the currency market are recovered in the futures market.

The similarity between the examples in Table 8.4 and 8.5 is that the trader receives foreign currency and spends U.S. dollars. Whether or not the firm is an importer or exporter is not the main issue. The issue is whether they are being paid or have to pay U.S. dollars. In the two examples, the firms are long dollars and short the foreign currency. Thus, they will need to sell the exchange futures contract where the contract is specified in U.S. dollars per unit of the foreign currency. If the firm is paid in U.S. dollars and pays out foreign currency, the opposite position in the futures market should be taken for a hedge. In this case, the trader will buy the exchange rate contract. We work this example next but will add a twist.

In the following example, suppose a pork processing firm in the U.S. imports hogs from western Canada, processes the animals into fresh pork, and then sells the pork to Japanese meat distributors. The firm is paid for the pork in Japanese yen and pays for the hogs in Canadian dollars (C\$). The U.S. firm contracts with a Japanese distributor to receive all of the pork processed through its facility during a two-week period in December. It is currently September. The firms agree to trade ¥425 million for that quantity of pork. The U.S. firm has also contracted with Canadian hog producers. These producers will provide hogs to their processing plant during this period. The hogs under contract will cost the processor C\$4.12 million. The Japanese yen exchange rate futures contract for December is trading at \$.0085/¥ and the Canadian dollar is trading at \$.70/C\$.

If the exchange rate between U.S. dollars and Japanese yen decreases, the U.S. dollar strengthens, or each yen buys fewer dollars, the firm will lose revenue on the pork. For example, suppose the exchange rate drops from \$.0085/¥ to \$.0080/¥. Revenue decreases from

$$\text{¥}425 \text{ million} \times 0.0085 \ \$/\text{¥} = \$3.6125 \text{ million}$$

to

$$\text{¥}425 \text{ million} \times 0.0080 \ \$/\text{¥} = \$3.4 \text{ million}.$$

If the exchange rate between U.S. dollars and Canadian dollars increases, the U.S. dollar weakens, or each U.S. dollar buys fewer Canadian dollars, and the cost of the hogs to the firm will increase. For example, suppose the exchange rate rises from \$.70/C\$ to \$.75/C\$. Costs increase from

$$\text{C}\$4.12 \text{ million} \times 0.70 \ \$/\text{C}\$ = \$2.884 \text{ million}$$

to

$$\text{C}\$4.12 \text{ million} \times 0.75 \ \$/\text{C}\$ = \$3.09 \text{ million}.$$

To hedge this position in two currencies, the U.S. firm would need to sell the Japanese yen exchange rate futures contract which expires in December and buy the similar Canadian dollar contract. The firm is hedging ¥425 million. The firm would trade 34 futures contracts (¥425 million / ¥12.5 million per futures contract = 34 contracts). The firm is hedging C$4.12 million. The firm would trade 41 futures contracts (C$4.12 million / C$100,000 per futures contract = 41.2 contracts). An example of where the exchange rate moves against the firm's cash position is shown in Table 8.6.

Thinking back to the basics of hedging, the hedger always avoids price risk and accepts basis risk. The same is true for exchange rate hedging. The general movements in relative currency values are captured in the exchange rate futures contract. Basis error for a currency hedge would be the difference between the exchange rate futures level and the actual exchange rate at which the processing firm must convert the Japanese yen to U.S. dollars and then U.S. dollars to Canadian dollars. This error is essentially zero in the futures contract expiration month. The currency market is very liquid, and currency is very inexpensive to deliver between various banks around the world. Currency is delivered or transacted between banks through electronic communication, and the cost is a very small percent of the amount of currency delivered. This is very different from physical commodities such as agricultural products, petroleum products, or minerals. Physical commodities have more illiquid markets and much higher market transaction costs; therefore, basis error and basis risk is often an issue. There are two things which are more important than basis error and basis risk for exchange rate contracts.

The first is the lumpiness of the currency contracts. Exchange rate futures involve large blocks of foreign currency. For example, in the previous Japanese yen and Canadian dollar hedge example, the processor would prefer to trade 41.2 Canadian dollar contracts. This is not possible. The larger the currency trade, of course, the less this is an issue. The difference between 41 and 41.2 contracts is not great, but the differ-

TABLE 8.6
Hedging an Exchange Rate in an Import and Export Example

Date	Hedge for U.S. Firm Importing Livestock from Canada and Exporting Meat to Japan: Cash Market	Futures Market
September	Contract to deliver ¥425 million in pork. Contract to purchase C$4.12 million in hogs.	Sell 34 December futures contracts at $.0085/¥ covering ¥425 million.
	Anticipate converting ¥425 million to $3.6125 million.	Buy 41 December futures contracts at $.70/C$ covering C$4.2 million.
	Anticipate converting $2.884 million to C$4.12 million.	
December	Deliver pork; receive ¥425 million. Purchase hogs; pay C$4.12 million.	Buy 34 December futures contracts at $.0080/¥.
	Convert ¥425 million to $3.4 million. Convert $3.09 million to C$4.12 million.	Sell 41 December futures contracts at $.75/C$.
	$212.5 thousand loss on ¥. $206 thousand loss on C$.	$212.5 thousand gain on ¥. $205 thousand gain on C$.
Net $3.6125 million received from pork and $2.885 million paid for hogs.		

ence can be important if the hedger desires to trade 1.5 contracts and has to choose between one or two contracts.

The second issue is that there is basis error if the hedge is not lifted at or close to the end of the expiration month of the futures contract. There are only four contracts traded for each currency per year. The contracts expire quarterly. This can be a problem if the trader desires to lift the hedge, for example, at the end of April and is trading the June contract. There can be a substantial difference between the exchange rate between two currencies across a two-to-three month period. But this difference is rather predictable. So we really should not call it basis risk, perhaps. This is the topic of the next section. It will answer the question: "What causes the difference between exchange rates for currency deliverable now versus three months from now or six months from now?"

Using exchange rate futures only looks a bit more complicated. Once you get the basic idea down, it all takes on intuitive sense. The example in which both the Japanese yen and the Canadian dollar were used is not really any more complex than the situation facing a cattle feeder who must manage exposure to risk in both selling price and input costs—and the basis is more predictable.

PRICING MODELS

This section presents two models used to explain the different exchange rates that will accompany forward or futures contracts that are deliverable at different times. For example, if it is currently October, can we explain why the exchange rate futures contract that expires in December is different from the contract that expires in March? Or, why is the 1-month ahead forward rate different from the 6-month ahead rate?

The two models used to summarize the difference in exchange rates are based on one underlying notion. The futures price for any financial instrument will equal the spot price plus the cost of carrying the instrument to the delivery date. In equation form,

$$S_t(1 + C_{t,T}) = F_{t,T}$$

where $F_{t,T}$ is the futures price of the financial instrument at time t of a contract that expires at time T, S_t is the spot price of the instrument in time t, and $C_{t,T}$ is the cost of carry for the financial instrument from t to T. As the futures contract approaches expiration, as t approaches T, then the carry cost shrinks to zero and the spot price and the futures price converge to

$$S_T = F_{T,T}.$$

This relationship also holds for financial instruments such as contracts on physical commodities. Futures prices for grains contracts reflect this carrying cost or cost of storage over the crop year. The difference between contracts on physical commodities and exchange rates is that at expiration, spot or cash price for the commodity will not necessarily equal the futures price because of the large costs of delivery. The cost-of-carry equation can be rewritten as follows if the cost of carry is a percentage:

$$S_t(1 + r)^{T-t} = F_{t,T}$$

where r is an annual interest rate and $T - t$ represents the length of time the instrument is held. For example, if the financial instrument is a bond that pays 8 percent per annum and costs the purchaser \$1,000, the futures price for the bond after it is held six months is

$$\$1000\,(1 + 0.08)^{0.5} = \$1039.23$$

and if the bond were held one and a half years, then

$$T - t = 1.5.$$

The first model used to explain the difference in exchange rates is called the Interest Rate Parity Model. The idea is that because the different world currencies are easily transferable, the people and banks that hold large reserves of currency will desire to hold the currency that offers them the greatest rate of return. The exchange rates will then adjust to reflect the supply and demand fundamentals for the respective currencies. The exchange rates will adjust so that, in equilibrium, the holders of currency are earning the same rate of return in all currencies. Thus, the term *interest rate parity*, means that equal interest rates emerge. Different world banks offer different interest rates for their home country currency. Exchange rates adjust so that investors are earning the same rate of interest in any currency. An example will illustrate this.

A currency trader living in the U.S. considers holding his liquid cash assets in both U.S. dollars and Canadian dollars. The trader lives in the U.S. and thus spends U.S. dollars but could easily exchange U.S. dollars for Canadian, place the currency in a Canadian bank, and exchange the Canadian dollars for U.S. when he needs cash. Further, there is no need to limit himself to the cash he has on hand; he could borrow. The trader considers the following: He could borrow the domestic currency (S_t^{dc}) at the domestic interest rate (r^{dc}), convert the domestic currency to the foreign currency at the spot exchange rate (S_t^{dc}/S_t^{fc}), invest the funds at the foreign interest rate (r^{fc}), and write a forward contract promising to deliver the foreign currency at the end of the investment period for the initial amount of currency plus the interest returned ($F_{t,T}^{fc}$). If enough traders do this, the spot and forward exchange rates adjust so that the amount borrowed, the left-hand side of the following equation, just equals the amount returned, the right-hand side of the equation, or

$$S_t^{dc}(1 + r_{dc})^{T-t} = \frac{S_t^{dc}}{S_t^{fc}}(1 + r_{fc})^{T-t} F_{t,T}^{fc}.$$

We need to rewrite this equation solving for the forward or futures price

$$F_{t,T}^{fc} = \frac{S_t^{dc}(1 + r_{dc})^{T-t}}{\dfrac{S_t^{dc}}{S_t^{fc}}(1 + r_{fc})^{T-t}} = S_t^{fc}\,\frac{(1 + r_{dc})^{T-t}}{(1 + r_{fc})^{T-t}} = F_{t,T}^{fc}$$

and we can see the forward rate is equal to the spot rate multiplied by a factor which is the ratio of the interest rates. This equation is a cost-of-carry equation between the spot and forward market where the cost of carry is

$$Cost\text{-}of\text{-}Carry = \frac{(1 + r_{dc})^{T-t}}{(1 + r_{fc})^{T-t}}.$$

It looks complicated, so let's work an example with numbers.

Suppose the U.S. interest rate is 8 percent, the Canadian rate is 5.1 percent, and the spot exchange rate between U.S. and Canadian dollars is 0.73. The forward rate deliverable in three months ($T - t = 90$ days / 360 days = 0.25) should then be 0.735. We see this from

$$\frac{(1 + 0.08)^{0.25}}{(1 + 0.051)^{0.25}} = 1.00683$$

and multiplying this factor by the spot rate gives

$$0.73 \times 1.00683 = 0.735.$$

We can also see this from the original cost-of-carry equation

$$(1 + 0.08)^{0.25} = \frac{1}{0.73}(1 + 0.051)^{0.25}\ 0.735$$

If the U.S. interest rate increases to 9 percent from 8 percent then the forward exchange rate will increase relative to the spot rate.

$$0.7367 = 0.73 \times 1.00915$$

The model also does more than link the current spot rate to a forward rate. The same relationship holds between two forward rates

$$F^{fc}_{t,T_2} = F^{fc}_{t,T_1} \frac{(1 + r_{dc})^{T_2 - T_1}}{(1 - r_{fc})^{T_2 - T_1}}$$

where the forward or futures contract that is deliverable in T_1 expires before the contract deliverable in T_2.

The second model used to explain exchange rates over time is a slight variation on the Interest Rate Parity Model. The second model is called the Purchasing Power Parity Model and it uses the idea that nominal interest rates across countries are not as important as real interest rates. Real interest rates are a ratio of the nominal rate and the expected inflation for the currency in question

$$(1 + r_n) = (1 + r_r)(1 + E(i))$$

where r_n is the nominal rate, r_r is the real rate, and $E(i)$ is the expected inflation rate. In the Purchasing Power Parity Model, the interest rates used in the cost-of-carry equation to figure out the ratio of the spot to the forward exchange rate are the real interest rates

$$(1 + r_r) = \frac{(1 + r_r)}{(1 + E(i))}$$

of the two respective currencies. This model will give identical answers to the Interest Rate Parity Model if the inflation rate is the same for both currencies. If the inflation rates are different, it would be important to use the real interest rates.

Now, how can the hedger use these two models? The models are useful for predicting basis for hedges that are not lifted in the exchange rate futures contract expiration month. For example, suppose a trader is interested in hedging a Canadian dollar transaction that will take place in October. The December Canadian dollar contract is trading at $.73/C$, the U.S. interest rate is 8 percent, the Canadian rate is 5.1 percent, and inflation rates in the two currencies are the same. The hedge will be lifted three months prior to contract expiration, so the cost of carry is

$$\frac{(1 + 0.08)^{0.25}}{(1 + 0.051)^{0.25}} = 1.00683$$

and the forward rate for October based on December futures is 0.725 = 0.73 ÷ 1.00683. The basis is –$.005/C$. The number may appear small, but the larger the block of currency in the transaction, the more important this basis difference will become.

The two pricing models are useful for explaining the differences between exchange rates in which the underlying contracts expire at different times. This is useful for predicting basis in nonexpiration months. The models help explain the premiums and discounts across contracts, or the price of one contract relative to some other contract. In many respects, these relationships are stable and generate an ability to handle any basis risk that is not present for physical agricultural commodities. All this makes life more manageable for the multinational firm—and for you as a beneficiary of world trade.

EXCHANGE RATE FUNDAMENTALS

The previous section discussed why different currency contracts have different exchange rates, but all of the discussion is about exchange rate for any contract of a particular currency relative to one other contract for that currency. The pricing models explain premiums and discounts but do not explain the overall exchange rate level that is seen. This question has to be dealt with in the realm of fundamental analysis and is the topic of this section.

Currency fundamentals are more substantial and complex than fundamentals for physical commodities. Understanding exchange rate levels and changes requires knowledge of concepts in international trade and macroeconomics. However, currency is much like any other commodity in that its price is determined by the interaction and balance of supply and demand. If the supply of a currency increases, the price will fall. If the demand for a currency increases, the price will rise. And we must remember that the price of a currency is a relative price; it is the value of U.S. dollars relative to deutsche marks, pounds sterling, or yen.

The most important factor determining exchange rates between world currencies and those of particular countries is the sum of all commercial and financial transactions between one country's people and government and the rest of the world. The sum of these transactions is the *balance of payments* for that country. These transactions include imports and exports of goods and services, investments in foreign countries and investments by foreign people in countries or foreign governments, and dispersion or receipt of foreign aid. The balance of payments includes all cross-border transactions. The *balance of trade* is a subset of the balance of payments and refers to imports and exports of goods and services. Items in the balance of trade are more short-term consumption items. These items are readily measurable and include agricultural commodities, computers, automobiles, and tourism spending. Balance of trade also includes general transfers of currency by people, businesses, and governments. The sum of all imports of goods and services adjusted by, or net of, exports of goods and services in the balance of trade is known as the *current account balance*. In addition to the short-term current account transactions, the balance of trade includes long-term transactions in land, building, equipment, equities, and debt instruments. The net of imports and exports of long-term transactions is known as the *capital account balance*.

Exchange rates settle to equilibrium levels given world trade flows in short-term goods and services, flows of long-term capital investments, and reciprocal flows of currency. Likewise, changes in world trade flows will result in exchange rate changes. Generally, decreasing balance of payments will weaken the currency of the country whose imports are increasing relative to exports. Increasing imports relative to exports increases the amount of currency held by the rest of the world. If that currency can only be spent in an importing country, people and businesses in other countries will have to exchange it for their own currency and the rate at which that occurs will decline. For example, if Australia increases imports from Japan relative to exports to Japan, then Japanese businesses will hold more Australian dollars which they will need to convert to yen. The more Australian dollars they hold in aggregate, the fewer yen they will be able to exchange for each dollar. *Much of the variation in exchange rates can be explained by this excess supply and excess demand argument that comes from examining the balance of payments.* This is especially true for the smaller world currencies.

However, this relationship does not necessarily hold for the major currencies of the world—the deutsche mark, Swiss franc, British pound, and Japanese yen, and especially the U.S. dollar. The majority of world trade is conducted using these currencies. Let's revisit the example from the previous paragraph to illustrate. Suppose U.S. imports from Japan increase relative to exports to Japan. Again, Japanese businesses will hold more U.S. dollars. However, this does not necessarily translate into a weaker dollar. These Japanese businesses, if they are international firms, can use the U.S. dollars in conducting business with other firms if the other firms are willing to accept dollars. Thus, the excess supply and demand argument that comes from examining the balance of payments is supplemented by a *transactions demand* for individual currencies.

What factors cause changes in the balance of payments? There are four general factors what we can study to anticipate changes in the balance of payments and exchange rates. Or at least we should understand these factors so that we may understand currency market reactions. The first factor is the *economic conditions* of the country of interest. We are referring to the private sector. Is the economy in the private sector strong? Is domestic demand strong relative to domestic supply? If so, people and businesses will consume more imports and more of domestic production that previously was exported. This will decrease the current account balance, and the increased flow of currency out of the country can weaken that currency. The counterpart to this argument is that a strong economy will attract foreign investment and this will increase the capital account balance. However, the current account is in general bigger than the capital account.

The second factor is *government debt* or the willingness of the government to accumulate debt. The economic argument here is exactly the same as that discussed in the previous paragraph, but the source of demand is in government expenditures. Because the determinants of government spending are different from the determinants of private spending, this factor is worth separate mentioning. If a government is willing to increase debt, or spend more relative to taxes collected, it will consume more domestic production and may consume imports or cause the private sector to consume more imports. This will decrease the current account balance and the increased flow of currency out of the country can weaken that currency. This is precisely the major cause of U.S. dollar devaluation in the mid-to late 1980s.

The third factor is real interest rate or *interest rate relative to inflation*. A country and currency with high nominal interest rates relative to inflation will attract foreign investment and capital. The flow of currency into the country will increase the capital account balance, strengthen the demand for the currency, and strengthen the value of the currency. However, over time the inflow of currency willing to purchase debt instruments will result in declining interest rates.

The fourth factor that impacts balance of payments is the *price level and productivity* of a nation. A country with relatively low prices and high productivity will be in a position to export relatively more than it imports, and thus will incur a balance-of-payments surplus, which will likely lead to a strong currency. In the long run, a strong currency will limit the ability of that country to export, but in the real world these imbalance may persist for some time.

There are two remaining factors that have strong impacts on exchange rates that do not necessarily work directly through the balance of payments. The first of these are actions by the government or central bank, and the second are market expectations. *Government and central bank actions* can have a large impact on exchange rates. Actions can have a direct impact on the import and export balance and balance of payments through trade policies. Different tariffs, quotas, and treaties will change trade flows. Central banks also often buy and sell large quantities of their own and foreign currencies. This is usually done to maintain target exchange rates and can be done to support or depress certain currencies. The long-term success of central banks in maintaining target exchange rate levels is questionable. Market adjustments in exchange rates are in response to trade flows and in the underlying financial condition of the economy and currency in question. However, in the short term, central bank intervention is very effective in controlling exchange rates.

It should be no surprise that the value of our dollar is determined by fundamental supply and demand forces. After all, the exchange rate and the interest rate that become important factors in all this are "prices" of a type. The interest rate is a direct price of money, and the exchange rate is a "price" relative to other currencies. The basic supply–demand framework will help you in understanding all of this.

SUMMARY

The market for currency is one of the largest in the world and it is not located in any particular place. The market exists within the communication system of large world banks during their business hours. The market follows the daylight around the world. Further, much of the volume of trade in this market is for the future delivery of currency. This market exists alongside the different world exchanges on which currency futures contracts are traded.

Exchange rate futures contracts traded on the Chicago Mercantile Exchange allow hedgers and speculators to trade different world currencies in relation to the U.S. dollar. The German mark and Japanese yen have the largest volume, followed by the currencies of other western European countries, British pounds, Swiss francs, and French francs, currencies from other North American countries, Canadian dollars and Mexican pesos, and Australian dollars. Currency futures contracts are subject to a large volume of trade worldwide. Futures contracts are almost always traded in the various futures exchanges around the world.

Exchange rates are a relative price. For example, an exchange rate is the number of U.S. dollars that will purchase one unit of a foreign currency. Caution must be used in speculating and hedging with exchange rate futures. The relationships at issue are not common to domestic commerce. For example, a strengthening of the U.S. dollar implies that one U.S. dollar will purchase more units of foreign currency. This implies that the exchange rate, measured as U.S. dollars per unit of foreign currency, will decrease. The converse is true for a weakening dollar.

Exchange rate futures contracts can be used to forward-price purchases and sales in foreign currency, and sales and purchases in U.S. dollars. The important question to ask is: "Is the firm long or short the U.S. dollar relative to foreign currency?" If the firm spends dollars and receives foreign currency, it is long dollars and short foreign currency. If the number of dollars a unit of foreign currency will buy decreases, then the firm loses money. In this case, to hedge the transaction, the firm needs to sell the appropriate CME exchange rate contract. If the firm receives dollars and spends foreign currency, it is short dollars and long foreign currency. If the number of dollars a unit of foreign currency will buy increases, then the firm loses money. In this case, to hedge the transaction, the firm needs to buy the CME exchange rate contract.

There is little if any basis risk in the exchange rate futures market. The currency markets are very well traded and delivery costs are low for those specializing in currency trade. However, only four exchange rate futures contracts are traded for any particular currency in the course of a year. There will be differences between the cash and futures exchange rates for nonexpiration months. These differences can be predicted by the Interest Rate Parity Model and the Purchasing Power Parity Model. If the differences can be predicted, the basis difference is not risk.

The Interest Rate Parity Model suggests that exchange rates adjust between countries so that the interest rates move to the same level. The person holding cash is paid the same interest rate no matter the currency that is held. Any premium between the current exchange rate and some future exchange rate is due to higher interest rates in the domestic country than the foreign country. The Purchasing Power Parity Model is an improvement on the Interest Rate Parity Model. The improvement is that interest rates are measured in real and not nominal terms. The difference between the two models is not important if inflation is stable and at similar rates between countries.

Understanding exchange rate fundamentals requires knowledge of interna-

tional trade and macroeconomic concepts. The main determinant of exchange rate is the balance of payments within a country. Balance-of-payments deficits will weaken a currency and the supply of that currency increases on world markets. Balance of payments surpluses will strengthen a currency, and the supply of that currency decreases on world markets. The balance of trade is the main component of the balance of payments and is the net of goods and services imported versus exported.

Economic events that can lead to a stronger currency include weakening domestic consumption, increasing foreign investment, decreases in government spending, high interest rates relative to inflation, and improving productivity. All of these events can lead to increases in the balance of payments. *Actions by central banks can also have large impacts on exchange rates.* Banks buy and sell very large amounts of their own currency, pushing the price of that currency, the exchange rate, up and down in response to the changing supply.

The desire by the world economy to hold and trade in a particular currency can also have a strong impact on the exchange rate of that currency. The case in point is the U.S. dollar. Much world trade involves the exchange of U.S. dollars. Changes in this transaction demand may push the value of the U.S. dollar up or down.

Recently, the volume of exchange rate futures contract trade on the CME has declined substantially. This is likely due to a period of relative stability in currency exchange rates associated with a period of low inflation and stability in monetary policy. However, the importance of world trade continues to grow. *Events such as the devaluation of the Mexican peso, and the more recent devaluation of Asian currencies, highlight the continued need for these exchange rate futures.*

KEY POINTS

- *Exchange rate futures* contracts allow hedgers and speculators to trade *different world currencies in relation to the U.S. dollar*. The German mark and Japanese yen have the largest volume, followed by the currencies of other western European countries, and currencies from Canada and Mexico.
- *Futures contracts for exchange rates* are traded in a number of different futures exchanges *around the world*.
- Exchange rates are a *relative price*. For example, an exchange rate is the *number of U.S. dollars that will purchase one unit of foreign currency*.
- *Caution must be used* in speculating and hedging with exchange rate futures. The relationships at issue *are not common to domestic commerce*.
- A *strengthening U.S. dollar* implies that the *exchange rate will decrease*. A *weakening U.S. dollar* implies exchange rate futures contracts will increase.
- The important question for hedging is: Is the firm *long or short the U.S. dollar relative* to foreign currency? If the firm pays out dollars and takes in foreign currency, it is long dollars and short foreign currency. The firm needs to *sell the CME exchange rate contract* to hedge the transaction. If the firm takes in dollars and pays out foreign currency, it is short dollars and long foreign currency. The firm needs to *buy the CME exchange rate contract* to hedge.
- There is *little if any basis risk* in the exchange rate futures market. However, there will be differences between the cash and futures exchange rates in nonexpiration

months. *These differences can be predicted* by the Interest Rate Parity and Purchasing Power Parity Models.

- *Exchange rate fundamentals* involve the supply of and demand for different currencies. If the *supply of a currency increases* on the world market, its price will fall. If the *demand increases*, its price will rise. The supply of currency is determined by the *balance of payments for a country*.
- The *strength of the domestic economy*, *level of government spending*, *inflation relative to interest rates*, and *productivity* all impact exchange rates. However, *central bank actions* often have the biggest impact on exchange rates.

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