9 CURRENCY FUTURES CONTRACTS

Currency futures contracts were developed in response to the shift from fixed to flexible exchange rates in 1971. At that time, the United States ceased redeeming dollars for gold. By 1973, most countries stopped maintaining the price of their currencies with respect to the dollar and allowed market forces to determine their exchange rates. The increased volatility of exchange rates created a demand for currency futures markets both as speculative and hedging vehicles.[1]

9.1 MARKETS FOR CURRENCIES[2]

Futures Market

The U.S. futures market in currencies operates like futures in any other item. Table 9.1 gives contract terms for the major foreign currency contracts, all of which are traded on the Chicago Mercantile Exchange's International Monetary Market. Prices are quoted in U.S. dollars per unit of foreign currency. An example of currency futures price quotes is contained in Table 9.2. While Table 9.1 indicates that eight maturity months are available, only the nearby months are actively traded. Unlike other futures contracts, delivery of currencies has relatively few complications. Only one "grade" of currency is available, delivery takes place on a specific date during the delivery month, and no transportation costs are incurred.

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[1] While flexible exchange rate systems have short run variability, they do not have the periodic large price changes and trade dislocations that were typical of fixed exchange rate systems.

[2] See Grabbe (1986) and Solnik (1988) for greater detail on currency markets and international bond and stock markets.

TABLE 9.1 Currency futures contracts specifications (most active contracts in U.S. markets).

Security (Exchange)	Trading Hours	Contract Months[a]	Units/ Minimum Price Fluctuation	Last Day of Trading	Delivery
Canadian Dollar (CME)	7:20–2:00 (CST)	1,3,4,6 7,9,10,12 current	100,000Can$/ .0001 ($10)	Two business days prior to third Wednesday	Third Wednesday
Deutsche Mark (CME)	7:20–2:00 (CST)	1,3,4,6 7,9,10,12 current	125,000DM/ .0001 ($12.50)	Two business days prior to third Wednesday	Third Wednesday
French Franc (CME)	7:20–2:00 (CST)	1,3,4,6 7,9,10,12 current	250,000FF/ .00005 ($12.50)	Two business days prior to third Wednesday	Third Wednesday
Japanese Yen (CME)	7:20–2:00 (CST)	1,3,4,6 7,9,10,12 current	12,500,000yen/ .000001 ($12.50)	Two business days prior to third Wednesday	Third Wednesday
British Pounds (CME)	7:20–2:00 (CST)	1,3,4,6 7,9,10,12 current	62,500pounds/ .0002 ($12.50)	Two business days prior to third Wednesday	Third Wednesday
Swiss Franc (CME)	7:20–2:00 (CST)	1,3,4,6 7,9,10,12 current	125,000SFr/ .0001 ($12.50)	Two business days prior to third Wednesday	Third Wednesday

a. The notation used in this column corresponds to the month of the calendar year (e.g., 1 is January, 2 is February, and so on).

Interbank Spot and Forward Market

By far the largest market in currencies is the interbank market. Major banks around the world trade currencies on a 24-hour basis. Banks supply currencies to their business customers and even out their positions by trading with other banks. Table 9.3 contains an example of prices from the interbank market.

The interbank market trades spot and forward currencies. Spot transactions call for delivery and payment within two days. Forward transactions call for delivery and payment at the time specified in the forward contract. Actively traded

TABLE 9.2 Currency futures contract prices.

FUTURES

	Open	High	Low	Settle	Change	Lifetime High	Lifetime Low	Open Interest
JAPAN YEN (IMM)—12.5 million yen; $ per yen (.00)								
Dec	.7691	.7699	.7671	.7679	− .0012	.7770	.6997	69,869
Mr92	.7666	.7684	.7659	.7665	− .0011	.7737	.7000	3,572
June		....	....	.7659	− .0010	.7730	.7015	917
Sept		....	....	.7659	− .0010	.7710	.7265	599
Dec		....	....	.7662	− .0009	.7700	.7512	1,290
Est vol 19,740; vol Tues 19,486; open int 76,247, +756.								
DEUTSCHEMARK (IMM)—125,000 marks; $ per mark								
Dec	.6088	.6108	.6060	.6088	+ .0007	.6770	.5365	72,328
Mr92	.6012	.6045	.5998	.6024	+ .0007	.6065	.5353	6,380
June	.5965	.5970	.5960	.5963	+ .0007	.5985	.5322	715
Est vol 56,177; vol Tues 36,905; open int 79,626, −1,188.								
CANADIAN DOLLAR (IMM)—100,000 dlrs.; $ per Can $								
Dec	.8771	.8817	.8763	.8812	+ .0019	.8906	.8175	20,341
Mr92	.8720	.8769	.8713	.8767	+ .0020	.8857	.8253	4,840
June	.8675	.8725	.8675	.8725	+ .0018	.8820	.8330	734
Sept	.8630	.8685	.8630	.8685	+ .0016	.8774	.8348	105
Est vol 13,890; vol Tues 7,534; open int 26,078, −782.								
BRITISH POUND (IMM)—62,500 pds.; $ per pound								
Dec	1.7640	1.7696	1.7560	1.7650	+.0024	1.7900	1.5670	27,784
Mr92	1.7430	1.7490	1.7370	1.7436	+.0024	1.7570	1.5560	2,964
Est vol 13,723; vol Tues 7,681; open int 30,780, −899.								
SWISS FRANC (IMM)—125,000 francs; $ per franc								
Dec	.6877	.6905	.6849	.6869	+ .0002	.8090	.6235	29,074
Mr92	.6829	.6852	.6797	.6819	+ .0004	.6995	.6225	2,196
June	.6766	.6795	.6750	.6771	+ .0004	.6840	.6546	296
Est vol 23,401; vol Tues 16,538; open int 31,566, −1,353.								
AUSTRALIAN DOLLAR (IMM)—100,000 dlrs.; $ per A.$								
Dec	.7825	.7839	.7822	.7832	− .0006	.7960	.7380	1,204
Est vol 113; vol Tues 164; open int 1,221, −246.								
U.S. DOLLAR INDEX (FINEX)—500 times USDX								
Dec	89.04	89.40	88.78	88.99	− .11	98.96	88.47	5,019
Mr92	90.07	90.30	89.90	90.08	− .10	98.90	89.60	1,045
Est vol 1,896; vol Tues 2,675; open int 6,090, −671.								
The index: High 88.86; Low 88.34; Close 88.54 −.08								

OTHER FUTURES

Settlement prices of selected contracts. Volume and open interest of all contract months.

British Pound (MCE) 12,500 pounds; $ per pound
Dec 1.7650 +.0024; Est. vol. 120; Open Int. 422
Japanese Yen (MCE) 6.25 million yen; $ per yen (.00)
Dec .7679 −.0012; Est. vol. 240; Open Int. 353
Swiss Franc (MCE) 62,500 francs; $ per franc
Dec .6869 +.0002; Est. vol. 1,020; Open Int. 253
Deutschemark (MCE) 62,500 marks; $ per mark
Dec .6088 +.0007; Est. vol. 360; Open Int. 837
BP/DM Cross Rate (IMM) US $50,000 times BP/DM
Dec 2.8990 +.0005; Est. vol. 80; Open Int. 245
DM/JY Cross Rate (IMM) US $125,000 times DM/JY
Dec .7928 +.0022; Est. vol. 6; Open Int. 583

FINEX—Financial Instrument Exchange, a division of the New York Cotton Exchange. IMM—International Monetary Market at the Chicago Mercantile Exchange. MCE—MidAmerica Commodity Exchange.

maturities are 30, 90, and 180 days, but other maturities are available. Forward contracts are contracts between two banks without the intervention of a clearing house. To reverse a forward contract, another contract must be entered into that reverses the first contract. For example, suppose a bank purchased British pounds 90 days forward. Ten days later, the bank wishes to offset that position. It could do so by selling British pounds 80 days forward.

Forward contracts are subject to two kinds of default risk—*credit risk* and *country risk*. Credit risk is the risk that the contra bank has poor credit. This risk is low because only the most creditworthy international banks participate in the interbank market. In the futures market, clearing house margin requirements serve to limit credit risk. Country risk is the risk that a country will impose restrictions on the transfer of currencies and thereby make it impossible for two banks to carry out the terms of their forward contract. Such restrictions were quite frequent under fixed exchange rate systems, but are less frequent today.

9.2 CURRENCY QUOTATIONS AND TRIANGULAR ARBITRAGE

We will follow the convention of quoting the price of a foreign currency just as we quote the price of any other commodity, in dollars per unit. Thus the price of the German mark might be 0.57 dollars per mark. Sometimes foreign currency prices are quoted as the number of units of foreign currency per dollar. In the case

TABLE 9.3 Spot and forward currency prices from the interbank market.

EXCHANGE RATES

Wednesday, November 13, 1991

The New York foreign exchange selling rates below apply to trading among banks in amounts of $1 million and more, as quoted at 3 p.m. Eastern time by Bankers Trust Co.and other sources. Retail transactions provide fewer units of foreign currency per dollar.

Country	U.S. $ equiv. Wed.	U.S. $ equiv. Tues.	Currency per U.S. $ Wed.	Currency per U.S. $ Tues.
Argentina (Austral) ...	.0001008	.0001008	9918.67	9918.67
Australia (Dollar)	.7860	.7870	1.2723	1.2706
Austria (Schilling)	.08681	.08681	11.52	11.52
Bahrain (Dinar)	2.6539	2.6539	.3768	.3768
Belgium (Franc)	.02966	.02966	33.72	33.72
Brazil (Cruzeiro)	.00144	.00146	694.71	685.60
Britain (Pound)	1.7730	1.7725	.5640	.5642
30-Day Forward	1.7648	1.7640	.5666	.5669
90-Day Forward	1.7504	1.7496	.5713	.5716
180-Day Forward	1.7299	1.7291	.5781	.5783
Canada (Dollar)	.8842	.8838	1.1310	1.1315
30-Day Forward	.8815	.8814	1.1344	1.1346
90-Day Forward	.8784	.8779	1.1384	1.1391
180-Day Forward	.8737	.8733	1.1445	1.1451
Chile (Peso)	.002844	.002780	351.56	359.65
China (Renminbi)	.185642	.185642	5.3867	5.3867
Colombia (Peso)	.001753	.001753	570.38	570.38
Denmark (Krone)	.1573	.1573	6.3570	6.3555
Ecuador (Sucre)				
Floating rate	.000966	.000966	1035.00	1035.00
Finland (Markka)	.24984	.24941	4.0025	4.0095
France (Franc)	.17881	.17879	5.5925	5.5930
30-Day Forward	.17813	.17808	5.6140	5.6156
90-Day Forward	.17690	.17685	5.6529	5.6545
180-Day Forward	.17510	.17504	5.7110	5.7130
Germany (Mark)	.6112	.6111	1.6362	1.6365
30-Day Forward	.6090	.6088	1.6421	1.6426
90-Day Forward	.6045	.6044	1.6543	1.6544
180-Day Forward	.5982	.5982	1.6717	1.6718
Greece (Drachma)	.005405	.005405	185.00	185.00
Hong Kong (Dollar) ...	.12884	.12884	7.7615	7.7615
India (Rupee)	.03880	.03880	25.77	25.77
Indonesia (Rupiah)	.0005056	.0005056	1978.00	1978.00
Ireland (Punt)	1.6330	1.6318	.6124	.6128
Israel (Shekel)	.4308	.4321	2.3215	2.3142
Italy (Lira)	.0008121	.0008117	1231.41	1232.01
Japan (Yen)	.007686	.007707	130.10	129.75
30-Day Forward	.007678	.007698	130.24	129.90
90-Day Forward	.007666	.007686	130.45	130.10
180-Day Forward	.007656	.007677	130.62	130.26
Jordan (Dinar)	1.4500	1.4500	.6897	.6897
Kuwait (Dinar)	3.4965	3.4965	.2860	.2860
Lebanon (Pound)	.001134	.001134	881.50	881.50
Malaysia (Ringgit)	.3650	.3647	2.7400	2.7420
Malta (Lira)	3.1250	3.1250	.3200	.3200
Mexico (Peso)				
Floating rate	.0003254	.0003254	3073.01	3073.01
Netherland (Guilder) .	.5423	.5422	1.8440	1.8445
New Zealand (Dollar)	.5610	.5620	1.7825	1.7794
Norway (Krone)	.1558	.1558	6.4175	6.4185
Pakistan (Rupee)	.0405	.0405	24.72	24.72
Peru (New Sol)	1.0152	1.0051	.99	.99
Philippines (Peso)	.03839	.03839	26.05	26.05
Portugal (Escudo)	.007067	.007063	141.50	141.59
Saudi Arabia (Riyal) ..	.26663	.26663	3.7505	3.7505
Singapore (Dollar)	.5958	.5959	1.6785	1.6780
South Africa (Rand)				
Commercial rate	.3568	.3574	2.8023	2.7981
Financial rate	.3248	.3240	3.0790	3.0860
South Korea (Won)	.0013310	.0013310	751.30	751.30
Spain (Peseta)	.009723	.009699	102.85	103.10
Sweden (Krona)	.1673	.1672	5.9775	5.9815
Switzerland (Franc) ..	.6888	.6892	1.4517	1.4510
30-Day Forward	.6872	.6875	1.4552	1.4546
90-Day Forward	.6835	.6839	1.4631	1.4621
180-Day Forward	.6788	.6792	1.4732	1.4724
Taiwan (Dollar)	.038850	.037908	25.74	26.38
Thailand (Baht)	.03926	.03926	25.47	25.47
Turkey (Lira)	.0002044	.0002020	4892.01	4950.00
United Arab (Dirham)	.2723	.2723	3.6725	3.6725
Uruguay (New Peso)				
Financial	.000425	.000425	2352.94	2352.94

of the German mark, that would be 1/.57 Deutsche marks per dollar.[3] Table 9.4 contains spot currency prices from both perspectives for some key currencies.

The dollar cost of a German mark should be the same if one first purchased francs and then used the francs to buy marks or if one purchased marks directly. In Table 9.4, the dollar price of a German mark is 0.612000 dollars. The French franc price of a German mark is 3.4171 francs. The number of dollars needed to buy 3.4171 francs (which buy one mark) is (.1791)(3.4171) = 0.612003. The two methods of buying one mark are virtually identical and differ only in the sixth decimal. If the two methods gave different answers, an opportunity for triangular arbitrage would exist. For example, suppose the dollar price of a French franc is only .1720 dollars and the franc price of the mark is as shown in the table. Then a mark could be purchased for (.1720)(3.4171) = 0.5877 dollars. An arbitrageur could borrow marks and sell them for 0.6120 dollars per mark and simultaneously take 0.5877 dollars to buy back the marks needed to repay the borrowings. The profit from this triangular arbitrage would be 0.6120 − 0.5877 = 0.0243 dollars per mark. To avoid triangular arbitrage opportunities, the following condition must be met for all trios of currencies:

$$S_{1,2} = S_{1,3}S_{3,2}, \tag{9.1}$$

where $S_{i,j}$ is the number of units of the i-th currency required to purchase one unit of the jth currency.

TABLE 9.4 Key currency cross rates.

Key Currency Cross Rates Late New York Trading Nov. 13, 1991

	Dollar	Pound	SFranc	Guilder	Yen	Lira	D-Mark	FFranc	CdnDlr
Canada	1.1313	2.0098	.78021	.61434	.00870	.00092	.69235	.20261	....
France	5.5835	9.919	3.8507	3.0320	.04292	.00454	3.4171	....	4.9355
Germany	1.6340	2.9028	1.1269	.88732	.01256	.00133	....	.29265	1.4444
Italy	1229.3	2183.8	847.76	667.53	9.449	....	752.29	220.16	1086.6
Japan	130.10	231.12	89.724	70.649	....	.10584	79.621	23.301	115.00
Netherlands	1.8415	3.2714	1.2700	....	.01415	.00150	1.1270	.32981	1.6278
Switzerland	1.4500	2.5759	....	.78740	.01115	.00118	.88739	.25969	1.2817
U.K.	.56290	....	.38821	.30568	.00433	.00046	.34449	.10082	.49757
U.S.	....	1.7765	.68966	.54304	.00769	.00081	.61200	.17910	.88394

Source: Telerate

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[3] In principle, the price of wheat could be quoted both as the dollar price of wheat, say four dollars per bushel, or the wheat price of dollars, which would be 1/4 bushels per dollar.

9.3 STRUCTURE OF CURRENCY FUTURES PRICES

Unlike agricultural commodities, which are sometimes in short supply, currencies are always in large supply. As a result, currency futures obey the cost-of-carry equilibrium developed in Chapter 3: $F_t = S_t e^{b(T-t)}$. In currencies, the cost of carry is the difference between the interest cost of the dollars invested in a currency and the interest earned on the foreign currency. The cost-of-carry relation can therefore be written as

$$F_t = S_t e^{(r_d - r_f)(T-t)}, \tag{9.2}$$

where $r_d(r_f)$ is the continuously compounded, riskless rate of interest in the domestic (foreign) currency and T is the maturity of the futures contract.

In international finance, the relation (9.2) is called the *interest rate parity (IRP) relation.* It is instructive to derive IRP in a somewhat different way. Consider an investor who has one U.S. dollar to invest. If the dollar is invested domestically at the riskless rate, the value at maturity is

$$e^{r_d(T-t)}.$$

On the other hand, the dollar may also be used to purchase foreign currency that is then invested at the foreign riskless rate of interest. If the proceeds at maturity of the foreign investment are sold in the futures market, a dollar return can be guaranteed at time t. At maturity, the dollar cash proceeds of a hedged foreign investment are

$$(1/S_t)e^{r_f(T-t)}F_t.$$

For example, consider an investment in Germany. Suppose $S_t = 0.57$, $r_f = 0.05$ per year, $T - t = 0.25$ years, and $F_t = 0.58$. The hedged dollar proceeds on the investment in Germany are 1.03034 dollars.

In equilibrium, the two ways of investing the dollar—directly in the U.S. or indirectly in a foreign country—must have the same value at maturity, assuming that both investments offer a riskless return and that there is no default risk on the futures or forward contract. In other words, the absence of costless arbitrage opportunities in the marketplace ensures that

$$e^{r_d(T-t)} = (1/S_t)e^{r_f(T-t)}F_t.$$

This expression is easily manipulated to give (9.2). Dividing by S_t and subtracting one from each side, equation (9.2) can also be written as

$$\frac{F_t - S_t}{S_t} = e^{(r_d - r_f)(T-t)} - 1. \tag{9.3}$$

The left-hand side of this expression, which in other futures markets we call the percentage basis, is called the *forward premium* or the *swap rate* in the currency markets. The term *swap rate* comes from the fact that investors frequently buy a foreign currency and agree to swap it back for dollars. The swap rate specifies the gain or loss on such a transaction. The right-hand side is the interest differential between the two countries over the time period $T - t$.

The IRP relation can also be derived for the case in which interest is earned discretely over the life of the futures contract. Suppose r_d^* and r_f^* are the U.S. and foreign riskless rates of interest for the time over which funds are invested, $T - t$. Then an investment in the U.S. is worth $\$(1 + r_d^*)$ at maturity, and a hedged investment in the foreign country is worth $\$(1/S)(1 + r_f^*)F$ at maturity. To eliminate riskless arbitrage opportunities, these outcomes must be equal, which implies

$$\frac{F - S}{S} = \frac{r_d^* - r_f^*}{1 + r_f^*}. \tag{9.4}$$

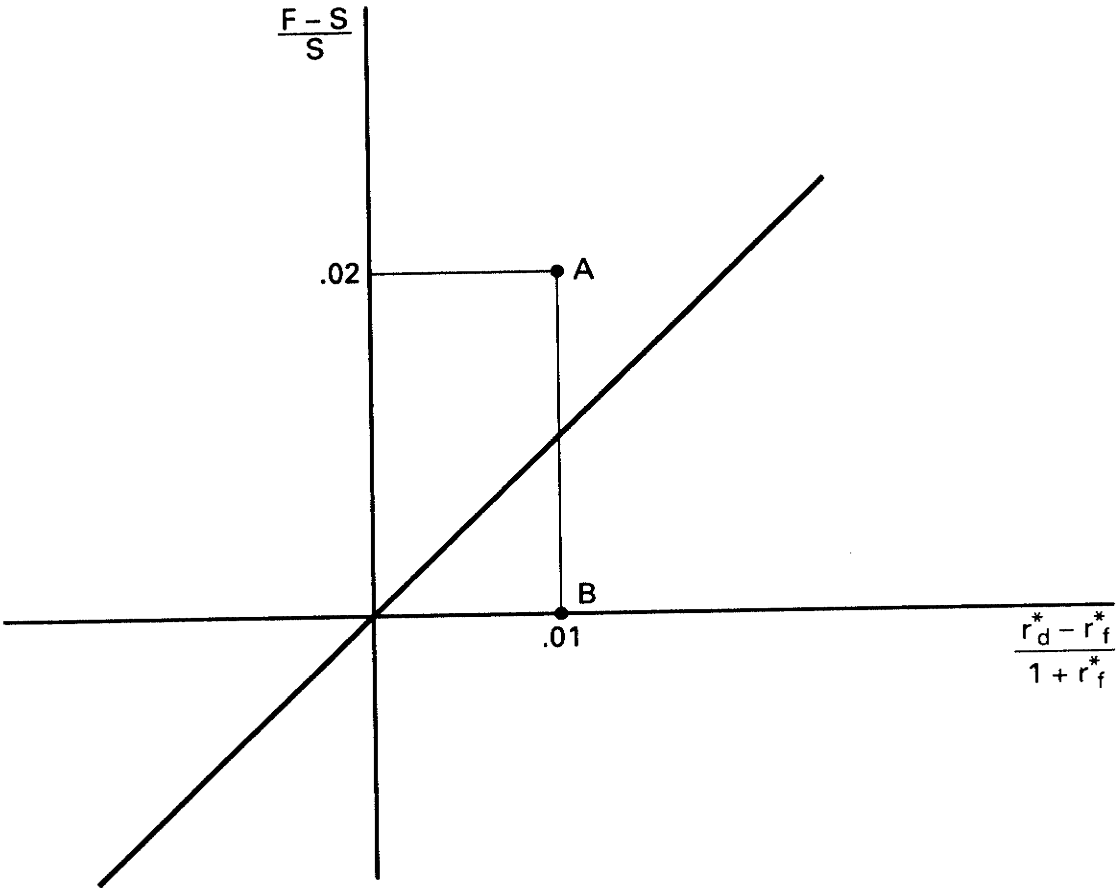
This equilibrium relation is plotted in Figure 9.1 as the 45-degree line. Arbitrage opportunities arise if an observation is not on the line.

For example, consider point A. At A, exchange rates are $S = 0.50$ and $F = 0.51$, yielding a forward premium $(F - S)/S = 0.02$; and three-month interest rates are $r_d^* = 0.03$ and $r_f^* = 0.02$, yielding an interest differential of $(r_d^* - r_f^*)/(1 + r_f^*) = 0.01$. Although the interest differential is in favor of the U.S., it is profitable to borrow in the U.S. and invest in the foreign country because the profit on the foreign exchange transaction exceeds the loss on the interest differential. An arbitrageur could borrow one million dollars in the U.S., thereby incurring an obligation to repay $(1 + r_d^*) = 1.03$ million dollars at maturity; and she would invest in the hedged foreign investment, which pays $(1/S)(1 + r_f^*)F = 1.0404$ million dollars at maturity. The arbitrage profit is 1.0404 million minus 1.03 million or 10,400 dollars. The activity of arbitrageurs results in a capital outflow from the U.S. that raises U.S. interest rates, raises the spot exchange rate, lowers foreign interest rates, and lowers the futures price, until equilibrium is restored. In fact, all points above the line in the figure imply a capital outflow from the U.S.

Points below the line, such as point B, imply a capital inflow into the United States. At point B, the interest differential is in favor of the U.S., but the forward premium is zero. Arbitrage profits could be earned by borrowing in the foreign country at r_f^*, selling the foreign currency at S, investing in the U.S. at r_d^*, and entering into a futures contract to purchase the foreign currency at F to repay the loan. The dollar value of the face amount of the foreign loan is $(1/S)(1 + r_f^*)F$, and the value of the dollar investment is $(1 + r_d^*)$. Assuming that $F = 0.50$, $S = 0.50$, $r_d^* = 0.03$, and $r_f^* = 0.02$, the profit is 0.01 for every dollar borrowed and invested in the United States.

In today's highly efficient international financial markets, arbitrage is instantaneous, and deviations from IRP are rarely observed except for very small devi-

FIGURE 9.1 Interest Rate Parity



ations caused by transaction costs. Apparent deviations may be observed for certain interest rates. Each country has only one spot rate and one futures rate for any maturity, but each country has many short-term interest rates that reflect different degrees of risk. Thus, it is possible to find two interest rates that cause IRP to be violated. Differences in risk or differences in transaction costs, however, usually explain deviations from IRP.

9.4 FACTORS AFFECTING EXCHANGE RATES

Many factors affect exchange rates. While it is beyond the scope of this book to consider all of these factors in detail, understanding some of the key factors that analysts consider is useful from a practical standpoint.[4]

Purchasing Power Parity

An important factor determining a country's currency value is the rate of inflation in the country. The higher the rate of inflation, the greater the decline in the pur-

[4] For detailed discussions of factors determining exchange rates, see Lessard (1985).

chasing power of one unit of the currency, and the lower the price of the currency. The theory of Purchasing Power Parity (*PPP*) is a macroeconomic version of the Law of One Price (*LOP*) discussed in Chapter 6. The *LOP* takes the exchange rate as given and says that the prices of a commodity in two different countries must be the same after adjustment for the exchange rate:

$$G_d = SG_f,$$

where G_d and G_f are the U.S. and foreign prices of the commodity and S is the spot exchange rate (the dollar price of the foreign currency). If commodity arbitrage takes place for every commodity, the *LOP* must hold for bundles of the same commodities in the two countries. Changes in the price of the bundle in one country due to inflation without a corresponding change in the price of the bundle in the other country must imply a change in the exchange rate. In other words, under *PPP*, the exchange rate is the dependent variable, and the prices of commodities in the two countries are independent variables.

The *absolute version of PPP* is written as

$$S_t = \frac{P_{d,t}}{P_{f,t}}. \tag{9.5}$$

The variable $P_{d,t}$ is the dollar price of a bundle of commodities in the U.S. and $P_{f,t}$ is the foreign currency price of the same bundle. For example, at $t = 1991$, $P_{d,t} = 500$ dollars and $P_{f,t} = 2{,}000$ units of foreign currency. That implies an exchange rate of .25 according to *PPP*. The *relative version of PPP* looks at the change in the exchange rate as a function of the relative changes in the prices of the bundle of commodities in each country. We can derive the relative version of *PPP* by writing equation (9.5) for a base period, time 0. Dividing the base period equation into (9.5) yields

$$\frac{S_t}{S_0} = \frac{P_{d,t}/P_{f,t}}{P_{d,0}/P_{f,0}} = \frac{P_{d,t}/P_{d,0}}{P_{f,t}/P_{f,0}}$$

or

$$\frac{S_t}{S_0} = \frac{I_{d,t}}{I_{f,t}}, \tag{9.6}$$

where $I_{d,t}$ and $I_{f,t}$ are the U.S. and foreign country price indexes with a time 0 base year. Equation (9.6) is the relative version of *PPP*. Suppose the base year is 1967 and that in that year the bundle costs $P_{d,0} = 200$ in the U.S. and $P_{f,0} = 400$ in the foreign country. That implies an exchange rate of .50 dollars in 1967. Using the 1991 bundle prices assumed above, the price indexes are $I_{d,t} = 2.50$ in the U.S. and $I_{f,t} = 5.00$ in the foreign country. The ratio of these indexes implies a ratio of exchange rates in 1991 versus 1967 of 0.5, which, according to *PPP*, means the exchange rate is 0.25 in 1991.

In practice, *PPP* does not seem to hold as well as in the example we have just presented. A difficulty arises from measurement problems. Price indexes in different countries do not include the same commodities or have the same weights when the same commodities are included. Difficulties also arise in measuring prices of commodities accurately and at the same time in the different countries. Another difficulty arises from the fact that transportation costs are high for many commodities, so that the law of one price cannot be established. Indeed, transport costs are prohibitive for certain commodities. Moreover, many items such as services are simply not traded. Services (say, haircuts) can only be traded by moving labor, but restrictions on international migration prevent arbitrage of services. Neither of these difficulties is severe if the source of a change in currency values is inflation that affects the prices of all commodities—traded and non-traded—in the same way. In that case, any index will be representative. *PPP* does not hold in practice, however, because the prices of different commodities move in different ways in different countries. It is possible, for example, for a country's traded goods not to increase in price (because of cost cutting measures in the traded goods sector of the economy), while the prices of non-traded goods increase considerably more. The exchange rate of that country will not depreciate as much as would be predicted by the aggregate inflation in the country because it has remained competitive in those goods that are traded internationally.

Despite these difficulties, *PPP* remains an important determinant of exchange rate changes over longer periods of time, particularly when comparing countries with significantly different inflation rates. Table 9.5 presents some data for the exchange rates and inflation of seven industrial nations for the period 1967 to 1983 in which substantial differences in inflation arose. The second column gives the ratio of the dollar price of the foreign currency in 1983 to the dollar price in 1967. During this period, the dollar appreciated relative to every country except West Germany and Japan. For example, the price of the British pound fell by 44.9 percent, whereas the price of the German mark rose by 56.4 percent. The third column shows that much of the change in exchange rates can be explained by differences in inflation rates. Typically, when U.S. inflation is less than foreign inflation, the price of the foreign currency falls, and when U.S. inflation is greater than foreign inflation, the price of the foreign currency rises. Japan is the only exception. According to the consumer price indexes for the U.S. and Japan, inflation was about equal in the two countries, yet the Japanese yen appreciated by 52.6 percent. Part of the explanation for this discrepancy lies in the fact that the consumer price index is not representative of the price of Japanese traded goods. Consumer goods within Japan have risen in price, but goods traded internationally have not risen in price to the extent implied by the Japanese consumer price index.

The Monetarist Approach to Exchange Rate Determination

The monetarist approach is an extension of purchasing power parity. Under the monetarist approach, the price level in each country is determined by monetary

TABLE 9.5 Exchange rates and inflation, 1967–1983.

Country	S_{83}/S_{67}	I_d/I_f	Real Exchange Rate
Canada	0.875	0.929	0.94
France	0.649	0.732	0.89
West Germany	1.564	1.468	1.07
Italy	0.412	0.472	0.87
Japan	1.526	0.963	1.58
United Kingdom	0.551	0.554	0.99

The second column is the ratio of the dollar price of the foreign currency in 1983 to the dollar price of the foreign currency in 1967. The third column is the ratio of the consumer price index in the United States to the consumer price index in the foreign country. The base year for both indexes is 1967. The fourth column is the ratio of the second column to the third column. A number greater than (less than) one indicates that the currency had a real appreciation (depreciation) relative to the dollar.

Source: International Monetary Fund, *International Financial Statistics*, monthly.

factors. The exchange rate then depends on the factors that determine the price level in each country.

The quantity theory of money states that

$$m_t v = I_t y_t, \tag{9.7}$$

where m_t is the money supply at time t divided by the money supply in the base period, v is the velocity of money, I_t is the price index, and y_t is real income at time t divided by real income in the base period. The price index can be written as

$$I_t = (m_t v)/y_t, \tag{9.8}$$

which shows that, under the assumption that the velocity of money is stable, the quantity theory states that inflation occurs if the money supply expands faster than real income.

Under the quantity theory, the price level may be written for both the domestic and foreign countries:

$$I_{d,t} = (m_{d,t}v_d)/y_{d,t}, \tag{9.8a}$$

$$I_{f,t} = (m_{f,t}v_f)/y_{f,t}. \tag{9.8b}$$

The base period for the variables is assumed to be the same in the two countries. Substituting (9.8a) and (9.8b) in (9.6) yields

$$\frac{S_t}{S_0} = \frac{I_{d,t}}{I_{f,t}} = \frac{m_{d,t}v_d y_{f,t}}{m_{f,t}v_f y_{d,t}}. \tag{9.9}$$

Equation (9.9) says that the change in the exchange rate depends on relative money supply growths and relative real income growths in the two countries, assuming constant velocities. Suppose that velocities in two countries are one, that real income grew 100 percent in the foreign country ($y_{f,t} = 2$) and 50 percent in the domestic economy ($y_{d,t} = 1.5$), that the money supply grew 300 percent in the foreign country ($m_{f,t} = 4$) and 100 percent in the domestic economy ($m_{d,t} = 2$). That would imply $S_t/S_0 = 0.67$, a 33 percent decline in the price of the foreign currency. The monetary approach can become a good deal more complicated as other factors that affect the impact of money supply changes on the economy are considered.

Like *PPP*, the monetarist approach is less successful in explaining short-run changes in exchange rates than in explaining long-run changes. Using the monetarist approach to predict exchange rates requires predicting money supply growths in the two countries and other variables that affect inflation, something that is not an easy task over short intervals.

Balance of Payments Approach to Exchange Rate Determination

Another set of factors considered by analysts is the balance of payments, particularly the current account. The current account balance of a country is the exports of goods and services minus imports. A country has a current account *surplus* when its exports exceed its imports, and it has a current account *deficit* when imports exceed exports. The U.S., for example, had a large current account deficit in the 1980s. Analysts who take the balance of payments approach argue that a deficit increases the demand for foreign exchange and raises the price of foreign currencies, whereas a surplus lowers the price of foreign currencies. It has been difficult to show, however, that exchange rates are, in fact, related to the current account deficit in this way. For example, the U.S. dollar appreciated during some periods in the 1980s when the current account deficit was large.

Part of the problem is that the current account is endogenous, that is, it depends on fundamental forces that also affect the exchange rate. For example, the current account depends on monetary and fiscal policy that also have a direct effect on the exchange rate. A country might import more because its real income has grown. A growth in real income could be consistent with a decline in the price of foreign currencies (a strengthening of the domestic exchange rate) as shown above for the monetarist approach.

Analysts often emphasize the current account, but the balance of payments also includes a capital account. Overall, the balance of payments must balance. A current account deficit must be matched by a capital account surplus (assuming government reserves and borrowings do not change), and a current account surplus must be matched by a capital account deficit. If a country imports more than it exports, the cost of the net imports must be financed by borrowing from abroad. If a country exports more than it imports, the foreign currency earnings must be invested abroad (or used to reduce foreign debt). Some analysts argue that capital flows are exogenous and that the current account is endogenous. Under this argument, the U.S. trade deficit results from a large capital inflow to the U.S. in response to higher U.S. interest rates and other factors. The capital account surplus, in turn, made resources available to the U.S., some of which were spent on imports, thereby generating the current account deficit. Under this scenario, the price of foreign currencies declined even though the U.S. ran a current account deficit.

Because of capital flows and other macroeconomic factors, the balance of payments approach, with its focus on the current account, has not proved adequate to explain the behavior of exchange rates.

The Asset Market Approach to Exchange Rate Determination

The asset approach to exchange rate determination argues that investors throughout the world allocate investment according to anticipated real returns and anticipated exchange rate changes. If Japan has a low expected real return relative to the U.S., funds will flow to the U.S., and the U.S. dollar will appreciate. The asset approach thus focuses on capital flows and the factors that determine capital flows. In addition to expected real returns, capital flows respond to risk.

In summary, a variety of complicated forces affect exchange rates. *PPP* is important, but short-run deviations from *PPP* are prevalent. These short-run deviations depend on monetary and fiscal policy, exogenous changes in the demand for imports and exports, and exogenous changes in capital flows.

9.5 RETURNS TO SPECULATORS IN CURRENCIES

As in other financial markets, it is difficult for currency speculators to make abnormal returns because competition among traders causes the currency markets to be efficient. One potential source of inefficiency is the intervention by central banks in the currency markets to "stabilize" their exchange rates. Such stabilization sometimes slows adjustment of exchange rates and makes it possible to predict future exchange rates. Most of the evidence, however, indicates that, like stock prices, exchange rate changes are hard to predict.

Spot Speculation and Futures Speculation

The fact that exchange rate changes are hard to predict does not keep people from trying. Speculation on exchange rate changes can be done in either the spot market or the futures market. In the futures market, a speculator would buy currency futures if she expects the spot rate at maturity to exceed the current futures price, and she would sell currency futures if she expected the spot rate at maturity to be less than the futures price. Her expected profit is $E(\tilde{S}_T) - F_t(T)$. In equilibrium, competition among speculators would eliminate profits and cause the futures price to equal the expected spot price:

$$F_t(T) = E(\tilde{S}_T). \quad \textbf{(9.10)}$$

We noted in Chapter 4 that the trading pressures of hedgers might cause speculators to demand a risk premium that brings about a divergence between the futures price and the expected spot price. In currency markets, the risk premium could easily be positive or negative since hedgers could be buying foreign currency or selling foreign currency. In the absence of a reason to assume the risk premium is a particular sign, we shall assume that condition (9.10) is met and that no risk premium exists.

A speculator who expects a foreign currency to appreciate could also borrow dollars and buy the foreign currency. The speculation is profitable if the currency appreciates more than the cost of holding the currency. The mechanics of spot speculation are as follows: borrow a dollar, buy $1/S_t$ units of foreign currency, invest the foreign currency at the foreign interest rate, r_f^*, sell the foreign currency at the future spot rate, $\tilde{S}_T$, and pay back the dollar plus interest of r_d^*. The expected profit is

$$(1/S_t)(1 + r_f^*)E(\tilde{S}_T) - (1 + r_d^*)$$

In the absence of a risk premium, equilibrium requires a zero-expected profit, which implies

$$S_t\left(\frac{1 + r_d^*}{1 + r_f^*}\right) = E(\tilde{S}_T). \quad \textbf{(9.11)}$$

It is worth noting that the left-hand sides of (9.10) and (9.11), taken together, yield IRP. Under IRP, spot speculation and futures speculation are equivalent.

The International Fisher Effect

Relation (9.11) is often called the *international Fisher effect (IFE)*. The *IFE* is usually written as

$$\frac{E(\tilde{S}_T)}{S_t} = \frac{1 + r_d^*}{1 + r_f^*}.$$

The *IFE* says that the expected change in the exchange rate equals the interest rate differential between the countries. For example, if the one-year interest rate in the U.S. is 8 percent and the one-year interest rate in Brazil is 80 percent, the IFE says the price of the Brazilian cruzeiro is expected to be 60 percent of its current value.

The *IFE* takes its name from Irving Fisher, who argued that the domestic interest rate is approximately equal to the real rate of interest plus the expected rate of inflation. The *IFE* assumes that international differences in interest rates reflect differences in expected inflation rates. According to Fisher,

$$(1 + r_d^*) = (1 + a_d^*)[1 + E(\tilde{\pi}_d^*)]$$

$$(1 + r_f^*) = (1 + a_f^*)[1 + E(\tilde{\pi}_f^*)],$$

where a_d^* and a_f^* are the domestic and foreign real rates of interest, and π_d^* and π_f^* are the U.S. and foreign inflation rates. If $a_d^* = a_f^*$, the *IFE* becomes

$$\frac{E(\tilde{S}_T)}{S_t} = \frac{1 + E(\tilde{\pi}_d^*)}{1 + E(\tilde{\pi}_f^*)}. \quad (9.12)$$

In this form, the *IFE* is very much like the relative *PPP* equation (9.6), except that *PPP* is an *ex post* relation between the realized exchange rate change and realized inflation while the *IFE* is an *ex ante* relation between the expected exchange rate change and expected inflation.

Forecasting Exchange Rates

In an efficient market without inside information, it is impossible to make better forecasts of exchange rates than the forecasts available from the financial markets. As we have just seen, financial markets provide two forecasts: the futures price and the difference in interest rates. In the absence of forecasting skill or inside information and an understanding of the actions of world monetary authorities, these readily available forecasts are as useful as more sophisticated forecasting. Careful analysis of fundamental factors such as inflation, monetary policy, balance of payments, and asset flows may result in superior forecasts, but competition among forecasters tends to eliminate abnormal returns.[5] Market-based forecasts are not necessarily accurate since unexpected events have a way of altering outcomes from the outcome that was expected, but they are unbiased and readily available.

9.6 HEDGING CURRENCY RISK

Given the uncertainties about the future value of a currency, companies engaged in international operations frequently want to hedge against the risks of exchange rate changes. Currency risk can arise in regard to a particular import or export transaction or because a company's balance sheet contains assets and liabilities denominated in a foreign currency.[6]

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[5]Evidence on forecasting ability is provided by Levich, "Evaluating the Performance of the Forecasters," in Lessard (1985).

[6]For greater detail on hedging and on other financial issues in managing international operations see Shapiro (1989) and Eiteman and Stonehill (1986).

Transactions Risk

Transactions risk refers to the foreign currency risk of a particular future transaction denominated in a foreign currency. For example, a U.S. company sells a product to a German importer who agrees to pay for the product in three months, when shipment is received. Payment is specified in German marks. The dollar value of that account receivable for the U.S. company is uncertain. This transaction can be hedged by selling forward the German marks to be received in three months. Such a forward sale is usually done through a bank because the quantity and other terms of the forward contract can be tailored to the specific transaction incurring currency risk. Futures contracts could also be used, but the size and maturity of a futures contract may not match the hedging need exactly.

An example of transactions risk might be a U.S. airplane manufacturer who has committed to deliver a jet to Lufthansa in one year for 40,000,000 marks, with payment to be made in one year. The spot price of the mark is assumed to be S_t = \$0.6000 and the one year forward price, F_t = \$0.61132075. If left unhedged, the dollar value of the contract is subject to fluctuations in the value of the German mark. At the current forward price, the contract is worth \$24,452,830, but if the spot price should fall two percent below its current value to \$0.5880, the contract would be worth \$23,520,000, a loss of nearly one million dollars. The manufacturer can hedge foreign exchange risk by entering a forward contract today to sell 40,000,000 marks a year from now at the forward price. At maturity, when payment is made, the German mark proceeds from the export of the jet are delivered to the bank in return for dollars. The manufacturer has a problem if there are delays in delivery and payment. In that case, the forward contract has to be rolled over at some cost.

An alternative to the forward market hedge is a money market hedge. Under interest rate parity, a money market hedge is equivalent to a forward market hedge. U.S. and German interest rates consistent with the spot, and forward rates in the example are $r_d^* = .08$ and $r_f^* = .06$. Under a money market hedge, the U.S. jet manufacturer borrows German marks against the proceeds of the sale of the jet, which amounts to 40,000,000/(1.06) = 37,735,849 marks, and converts the marks to dollars at the current spot rate to get (0.60)(37,735,849) = 22,641,509. If this amount is invested at 8 percent, the proceeds at maturity are (22,641,509)(1.08) = 24,452,830, the same as under the forward contract. In practice, the two approaches may not be the same since the short-term interest rates that cause interest rate parity to hold may not be the rates at which the manufacturer can borrow and lend. If the manufacturer is in need of funds, the money market hedge is preferable to the forward market hedge.

Balance Sheet Risk

In many cases, a company faces foreign exchange risk that is less specifically tied to a particular transaction. For example, a company exporting to Germany may build up accounts receivable with many different maturity dates, or it may hold inventory in Germany which is exposed to currency risk. Indeed, a company's balance sheet may have both assets and liabilities denominated in various foreign currencies. Appropriate hedging procedures for this more general case are quite complex. They depend on whether the foreign currency obligation is contractual or not. A *contractual* obligation denominated in a foreign currency is subject to foreign exchange risk because the contract price is set and cannot be changed, as in the case of the U.S. exporter of jets. If the value of the currency falls, the foreign currency price cannot be adjusted. On the other hand, a *non-contractual* business operation is less subject to exchange risk because changes in exchange rates can, perhaps, be offset by price changes in the foreign currency. A U.S. toothpaste manufacturer with an Italian subsidiary, for example, may find it possible to offset declines in the value of the Italian lira with increases in the price of toothpaste sold in Italy.

A simple example of a balance sheet hedge of a contractual asset is that of a British subsidiary with a cash balance of 5,000 pounds. The U.S. parent, worried about a possible decline in the British pound, decides to hedge that position by selling futures in the amount of 5,000 pounds. If the value of the pound falls, the decline in the dollar value of the cash is offset by the profit on the short futures position. This hedge is equivalent to a hedge of a particular transaction, in the sense that both are contractual. It is different in that the cash balance has no maturity and is changed daily as a result of business operations.

An example of a balance sheet hedge of a non-contractual item is hedging a finished goods inventory position valued at 5,000 pounds at the current price of the product in Britain. This hedge is more complicated because a decline in the value of the British pound that would reduce the dollar value of the inventory might be offset by an increase in the price of the finished good in the United Kingdom. Indeed, under *PPP*, that is exactly what would be expected. Suppose declines in the dollar price of the British pound can be partially offset by increasing product prices by 50 percent of the amount they would increase under *PPP*. If repricing offsets half the decline in the price of the pound, the optimal hedge is to sell short about 2,500 pounds. In effect, the ability to reprice inventory in the U.K. provides a partial natural hedge (for 50 percent of the decline). The futures market hedge hedges the other half of the exchange rate decline. Table 9.6 details this example.

9.7 SUMMARY

This chapter begins by describing currency markets and currency quotations. The cost-of-carry model for currency futures is then derived and shown to be the same as the well-known interest rate parity condition. Theories of the determinants of exchange rates—the purchasing power parity approach, the monetarist approach, the balance of payments approach, and the asset approach—are described.

We distinguish futures speculation and spot speculation. Competition among speculators in the futures market implies that the futures price is a good estimate of the expected spot price. Similarly, competition in spot speculation leads to the international Fisher effect—that the expected change in the exchange rate equals the interest differential between two countries.

Currency futures may be used to hedge against fluctuations in exchange rates. The chapter concludes with descriptions of hedging transaction risk and balance sheet risk.

TABLE 9.6 Hedging foreign exchange risk of 1000 units of finished goods inventory when 50 percent of the exchange rate change can be offset by raising the sale price.

	Inventory			Futures Market		
Date	Value[a] (pounds)	Exch. Rate	Value (dollars)	Futures Position (pounds)	Futures Price	Value (dollars)
Sept. 1	5,000	1.60	8,000	–2,500	1.60	–4,000
Dec. 1	5,833	1.20	7,000	–2,500	1.20	–3,000
Gain			–1,000			1,000

a. The initial price of inventory is assumed to be 5 pounds per unit. The old exchange rate is 1/3 greater than the new exchange rate. The table assumes the selling price can be raised by half the amount that would offset the change in the exchange rate, or by .5(1/3)(5).