CHAPTER 5

Chapter 3 noted that the United States has both an *over-the-counter* market in foreign exchange and an *exchange-traded* segment of the market. The *OTC* market is the U.S. portion of an international OTC network of major dealers—mainly but not exclusively banks—operating in financial centers around the world, trading with each other and with customers, via computers, telephones, and other means. The *exchange-traded* market covers trade in a limited number of foreign exchange products on the floors of organized exchanges located in Chicago, Philadelphia, and New York.

This chapter describes the foreign exchange products traded in the OTC market. It covers the three "traditional" foreign exchange instruments —*spot*, *outright forwards*, and *FX swaps*, which were the *only* instruments traded before the 1970s, and which still constitute the overwhelming share of all foreign exchange market activity. It also covers two more recent products in which OTC trading has developed since the 1970s—*currency swaps* and *OTC currency options*.

The next chapter describes *currency futures* and *exchange-traded currency options*, which currently are traded in U.S. exchanges.

1. SPOT

A *spot* transaction is a straightforward (or "outright") exchange of one currency for another. The spot rate is the current market price, the benchmark price.

Spot transactions do not require *immediate* settlement, or payment "on the spot." By convention, the settlement date, or "value date," is the *second* business day after the "deal date" (or "trade date") on which the transaction is agreed to by the two traders. The two-day period provides ample time for the two parties to confirm the agreement and arrange the clearing and necessary debiting and crediting of bank accounts in various international locations.

Exceptionally, spot transactions between the Canadian dollar and U.S. dollar conventionally are settled *one* business day after the deal, rather than *two* business days later, since Canada is in the same time zone as the United States and an earlier value date is feasible.

It is possible to trade for value dates *in advance* of the spot value date two days hence ("pre-spot" or "ante-spot"). Traders can trade for "value tomorrow," with settlement one business day after the deal date (one day before spot); or even for "cash," with settlement on the deal date (two days before spot). Such transactions are a very small part of the market, particularly same day "cash" transactions for the U.S. dollar against European

or Asian currencies, given the time zone differences. Exchange rates for cash or value tomorrow transactions are based on spot rates, but differ from spot, reflecting in part, the fact that interest rate differences between the two currencies affect the cost of earlier payment. Also, pre-spot trades are much less numerous and the market is less liquid.

A spot transaction represents a *direct exchange* of one currency for another, and when executed, leads to transfers through the payment systems of the two countries whose currencies are involved. In a typical spot transaction, Bank A in New York will agree on June 1 to sell $10 million for Deutsche marks to Bank B in Frankfurt at the rate of, say, DEM 1.7320 per dollar, for value June 3. On June 3, Bank B will pay DEM 17.320 million for credit to Bank A's account at a bank in Germany, and Bank A will pay $10 million for credit to Bank B's account at a bank in the United States. The execution of the two payments completes the transaction.

There is a Buying Price and a Selling Price

In the foreign exchange market there are always *two prices* for every currency—one price at which sellers of that currency want to sell, and another price at which buyers want to buy. A *market maker* is expected to quote simultaneously for his customers *both* a price at which he is willing to sell and a price at which he is willing to buy standard amounts of any currency for which he is making a market.

How Spot Rates are Quoted: Direct and Indirect Quotes, European and American Terms

Exchange rate quotes, as the price of one currency in terms of another, come in two forms: a "direct" quotation is the amount of domestic currency (dollars and cents if you are in the United States) per unit of foreign currency and an "indirect" quotation is the amount of foreign currency per unit of domestic currency (per dollar if you are in the United States).

The phrase "*American terms*" means a direct quote from the point of view of someone located in the United States. For the dollar, that means that the rate is quoted in *variable amounts of U.S. dollars and cents per one unit of foreign currency (e.g., $0.5774 per DEM1)*. The phrase "*European terms*" means a direct quote from the point of view of someone located in Europe. For the dollar, that means *variable amounts of foreign currency per one U.S. dollar (or DEM 1.7320 per $1)*.

In daily life, most prices are quoted "directly," so when you go to the store you pay x dollars and y cents for one loaf (unit) of bread. For many years, all dollar exchange rates also were quoted directly. That meant dollar exchange rates were quoted in European terms in Europe, and in American terms in the United States. However, in 1978, as the foreign exchange market was integrating into a single global market, for convenience, the practice in the U.S. market was changed—at the initiative of the brokers community—to conform to the European convention. Thus, OTC markets in all countries now quote dollars in European terms against nearly all other currencies (amounts of foreign currency per $1). That means that the dollar is nearly always the *base* currency, one unit of which (one dollar) is being bought or sold for a variable amount of a foreign currency.

There are still exceptions to this general rule, however. In particular, in all OTC markets around the world, the pound sterling continues to be quoted as the base currency against the dollar and other currencies. Thus, market makers and brokers everywhere quote the pound sterling at x dollars and cents per pound, or y DEM per pound, and so forth. The

United Kingdom did not adopt a decimal currency system until 1971, and it was much easier mathematically to quote and trade in terms of variable amounts of foreign currency per pound than the other way around.

Certain currencies historically linked to the British pound—the Irish, Australian, and New Zealand currencies—are quoted in the OTC market in the same way as the pound: variable amounts of dollars and cents per unit. The SDR and the ECU, composite currency units of the IMF and the European Monetary Union, also are quoted in dollars and cents per SDR or ECU. Similarly, it is expected that the euro will be quoted in dollars and cents per euro, at least among dealers. But all other currencies traded in the OTC market are quoted in variable amounts of foreign currency per one dollar.

Direct and indirect quotes are reciprocals, and either can easily be determined from the other. In the United States, the financial press typically reports the quotes both ways, as shown in the excerpt from The New York Times in Figure 5-2 at the end of the chapter.

The third and fourth columns show the quotes for the previous two days in "European terms"—the foreign currency price of one dollar—which is the convention used for most exchange rates by dealers in the OTC market.

The first and second columns show the (reciprocal) quotes for the same two days in American terms—the price in dollars and cents of one unit of each of various foreign currencies—which is the approach sometimes used by traders in dealings with commercial customers, and is also the convention used for quoting dollar exchange rates in the exchange-traded segment of the U.S. foreign exchange market.

There Is a Base Currency and a Terms Currency

Every foreign exchange transaction involves two currencies—and it is important to keep straight which is the *base* currency (or *quoted*, *underlying*, or *fixed* currency) and which is the *terms* currency (or *counter* currency). A trader always buys or sells a fixed amount of the "base" currency—as noted above, most often the dollar—and adjusts the amount of the "terms" currency as the exchange rate changes.

The terms currency is thus the *numerator* and the base currency is the *denominator*. When the numerator increases, the base currency is strengthening and becoming more expensive; when the numerator decreases, the base currency is weakening and becoming cheaper.

In oral communications, the base currency is always stated *first*. For example, a quotation for "dollar-yen" means the dollar is the base and the denominator, and the yen is the terms currency and the numerator; "dollar-swissie" means that the Swiss franc is the terms currency; and "sterling-dollar" (usually called "cable") means that the dollar is the terms currency. ~~Currency codes are also used to denote currency pairs, with the base currency usually presented first, followed by an oblique. Thus "dollar-yen" is *USD/JPY*; "dollar-Swissie" is *USD/CHF*; and "sterling-dollar" is *GBP/USD*.~~

Bids and Offers Are for the Base Currency

Traders *always* think in terms of how much it costs to *buy* or *sell* the *base* currency. A market maker's quotes are *always* presented *from the market maker's point of view*, so the *bid* price is the amount of terms currency that the market maker will pay for a unit of the base currency; the *offer* price is the amount of terms currency the market maker will charge for a unit of the base currency. A market maker asked for a quote on "dollar-swissie" might respond "1.4975-85," indicating a bid price of CHF

1.4975 per dollar and an offer price of CHF 1.4985 per dollar. Usually the market maker will simply give the quote as "75-85," and assume that the counterparty knows that the "big figure" is 1.49. The bid price always is offered *first* (the number on the left), and is *lower* (a smaller amount of terms currency) than the *offer* price (the larger number on the right). This differential is the dealer's *spread*.

Quotes Are in Basis Points

For most currencies, bid and offer quotes are presented to the *fourth* decimal place—that is, to one-hundredth of one percent, or 1/10,000th of the *terms* currency unit, usually called a "pip." However, for a few currency units that are relatively small in absolute value, such as the Japanese yen and the Italian lira, quotes may be carried to *two* decimal places and a "pip" is 1/100 of the terms currency unit. In any market, a "pip" or a "tick" is the smallest amount by which a price can move in that market, and in the foreign exchange market "pip" is the term commonly used.

Cross Rate Trading

Cross rates, as noted in Chapter 3, are exchange rates in which the dollar is neither the base nor the terms currency, such as "mark-yen," in which the DEM is the base currency; and "sterling-mark," in which the pound sterling is the base currency. In cross trades, either currency can be made the base, although there are standard pairs—mark-yen, sterling-swissie, etc. As usual, the base currency is mentioned first.

There are both *derived* cross rates and *directly traded* cross rates. Historically, cross rates were derived from the dollar rates of the two named currencies, even if the transaction was not actually channeled through the dollar. Thus, a cross rate for sterling-yen would be derived from the sterling-dollar and dollar-yen rates. That continues to be the practice for many currency pairs, as described in Box 5.1, but for other pairs, viable markets have developed and direct trading sets the cross rates, within the boundary rates established by the derived cross rate calculations.

BOX 5-1

Deriving Cross Rates From Dollar Exchange Rates

There are simplified, short-cut ways to *derive* cross rates from the dollar exchange rates of the two cross currencies, by cross dividing or by multiplying.

There are *three* cases—the case in which the dollar exchange rates of both of the cross rate currencies are *quoted* "*indirectly*"; the case in which both currencies are *quoted* "*directly*"; and the case in which one is *quoted indirectly and the other is quoted directly*.

- **Cass 1.** If *both* of the cross rate currencies are quoted against the dollar in the more common *indirect or European* terms, for example, "dollar-Swiss franc" and "dollar-yen," to get a *Swiss franc-yen* derived cross rate, *cross divide* as follows:
  - —for the cross rate *bid*: divide the bid of the cross rate terms currency *by* the offer of the base currency;
  - —for the cross rate offer: divide the offer of the terms currency by the bid of the base currency.

Thus, if the dollar-swissie rate is 1.5000-10 and the dollar-yen rate is 100.00-10, for a Swiss franc-yen derived cross rate: the bid would be 100.00 divided by 1.5010, or 66.6223 yen per Swiss franc, and the offer would be 100.10 divided by 1.5000, or 66.7333 yen per Swiss franc.

◗ **Case 2.** If *both* of the two cross rate currencies are quoted against the dollar in the less common *direct, or American terms*, (i.e., reciprocal, or "upside down") for example, "sterling-dollar" and "Irish punt-dollar," to get a *sterling-Irish punt* derived *cross rate*, *cross divide* as follows:

—for the cross rate *bid*: divide the offer of the cross rate terms currency *into* the bid of the base currency;

—for the cross rate *offer*: divide the bid of the terms currency *into* the offer of the base currency.

Thus, if the sterling-dollar rate is 1.6000-10 and the Irish punt-dollar rate is 1.4000-10, for a *sterling-Irish punt* derived cross rate: the bid would be 1.6000 divided by 1.4010, or 1.1420 Irish punt per pound sterling, and the offer would be 1.6010 divided by 1.4000, or *1.1436* punt per pound sterling.

◗ **Case 3.** If the two cross currencies are quoted in *different terms*, i.e., one in indirect or European terms (for example, "dollar-yen") and one in direct or American terms (for example, "sterling-dollar"), to get a *sterling-yen* derived cross rate, *multiply* as follows:

—for the cross rate *bid*: multiply the bid of the cross rate terms currency by the bid of the base currency;

—for the cross rate *offer*: multiply the offer of the terms currency by the offer of the base currency.

Thus, if the sterling-dollar rate is 1.6000-10 and the dollar-yen rate is 100.00-10, for a *sterling-yen* derived cross rate: the bid would be 1.6000 multiplied by 100.00, or *160.00* yen per pound, and the offer would be 1.6010 multiplied by 100.10, or *160.26* yen per pound.

These derived, or conceptual, prices are the "boundary" prices (beyond these prices, risk-free arbitrage is possible). But they are not necessarily the prices, or the spreads, that will prevail in the market, and traders may have to shave their spreads to compete with cross rates being quoted and perhaps directly traded. For example, there are likely to be some players who have one or another of the "component" currencies in balances they are willing to use, or a trader may want to use the transaction to accumulate balances of a particular currency.

The same general rules are used to derive cross rates through a vehicle currency other than the U.S. dollar. Thus, if two cross currencies are quoted against the vehicle in the same terms, divide as appropriate by or into the base of the pair; if in *different* terms, multiply.

During the 1980s and '90s, there was a very large expansion of *direct* cross trading, in which the dollar was not involved either as metric or as medium of exchange. Much of this direct cross trading activity involved the Deutsche mark. Direct trading activity between the mark and other European currencies developed to the point where most trading of currencies in the European Monetary System took place directly through cross rates, and the most widely direct-traded crosses came to be used to quote rates for other, less widely traded currency pairs. By the mid-1990s, mark-yen, sterling-mark, mark-French franc (or mark-Paris), and mark-Swiss all were very actively traded pairs.

Deutsche mark cross trading with European currencies developed to the point where rates in the New York market for dollar-lira, dollar-French franc, etc., were usually calculated from the mark-lira, mark-French franc, etc., particularly during the afternoon in New York, when European markets were closed.

As direct cross currency trading between non-dollar currencies expanded, new trading opportunities developed. Various arbitrage opportunities became possible between the cross rate markets and the direct dollar markets. Traders had more choices than they had in a system in which the dollar was virtually always the vehicle currency.

With the launching of the euro in 1999, major structural changes in cross trading activity can be expected. With the euro replacing a number of European currencies, much of the earlier cross trading will no longer be required. What role the euro itself may play as a vehicle currency remains to be seen.

2. Outright Forwards

An *outright forward* transaction, like a spot transaction, is a straightforward single purchase/sale of one currency for another. The only difference is that spot is settled, or delivered, on a value date no later than two business days after the deal date, while *outright forward* is settled on any pre-agreed date three or more business days after the deal date. Dealers use the term "outright forward" to make clear that it is a single purchase or sale on a future date, and not part of an "FX swap" (described later).

There is a specific exchange rate for each forward maturity of a currency, almost always different from the spot rate. The exchange rate at which the outright forward transaction is executed is fixed at the outset. No money necessarily changes hands until the transaction actually takes place, although dealers may require some customers to provide collateral in advance.

Outright forwards can be used for a variety of purposes—covering a known future expenditure, hedging, speculating, or any number of commercial, financial, or investment purposes. The instrument is very flexible, and forward transactions can be tailored and customized to meet the particular needs of a customer with respect to currency, amount, and maturity date. Of course, customized forward contracts for non-standard dates or amounts are generally more costly and less liquid, and more difficult to reverse or modify in the event of need than are standard forward contracts. Also, forward contracts for minor currencies and exotic currencies can be more difficult to arrange and more costly.

Outright forwards in major currencies are available over-the-counter from dealers for standard contract periods or "straight dates" (one, two, three, six, and twelve months); dealers tend to deal with each other on straight dates. However, customers can obtain "odd-date" or "broken-date" contracts for deals falling between standard dates, and traders will determine the rates through a process of interpolation. The agreed-upon maturity can range from a few days to months or even two or three years ahead, although very long-dated forwards are rare because they tend to have a large bid-asked spread and are relatively expensive.

◗ Relationship of Forward to Spot—Covered Interest Rate Parity

The *forward* rate for any two currencies is a function of their spot rate and the *interest rate differential* between them. For major currencies, the interest rate differential is determined in the Eurocurrency deposit market. Under the *covered interest rate parity principle*, and with the opportunity of arbitrage, the forward rate will

tend toward an equilibrium point at which any difference in Eurocurrency interest rates between the two currencies would be exactly offset, or neutralized, by a premium or discount in the forward rate.

If, for example, six-month Euro-dollar deposits pay interest of 5 percent per annum, and six-month Euro-yen deposits pay interest of 3 percent per annum, *and* if there is no premium or discount on the forward yen against the forward dollar, there would be an opportunity for "round-tripping" and an arbitrage profit with no exchange risk. Thus, it would pay to borrow yen at 3 percent, sell the yen spot for dollars and simultaneously resell dollars forward for yen six months hence, meanwhile investing the dollars at the higher interest rate of 5 percent for the six-month period. This arbitrage opportunity would tend to drive up the forward exchange rate of the yen relative to the dollar (or force some other adjustment) until there were an equal return on the two investments after taking into account the cost of covering the forward exchange risk.

Similarly, if short-term dollar investments and short-term yen investments both paid the same interest rate, and if there were a premium on the forward yen against the forward dollar, there would once again be an opportunity for an arbitrage profit with no exchange risk, which again would tend to reduce the premium on the forward yen (or force some other adjustment) until there were an equal return on the two investments after covering the cost of the forward exchange risk.

In this state of equilibrium, or condition of covered interest rate parity, an investor (or a borrower) who operates in the forward exchange market will realize the same domestic return (or pay the same domestic cost) whether investing (borrowing) in his domestic currency or in a foreign currency, net of the costs of forward exchange rate cover. The forward exchange rate should offset, or neutralize, the interest rate differential between the two currencies.

The forward rate in the *market* can deviate from this theoretical, or implied, equilibrium rate derived from the interest rate differential to the extent that there are significant costs, restrictions, or market inefficiencies that prevent arbitrage from taking place in a timely manner. Such constraints could take the form of transaction costs, information gaps, government regulations, taxes, unavailability of comparable investments (in terms of risk, maturity, amount, etc.), and other impediments or imperfections in the capital markets. However, today's large and deregulated foreign exchange markets and Eurocurrency deposit markets for the dollar and other heavily traded currencies are generally free of major impediments.

◗ Role of the Offshore Deposit Markets for Euro-Dollars and Other Currencies

Forward contracts have existed in commodity markets for hundreds of years. In the foreign exchange markets, forward contracts have been traded since the nineteenth century, and the concept of interest arbitrage has been understood and described in economic literature for a long time. (Keynes wrote about it and practiced it in the 1920s.) But it was the development of the offshore *Eurocurrency deposit markets*—the markets for offshore deposits in dollars and other major currencies—in the 1950s and '60s that facilitated and refined the process of interest rate arbitrage in practice and brought it to its present high degree of efficiency, closely linking the foreign exchange market and the money markets of the major nations, and equalizing returns through the two channels.

With large and liquid offshore deposit markets in operation, and with information transfers greatly improved and accelerated, it became much easier and quicker to detect any significant deviations from covered interest rate parity, and to take advantage of any such arbitrage opportunities. From the outset, deposits in these offshore markets were generally free of taxes, reserve requirements, and other government restrictions. The offshore deposit markets in London and elsewhere quickly became very convenient for, and closely attached to, the foreign exchange market. These offshore Eurocurrency markets for the dollar and other major currencies were, from the outset, handled by the banks' foreign exchange trading desks, and many of the same business practices were adopted. These deposits trade over the telephone like foreign exchange, with a bid/offer spread, and they have similar settlement dates and other trading conventions. Many of the same counterparties participate in both markets, and credit risks are similar. It is thus no surprise that the interest rates in the offshore deposit market in London came to be used for interest parity and arbitrage calculations and operations. Dealers keep a very close eye on the interest rates in the London market when quoting forward rates for the major currencies in the foreign exchange market. For currencies not traded in the offshore Eurocurrency deposit markets in London and elsewhere, deposits in domestic money markets may provide a channel for arbitraging the forward exchange rate and interest rate differentials.

◗ How Forward Rates are Quoted by Traders

Although spot rates are quoted in *absolute* terms—say, x yen per dollar—forward rates, as a matter of convenience are quoted among dealers in *differentials*—that is, in premiums or discounts from the spot rate. The premium or discount is measured in "points," which represent the interest rate differential between the two currencies for the period of the forward, converted into foreign exchange. Specifically, points are the amount of foreign exchange (or basis points) that will neutralize the interest rate differential between two currencies for the applicable period. Thus, if interest rates are *higher* for currency A than currency B, the points will be the number of basis points to *subtract* from currency A's spot exchange rate to yield a forward exchange rate that neutralizes or offsets the interest rate differential (see Box 5-2). Most forward contracts are arranged so that, at the outset, the present value of the contract is zero.

Traders in the market thus know that for *any* currency pair, if the base currency earns a

BOX 5-2

Calculating Forward Premium/Discount Points

◗ Formulas for calculating forward premiums and discounts, expressed as points of the spot rate, equate the two cash flows so that the forward premium or discount neutralizes the differential between interest rates in the two currencies. A generalized formula is:

$$\text{Points} = \text{Spot Rate} \left(\frac{1 + \text{Terms Currency Interest Rate} \times \frac{\text{Forward Days}}{\text{Interest Rate Year}}}{1 + \text{Base Currency Interest Rate} \times \frac{\text{Forward Days}}{\text{Interest Rate Year}}} - 1 \right)$$

◗ Thus, if the dollar is the base currency, with a Euro-dollar (offshore) interest rate of 5 percent,

and the Swiss franc is the terms currency, with 6 percent interest in the offshore market, and the spot rate is CHF 1.6000 per dollar, then the points for a six-month (181-day) forward rate would be 78. (Most currencies use a 360-day interest rate year, except the pound sterling and a few others, which use a 365-day year.)

$$\text{Points} = 1.6000 \frac{1 + [\ .06 \times \frac{(181)}{(360)}\ ]}{1 + [\ .05 \times \frac{(180)}{(360)}\ ]} - 1 = 78$$

The six month outright forward rate would be CHF 1.6078 per dollar.

- The above generalized formula takes no account of the differences between borrowing and lending rates in the offshore deposit market. In pricing possible forward transactions, a trader would take account of those differences, calculate the costs of putting together the deal, determine the "boundary" rates, and perhaps shade the price to reflect competitive quotes, perspectives on market performance, the trader's own portfolio of existing contracts, and other factors.

higher interest rate than the terms currency, the base currency will trade at a forward *discount*, or below the spot rate; and if the base currency earns a *lower* interest rate than the terms currency, the base currency will trade at a forward *premium*, or above the spot rate. Whichever side of the transaction the trader is on, the trader won't gain (or lose) from *both* the interest rate differential and the forward premium/discount. A trader who *loses* on the interest rate will *earn* the forward premium, and vice versa.

Traders have long used rules of thumb and shortcuts for calculating whether to add or subtract the points. Points are subtracted from the spot rate when the interest rate of the base currency is the *higher* one, since the base currency should trade at a forward *discount*; points are added when the interest rate of the base currency is the lower one, since the base currency should trade at a forward *premium*. Another rule of thumb is that the points must be *added* when the small number comes first in the quote of the differential, but *subtracted* when the larger number comes first. For example, the spot CHF might be quoted at "1.5020- 30," and the 3-month forward at "40-60" (to be added) or "60-40" (to be subtracted). Also, the spread will always *grow larger* when shifting from the spot quote to the forward quote. Screens now show positive and negative signs in front of points, making the process easier still.

Non-Deliverable Forwards (NDFs)

In recent years, markets have developed for some currencies in "non-deliverable forwards." This instrument is in concept similar to an outright forward, except that there is no physical delivery or transfer of the local currency. Rather, the agreement calls for settlement of the net amount in dollars or other major transaction currency. NDFs can thus be arranged offshore without the need for access to the local currency markets, and they broaden hedging opportunities against exchange rate risk in some currencies otherwise considered unhedgeable. Use of NDFs with respect to certain currencies in Asia and elsewhere is growing rapidly.

3. FX Swaps

In the spot and outright forward markets, one currency is traded outright for another, but in the FX swap market, one currency is swapped for another for a period of time, and then swapped back, creating an exchange and re-exchange.

An *FX swap* has two separate legs settling on two different value dates, even though it is arranged as a single transaction and is recorded in the turnover statistics as a single transaction. The two counterparties agree to exchange two currencies at a particular rate on one date (the "near date") and to reverse payments, almost always at a different rate, on a specified subsequent date (the "far date"). Effectively, it is a spot transaction and an outright forward transaction going in opposite directions, or else two outright forwards with different settlement dates, and going in opposite directions. If both dates are less than one month from the deal date, it is a "short-dated swap"; if one or both dates are one month or more from the deal date, it is a "forward swap."

The two legs of an FX swap can, in principle, be attached to any pair of value dates. In practice, a limited number of standard maturities account for most transactions. The first leg usually occurs on the spot value date, and for about two-thirds of all FX swaps the second leg occurs within a week. However, there are FX swaps with longer maturities. Among dealers, most of these are arranged for even or straight dates—e.g., one week, one month, three months—but odd or broken dates are also traded for customers.

The FX swap is a standard instrument that has long been traded in the over-the-counter market. Note that it provides for one exchange and one re-exchange only, and is not a stream of payments. The FX swap thus differs from the *interest rate swap*, which provides for an exchange of a stream of interest payments in the same currency but with no exchange of principal; it also differs from the *currency swap* (described later), in which counterparties exchange and re-exchange principal and streams of fixed or floating interest payments in two different currencies.

In the *spot and outright forward markets*, a fixed amount of the base currency (most often the dollar) is always traded for a variable amount of the terms currency (most often a non-dollar currency). However, in the *FX swap market*, a trade for a fixed amount of *either* currency can be arranged.

There are *two* kinds of FX swaps: a *buy/sell* swap, which means buying the fixed, or base, currency on the near date and selling it on the far date; and a *sell/buy* swap, which means selling the fixed currency on the near date and buying it on the far date. If, for example, a trader bought a fixed amount of pounds sterling spot for dollars (the exchange) and sold those pounds sterling six months forward for dollars (the re-exchange), that would be called a *buy/sell sterling swap*.

Why FX Swaps Are Used

The popularity of FX swaps reflects the fact that banks and others in the dealer, or interbank, market often find it useful to shift temporarily into or out of one currency in exchange for a second currency without incurring the exchange rate risk of holding an open position or exposure in the currency that is temporarily held. This avoids a change in currency exposure, and differs from the spot or outright forward, where the purpose is to change a currency exposure. The use of FX swaps is similar to actual borrowing and lending of currencies on a collateralized basis. FX swaps provide a way of using the foreign exchange

markets as a funding instrument and an alternative to borrowing and lending in the Eurodollar and other offshore markets. They are widely used by traders and other market participants for managing liquidity and shifting delivery dates, for hedging, speculation, taking positions on interest rates, and other purposes.

Pricing FX Swaps

The cost of an FX swap is determined by the interest rate differential between the two swapped currencies. Just as in the case of outright forwards, arbitrage and the principle of covered interest rate parity will operate to make the cost of an FX swap equal to the foreign exchange value of the interest rate differential between the two currencies for the period of the swap.

The cost of an FX swap is measured by swap points, or the foreign exchange equivalent of the interest rate differential between two currencies for the period. The difference between the amounts of interest that can be earned on the two currencies during the period of the swap can be calculated by formula (see Box 5-4). The counterparty who holds for the period of the swap the currency that pays the *higher* interest rate will *pay* the points, neutralizing the interest rate differential and equalizing the return on the two currencies; and the counterparty who holds the currency that pays the *lower* interest will *earn* or receive the points. At the outset, the present value of the FX swap contract is usually arranged to be zero.

The same conditions prevail with an FX swap as with an outright forward—a trader who pays the points in the forward also pays them in the FX swap; a trader who earns the points in the forward also earns them in the FX swap.

For most currencies, swap points are carried to the fourth decimal place. A dollar-swissie swap quoted at 244-221 means that the dealer will buy the dollar forward at his spot bid rate less 0.0244 (in Swiss francs), and sell the dollar forward at his spot offer rate less 0.0221 (in Swiss francs), yielding an (additional) spread of 23 points (or 0.0023).

The FX swap is the difference between the spot and the outright forward (or the difference between the two outright forwards). When you trade an FX swap you are trading the interest rate differential between the two currencies. The FX swap is a very flexible and convenient instrument that is used for a variety of funding, hedging, position management, speculation, and other purposes. FX swaps are extremely popular among OTC interbank dealers, and now account for nearly half of total turnover in the U.S. OTC foreign exchange market. Among its uses are those described in Box 5-3:

BOX 5-3

Some Uses of FX Swaps

Managing positions and changing settlement dates. FX swaps can be very helpful in managing day-to-day positions. Of particular convenience and interest to professional market making and dealing institutions are the "spot-next" swap and the "tom-next" swap, which are used by traders to roll over settlements and to balance maturing buys and sells of particular currencies in their books. A dealer who knows on, say June 1, that he has to pay out a certain

(continued on page 42)

BOX 5-3

(continued from page 41)

currency on June 3, may find it convenient or profitable to extend the settlement for a day, for example, when he may be scheduled to receive balances of that currency. The dealer can enter into a "spot-next" swap on the deal date, June 1, and extend the June 3 settlement to June 4. Alternatively, on June 2, the day before the June 3 settlement, the dealer might arrange a "tom-next" swap, to extend that settlement until June 4,[3] which is the spot settlement date for June 2, and a more liquid market. The cost of these one-day swaps would reflect the points (the value of one day's interest differential), or "cost of carry," which would be added to or subtracted from the spot rate. If it then looked as though a June 4 settlement would be difficult, the dealer might roll over the transaction for another day, or longer.

The interest rate differential is also important in calculating "pre-spot" rates—"value tomorrow" transactions, which are settled *one* day *before* spot and "cash," which are settled *two* days *before* spot, or on the deal date.

To calculate (approximate) "pre-spot" rates, you work *backwards*. Thus, assume that dollar-swissie were trading spot at 1.5000-10. Assume that the points for a "tom-next" swap were 3/5, reflecting one day's interest rate differential—the price of extending settlement from day 2 to day 3. To calculate a "value tomorrow" quote—shifting settlement from day 3 to day 2, you would turn the points around (to 5/3) and reverse the sign (in this case subtract them from, rather than add them to, the spot rate), for a quote of *1.4995-97*. (In shifting a settlement *forward*, the higher interest rate currency moves to *discount*; in shifting *backward* to "cash" or "value tomorrow," the higher interest rate currency moves to *premium*.)

Hedging interest rate differential risk. A dealer, for example, who has agreed to buy pounds sterling one year forward faces both an exchange rate risk (that the exchange rate may change) and an interest rate differential risk (that the interest rate differential on which the transaction was priced may change). The dealer can offset the *exchange rate risk* by selling sterling spot (to offset the forward purchase), but he would still have an *interest rate differential risk*. That risk can be offset in two ways: either by borrowing and investing in the off-shore deposit (Euro-currency) markets, or by entering into a new swap (an "unwind") that is the opposite of his outstanding position (that is, the trader can enter into a *buy/sell sterling swap* for a one-year period to offset the position resulting from his forward sterling purchase and spot sterling sale). If neither of the two interest rates nor the spot rate has changed between the time of the trader's initial forward purchase of sterling and the time when the trader's hedging activities are put in place, the trader can cover risk in *either* the FX swap market or the offshore deposit market—the trader has a "perfect" hedge—but the swap may be carried "off-balance-sheet" and thus may be "lighter" on the trader's balance sheet than the borrowing and lending.

Speculating on interest rate differentials. A dealer who expects an interest rate differential to *widen* would enter into an FX swap in which the dealer *pays* the swap points now (when the differential is small), and—after the interest rate differential has widened—would then enter

into another FX swap in the opposite direction (an unwind), in which case the trader would *earn* more swap points from the wider differential than he is paying on the initial swap. A trader who expects interest rate differentials to *narrow* would do the reverse—arrange swaps in which he *earns* the swap points now, when the differential is wide, and *pays* the swap points later, after the differential narrows.

Arbitraging the foreign exchange market and the interest rate market. When the two markets are in equilibrium, a dealer may be more or less indifferent whether he invests through the offshore deposit market (borrowing/lending currencies) or through the foreign exchange market (FX swaps). But there are times when swap points in the foreign exchange market are *not* precisely equivalent to interest rate differentials in the offshore deposit market, and arbitrageurs can use FX swaps together with deposit borrowing and lending operations to fund in the lower-cost market and invest in the higher-return market.

BOX 5-4

Calculating FX Swap Points

A market maker will calculate swap points on the basis of borrowing and lending rates in the offshore deposit markets:

$$\text{A. Bid Side Swap Points} = \text{Spot Rate} \times \frac{1+\left(\text{ODBRTC} \times \frac{\text{Swap Days}}{360 \text{ or } 365}\right)}{1+\left(\text{ODLRBC} \times \frac{\text{Swap Days}}{360 \text{ or } 365}\right)} - 1$$

$$\text{B. Offer Side Swap Points} = \text{Spot Rate} \times \frac{1+\left(\text{ODLRTC} \times \frac{\text{Swap Days}}{360 \text{ or } 365}\right)}{1+\left(\text{ODBRBC} \times \frac{\text{Swap Days}}{360 \text{ or } 365}\right)} - 1$$

where ODBRTC = offshore deposit borrowing rate in terms currency, ODLRTC = offshore deposit lending rate in base currency, ODBRBC = Euro borrow rate in base currency, and ODLRBC = offshore deposit lending rate in base currency. Assume that offshore deposit $ rates = 5 - 5.25, offshore deposit DEM rates = 6.25 - 6.50, the swap period = 62 days, and the spot rate = DEM 1.600 per dollar. Then, swap points can be calculated as:

$$\text{A. Bid Side Points} = 1.600 \times \frac{1+\left(.0625 \times \frac{62}{360}\right)}{1+\left(.0525 \times \frac{62}{360}\right)} - 1 = \underline{28}$$

$$\text{B. Offer Side Points} = 1.600 \times \frac{1+\left(.0650 \times \frac{62}{360}\right)}{1+\left(.05 \times \frac{62}{360}\right)} - 1 = \underline{41}$$

(continued on page 44)

BOX 5-4

(continued from page 43)

Based on these calculations, the market makers' spread would be 28-41. You *add* when the number on the left is *smaller*; thus

Bid: 1.6000 + .0028 = 1.6028
Offer: 1.6000 + .0041 = 1.6041

4. Currency Swaps

A *currency swap* is structurally different from the *FX swap* described above. In a typical *currency* swap, counterparties will (a) exchange equal initial principal amounts of two currencies at the spot exchange rate, (b) exchange *a stream of fixed or floating interest rate payments in their swapped currencies* for the agreed period of the swap, and then (c) re-exchange the principal amount at maturity at the initial spot exchange rate. Sometimes, the initial exchange of principal is omitted. Sometimes, instead of exchanging interest payments, a "difference check" is paid by one counterparty to the other to cover the net obligation.

The currency swap provides a mechanism for shifting a loan from one currency to another, or shifting the currency of an asset. It can be used, for example, to enable a company to borrow in a currency different from the currency it needs for its operations, and to receive protection from exchange rate changes with respect to the loan.

The currency swap is closely related to the *interest rate swap*. There are, however, major differences in the two instruments. An interest rate swap is an exchange of interest payment streams of differing character (e.g., fixed rate interest for floating), but in the *same currency*, and involves no exchange of principal. The currency swap is in concept an interest rate swap in more than one currency, and has existed since the 1960s. The interest rate swap became popular in the early 1980s; it subsequently has become an almost indispensable instrument in the financial tool box.

Currency swaps come in various forms. One variant is the *fixed-for-fixed* currency swap, in which the interest rates on the periodic interest payments of the two currencies are fixed at the outset for the life of the swap. Another variant is the *fixed-for-floating* swap, also called *cross-currency swap*, or *currency coupon swap*, in which the interest rate in one currency is floating (e.g., based on LIBOR) and the interest rate in the other is fixed. It is also possible to arrange *floating-for-floating* currency swaps, in which both interest rates are floating.

Purposes of Currency Swaps

The motivations for the various forms of currency swap are similar to those that generate a demand for interest rate swaps. The incentive may arise from a comparative advantage that a borrowing company has in a particular currency or capital market. It may result from a company's desire to diversify and spread its borrowing around to

different capital markets, or to shift a cash flow from foreign currencies. It may be that a company cannot gain access to a particular capital market. Or, it may reflect a move to avoid exchange controls, capital controls, or taxes. Any number of possible "market imperfections" or pricing inconsistencies provide opportunities for arbitrage.

Before currency swaps became popular, *parallel loans* and *back-to-back loans* were used by market participants to circumvent exchange controls and other impediments. Offsetting loans in two different currencies might be arranged between two parties; for example, a U.S. firm might make a dollar loan to a French firm in the United States, and the French firm would lend an equal amount to the U.S. firm or its affiliate in France. Such structures have now largely been abandoned in favor of currency swaps.

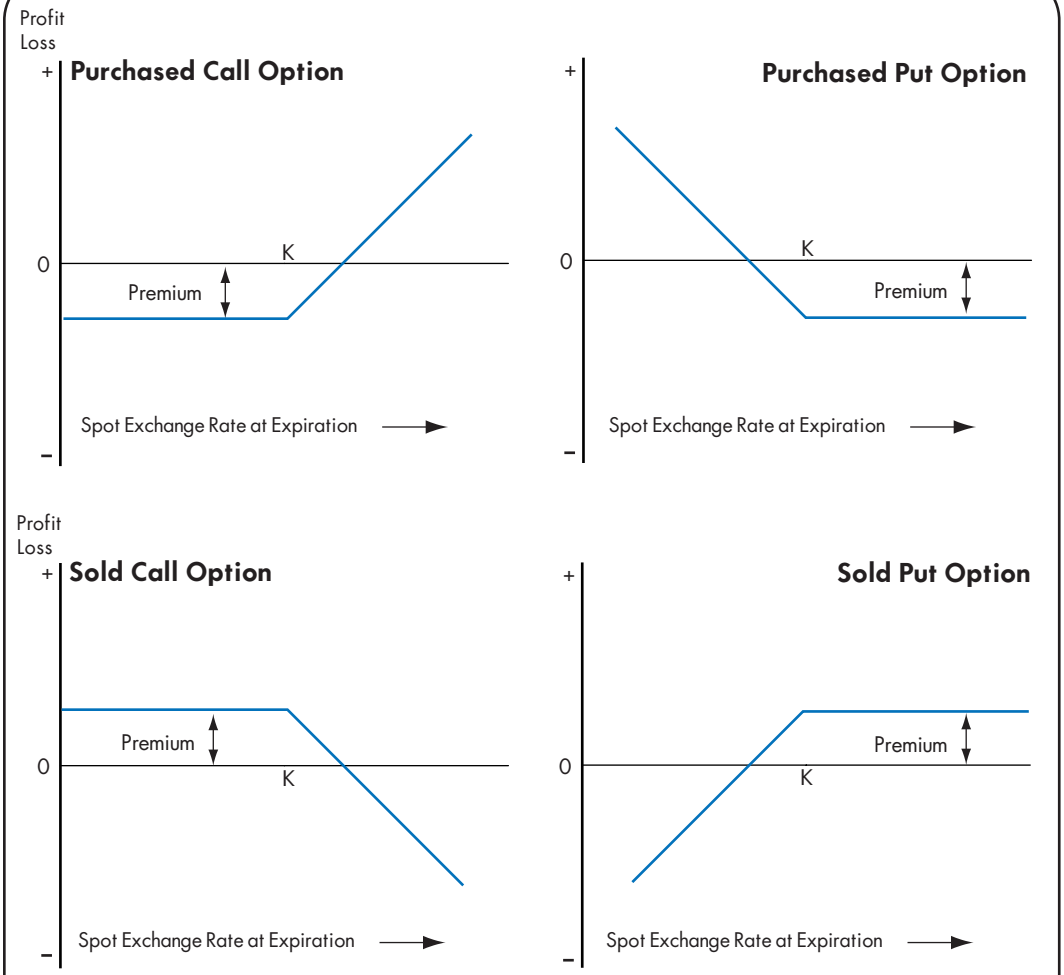
Because a currency swap, like an interest rate swap, is structurally similar to a forward, it can be seen as an exchange and re-exchange of principal plus a "portfolio of forwards"—a series of forward contracts, one covering each period of interest payment. The currency swap is part of the wave of financial derivative instruments that became popular during the 1980s and '90s. But currency swaps have gained only a modest share of the foreign exchange business. It has been suggested that the higher risk and related capital costs of instruments involving an exchange of principal may in part account for this result.[4] In the 1998 global turnover survey, turnover in currency swaps by reporting dealers was estimated at $10 billion per day. In the United States, turnover was $1.4 billion, well behind the United Kingdom—at $5 billion—and six other countries.

5. Over-the-Counter Foreign Currency Options

A foreign exchange or currency option contract gives the buyer the *right*, but not the *obligation*, to buy (or sell) a specified amount of one currency for another at a specified price on (in some cases, on or before) a specified date. Options are unique in that the right to execute will be exercised only if it is in the holder's interest to do so. That differs from a *forward* contract, in which the parties are obligated to execute the transaction on the maturity date, and it differs from a *futures* contract, in which the parties are obligated, in principle to transact at maturity, but that obligation easily can be—and normally is—bought out and liquidated before the maturity or delivery date.

A *call* option is the right, but not the obligation, to buy the underlying currency, and a *put* option is the right, but not the obligation, to sell the underlying currency. All currency option trades involve two sides—the purchase of one currency and the sale of another—so that a *put* to sell pounds sterling for dollars at a certain price is also a *call* to buy dollars for pounds sterling at that price. The purchased currency is the call side of the trade, and the sold currency is the put side of the trade. The party who purchases the option is the holder or buyer, and the party who creates the option is the seller or writer. The price at which the underlying currency may be bought or sold is the exercise, or strike, price. The option premium is the price of the option that the buyer pays to the writer. In exchange for paying the option premium up front, the buyer gains insurance against adverse movements in the underlying spot exchange rate

CHART 5-1

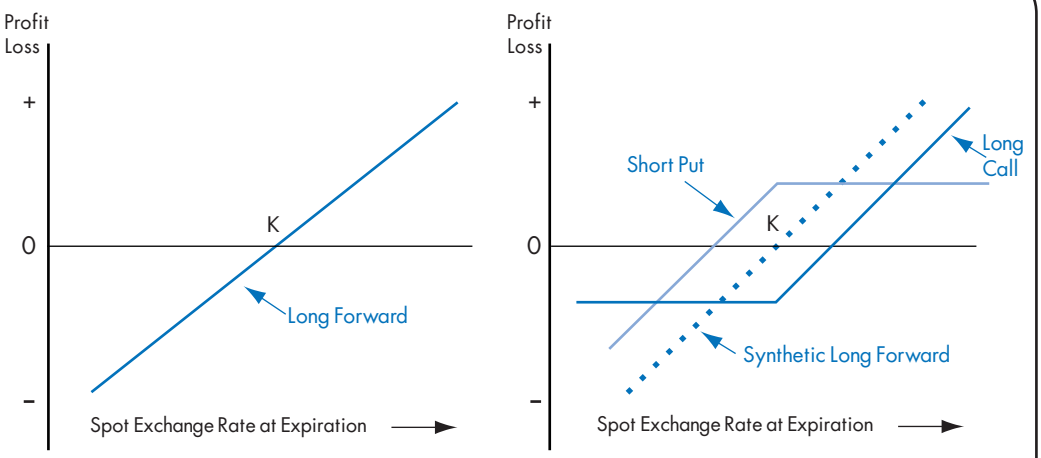


Note: These figures depict the net value of an option contract at expiration as a function of the underlying exchange rate. The vertical axis represents the net value of the contract, and the exchange rate (price of the foreign currency) is on the horizontal axis. The strike price is at point K.

while retaining the opportunity to benefit from favorable movements. The option writer, on the other hand, is exposed to unbounded risk—although the writer can (and typically does) seek to protect himself through hedging or offsetting transactions.

In general, options are written either "European style," which may be exercised only on the expiration date, or "American style," which may be exercised at any time prior to, and including, the expiration date. The American option is at least as valuable as the European option, since it provides the buyer with more opportunities, but is analytically more complex. American calls on the higher interest rate currency are likely to be more valuable than the equivalent European option. The bulk of trading in the OTC interbank market consists of European options, while American options are standard on some of the exchanges.

CHART 5-2



Note: These figures show how the combination of a purchased call option and a sold put option replicates the payoff from a forward contract. In the right hand panel, the net payoff from the options equals the dotted line, which is identical to the payoff from a forward contract (depicted in the left hand panel).

The option is one of the most basic financial instruments. All derivatives, including the various derivative financial products developed in recent years—the many forms of forwards, futures, swaps, and options—are based either on *forwards* or on *options*; and *forwards* and *options*, notwithstanding their differences, are related to each other. A *forward* can be created synthetically from a combination of European *options*: Buying a call option and selling a put option (long a call, short a put) on a currency with strike prices at the forward rate provides the same risk position as buying a forward contract on that currency. At expiration, the payoff profiles of the forward and the synthetic forward made up of the two options would be the same: The holder would receive the same payoff whether he held the forward or the combination of two options.

As a financial instrument, the option has a long history. But *foreign exchange* options trading first began to flourish in the 1980s, fostered by an international environment of fluctuating exchange rates, volatile markets, deregulation, and extensive financial innovation. The trading of currency options was initiated in U.S. commodity exchanges and subsequently was introduced into the over-the-counter market. However, options still account for only a small share of total foreign exchange trading.

An over-the-counter foreign exchange option is a bilateral contract between two parties. In contrast to the exchange-traded options market (described later), in the OTC market, no clearinghouse stands between the two parties, and there is no regulatory body establishing trading rules.

Also, in contrast to the exchange-traded options market, which trades in standardized contracts and amounts, for a limited number of currency pairs, and for selected maturity dates, an OTC option can be tailored to meet the special needs of an institutional investor for particular features to satisfy its investment and hedging objectives. But while OTC options

contracts can be customized, a very large share of the OTC market consists of generic, or "plain vanilla," options written for major currencies in standard amounts and for even dates.

OTC options are typically written for much larger amounts than exchange-traded options—an average OTC option is $30-$40 million equivalent—and a much broader range of currencies is covered. The volume of OTC options is far greater than that of exchange-traded options; indeed, the OTC market accounts for about four-fifths of the total foreign exchange options traded in the United States.

The two options markets, OTC and exchange-traded, are competitors to some extent, but they also complement each other. Traders use both markets in determining the movement of prices, and are alert to any arbitrage opportunities that may develop between the two markets. Dealers in the OTC market may buy and sell options on the organized exchanges as part of the management of their own OTC positions, hedging or laying off part of an outstanding position in an exchange market.

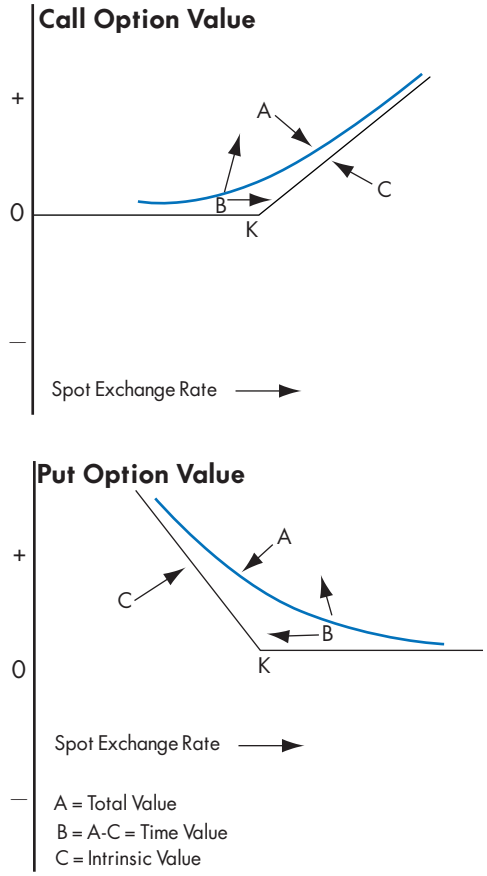
The Pricing of Currency Options

It is relatively easy to determine the value of a European option at its expiration. The value of a European option at expiration is its intrinsic value—the absolute amount by which the strike price of the option is more advantageous to the holder that the spot exchange rate. If at expiration the strike price is *more advantageous* than the spot rate of the underlying, the option is "in the money"; if the difference between the strike price and the spot rate is *zero*, the position is "at the money"; if the strike price is *less advantageous* than the spot rate, the option is "out of the money."

Determining the price of an option *prior* to expiration, on the other hand, is much more difficult. Before expiration, the total value of an option is based, not only on its *intrinsic* value (reflecting the difference between the strike price and the then current exchange rate), but also on what is called its *time* value, which is the additional value that the market places on the option, reflecting the time remaining to maturity, the forecast volatility of the exchange rate, and other factors.

Time value is not *linear*. A one-year option is not valued at twice the value of a six-month

CHART 5-3



Note: These figures show the intrinsic value and the time value of an option. The top line in each panel represents the value of the option, the bottom line represents the intrinsic value, and the difference is the time value. The point K is the strike price of the option.

option. An "at-the-money" option has greater time value than an "in-the-money" or "out-of-the-money" option. Accordingly, options—unlike forwards and futures—have *convexity*; that is, the change in the value of an option for a given change in the price of the underlying asset does not remain constant. This makes pricing options much more complex than pricing other foreign exchange instruments.

A major advance in the general theory of options pricing was introduced by Professors Black and Scholes in 1973. Their work, which was subsequently adapted for foreign exchange options, showed that under certain restrictive assumptions, the value of a European option on an underlying currency depends on six factors: 1) the spot exchange rate; 2) the interest rate on the base (or underlying) currency; 3) the interest rate on the terms currency; 4) the strike price at which the option can be exercised; 5) the time to expiration; and 6) the volatility of the exchange rate.

Volatility, a statistical measure of the tendency of a market price—in this case, the spot exchange rate—to vary over time, is the *only* one of these variables that is not known in advance, and is critically important in valuing and pricing options. Volatility is the annualized percentage change in an exchange rate, in terms of standard deviation (which is the most widely used statistical measurement of variation about a mean). The greater the forecast volatility, the greater the expected future movement potential in the exchange rate during the life of the option—i.e., the higher the likelihood the option will move "in-the-money," and so, the greater the value (and the cost) of the option, be it a put or a call. (With zero volatility, the option should cost nothing.)

If the one-year forward dollar-Swiss franc exchange rate is CHF 1.6000 = $1, and the volatility of a one-year European option price is forecast at 10 percent, there is implied the expectation, with a 68 percent probability, that one year hence, the exchange rate will be within CHF 1.6000 per dollar plus or minus 10 percent—that is, between CHF 1.4400 and CHF 1.7600 per dollar.

There are different measurements of volatility:

- *Historical* volatility is the actual volatility, or variance, of an exchange rate that occurred during some defined past time frame. This can be used as an indication or guide to future movements in the exchange rate.
- *Future* volatility is the expected variance in the exchange rate over the life of the option, and must be forecast.
- *Implied* volatility is the variance in an exchange rate that is implied by or built into the present market price of an option—thus, it is the market's current estimate of future movement potential as determined by supply and demand for the option in the market.

Implied volatility is a critical factor in options pricing. In trading options in the OTC interbank market, dealers express their quotes and execute their deals in terms of implied volatility. It is the metric, or measuring rod—dealers *think* and *trade* in terms of implied volatilities and *make their predictions* in that framework, rather than in terms of options *prices* expressed in units of a currency (which can change for reasons other than volatility changes—e.g., interest rates). It is easier to compare the prices of different options, or compare changes in market prices of an option over time, by focusing on implied volatility and quoting prices in terms of volatility. (For similar reasons, traders in outright forwards deal in terms of discounts and premiums from spot, rather than in terms of actual forward exchange rates.)

If market quotes and trades are to be made in terms of implied volatilities (or vols), all traders must use the same concept and conventions for computing volatility, so that they are all speaking the same language. The technique used in the market is to solve the Black-Scholes formula backwards—to take the price of an option in the market as given and calculate the volatility that is implied by that market price. Traders use this Black-Scholes-based computation of implied volatility as a way of communicating and understanding each other, even though they know that it has certain limitations. For example, they know (and take into account) that the technique inherently incorporates into the estimate of "implied volatility" all sources of mispricing, data errors, effects of bid-offer spreads, etc. They also know that the calculation assumes that all of the rigorous assumptions in the Black-Scholes theoretical pricing model apply, whereas in the market in which they are operating in the "real" world, these assumptions may not all apply.

Delta. Another important parameter for assessing options risk, also calculated from the Black- Scholes equation, is the *delta*, which measures how much the price of an option changes with a small (e.g., one percent) change in the value of the underlying currency.

Very importantly, the delta is also the *hedge ratio*, because it tells an option writer or a holder at any particular moment just how much spot foreign exchange he must be long or short to hedge an option position and eliminate (at least for that moment) the spot position risk.

Thus, if a trader *sold* a European call option on marks/put option on dollars with the face amount of $10 million, with the strike price set at the forward rate (an "at-the-money forward"), the chances *at that moment* are about 50-50 that the option will rise in value and at expiration be exercised, or fall in value and at expiration be worthless. If the option at that moment had a delta of 0.50, the trader could hedge, or neutralize, his option risk by taking an opposite spot position (purchase of marks/sale of dollars) equal to 50 percent of the option's face amount, or $5 million. This is called a "delta hedge." (If the strike price were "in-the-money," the delta would be between 0.50 and 1.00; if the strike price were "out-of-the-money," the delta would be between 0 and 0.50. At expiration, delta ends up either 0 (out-of-the-money and won't be exercised), or 1.00 (in the money and will be exercised).

Most option traders routinely "delta hedge" each option they purchase or write, buying or selling in the spot or forward market an amount that will fully hedge their initial exchange rate risk. Subsequently, as the exchange rate moves up or down, the option dealer will consider whether to maintain a neutral hedge by increasing or reducing this initial position in the spot or forward market.

However, the delta, or hedge ratio, whether it starts out at 0.50 or at some other number, will change continually, not only with each significant change in the exchange rate, but also with changes in volatility, or changes in interest rates, and, very importantly, delta will change with the passage of time. An option with a longer time to run is more valuable than an option with a shorter time to run. Thus, new calculations will continually be required as conditions change, to determine the new delta and the change in spot or forward foreign exchange position needed to maintain a neutral hedge position.

BOX 5-5

Delta Hedging

Option dealers who are actively trading in the market usually enter into an initial hedge (delta hedge) for each option each time they buy or write a put or a call.

Thus, if the delta is 0.50, the writer (seller) of a GBP 10 million *call* option might buy GBP 5 million spot and the buyer of the option sell GBP 5 million, as part of the option transaction.

At that point, *both* parties are hedged—the values of their option positions are exactly the same as the values of their spot hedges, but in opposite directions. Thus, if the price of the underlying currency moves up or down *by a very small amount* (say less than 1%), the option writer (and the option buyer) will gain or lose from the value of his spot hedge position an amount which would approximately *offset* the loss or gain in the value of the option.

However, the delta and the need for a spot hedge position change if the exchange rate changes and the option moves "into" or "out of" the money. If the price of the underlying currency moves up, and the value of the *call* option moves up, the delta moves up to, say, 0.60, so that to stay fully hedged the *writer* of the option has to *buy* more spot GBP, and the *buyer* of the option has to *sell* more spot GBP.

Option dealers have to keep a very close eye on exchange rate movements and decide, with each significant move up or down, whether to adjust delta hedges. In very choppy markets, it can be very expensive to delta hedge every movement up or down. For example, if a dealer wrote an option and the exchange rate bounced up and down (that is, had high volatility) so that the delta moved numerous times during the life of the option between, say, 0.45 and 0.55, the dealer could spend far more for hedging than for the premium that he received for writing the option—and incur a large overall loss even though the option might end up "out-of-the-money" and not be exercised.

Whether the option would result in a net gain or net loss for the option writer, assuming every exchange rate were delta hedged efficiently, would depend on whether the writer correctly forecast the *volatility* of the underlying currency, and priced the option on the basis of that volatility.

If the actual volatility of the currency over the life of the option turned out to be *exactly* the same as the volatility used in calculating the original premium, the delta hedge losses would (in principle) equal the original premium received, and the option writer would break even. If actual volatility turned out to be greater than forecast, the option writer would lose; if actual volatility were less than forecast, the option writer would gain. (This is not a surprising outcome, since an option is a bet on volatility—greater-than-anticipated volatility is beneficial to an option holder, and harmful to an option writer; less-than-anticipated volatility is the other way around.)

Delta hedging is a very important feature of the currency options market. It allows an important element of options risk to be transferred to the much larger and more liquid spot market, and thus allows options traders to quote a much broader range of options, and to quote narrower margins.

Put-Call Parity

"Put-call parity" says that the price of a European *put* (or call) option can be deduced from the price of a European *call* (or put) option on the same currency, with the same strike price and expiration. When the strike price is the *same* as the forward rate (an "at-the-money" forward), the put and the call will be *equal* in value. When the strike price is *not* the same as the forward price, the *difference* between the value of the put and the value of the call will equal the *difference* in the present values of the two currencies.

Arbitrage assures this result. If the "put-call parity" relationship did *not* hold, it would pay to create *synthetic* puts or calls and gain an arbitrage profit. If, for example, an "at-the-money forward" call option were priced in the market at *more than* (rather than equal to) an "at-the-money forward" put option for a particular currency, a *synthetic* call option could be created at a cheaper price (by buying a put at the lower price and buying a forward at the market price). Other synthetics can be produced by other combinations (e.g., buying a call and selling a forward to produce a *synthetic put*; buying a call and selling a put to create a *synthetic long forward*; or selling a call and buying a put to create a *synthetic short forward*).

The "put-call parity" is very useful to options traders. If, for example, puts for a particular currency are being traded, but there are no market quotes for the corresponding call, traders can deduce an approximate market price for the corresponding call.

How Currency Options are Traded

The OTC options market has become a 24-hour market, much like the spot and forward markets, and has developed its own practices and conventions. Virtually all of the major foreign exchange dealer institutions participate as market makers and traders. They try to stay fully abreast of developments, running global options books that they may pass from one major center to another every eight hours, moving in and out of various positions in different markets as opportunities arise. Some major dealers offer options on large numbers of currency pairs (fifty or more), and are flexible in tailoring amounts and maturities (from same day to several years ahead). They can provide a wide array of different structures and features to meet customer wishes.

A professional in the OTC interbank options market asking another professional for a quote must specify more parameters than when asking for, say, a spot quote. The currency pair, the type of option, the strike price, the expiration date, and the face amount must be indicated. Dealers can do business with each other directly, by telephone or (increasingly) via electronic dealing system, which makes possible a two-way recorded conversation on a computer screen. Also, they can deal through an OTC (voice) broker. Among these dealers and brokers, quotes are presented in terms of the *implied volatility* of the option being traded.

As in other foreign exchange markets, a market maker is expected to give both a *bid*—the volatility at which he is prepared to *buy* an option of the specified features—and an *offer*—the volatility at which he is prepared to *sell* such an option.

For example, an interbank dealer, Jack from Bank X, might contact a market maker, Jill from Bank Z, identify himself and his institution and ask for a quote:

- Jack: "Three month 50-delta dollar put/yen call on 20 dollars, please."
  Jill: "14.50-15."
- Jack: "Yours at 14.50."
  Jill: "Done. I buy European three-month 50-delta dollar put/yen call on 20 dollars."

After this commitment to the trade, details ("deets") would then be worked out and agreed upon with respect to the exact expiration date, the precise spot rate, the exact strike price, and option premium. Customarily, in trades between dealers, there would be an offsetting transaction in spot or forward trade, in the opposite direction to the option, to provide both parties with the initial delta hedge.

Note that Jack and Jill specified *both* currencies—"dollar put/yen call." In foreign exchange options, since a call allowing you to buy yen for dollars at a certain price is also a put allowing you to sell dollars for yen at that price, it helps to avoid confusion if *both* formulations are mentioned.

Options Combinations and Strategies

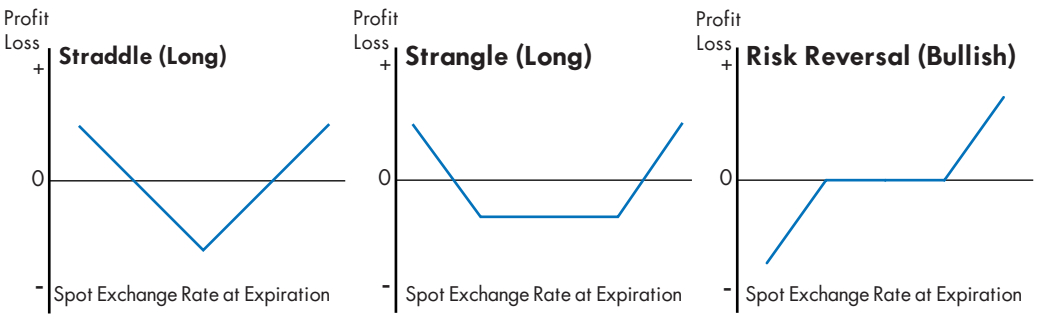
Combinations of options are used among the professionals for many purposes, including taking *directional* views on currencies—anticipating that a particular currency will move up or down—as well as taking *volatility* views on currencies—anticipating that a particular exchange rate will vary by more or by less than the market expects. Among the options combinations that are currently most widely used by traders in the OTC market are the following:

- A *straddle* consists of one put and one call with the same expiration date, face amount, and strike price. The strike price is usually set *at* the forward rate—or "at-the-money forward" (ATMF)—where the delta is about 0.50. A long straddle gains if there is higher than forecast volatility, regardless of which of the two currencies in the pair goes up and which goes down—and any potential loss is limited to the cost of the two premiums. By the same token, a short straddle gains if there is less than expected volatility, and the potential gain is limited to the premiums. Thus, a trader buys volatility by buying a straddle, and sells volatility by selling a straddle. Straddles account for the largest volume of transactions in interbank trading.

- A *strangle* differs from a straddle in that it consists of a put and a call at *different* strike prices, both of which are "out-of-the-money," rather than "at-the-money." Often the strike prices are set at 0.25 delta. It is a less aggressive position than the straddle—a long strangle costs less to buy, but it requires a higher volatility (relative to market expectations of volatility) to be profitable.

- A *risk reversal* is a directional play, rather than a volatility play. A dealer exchanges an out-of-the-money (OTM) put for an OTM call (or vice versa) with a counterparty. Since the OTM put and the OTM call will usually be of different values, the dealer pays or receives a premium for making the exchange. The dealer will quote the implied volatility differential at which he is prepared to a make the exchange. If, for example, market expectations that the dollar will fall sharply against the Swiss franc are much greater than market expectations that the dollar will rise sharply against the Swiss franc, the dealer might quote the price of dollar-swissie risk reversals as follows: "For a three-month 0.25-delta risk reversal, 0.6 at 1.4 swissie calls over." That means the dealer is willing to *pay* a net premium of 0.6 vols (above the current implied ATM volatility) to buy a 0.25-delta OTM Swiss franc call and sell a 0.25-delta OTM Swiss franc put against the dollar, and he wants to *earn* a net premium of 1.4 vols (above the current implied ATM premium) for the opposite transaction. The holder of a risk reversal who has sold an OTM put and bought an OTM call will gain if the call is exercised, and he will lose if the put is exercised—but unlike the holder of a long straddle or long strangle (where the maximum loss is the premium paid), on the put he has sold his potential loss is unbounded.

CHART 5 - 4



Note: These figures show the payoff at expiration of various option combinations. The left hand panel shows the combination of a purchased call and a purchased put, both at the same strike. The middle panel shows a purchased call and a purchased put, where the strike price of the call is higher than the put's strike price. The right hand panel depicts a purchased call and a sold put, where the call has a higher strike price.

BOX 5 - 6

Foreign Exchange Options Galore

The array of foreign exchange options available in the OTC market to dealers and the broader market of customers is almost endless, and new forms are being created all the time. Naturally, the following list is not comprehensive.

- *Multi-currency options* give the right to exchange one currency, say dollars, for one of a number of foreign currencies at specified rates of exchange.
- *Split fee options* enable the purchaser to pay a premium up front, and a "back fee" in the future to obtain the foreign currency if the exchange rate moves in favor of the option.
- *Contingent options* involve a payoff that depends, not only on the exchange rate, but also on such conditions as whether the firm buying the option obtains the contract for which it is tendering, and for which the option was needed.
- There are a large number of options with *reduced or zero cash outlay* up front—which is made possible by combinations (buying one or more options and selling others) that result in a small or zero net initial outlay. One example is the *range forward* or *cylinder option*, which gives the buyer assurance that not more than an agreed maximum rate will be paid for needed foreign currency, but requires that the buyer agree he will pay no less than a stipulated (lower) minimum rate. Another example is the *conditional forward*, in which the premium is paid in the future but only if the exchange rate is below a specified level. A third example is the *participating forward*, in which the buyer is fully protected against a rise in the exchange rate, but pays a proportion of any decrease in the exchange rate. Such options—and there are any number of varieties—are popular since the buyer pays for his option by providing another option, rather than by paying cash, giving the *appearance* (which can be misleading) of cost-free protection, or the proverbial free lunch.

- There is the *all-or-nothing*, or *binary*, *option*, where, if the exchange rate is beyond the strike price at expiration, there is a fixed payout, and the amount is not affected by the magnitude of the difference between the underlying and the strike price.
- There are various forms of *path dependent* options, in which the option's value is determined, not simply by the exchange rate at the expiration of the option, but partly or exclusively by the path that the exchange rate took in arriving there. There are *barrier options*, in which, for example, the option expires worthless if the exchange rate hits some pre-agreed level, or, alternatively, in which the option pays off only if some pre-specified exchange rate is reached prior to expiration. There are *Bermuda* options (somewhere between American and European options) in which rights are exercisable on certain specified dates. There are Asian, or average rate, options, which pay off at maturity on the difference between the strike price and the average exchange rate over the life of the contract. There are look back options, or "no regrets" options, which give the holder the retroactive right to buy (sell) the underlying at its minimum (maximum) within the look back period. There are down-and-out options, knock-out options, and kick-out options, that expire if the market price of the underlying drops below a predetermined (out strike) price, and down-and-in options etc., that take effect only if the underlying drops to a predetermined (in strike) price.
- *Compound* options are options on options, and *chooser* options allow the holder to select before a certain date whether the option will be a put or a call.
- There are *non-deliverable currency options* (as there are non-deliverable forwards) which do not provide for physical delivery of the underlying currency when the option is exercised. If exercised, the option seller pays the holder the "in the money" amount on the settlement date in dollars or other agreed settlement currency.
- Other permutations include models developed in-house by the major dealers to meet individual customers' needs, and any number of customized arrangements that attach or embed options as part of more complex transactions.

FIGURE 5-1

MAIN CONTRACTS IN THE U.S. FOREIGN EXCHANGE MARKET

CONTRACTS	DESCRIPTION
Over-the-Counter Instruments	
A. *Outright Contracts*	Straightforward exchanges with various settlement dates
1. Spot	Settles two business days after deal date (or day 3) except Canada
Cash	Settles on deal date (or day 1)

(continued on page 56)

(continued from page 55)

Main Contracts in the U.S. Foreign Exchange Market

Value Tomorrow	Settles one business day after deal date (day 2)
2. Outright Forward	Settles on any pre-arranged date three or more business days after deal date (day 4 or beyond)
B. *FX Swap Contracts*	Exchange of principal with subsequent re-exchange at pre-agreed rate on pre-arranged date
◗ Short-Dated FX Swaps	Re-exchange in less than one month
1. Spot-Next	Arranged 2 days before spot value date; (or day 1); first leg settles on spot value date (or day 3); second leg settles next business day (or day 4)
2. Tom-Next	Arranged 1 day before spot value date; (or day 2); first leg settles on spot date (or day 3) second leg settles following business day (or day 4)
3. Spot-A-Week; (Spot-Two-Weeks)	Second leg settles same day one week later; (same day two weeks later)
◗ Forward FX Swaps	Re-exchange in one month or longer
1. Spot-Forward	First leg settles on spot date; second leg on a "straight" or standard forward date, e.g. 1, 2, 3, 6, 12 months
2. Odd-Date or Broken Date	First leg settles on spot date; second leg settles on a non-straight later date
3. Forward-Forward	First leg usually on a standard forward contract date; second leg a later standard forward contract date
4. Long Dates	First leg, spot date; second leg, a date beyond one year
C. Currency Swap Contracts	Initial exchange of principal (sometimes omitted), stream of interest payments, with subsequent re-exchange of principal on pre-arranged date
D. OTC Currency Option Contracts	Customized options; premium paid upfront; settlement two business days after exercise
Exchange-Traded Contracts	
A. *Futures Contracts*	Standardized quarterly or other maturity dates; initial and maintenance margins with daily mark-to-market
B. *Exchange-Traded Currency Options Contracts*	
1. Options on Spot (Philadelphia)	On exercise, settlement in currency
2. Options on Futures (Chicago)	On exercise, settlement in futures position in currency

FIGURE 5-2

FOREIGN EXCHANGE

MONDAY, APRIL 27,1998

Currency	Foreign Currency in Dollars Mon.	Fri.	Dollars in Foreign Currency Mon.	Fri.
f-Argent (Peso)	1.0001	1.0001	.9999	.9999
Australia (Dollar)	.6467	.6513	1.5463	1.5354
Austria (Schilling)	.0795	.0792	12.577	12.620
c-Belgium (Franc)	.0270	.0270	37.02	36.98
Brazil (Real)	.8746	.8749	1.1434	1.1430
Britain (Pound)	1.6742	1.6692	.5973	.5991
30-day fwd	1.6738	1.6640	.5974	.6010
60-day fwd	1.6714	1.6591	.5983	.6027
90-day fwd	1.6670	1.6571	.5999	.6035
Canada (Dollar)	.6949	.6969	1.4390	1.4350
30-day fwd	.6954	.6970	1.4380	1.4347
60-day fwd	.6958	.6974	1.4371	1.4338
90-day fwd	.6962	.6978	1.4364	1.4331
y-Chile (Peso)	.002205	.002215	453.55	451.45
China (Renminbi)	.1208	.1208	8.2784	8.2789
Colombia (Peso)	.000738	.000737	1354.91	1355.94
c-CzechRep (Koruna)	.0302	.0301	33.15	33.26
Denmark (Krone)	.1462	.1458	6.8386	6.8580
Dominican (Peso)	.0671	.0676	14.90	14.80
ECU (ECU)	1.10310	1.09970	.9065	.9093
z-Ecudr (Sucre)	.000200	.000200	4995.00	4995.00
d-Egypt (Pound)	.2926	.2926	3.4180	3.4180
Finland (Mark)	.1846	.1830	5.4165	5.4630
France (Franc)	.1668	.1666	5.9935	6.0010
Germany (Mark)	.5594	.5588	1.7876	1.7895
30-day fwd	.5609	.5593	1.7828	1.7881
60-day fwd	.5619	.5603	1.7797	1.7849
90-day fwd	.5628	.5612	1.7768	1.7820
Greece (Drachma)	.003181	.003206	314.40	311.92
Hong Kong (Dollar)	.1291	.1290	7.7484	7.7497
Hungary (Forint)	.0048	.0048	210.40	210.11
y-India (Rupee)	.0252	.0252	39.680	39.690
Indnsia (Rupiah)	.000125	.000124	8000.00	8050.00
y-Iran (Rial)	.000333	.000333	3000.00	3000.00
Ireland (Punt)	1.4128	1.4043	.7078	.7121
Israel (Shekel)	.2668	.2674	3.7476	3.7403
Italy (Lira)	.000566	.000565	1766.50	1770.00
Japan (Yen)	.007563	.007624	132.23	131.16
30-day fwd	.007599	.007668	131.59	130.41
60-day fwd	.007634	.007701	131.00	129.86
90-day fwd	.007667	.007733	130.43	129.31
Jordan (Dinar)	1.4134	1.4134	.70751	.70751
Lebanon (Pound)	.000658	.000658	1520.50	1520.50
Malaysia (Ringgit)	.2635	.2644	3.7950	3.7820
z-Mexico (Peso)	.117385	.117966	8.5190	8.4770
NethrInd (Guilder)	.4960	.4942	2.0160	2.0234
N. Zealand (Dollar)	.5539	.5615	1.8054	1.7809
Norway (Krone)	.1340	.1337	7.4601	7.4778
Pakistan (Rupee)	.0229	.0229	43.64	43.68
y-Peru (New Sol)	.3551	.3559	2.816	2.810
z-Philpins (Peso)	.0256	.0260	39.04	38.42
Poland (Zloty)	.2950	.2933	3.39	3.41
Portugal (Escudo)	.005466	.005428	182.94	184.24
a-Russia (Ruble)	.1631	.1631	6.1310	6.1310
Saudi Arab (Riyal)	.2667	.2666	3.7502	3.7505
Singapore (Dollar)	.6266	.6289	1.5960	1.5900
SlovakRep (Koruna)	.0289	.0288	34.65	34.71
So. Africa (Rand)	.1982	.1975	5.0455	5.0635
So. Korea (Won)	.000737	.000732	1356.00	1367.00
Spain (Peseta)	.006596	.006549	151.61	152.70
Sweden (Krona)	.1298	.1293	7.7032	7.7313
SwitzerInd (Franc)	.6727	.6708	1.4866	1.4907
30-day fwd	.6761	.6733	1.4790	1.4852
60-day fwd	.6786	.6759	1.4736	1.4796
90-day fwd	.6810	.6781	1.4685	1.4746
Taiwan (Dollar)	.0303	.0303	33.04	32.99
Thailand (Baht)	.02574	.02545	38.85	39.30
Turkey (Lira)	.000004	.000004	247355.00	246535.00
U.A.E. (Dirham)	.2723	.2723	3.6728	3.6730
f-Uruguay (New Peso)	.0971	.0970	10.3000	10.3050
Venzuel (Bolivar)	.0019	.0019	535.7000	535.0000

ECU: European Currency Unit, a basket of European currencies. The Federal Reserve Boards's index of the value of the dollar against 10 other currencies weighted on the basis of trade was 99.48 Monday, up 0.03 points or 0.03 percent from Friday's 99.45. A year ago the index was 97.04

a-Russian Central Bank rate.
c-commercial rate, d-free market rate, f-financial rate, y-official rate, z-floating rate.
Prices as of 3:00 p.m. Eastern Time from Dow Jones Telerate and other sources.