CFA Institute

ECONOMICS

CFA® Program Curriculum

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How to Use the CFA Program Curriculum

The CFA® Program exams measure your mastery of the core knowledge, skills, and abilities required to succeed as an investment professional. These core competencies are the basis for the Candidate Body of Knowledge (CBOK™). The CBOK consists of four components:

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OTHER FEEDBACK

Please send any comments or suggestions to info@cfainstitute.org, and we will review your feedback thoughtfully.

Economics

LEARNING MODULE

1

Currency Exchange Rates: Understanding Equilibrium Value

by Michael R. Rosenberg, and William A. Barker, PhD, CFA.

Michael R. Rosenberg (USA). William A. Barker, PhD, CFA (Canada).

LEARNING OUTCOMES

Mastery	***The candidate should be able to:***
☐	calculate and interpret the bid–offer spread on a spot or forward currency quotation and describe the factors that affect the bid–offer spread
☐	identify a triangular arbitrage opportunity and calculate its profit, given the bid–offer quotations for three currencies
☐	explain spot and forward rates and calculate the forward premium/discount for a given currency
☐	calculate the mark-to-market value of a forward contract
☐	explain international parity conditions (covered and uncovered interest rate parity, forward rate parity, purchasing power parity, and the international Fisher effect)
☐	describe relations among the international parity conditions
☐	evaluate the use of the current spot rate, the forward rate, purchasing power parity, and uncovered interest parity to forecast future spot exchange rates
☐	explain approaches to assessing the long-run fair value of an exchange rate
☐	describe the carry trade and its relation to uncovered interest rate parity and calculate the profit from a carry trade
☐	explain how flows in the balance of payment accounts affect currency exchange rates
☐	explain the potential effects of monetary and fiscal policy on exchange rates
☐	describe objectives of central bank or government intervention and capital controls and describe the effectiveness of intervention and capital controls
☐	describe warning signs of a currency crisis

1 INTRODUCTION

Exchange rates are well known to follow a random walk, whereby fluctuations from one day to the next are unpredictable. The business of currency forecasting can be a humbling experience. Alan Greenspan, former chair of the US Federal Reserve Board, famously noted that "having endeavored to forecast exchange rates for more than half a century, I have understandably developed significant humility about my ability in this area."

Hence, our discussion is not about predicting exchange rates but about the tools the reader can use to better understand long-run equilibrium value. This outlook helps guide the market participant's decisions with respect to risk exposures, as well as whether currency hedges should be implemented and, if so, how they should be managed. After discussing the basics of exchange rate transactions, we present the main theories for currency determination—starting with the international parity conditions—and then describe other important influences, such as current account balances, capital flows, and monetary and fiscal policy.

Although these fundamentals-based models usually perform poorly in predicting future exchange rates in the short run, they are crucial for understanding long-term currency value. Thus, we proceed as follows:

- We review the basic concepts of the foreign exchange market covered in the CFA Program Level I curriculum and expand this previous coverage to incorporate more material on bid–offer spreads.
- We then begin to examine determinants of exchange rates, starting with longer-term interrelationships among exchange rates, interest rates, and inflation rates embodied in the international parity conditions. These parity conditions form the key building blocks for many long-run exchange rate models.
- We also examine the foreign exchange (FX) carry trade, a trading strategy that exploits deviations from uncovered interest rate parity and discuss the relationship between a country's exchange rate and its balance of payments.
- We then examine how monetary and fiscal policies can *indirectly* affect exchange rates by influencing the various factors described in our exchange rate model.
- The subsequent section focuses on *direct* public sector actions in foreign exchange markets, both through capital controls and by foreign exchange market intervention (buying and selling currencies for policy purposes).
- The last section examines historical episodes of currency crisis and some leading indicators that may signal the increased likelihood of a crisis.

2 FOREIGN EXCHANGE MARKET CONCEPTS

☐ calculate and interpret the bid–offer spread on a spot or forward currency quotation and describe the factors that affect the bid–offer spread

We begin with a brief review of some of the basic conventions of the FX market that were covered in the CFA Program Level I curriculum. In this section, we cover (1) the basics of exchange rate notation and pricing, (2) arbitrage pricing constraints on spot rate foreign exchange quotes, and (3) forward rates and covered interest rate parity.

An exchange rate is the price of the *base* currency expressed in terms of the *price* currency. For example, a USD/EUR rate of 1.1650 means the euro, the base currency, costs 1.1650 US dollars (an appendix defines the three-letter currency codes). The exact notation used to represent exchange rates can vary widely between sources, and occasionally the same exchange rate notation will be used by different sources to mean completely different things. *The reader should be aware that the notation used here may not be the same as that encountered elsewhere.* To avoid confusion, we will identify exchange rates using the convention of "P/B," referring to the price of the base currency, "B," expressed in terms of the price currency, "P."

NOTATION CONVENTIONS

Notation is generally not standardized in global foreign exchange markets, and there are several common ways of expressing the same currency pair (e.g., JPY/USD, USD:JPY, $/¥). What is common in FX markets, however, is the concept of a "base" and a "price" currency when setting exchange rates. We will sometimes switch to discussing a "domestic" and a "foreign" currency, quoted as foreign/domestic (f/d). This is only an illustrative device for more easily explaining various theoretical concepts. The candidate should be aware that currency pairs are not described in terms of "foreign" and "domestic" currencies in professional FX markets. This is because what is the "foreign" and what is the "domestic" currency depend on where one is located, which can lead to confusion. For instance, what is "foreign" and what is "domestic" for a Middle Eastern investor trading CHF against GBP with the New York branch of a European bank, with the trade ultimately booked at the bank's headquarters in Paris?

The spot exchange rate is usually used for settlement on the second business day after the trade date, referred to as $T + 2$ settlement (the exception being CAD/USD, for which standard spot settlement is $T + 1$). In foreign exchange markets—as in other financial markets—market participants are presented with a two-sided price in the form of a bid price and an offer price (also called an ask price) quoted by potential counterparties. The bid price is the price, defined in terms of the price currency, at which the counterparty is willing to buy one unit of the base currency. Similarly, the offer price is the price, in terms of the price currency, at which that counterparty is willing to sell one unit of the base currency. For example, given a price request from a client, a dealer might quote a two-sided price on the spot USD/EUR exchange rate of 1.1648/1.1652. This means that the dealer is willing to pay USD 1.1648 to buy one EUR and that the dealer is willing to sell one EUR for USD 1.1652.

There are two points to bear in mind about bid–offer quotes:

1. *The offer price is always higher than the bid price.* The bid–offer spread—the difference between the offer price and the bid price—is the compensation that counterparties seek for providing foreign exchange to other market participants.
2. *The party in the transaction who requests a two-sided price quote has the option (but not the obligation) to deal at either the bid (to sell the base currency) or the offer (to buy the base currency) quoted by the dealer.* If the party chooses to trade at the quoted prices, the party is said to have either "*hit the*

bid” or “*paid the offer*.” If the base currency is being sold, the party is said to have hit the bid. If the base currency is being bought, the party is said to have paid the offer.

We will distinguish here between the bid–offer pricing *a client receives from a dealer* and the pricing *a dealer receives from the interbank market*. Dealers buy and sell foreign exchange among themselves in what is called the interbank market. This global network for exchanging currencies among professional market participants allows dealers to adjust their inventories and risk positions, distribute foreign currencies to end users who need them, and transfer foreign exchange rate risk to market participants who are willing to bear it. The interbank market is typically for dealing sizes of at least 1 million units of the base currency. Of course, the dealing amount can be larger than 1 million units; indeed, interbank market trades generally are measured in terms of multiples of a million units of the base currency. Please note that many non-bank entities can now access the interbank market. They include institutional asset managers and hedge funds.

The bid–offer spread a dealer provides to most clients typically is slightly wider than the bid–offer spread observed in the interbank market. Most currencies, except for the yen, are quoted to four decimal places. The fourth decimal place (0.0001) is referred to as a “pip.” The yen is typically quoted to just two decimal places; in yen quotes, the second decimal place (0.01) is referred to as a pip.

For example, if the quote in the interbank USD/EUR spot market is 1.1649/1.1651 (two pips wide), the dealer might quote a client a bid–offer of 1.1648/1.1652 (four pips wide) for a spot USD/EUR transaction. When the dealer buys (sells) the base currency from (to) a client, the dealer is typically expecting to quickly turn around and sell (buy) the base currency in the interbank market. This offsetting transaction allows the dealer to divest the risk exposure assumed by providing a two-sided price to the client and to hopefully make a profit. Continuing our example, suppose the dealer’s client hits the dealer’s bid and sells EUR to the dealer for USD 1.1648. The dealer is now long EUR (and short USD) and wants to cover this position in the interbank market. To do this, the dealer sells the EUR in the interbank market by hitting the interbank bid. As a result, the dealer *bought* EUR from the client at USD 1.1648 and then *sold* the EUR in the interbank for USD 1.1649. This gives the dealer a profit of USD 0.0001 (one pip) for every EUR transacted. This one pip translates into a profit of USD 100 per EUR million bought from the client. If, instead of hitting his bid, the client paid the offer (1.1652), then the dealer could pay the offer in the interbank market (1.1651), earning a profit of one pip.

The size of the bid–offer spread quoted to dealers’ clients in the FX market can vary widely across exchange rates and is not constant over time, even for a single exchange rate. The size of this spread depends primarily on three factors:

- the bid–offer spread in the interbank foreign exchange market for the two currencies involved,
- the size of the transaction, and
- the relationship between the dealer and the client.

We examine each factor in turn.

The size of the bid–offer spread quoted in the interbank market depends on the liquidity in this market. Liquidity is influenced by several factors:

1. *The currency pair involved.* Market participation is greater for some currency pairs than for others. Liquidity in the major currency pairs—for example, USD/EUR, JPY/USD, and USD/GBP—can be quite high. These markets are almost always deep, with multiple bids and offers from market participants around the world. In other currency pairs, particularly some of

the more obscure currency cross rates (e.g., MXN/CHF), market participation is much thinner and consequently the bid–offer spread in the interbank market will be wider.

2. *The time of day.* The interbank FX markets are most liquid when the major FX trading centers are open. Business hours in London and New York—the two largest FX trading centers—overlap from approximately 8:00 a.m. to 11:00 a.m. New York time. The interbank FX market for most currency pairs is typically most liquid during these hours. After London closes, liquidity is thinner through the New York afternoon. The Asian session starts when dealers in Tokyo, Singapore, and Hong Kong SAR open for business, typically by 7:00 p.m. New York time. For most currency pairs, however, the Asian session is not as liquid as the London and New York sessions. Although FX markets are open 24 hours a day on business days, between the time New York closes and the time Asia opens, liquidity in interbank markets can be very thin because Sydney, Australia, tends to be the only active trading center during these hours. For reference, the chart below shows a 24-hour period from midnight (00:00) to midnight (24:00) London time, corresponding standard times in Tokyo and New York, and, shaded in grey, the *approximate* hours of the most liquid trading periods in each market.

Standard Time and Approximate FX Trading Hours in Major Markets: Midnight to Midnight (London Time)

Tokyo	09:00	13:00	17:00	21:00	01:00 Day+1	05:00 Day+1	09:00 Day+1
London	00:00	04:00	08:00	12:00	16:00	20:00	24:00
New York	19:00 Day−1	23:00 Day−1	03:00	07:00	11:00	15:00	19:00

3. *Market volatility.* As in any financial market, when major market participants have greater uncertainty about the factors influencing market pricing, they will attempt to reduce their risk exposures and/or charge a higher price for taking on risk. In the FX market, this response implies wider bid–offer spreads in both the interbank and broader markets. Geopolitical events (e.g., war, civil strife), market crashes, and major data releases (e.g., US non-farm payrolls) are among the factors that influence spreads and liquidity.

The size of the transaction can also affect the bid–offer spread shown by a dealer to clients. Typically, the larger the transaction, the further away from the current spot exchange rate the dealing price will be. Hence, a client who asks a dealer for a two-sided spot CAD/USD price on, for example, USD 50 million will be shown a wider bid–offer spread than a client who asks for a price on USD 1 million. The wider spread reflects the greater difficulty the dealer faces in offsetting the foreign exchange risk of the position in the interbank FX market. Smaller dealing sizes can also affect the bid–offer quote shown to clients. "Retail" quotes are typically for dealing sizes smaller than 1 million units of the base currency and can range all the way down to foreign exchange transactions conducted by individuals. The bid–offer spreads for these retail transactions can be very large compared with those in the interbank market.

The relationship between the dealer and the client can also affect the size of the bid–offer spread shown by the dealer. For many clients, the spot foreign exchange business is only one business service among many that a dealer provides to that client. For example, the dealer firm might also transact in bond and/or equity securities with the same client. In a competitive business environment, in order to win the client's business for these other services, the dealer might provide a tighter (i.e., smaller) bid–offer spot exchange rate quote. The dealer might also give tighter bid–offer quotes in order to win repeat FX business. A client's credit risk can also be a factor. A client with a poor credit profile may be quoted a wider bid–offer spread than one with good credit. Given the short settlement cycle for spot FX transactions (typically two business days), however, credit risk is not the most important factor in determining the client's bid–offer spread on spot exchange rates.

3 ARBITRAGE CONSTRAINTS ON SPOT EXCHANGE RATE QUOTES

- [ ] identify a triangular arbitrage opportunity and calculate its profit, given the bid–offer quotations for three currencies

The bid–offer quotes a dealer shows in the interbank FX market must respect two arbitrage constraints; otherwise the dealer creates riskless arbitrage opportunities for other interbank market participants. We will confine our attention to the interbank FX market because arbitrage presumes the ability to deal simultaneously with different market participants and in different markets, the ability to access "wholesale" bid–offer quotes, and the market sophistication to spot arbitrage opportunities.

First, the bid shown by a dealer in the interbank market cannot be higher than the current interbank offer, and the offer shown by a dealer cannot be lower than the current interbank bid. If the bid–offer quotes shown by a dealer are inconsistent with the then-current interbank market quotes, other market participants will buy from the cheaper source and sell to the more expensive source. This arbitrage will eventually bring the two prices back into line. For example, suppose that the current spot USD/EUR price in the interbank market is 1.1649/1.1651. If a dealer showed a misaligned price quote of 1.1652/1.1654, then other market participants would pay the offer in the interbank market, *buying* EUR at a price of USD 1.1651, and then *sell* the EUR to the dealer by hitting the dealer's bid at USD 1.1652—thereby making a riskless profit of one pip on the trade. This arbitrage would continue as long as the dealer's bid–offer quote violated the arbitrage constraint.

Second, the cross-rate bids (offers) posted by a dealer must be lower (higher) than the implied cross-rate offers (bids) available in the interbank market. A currency dealer located in a given country typically provides exchange rate quotations between that country's currency and various foreign currencies. If a particular currency pair is not explicitly quoted, it can be inferred from the quotes for each currency in terms of the exchange rate with a third nation's currency. For example, given exchange rate quotes for the currency pairs A/B and C/B, we can back out the implied cross rate of A/C. This implied A/C cross rate must be consistent with the A/B and C/B rates. This again reflects the basic principle of arbitrage: If identical financial products are priced differently, then market participants will buy the cheaper one and sell the more expensive one until the price difference is eliminated. In the context of FX cross rates, there are two ways to trade currency A against currency C: (1) using the cross rate A/C or (2) using the A/B and C/B rates. Because, in the end, both methods involve selling (buying) currency C in order to buy (sell) currency A, the exchange rates for these two approaches must be consistent. If the exchange rates are not consistent, the arbitrageur will buy currency C from a dealer if it is undervalued (relative to the cross rate) and sell currency A. If currency C is overvalued by a dealer (relative to the cross rate), it will be sold and currency A will be bought.

To illustrate this **triangular arbitrage** among three currencies, suppose that the interbank market bid–offer in USD/EUR is 1.1649/1.1651 and that the bid–offer in JPY/USD is 105.39/105.41. We need to use these two interbank bid–offer quotes to calculate the market-implied bid–offer quote on the JPY/EUR cross rate.

Begin by considering the transactions required to *sell* JPY and *buy* EUR, going through the JPY/USD and USD/EUR currency pairs. We can view this process intuitively as follows:

Sell JPY Buy EUR	=	Sell JPY Buy USD	then	Sell USD Buy EUR

Note that "Buy USD" and "Sell USD" in the expressions on the right-hand side of the equal sign will cancel out to give the JPY/EUR cross rate. In equation form, we can represent this relationship as follows:

$$\left(\frac{\text{JPY}}{\text{EUR}}\right) = \left(\frac{\text{JPY}}{\cancel{\text{USD}}}\right)\left(\frac{\cancel{\text{USD}}}{\text{EUR}}\right).$$

Now, let's incorporate the bid–offer rates in order to do the JPY/EUR calculation. A rule of thumb is that when we speak of a bid or offer exchange rate, we are referring to the bid or offer for the currency in the denominator (the base currency).

i. The left-hand side of the above equal sign is "Sell JPY, Buy EUR." In the JPY/EUR price quote, the EUR is in the denominator (it is the base currency). Because we want to buy the currency in the denominator, we need an exchange rate that is an offer rate. Thus, we will be calculating the *offer* rate for JPY/EUR.

ii. The first term on the right-hand side of the equal sign is "Sell JPY, Buy USD." Because we want to buy the currency in the denominator of the quote, we need an exchange rate that is an offer rate. Thus, we need the *offer* rate for JPY/USD.

iii. The second term on the right-hand side of the equal sign is "Sell USD, Buy EUR." Because we want to buy the currency in the denominator of the quote, we need an exchange rate that is an offer rate. Thus, we need the *offer* rate for USD/EUR.

Combining all of this conceptually and putting in the relevant offer rates leads to a JPY/EUR offer rate of

$$\left(\frac{\text{JPY}}{\text{EUR}}\right)_{offer} = \left(\frac{\text{JPY}}{\boxed{\text{USD}}}\right)_{offer}\left(\frac{\boxed{\text{USD}}}{\text{EUR}}\right)_{offer} = 105.41 \times 1.1651 = 122.81.$$

Perhaps not surprisingly, calculating the implied JPY/EUR *bid* rate uses the same process as above but with "Buy JPY, Sell EUR" for the left-hand side of the equation, which leads to

$$\left(\frac{\text{JPY}}{\text{EUR}}\right)_{bid} = \left(\frac{\text{JPY}}{\boxed{\text{USD}}}\right)_{bid}\left(\frac{\boxed{\text{USD}}}{\text{EUR}}\right)_{bid} = 105.39 \times 1.1649 = 122.77.$$

As one would expect, the implied cross-rate bid (122.77) is less than the offer (122.81).

This simple formula seems relatively straightforward: To get the implied *bid* cross rate, simply multiply the *bid* rates for the other two currencies. However, depending on the quotes provided, it may be necessary to *invert* one of the quotes in order to complete the calculation.

This is best illustrated with an example. Consider the case of calculating the implied GBP/EUR cross rate if you are given USD/GBP and USD/EUR quotes. Simply using the provided quotes will not generate the desired GBP/EUR cross rate:

$$\frac{\text{GBP}}{\text{EUR}} \neq \left(\frac{\text{USD}}{\text{GBP}}\right)\left(\frac{\text{USD}}{\text{EUR}}\right).$$

Instead, because the USD is in the numerator in both currency pairs, we will have to invert one of the pairs to derive the GBP/EUR cross rate.

The following equation represents the cross-rate relationship we are trying to derive:

$$\frac{\text{GBP}}{\text{EUR}} = \left(\frac{\text{GBP}}{\text{USD}}\right)\left(\frac{\text{USD}}{\text{EUR}}\right).$$

But we don't have the GBP/USD quote. We can, however, invert the USD/GBP quote and use that in our calculation. Let's assume the bid–offer quote provided is for USD/GBP and is 1.2302/1.2304. With this quote, if we want to *buy* GBP (the currency in the denominator), we will buy GBP at the offer and the relevant quote is 1.2304. We can invert this quote to arrive at the needed GBP/USD quote: 1 ÷ 1.2304 = 0.81274. Note that, in this example, when we buy the GBP, we are also selling the USD. When we invert the provided USD/GBP offer quote, we obtain 0.81274 GBP/USD. This is the price at which we sell the USD—that is, the GBP/USD *bid*. It may help here to remember our rule of thumb from above: When we speak of a bid or offer exchange rate, we are referring to the bid or offer for the currency in the denominator (the base currency).

Similarly, to get a GBP/USD *offer*, we use the inverse of the USD/GBP *bid* of 1.2302: 1 ÷ 1.2302 = 0.81288. (Note that we extended the calculated GBP/USD 0.81274/0.81288 quotes to five decimal places to avoid truncation errors in subsequent calculations.)

We can now finish the calculation of the bid and offer cross rates for GBP/EUR. Using the previously provided 1.1649/1.1651 as the bid–offer in USD/EUR, we calculate the GBP/EUR *bid* rate as follows:

$$\left(\frac{\text{GBP}}{\text{EUR}}\right)_{bid} = \left(\frac{\text{GBP}}{\boxed{\text{USD}}}\right)_{bid}\left(\frac{\boxed{\text{USD}}}{\text{EUR}}\right)_{bid} = 0.81274 \times 1.1649 = 0.9468.$$

Similarly, the implied GBP/EUR *offer* rate is

$$\left(\frac{\text{GBP}}{\text{EUR}}\right)_{offer} = \left(\frac{\text{GBP}}{\boxed{\text{USD}}}\right)_{offer}\left(\frac{\boxed{\text{USD}}}{\text{EUR}}\right)_{offer} = 0.81288 \times 1.1651 = 0.9471.$$

Note that the implied *bid* rate is less than the implied *offer* rate, as it must be to prevent arbitrage.

We conclude this section on arbitrage constraints with some simple observations:

- The arbitrage constraint on implied cross rates is similar to that for spot rates (posted bid rates cannot be higher than the market's offer; posted offer rates cannot be lower than the market's bid). The only difference is that this second arbitrage constraint is applied *across* currency pairs instead of involving a *single* currency pair.
- In reality, any violations of these arbitrage constraints will quickly disappear. Both human traders and automatic trading algorithms are constantly on alert for any pricing inefficiencies and will arbitrage them away almost instantly. If Dealer 1 is buying a currency at a price higher than the price at which Dealer 2 is selling it, the arbitrageur will buy the currency from Dealer 2 and resell it to Dealer 1. As a result of buying and selling pressures, Dealer 2 will raise his offer prices and Dealer 1 will reduce her bid prices to the point where arbitrage profits are no longer available.
- Market participants do not need to calculate cross rates *manually* because electronic dealing machines (which are essentially just specialized computers) will automatically calculate cross bid–offer rates given any two underlying bid–offer rates.

EXAMPLE 1

Bid–Offer Rates

The following are spot rate quotes in the interbank market:

USD/EUR	1.1649/1.1651
JPY/USD	105.39/105.41
CAD/USD	1.3199/1.3201
SEK/USD	9.6300/9.6302

1. What is the bid–offer on the SEK/EUR cross rate implied by the interbank market?

   A. 0.1209/0.1211

   B. 8.2656/8.2668

   C. 11.2180/11.2201

   Solution

   C is correct. Using the provided quotes and setting up the equations so that the cancellation of terms results in the SEK/EUR quote,

   $$\frac{\text{SEK}}{\text{EUR}} = \frac{\text{SEK}}{\text{USD}} \times \frac{\text{USD}}{\text{EUR}}.$$

   Hence, to calculate the SEK/EUR bid (offer) rate, we multiply the SEK/USD and USD/EUR bid (offer) rates to get the following:

Bid:	11.2180 = 9.6300 × 1.1649.
Offer:	11.2201 = 9.6302 × 1.1651.

2. What is the bid–offer on the JPY/CAD cross rate implied by the interbank market?

   A. 78.13/78.17

   B. 79.85/79.85

   C. 79.84/79.86

   Solution

   C is correct. Using the intuitive equation-based approach,

   $$\frac{\text{JPY}}{\text{CAD}} = \frac{\text{JPY}}{\text{USD}} \times \left(\frac{\text{CAD}}{\text{USD}}\right)^{-1} = \frac{\text{JPY}}{\cancel{\text{USD}}} \times \frac{\cancel{\text{USD}}}{\text{CAD}}.$$

   This equation shows that we have to invert the CAD/USD quotes to get the USD/CAD bid–offer rates of 0.75752/0.75763. That is, given the CAD/USD quotes of 1.3199/1.3201, we take the inverse of each and interchange bid and offer, so that the USD/CAD quotes are (1/1.3201)/(1/1.3199), or 0.75752/0.75763. Multiplying the JPY/USD and USD/CAD bid–offer rates then leads to the following:

Bid:	79.84 = 105.39 × 0.75752.
Offer:	79.86 = 105.41 × 0.75763.

3. If a dealer quoted a bid–offer rate of 79.81/79.83 in JPY/CAD, then a triangular arbitrage would involve buying:

   A. CAD in the interbank market and selling it to the dealer, for a profit of JPY 0.01 per CAD.

   B. JPY from the dealer and selling it in the interbank market, for a profit of CAD 0.01 per JPY.

   C. CAD from the dealer and selling it in the interbank market, for a profit of JPY 0.01 per CAD.

   Solution

   C is correct. The implied interbank cross rate for JPY/CAD is 79.84/79.86 (the answer to Question 2). Hence, the dealer is offering to sell the CAD (the base currency in the quote) too cheaply, at an offer rate that is below the interbank bid rate (79.83 versus 79.84, respectively). Triangular arbitrage would involve buying CAD from the dealer (paying the dealer's offer) and selling CAD in the interbank market (hitting the interbank bid), for a profit of JPY 0.01 (79.84 – 79.83) per CAD transacted.

4. If a dealer quoted a bid–offer of 79.82/79.87 in JPY/CAD, then you could:

   A. not make any arbitrage profits.

   B. make arbitrage profits buying JPY from the dealer and selling it in the interbank market.

   C. make arbitrage profits buying CAD from the dealer and selling it in the interbank market.

   Solution

   A is correct. The arbitrage relationship is not violated: The dealer's bid (offer) is not above (below) the interbank market's offer (bid). The implied interbank cross rate for JPY/CAD is 79.84/79.86 (the solution to Question 2).

5. A market participant is considering the following transactions:

Transaction 1	Buy CAD 100 million against the USD at 15:30 London time.
Transaction 2	Sell CAD 100 million against the KRW at 21:30 London time.
Transaction 3	Sell CAD 10 million against the USD at 15:30 London time.

   Given the proposed transactions, what is the *most likely* ranking of the bid–offer spreads, from tightest to widest, under normal market conditions?

   A. Transactions 1, 2, 3

   B. Transactions 2, 1, 3

   C. Transactions 3, 1, 2

   Solution

   C is correct. The CAD/USD currency pair is most liquid when New York and London are both in their most liquid trading periods at the same time (approximately 8:00 a.m. to 11:00 a.m. New York time, or about 13:00 to 16:00 London time). Transaction 3 is for a smaller amount than Transaction 1. Transaction 2 is for a less liquid currency pair (KRW/CAD is traded less than CAD/USD) and occurs outside of normal dealing hours in all three major centers (London, North America, and Asia); the transaction is also for a large amount.

FORWARD MARKETS

4

☐ explain spot and forward rates and calculate the forward premium/discount for a given currency

Outright forward contracts (often referred to simply as forwards) are agreements to exchange one currency for another on a future date at an exchange rate agreed upon today. Any exchange rate transaction that has a settlement date longer than $T + 2$ is a forward contract.

Forward exchange rates must satisfy an arbitrage relationship that equates the investment return on two alternative but equivalent investments. To simplify the explanation of this arbitrage relationship and to focus on the intuition behind forward rate calculations, we will ignore the bid–offer spread on exchange rates and money market instruments. In addition, we will alter our exchange rate notation from price/base currency (P/B) to "foreign/domestic currency" (f/d), making the assumption that the domestic currency for an investor is the base currency in the exchange rate quotation. Using this (f/d) notation will make it easier to illustrate the choice an investor faces between domestic and foreign investments, as well as the arbitrage relationships that equate the returns on these investments when their risk characteristics are equivalent.

Consider an investor with one unit of domestic currency to invest for one year. The investor faces two alternatives:

A. One alternative is to invest cash for one year at the domestic risk-free rate (i_d). At the end of the year, the investment would be worth $(1 + i_d)$.

B. The other alternative is to convert the domestic currency to foreign currency at the spot rate of $S_{f/d}$ and invest for one year at the foreign risk-free rate (i_f). At the end of the period, the investor would have $S_{f/d}(1 + i_f)$ units of foreign currency. These funds then must be converted back to the investor's domestic currency. If the exchange rate to be used for this end-of-year conversion is set at the start of the period using a one-year forward contract, then the investor will have eliminated the foreign exchange risk associated with converting at an unknown future spot rate. If we let $F_{f/d}$ denote the forward rate, the investor would obtain $(1/F_{f/d})$ units of the domestic currency for each unit of foreign currency sold forward. Hence, in domestic currency, at the end of the year, the investment would be worth $S_{f/d}(1 + i_f)(1/F_{f/d})$.

The two investment alternatives above (A and B) are risk free and therefore must offer the same return. If they did not offer the same return, investors could earn a riskless arbitrage profit by borrowing in one currency, lending in the other, and using the spot and forward exchange markets to eliminate currency risk. Equating the returns on these two investment alternatives—that is, putting investments A and B on opposite sides of the equal sign—leads to the following relationship:

$$(1 + i_d) = S_{f/d}(1 + i_f)\left(\frac{1}{F_{f/d}}\right).$$

To see the intuition behind forward rate calculations, note that the right-hand side of the expression (for investment B) also shows the chronological order of this investment: Convert from domestic to foreign currency at the spot rate ($S_{f/d}$); invest this foreign currency amount at the foreign risk-free interest rate $(1 + i_f)$; and then at maturity, convert the foreign currency investment proceeds back into the domestic currency using the forward rate $(1/F_{f/d})$.

For simplicity, we assumed a one-year horizon in the preceding example. However, the argument holds for any investment horizon. The risk-free assets used in this arbitrage relationship are typically bank deposits quoted using the appropriate Market Reference Rate for each currency involved. The day count convention MRR deposits may be Actual/360 or Actual/365. The notation Actual/360 means that interest is calculated as if there were 360 days in a year. The notation Actual/365 means interest is calculated as if there were 365 days in a year. The main exception to the Actual/360 day count convention is the GBP, for which the convention is Actual/365. For the purposes of our discussion, we will use Actual/360 consistently in order to avoid complication. Incorporating this day count convention into our arbitrage formula leads to

$$\left(1 + i_d\left[\frac{\text{Actual}}{360}\right]\right) = S_{f/d}\left(1 + i_f\left[\frac{\text{Actual}}{360}\right]\right)\left(\frac{1}{F_{f/d}}\right).$$

This equation can be rearranged to isolate the forward rate:

$$F_{f/d} = S_{f/d}\left(\frac{1 + i_f\left[\frac{\text{Actual}}{360}\right]}{1 + i_d\left[\frac{\text{Actual}}{360}\right]}\right). \tag{1}$$

Equation 1 describes **covered interest rate parity**. Our previous work shows that covered interest rate parity is based on an arbitrage relationship among risk-free interest rates and spot and forward exchange rates. Because of this arbitrage relationship between investment alternatives, Equation 1 can also be described as saying that the covered (i.e., currency-hedged) interest rate differential between the two markets is zero.

The covered interest rate parity equation can also be rearranged to give an expression for the forward premium or discount:

$$F_{f/d} - S_{f/d} = S_{f/d}\left(\frac{\left[\frac{\text{Actual}}{360}\right]}{1 + i_d\left[\frac{\text{Actual}}{360}\right]}\right)(i_f - i_d).$$

The domestic currency will trade at a forward premium ($F_{f/d} > S_{f/d}$) if, and only if, the foreign risk-free interest rate exceeds the domestic risk-free interest rate ($i_f > i_d$). Equivalently, in this case, the foreign currency will trade at a lower rate in the forward contract (relative to the spot rate), and we would say that the foreign currency trades at a forward discount. In other words, if it is possible to earn more interest in the foreign market than in the domestic market, then the forward discount for the foreign currency will offset the higher foreign interest rate. Otherwise, covered interest rate parity would not hold and arbitrage opportunities would exist.

When the foreign currency is at a higher rate in the forward contract, relative to the spot rate, we say that the foreign currency trades at a forward premium. In the case of a forward premium for the foreign currency, the foreign risk-free interest rate will be less than the domestic risk-free interest rate. Additionally, as can be seen in the equation above, the premium or discount is proportional to the spot exchange rate ($S_{f/d}$), proportional to the interest rate differential ($i_f - i_d$) between the markets, and approximately proportional to the time to maturity (Actual/360).

Although we have illustrated the covered interest rate parity equation (Equation 1) in terms of foreign and domestic currencies (using the notation f/d), this equation can also be expressed in our more standard exchange rate quoting convention of price and base currencies (P/B):

$$F_{P/B} = S_{P/B}\left(\frac{1 + i_P\left[\frac{\text{Actual}}{360}\right]}{1 + i_B\left[\frac{\text{Actual}}{360}\right]}\right).$$

When dealing in professional FX markets, it may be more useful to think of the covered interest rate parity equation and the calculation of forward rates in this P/B notation rather than in foreign/domestic (*f*/*d*) notation. Domestic and foreign are relative concepts that depend on where one is located, and because of the potential for confusion, these terms are not used for currency quotes in professional FX markets.

EXAMPLE 2

Calculating the Forward Premium (Discount)

The following table shows the mid-market rate (i.e., the average of the bid and offer) for the current CAD/AUD spot exchange rate as well as for AUD and CAD 270-day MRR (annualized):

Spot (CAD/AUD)	0.9000
270-day MRR (AUD)	1.47%
270-day MRR (CAD)	0.41%

1. The forward premium (discount) for a 270-day forward contract for CAD/AUD would be *closest* to:
   - **A.** −0.0094.
   - **B.** −0.0071.
   - **C.** +0.0071.

   Solution

   B is correct. The equation to calculate the forward premium (discount) is as follows:

$$F_{P/B} - S_{P/B} = S_{P/B}\left(\frac{\left[\frac{\text{Actual}}{360}\right]}{1 + i_B\left[\frac{\text{Actual}}{360}\right]}\right)(i_P - i_B).$$

   Because AUD is the base currency in the CAD/AUD quote, putting in the information from the table gives us

$$F_{P/B} - S_{P/B} = 0.9000\left(\frac{\left[\frac{270}{360}\right]}{1 + 0.0147\left[\frac{270}{360}\right]}\right)(0.0041 - 0.0147) = -0.0071.$$

In professional FX markets, forward exchange rates are typically quoted in terms of points—the difference between the forward exchange rate quote and the spot exchange rate quote, scaled so that the points can be directly related to the last decimal place in the spot quote. Thus, the forward rate quote is typically shown as the bid–offer on the spot rate and the number of forward points at each maturity, as shown in Exhibit 1 ("Maturity" is defined in terms of the time between spot settlement—usually T + 2—and the settlement of the forward contract).

Exhibit 1: Sample Spot and Forward Quotes (Bid–Offer)

Maturity	Spot Rate
Spot (USD/EUR)	1.1649/1.1651
	Forward Points
1 month	−5.6/−5.1
3 months	−15.9/−15.3
6 months	−37.0/−36.3
12 months	−94.3/−91.8

Note the following:

- As always, the offer in the bid–offer quote is larger than the bid. In this example, the forward points are negative (i.e., the forward rate for the EUR is at a discount to the spot rate) but the bid is a smaller number (−5.6 versus −5.1 at the one-month maturity).
- The absolute number of forward points is a function of the term of the forward contract: A longer contract term results in a larger number of points.
- Because this is an OTC market, a client is not restricted to dealing *only* at the dates/maturities shown. Dealers typically quote standard forward dates, but forward deals can be arranged for any forward date the client requires. The forward points for these non-standard (referred to as "broken") forward dates will typically be interpolated on the basis of the points shown for the standard settlement dates.
- The quoted points are already scaled to each maturity—they are not annualized—so there is no need to adjust them.

To convert any of these quoted forward points into a forward rate, divide the number of points by 10,000 (to scale it down to the same four decimal places in the USD/EUR spot quote) and then add the result to the spot exchange rate quote (because the JPY/USD exchange rate is quoted to only two decimal places, forward points for the dollar–yen currency pair are divided by 100). Be careful, however, about which side of the market (bid or offer) is being quoted. For example, suppose a market participant is *selling* the EUR forward against the USD and is given a USD/EUR quote. The EUR is the base currency; thus, the market participant must use the *bid* rates (i.e., hit the bid). Using the data in Exhibit 1, the three-month forward *bid* rate in this case would be based on the spot bid and the forward points bid and hence would be

$$1.1649 + (-15.9/10{,}000) = 1.16331.$$

The market participant would be selling EUR three months forward at a price of USD 1.16331 per EUR.

5 THE MARK-TO-MARKET VALUE OF A FORWARD CONTRACT

☐ calculate the mark-to-market value of a forward contract

Next, we consider the mark-to-market value of forward contracts. As with other financial instruments, the mark-to-market value of forward contracts reflects the profit (or loss) that would be realized from closing out the position at current market prices. To close out a forward position, we must offset it with an equal and opposite forward position using the spot exchange rate and forward points available in the market when the offsetting position is created. When a forward contract is initiated, the mark-to-market value of the contract is zero, and no cash changes hands. From that moment onward, however, the mark-to-market value of the forward contract will change as the spot exchange rate changes and as interest rates change in either of the two currencies.

Let's look at an example. Suppose that a market participant bought GBP 10 million for delivery against the AUD in six months at an "all-in" forward rate of 1.8100 AUD/GBP. (The all-in forward rate is simply the sum of the spot rate and the scaled forward points.) Three months later, the market participant wants to close out this forward contract. This would require selling GBP 10 million three months forward using the AUD/GBP spot exchange rate and forward points in effect at that time. Before looking at this exchange rate, note that the offsetting forward contract is defined in terms of the original position taken. The original position in this example was "long GBP 10 million," so the offsetting contract is "short GBP 10 million." However, there is ambiguity here: To be long GBP 10 million at 1.8100 AUD/GBP is equivalent to being short AUD 18,100,000 (10,000,000 × 1.8100) at the same forward rate. To avoid this ambiguity, for the purposes of this discussion, we will state what the relevant forward position is for mark-to-market purposes. The net gain or loss from the transaction will be reflected in the alternate currency.

Assume the bid–offer quotes for spot and forward points three months prior to the settlement date are as follows:

Spot rate (AUD/GBP)	1.8210/1.8215
Three-month points	130/140

To sell GBP (the base currency in the AUD/GBP quote), we will be calculating the *bid* side of the market. Hence, the appropriate all-in three-month forward rate to use is

$$1.8210 + 130/10{,}000 = 1.8340.$$

This means that the market participant originally bought GBP 10 million at an AUD/GBP rate of 1.8100 and subsequently sold that amount at a rate of 1.8340. These GBP amounts will net to zero at the settlement date (GBP 10 million both bought and sold), but the AUD amounts will not, because the forward rate has changed. The AUD cash flow at the settlement date will be

$$(1.8340 - 1.8100) \times 10{,}000{,}000 = +\text{AUD } 240{,}000.$$

This is a cash *inflow* because the market participant was long the GBP with the original forward position and the GBP subsequently appreciated (the AUD/GBP rate increased).

This cash flow will be paid at the settlement day, which is still three months away. To calculate the mark-to-market value of the dealer's position, we must discount this cash flow to the present. The present value of this amount is found by discounting the settlement day cash flow by the three-month discount rate. Because this amount is in AUD, we use the three-month AUD discount rate. Suppose that three-month AUD MRR is 2.40% (annualized). The present value of this future AUD cash flow is then

$$\frac{\text{AUD } 240{,}000}{1 + 0.024\left(\frac{90}{360}\right)} = \text{AUD } 238{,}569.$$

This result is the mark-to-market value of the original long GBP 10 million six-month forward when it is closed out three months prior to settlement.

To summarize, the process for marking to market a forward position is relatively straightforward:

1. Create an offsetting forward position that is equal to the original forward position. (In the example above, the market participant was long GBP 10 million forward, so the offsetting forward contract would be to sell GBP 10 million.)
2. Determine the appropriate all-in forward rate for this new, offsetting forward position. If the base currency of the exchange rate quote is being sold (bought), then use the bid (offer) side of the market.
3. Calculate the cash flow at the settlement day. This amount will be based on the original contract size times the difference between the original forward rate and that calculated in Step 2. If the currency the market participant was originally long (short) subsequently appreciated (depreciated), then there will be a cash *inflow* (*outflow*). (In the above example, the market participant was long the GBP, which subsequently appreciated, leading to a cash inflow at the settlement day.)
4. Calculate the present value of this cash flow at the future settlement date. The currency of the cash flow and the discount rate must match. (In the example above, the cash flow at the settlement date was in AUD, so an AUD MRR was used to calculate the present value.)

The factors that affect the bid–offer spread for forward points are the same as those we discussed for spot bid–offer rates: the interbank market liquidity of the underlying currency pair, the size of the transaction, and the relationship between the client and the dealer. For forward bid–offer spreads, we can also add a fourth factor: the term of the forward contract. Generally, the longer the term of the forward contract, the wider the bid–offer spread. This relationship holds because as the term of the contract increases,

- liquidity in the forward market tends to decline,
- the exposure to counterparty credit risk increases, and
- the interest rate risk of the contract increases (forward rates are based on interest rate differentials, and a longer duration means greater price sensitivity to movements in interest rates).

EXAMPLE 3

Forward Rates and the Mark-to-Market Value of Forward Positions

A dealer is contemplating trade opportunities in the CHF/GBP currency pair. The following are the current spot rates and forward points being quoted for the CHF/GBP currency pair:

Spot rate (CHF/GBP)	1.2939/1.2941
One month	−8.3/−7.9
Two months	−17.4/−16.8
Three months	−25.4/−24.6
Four months	−35.4/−34.2
Five months	−45.9/−44.1
Six months	−56.5/−54.0

1. The current all-in bid rate for delivery of GBP against the CHF in three months is *closest* to:

   A. 1.29136.

   B. 1.29150.

   C. 1.29164.

   Solution

   A is correct. The current all-in three-month bid rate for GBP (the base currency) is equal to 1.2939 + (−25.4/10,000) = 1.29136.

2. The all-in rate that the dealer will be quoted today by another dealer to sell the CHF six months forward against the GBP is *closest* to:

   A. 1.28825.

   B. 1.28835.

   C. 1.28870.

   Solution

   C is correct. The dealer will sell CHF against the GBP, which is equivalent to buying GBP (the base currency) against the CHF. Hence, the *offer* side of the market will be used for forward points. The all-in forward price will be 1.2941 + (−54.0/10,000) = 1.28870.

3. Some time ago, Laurier Bay Capital, an investment fund based in Los Angeles, hedged a long exposure to the New Zealand dollar by selling NZD 10 million forward against the USD; the all-in forward price was 0.7900 (USD/NZD). Three months prior to the settlement date, Laurier Bay wants to mark this forward position to market. The bid–offer for the USD/NZD spot rate, the three-month forward points, and the three-month MRRs (annualized) are as follows:

Spot rate (USD/NZD)	0.7825/0.7830
Three-month points	−12.1/−10.0
Three-month MRR (NZD)	3.31%
Three-month MRR (USD)	0.31%

   The mark-to-market value for Laurier Bay's forward position is *closest* to:

   A. −USD 87,100.

   B. +USD 77,437.

   C. +USD 79,938.

   Solution

   C is correct. Laurier Bay sold NZD 10 million forward to the settlement date at an all-in forward rate of 0.7900 (USD/NZD). To mark this position to market, the fund would need an offsetting forward transaction involving buying NZD 10 million three months forward to the settlement date. The NZD amounts on the settlement date net to zero. For the offsetting forward contract, because the NZD is the base currency in the USD/NZD quote, buying NZD forward means paying the offer for both the spot rate and the forward points. This scenario leads to an all-in three-month forward rate of 0.7830 − 0.0010 = 0.7820. On the settlement day, Laurier Bay will receive USD 7,900,000 (NZD 10,000,000 × 0.7900 USD/NZD) from the original forward contract and pay out USD 7,820,000 (NZD 10,000,000 × 0.7820 USD/

NZD) based on the offsetting forward contract. The result is a net cash flow on the settlement day of 10,000,000 × (0.7900 – 0.7820) = +USD 80,000. This is a cash inflow because Laurier Bay sold the NZD forward and the NZD depreciated against the USD. This USD cash inflow will occur in three months. To calculate the mark-to-market value of the original forward position, we need to calculate the present value of this USD cash inflow using the three-month USD discount rate (we use USD MRR for this purpose):

$$\frac{\text{USD } 80,000}{1 + 0.0031\left(\frac{90}{360}\right)} = +\text{USD } 79,938.$$

4. Now, suppose that instead of having a long exposure to the NZD, Laurier Bay Capital had a long forward exposure to the USD, which it hedged by selling USD 10 million forward against the NZD at an all-in forward rate of 0.7900 (USD/NZD). Three months prior to settlement date, it wants to close out this short USD forward position.

   Using the above table, the mark-to-market value for Laurier Bay's short USD forward position is *closest* to:

   A. –NZD 141,117.

   B. –NZD 139,959.

   C. –NZD 87,100.

Solution

B is correct. Laurier Bay initially sold USD 10 million forward, and it will have to buy USD 10 million forward to the same settlement date (i.e., in three months' time) in order to close out the initial position. Buying USD using the USD/NZD currency pair is the same as selling the NZD. Because the NZD is the base currency in the USD/NZD quote, selling the NZD means calculating the *bid* rate:

0.7825 + (−12.1/10,000) = 0.78129.

At settlement, the USD amounts will net to zero (USD 10 million both bought and sold). The NZD amounts will not net to zero, however, because the all-in forward rate changed between the time Laurier Bay initiated the original position and the time it closed out this position. At initiation, Laurier Bay contracted to sell USD 10 million and receive NZD 12,658,228 (i.e., 10,000,000/0.7900) on the settlement date. To close out the original forward contract, Laurier Bay entered into an offsetting forward contract to receive USD 10 million and pay out NZD 12,799,345 (i.e., 10,000,000/0.78129) at settlement. The difference between the NZD amounts that Laurier Bay will receive and pay out on the settlement date equals

NZD 12,658,228 − NZD 12,799,345 = −NZD 141,117.

This is a cash *outflow* for Laurier Bay because the fund was *short* the USD in the original forward position and the USD subsequently *appreciated* (i.e., the NZD subsequently depreciated, because the all-in forward rate in USD/NZD dropped from 0.7900 to 0.78129). This NZD cash outflow occurs in three months' time, and we must calculate its present value using the three-month NZD MRR:

$$\frac{-\text{NZD } 141,117}{1 + 0.0331\left(\frac{90}{360}\right)} = -\text{NZD } 139,959.$$

INTERNATIONAL PARITY CONDITIONS

6

☐ explain international parity conditions (covered and uncovered interest rate parity, forward rate parity, purchasing power parity, and the international Fisher effect)

Having reviewed the basic tools of the FX market, we now turn our focus to how they are used in practice. At the heart of the trading decision in FX markets lies a view on equilibrium market prices. An understanding of equilibrium pricing will assist the investor in framing decisions regarding risk exposures and how they should be managed.

In this and the following sections, we lay out a framework for developing a view on equilibrium exchange rates. We begin by examining international parity conditions, which describe the inter-relationships that jointly determine *long-run* movements in exchange rates, interest rates, and inflation. These parity conditions are the basic building blocks for describing long-term equilibrium levels for exchange rates. In subsequent sections, we expand beyond the parity conditions by discussing other factors that influence a currency's value.

Always keep in mind that exchange rate movements reflect complex interactions among multiple forces. In trying to untangle this complex web of interactions, we must clearly delineate the following concepts:

1. Long run versus short run: Many of the factors that determine exchange rate movements exert subtle but persistent influences over long periods of time. Although a poor guide for short-term prediction, longer-term equilibrium values act as an anchor for exchange rate movements.
2. Expected versus unexpected changes: In reasonably efficient markets, prices will adjust to reflect market participants' expectations of future developments. When a key factor—say, inflation—is trending gradually in a particular direction, market pricing will eventually come to reflect expectations that this trend will continue. In contrast, large, unexpected movements in a variable (for example, a central bank intervening in the foreign exchange market) can lead to immediate, discrete price adjustments. This concept is closely related to risk. For example, a moderate but steady rate of inflation will not have the same effect on market participants as an inflation rate that is very unpredictable. The latter clearly describes a riskier financial environment. Market pricing will reflect risk premiums—that is, the compensation that traders and investors demand for being exposed to unpredictable outcomes. Whereas expectations of long-run equilibrium values tend to evolve slowly, risk premiums—which are closely related to confidence and reputation—can change quickly in response to unexpected developments.
3. Relative movements: An exchange rate represents the relative price of one currency in terms of another. Hence, for exchange rate determination, the level or variability of key factors in any particular country is typically much less important than the *differences* in these factors across countries. For example, knowing that inflation is increasing in Country A may not give much insight into the direction of the A/B exchange rate without also knowing what is happening with the inflation rate in Country B.

As a final word of caution—and this cannot be emphasized enough—*there is no simple formula, model, or approach that will allow market participants to precisely forecast exchange rates.* Models that work well in one period may fail in others. Models that work for one set of exchange rates may fail to work for others.

Nonetheless, market participants must have a market view to guide their decisions, even if this view requires significant revision as new information becomes available. The following sections provide a framework for understanding FX markets, a guide for thinking through the complex forces driving exchange rates. As with all theory, however, it does not eliminate the need for insightful analysis of actual economic and market conditions.

International Parity Conditions

International parity conditions form the building blocks of most models of exchange rate determination. The key international parity conditions are as follows:

1. covered interest rate parity,
2. uncovered interest rate parity,
3. forward rate parity,
4. purchasing power parity, and
5. the international Fisher effect.

Parity conditions show how expected inflation differentials, interest rate differentials, forward exchange rates, current spot exchange rates, and expected future spot exchange rates would be linked in an ideal world. These conditions typically make simplifying assumptions, such as zero transaction costs, perfect information that is available to all market participants, risk neutrality, and freely adjustable market prices.

Although empirical studies have found that the parity conditions rarely hold in the short term, they do help form a broadly based, long-term view of exchange rates and accompanying risk exposures. The exception to the rule that parity conditions do not hold in the short term is covered interest rate parity, which is the only parity condition that is enforced by arbitrage. We examine this parity condition first.

7 COVERED AND UNCOVERED INTEREST RATE PARITY AND FORWARD RATE PARITY

- ☐ explain international parity conditions (covered and uncovered interest rate parity, forward rate parity, purchasing power parity, and the international Fisher effect)
- ☐ describe relations among the international parity conditions
- ☐ evaluate the use of the current spot rate, the forward rate, purchasing power parity, and uncovered interest parity to forecast future spot exchange rates

We have already discussed covered interest rate parity in our examination of forward exchange rates. Under this parity condition, *an investment in a foreign money market instrument that is completely hedged against exchange rate risk should yield exactly the same return as an otherwise identical domestic money market investment.* Given the spot exchange rate and the domestic and foreign yields, the forward exchange rate must equal the rate that gives these two alternative investment strategies—invest either in a domestic money market instrument or in a fully currency-hedged foreign money market instrument—exactly the same holding period return. If one strategy gave a higher holding period return than the other, then an investor could short-sell the lower-yielding approach and invest the proceeds in the higher-yielding approach, earning riskless arbitrage profits in the process. In real-world financial markets, such a disparity will be quickly arbitraged away so that no further arbitrage profits are available. Covered interest rate parity is thus said to be a no-arbitrage condition.

For covered interest rate parity to hold exactly, it must be assumed that there are zero transaction costs and that the underlying domestic and foreign money market instruments being compared are identical in terms of liquidity, maturity, and default risk. Where capital is permitted to flow freely, spot and forward exchange markets are liquid, and financial market conditions are relatively stress free, covered interest rate differentials are generally found to be close to zero and covered interest rate parity holds.

Uncovered Interest Rate Parity

According to the **uncovered interest rate parity** condition, the *expected* return on an uncovered (i.e., unhedged) foreign currency investment should equal the return on a comparable domestic currency investment. Uncovered interest rate parity states that *the change in spot rate over the investment horizon should, on average, equal the differential in interest rates between the two countries. That is, the expected appreciation/depreciation of the exchange rate will just offset the yield differential.*

To explain the intuition behind this concept, let's switch, as we did with the examples for covered interest rate parity, from the standard price/base currency notation (P/B) to foreign/domestic currency notation (*f*/*d*) in order to emphasize the choice between foreign and domestic investments. As before, we also will assume that for the investor, the base currency is the domestic currency. (In *covered* interest rate parity, we assumed the investor transacted at a forward rate that was locked in at strategy initiation. In *uncovered* interest rate parity, the investor is assumed to transact at a future spot rate that is unknown at the time the strategy is initiated and the investor's currency position in the future is not hedged—that is, uncovered.)

For our example, assume that this investor has a choice between a one-year domestic money market instrument and an unhedged one-year foreign-currency-denominated money market investment. Under the assumption of uncovered interest rate parity, the investor will compare the *known* return on the domestic investment with the *expected* all-in return on the unhedged foreign-currency-denominated investment (which includes the foreign yield as well as any movements in the exchange rate, in $S_{f/d}$ terms). The choice between these two investments will depend on which market offers the higher expected return on an unhedged basis.

For example, assume that the return on the one-year foreign money market instrument is 10% while the return on the one-year domestic money market instrument is 4%. From the investor's perspective, the 4% expected return on the one-year domestic investment in domestic currency terms is known with complete certainty. This is not the case for the uncovered investment in the foreign currency money market instrument. In domestic currency terms, the investment return on an uncovered (or unhedged) foreign-currency-denominated investment is equal to $\left(1 + i_f\right)\left(1 - \%\Delta S_{f/d}\right) - 1$.

Intuitively, the formula says that the investor's return on a foreign investment is a function of both the foreign interest rate and the change in the spot rate, whereby a depreciation in the foreign currency reduces the investor's return. The percentage change in $S_{f/d}$ enters with a minus sign because an *increase* in $S_{f/d}$ means the foreign currency *declines* in value, thereby reducing the all-in return from the domestic currency perspective of our investor. This all-in return depends on *future* movements in the $S_{f/d}$ rate, which cannot be known until the end of the period. This return can be approximated by $\cong i_f - \%\Delta S_{f/d}$.

Note that this approximate formula holds because the product ($i \times \%\Delta S$) is small compared with the interest rate (i) and the percentage change in the exchange rate ($\%\Delta S$). For simplicity of exposition, we will use the ≅ symbol when we introduce an approximation but will subsequently treat the relationship as an equality (=) unless the distinction is important for the issue being discussed.

Using the previous example, consider three cases:

1. The $S_{f/d}$ rate is expected to remain unchanged.
2. The domestic currency is expected to appreciate by 10%.
3. The domestic currency is expected to appreciate by 6%.

In the first case, the investor would prefer the foreign-currency-denominated money market investment because it offers a 10% (= 10% − 0%) expected return, while the comparable domestic investment offers only 4%. In the second case, the investor would prefer the domestic investment because the expected return on the foreign-currency-denominated investment is 0% (= 10% − 10%). In the third case, uncovered interest rate parity holds because both investments offer a 4% (for the foreign investment, 10% − 6%) expected return. In this case, the risk-neutral investor is assumed to be indifferent between the alternatives.

Note that in the third case, in which uncovered interest rate parity holds, while the *expected* return over the one-year investment horizon is the same for both instruments, that expected return is *just a point on the distribution* of possible total return outcomes. The all-in return on the foreign money market instrument is uncertain because the *future* $S_{f/d}$ rate is uncertain. Hence, when we say that the investor would be indifferent between owning domestic and foreign investments because they both offer the same *expected* return (4%), we are assuming that the investor is *risk neutral* (risk-neutral investors base their decisions solely on the expected return and are indifferent to the investments' risk). Thus, uncovered interest rate parity assumes that there are enough risk-neutral investors to force equality of expected returns.

Using our example's foreign/domestic (*f*/*d*) notation, uncovered interest rate parity says the expected change in the spot exchange rate over the investment horizon should be reflected in the interest rate differential:

$$\%\Delta S^e_{f/d} = i_f - i_d, \qquad (2)$$

where ΔS^e indicates the change in the spot rate expected for *future* periods. Note that Equation 2 cannot hold simultaneously for $S_{f/d}$ and $S_{d/f}$ (= $1/S_{f/d}$) because their percentage changes are not of exactly equal magnitude. This reflects our earlier approximation. Using the exact return on the unhedged foreign instrument would alleviate this issue but would produce a less intuitive equation.

In our example, if the yield spread between the foreign and domestic investments is 6% ($i_f - i_d$ = 6%), then this spread implicitly reflects the expectation that the domestic currency will strengthen versus the foreign currency by 6%.

Uncovered interest rate parity assumes that the country with the *higher* interest rate or money market yield will see its currency *depreciate*. The depreciation of the currency offsets the initial higher yield so that the (expected) all-in return on the two investment choices is the same. Hence, if the uncovered interest rate parity condition held consistently in the real world, it would rule out the possibility of earning excess returns from going long a high-yield currency and going short a low-yield currency: The depreciation of the high-yield currency would exactly offset the yield advantage that the high-yield currency offers. Taking this scenario to its logical conclusion, if uncovered interest rate parity held at all times, investors would have no incentive to shift capital from one currency to another because expected returns on otherwise identical money market investments would be equal across markets and risk-neutral investors would be indifferent among them.