READING

18

Currency Exchange Rates

by William A. Barker, PhD, CFA, Paul D. McNelis, and Jerry Nickelsburg

William A. Barker, PhD, CFA (Canada). Paul D. McNelis is at Gabelli School of Business, Fordham University (USA). Jerry Nickelsburg (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** define an exchange rate and distinguish between nominal and real exchange rates and spot and forward exchange rates;
☐	**b.** describe functions of and participants in the foreign exchange market;
☐	**c.** calculate and interpret the percentage change in a currency relative to another currency;
☐	**d.** calculate and interpret currency cross-rates;
☐	**e.** convert forward quotations expressed on a points basis or in percentage terms into an outright forward quotation;
☐	**f.** explain the arbitrage relationship between spot rates, forward rates, and interest rates;
☐	**g.** calculate and interpret a forward discount or premium;
☐	**h.** calculate and interpret the forward rate consistent with the spot rate and the interest rate in each currency;
☐	**i.** describe exchange rate regimes;
☐	**j.** explain the effects of exchange rates on countries' international trade and capital flows.

INTRODUCTION 1

Measured by daily turnover, the foreign exchange (FX) market—the market in which currencies are traded against each other—is by far the world's largest market. Current estimates put daily turnover at approximately USD5.1 trillion for 2016. This is about 10 to 15 times larger than daily turnover in global fixed-income markets and about 50 times larger than global turnover in equities.

The FX market is also a truly global market that operates 24 hours a day, each business day. It involves market participants from every time zone connected through electronic communications networks that link players as large as multibillion-dollar investment funds and as small as individuals trading for their own account—all brought together in real time. International trade would be impossible without the trade in currencies that facilitates it, and so too would cross-border capital flows that connect all financial markets globally through the FX market.

These factors make foreign exchange a key market for investors and market participants to understand. The world economy is increasingly transnational in nature, with both production processes and trade flows often determined more by global factors than by domestic considerations. Likewise, investment portfolio performance increasingly reflects global determinants because pricing in financial markets responds to the array of investment opportunities available worldwide, not just locally. All of these factors funnel through, and are reflected in, the foreign exchange market. As investors shed their "home bias" and invest in foreign markets, the exchange rate—the price at which foreign-currency-denominated investments are valued in terms of the domestic currency—becomes an increasingly important determinant of portfolio performance.

Even investors adhering to a purely "domestic" portfolio mandate are increasingly affected by what happens in the foreign exchange market. Given the globalization of the world economy, most large companies depend heavily on their foreign operations (for example, by some estimates about 30 percent of S&P 500 Index earnings are from outside the United States). Almost all companies are exposed to some degree of foreign competition, and the pricing for domestic assets—equities, bonds, real estate, and others—will also depend on demand from foreign investors. All of these various influences on investment performance reflect developments in the foreign exchange market.

This reading introduces the foreign exchange market, providing the basic concepts and terminology necessary to understand exchange rates as well as some of the basics of exchange rate economics.

The reading is divided up as follows. Section 2 describes the organization of the foreign exchange market and discusses the major players—who they are, how they conduct their business, and how they respond to exchange rate changes. Section 3 takes up the mechanics of exchange rates: definitions, quotes, and calculations. This section shows that the reader has to pay close attention to conventions used in various foreign exchange markets around the world because they can vary widely. Sometimes exchange rates are quoted in the number of domestic currency units per unit of foreign currency, and sometimes they are quoted in the opposite way. The exact notation used to represent exchange rates can vary widely as well, and occasionally the same exchange rate notation will be used by different sources to mean completely different things. The notation used here may not be the same as that encountered elsewhere. Therefore, the focus should be on understanding the underlying concepts rather than relying on rote memorization of formulas. We also show how to calculate cross-exchange rates and how to compute the forward exchange rate given either the forward points or the percentage forward premium or discount. In Section 4, we discuss alternative exchange rate regimes operating throughout the world. Finally, in Section 5, we discuss how exchange rates affect a country's international trade (exports and imports) and capital flows. A summary and practice problems conclude the reading.

THE FOREIGN EXCHANGE MARKET

2

To understand the FX market, it is necessary to become familiar with some of its basic conventions. Individual currencies are often referred to by standardized three-letter codes that the market has agreed upon through the International Organization for Standardization (ISO). Exhibit 1 lists some of the major global currencies and their identification codes.

Exhibit 1 Standard Currency Codes

Three-Letter Currency Code	Currency
USD	US dollar
EUR	Euro
JPY	Japanese yen
GBP	British pound
CHF	Swiss franc
CAD	Canadian dollar
AUD	Australian dollar
NZD	New Zealand dollar
ZAR	South African rand
SEK	Swedish krona
NOK	Norwegian krone
BRL	Brazilian real
SGD	Singapore dollar
MXN	Mexican peso
CNY	Chinese yuan
HKD	Hong Kong dollar
INR	Indian rupee
KRW	South Korean won
RUB	Russian ruble

It is important to understand that there is a difference between referring to an *individual currency* and an *exchange rate*. One can hold an individual currency (for example, in a EUR100 million deposit), but an exchange rate refers to the price of one currency in terms of another (for example, the exchange rate between the EUR and USD). An individual currency can be singular, but there are always two currencies involved in an exchange rate: the price of one currency relative to another. The exchange rate is the number of units of one currency (called the *price currency*) that one unit of another currency (called the *base currency*) will buy. An equivalent way of describing the exchange rate is as the cost of one unit of the base currency in terms of the price currency.

This distinction between individual currencies and exchange rates is important because, as we will see in a later section, these three-letter currency codes can be used both ways. (For example, when used as an exchange rate in the professional FX market, EUR is understood to be the exchange rate between the euro and US dollar). But be aware of the context (either as a currency or as an exchange rate) in which these three-letter currency codes are being used. To avoid confusion, this reading will identify exchange rates using the convention of "A/B," referring to the number of

units of currency A that one unit of currency B will buy. For example, a USD/EUR exchange rate of 1.1700 means that 1 euro will buy 1.1700 US dollars (i.e., 1 euro costs 1.1700 US dollars).[1] In this case, the euro is the base currency and the US dollar is the price currency. A decrease in this exchange rate would mean that the euro costs less or that fewer US dollars are needed to buy one euro. In other words, a decline in this exchange rate indicates that the USD is *appreciating* against the EUR or, equivalently, the EUR is *depreciating* against the USD.

The exchange rates described above are referred to as *nominal* exchange rates. This is to distinguish them from *real* exchange rates, which are indexes often constructed by economists and other market analysts to assess changes in the relative purchasing power of one currency compared with another. Creating these indexes requires adjusting the nominal exchange rate by using the price levels in each country of the currency pair (hence the name "real exchange rates") in order to compare the relative purchasing power between countries.

In a world of homogenous goods and services and with no market frictions or trade barriers, the relative purchasing power across countries would tend to equalize: Why would you pay more, in real terms, domestically for a "widget" if you could import an identical "widget" from overseas at a cheaper price? This basic concept is the intuition behind a theory known as "purchasing power parity" (PPP), which describes the long-term equilibrium of nominal exchange rates. PPP asserts that nominal exchange rates adjust so that identical goods (or baskets of goods) will have the same price in different markets. Or, put differently, the purchasing power of different currencies is equalized for a standardized basket of goods.

In practice, the conditions required to enforce PPP are not satisfied: Goods and services are not identical across countries; countries typically have different baskets of goods and services produced and consumed; many goods and services are not traded internationally; there are trade barriers and transaction costs (e.g., shipping costs and import taxes); and capital flows are at least as important as trade flows in determining nominal exchange rates. As a result, nominal exchange rates exhibit persistent deviations from PPP. Moreover, relative purchasing power among countries displays a weak, if any, tendency toward long-term equalization. A simple example of a cross-country comparison of the purchasing power of a standardized good is the "Big Mac" index produced by the *Economist*, which shows the relative price of this standardized hamburger in different countries. The Big Mac index shows that fast-food hamburger prices can vary widely internationally and that this difference in purchasing power is typical of most goods and services. Hence, movements in real exchange rates provide meaningful information about changes in relative purchasing power among countries.

Consider the case of an individual who wants to purchase goods from a foreign country. The individual would be able to buy fewer of these goods if the nominal spot exchange rate for the foreign currency appreciated or if the foreign price level increased. Conversely, the individual could buy more foreign goods if the individual's domestic income increased. (For this example, we will assume that changes in the individual's income are proportional to changes in the domestic price level.) Hence, in *real* purchasing power terms, the real exchange rate that an individual faces is an increasing function of the nominal exchange rate (quoted in terms of the number of units of domestic currency per one unit of foreign currency) and the foreign price level and a decreasing function of the domestic price level. The *higher* the real exchange

1 This convention is consistent with the meaning of "/" in mathematics and the straightforward interpretation of "A/B" as "A per B" is helpful in understanding exchange rates as the price of one currency in terms of another. Nevertheless, other notation conventions exist. "B/A" and "B:A" are sometimes used to denote what this reading denotes as "A/B." Careful attention to the context will usually make the convention clear.

rate that this individual faces, the *fewer* foreign goods, in real terms, the individual can purchase and the *lower* that individual's relative purchasing power compared with the other country.

An equivalent way of viewing the real exchange rate is that it represents the relative price levels in the domestic and foreign countries. Mathematically, we can represent the foreign price level in terms of the domestic currency as:

$$\text{Foreign price level in domestic currency} = S_{d/f} \times P_f$$

where $S_{d/f}$ is the spot exchange rate (quoted in terms of the number of units of domestic currency per one unit of foreign currency) and P_f is foreign price level quoted in terms of the foreign currency. We can define the domestic price level, in terms of the domestic currency, as P_d. Hence, the ratio between the foreign and domestic price levels is:

$$\text{Real exchange rate}_{(d/f)} = (S_{d/f} \times P_f)/P_d = S_{d/f} \times (P_f/P_d)$$

For example, for a British consumer wanting to buy goods made in the Eurozone, the real exchange rate (defined in GBP/EUR terms; note that the domestic currency for the United Kingdom is the price currency, not the base currency) will be an increasing function of the nominal spot exchange rate (GBP/EUR) and the Eurozone price level and a decreasing function of the UK price level. This is written as:

$$\text{Real exchange rate}_{\frac{GBP}{EUR}} = S_{\frac{GBP}{EUR}} \times \left(\frac{CPI_{eur}}{CPI_{UK}}\right)$$

Let's examine the effect of movements in the domestic and foreign price levels, and the nominal spot exchange rate, on the real purchasing power of an individual in the United Kingdom wanting to purchase Eurozone goods. Assume that the nominal spot exchange rate (GBP/EUR) increases by 10 percent, the Eurozone price level by 5 percent, and the UK price level by 2 percent. The change in the real exchange rate is then:

$$\left(1 + \frac{\Delta S_{\frac{d}{f}}}{S_{\frac{d}{f}}}\right) \times \frac{\left(1 + \frac{\Delta P_f}{P_f}\right)}{\left(1 + \frac{\Delta P_d}{P_d}\right)} - 1 = (1 + 10\%) \times \frac{1 + 5\%}{1 + 2\%} - 1 \approx 10\% + 5\% - 2\% \approx 13\%$$

In this case, the real exchange rate for the UK-based individual has *increased* about 13 percent, meaning that it now costs *more*, in real terms, to buy Eurozone goods. Or put differently, the UK individual's real purchasing power relative to Eurozone goods has *declined* by about 13 percent. An easy way to remember this relationship is to consider the real exchange rate (stated with the domestic currency as the price currency) as representing the real price you face in order to purchase foreign goods and services: The *higher* the price (real exchange rate), the *lower* your relative purchasing power.

The real exchange rate for a currency can be constructed for the domestic currency relative to a single foreign currency or relative to a basket of foreign currencies. In either case, these real exchange rate indexes depend on the assumptions made by the analyst creating them. Several investment banks and central banks create proprietary measures of real exchange rates. It is important to note that real exchange rates are *not* quoted or traded in global FX markets: They are only indexes created by analysts to understand the international competitiveness of an economy and the real purchasing power of a currency.

In this context, real exchange rates can be useful for understanding trends in international trade and capital flows and hence can be seen as one of the influences on nominal spot exchange rates. As an example, consider the exchange rate between the Indian rupee and the US dollar. During 2018, the nominal rupee exchange rate against the US dollar (INR/USD) rose by approximately 6.7 percent—meaning that

the US dollar appreciated against the rupee. However, the annual inflation rates in the United States and India were different during 2018—approximately 2.5 percent for the United States and 4.7 percent for India. This means that the real exchange rate (in INR/USD terms) was depreciating less rapidly than the nominal INR/USD exchange rate:

$$\left(1 + \%\Delta S_{\frac{INR}{USD}}\right) \times \frac{\left(1 + \%\Delta P_{US}\right)}{\left(1 + \%\Delta P_{India}\right)} - 1 \approx +6.7\% + 2.5\% - 4.7\% \approx 4.5\%$$

This combination of a much weaker rupee and a higher Indian inflation rate meant that the real exchange rate faced by India was increasing, thus decreasing Indian purchasing power in USD terms.

Movements in real exchange rates can have a similar effect as movements in nominal exchange rates in terms of affecting relative prices and hence trade flows. Even if the nominal spot exchange rate does not move, differences in inflation rates between countries affect their relative competitiveness.

Although real exchange rates can exert some influence on nominal exchange rate movements, they are only one of many factors; it can be difficult to disentangle all of these inter-relationships in a complex and dynamic FX market. As discussed earlier, PPP is a poor guide to predicting future movements in nominal exchange rates because these rates can deviate from PPP equilibrium—and even continue to trend away from their PPP level—for years at a time. Hence, it should not be surprising that real exchange rates, which reflect changes in relative purchasing power, have a poor track record as a predictor of future nominal exchange rate movements.

EXAMPLE 1

Nominal and Real Exchange Rates

An investment adviser located in Sydney, Australia, is meeting with a local client who is looking to diversify her domestic bond portfolio by adding investments in fixed-rate, long-term bonds denominated in HKD. The client frequently visits Hong Kong SAR, and many of her annual expenses are denominated in HKD. The client, however, is concerned about the foreign currency risks of offshore investments and whether the investment return on her HKD-denominated investments will maintain her purchasing power—both domestically (i.e., for her AUD-denominated expenses) and in terms of her foreign trips (i.e., denominated in HKD, for her visits to Hong Kong SAR). The investment adviser explains the effect of changes in nominal and real exchange rates to the client and illustrates this explanation by making the following statements:

Statement 1	All else equal, an increase in the nominal AUD/HKD exchange rate will lead to an increase in the AUD-denominated value of your foreign investment.
Statement 2	All else equal, an increase in the nominal AUD/HKD exchange rate means that your relative purchasing power for your Hong Kong SAR trips will increase (based on paying for your trip with the income from your HKD-denominated bonds).
Statement 3	All else equal, an increase in the Australian inflation rate will lead to an increase in the real exchange rate (AUD/HKD). A higher real exchange rate means that the relative purchasing power of your AUD-denominated income is higher.

Statement 4 All else equal, a decrease in the nominal exchange rate (AUD/HKD) will decrease the real exchange rate (AUD/HKD) and increase the relative purchasing power of your AUD-denominated income.

To demonstrate the effects of the changes in inflation and nominal exchange rates on relative purchasing power, the adviser uses the following scenario: "Suppose that the AUD/HKD exchange rate increases by 5 percent, the price of goods and services in Hong Kong SAR goes up by 5 percent, and the price of Australian goods and services goes up by 2 percent."

1 Statement 1 is:

A correct.

B incorrect, because based on the quote convention the investment's value would be decreasing in AUD terms.

C incorrect, because the nominal AUD value of the foreign investments will depend on movements in the Australian inflation rate.

2 Statement 2 is:

A correct.

B incorrect, because purchasing power is not affected in this case.

C incorrect, because based on the quote convention, the client's relative purchasing power would be decreasing.

3 Statement 3 is:

A correct.

B incorrect with respect to the real exchange rate only.

C incorrect with respect to both the real exchange rate and the purchasing power of AUD-denominated income.

4 Statement 4 is:

A correct.

B incorrect with respect to the real exchange rate.

C incorrect with respect to the purchasing power of AUD-denominated income.

5 Based on the adviser's scenario and assuming that the HKD value of the HKD bonds remained unchanged, the nominal AUD value of the client's HKD investments would:

A decrease by about 5 percent.

B increase by about 5 percent.

C remain approximately the same.

6 Based on the adviser's scenario, the change in the relative purchasing power of the client's AUD-denominated income is *closest* to:

A –8 percent.

B +8 percent.

C +12 percent.

Solution to 1:

A is correct. Given the quoting convention, an increase in the AUD/HKD rate means that the base currency (HKD) is appreciating (one HKD will buy more AUD). This is increasing the nominal value of the HKD-denominated investments when measured in AUD terms.

Solution to 2:

B is correct. When paying for HKD-denominated expenses with HKD-denominated income, the value of the AUD/HKD spot exchange rate (or any other spot exchange rate) would not be relevant. In fact, this is a basic principle of currency risk management: reducing FX risk exposures by denominating assets and liabilities (or income and expenses) in the same currency.

Solution to 3:

C is correct. An increase in the Australian (i.e., domestic) inflation rate means that the real exchange rate (measured in domestic/foreign, or AUD/HKD, terms) would be decreasing, not increasing. Moreover, an increase in the real exchange rate ($R_{AUD/HKD}$) would be equivalent to a reduction of the purchasing power of the Australian client: Goods and services denominated in HKD would cost more.

Solution to 4:

A is correct. As the spot AUD/HKD exchange rate decreases, the HKD is depreciating against the AUD; or equivalently, the AUD is appreciating against the HKD. This is reducing the real exchange rate ($R_{AUD/HKD}$) and increasing the Australian client's purchasing power.

Solution to 5:

B is correct. As the AUD/HKD spot exchange rate increases by 5 percent, the HKD is appreciating against the AUD by 5 percent and, all else equal, the value of the HKD-denominated investment is increasing by 5 percent in AUD terms.

Solution to 6:

A is correct. The real exchange rate ($R_{AUD/HKD}$) is expressed as:

$$R_{\frac{AUD}{HKD}} = S_{\frac{AUD}{HKD}} \times \frac{P_{HKD}}{P_{AUD}}$$

The information in the adviser's scenario can be expressed as:

$$\%\Delta R_{\frac{AUD}{HKD}} \approx \%\Delta S_{\frac{AUD}{HKD}} + \%\Delta P_{HKD} - \%\Delta P_{AUD} \approx +5\% + 5\% - 2\% \approx +8\%$$

Because the real exchange rate (expressed in AUD/HKD terms) has gone up by about 8 percent, the real purchasing power of the investor based in Australia has declined by about 8 percent. This can be seen from the fact that HKD has appreciated against the AUD in nominal terms, and the Hong Kong SAR price level has also increased. This increase in the cost of Hong Kong SAR goods and services (measured in AUD) is only partially offset by the small (2 percent) increase in the investor's income (assumed equal to the change in the Australian price level).

2.1 Market Functions

FX markets facilitate international trade in goods and services, where companies and individuals need to make transactions in foreign currencies. This would cover everything from companies and governments buying and selling products in other countries, to tourists engaged in cross-border travel (for example, a German tourist selling euros and buying sterling for a visit to London). Although this is an important dimension of FX markets, and despite the growth of global trade in recent years, an even larger proportion of the daily turnover in FX markets is accounted for by capital market transactions, where investors convert between currencies for the purpose of moving funds into (or out of) foreign assets. These types of transactions cover the

range from direct investments (for example, companies buying such fixed assets as factories) in other countries to portfolio investments (the purchase of stocks, bonds, and other financial assets denominated in foreign currencies). Because capital is extremely mobile in modern financial markets, this ebb and flow of money across international borders and currencies generates a huge and growing volume of FX transactions.

Regardless of the underlying motivation for the FX transaction, it will eventually require that one currency be exchanged for another in the FX market. In advance of that required transaction, market participants are exposed to the risk that the exchange rate will move against them. Often they will try to reduce (hedge) this risk through a variety of FX instruments (described in more detail later). Conversely, market participants may form opinions about future FX movements and undertake speculative FX risk exposures through a variety of FX instruments in order to profit from their views.

The distinction between hedging and speculative positions is not always clear cut. For example, consider the case of a corporation selling its products overseas. This creates an FX risk exposure because the revenue from foreign sales will ultimately need to be converted into the corporation's home currency. This risk exposure is typically hedged, and corporate hedging often accounts for large FX flows passing through the market. The amount and timing of foreign revenue, however, are generally hard to predict with precision: They will depend on the pace of foreign sales, the sales prices realized, the pace at which foreign clients pay for their purchases, and so forth. In the face of this uncertainty, the corporate treasury will estimate the timing and amount of foreign revenue and will then hedge a portion of this estimated amount. Many corporate treasuries have hedging targets based on this estimate, but they also have the flexibility to under-hedge or over-hedge based on their opinions about future FX rate movements. In order to judge the effectiveness of these discretionary trades, the performance of the corporate treasury is compared with a benchmark, usually stated in terms of a fixed amount hedged relative to total sales. (For example, the benchmark may be a 100 percent fully hedged position. The profitability of the hedge actually implemented—which, based on the treasury's discretion, can vary above or below 100 percent—is then compared with what would have been achieved with a passive, 100 percent fully hedged position.) Treasury managers' performance is judged based on gains or losses relative to the benchmark, just as an investment fund manager's performance is benchmarked against performance targets.

At the other end of the spectrum between hedging and speculation, consider the archetypical speculative account: a hedge fund. Although it is true that hedge funds will seek out, accept, and manage risk for profit, a hedge fund is, after all, a hedge fund: Strict risk control procedures are critical to the fund's success, especially when leverage is involved. This mixture of speculative and hedging motives is common throughout the FX space as market participants shape their FX exposures to suit their market forecasts, operational mandates, and appetites for risk.

The FX market provides a variety of products that provide the flexibility to meet this varied and complex set of financial goals. *Spot* transactions involve the exchange of currencies for immediate delivery. For most currencies, this corresponds to "T + 2" delivery, meaning that the exchange of currencies is settled two business days after the trade is agreed to by the two sides of the deal. (One exception is the Canadian dollar, for which spot settlement against the US dollar is on a T + 1 basis.) The exchange rate used for these spot transactions is referred to as the spot exchange rate, and it is the exchange rate that most people refer to in their daily lives (for example, this is the exchange rate usually quoted by the financial press, on the evening news, and so forth).

It is important to realize, however, that spot transactions make up only a minority of total daily turnover in the global FX market: The rest is accounted for by trade in outright forward contracts, FX swaps, and FX options. Although these products will be covered in more depth in a subsequent section, and at Level II of the CFA curriculum, we will provide a brief introduction to these products here.

Outright *forward contracts* (often referred to simply as forwards) are agreements to deliver foreign exchange at a future date at an exchange rate agreed upon today. For example, suppose that a UK-based company expects to receive a payment of 100 million euros in 85 days. Although it could convert these euros to British pounds with a spot transaction (the spot rate would be the GBP/EUR rate in 83 days, because of T + 2 settlement), this future spot rate is currently unknown and represents a foreign exchange risk to the company. The company can avoid this risk by entering into a transaction with a foreign exchange dealer to sell 100 million euros against the British pound for settlement 85 days from today at a rate—the forward exchange rate—agreed upon today.

As such, forward contracts are any exchange rate transactions that occur with currency settlement longer than the usual T + 2 settlement for spot delivery. Each of these contracts requires two specifications: the date at which the currencies are to be exchanged and the exchange rate to be applied on the settlement date. Accordingly, exchange rates for these transactions are called *forward exchange rates* to distinguish them from spot rates.

Dealers will typically quote forward rates for a variety of standard forward settlement dates (for example, one week, one month, or 90 days) on their dealing screens. In an over-the-counter (OTC) market, however, traders can arrange forward settlement at *any* future date they agree upon, with the forward exchange rate scaled appropriately for the specific term to settlement. Standard forward settlement dates (such as three months) are defined in terms of the spot settlement date, which is generally T + 2. For example, if today is 18 October and spot settlement is for 20 October, then a three-month forward settlement would be defined as 20 January of the following year. Note as well that these standard forward settlement dates may not always be good business days: 20 January could be a weekend or a holiday. In that case, the forward settlement date is set to the closest good business day. Traders always confirm the exact forward settlement date when making these types of trades, and the forward rate is scaled by the exact number of days to settlement.

In an OTC market, the size of the forward contracts can also be any size that the two counterparties agree upon. In general, however, liquidity in forward markets declines the longer the term to maturity and the larger the trade size. The concept of the forward exchange rate and exchange hedging is developed further in Section 3.

Although the OTC market accounts for the majority of foreign exchange trades with future (i.e., greater than T + 2) settlement dates, there is also a deep, liquid market in exchange-traded *futures* contracts for currencies. Although there are technical differences between futures and forward contracts, the basic concept is the same: The price is set today for settlement on a specified future date. Futures contracts on currencies trade on several exchanges globally, but the majority of volume in exchange-traded currency futures contracts is found on the International Monetary Market (IMM) division of the Chicago Mercantile Exchange (CME). Futures contracts differ from OTC forward contracts in several important ways: They trade on exchanges (such as the CME) rather than OTC; they are only available for fixed contract amounts and fixed settlement dates; the exchanges demand that a fixed amount of collateral be posted against the futures contract trade; and this collateral is marked-to-market daily, with counterparties asked to post further collateral if their positions generate losses. On balance, futures contracts are somewhat less flexible than forward contracts. Nonetheless, they provide deep, liquid markets for deferred delivery with a minimum of counterparty (i.e., default) risk—a proposition that many FX traders find attractive. Accordingly, daily turnover in FX futures contracts is huge. As of 2010, the average daily trading volume of FX futures on the CME alone was estimated to be about USD140 billion, which is almost comparable in size to the interbank volume of spot transactions.

Because forward contracts eventually expire, existing speculative positions or FX hedges that need to be extended must be rolled prior to their settlement dates. This typically involves a spot transaction to offset (settle) the expiring forward contract and a new forward contract to be set at a new, more distant settlement date. The combination of an offsetting spot transaction and a new forward contract is referred to as an **FX swap**.[2]

An FX swap is best illustrated by an example. Suppose that a trader sells 100 million euros with settlement 95 days from today at a forward exchange rate (USD/EUR) of 1.2000. In 93 days, the forward contract is two days from settlement, specifically the T + 2 days to spot settlement. To roll the forward contract, the trader will engage in the following FX swap. First, the trader will need to buy 100 million euros spot, for which T + 2 settlement will fall on day 95, the same day as the settlement of the expiring forward contract. The purchase of the 100 million euros spot will be used to satisfy the delivery of the 100 million euros sold in the expiring forward contract. Because 100 million euros are being both bought and sold on day 95, there is no exchange of euros between counterparties on that day: The amounts net to zero. However, there will be an exchange of US dollars, reflecting the movement in exchange rates between the date the forward contract was agreed to (day 0) and day 93. Suppose that on day 93 the spot exchange rate for USD/EUR is 1.1900. This means that the trader will see a cash flow on day 95 of USD1,000,000. This is calculated as follows:

$$\text{EUR}100{,}000{,}000 \times (1.2000 - 1.1900) = \text{USD}1{,}000{,}000$$

The trader receives USD1,000,000 from the counterparty because the euro was *sold* forward to day 95 at a price of 1.2000; it was *bought* (on day 93) for spot settlement on day 95 at a price of 1.1900. This *price* movement in the euro indicates a profit to the trader, but because the euro *quantities* exchanged on day 95 net to zero (100,000,000 euros both bought and sold), this cash flow is realized in US dollars. The second leg of the FX swap is then to initiate a new forward sale of 100 million euros at the USD/EUR forward exchange rate being quoted on day 93. This renews the forward position (a forward sale of the euro) to a new date.

FX swaps will be dealt with in more detail at Level II in the curriculum. For the purposes of this reading, it is only necessary to understand that (1) an FX swap consists of a simultaneous spot and forward transaction; (2) these swap transactions can extend (roll) an existing forward position to a new future date; and (3) rolling the position forward leads to a cash flow on settlement day. This cash flow can be thought of as a mark-to-market on the forward position. FX swaps are a large component of daily FX market turnover because market participants have to roll over existing speculative or hedging positions as the underlying forward contracts mature in order to extend the hedge or speculative position (otherwise, the position is closed out on the forward settlement date).

One other area where FX swaps are used in FX markets also bears mentioning: They are often used by market participants as a funding source (called swap funding). Consider the case of a UK-based firm that needs to borrow GBP100 million for 90 days, starting 2 days from today. One way to do this is simply to borrow 90-day money in GBP-denominated funds starting at T + 2. An alternative is to borrow in US dollars and exchange these for British pounds in the spot FX market (both with T + 2 settlement) and then sell British pounds 90 days forward against the US dollar. (Recall that the maturity of a forward rate contract is defined in terms of the spot settlement date, so the 90-day forward rate would be for settlement in 92 days from today.) The company has the use of GBP100 million for 90 days, starting on T + 2, and at the end of this

2 Note that an "FX swap" is not the same as a "currency swap." An FX swap is simply the combination of a spot and a forward FX transaction (i.e., only two settlement dates—spot and forward—are involved). A currency swap is generally used for multiple periods and payments.

period can pay off the US dollar loan at a known, pre-determined exchange rate (the 90-day forward rate). By engaging in simultaneous spot and forward transactions (i.e., an FX swap), the company has eliminated any FX risk from the foreign borrowing. The all-in financing rate using an FX swap will typically be close to that of domestic borrowing, usually within a few basis points. This near equivalence is enforced by an arbitrage relationship that will be described in Section 3.3. On large borrowing amounts, however, even a small differential can add up to substantial cost savings.

Another way to hedge FX exposures, or implement speculative FX positions, is to use options on currencies. FX options are contracts that, for an upfront premium or fee, give the purchaser the right, but not the obligation, to make an FX transaction at some future date at an exchange rate agreed upon today (when the contract is agreed to). The holder of an FX option will exercise the option only if it is advantageous to do so—that is, if the agreed upon exchange rate for the FX option contract is better than the FX rate available in the market at option expiry. As such, options are extremely flexible tools for managing FX exposures and account for a large percentage of daily turnover in the FX market.

Another concept to bear in mind is that spot, forward, swap, and option products are typically not used in isolation. Most major market participants manage their FX transactions and FX risk exposures through concurrent spot, forward, swap, and option positions. Taken together, these instruments (the building blocks of the FX market) provide an extremely flexible way for market participants to shape their FX risk exposures to match their operational mandate, risk tolerance, and market opinion. Moreover, FX transactions are often made in conjunction with transactions in other financial markets—such as equities, fixed income, and commodities. These markets have a variety of instruments as well, and market participants jointly tailor their *overall* position simultaneously using the building blocks of the FX market and these other markets.

EXAMPLE 2

Spot and Forward Exchange Rates

The investment adviser based in Sydney, Australia, continues her meeting with the local client who has diversified her domestic bond portfolio by adding investments in fixed-rate, long-term bonds denominated in HKD. Given that the client spends most of the year in Australia, she remains concerned about the foreign exchange risk of her foreign investments and asks the adviser how these might be managed. The investment adviser explains the difference between spot and forward exchange rates and their role in determining foreign exchange risk exposures. The investment adviser suggests the following investment strategy to the client: "You can exchange AUD for HKD in the spot exchange market, invest in a risk-free, one-year HKD-denominated zero coupon bond, and use a one-year forward contract for converting the proceeds back into AUD."

Spot exchange rate (AUD/HKD)	0.1714
One-year HKD interest rate	2.20%
One-year forward exchange rate (AUD/HKD)	0.1724

1 Which of the following statements is *most* correct? Over a one-year horizon, the exchange rate risk of the client's investment in HKD-denominated bonds is determined by uncertainty over:

A today's AUD/HKD forward rate.

B the AUD/HKD spot rate one year from now.

C the AUD/HKD forward rate one year from now.

2 To reduce the exchange rate risk of the Hong Kong SAR investment, the client should:

A sell AUD spot.

B sell AUD forward.

C sell HKD forward.

3 Over a one-year horizon, the investment proposed by the investment adviser is *most* likely:

A risk free.

B exposed to interest rate risk.

C exposed to exchange rate risk.

4 To set up the investment proposed by the adviser, the client would need to:

A sell AUD spot; sell a one-year, HKD-denominated bond; and buy AUD forward.

B buy AUD spot; buy a one-year, HKD-denominated bond; and sell AUD forward.

C sell AUD spot; buy a one-year, HKD-denominated bond; and buy AUD forward.

5 The return (in AUD) on the investment proposed by the investment adviser is *closest* to:

A 2.00 percent.

B 3.00 percent.

C 5.00 percent.

Solution to 1:

B is correct. The exchange rate risk (for an unhedged investment) is defined by the uncertainty over future spot rates. In this case, the relevant spot rate is that which would prevail one year from now. Forward rates that would be in effect one year from now would be irrelevant, and the current forward rate is known with certainty.

Solution to 2:

C is correct. The Australian-based investor owns HKD-denominated bonds, meaning that she is long HKD exposure. To hedge this exposure, she could enter into a forward contract to sell the HKD against the AUD for future delivery (that is, match a long HKD exposure in the cash market with a short HKD exposure in the derivatives market). The forward rate is established at the time the forward contract is entered into, eliminating any uncertainty about what exchange rate would be used to convert HKD-denominated cash flows back into AUD.

Solution to 3:

A is correct. The investment is risk free because the investment is based on a risk-free, one-year, zero coupon, HKD-denominated bond—meaning there is no default or reinvestment risk. The investment will mature in one-year at par; there is no interest rate risk. The use of a forward contract to convert the HKD-denominated proceeds back to AUD eliminates any exchange rate risk.

Solution to 4:

C is correct. To create the investment, the client needs to convert AUD to HKD in the spot exchange market, invest in (buy) the one-year HKD bond, and sell the HKD forward/buy the AUD forward. Note that this process is directly comparable to the swap financing approach described in this section of the reading.

Solution to 5:

B is correct. Converting one AUD to HKD in the spot market gives the client (1/0.1714) = HKD5.83. Investing this for one year leads to 5.83 × (1.022) = HKD5.96. Selling this amount of HKD at the forward rate gives 5.96 × 0.1724= AUD1.028 (rounding to three decimal places). This implies an AUD-denominated return of 2.8 percent which rounds up to 3 percent.

2.2 Market Participants

We now turn to the counterparties that participate in FX markets. As mentioned previously, there is an extremely diverse range of market participants, ranging in size from multi-billion-dollar investment funds down to individuals trading for their own account (including foreign tourists exchanging currencies at airport kiosks).

To understand the various market participants, it is useful to separate them into broad categories. One broad distinction is between what the market refers to as the *buy side* and the *sell side*. The sell side generally consists of large FX trading banks (such as Citigroup, UBS, and Deutsche Bank); the buy side consists of clients who use these banks to undertake FX transactions (i.e., buy FX products) from the sell-side banks.

The buy side can be further broken down into several categories:

- *Corporate accounts*: Corporations of all sizes undertake FX transactions during cross-border purchases and sales of goods and services. Many of their FX flows can also be related to cross-border investment flows—such as international mergers and acquisitions (M&A) transactions, investment of corporate funds in foreign assets, and foreign currency borrowing.
- *Real money accounts*: These are investment funds managed by insurance companies, mutual funds, pension funds, endowments, exchange-traded funds (ETFs), and other institutional investors. These accounts are referred to as real money because they are usually restricted in their use of leverage or financial derivatives. This distinguishes them from leveraged accounts (discussed next); although, many institutional investors often engage in some form of leverage, either directly through some use of borrowed funds or indirectly using financial derivatives.
- *Leveraged accounts*: This category, often referred to as the professional trading community, consists of hedge funds, proprietary trading shops, commodity trading advisers (CTAs), high-frequency algorithmic traders, and the proprietary trading desks at banks—and indeed, almost any active trading account that accepts and manages FX risk for profit. The professional trading community accounts for a large and growing proportion of daily FX market turnover. These active trading accounts also have a wide diversity of trading styles. Some are macro-hedge funds that take longer term FX positions based on their views of the underlying economic fundamentals of a currency. Others are high-frequency algorithmic traders that use technical trading strategies (such as those based on moving averages or Fibonacci levels) and whose trading cycles and investment horizons are sometimes measured in milliseconds.

- *Retail accounts*: The simplest example of a retail account is the archetypical foreign tourist exchanging currency at an airport kiosk. However, it is important to realize that as electronic trading technology has reduced the barriers to entry into FX markets and the costs of FX trading, there has been a huge surge in speculative trading activity by retail accounts—consisting of individuals trading for their own accounts as well as smaller hedge funds and other active traders. This also includes households using electronic trading technology to move their savings into foreign currencies (this is relatively widespread among households in Japan, for example). It is estimated that retail trading accounts for as much as 10 percent of all spot transactions in some currency pairs and that this proportion is growing.
- *Governments*: Public entities of all types often have FX needs, ranging from relatively small (e.g., maintaining consulates in foreign countries) to large (e.g., military equipment purchases or maintaining overseas military bases). Sometimes these flows are purely transactional—the business simply needs to be done—and sometimes government FX flows reflect, at least in part, the public policy goals of the government. Some government FX business resembles that of investment funds, although sometimes with a public policy mandate as well. In some countries, public sector pension plans and public insurance schemes are run by a branch of the government. One example is the Caisse de dépôt et placement du Québec, which was created by the Québec provincial government in Canada to manage that province's public sector pension plans. The Caisse, as it is called, is a relatively large player in financial markets, with about CAD308 billion of assets under management as of mid-2018. Although it has a mandate to invest these assets for optimal return, it is also called upon to help promote the economic development of Québec. It should be noted that many governments—both at the federal and provincial/state levels—issue debt in foreign currencies; this, too, creates FX flows. Such supranational agencies as the World Bank and the African Development Bank issue debt in a variety of currencies as well.
- *Central banks*: These entities sometimes intervene in FX markets in order to influence either the level or trend in the domestic exchange rate. This often occurs when the central banks judge their domestic currency to be too weak and when the exchange rate has overshot any concept of equilibrium level (e.g., because of a speculative attack) to the degree that the exchange rate no longer reflects underlying economic fundamentals. Alternatively, central banks also intervene when the FX market has become so erratic and dysfunctional that end-users such as corporations can no longer transact necessary FX business. Conversely, sometimes central banks intervene when they believe that their domestic currency has become too strong, to the point that it undercuts that country's export competitiveness. The Bank of Japan intervened against yen strength versus the US dollar in 2004 and again in March 2011 after the massive earthquake and nuclear disaster. Similarly, in 2010, 2013, and again in 2015, the Swiss National Bank intervened against strength in the Swiss franc versus the euro by selling the Swiss franc on the euro–Swiss (CHF/EUR) cross-rate. Central bank reserve managers are also frequent participants in FX markets in order to manage their country's FX reserves. In this context, they act much like real money investment funds—although generally with a cautious, conservative mandate to safeguard the value of their country's foreign exchange reserves. The foreign exchange reserves of some countries are enormous, and central bank participation in FX markets can sometimes have a material impact on exchange rates even when these reserve managers are not intervening for public policy

purposes. Exhibit 2 provides information on central bank reserve holdings as of the second quarter of 2015.[3] Total central bank reserve holdings have held steady for several years and as of the first quarter of 2018 were $11,594 billion.

Exhibit 2 Currency Composition of Official Foreign Exchange Reserves, as of 1st Quarter 2015 (USD billion)

Total foreign exchange holdings globally	11,433
Held by advanced economies	3,946
Held by emerging and developing economies	7,487
Percent of global holdings held in the US dollar[a]	66%

[a] This percentage is calculated using that amount of global currency reserves for which the currency composition can be identified.

Note that the amount of foreign exchange reserves now held by emerging economies comfortably exceeds those held by developed economies. This largely reflects the rapid growth in foreign reserves held by Asian central banks, because these countries typically run large current account surpluses with the United States and other developed economies. Reserve accumulation by energy exporting countries in the Middle East and elsewhere is also a factor. Most of the global currency reserves are held in US dollars; the percentage held in USD is more than twice the portion held in the euro, the second most widely held currency in central bank foreign exchange reserves.

- *Sovereign wealth funds (SWFs)*: Many countries with large current account surpluses have diverted some of the resultant international capital flows into SWFs rather than into foreign exchange reserves managed by central banks. Although SWFs are government entities, their mandate is usually more oriented to purely investment purposes rather than public policy purposes. As such, SWFs can be thought of as akin to real money accounts, although some SWFs can employ derivatives or engage in aggressive trading strategies. It is generally understood that SWFs use their resources to help fulfill the public policy mandate of their government owners. The SWFs of many current account surplus countries (such as exporting countries in East Asia or oil-exporting countries) are enormous, and their FX flows can be an important determinant of exchange rate movements in almost all of the major currency pairs.

As mentioned, the sell side generally consists of the FX dealing banks that sell FX products to the buy side. Even here, however, distinctions can be made.

- A large and growing proportion of the daily FX turnover is accounted for by the very largest dealing banks, such as Deutsche Bank, Citigroup, UBS, HSBC, and a few other multinational banking behemoths. Maintaining a competitive advantage in FX requires huge fixed-cost investments in the electronic technology that connects the FX market, and it also requires a broad, global client base. As a result, only the largest banks are able to compete successfully in providing competitive price quotes to clients across the broad range of FX products. In fact, among the largest FX dealing banks, a large proportion of their business

3 See International Monetary Fund (2018) Currency Composition of Foreign Exchange Reserves (COFER) Tables 1-3.

is crossed internally, meaning that these banks are able to connect buyers and sellers within their own extremely diverse client base and have no need to show these FX flows outside of the bank.

- All other banks fall into the second and third tier of the FX market sell side. Many of these financial institutions are regional or local banks with well-developed business relationships, but they lack the economies of scale, broad global client base, or information technology (IT) expertise required to offer competitive pricing across a wide range of currencies and FX products. In many cases, these are banks in emerging markets that don't have the business connections or credit lines required to access the FX market on a cost-effective basis on their own. As a result, these banks often outsource FX services by forming business relationships with the larger tier-one banks; otherwise, they depend on the deep, competitive liquidity provided by the largest FX market participants.

The categories presented are based on functions that are closely associated with the named groups. However, in some cases, functions typifying a group may also be assumed by or shared with another group. For example, sell-side banks provide FX price quotes. However, hedge funds and other large players may access the professional FX market on equal terms with the dealing banks and effectively act as market makers.

One of the most important ideas to draw from this categorization of market participants is that there is an extremely wide variety of FX market participants, reflecting a complex mix of trading motives and strategies that can vary with time. Most market participants reflect a combination of hedging and speculative motives in tailoring their FX risk exposures. Among public sector market participants, public policy motives may also be a factor. The dynamic, complex interaction of FX market participants and their trading objectives makes it difficult to analyze or predict movements in FX rates with any precision, or to describe the FX market adequately with simple characterizations.

2.3 Market Size and Composition

In this section, we present a descriptive overview of the global FX market drawn from the 2016 Triennial Survey undertaken by the Bank for International Settlements (BIS). The BIS is an umbrella organization for the world's central banks. Every three years, participating central banks undertake a survey of the FX market in their jurisdictions, the results of which are aggregated and compiled at the BIS. The most recent survey, taken in April 2016, gives a broad indication of the current size and distribution of global FX market flows.

As of April 2016, the BIS estimates that average daily turnover in the traditional FX market (comprised of spot, outright forward, and FX swap transactions) totaled approximately USD5.1 trillion. Exhibit 3 shows the approximate percentage allocation among FX product types, including both traditional FX products and exchange-traded FX derivatives. Note that this table of percentage allocations adds exchange-traded derivatives to the BIS estimate of average daily turnover of USD5.1 trillion; the "Spot" and "Outright forwards" categories include only transactions that are not executed as part of a swap transaction.

Exhibit 3 FX Turnover by Instrument

Spot	33%
Outright forwards	14
Swaps[a]	49

(continued)

Exhibit 3 (Continued)	
FX options	5
Total	**100%**

[a] Includes both FX and currency swaps.

The survey also provides a percentage breakdown of the average daily flows between sell-side banks (called the interbank market), between banks and financial customers (all non-bank financial entities, such as real money and leveraged accounts, SWFs, and central banks), and between banks and non-financial customers (such as corporations, retail accounts, and governments). The breakdown is provided in Exhibit 4. It bears noting that the proportion of average daily FX flow accounted for by financial clients is much larger than that for non-financial clients. The BIS also reports that the proportion of financial client flows has been growing rapidly, and in 2010 it exceeded interbank trading volume for the first time. This underscores the fact that only a minority of the daily FX flow is accounted for by corporations and individuals buying and selling foreign goods and services. Huge investment pools and professional traders are accounting for a large and growing proportion of the FX business.

Exhibit 4 FX Flows by Counterparty	
Interbank	42%
Financial clients	51
Non-financial clients	8

The 2016 BIS survey also identifies the top five currency pairs in terms of their percentage share of average daily global FX turnover. These are shown in Exhibit 5. Note that each of these most active pairs includes the US dollar (USD).

Exhibit 5 FX Turnover by Currency Pair	
Currency Pair	**% of Market**
USD/EUR	23.1%
JPY/USD	17.8%
USD/GBP	9.3%
USD/AUD	5.2%
CAD/USD	4.3%

The largest proportion of global FX trading occurs in London, followed by New York. This means that FX markets are most active between approximately 8:00 A.M. and 11:30 A.M. New York time, when banks in both cities are open. (The official London close is at 11:00 A.M. New York time, but London markets remain relatively active for a period after that.) Tokyo is the third-largest FX trading hub.

EXAMPLE 3

Market Participants and Composition of Trades

The investment adviser based in Sydney, Australia, makes the following statements to her client when describing some of the basic characteristics of the foreign exchange market:

Statement 1 "Foreign exchange transactions for spot settlement see the most trade volume in terms of average daily turnover because the FX market is primarily focused on settling international trade flows."

Statement 2 "The most important foreign exchange market participants on the buy side are corporations engaged in international trade; on the sell side they are the local banks that service their FX needs."

1 Statement 1 is:

A correct.

B incorrect with respect to the importance of spot settlements.

C incorrect both with respect to the importance of spot settlements and international trade flows.

2 Statement 2 is:

A correct.

B incorrect with respect to corporations engaged in international trade.

C incorrect with respect to both corporations and the local banks that service their trade needs.

Solution to 1:

C is correct. Although the media generally focus on the spot market when discussing foreign exchange, the majority of average daily trade volume involves the FX swap market as market participants either roll over or modify their existing hedging and speculative positions (or engage in FX swap financing). Although it is true that all international trade transactions eventually result in some form of spot settlement, this typically generates a great deal of hedging (and speculative) activity in advance of spot settlement. Moreover, an important group of FX market participants engages in purely speculative positioning with no intention of ever delivering/receiving the principal amount of the trades. Most FX trading volume is not related to international trade: Portfolio flows (cross-border capital movements) and speculative activities dominate.

Solution to 2:

C is correct. As of 2016, the most important foreign exchange market participants in terms of average daily turnover are found not among corporations engaged in international trade but among huge investment managers, both private (e.g., pension funds) and public (e.g., central bank reserve managers or sovereign wealth funds). A large and growing amount of daily turnover is also being generated by high-frequency traders who use computer algorithms to automatically execute extremely high numbers of speculative trades (although their individual ticket sizes are generally small, they add up to large aggregate flows). On the sell side, the largest money center banks (e.g., Deutsche Bank, Citigroup, HSBC, UBS) are

increasingly dominating the amount of trading activity routed through dealers. Regional and local banks are increasingly being marginalized in terms of their share of average daily turnover in FX markets.

3 CURRENCY EXCHANGE RATE CALCULATIONS

3.1 Exchange Rate Quotations

Exchange rates represent the relative price of one currency in terms of another. This price can be represented in two ways: 1) currency A buys how many units of currency B; or 2) currency B buys how many units of currency A. Of course, these two prices are simply the inverse of each other.

To distinguish between these two prices, market participants sometimes distinguish between *direct* and *indirect* exchange rates. In the quoting convention A/B (where there is a certain number of units of currency A per one unit of currency B), we refer to currency A as the *price currency* (or quote currency); currency B is referred to as the *base currency*. (The reason for this choice of names will become clearer below.) The base currency is always set at a quantity of one. A *direct* currency quote takes the domestic country as the price currency and the foreign country as the base currency. For example, for a Paris-based trader, the domestic currency would be the euro (EUR) and a foreign currency would be the UK pound (GBP). For this Paris-based trader, a *direct* quote would be EUR/GBP. An exchange rate quote of EUR/GBP = 1.1211 means that 1 GBP costs 1.1211 EUR. For this Paris-based trader, an *indirect* quote has the domestic currency—the euro—as the base currency. An indirect quote of GBP/EUR = 0.8920 means that 1 EUR costs 0.8920 GBP. *Direct and indirect quotes are just the inverse (reciprocal) of each other.*

It can be confusing to describe exchange rates as either being direct or indirect because determining the domestic currency and the foreign currency depends on where one is located. For a London-based market participant, the UK pound (GBP) is the domestic currency and the euro (EUR) is a foreign currency. For a Paris-based market participant, it would be the other way around.

To avoid confusion, the professional FX market has developed a set of market conventions that all market participants typically adhere to when making and asking for FX quotes. Exhibit 6 displays some of these for the major currencies: the currency code used for obtaining exchange rate quotes, how the market lingo refers to this currency pair, and the actual ratio—price currency per unit of base currency—represented by the quote.

Exhibit 6 Exchange Rate Quote Conventions

FX Rate Quote Convention	Name Convention	Actual Ratio (Price currency/Base currency)
EUR	Euro	USD/EUR
JPY	Dollar–yen	JPY/USD
GBP	Sterling	USD/GBP
CAD	Dollar–Canada	CAD/USD
AUD	Aussie	USD/AUD
NZD	Kiwi	USD/NZD
CHF	Swiss franc	CHF/USD

Exhibit 6 (Continued)

FX Rate Quote Convention	Name Convention	Actual Ratio (Price currency/Base currency)
EURJPY	Euro–yen	JPY/EUR
EURGBP	Euro–sterling	GBP/EUR
EURCHF	Euro–Swiss	CHF/EUR
GBPJPY	Sterling–yen	JPY/GBP
EURCAD	Euro–Canada	CAD/EUR
CADJPY	Canada–yen	JPY/CAD

Several things should be noted in this exhibit. First, the three-letter currency codes in the first column (for FX rate quotes) refer to what are considered the major exchange rates. Remember that an exchange rate is the price of one currency in terms of another: There are always two currencies involved in the price. This is different from referring to a single currency in its own right. For example, one can refer to the euro (EUR) as a *currency*; but if we refer to a euro *exchange rate* (EUR), it is always the price of the euro in terms of another currency, in this case the US dollar. This is because in the professional FX market, the three-letter code EUR is always taken to refer to the euro–US dollar exchange rate, which is quoted in terms of the number of US dollars per euro (USD/EUR). Second, where there are six-letter currency codes in the first column, these refer to some of the major *cross-rates*. This topic will be covered in the next section, but generally these are secondary exchange rates and they are not as common as the main exchange rates. (It can be noted that three-letter codes are always in terms of an exchange rate involving the US dollar, while the six-letter codes are not.) Third, when both currencies are mentioned in the code or the name convention, *the base currency is always mentioned first, the opposite order of the actual ratio (price currency/base currency).* Thus, the code for "Sterling–yen" is "GBPJPY," but the actual number quoted is the number of yen per sterling (JPY/GBP). It should also be noted that *the codes may appear in a variety of formats that all mean the same thing.* For example, GBPJPY might instead appear as GBP:JPY or GBP–JPY. Fourth, regardless of where a market participant is located, there is always a mix of direct and indirect quotes in common market usage. For example, a trader based in Toronto will typically refer to the euro–Canada and Canada–yen exchange rates—a mixture of direct (CAD/EUR) and indirect (JPY/CAD) quotes for a Canadian-based trader. There is no overall consistency in this mixture of direct and indirect quoting conventions in the professional FX market; a market participant just has to get familiar with how the conventions are used.[4]

Another concept involving exchange rate quotes in professional FX markets is that of a *two-sided price*. When a client asks a bank for an exchange rate quote, the bank will provide a "*bid*" (the price at which the bank is willing to buy the currency) and an "*offer*" (the price at which the bank is willing to sell the currency). But there are *two* currencies involved in an exchange rate quote, which is always the price of one currency relative to the other. So, which one is being bought and sold in this two-sided price quote? This is where the lingo involving the price currency (or quote currency)

4 In general, however, there is a hierarchy for quoting conventions. For quotes involving the EUR, it serves as the base currency (e.g., GBP/EUR). Next in the priority sequence, for quotes involving the GBP (but not the EUR) it serves as the base currency (e.g., USD/GBP). Finally, for quotes involving the USD (but not the GBP or EUR) it serves as the base currency (e.g., CAD/USD). Exceptions among the major currencies are the AUD and NZD: they serve as the base currency when quoted against the USD (i.e., USD/AUD, USD/NZD).

and the base currency, explained above, becomes useful. *The two-sided price quoted by the dealer is in terms of buying/selling the base currency*. It shows the number of units of the *price* currency that the client will receive from the dealer for one unit of the base currency (the bid) and the number of units of the price currency that the client must sell to the dealer to obtain one unit of the base currency (the offer). Consider the case of a client that is interested in a transaction involving the Swiss franc (CHF) and the euro (EUR). As we have seen above, the market convention is to quote this as euro–Swiss (CHF/EUR). The EUR is the base currency, and the two-sided quote (price) shows the number of units of the price currency (CHF) that must be paid or will be received for 1 euro. For example, a two-sided price in euro–Swiss (CHF/EUR) might look like: 1.1583–1.1585. The client will receive CHF1.1583 for selling EUR1 to the dealer and must pay CHF1.1585 to the dealer to buy EUR1. Note that *the price is shown in terms of the price currency* and that *the bid is always less than the offer*: The bank buys the base currency (EUR, in this case) at the low price and sells the base currency at the high price. Buying low and selling high is profitable for banks, and spreading clients—trying to widen the bid/offer spread—is how dealers try to increase their profit margins. However, it should be noted that the electronic dealing systems currently used in professional FX markets are extremely efficient in connecting buyers and sellers globally. Moreover, this worldwide competition for business has compressed most bid/offer spreads to very tight levels. For simplicity, in the remainder of this reading we will focus on exchange rates as a single number (with no bid/offer spread).

One last thing that can be pointed out in exchange rate quoting conventions is that most major spot exchange rates are typically quoted to four decimal places. One exception among the major currencies involves the yen, for which spot exchange rates are usually quoted to two decimal places. (For example, using spot exchange rates from the middle of 2018, a USD/EUR quote would be expressed as 1.1701, while a JPY/EUR quote would be expressed as 130.9761.) This difference involving the yen comes from the fact that the units of yen per unit of other currencies is typically relatively large already, and hence extending the exchange rate quote to four decimal places is viewed as unnecessary.

Regardless of what quoting convention is used, changes in an exchange rate can be expressed as a percentage appreciation of one currency against the other: One simply has to be careful in identifying which currency is the price currency and which is the base currency. For example, let's suppose the exchange rate for the euro (USD/EUR) increases from 1.1500 to 1.2000. This represents an (un-annualized) percentage change of:

$$\frac{1.2000}{1.1500} - 1 = 4.35\%$$

This represents a 4.35 percent appreciation in the euro against the US dollar (and not an appreciation of the US dollar against the euro) because the USD/EUR exchange rate is expressed with the dollar as the price currency.

Note that this appreciation of the euro against the US dollar can also be expressed as a depreciation of the US dollar against the euro; but in this case, the depreciation is not equal to 4.35 percent. Inverting the exchange rate quote from USD/EUR to EUR/USD, so that the euro is now the price currency, leads to:

$$\frac{\left(\frac{1}{1.2000}\right)}{\left(\frac{1}{1.1500}\right)} - 1 = \frac{1.1500}{1.2000} - 1 = -4.17\%$$

Note that the US dollar depreciation is not the same, in percentage terms, as the euro appreciation. This will always be true; it is simply a matter of arithmetic.

EXAMPLE 4

Exchange Rate Conventions

A dealer based in New York City provides a spot exchange rate quote of 18.8590 MXN/USD to a client in Mexico City. The inverse of 18.8590 is 0.0530.

1 From the perspective of the Mexican client, the *most* accurate statement is that the:
   - **A** direct exchange rate quotation is equal to 0.0530.
   - **B** direct exchange rate quotation is equal to 18.8590.
   - **C** indirect exchange rate quotation is equal to 18.8590.

2 If the bid/offer quote from the dealer was 18.8580 ~ 18.8600 MXN/USD, then the bid/offer quote in USD/MXN terms would be *closest* to:
   - **A** 0.05302 ~ 0.05303.
   - **B** 0.05303 ~ 0.05302.
   - **C** 0.053025 ~ 0.053025.

Solution to 1:

B is correct. A direct exchange rate uses the domestic currency as the price currency and the foreign currency as the base currency. For an MXN/USD quote, the MXN is the price currency; therefore, the direct quote for the Mexican client is 18.8590 (it costs 18.8590 pesos to purchase 1 US dollar). Another way of understanding a *direct* exchange rate quote is that it is the price of one unit of foreign currency in terms of your own currency. This purchase of a unit of foreign currency can be thought of as a purchase much like any other you might make; think of the unit of foreign currency as just another item that you might be purchasing with your domestic currency. For example, for someone based in Canada, a liter of milk currently costs about CAD1.25 and USD1 costs about CAD1.30. This *direct* currency quote uses the *domestic* currency (the Canadian dollar, in this case) as the *price* currency and simply gives the price of a unit of foreign currency that is being purchased.

Solution to 2:

A is correct. An MXN/USD quote means the amount of MXN the dealer is bidding (offering) to buy (sell) USD1. The dealer's bid to buy USD1 at MXN18.8580 is equivalent to the dealer paying MXN18.8580 to buy USD1. Dividing both terms by 18.8580 means the dealer is paying (i.e., selling) MXN1 to buy USD0.05303. This is the offer in USD/MXN terms: The dealer offers to sell MXN1 at a price of USD0.08063. In USD/MXN terms, the dealer's bid for MXN1 is 0.08061, calculated by inverting the offer of 18.8600 in MXN/USD terms (1/18.8600 = 0.05302). Note that in any bid/offer quote, no matter what the base or price currencies, the bid is always lower than the offer.

3.2 Cross-Rate Calculations

Given two exchange rates involving three currencies, it is possible to back out what the cross-rate must be. For example, as we have seen, the FX market convention is to quote the exchange rate between the US dollar and the euro as euro–dollar (USD/EUR). The FX market also quotes the exchange rate between the Canadian dollar

and US dollar as dollar–Canada (CAD/USD). Given these two exchange rates, it is possible to back out the cross-rate between the euro and the Canadian dollar, which according to market convention is quoted as euro–Canada (CAD/EUR). This calculation is shown as:

$$\frac{\text{CAD}}{\text{USD}} \times \frac{\text{USD}}{\text{EUR}} = \frac{\text{CAD}}{\cancel{\text{USD}}} \times \frac{\cancel{\text{USD}}}{\text{EUR}} = \frac{\text{CAD}}{\text{EUR}}$$

Hence, to get a euro–Canada (CAD/EUR) quote, we must multiply the dollar–Canada (CAD/USD) quote by the euro–dollar (USD/EUR) quote. For example, assume the exchange rate for dollar–Canada is 1.3020 and the exchange rate for euro–dollar is 1.1701. Using these sample spot exchange rates, calculating the euro–Canada cross-rate equals:

1.3020 × 1.1701 = 1.5235 CAD per EUR

It is best to avoid talking in terms of direct or indirect quotes because, as noted above, these conventions depend on where one is located and hence what the domestic and foreign currencies are. Instead, focus on how the math works: Sometimes it is necessary to invert one of the quotes in order to get the intermediary currency to cancel out in the equation to get the cross-rate. For example, to get a Canada–yen (JPY/CAD) quote, one is typically using the dollar–Canada (CAD/USD) rate and dollar–yen (JPY/USD) rate, which are the market conventions. This Canada–yen calculation requires that the dollar–Canada rate (CAD/USD) be inverted to a USD/CAD quote for the calculations to work, as shown below:

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

Hence, to get a Canada–yen (JPY/CAD) quote, we must first invert the dollar–Canada (CAD/USD) quote before multiplying by the dollar–yen (JPY/USD) quote. As an example, let's assume that we have spot exchange rates of 1.3020 for dollar–Canada (CAD/USD) and 111.94 for dollar–yen (JPY/USD). The dollar–Canada rate of 1.3020 inverts to 0.7680; multiplying this value by the dollar–yen quote of 111.94 gives a Canada–yen quote of:

0.7680 × 111.94 = 85.97 JPY per CAD

Market participants asking for a quote in a cross-rate currency pair typically will not have to do this calculation themselves: Either the dealer or the electronic trading platform will provide a quote in the specified currency pair. (For example, a client asking for a quote in Canada–yen will receive that quote from the dealer; he will not be given separate dollar–Canada and dollar–yen quotes in order to do the math.) But be aware that dealers providing the quotes often have to do this calculation themselves if only because the dollar–Canada and dollar–yen currency pairs often trade on different trading desks and involve different traders. Electronic dealing machines used in both the interbank market and bank-to-client markets often provide this mathematical operation to calculate cross-rates automatically.

Because market participants can receive both a cross-rate quote (for example, Canada–yen) as well as the component underlying exchange rate quotes (for example, dollar–Canada and dollar–yen), these cross-rate quotes must be consistent with the above equation; otherwise, the market will arbitrage the mispricing. Extending our example above, we calculate a Canada–yen (JPY/CAD) rate of 85.97 based on underlying dollar–Canada (CAD/USD) and dollar–yen (JPY/USD) rates of 1.3020 and 111.94, respectively. Now suppose that at the same time a misguided dealer quotes a Canada–yen rate of 86.20. This is a different price in JPY/CAD for an identical service: converting yen into Canadian dollars. Hence, any trader could buy CAD1 at the lower price of JPY85.97and then turn around and sell CAD1 at JPY86.20(recall our earlier

discussion of how price and base currencies are defined). The riskless arbitrage profit is JPY0.23 per CAD1. The arbitrage—called *triangular arbitrage*, "tri-," because it involves three currencies—would continue until the price discrepancy was removed.

In reality, however, these discrepancies in cross-rates almost never occur because both human traders and automatic trading algorithms are constantly on alert for any pricing inefficiencies. In practice, and for the purposes of this reading, we can consider cross-rates as being consistent with their underlying exchange rate quotes and that given any two exchange rates involving three currencies, we can back out the third cross-rate.

EXAMPLE 5

Cross Exchange Rates and Percentage Changes

A research report produced by a dealer includes the following exhibit:

	Spot Rate	Expected Spot Rate in One Year
USD/EUR	1.1701	1.1619
CHF/USD	0.9900	0.9866
USD/GBP	1.3118	1.3066

1 The spot CHF/EUR cross-rate is *closest* to:

A 0.8461.

B 0.8546.

C 1.1584.

2 The spot GBP/EUR cross-rate is *closest* to:

A 0.8920.

B 1.1211.

C 1.4653.

3 Based on the exhibit, the euro is expected to appreciate by how much against the US dollar over the next year?

A –0.7 percent

B +0.7 percent

C +1.0 percent

4 Based on the exhibit, the US dollar is expected to appreciate by how much against the British pound over the next year?

A +0.6 percent

B –0.4 percent

C +0.4 percent

5 Over the next year, the Swiss franc is expected to:

A depreciate against the GBP.

B depreciate against the EUR.

C appreciate against the GBP, EUR, and USD.

6 Based on the exhibit, which of the following lists the three currencies from strongest to weakest over the next year?

A USD, GBP, EUR

B USD, EUR, GBP

C EUR, USD, GBP

7 Based on the exhibit, which of the following lists the three currencies in order of appreciating the most to appreciating the least (in percentage terms) against the USD over the next year?

A GBP, CHF, EUR

B CHF, GBP, EUR

C EUR, CHF, GBP

Solution to 1:

C is correct:

$$\frac{\text{CHF}}{\text{EUR}} = \frac{\text{USD}}{\text{EUR}} \times \frac{\text{CHF}}{\text{USD}} = 1.1701 \times 0.9900 = 1.1584$$

Solution to 2:

A is correct:

$$\frac{\text{GBP}}{\text{EUR}} = \frac{\text{USD}}{\text{EUR}} \times \left(\frac{\text{USD}}{\text{GBP}}\right)^{-1} = \frac{\text{USD}}{\text{EUR}} \times \frac{\text{GBP}}{\text{USD}} = \frac{1.1701}{1.3118} = 0.8920$$

Solution to 3:

A is correct. The euro is the base currency in the USD/EUR quote, and the expected decrease in the USD/EUR rate indicates that the EUR is depreciating (in one year it will cost less USD to buy one EUR). Mathematically:

$$\frac{1.1619}{1.1701} - 1 = -0.7\%$$

Solution to 4:

C is correct. The GBP is the base currency in the USD/GBP quote, and the expected decrease in the USD/GBP rate means that the GBP is expected to depreciate against the USD. Or equivalently, the USD is expected to appreciate against the GBP. Mathematically:

$$\left(\frac{1.3066}{1.3118}\right)^{-1} - 1 = \frac{1.3118}{1.3066} - 1 = +0.4\%$$

Solution to 5:

C is correct: Because the question does not require calculating the magnitude of the appreciation or depreciation, we can work with CHF as either the price currency or the base currency. In this case, it is easiest to use it as the price currency. According to the table, CHF/USD is expected to decline from 0.9900 to 0.9866, so CHF is expected to be stronger (i.e., it should appreciate against the USD). CHF/EUR is currently 1.1584 (see the solution to problem 1) and is expected to be 1.1463 (= 0.9866 × 1.1619), so CHF is expected to appreciate against the EUR. CHF/GBP is currently 1.2987 (= 0.9900 × 1.3118) and is expected to be 1.2891 (= 0.9866 × 1.3066), so CHF is also expected to appreciate against the GBP.

Alternatively, we can derive this answer intuitively. The table shows that the CHF/USD rate is expected to decline: That is, the USD is expected to depreciate against the CHF, or alternatively, the CHF is expected to appreciate against the USD. The table also shows that the USD/EUR and USD/GBP rates are also decreasing, meaning that the EUR and GBP are expected to depreciate against the USD, or alternatively, the USD is expected to appreciate against the EUR

and GBP. If the CHF is expected to appreciate against the USD and the USD is expected to appreciate against both the EUR and GBP, it follows that the CHF is expected to appreciate against both the EUR and GBP.

Solution to 6:

A is correct. According to the table, USD/EUR is expected to decline from 1.1701 to 1.1619, while USD/GBP is expected to decline from 1.3118 to 1.3066. So, the USD is expected to be stronger than both the EUR and GBP. GBP/EUR is currently 0.8920 [= $(1.3118)^{-1} \times 1.1701$] and is expected to be 0.8893 [= $(1.3066)^{-1} \times 1.1619$], so the GBP is expected to be stronger than the EUR.

Solution to 7:

B is correct. The USD/EUR rate depreciates by –0.7 percent (= [1.1619/1.1701] – 1), which is the depreciation of the base currency EUR against the USD. The USD/GBP rate declines –0.4 percent (= [1.3066/1.3118] – 1), which is the depreciation of the GBP against the USD. Inverting the CHF/USD rate to a USD/CHF convention shows that the base currency CHF appreciates by +0.35 percent against the USD (= [1.0136/1.0101] – 1).

3.3 Forward Calculations

In professional FX markets, forward exchange rates are typically quoted in terms of points (also sometimes referred to as "pips"). The points on a forward rate quote are simply the difference between the forward exchange rate quote and the spot exchange rate quote, with the points scaled so that they can be related to the last decimal in the spot quote. When the forward rate is higher than the spot rate, the points are positive and the base currency is said to be trading at a *forward premium*. Conversely, if the forward rate is less than the spot rate, the points (forward rate minus spot rate) are negative and the base currency is said to be trading at a *forward discount*. Of course, if the base currency is trading at a forward premium, then the price currency is trading at a forward discount, and vice versa.

This can best be explained by means of an example. Mid-2018, the spot euro–dollar exchange rate (USD/EUR) was 1.15885 and the one-year forward rate was 1.19532. Hence, the forward rate was trading at a premium to the spot rate (the forward rate was larger than the spot rate) and the one-year forward points were quoted as +364.7. This +364.7 comes from:

1.19532 – 1.15885 = +0.03647

Recall that most non-yen exchange rates are quoted to four decimal places, so in this case we would scale up by four decimal places (multiply by 10,000) so that this +0.03647 would be represented as +364.7 points. Notice that the points are scaled to the size of the last digit in the spot exchange rate quote—usually the fourth decimal place. Notice as well that points are typically quoted to one (or more) decimal places, meaning that the forward rate will typically be quoted to five or more decimal places. The exception among the major currencies is the yen, which is typically quoted to two decimal places for spot rates. Here, forward points are scaled up by two decimal places—the last digit in the spot rate quote—by multiplying the difference between forward and spot rates by 100.

Typically, quotes for forward rates are shown as the number of forward points at each maturity.[5] These forward points are also called *swap points* because an FX swap consists of simultaneous spot and forward transactions. In the middle of 2018, a trader would have faced a spot rate and forward points in the euro–dollar (USD/EUR) currency pair similar to those in Exhibit 7:

Exhibit 7 Sample Spot and Forward Quotes

Maturity	Spot Rate or Forward Points
Spot	1.15885
One week	+5.6
One month	+27.1
Three months	+80.9
Six months	+175.6
Twelve months	+364.7

Notice that the absolute number of points generally increases with maturity. This is because the number of points is proportional to the yield differential between the two countries (the Eurozone and the United States, in this case) scaled by the term to maturity. Given the interest rate differential, the longer the term to maturity, the greater the absolute number of forward points. Similarly, given the term to maturity, a wider interest rate differential implies a greater absolute number of forward points. (This will be explained and demonstrated in more detail later in this section.)

To convert any of these quoted forward points into a forward rate, one would divide the number of points by 10,000 (to scale down to the fourth decimal place, the last decimal place in the spot quote) and then add the result to the spot exchange rate quote.[6] For example, using the data in Exhibit 7, the three-month forward rate in this case would be:

$$1.15885 + \left(\frac{+80.9}{10{,}000}\right) = 1.15885 + 0.00809 = 1.16694$$

Occasionally, one will see the forward rate or forward points represented as a percentage of the spot rate rather than as an absolute number of points. Continuing our example from above, the three-month forward rate for USD/EUR can be represented as:

$$\frac{1.15885 + 0.00809}{1.15885} - 1 = \left(\frac{1.16694}{1.15885}\right) - 1 = +0.698\%$$

This shows that either the forward rate or the forward points can be used to calculate the percentage discount (or premium) in the forward market—in this case, +0.698 percent rounding to three decimal places. To convert a spot quote into a forward quote when the points are shown as a percentage, one simply multiples the spot rate by one plus the percentage premium or discount:

$$1.15885 \times (1 + 0.698\%) = 1.15885 \times (1.0000 + 0.00698) \approx 1.16694$$

5 As mentioned earlier, "maturity" is defined in terms of the time between spot settlement (usually T + 2) and the settlement of the forward contract.

6 Because the JPY/USD exchange rate is only quoted to two decimal places, forward points for the dollar–yen currency pair are divided by 100.

Note that, rounded to the fifth decimal place, this is equal to our previous calculation. However, it is typically the case in professional FX markets that forward rates will be quoted in terms of pips rather than percentages.

We now turn to the relationship between spot rates, forward rates, and interest rates and how their relationship is derived. Forward exchange rates are based on an arbitrage relationship that equates the investment return on two alternative but equivalent investments. Consider the case of an investor with funds to invest. For simplicity, we will assume that there is one unit of the investor's domestic currency to be invested for one period. One alternative is to invest for one period at the domestic risk-free rate (i_d); at the end of the period, the amount of funds held is equal to ($1 + i_d$). An alternative investment is to convert this one unit of domestic currency to foreign currency using the spot rate of $S_{f/d}$ (number of units of foreign currency per one unit of domestic currency). This can be invested for one period at the foreign risk-free rate; at the end of the period, the investor would have $S_{f/d}(1 + i_f)$ units of foreign currency. These funds must then be converted back to the investor's domestic currency. If the exchange rate to be used for this end-of-period conversion was precontracted at the start of the period (i.e., a forward rate was used), it would eliminate any foreign exchange risk from converting at a future, unknown spot rate. Given the assumed exchange rate convention here (foreign/domestic), the investor would obtain ($1/F_{f/d}$) units of the domestic currency for each unit of foreign currency sold forward. Note that this process of converting domestic funds in the spot FX market, investing at the foreign risk-free rate, and then converting back to the domestic currency with a forward rate is identical to the concept of swap financing described in an earlier section of this reading.

Hence, we have two alternative investments—both risk-free because both are invested at risk-free interest rates and because any foreign exchange risk was eliminated (hedged) by using a forward rate. Because these two investments are equal in risk characteristics, they must have the same return. Bearing in mind that the currency quoting convention is the number of foreign currency units per single domestic unit (*f/d*), this relationship can be stated as:

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

This is an arbitrage relationship because it describes two alternative investments (one on either side of the equal sign) that should have equal returns. If they do not, a riskless arbitrage opportunity exists because an investor can sell short the investment with the lower return and invest the funds in the investment with the higher return; the difference between the two returns is pure profit.[7]

This formula is perhaps the easiest and most intuitive way to remember the formula for the forward rate because it is based directly on the underlying intuition (the arbitrage relationship of two alternative but equivalent investments, one on either side of the equal sign). Also, the right-hand side of the equation, for the hedged foreign investment alternative, is arranged in proper time sequence: a) convert domestic to foreign currency; then b) invest the foreign currency at the foreign interest rate; and finally c) convert the foreign currency back to the domestic currency.[8]

7 It is because of this arbitrage relationship that the all-in financing rate using swap financing is close to the domestic interest rate.

8 Recall that this equation is based on an *f*/*d* exchange rate quoting convention. If the exchange rate data were presented in *d/f* form, one could either invert these quotes back to *f/d* form and use the above equation or use the following equivalent equation: $(1 + i_d) = (1/S_{d/f})(1 + i_f)F_{d/f}$. If this latter equation were used, remember that forward and spot exchange rates are now being quoted on a *d*/*f* convention.

This arbitrage equation can be re-arranged as needs require. For example, to get the formula for the forward rate, the above equation can be restated as:

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

Another way of looking at this is, given the spot exchange rate and the domestic and foreign risk-free interest rates, the forward rate is whatever value completes this equation and eliminates any arbitrage opportunity. For example, let's assume that the spot exchange rate ($S_{f/d}$) is 1.6535, the domestic 12-month risk-free rate is 3.50 percent, and the foreign 12-month risk-free rate is 5.00 percent. The 12-month forward rate ($F_{f/d}$) must then be equal to:

$$1.6535\left(\frac{1.0500}{1.0350}\right) = 1.6775$$

Suppose instead that, with the spot exchange rate and interest rates unchanged, you were given a quote on the 12-month forward rate ($F_{f/d}$) of 1.6900. Because this misquoted forward rate does not agree with the arbitrage equation, it would present a riskless arbitrage opportunity. This can be seen by using the arbitrage equation to compute the return on the two alternative investment strategies. The return on the domestic-only investment approach is the domestic risk-free rate (3.50 percent). In contrast, the return on the hedged foreign investment when this misquoted forward rate is put into the arbitrage equation equals:

$$S_{f/d}\left(1+i_f\right)\left(\frac{1}{F_{f/d}}\right) = 1.6535(1.05)\left(\frac{1}{1.6900}\right) = 1.0273$$

This defines a return of 2.73 percent. Hence, the investor could make riskless arbitrage profits by borrowing at the higher foreign risk-free rate, selling the foreign currency at the spot exchange rate, hedging the currency exposure (buying the foreign currency back) at the misquoted forward rate, investing the funds at the lower domestic risk-free rate, and thereby getting a profit of 77 basis points (3.50% – 2.73%) for each unit of domestic currency involved—all with no upfront commitment of the investor's own capital. Any such opportunity in real-world financial markets would be quickly "arbed" away. It is interesting to note that in this example, the investor actually borrows at the higher of the two interest rates but makes a profit because the foreign currency is underpriced in the forward market.

The underlying arbitrage equation can also be re-arranged to show the forward rate as a percentage of the spot rate:

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

This shows that, given an *f/d* quoting convention, the forward rate will be higher than (be at a premium to) the spot rate if foreign interest rates are higher than domestic interest rates. More generally, and regardless of the quoting convention, *the currency with the higher (lower) interest rate will always trade at a discount (premium) in the forward market.*

One context in which forward rates are quoted as a percentage of spot rates occurs when forward rates are interpreted as expected future spot rates, or:

$$F_t = \hat{S}_{t+1}$$

Substituting this expression into the previous equation and doing some re-arranging leads to:

$$\frac{\hat{S}_{t+1}}{S_t} - 1 = \%\Delta\hat{S}_{t+1} = \left(\frac{i_f - i_d}{1 + i_d}\right)$$

This shows that if forward rates are interpreted as expected future spot rates, the expected percentage change in the spot rate is proportional to the interest rate differential ($i_f - i_d$).

It is intuitively appealing to see forward rates as expected future spot rates. However, this interpretation of forward rates should be used cautiously. First, the direction of the expected change in spot rates is somewhat counter-intuitive. All else being equal, an increase in domestic interest rates (for example, the central bank tightens monetary policy) would typically be expected to lead to an increase in the value of the domestic currency. In contrast, the equation above indicates that, all else equal, a higher domestic interest rate implies slower expected appreciation (or greater expected depreciation) of the domestic currency (recall that this equation is based on an *f/d* quoting convention).

More important, historical data show that forward rates are poor predictors of future spot rates. Although various econometric studies suggest that forward rates may be unbiased predictors of future spot rates (i.e., they do not systematically over- or under-estimate future spot rates), this is not particularly useful information because the margin of error for these forecasts is so large. As we have seen in our introductory section, the FX market is far too complex and dynamic to be captured by a single variable, such as the level of the yield differential between countries. Moreover, as can be seen in the formula above for the forward rate, forward rates are based on domestic and foreign interest rates. This means that anything that affects the level and shape of the yield curve in either the domestic or foreign market will also affect the relationship between spot and forward exchange rates. In other words, FX markets do not operate in isolation but will reflect almost all factors affecting other markets globally; anything that affects expectations or risk premia in these other markets will reverberate in forward exchange rates as well. Although the level of the yield differential is one factor that the market may look at in forming spot exchange rate expectations, it is only one of many factors. (Many traders look to the trend in the yield differential rather than the level of the differential.) Moreover, there is a lot of noise in FX markets that makes almost any model—no matter how complex—a relatively poor predictor of spot rates at any given point in the future. In practice, FX traders and market strategists do *not* base either their currency expectations or trading strategies solely on forward rates.

For the purposes of this reading, *it is best to understand forward exchange rates simply as a product of the arbitrage equation outlined earlier and forward points as being related to the (time-scaled) interest rate differential between the two countries.* Reading any more than that into forward rates or interpreting them as the "market forecast" can be potentially misleading.

To understand the relationship between maturity and forward points, we need to generalize our arbitrage formula slightly. Suppose the investment horizon is a fraction, τ, of the period for which the interest rates are quoted. Then the interest earned in the domestic and foreign markets would be ($i_d\,\tau$) and ($i_f\,\tau$), respectively. Substituting this into our arbitrage relationship and solving for the difference between the forward and spot exchange rates gives:

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

This equation shows that forward points (appropriately scaled) are proportional to the spot exchange rate and to the interest rate differential and approximately (but not exactly) proportional to the horizon of the forward contract.

Let's demonstrate this using an example. Suppose that we wanted to determine the 30-day forward exchange rate given a 30-day domestic risk-free interest rate of 2.00 percent per year, a 30-day foreign risk-free interest rate of 3.00 percent per year, and a spot exchange rate ($S_{f/d}$) of 1.6555. The risk-free assets used in this arbitrage relationship are typically bank deposits quoted using the London Interbank Offered Rate (Libor) for the currencies involved. The day count convention for Libor deposits is Actual/360.[9] Incorporating the fractional period (τ) as above and inserting the data into the forward rate equation leads to a 30-day forward rate of:

$$F_{f/d} = S_{f/d}\left(\frac{1+i_f\tau}{1+i_d\tau}\right) = 1.6555\left(\frac{1+0.0300\left[\frac{30}{360}\right]}{1+0.0200\left[\frac{30}{360}\right]}\right) = 1.6569$$

This means that, for a 30-day term, forward rates are trading at a premium of 14 pips (1.6569 – 1.6555). This can also be calculated using the above formula for swap points:

$$F_{f/d} - S_{f/d} = S_{f/d}\left(\frac{i_f - i_d}{1+i_d\tau}\right)\tau = 1.6555\left(\frac{0.0300-0.0200}{1+0.0200\left[\frac{30}{360}\right]}\right)\left[\frac{30}{360}\right] = 0.0014$$

As should be clear from this expression, the absolute number of swap points will be closely related to the term of the forward contract (i.e., approximately proportional to τ = Actual/360). For example, leaving the spot exchange rate and interest rates unchanged, let's set the term of the forward contract to 180 days:

$$F_{f/d} - S_{f/d} = 1.6555\left(\frac{0.0300-0.0200}{1+0.0200\left[\frac{180}{360}\right]}\right)\left[\frac{180}{360}\right] = 0.0082$$

This leads to the forward rate trading at a premium of 82 pips. The increase in the number of forward points is approximately proportional to the increase in the term of the contract (from 30 days to 180 days). Note that although the term of the 180-day forward contract is six times longer than that of a 30-day contract, the number of forward points is not exactly six times larger: 6 × 14 = 84.

Similarly, the number of forward points is proportional to the spread between foreign and domestic interest rates ($i_f - i_d$). For example, with reference to the original 30-day forward contract, let's set the foreign interest rate to 4.00 percent leaving the domestic interest rate and spot exchange rate unchanged. This doubles the interest rate differential ($i_f - i_d$) from 1.00 percent to 2.00 percent; it also doubles the forward points (rounding to four decimal places):

$$F_{f/d} - S_{f/d} = 1.6555\left(\frac{0.0400-0.0200}{1+0.0200\left[\frac{30}{360}\right]}\right)\left[\frac{30}{360}\right] = 0.0028$$

9 This means that for interest calculation purposes, it is assumed that there are 360 days in the year. However, the actual number of days the funds are on deposit is used to calculate the interest payable.

EXAMPLE 6

Forward Rates

A French company has recently finalized a sale of goods to a UK-based client and expects to receive a payment of GBP50 million in 32 days. The corporate treasurer at the French company wants to hedge the foreign exchange risk of this transaction and receives the following exchange rate information from a dealer:

GBP/EUR spot rate	0.8752
One-month forward points	–1.4

1 Given the above data, the treasurer could hedge the foreign exchange risk by:

A buying EUR (selling GBP) at a forward rate of 0.87380.

B buying EUR (selling GBP) at a forward rate of 0.87506.

C selling EUR (buying GBP) at a forward rate of 0.87506.

2 The *best* interpretation of the forward discount shown is that:

A the euro is expected to depreciate over the next 30 days.

B one-month UK interest rates are higher than those in the Eurozone.

C one-month Eurozone interest rates are higher than those in the United Kingdom.

3 If the 12-month forward rate is 0.87295 GBP/EUR, then based on the data the 12-month forward points are *closest* to:

A –22.5.

B –2.25.

C –0.00225.

4 If a second dealer quotes GBP/EUR at a 12-month forward discount of 0.30 percent on the same spot rate, the French company could:

A trade with either dealer because the 12-month forward quotes are equivalent.

B lock in a profit in 12 months by buying EUR from the second dealer and selling it to the original dealer.

C lock in a profit in 12 months by buying EUR from the original dealer and selling it to the second dealer.

5 If the 270-day Libor rates (annualized) for the EUR and GBP are 1.370% and 1.325%, respectively, and the spot GBP/EUR exchange rate is 0.8489, then the number of forward points for a 270-day forward rate ($F_{GBP/EUR}$) is *closest* to:

A –22.8.

B –3.8.

C –2.8.

Solution to 1:

B is correct. The French company would want to convert the GBP to its domestic currency, the EUR (it wants to sell GBP, buy EUR). The forward rate would be equal to: 0.8752 + (–1.4/10,000) = 0.87506.

Solution to 2:

C is correct. A forward discount indicates that interest rates in the base currency country (France in this case, which uses the euro) are higher than those in the price currency country (the United Kingdom).

Solution to 3:

A is correct. The number of forward points is equal to the scaled difference between the forward rate and the spot rate. In this case: 0.87295 – 0.87520 = –0.00225. This is then multiplied by 10,000 to convert to the number of forward points.

Solution to 4:

B is correct. A 0.30 percent discount means that the second dealer will sell euros 12 months forward at 0.8752 × (1 – 0.0030) = 0.87257, a lower price per euro than the original dealer's quote of 0.87295. Buying euros at the cheaper 12-month forward rate (0.87257) and selling the same amount of euros 12 months forward at the higher 12-month forward rate (0.87295) means a profit of (0.87295 – 0.87257 = GBP 0.00038) per euro transacted, receivable when both forward contracts settle in 12 months.

Solution to 5:

C is correct, because the forward rate is calculated as:

$$F_{\frac{GBP}{EUR}} = S_{\frac{GBP}{EUR}}\left(\frac{1+i_{GBP}\left[\frac{Actual}{360}\right]}{1+i_{EUR}\left[\frac{Actual}{360}\right]}\right) = 0.8489\left(\frac{1+0.01325\left[\frac{270}{360}\right]}{1+0.01370\left[\frac{270}{360}\right]}\right) = 0.84862$$

This shows that the forward points are at a discount of: 0.84862 – 0.84890 = –0.00028, or –2.8 points. This can also be seen using the swap points formula:

$$F_{\frac{GBP}{EUR}} - S_{\frac{GBP}{EUR}} = 0.8489\left(\frac{0.01325-0.01370}{1+0.01370\left[\frac{270}{360}\right]}\right)\left[\frac{270}{360}\right] = -0.00028$$

The calculation of –3.8 points omits the day count (270/360), and –22.8 points gets the scaling wrong.

4 EXCHANGE RATE REGIMES

Highly volatile exchange rates create uncertainty that undermines the efficiency of real economic activity and the financial transactions required to facilitate that activity. Exchange rate volatility also has a direct impact on investment decisions because it is a key component of the risk inherent in foreign (i.e., foreign-currency-denominated) assets. Exchange rate volatility is also a critical factor in selecting hedging strategies for foreign currency exposures.

The amount of foreign exchange rate volatility will depend, at least in part, on the institutional and policy arrangements associated with trade in any given currency. Virtually every exchange rate is managed to some degree by central banks. The policy framework that each central bank adopts is called an *exchange rate regime*. Although

there are many potential variations, these regimes fall into a few general categories. Before describing each of these types, we consider the possibility of an ideal regime and provide some historical perspective on the evolution of currency arrangements.

4.1 The Ideal Currency Regime

The ideal currency regime would have three properties. First, the exchange rate between any two currencies would be credibly fixed. This would eliminate currency-related uncertainty with respect to the prices of goods and services as well as real and financial assets. Second, all currencies would be fully convertible (i.e., currencies could be freely exchanged for any purpose and in any amount). This condition ensures unrestricted flow of capital. Third, each country would be able to undertake fully independent monetary policy in pursuit of domestic objectives, such as growth and inflation targets.

Unfortunately, these three conditions are not consistent. If the first two conditions were satisfied—credibly fixed exchange rates and full convertibility—then there would really be only one currency in the world. Converting from one national currency to another would have no more significance (indeed less) than deciding whether to carry coins or paper currency in your wallet. Any attempt to influence interest rates, asset prices, or inflation by adjusting the supply of one currency versus another would be futile. Thus, it should be clear that independent monetary policy is not possible if exchange rates are credibly fixed and currencies are fully convertible. *There can be no ideal currency regime.*

The impact of the currency regime on a country's ability to exercise independent monetary policy is a recurring theme in open-economy macroeconomics. It will be covered in more detail in other readings; however, it is worthwhile to emphasize the basic point by considering what would happen in an idealized world of perfect capital mobility. If the exchange rate were credibly fixed, then any attempt to decrease default-free interest rates in one country below those in another—that is, to undertake independent, expansionary monetary policy—would result in a potentially unlimited outflow of capital because funds would seek the higher return. The central bank would be forced to sell foreign currency and buy domestic currency to maintain the fixed exchange rate. The loss of reserves and reduction in the domestic money supply would put upward pressure on domestic interest rates until rates were forced back to equality, negating the initial expansionary policy. Similarly, contractionary monetary policy (higher interest rates) would be thwarted by an inflow of capital.

The situation is quite different, however, with a floating exchange rate. A decrease in the domestic interest rate would make the domestic currency less attractive. The resulting depreciation of the domestic currency would shift demand toward domestically produced goods (i.e., exports rise and imports fall), reinforcing the expansionary impact of the initial decline in the interest rate. Similarly, a contractionary increase in the interest rate would be reinforced by appreciation of the domestic currency.

In practice, of course, capital is not perfectly mobile and the impact on monetary policy is not so stark. The fact remains, however, that fixed exchange rates limit the scope for independent monetary policy and that national monetary policy regains potency and independence, at least to some degree, if the exchange rate is allowed to fluctuate and/or restrictions are placed on convertibility. In general, the more freely the exchange rate is allowed to float and the more tightly convertibility is controlled, the more effective the central bank can be in addressing domestic macroeconomic objectives. The downside, of course, is the potential distortion of economic activity caused by exchange rate risk and inefficient allocation of financial capital.

4.2 Historical Perspective on Currency Regimes

How currencies exchange for one another has evolved over the centuries. At any point in time, different exchange rate systems may coexist; still, there tends to be one dominant system in the world economy. Throughout most of the 19th century and the early 20th century until the start of World War I, the US dollar and the UK pound sterling operated on the "classical gold standard." The price of each currency was fixed in terms of gold. Gold was the numeraire[10] for each currency; therefore, it was indirectly the numeraire for all other prices in the economy. Many countries (e.g., the colonies of the United Kingdom) fixed their currencies relative to sterling and were therefore implicitly also operating on the classical gold standard.

The classical gold standard operated by what is called the *price-specie-flow mechanism*. This mechanism operated through the impact of trade imbalances on capital flows, namely gold. As countries experienced a trade surplus, they accumulated gold as payment, their domestic money supply expanded by the amount dictated by the fixed parity, prices rose, and exports fell. Similarly, when a country ran a trade deficit, there was an automatic outflow of gold, a contraction of the domestic money supply, and a fall in prices leading to increased exports.

In this system, national currencies were backed by gold. A country could only print as much money as its gold reserve warranted. The system was limited by the amount of gold, but it was self-adjusting and inspired confidence. With a fixed stock of gold, the price-specie-flow mechanism would work well. Still, new gold discoveries as well as more efficient methods of refining gold would enable a country to increase its gold reserves and increase its money supply apart from the effect of trade flows. In general, however, trade flows drove changes in national money supplies.[11]

There is much disagreement among economic historians about the effect of the classical gold standard on overall macroeconomic stability. Was it destabilizing? On the one hand, monetary policy was tied to trade flows, so a country could not engage in expansionary policies when there was a downturn in the non-traded sector. On the other hand, it has been argued that tying monetary policy to trade flows kept inflation in check.

During the 1930s, the use of gold as a clearing device for settlement of trade imbalances, combined with increasing protectionism on the part of economies struggling with depression as well as episodes of deflation and hyperinflation, created a chaotic environment for world trade. As a consequence of these factors, world trade dropped by over 50 percent and the gold standard was abandoned.

In the later stages of World War II, a new system of fixed exchange rates with periodic realignments was devised by John Maynard Keynes and Harry Dexter White, representing the UK and US Treasuries, respectively. The Bretton Woods system, named after the town where it was negotiated, was adopted by 44 countries in 1944. From the end of the war until the collapse of the system in the early 1970s, the United States, Japan, and most of the industrialized countries of Europe maintained a system of fixed parities for exchange rates between currencies. When the parities were significantly and persistently out of line with the balancing of supply and demand, there would be a realignment of currencies with some appreciating in value and others depreciating in value. These periodic realignments were viewed as a part of standard monetary policy.

---

10 Economists refer to the unit of account in terms of which other goods, services, and assets are priced as the *numeraire*. Under the classical gold standard, the official value of each currency was expressed in ounces of gold.

11 The European inflation of the 17th century was an important exception. Discoveries of gold in South America led to an increase in the world gold stock and in prices throughout Europe. The impact was especially pronounced in Imperial Spain, the primary importing country. Historians have attributed the decline of the Spanish Empire, in part, to the loss of control of domestic prices.

By 1973, with chronic inflation taking hold throughout the world, most nations abandoned the Bretton Woods system in favor of a flexible exchange rate system under what are known as the Smithsonian Agreements. Milton Friedman had called for such a system as far back as the 1950s.[12] His argument was that the fixed parity system with periodic realignments would become unsustainable. When the inevitable realignments were imminent, large speculative profit opportunities would appear. Speculators would force the hand of monetary policy authorities, and their actions would distort the data needed to ascertain appropriate trade-related parities. It is better, he argued, to let the market, rather than central bank governors and treasury ministers, determine the exchange rate.

After 1973, most of the industrialized world changed to a system of flexible exchange rates. The original thinking was that the forces that caused exchange rate chaos in the 1930s—poor domestic monetary policy and trade barriers—would not be present in a flexible exchange rate regime, and therefore exchange rates would move in response to the exchange of goods and services among countries. As it turned out, however, exchange rates moved around much more than anyone expected. Academic economists and financial analysts alike soon realized that the high degree of exchange rate volatility was the manifestation of a highly liquid, forward-looking asset market.[13] Investment-driven FX transactions—for both long-term investment and short-term speculation—mattered much more in setting the spot exchange rate than anyone had previously imagined.

There are costs, of course, to a high degree of exchange rate volatility. These include difficulty planning without hedging exchange rate risks—a form of insurance cost, domestic price fluctuations, uncertain costs of raw materials, and short-term interruptions in financing transactions. For these reasons, in 1979 the European Economic Community opted for a system of limited flexibility, the European Exchange Rate Mechanism (ERM).

Initially, the system called for European currency values to fluctuate within a narrow band called "the snake." This did not last long. The end of the Cold War and the re-unification of Germany created conditions ripe for speculative attack. In the early 1990s, the United Kingdom was in a recession and the government's monetary policy leaned toward low interest rates to stimulate economic recovery. Germany was issuing large amounts of debt to pay for re-unification, and the German central bank (the Deutsche Bundesbank) opted for high interest rates to ensure price stability. Capital began to flow from sterling to Deutsche marks to obtain the higher interest rate. The Bank of England tried to lean against these flows and maintain the exchange rate within the Exchange Rate Mechanism, but eventually it began to run out of marks to sell. Because it was almost certain that devaluation would be required, holders of sterling rushed to purchase marks at the old rate and the speculative attack forced the United Kingdom out of the ERM in September 1992, only two years after it finally joined the system.

Despite these difficulties, 1999 saw the creation of a common currency for most Western European countries, without Switzerland or the United Kingdom, called the euro.[14] The hope was that the common currency would increase transparency of prices across borders in Europe, enhance market competition, and facilitate more

12 Friedman (1953).

13 Whether or not FX markets satisfy recognized definitions of market efficiency—correctly reflecting all available information—is debatable (e.g., some point to evidence of trending as a clear violation of efficiency). However, there is no doubt that FX market participants attempt to incorporate new information, which is often lumpy and difficult to decipher, into their expectations about the future. Changing expectations—accurate or otherwise—affect the value that investors place on holding different currencies and, in a highly liquid market, lead to rapid and sometimes violent exchange rate movements.

14 The number of European countries adopting the euro has continued to expand since its inception; the most recent country to join the euro was Lithuania, on 1 January 2015.

efficient allocation of resources. The drawback, of course, is that each member country lost the ability to manage its exchange rate and therefore to engage in independent monetary policy.

4.3 A Taxonomy of Currency Regimes

Although the pros and cons of fixed and flexible exchange rate regimes continue to be debated, regimes have been adopted that lie somewhere between these polar cases. In some cases, the driving force is the lack of credibility with respect to sound monetary policy. An economy with a history of hyperinflation may be forced to adopt a form of fixed-rate regime because its promise to maintain a sound currency with a floating rate regime would not be credible. This has been a persistent issue in Latin America. In other cases, the driving force is as much political as economic. The decision to create the euro was strongly influenced by the desire to enhance political union within the European Community, whose members had been at war with each other twice in the 20th century.

As of April 2008, the International Monetary Fund (IMF) classified exchange rate regimes into the eight categories shown in Exhibit 8.

Exhibit 8 Exchange Rate Regimes for Selected Economies[15] As of 30 April 2008

	Currency Anchor		
Type of Regime	**USD**	**EUR**	**Basket/None**
No separate legal tender			
Dollarized	Ecuador, El Salvador, Marshall Islands, Micronesia, Palau, Panama, Timor-Leste, Zimbabwe	Kosovo, Montenegro, San Marino	Kiribati, Tuvalu
Monetary union		*EMU*: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Lithuania, Malta, Netherlands, Portugal, Slovak Rep., Slovenia, Spain	
Currency board	Djibouti, Hong Kong SAR, Antigua and Barbuda	Bosnia and Herzegovina, Bulgaria	Brunei Darussalam
Fixed parity	Aruba, The Bahamas, Bahrain, Barbados, Belize, Curaçao and Saint Maarten, Eritrea, Jordan, Oman, Qatar, Saudi Arabia, South Sudan, Turkmenistan, UAE, Venezuela	Cabo Verde, Comoros, Denmark, São Tomé and Príncipe WAEMU: Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, Togo CEMAC: Cameroon, Central African Rep., Chad, Rep. of Congo, Equatorial Guinea, Gabon	Fiji, Kuwait, Libya, Morocco, Samoa, Bhutan, Lesotho, Namibia, Nepal, Swaziland

15 The classifications are described in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions 2014. In some cases, the labels used by the IMF do not clearly distinguish among the regimes. Hence, the names applied here to the regimes differ somewhat from the IMF's original taxonomy.

Exhibit 8 (Continued)

	Currency Anchor		
Type of Regime	**USD**	**EUR**	**Basket/None**
Target zone		Slovak Republic	Syria
Crawling peg	Nicaragua		Botswana
Crawling band	Honduras, Jamaica	Croatia	China, Ethiopia, Uzbekistan, Armenia, Dominican Republic, Guatemala, Argentina, Belarus, Haiti, Switzerland, Tunisia
Managed float	Cambodia, Liberia		Algeria, Iran, Syria, The Gambia, Myanmar, Nigeria, Rwanda, Czech Rep., Costa Rica, Malaysia, Mauritania Pakistan, Russia, Sudan, Vanuatu
Independent float *Currency columns due to floating*	Australia, Canada, Chile, Japan, Mexico, Norway, Poland, Sweden, United Kingdom, Somalia, United States	Albania, Brazil, Colombia, Georgia, Ghana, Hungary, Iceland, Indonesia, Israel, Korea, Moldova, New Zealand, Paraguay, Peru	Philippines, Romania, Serbia, South Africa, Thailand, Turkey, Uganda

It should be noted that global financial markets are too complex and diverse to be fully captured by this (or any other) classification system. A government's control over the domestic currency's exchange rate will depend on many factors; for example, the degree of capital controls used to prevent the free flow of funds in and out of the economy. Also, even under an "independent float" regime monetary authorities will occasionally intervene in foreign exchange markets in order to influence the value of their domestic currency. Additionally, the specifics of exchange rate policy implementation are subject to change.

This means that the classifications in Exhibit 8 are somewhat arbitrary and subject to interpretation, as well as change, over time. The important point to be drawn from this discussion is that the prices and flows in foreign exchange markets will, to varying degrees, reflect the legal and regulatory framework imposed by governments, not just "pure" market forces. Governments have a variety of motives and tools for attempting to manage exchange rates. The taxonomy in Exhibit 8 can be used to help understand the main distinctions among currency regimes and the rationales for adopting them, but the specific definitions should not be interpreted too rigidly. Instead, the focus should be on the diversity of foreign exchange markets globally as well as the implications of these various currency regimes for market pricing.

4.3.1 *Arrangements with No Separate Legal Tender*

The IMF identifies two types of arrangements in which a country does not have its own legal tender. In the first, known as *dollarization*, the country uses the currency of another nation as its medium of exchange and unit of account. In the second, the country participates in a monetary union whose members share the same legal tender. In either case, the country gives up the ability to conduct its own monetary policy.

In principle, a country could adopt any currency as its medium of exchange and unit of account, but the main reserve currency, the US dollar, is an obvious choice—hence the name dollarization. Many countries are dollarized: East Timor, El Salvador, Ecuador, and Panama, for example. By adopting another country's currency as legal

tender, a dollarized country inherits that country's currency credibility, but not its credit-worthiness. For example, although local banks may borrow, lend, and accept deposits in US dollars, they are not members of the US Federal Reserve System nor are they backed by deposit insurance from the Federal Deposit Insurance Corporation. Thus, interest rates on US dollars in a dollarized economy need not be, and generally are not, the same as on dollar deposits in the United States.

Dollarization imposes fiscal discipline by eliminating the possibility that the central bank will be induced to monetize government debt (i.e., to persistently purchase government debt with newly created local currency). For countries with a history of fiscal excess or lack of monetary discipline, dollarizing the economy can facilitate growth of international trade and capital flows if it creates an expectation of economic and financial stability. In the process, however, it removes another potential source of stabilization—domestic monetary policy.

The European Economic and Monetary Union (EMU) is the most prominent example of the second type of arrangement lacking separate legal tender. Each EMU member uses the euro as its currency. Although member countries cannot have their own monetary policies, they jointly determine monetary policy through their representation at the European Central Bank (ECB). As with dollarization, a monetary union confers currency credibility on members with a history of fiscal excess and/or a lack of monetary discipline. However, as shown by the 2010 EMU sovereign debt crisis, monetary union alone cannot confer credit-worthiness.

4.3.2 *Currency Board System*

The IMF defines a *currency board system* (CBS) as:

> A monetary regime based on an explicit legislative commitment to exchange domestic currency for a specified foreign currency at a fixed exchange rate, combined with restrictions on the issuing authority to ensure fulfillment of its legal obligation. This implies that domestic currency will be issued only against foreign exchange and it remains fully backed by foreign assets….[16]

Hong Kong SAR has the leading example of a long-standing (since 1983) currency board. US dollar reserves are held to cover, at the fixed parity, the entire *monetary base*—essentially bank reserves plus all HKD notes and coins in circulation.[17] Note that HKD-denominated bank deposits are not fully collateralized by US dollar reserves; to do so would mean that banks could not lend against their deposits. The Hong Kong Monetary Authority (HKMA) does not function as a traditional central bank under this system because the obligation to maintain 100 percent foreign currency reserves against the monetary base prevents it from acting as a lender-of-last-resort for troubled financial institutions. However, it can provide short-term liquidity by lending against foreign currency collateral.

A CBS works much like the classical gold standard in that expansion and contraction of the monetary base are directly linked to trade and capital flows. As with the gold standard, a CBS works best if domestic prices and wages are very flexible, non-traded sectors of the domestic economy are relatively small, and the global supply of the reserve asset grows at a slow, steady rate consistent with long-run real growth with stable prices. The first two of these conditions are satisfied in Hong Kong SAR. Until and unless Hong Kong SAR selects a new reserve asset, however, the third condition depends on US monetary policy.

16 International Monetary Fund (2006).

17 For a description of Hong Kong's currency board system, see Hong Kong Monetary Authority (2005).

In practice, the HKD exhibits modest fluctuations around the official parity of HKD/USD = 7.80 because the HKMA buys (sells) USD at a pre-announced level slightly below (above) the parity. Persistent flows on one side of this convertibility zone or the other result in interest rate adjustments rather than exchange rate adjustments. Inside the zone, however, the exchange rate is determined by the market and the HKMA is free to conduct limited monetary operations aimed at dampening transitory interest rate movements.

One of the advantages of a CBS as opposed to dollarization is that the monetary authority can earn a profit by paying little or no interest on its liability—the monetary base—and can earn a market rate on its asset—the foreign currency reserves. This profit is called *seigniorage*.[18] Under dollarization, the seigniorage goes to the monetary authority whose currency is used.

4.3.3 *Fixed Parity*

A simple fixed-rate system differs from a CBS in two important respects. First, there is no legislative commitment to maintaining the specified parity. Thus, market participants know that the country may choose to adjust or abandon the parity rather than endure other, potentially more painful, adjustments. Second, the target level of foreign exchange reserves is discretionary; it bears no particular relationship to domestic monetary aggregates. Thus, although monetary independence is ultimately limited as long as the exchange peg is maintained, the central bank can carry out traditional functions, such as serving as lender of last resort.

In the conventional fixed-rate system, the exchange rate may be pegged to a single currency—for example, the US dollar—or to a basket index of the currencies of major trading partners. There is a band of up to ±1 percent around the parity level within which private flows are allowed to determine the exchange rate. The monetary authority stands ready to spend its foreign currency reserves, or buy foreign currency, in order to maintain the rate within these bands.

The credibility of the fixed parity depends on the country's willingness and ability to offset imbalances in private sector demand for its currency. Both excess and deficient private demand for the currency can exert pressure to adjust or abandon the parity. Excess private demand for the domestic currency implies a rapidly growing stock of foreign exchange reserves, expansion of the domestic money supply, and potentially accelerating inflation. Deficient demand for the currency depletes foreign exchange reserves and exerts deflationary pressure on the economy. If market participants believe the foreign exchange reserves are insufficient to sustain the parity, then that belief may be self-fulfilling because the resulting speculative attack will drain reserves and may force an immediate devaluation. Thus, the level of reserves required to maintain credibility is a key issue for a simple fixed exchange rate regime.

4.3.4 *Target Zone*

A target zone regime has a fixed parity with fixed horizontal intervention bands that are somewhat wider—up to ±2 percent around the parity—than in the simple fixed parity regime. The wider bands provide the monetary authority with greater scope for discretionary policy.

18 More generally, seigniorage is the profit earned when the value of money issued exceeds the cost of producing it. For physical currency, seigniorage arises when a coin is minted for a fraction of its face value and then issued (sold) at its face value.

4.3.5 *Active and Passive Crawling Pegs*

Crawling pegs for the exchange rate—usually against a single currency, such as the US dollar—were common in the 1980s in Latin America, particularly Brazil, during the high inflation periods. To prevent a run on the US dollar reserves, the exchange rate was adjusted frequently (weekly or daily) to keep pace with the inflation rate. Such a system was called a passive crawl. An adaptation used in Argentina, Chile, and Uruguay was the active crawl: The exchange rate was pre-announced for the coming weeks with changes taking place in small steps. The aim of the active crawl was to manipulate expectations of inflation. Because the domestic prices of many goods were directly tied to import prices, announced changes in the exchange rate would effectively signal future changes in the inflation rate of these goods.

4.3.6 *Fixed Parity with Crawling Bands*

A country can also have a fixed central parity with crawling bands. Initially, a country may fix its rates to a foreign currency to anchor expectations about future inflation but then gradually permit more and more flexibility in the form of a pre-announced widening band around the central parity. Such a system has the desirable property of allowing a gradual exit strategy from the fixed parity. A country might want to introduce greater flexibility and greater scope for monetary policy, but it may not yet have the credibility or financial infrastructure for full flexibility. So it maintains a fixed parity with slowly widening bands.

4.3.7 *Managed Float*

A country may simply follow an exchange rate policy based on either internal or external policy targets—intervening or not to achieve trade balance, price stability, or employment objectives. Such a policy, often called *dirty floating,* invites trading partners to respond likewise with their exchange rate policy and potentially decreases stability in foreign exchange markets as a whole. The exchange rate target, in terms of either a level or a rate of change, is typically not explicit.

4.3.8 *Independently Floating Rates*

In this case, the exchange rate is left to market determination and the monetary authority is able to exercise independent monetary policy aimed at achieving such objectives as price stability and full employment. The central bank also has latitude to act as a lender of last resort to troubled financial institutions, if necessary.

It should be clear from recent experience that the concepts of float, managed float, crawl, and target zone are not hard and fast rules. Central banks do occasionally engage, implicitly or explicitly, in regime switches—even in countries nominally following an independently floating exchange rate regime. For example, when the US dollar appreciated in the mid-1980s with record US trade deficits, then-US Treasury Secretary James Baker engineered the Plaza Accord, in which Japan and Germany engineered an appreciation of their currencies against the US dollar. (The "Plaza Accord" is so named because it was negotiated at the Plaza Hotel in New York City.) This 1985 policy agreement involved a combination of fiscal and monetary policy measures by the countries involved as well as direct intervention in foreign exchange markets. The Plaza Accord was a clear departure from a pure independently floating exchange rate system.

There are more recent examples of government intervention in foreign exchange markets. In September 2000, the European Central Bank, the Federal Reserve Board, the Bank of Japan, the Bank of England, and the Bank of Canada engaged in "concerted" intervention in order to support the value of the euro, a "freely floating" currency which was then under pressure within foreign exchange markets. (This intervention was described as "concerted" because it was pre-arranged and coordinated among

the central banks involved.) During 2010, many countries engaged in unilateral intervention to prevent the rapid appreciation of their currencies against the US dollar. Several of these countries also employed various fiscal and regulatory measures (for example, taxes on capital inflows) in order to further affect exchange rate movements.

The important point to draw from this discussion is that exchange rates do not only reflect private sector market forces but will also, to varying degrees, be influenced by the legal and regulatory framework (currency regimes) within which foreign exchange markets operate. Moreover, they will occasionally be influenced by government polices (fiscal, monetary, and intervention) intended to manage exchange rates. All of these can vary widely among countries and are subject to change with time.

Nonetheless, the most widely traded currencies in foreign exchange markets (the US dollar, yen, euro, UK pound, Swiss franc, and the Canadian and Australian dollars) are typically considered to be free floating, although subject to relatively infrequent intervention.

EXAMPLE 7

Currency Regimes

An investment adviser in Los Angeles, USA, is meeting with a client who wishes to diversify her portfolio by including more international investments. In order to evaluate the suitability of international diversification for the client, the adviser attempts to explain some of the characteristics of foreign exchange markets. The adviser points out that exchange rate regimes affect the performance of domestic economies as well as the amount of foreign exchange risk posed by international investments.

The client and her adviser discuss potential investments in Hong Kong SAR, Panama, and Canada. The adviser notes that the currency regimes of Hong Kong SAR, Panama, and Canada are a currency board, dollarization, and a free float, respectively. The adviser tells his client that these regimes imply different degrees of foreign exchange risk for her portfolio.

The discussion between the investment adviser and his client then turns to potential investments in other markets with different currency regimes. The adviser notes that some markets are subject to fixed parity regimes against the US dollar. The client asks whether a fixed parity regime would imply less foreign currency risk for her portfolio than would a currency board. The adviser replies: "Yes, a fixed parity regime means a constant exchange rate and is more credible than a currency board."

The adviser goes on to explain that in some markets exchange rates are allowed to vary, although with different degrees of foreign exchange market intervention to limit exchange rate volatility. Citing examples, he notes that mainland China has a crawling peg regime with reference to the US dollar, but the average daily percentage changes in mainland China/US exchange rate are very small compared with the average daily volatility for a freely floating currency. The adviser also indicates that Denmark has a target zone regime with reference to the euro, and South Korea usually follows a freely floating currency regime but sometimes switches to a managed float regime. The currencies of mainland China, Denmark, and South Korea are the yuan renminbi (CNY), krone (DKK), and won (KRW), respectively.

1 Based solely on the exchange rate risk the client would face, what is the correct ranking (from most to least risky) of the following investment locations?

A Panama, Canada, Hong Kong SAR.

B Canada, Hong Kong SAR, Panama.

C Hong Kong SAR, Panama, Canada.

2 Based solely on their foreign exchange regimes, which investment location is least likely to import inflation or deflation from the United States?

A Canada.

B Panama.

C Hong Kong SAR.

3 The adviser's statement about fixed parity regimes is incorrect with regard to:

A credibility.

B a constant exchange rate.

C both a constant exchange rate and credibility.

4 Based on the adviser's categorization of mainland China's currency regime, if the USD is depreciating against the KRW, then it is *most* likely correct that the CNY is:

A fixed against the KRW.

B appreciating against the KRW.

C depreciating against the KRW.

5 Based on the adviser's categorization of Denmark's currency regime, it would be *most* correct to infer that the:

A krone is allowed to float against the euro within fixed bands.

B Danish central bank will intervene if the exchange rate strays from its target level.

C target zone will be adjusted periodically in order to manage inflation expectations.

6 Based on the adviser's categorization of South Korea's currency policy, it would be *most* correct to infer that the:

A Korean central bank is engineering a gradual exit from a fixed-rate regime.

B government is attempting to peg the exchange rate within a predefined zone.

C won is allowed to float, but with occasional intervention by the Korean central bank.

Solution to 1:

B is correct. The CAD/USD exchange rate is a floating exchange rate, and Canadian investments would therefore carry exchange rate risk for a US-based investor. Although Hong Kong SAR follows a currency board system, the HKD/USD exchange rate nonetheless does display some variation, albeit much less than in a floating exchange rate regime. In contrast, Panama has a dollarized economy (i.e., it uses the US dollar as the domestic currency); therefore, there is no foreign exchange risk for a US investor.

Solution to 2:

A is correct. The Canadian dollar floats independently against the US dollar leaving the Bank of Canada able to adjust monetary policy to maintain price stability. Neither Hong Kong SAR (currency board) nor Panama (dollarized) can exercise independent monetary policy to buffer its economy from the inflationary/deflationary consequences of US monetary policy.

Solution to 3:

C is correct. A fixed exchange rate regime does not mean that the exchange rate is rigidly fixed at a constant level. In practice, both a fixed-rate regime and a currency board allow the exchange rate to vary within a band around the stated parity level. Thus, both regimes involve at least a modest amount of exchange rate risk. The fixed parity regime exposes the investor to the additional risk that the parity may not be maintained. In a fixed parity regime, the level of foreign currency reserves is discretionary and typically only a small fraction of the domestic money supply. With no legal obligation to maintain the parity, the monetary authority may adjust the parity (devalue or revalue its currency) or allow its currency to float if doing so is deemed to be less painful than other adjustment mechanisms (e.g., fiscal restraint). In contrast, a currency board entails a legal commitment to maintain the parity and to fully back the domestic currency with reserve currency assets. Hence, there is little risk that the parity will be abandoned.

Solution to 4:

C is correct. If the CNY is subject to a crawling peg with very small daily adjustments versus the USD and the USD is depreciating against the KRW, then the CNY would *most* likely be depreciating against the KRW as well. In fact, this was an important issue in foreign exchange markets through the latter part of 2010: As the USD depreciated against most Asian currencies (and less so against the CNY), many Asian countries felt that they were losing their competitive export advantage because the CNY was so closely tied to the USD. This led many Asian countries to intervene in FX markets against the strength of their domestic currencies in order not to lose an export pricing advantage against the Chinese mainland.

Solution to 5:

A is correct. A target zone means that the exchange rate between the euro and Danish krone (DKK) will be allowed to vary within a fixed band (as of 2010, the target zone for the DKK/EUR is a ±2.5 percent band). This does not mean that the DKK/EUR rate is fixed at a certain level (B is incorrect) or that the target zone will vary in order to manage inflation expectations (this is a description of a crawling peg, which makes C incorrect).

Solution to 6:

C is correct. Similar to the monetary authorities responsible for many of the world's major currencies, the South Korean policy typically involves letting market forces determine the exchange rate (an independent floating rate regime). But this approach does not mean that market forces are the sole determinant of the won exchange rate. As with most governments, the South Korean policy is to intervene in foreign exchange markets when movements in the exchange rate are viewed as undesirable (a managed float). For example, during the later part of 2010, South Korea and many other countries intervened in foreign exchange markets to moderate the appreciation of their currencies against the US dollar. Answer A describes a fixed parity with a crawling bands regime, and B describes a target zone regime: Both answers are incorrect.

5 EXCHANGE RATES, INTERNATIONAL TRADE, AND CAPITAL FLOWS

Just as a family that spends more than it earns must borrow or sell assets to finance the excess, a country that imports more goods and services than it exports must borrow from foreigners or sell assets to foreigners to finance the trade deficit. Conversely, a country that exports more goods and services than it imports must invest the excess either by lending to foreigners or by buying assets from foreigners. Thus, a trade deficit (surplus) must be exactly matched by an offsetting *capital account* surplus (deficit).[19] This implies that any factor that affects the trade balance must have an equal and opposite impact on the capital account, and vice versa. To put this somewhat differently, the *impact of exchange rates and other factors on the trade balance must be mirrored by their impact on capital flows*: They cannot affect one without affecting the other.

Using a fundamental identity from macroeconomics, the relationship between the trade balance and expenditure/saving decisions can be expressed as:[20]

$$X - M = (S - I) + (T - G)$$

where X represents exports, M is imports, S is private savings, I is investment in plant and equipment, T is taxes net of transfers, and G is government expenditure. From this relationship, we can see that a trade surplus ($X > M$) must be reflected in a fiscal surplus ($T > G$), an excess of private saving over investment ($S > I$), or both. Because a fiscal surplus can be viewed as government saving, we can summarize this relationship more simply by saying that a trade surplus means the country saves more than enough to fund its investment (I) in plant and equipment. The excess saving is used to accumulate financial claims on the rest of the world. Conversely, a trade deficit means the country does not save enough to fund its investment spending (I) and must reduce its net financial claims on the rest of the world.

Although this identity provides a key link between real expenditure/saving decisions and the aggregate flow of financial assets into or out of a country, it does not tell us what type of financial assets will be exchanged or in what currency they will be denominated. All that can be said is that asset prices and exchange rates at home and abroad must adjust so that all financial assets are willingly held by investors.

If investors anticipate a significant change in an exchange rate, they will try to sell the currency that is expected to depreciate and buy the currency that is expected to appreciate. This implies an incipient (i.e., potential) flow of capital from one country to the other, which must either be accompanied by a simultaneous shift in the trade balance or be discouraged by changes in asset prices and exchange rates. Because expenditure/saving decisions and prices of goods change much more slowly than financial investment decisions and asset prices, most of the adjustment usually occurs within the financial markets. That is, *asset prices and exchange rates adjust so that the potential flow of financial capital is mitigated and actual capital flows remain consistent with trade flows*. In a fixed exchange rate regime, the central bank offsets the private capital flows in the process of maintaining the exchange rate peg and the adjustment occurs in other asset prices, typically interest rates, until and unless the

19 In official balance of payments accounts, investment/financing flows are separated into two categories: the capital account and the financial account. Because the technical distinction is immaterial for present purposes, we will simply refer to the balance of investment/financing flows as the capital account. Similarly, we ignore the technical distinction between the trade balance and the *current account* balance. The details of balance of payments accounting are presented in the Level I curriculum reading on International Trade and Capital Flows.

20 This relationship is developed in the Level I curriculum reading on Aggregate Output, Prices, and Economic Growth.

central bank is forced to allow the exchange rate to adjust.[21] In a floating exchange rate regime, the main adjustment is often a rapid change in the exchange rate that dampens an investor's conviction that further movement will be forthcoming. Thus, *capital flows—potential and actual—are the primary determinant of exchange rate movements in the short-to-intermediate term*. Trade flows become increasingly important in the longer term as expenditure/saving decisions and the prices of goods and services adjust.

With the correspondence between the trade balance and capital flows firmly established, we can now examine the impact of exchange rate changes on the trade balance from two perspectives. The first approach focuses on the effect of changing the relative price of domestic and foreign goods. This approach, which is called the *elasticities approach*, highlights changes in the composition of spending. The second approach, called the *absorption approach*, focuses on the impact of exchange rates on aggregate expenditure/saving decisions.

5.1 Exchange Rates and the Trade Balance: The Elasticities Approach

The effectiveness of devaluation (in a fixed system) or depreciation (in a flexible system) of the currency for reducing a trade deficit depends on well-behaved demand and supply curves for goods and services. The condition that guarantees that devaluations improve the trade balance is called the Marshall–Lerner condition. The usual statement of this condition assumes that trade is initially balanced. We will present a generalization of the condition that allows for an initial trade imbalance and hence is more useful in addressing whether exchange rate movements will correct such imbalances.

Recall from microeconomics that the price elasticity of demand is given by:[22]

$$\varepsilon = -\frac{\%\ change\ in\ quantity}{\%\ change\ in\ price} = -\frac{\%\Delta Q}{\%\Delta P}$$

For example, a demand elasticity of 0.6 means that quantity demanded increases by 6 percent if price declines by 10 percent. Note that the elasticity of demand is defined so that it is a positive number. Because expenditure (R) equals price multiplied by quantity ($P \times Q$), by re-arranging the above expression to solve and substitute for $\%\Delta Q$, we can see that:

$$\%\ change\ in\ expenditure = \%\Delta R = \%\Delta P + \%\Delta Q = (1 - \varepsilon)\%\Delta P$$

From this we can see that an increase in price decreases expenditure if $\varepsilon > 1$, but it increases expenditure if $\varepsilon < 1$. By convention, if $\varepsilon > 1$ demand is described as being "elastic," while if $\varepsilon < 1$ demand is described as "inelastic."

The basic idea behind the Marshall–Lerner condition is that demand for imports and exports must be sufficiently price-sensitive so that increasing the relative price of imports increases the difference between export receipts and import expenditures. The generalized Marshall–Lerner condition is:

$$\omega_X \varepsilon_X + \omega_M(\varepsilon_M - 1) > 0$$

where ω_X and ω_M are the shares of exports and imports, respectively, in total trade (i.e., imports + exports) and ε_X and ε_M are the price elasticities of foreign demand for domestic country exports and domestic country demand for imports, respectively.

21 A classic example of this occurred in September 1992, when the United Kingdom was forced to withdraw from the European Exchange Rate Mechanism, the forerunner of the current European Economic and Monetary Union (EMU).

22 See the Level I curriculum reading Topics in Demand and Supply Analysis.

Note that $(\omega_X + \omega_M) = 1$ and that an initial trade deficit implies $\omega_M > \omega_X$. If this condition is satisfied, a devaluation/depreciation of the domestic currency will move the trade balance toward surplus.

The first term in the generalized Marshall–Lerner condition reflects the change in export receipts assuming the domestic currency price of exports is unchanged (i.e., foreigners are billed in the domestic currency). It will be positive as long as export demand is not totally insensitive to price. Depreciation of the domestic currency makes exports cheaper in foreign currency and induces an increase in the quantity demanded by foreigners. This is reflected by the elasticity ε_x. There is no direct price impact on domestic currency export revenue because the domestic currency price is assumed to be unchanged. Hence, the percentage change in export revenue corresponding to a 1 percent depreciation of the currency is simply ε_x. The second term in the generalized Marshall–Lerner condition reflects the impact on import expenditures. Assuming that imports are billed in a foreign currency, the domestic currency price of imports rises as the domestic currency depreciates. The direct price effect increases import expenditures, while the induced reduction in the quantity of imports decreases import expenditures. The net effect depends on the elasticity of import demand, ε_M. Import expenditure declines only if import demand is elastic (i.e., $\varepsilon_M > 1$).

Examination of the generalized Marshall–Lerner condition indicates that more elastic demand—for either imports or exports—makes it more likely that the trade balance will improve. Indeed, if the demand for imports is elastic, $\varepsilon_M > 1$, then the trade balance will definitely improve. It should also be clear that the elasticity of import demand becomes increasingly important, and the export elasticity less important, as the initial trade deficit gets larger—that is, as ω_M increases. In the special case of initially balanced trade, $\omega_X = \omega_M$, the condition reduces to $(\varepsilon_X + \varepsilon_M > 1)$, which is the classic Marshall–Lerner condition.

Exhibit 9 illustrates the impact of depreciation on the trade balance. For ease of reference, we assume the domestic currency is the euro. A 10 percent depreciation of the euro makes imports 10 percent more expensive in euro terms. With an import elasticity of 0.65, this induces a 6.5 percent reduction in the quantity of imports. But import expenditures increase by 3.5 percent [10% × (1 – 0.65)] or €21,000,000 because the drop in quantity is not sufficient to offset the increase in price. On the export side, the euro price of exports does not change but the foreign currency price of exports declines by 10 percent. This induces a 7.5 percent increase in the quantity of exports given an elasticity of 0.75. The euro value of exports therefore increases by 7.5 percent or €30,000,000. The net effect is a €9,000,000 improvement in the trade balance and a €51,000,000 increase in total trade.

Exhibit 9 Marshall–Lerner Condition with a 10 Percent Depreciation of Domestic Currency (€)

Assumptions	Exports	Imports
Demand elasticity	0.75	0.65
Percent price change		

Exhibit 9 (Continued)

Assumptions	Exports	Imports
In domestic currency (€)	0	10%
In foreign currency	–10%	0

Results	Initial value(€)	Change(€)
Exports	400,000,000	30,000,000
Imports	600,000,000	21,000,000
Trade balance	–200,000,000	9,000,000
Total trade	1,000,000,000	51,000,000

The balance of trade improves after the depreciation of the euro because the Marshall–Lerner condition is satisfied: The increase in the euro-value of exports exceeds the increase in the value of imports. Based on the data in Exhibit 9, $\omega_M = 0.6$ (i.e., 600,000,000/1,000,000,000) and $\omega_X = 0.4$ (i.e., 1 – 0.6). Thus, the Marshall–Lerner equation is greater than zero:

$$\omega_X \varepsilon_X + \omega_M(\varepsilon_M - 1) = 0.4 \times 0.75 + 0.6(0.65 - 1) = 0.09$$

The elasticity of demand for any good or service depends on at least four factors: 1) the existence or absence of close substitutes, 2) the structure of the market for that product (e.g., a monopoly or perfect competition), 3) its share in people's budgets, and 4) the nature of the product and its role in the economy. Demand for a product with close substitutes is highly price-sensitive, whereas demand for a unique product tends to be much less elastic. The demand curve faced by any producer also depends on the nature and level of competition among producers of that product. If there are many sellers of identical products, then each producer faces highly elastic demand for its output even if global demand for that product is insensitive to price. Producers who are able to differentiate their product, perhaps through branding, face somewhat less elastic demand. In markets with only a few sellers, each producer faces demand that is highly dependent upon strategic maneuvers by its competitors. If competitors match price decreases but not increases, then the producer loses market share by raising his price but fails to gain market share by reducing his price.

Price changes have two effects on demand. The *substitution effect* refers to changes in the composition of spending across different products. As a product gets more expensive (cheaper) relative to other products, customers demand less (more) of it. This is what people usually think of first when they consider the effect of a price change. The *income effect* refers to the fact that price changes affect real purchasing power. When the price of a good rises (falls), people's purchasing power is reduced (increased). The strength of this effect depends on the product's share in people's budgets—the more important the product, the stronger the income effect. The income effect also depends on the nature of the product. The demand for luxuries is highly sensitive to income, whereas the demand for necessities is fairly insensitive to income.

To illustrate the differential impact of the two drivers of the income effect—share of expenditure and nature of the product—consider the demand for food. Clearly, food is a necessity. Based on this fact, we would expect demand to be inelastic. However, the share of expenditures that go to food varies across countries. In poor countries, food represents a much larger share of expenditure than in rich countries. Hence, all else being equal, we would expect the demand for food to be more price elastic in poorer countries. Of course, even in rich countries, the composition of spending on food may change considerably even if overall demand for food does not.

A significant portion of international trade occurs in intermediate products—products that are used as inputs into the production of other goods. Demand for these products derives from supply and demand decisions for the final products. However, the same basic considerations apply for intermediate products as for final products. Are there close substitutes for it in the production process? If not, its demand will tend to be less elastic than would be the case if there were readily available substitutes. How important is it to the overall economy? All else equal, the larger its share in overall production costs for the economy, the bigger its impact on production decisions and therefore the more price-elastic its derived demand. Oil is a classic example of a widely used input with few readily adoptable substitutes, at least in the short run. Lack of substitutes tends to make oil demand price-inelastic. However, it is so important in modern industrial economies that changes in its price can induce expansion or contraction of aggregate output. This makes short-run oil demand somewhat more elastic—at least for significant price changes. In the longer run, the feasibility of substitution among energy sources enhances the price sensitivity of oil demand.

Exhibit 10 shows estimates of demand elasticity for various products. The estimates range from essentially zero for pediatric doctor visits—a necessity for which there is virtually no substitute—to 3.8 for Coca-Cola, a specific brand for which there are many substitutes. Note that the elasticity of demand for soft drinks in general is much lower than for Coca-Cola, roughly 0.9. The elasticity of demand for rice in Japan versus in Bangladesh clearly illustrates the impact of expenditure share on price sensitivity. Similarly, although air travel for pleasure (a luxury) is quite price elastic, demand for first-class air travel is fairly insensitive to price. This is most likely because many first-class passengers are either traveling on business (presumably deemed to have high value added) or wealthy enough that the cost of first-class airfare is inconsequential.

Exhibit 10 Estimates of Demand Elasticities

Product Description	Elasticity	Rationale/Comment
Travel and transport		
Airline travel (US)		
For pleasure	1.5	Luxury
1st class	0.3	Business and wealthy travelers
Car fuel (US, long term)	0.3	
Bus travel (US)	0.2	
Ford compact car	2.8	Large purchase; specific brand
Food and beverages		
Rice		Necessity; staple food
Bangladesh	0.8	Poor country
Japan	0.3	Wealthy country
Soft drinks		
All	0.8–1.0	
Coca-Cola	3.8	Specific brand; competitive market
Medical care (US)		
Health insurance	0.3	
Pediatric doctor visit	0.0–0.1	No good substitute
Materials and energy		Necessary inputs

Exhibit 10 (Continued)

Product Description	Elasticity	Rationale/Comment
Steel	0.2–0.3	
Oil	0.4	

Sources: Various studies cited in Wikipedia, "Price Elasticity of Demand," accessed August 2018 (http://en.wikipedia.org/wiki/Price_elasticity_of_demand).

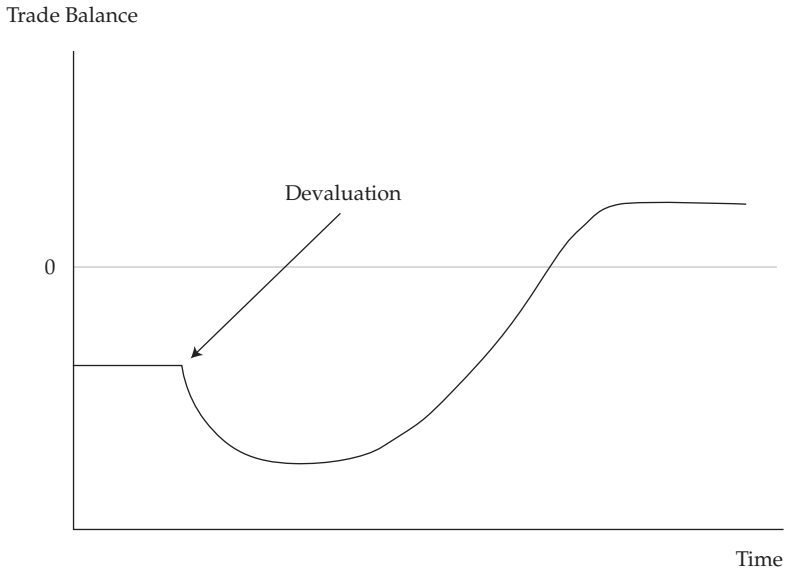
In practice, most countries import and export a variety of products. Hence, the overall price elasticities of their imports and exports reflect a composite of the products they trade. In conjunction with the Marshall–Lerner condition, our review of the factors that determine price elasticities suggests that exchange rate changes will be a more-effective mechanism for trade balance adjustment if a country imports and exports the following:

- Goods for which there are good substitutes
- Goods that trade in competitive markets
- Luxury goods, rather than necessities
- Goods that represent a large portion of consumer expenditures or a large portion of input costs for final producers

Note that each of these conditions is associated with higher demand elasticities (ε_X and ε_M).

Even when the Marshall–Lerner condition is satisfied, it is still possible that devaluation (in a fixed parity regime) or depreciation (in a floating regime) of the currency will initially make the trade balance worse before making it better. This effect, called the *J*-curve effect, is illustrated in Exhibit 11.

Exhibit 11 Trade Balance Dynamics: The *J*-Curve



In the very short run, the *J*-curve reflects the order delivery lags that take place in import and export transactions. Imagine a clothing importer in Washington. Orders are placed in January for French spring fashions. Market forces cause the dollar to depreciate in February, but contracts were already signed for payment in euros. When the fashions arrive in March, more dollars have to go out to pay for the order signed in euros. Thus, the trade balance gets worse. However, after the depreciation, the clothing importer has to put in new orders for summer fashions. As a result of the currency depreciation, the French summer fashions are now more expensive, so the clothing store cuts the demand for imported clothes from France. The depreciation eventually improves the trade balance, even though it initially made it worse.

A *J*-curve pattern may also arise if short-term price elasticities do not satisfy the Marshall–Lerner condition but long-term elasticities do satisfy it. As noted above in the case of oil, significant changes in spending patterns often take time. Thus, the trade balance may worsen initially and then gradually improve following a depreciation of the currency as firms and consumers adapt.

5.2 Exchange Rates and the Trade Balance: The Absorption Approach

The elasticities approach focuses on the expenditure-switching effect of changing the relative prices of imports and exports. It is essentially a microeconomic view of the relationship between exchange rates and the trade balance. The absorption approach adopts an explicitly macroeconomic view of this relationship.

Recall from above that the trade balance is equal to the country's saving, including the government fiscal balance, minus its investment in new plants and equipment. Equivalently, it is equal to the difference between income (GDP) and domestic expenditure, or absorption. Thus, in order to move the trade balance toward surplus, a devaluation/depreciation of the domestic currency must increase income relative to expenditure or, equivalently, increase national saving relative to investment in physical capital.

If there is excess capacity in the economy, then by switching demand toward domestically produced goods and services, depreciation of the currency can increase output/income. Because some of the additional income will be saved, income rises relative to expenditure and the trade balance improves. If the economy is at full employment, however, the trade balance cannot improve unless domestic expenditure declines. If expenditure does not decline, then the depreciation will put upward pressure on domestic prices until the stimulative effect of the exchange rate change is negated by the higher price level and the trade balance reverts to its original level.

How might depreciation of the currency reduce domestic expenditure relative to income? The main mechanism is a wealth effect. A weaker currency reduces the purchasing power of domestic-currency-denominated assets (including the present value of current and future earned income). Households respond by reducing expenditure and increasing saving in order to rebuild their wealth. Of course, as real wealth is rebuilt, the effect on saving is likely to be reversed—resulting in only a temporary improvement in the trade balance. Thus, in the absence of excess capacity in the economy, currency depreciation is likely to provide only a temporary solution for a chronic trade imbalance. Lasting correction of the imbalance requires more fundamental changes in expenditure/saving behavior (e.g., a policy shift that improves the fiscal balance or an increase in saving relative to capital investment induced by an increase in real interest rates).

The absorption approach also reminds us that currency depreciation cannot improve the trade balance unless it also induces a corresponding change in the capital account. Not only must domestic saving increase, but that saving must also be

willingly channeled into buying financial assets from foreigners. All else equal, this implies that foreign and domestic asset prices must change such that foreign assets become relatively more attractive and domestic assets relatively less attractive to both foreign and domestic investors.

EXAMPLE 8

Exchange Rates and the Trade Balance

An analyst at a foreign exchange dealing bank is examining the exchange rate for the Australian dollar (AUD), which is a freely floating currency. Currently, Australia is running a trade surplus with the rest of the world, primarily reflecting strong demand for Australian resource exports generated by rapid growth in emerging market economies in the Western Pacific region. In turn, Australia imports food and energy from a variety of foreign countries that compete with each other as well as with Australian producers of these products. The analyst uses data in the following table to estimate the effect of changes in the AUD exchange rate on Australia's balance of trade.

	Volume (AUD billions)	Demand Elasticity
Exports	200	0.3
Imports	180	0.6

The analyst's research report on this topic notes that the mix of products that Australia imports and exports seems to be changing and that this will affect the relation between the exchange rates and the trade surplus. The proportion of Australian exports accounted for by fine wines is increasing. These are considered a luxury good and must compete with increased wine exports from comparable-producing regions (such as Chile and New Zealand). At the same time, rising income levels in Australia are allowing the country to increase the proportion of its imports accounted for by luxury goods, and these represent a rising proportion of consumer expenditures. The analyst's report states: "Given the changing export mix, an appreciation of the currency will be more likely to reduce Australia's trade surplus. In contrast, the changing import mix will have the opposite effect."

1 Given the data in the table, an appreciation in the AUD will:
   - **A** cause the trade balance to increase.
   - **B** cause the trade balance to decrease.
   - **C** have no effect on the trade balance.

2 All else equal, an appreciation in the AUD will be *more* likely to reduce the trade surplus if the demand:
   - **A** elasticities for imports and exports increase.
   - **B** elasticity for exports and the export share in total trade decrease.
   - **C** elasticity for imports decreases and the import share in total trade increases.

3 All else equal, an appreciation in the AUD will be *more* likely to reduce the trade surplus if it leads to an increase in Australian:
   - **A** tax receipts.
   - **B** private sector investment.
   - **C** government budget surpluses.

4 The report's statement about the effect of changing import and export mixes is *most* likely:

A correct.

B incorrect with respect to the import effect.

C incorrect with respect to the export effect.

5 Suppose the Australian government imposed capital controls that prohibited the flow of financial capital into or out of the country. What impact would this have on the Australian trade balance?

A The trade surplus would increase.

B The trade balance would go to zero.

C The trade balance would not necessarily be affected.

6 Suppose the Australian government imposed capital controls that prohibited the flow of financial capital into or out of the country. The impact on the trade balance, if any, would most likely take the form of:

A a decrease in private saving.

B a decrease in private investment.

C an increase in the government fiscal balance.

Solution to 1:

A is correct. As the AUD appreciates, the price of exports to *offshore buyers* goes up and they demand fewer of them; hence, the AUD-denominated revenue from exports decreases. (Although export demand is inelastic, or $\varepsilon_X < 1$, recall that the *Australian* price of these exports is assumed not to have changed, so the amount of export revenue received by Australia, in AUD-terms, unambiguously declines as the quantity of exports declines.) Australian expenditure for imports also declines. Although the price of imports declines as the AUD appreciates, the Australians do not increase their import purchases enough to lead to higher expenditures. This is because import demand is also inelastic ($\varepsilon_M < 1$). This effect on import expenditure can be seen from: $\%\Delta R_M = (1 - \varepsilon_M)\%\Delta P_M$, where $\%\Delta P_M$ is negative (import prices are declining) and import demand is inelastic (so $(1 - \varepsilon_M) > 0$). With both import expenditures and export revenues declining, the net effect on the trade balance comes down to the relative size of the import and export weights (ω_M and ω_X, respectively). In this case, $\omega_X = 0.53$ (i.e., 200/380) and $\omega_M = 0.47$ (i.e., 180/380). Putting this into the Marshall–Lerner equation leads to:

$$\omega_X\varepsilon_X + \omega_M(\varepsilon_M - 1) = 0.53 \times 0.3 + 0.47(0.6 - 1) = -0.03$$

Because the Marshall–Lerner condition is not satisfied, exchange rate movements do not move the trade balance in the expected direction [i.e., appreciation (depreciation) of the currency does not decrease (increase) the trade balance]. However, note that with different import/export weights and the same elasticities, the Marshall–Lerner condition would be met. In particular, the condition would be met for any value of ω_X greater than 4/7 (≈ 0.571).

Solution to 2:

A is correct. The basic intuition of the Marshall–Lerner condition is that in order for an exchange rate movement to rebalance trade, the demands for imports and exports must be sufficiently price-sensitive (i.e., they must have sufficiently high elasticities). However, the relative share of imports and exports in total trade must also be considered. The generalized Marshall–Lerner condition requires:

$$\omega_X\varepsilon_X + \omega_M(\varepsilon_M - 1) > 0$$

An increase in both ε_X and ε_M will clearly make this expression increase (A is correct). In contrast, a decrease in both ω_X and ε_X tends to make the expression smaller (B is incorrect).[23] If ε_M decreases and ω_M increases, import demand will respond less to an exchange rate movement and will have a larger role in determining the trade balance (C is incorrect).

Solution to 3:

B is correct. An Australian trade surplus means that Australia is spending less than it earns and is accumulating claims on foreigners. Equivalently, Australian saving, inclusive of both private saving and the government fiscal balance, is more than sufficient to fund Australian private sector investment. The relationship between the trade balance and expenditure/saving decisions is given by:

$$X - M = (S - I) + (T - G) > 0$$

For Australia's trade balance to decline, it must save less (S down), invest more (I up), decrease its fiscal balance ($T - G$ down), or some combination of these. Increasing tax receipts (T up) increases rather than decreases the fiscal balance, so answer A is incorrect. Similarly, answer C, increasing the government budget surplus, is incorrect. Increasing private investment (I up) does decrease the trade balance, so answer B is correct.

Solution to 4:

B is correct. As Australian exports become more dominated by luxury goods that face highly competitive market conditions, the elasticity of export demand (ε_X) is likely to be increasing. Increasing export elasticity makes the trade surplus more responsive to an AUD appreciation (the increase in ε_X will tend to increase the computed value for the Marshall–Lerner equation). Similarly, as Australian imports become more dominated by luxury goods that are an increasing proportion of household expenditure, import elasticity (ε_M) will most likely increase. This will also tend to increase the computed value for the Marshall–Lerner equation.

Solution to 5:

B is correct. A trade deficit (surplus) must be exactly matched by an offsetting capital account surplus (deficit). Anything that impacts the trade balance must impact the capital account, and vice versa. If capital flows are prohibited, then both the capital account and the trade balance must be zero.

Solution to 6:

A is correct. The trade balance must go to zero. An increase in the fiscal balance implies an increase in the existing trade surplus, so answer C is incorrect. A decrease in private investment will also cause an increase in the trade surplus, so answer B is incorrect. A decrease in private saving will decrease the trade surplus as required, so answer A is correct: A decrease in saving will most likely reflect a decline in national income, especially the profit component, as export demand is choked off by the inability to extend credit to foreigners.

23 Because $\omega_M = 1 - \omega_X$ and $\varepsilon_M < 1$ in this example, a decrease in ω_X also decreases the second terms, $\omega_M(\varepsilon_M - 1)$, in the Marshall–Lerner condition.

SUMMARY

Foreign exchange markets are crucial for understanding both the functioning of the global economy as well as the performance of investment portfolios. In this reading, we have described the diverse array of FX market participants and have introduced some of the basic concepts necessary to understand the structure and functions of these markets. The reader should be able to understand how exchange rates—both spot and forward—are quoted and be able to calculate cross exchange rates and forward rates. We also have described the array of exchange rate regimes that characterize foreign exchange markets globally and how these regimes determine the flexibility of exchange rates, and hence, the degree of foreign exchange rate risk that international investments are exposed to. Finally, we have discussed how movements in exchange rates affect international trade flows (imports and exports) and capital flows.

The following points, among others, are made in this reading:

- Measured by average daily turnover, the foreign exchange market is by far the largest financial market in the world. It has important effects, either directly or indirectly, on the pricing and flows in all other financial markets.
- There is a wide diversity of global FX market participants that have a wide variety of motives for entering into foreign exchange transactions.
- Individual currencies are usually referred to by standardized three-character codes. These currency codes can also be used to define exchange rates (the price of one currency in terms of another). There are a variety of exchange rate quoting conventions commonly used.
- A direct currency quote takes the domestic currency as the price currency and the foreign currency as the base currency (i.e., $S_{d/f}$). An indirect quote uses the domestic currency as the base currency (i.e., $S_{f/d}$). To convert between direct and indirect quotes, the inverse (reciprocal) is used. Professional FX markets use standardized conventions for how the exchange rate for specific currency pairs will be quoted.
- Currencies trade in foreign exchange markets based on nominal exchange rates. An increase (decrease) in the exchange rate, quoted in indirect terms, means that the domestic currency is appreciating (depreciating) versus the foreign currency.
- The real exchange rate, defined as the nominal exchange rate multiplied by the ratio of price levels, measures the relative purchasing power of the currencies. An increase in the real exchange rate ($R_{d/f}$) implies a reduction in the relative purchasing power of the domestic currency.
- Given exchange rates for two currency pairs—A/B and A/C—we can compute the cross-rate (B/C) between currencies B and C. Depending on how the rates are quoted, this may require inversion of one of the quoted rates.
- Spot exchange rates are for immediate settlement (typically, T + 2), while forward exchange rates are for settlement at agreed-upon future dates. Forward rates can be used to manage foreign exchange risk exposures or can be combined with spot transactions to create FX swaps.
- The spot exchange rate, the forward exchange rate, and the domestic and foreign interest rates must jointly satisfy an arbitrage relationship that equates the investment return on two alternative but equivalent investments. Given the spot exchange rate and the foreign and domestic interest rates, the forward exchange rate must take the value that prevents riskless arbitrage.

- Forward rates are typically quoted in terms of forward (or swap) points. The swap points are added to the spot exchange rate in order to calculate the forward rate. Occasionally, forward rates are presented in terms of percentages relative to the spot rate.
- The base currency is said to be trading at a forward premium if the forward rate is above the spot rate (forward points are positive). Conversely, the base currency is said to be trading at a forward discount if the forward rate is below the spot rate (forward points are negative).
- The currency with the higher (lower) interest rate will trade at a forward discount (premium).
- Swap points are proportional to the spot exchange rate and to the interest rate differential and approximately proportional to the term of the forward contract.
- Empirical studies suggest that forward exchange rates may be unbiased predictors of future spot rates, but the margin of error on such forecasts is too large for them to be used in practice as a guide to managing exchange rate exposures. FX markets are too complex and too intertwined with other global financial markets to be adequately characterized by a single variable, such as the interest rate differential.
- Virtually every exchange rate is managed to some degree by central banks. The policy framework that each central bank adopts is called an exchange rate regime. These regimes range from using another country's currency (dollarization), to letting the market determine the exchange rate (independent float). In practice, most regimes fall in between these extremes. The type of exchange rate regime used varies widely among countries and over time.
- An ideal currency regime would have three properties: (1) the exchange rate between any two currencies would be credibly fixed; (2) all currencies would be fully convertible; and (3) each country would be able to undertake fully independent monetary policy in pursuit of domestic objectives, such as growth and inflation targets. However, these conditions are inconsistent. In particular, a fixed exchange rate and unfettered capital flows severely limit a country's ability to undertake independent monetary policy. Hence, there cannot be an ideal currency regime.
- The IMF identifies the following types of regimes: arrangements with no separate legal tender (dollarization, monetary union), currency board, fixed parity, target zone, crawling peg, crawling band, managed float, and independent float. Most major currencies traded in FX markets are freely floating, albeit subject to occasional central bank intervention.
- A trade surplus (deficit) must be matched by a corresponding deficit (surplus) in the capital account. Any factor that affects the trade balance must have an equal and opposite impact on the capital account, and vice versa.
- A trade surplus reflects an excess of domestic saving (including the government fiscal balance) over investment spending. A trade deficit indicates that the country invests more than it saves and must finance the excess by borrowing from foreigners or selling assets to foreigners.
- The impact of the exchange rate on trade and capital flows can be analyzed from two perspectives. The elasticities approach focuses on the effect of changing the relative price of domestic and foreign goods. This approach highlights changes in the composition of spending. The absorption approach focuses on the impact of exchange rates on aggregate expenditure/saving decisions.

- The elasticities approach leads to the Marshall–Lerner condition, which describes combinations of export and import demand elasticities such that depreciation (appreciation) of the domestic currency will move the trade balance toward surplus (deficit).
- The idea underlying the Marshall–Lerner condition is that demand for imports and exports must be sufficiently price-sensitive so that an increase in the relative price of imports increases the difference between export receipts and import expenditures.
- In order to move the trade balance toward surplus (deficit), a change in the exchange rate must decrease (increase) domestic expenditure (also called absorption) relative to income. Equivalently, it must increase (decrease) domestic saving relative to domestic investment.
- If there is excess capacity in the economy, then currency depreciation can increase output/income by switching demand toward domestically produced goods and services. Because some of the additional income will be saved, income rises relative to expenditure and the trade balance improves.
- If the economy is at full employment, then currency depreciation must reduce domestic expenditure in order to improve the trade balance. The main mechanism is a wealth effect: A weaker currency reduces the purchasing power of domestic-currency-denominated assets (including the present value of current and future earned income), and households respond by reducing expenditure and increasing saving.

REFERENCES

Bank for International Settlements (BIS). 2010. "Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in 2010" (www.bis.org).

Friedman, Milton. 1953. "The Monetarist Theory of Flexible Exchange Rate Systems." In *Essays in Positive Economics*. Chicago: University of Chicago Press.

Hong Kong Monetary Authority (HKMA). 2005. *HKMA Background Brief No. 1: Hong Kong's Linked Exchange Rate System*. 2nd ed. (November): www.info.gov.hk.

International Monetary Fund (IMF). 2006. "De Facto Classification of Exchange Rate Regimes and Monetary Policy Framework" (www.imf.org).

International Monetary Fund (IMF). 2010. "Currency Composition of Official Foreign Exchange Reserves (COFER)" report (www.imf.org).

PRACTICE PROBLEMS

1 An exchange rate:
   A is most commonly quoted in real terms.
   B is the price of one currency in terms of another.
   C between two currencies ensures they are fully convertible.

2 A decrease in the real exchange rate (quoted in terms of domestic currency per unit of foreign currency) is *most likely* to be associated with an increase in which of the following?
   A Foreign price level.
   B Domestic price level.
   C Nominal exchange rate.

3 In order to minimize the foreign exchange exposure on a euro-denominated receivable due from a German company in 100 days, a British company would *most likely* initiate a:
   A spot transaction.
   B forward contract.
   C real exchange rate contract.

4 Which of the following counterparties is *most likely* to be considered a sell-side foreign-exchange market participant?
   A A large corporation that borrows in foreign currencies.
   B A sovereign wealth fund that influences cross-border capital flows.
   C A multinational bank that trades foreign exchange with its diverse client base.

5 What will be the effect on a direct exchange rate quote if the domestic currency appreciates?
   A Increase
   B Decrease
   C No change

6 An executive from Switzerland checked into a hotel room in Spain and was told by the hotel manager that 1 EUR will buy 1.2983 CHF. From the executive's perspective, an indirect exchange rate quote would be:
   A 0.7702 EUR per CHF.
   B 0.7702 CHF per EUR.
   C 1.2983 EUR per CHF.

7 Over the past month, the Swiss Franc (CHF) has depreciated 12 percent against pound sterling (GBP). How much has the pound sterling appreciated against the Swiss Franc?
   A 12%
   B Less than 12%
   C More than 12%

8 An exchange rate between two currencies has increased to 1.4500. If the base currency has appreciated by 8% against the price currency, the initial exchange rate between the two currencies was *closest* to:

A 1.3340.

B 1.3426.

C 1.5660.

The following information relates to Questions 9–10

A dealer provides the following quotes:

Ratio	Spot rate
CNY/HKD	0.8422
CNY/ZAR	0.9149
CNY/SEK	1.0218

9 The spot ZAR/HKD cross-rate is *closest* to:

A 0.9205.

B 1.0864.

C 1.2978.

10 Another dealer is quoting the ZAR/SEK cross-rate at 1.1210. The arbitrage profit that can be earned is *closest* to:

A ZAR 3671 per million SEK traded.

B SEK 4200 per million ZAR traded.

C ZAR 4200 per million SEK traded.

---

11 A BRL/MXN spot rate is listed by a dealer at 0.1378. The 6-month forward rate is 0.14193. The 6-month forward points are *closest* to:

A –41.3.

B +41.3.

C +299.7.

12 A three-month forward exchange rate in CAD/USD is listed by a dealer at 1.0123. The dealer also quotes 3-month forward points as a percentage at 6.8%. The CAD/USD spot rate is *closest* to:

A 0.9478.

B 1.0550.

C 1.0862.

13 If the base currency in a forward exchange rate quote is trading at a forward discount, which of the following statements is *most* accurate?

A The forward points will be positive.

B The forward percentage will be negative.

C The base currency is expected to appreciate versus the price currency.

14 A forward premium indicates:

A an expected increase in demand for the base currency.

B the interest rate is higher in the base currency than in the price currency.

C the interest rate is higher in the price currency than in the base currency.

15 The JPY/AUD spot exchange rate is 82.42, the JPY interest rate is 0.15%, and the AUD interest rate is 4.95%. If the interest rates are quoted on the basis of a 360-day year, the 90-day forward points in JPY/AUD would be *closest* to:

A –377.0.

B –97.7.

C 98.9.

16 Which of the following is *not* a condition of an ideal currency regime?

A Fully convertible currencies.

B Fully independent monetary policy.

C Independently floating exchange rates.

17 In practice, both a fixed parity regime and a target zone regime allow the exchange rate to float within a band around the parity level. The *most likely* rationale for the band is that the band allows the monetary authority to:

A be less active in the currency market.

B earn a spread on its currency transactions.

C exercise more discretion in monetary policy.

18 A fixed exchange rate regime in which the monetary authority is legally required to hold foreign exchange reserves backing 100% of its domestic currency issuance is best described as:

A dollarization.

B a currency board.

C a monetary union.

19 A country with a trade deficit will *most likely*:

A have an offsetting capital account surplus.

B save enough to fund its investment spending.

C buy assets from foreigners to fund the imbalance.

20 A large industrialized country has recently devalued its currency in an attempt to correct a persistent trade deficit. Which of the following domestic industries is *most likely* to benefit from the devaluation?

A Luxury cars.

B Branded prescription drugs.

C Restaurants and live entertainment venues.

21 A country with a persistent trade surplus is being pressured to let its currency appreciate. Which of the following *best* describes the adjustment that must occur if currency appreciation is to be effective in reducing the trade surplus?

A Domestic investment must decline relative to saving.

B Foreigners must increase investment relative to saving.

C Global capital flows must shift toward the domestic market.

SOLUTIONS

1 B is correct. The exchange rate is the number of units of the price currency that 1 unit of the base currency will buy. Equivalently, it is the number of units of the price currency required to buy 1 unit of the base currency.

2 B is correct. The real exchange rate (quoted in terms of domestic currency per unit of foreign currency) is given by:

$$\text{Real exchange rate}_{(d/f)} = S_{d/f} \times (P_f/P_d)$$

An increase in the domestic price level (P_d) *decreases* the real exchange rate because it implies an *increase* in the relative purchasing power of the domestic currency.

3 B is correct. The receivable is due in 100 days. To reduce the risk of currency exposure, the British company would initiate a forward contract to sell euros/buy pounds at an exchange rate agreed to today. The agreed-upon rate is called the forward exchange rate.

4 C is correct. The sell side generally consists of large banks that sell foreign exchange and related instruments to buy-side clients. These banks act as market makers, quoting exchange rates at which they will buy (the bid price) or sell (the offer price) the base currency.

5 B is correct. In the case of a direct exchange rate, the domestic currency is the price currency (the numerator) and the foreign currency is the base currency (the denominator). If the domestic currency appreciates, then fewer units of the domestic currency are required to buy 1 unit of the foreign currency and the exchange rate (domestic per foreign) declines. For example, if sterling (GBP) appreciates against the euro (EUR), then euro–sterling (GBP/EUR) might decline from 0.8650 to 0.8590.

6 A is correct. An indirect quote takes the foreign country as the price currency and the domestic country as the base currency. To get CHF—which is the executive's domestic currency—as the base currency, the quote must be stated as EUR/CHF. Using the hotel manager's information, the indirect exchange rate is (1/1.2983) = 0.7702.

7 C is correct. The appreciation of sterling against the Swiss franc is simply the inverse of the 12% depreciation of the Swiss franc against Sterling: [1/(1 – 0.12)] – 1 = (1/0.88) – 1 = 0.1364, or 13.64%.

8 B is correct. The percentage appreciation of the base currency can be calculated by dividing the appreciated exchange rate by the initial exchange rate. In this case, the unknown is the initial exchange rate. The initial exchange is the value of X that satisfies the formula:

$$1.4500/X = 1.08$$

Solving for X leads to 1.45/1.08 = 1.3426.

9 A is correct. To get to the ZAR/HKD cross-rate, it is necessary to take the inverse of the CNY/ZAR spot rate and then multiply by the CNY/HKD exchange rate:

$$\begin{aligned}\text{ZAR/HKD} &= (\text{CNY/ZAR})^{-1} \times (\text{CNY/HKD}) \\ &= (1 / 0.9149) \times 0.8422 = 0.9205\end{aligned}$$

10 C is correct. The ZAR/SEK cross-rate from the original dealer is (1.0218/0.9149) = 1.1168, which is lower than the quote from the second dealer. To earn an arbitrage profit, a currency trader would buy SEK (sell ZAR) from the original dealer and sell SEK (buy ZAR) to the second dealer. On 1 million SEK the profit would be

SEK 1,000,000 × (1.1210 – 1.1168) = ZAR 4200

11 B is correct. The number of forward points equals the forward rate minus the spot rate, or 0.14193 – 0.1378 = 0.00413, multiplied by 10,000: 10,000 × 0.00413= 41.3 points. By convention, forward points are scaled so that ±1 forward point corresponds to a change of ±1 in the last decimal place of the spot exchange rate.

12 A is correct. Given the forward rate and forward points as a percentage, the unknown in the calculation is the spot rate. The calculation is as follows:

Spot rate × (1 + Forward points as a percentage) = Forward rate

Spot rate × (1 + 0.068) = 1.0123

Spot = 1.0123/1.068 =0.9478

13 B is correct. The base currency trading at a forward discount means that 1 unit of the base currency costs less for forward delivery than for spot delivery; i.e., the forward exchange rate is less than the spot exchange rate. The forward points, expressed either as an absolute number of points or as a percentage, are negative.

14 C is correct. To eliminate arbitrage opportunities, the spot exchange rate (S), the forward exchange rate (F), the interest rate in the base currency (i_b), and the interest rate in the price currency (i_p) must satisfy:

$$\frac{F}{S} = \left(\frac{1 + i_p}{1 + i_b}\right)$$

According to this formula, the base currency will trade at forward premium ($F > S$) if, and only if, the interest rate in the price currency is higher than the interest rate in the base currency ($i_p > i_b$).

15 B is correct. The forward exchange rate is given by

$$F_{JPY/AUD} = S_{JPY/AUD}\left(\frac{1 + i_{JPY}\tau}{1 + i_{AUD}\tau}\right) = 82.42\left(\frac{1 + .0015\left(\frac{90}{360}\right)}{1 + .0495\left(\frac{90}{360}\right)}\right)$$

$$= 82.42 \times .98815 = 81.443$$

The forward points are 100 × ($F – S$) = 100 × (81.443 – 82.42) = 100 × (–0.977) = –97.7. Note that because the spot exchange rate is quoted with two decimal places, the forward points are scaled by 100.

16 C is correct. An ideal currency regime would have credibly fixed exchange rates among all currencies. This would eliminate currency-related uncertainty with respect to the prices of goods and services as well as real and financial assets.

17 C is correct. Fixed exchange rates impose severe limitations on the exercise of independent monetary policy. With a rigidly fixed exchange rate, domestic interest rates, monetary aggregates (e.g., money supply), and credit conditions are dictated by the requirement to buy/sell the currency at the rigid parity. Even

a narrow band around the parity level allows the monetary authority to exercise some discretionary control over these conditions. In general, the wider the band, the more independent control the monetary authority can exercise.

18 B is correct. With a currency board, the monetary authority is legally required to exchange domestic currency for a specified foreign currency at a fixed exchange rate. It cannot issue domestic currency without receiving foreign currency in exchange, and it must hold that foreign currency as a 100% reserve against the domestic currency issued. Thus, the country's monetary base (bank reserves plus notes and coins in circulation) is fully backed by foreign exchange reserves.

19 A is correct. A trade deficit must be exactly matched by an offsetting capital account surplus to fund the deficit. A capital account surplus reflects borrowing from foreigners (an increase in domestic liabilities) and/or selling assets to foreigners (a decrease in domestic assets). A capital account surplus is often referred to as a "capital inflow" because the net effect is foreign investment in the domestic economy.

20 A is correct. A devaluation of the domestic currency means domestic producers are cutting the price faced by their foreign customers. The impact on their unit sales and their revenue depends on the elasticity of demand. Expensive luxury goods exhibit high price elasticity. Hence, luxury car producers are likely to experience a sharp increase in sales and revenue due to the devaluation.

21 C is correct. The trade surplus cannot decline unless the capital account deficit also declines. Regardless of the mix of assets bought and sold, foreigners must buy more assets from (or sell fewer assets to) domestic issuers/investors.