PARITY CONDITIONS IN INTERNATIONAL FINANCE AND CURRENCY FORECASTING

It is not for its own sake that men desire money, but for the sake of what they can purchase with it.

Adam Smith (1776)

Chapter Learning Objectives

- To describe the meaning of “the law of one price” and its importance to the study of international finance
- To explain how arbitrage links goods prices and asset returns internationally
- To list and describe the five key theoretical relationships among spot exchange rates, forward exchange rates, inflation rates, and interest rates that result from international arbitrage activities
- To differentiate between the real and nominal exchange rate and the real and nominal interest rate
- To list and describe the four requirements for successful currency forecasting
- To identify a five-stage procedure for forecasting exchange rates in a fixed-rate system
- To describe how to forecast exchange rates in a floating-rate system using the predictions already embodied in interest and forward rates
- To describe the meaning and likelihood of forecasting success in both fixed-rate and floating-rate systems

Key Terms

- arbitrage
- black-market exchange rate
- capital market integration
- capital market segmentation
- charting
- covered interest arbitrage
- covered interest differential
- currency forecasting
- Fisher effect (FE)
- forward discount
- forward premium
- fundamental analysis
- inflation differential
- interest rate differential
- interest rate parity
- international Fisher effect (IFE)
- law of one price
- market-based forecasts
- model-based forecasts
- nominal exchange rate
- nominal interest rate
- parity conditions
- peso problem
- purchasing power parity (PPP)
- real exchange rate
- real interest rate
- technical analysis
- trend analysis
- unbiased forward rate (UFR)
- unbiased predictor
On the basis of the flows of goods and capital discussed in Chapter 2, this chapter presents a simple yet elegant set of equilibrium relationships that should apply to product prices, interest rates, and spot and forward exchange rates if markets are not impeded. These relationships, or parity conditions, provide the foundation for much of the remainder of this text; they should be clearly understood before you proceed further. The final section of this chapter examines the usefulness of a number of models and methodologies in profitably forecasting currency changes under both fixed-rate and floating-rate systems.

4.1 Arbitrage and the Law of One Price

Arbitrage is one of the most important concepts in all of finance. It is ordinarily defined as the simultaneous purchase and sale of the same assets or commodities on different markets to profit from price discrepancies. The concept of arbitrage is of particular importance in international finance because so many of the relationships between domestic and international financial markets, exchange rates, interest rates, and inflation rates depend on arbitrage for their existence. Indeed, by linking markets together, arbitrage underlies the globalization of markets.

One of the central ideas of international finance stems from arbitrage: In competitive markets, characterized by numerous buyers and sellers having low-cost access to information, exchange-adjusted prices of identical tradable goods and financial assets must be within transaction costs of equality worldwide. This idea, referred to as the law of one price, is enforced by international arbitrageurs who follow the profit-guaranteeing dictum of “buy low, sell high” and prevent all but trivial deviations from equality. Similarly, in the absence of market imperfections, risk-adjusted expected returns on financial assets in different markets should be equal.

Five key theoretical economic relationships, which are depicted in Exhibit 4.1, result from these arbitrage activities:

- Purchasing power parity (PPP)
- Fisher effect (FE)
- International Fisher effect (IFE)
- Interest rate parity (IRP)
- Forward rates as unbiased predictors of future spot rates (UFR)

The framework of Exhibit 4.1 emphasizes the links among prices, spot exchange rates, interest rates, and forward exchange rates. Before proceeding, some terminology is in order. Specifically, a foreign currency is said to be at a forward discount if the forward rate expressed in dollars is below the spot rate, whereas a forward premium exists if the forward rate is above the spot rate. The forward discount or premium is expressed in annualized percentage terms as follows:

\[
\text{Forward premium or discount} = \left( \frac{\text{Forward rate} - \text{Spot rate}}{\text{Spot rate}} \right) \times \frac{360}{\text{Forward contract number of days}}
\] (4.1)

where the exchange rate is stated in domestic currency units per unit of foreign currency.

According to the diagram in Exhibit 4.1, if inflation in, say, Mexico is expected to exceed inflation in the United States by 3 percent for the coming year, then the
Mexican peso should decline in value by about 3 percent relative to the dollar. By the same token, the one-year forward Mexican peso should sell at a 3 percent discount relative to the U.S. dollar. Similarly, one-year interest rates in Mexico should be about 3 percent higher than one-year interest rates on securities of comparable risk in the United States.

The common denominator of these parity conditions is the adjustment of the various rates and prices to inflation. According to modern monetary theory, inflation is the logical outcome of an expansion of the money supply in excess of real output growth. Although this view of the origin of inflation is not universally subscribed to, it has a solid microeconomic foundation. In particular, it is a basic precept of price theory that as the supply of one commodity increases relative to supplies of all other commodities, the price of the first commodity must decline relative to the prices of other commodities. Thus, for example, a bumper crop of corn should cause corn’s value in exchange—its exchange rate—to decline. Similarly, as the supply of money increases relative to the supply of goods and services, the purchasing power of money—the exchange rate between money and goods—must decline.

The mechanism that brings this adjustment about is simple and direct. Suppose, for example, that the supply of U.S. dollars exceeds the amount that individuals desire to hold. In order to reduce their excess holdings of money, individuals increase their spending on goods, services, and securities, causing U.S. prices to rise. Moreover, as we saw in Chapter 2, this price inflation will cause the value of the dollar to decline.

The adverse consequences of an expansionary monetary policy and the benefits of a stable monetary policy—one that leads to stable prices and is not subject to sharp expansions or contractions—are both illustrated in “Bolivia Ends Its Hyperinflation.”
Illustration

A further link in the chain relating money-supply growth, inflation, interest rates, and exchange rates is the notion that money is neutral. That is, money should have no impact on real variables. Thus, for example, a 10 percent increase in the supply of money relative to the demand for money should cause prices to rise by 10 percent. This view has important implications for international finance. Specifically, although a change in the quantity of money will affect prices and exchange rates, this change should not affect the rate at which domestic goods are exchanged for foreign goods or the rate at which goods today are exchanged for goods in the future. These ideas are formalized as purchasing power parity and the Fisher effect, respectively. We will examine them here briefly and then in greater detail in the next two sections.

EXHIBIT 4.2 • Bolivia Ends Its Hyperinflation in 1985 by Shutting Down the Printing Presses

A further link in the chain relating money-supply growth, inflation, interest rates, and exchange rates is the notion that money is neutral. That is, money should have no impact on real variables. Thus, for example, a 10 percent increase in the supply of money relative to the demand for money should cause prices to rise by 10 percent. This view has important implications for international finance. Specifically, although a change in the quantity of money will affect prices and exchange rates, this change should not affect the rate at which domestic goods are exchanged for foreign goods or the rate at which goods today are exchanged for goods in the future. These ideas are formalized as purchasing power parity and the Fisher effect, respectively. We will examine them here briefly and then in greater detail in the next two sections.
The international analogue to inflation is home currency depreciation relative to foreign currencies. The analogy derives from the observation that inflation involves a change in the exchange rate between the home currency and domestic goods, whereas home currency depreciation—a decline in the foreign currency value of the home currency—results in a change in the exchange rate between the home currency and foreign goods.

That inflation and currency depreciation are related is no accident. Excess money-supply growth, through its impact on the rate of aggregate spending, affects the demand for goods produced abroad as well as goods produced domestically. In turn, the domestic demand for foreign currencies changes, and, consequently, the foreign exchange value of the domestic currency changes. Thus, the rate of domestic inflation and changes in the exchange rate are jointly determined by the rate of domestic money growth relative to the growth of the amount that people—domestic and foreign—want to hold.

If international arbitrage enforces the law of one price, then the exchange rate between the home currency and domestic goods must equal the exchange rate between the home currency and foreign goods. In other words, a unit of home currency (HC) should have the same purchasing power worldwide. Thus, if a dollar buys a pound of bread in the United States, it should also buy a pound of bread in Great Britain. For this to happen, the foreign exchange rate must change by (approximately) the difference between the domestic and foreign rates of inflation. This relationship is called purchasing power parity (PPP).

Similarly, the nominal interest rate, the price quoted on lending and borrowing transactions, determines the exchange rate between current and future dollars (or any other currency). For example, an interest rate of 10 percent on a one-year loan means that one dollar today is being exchanged for 1.1 dollars a year from now. But what really matters, according to the Fisher effect (FE), is the exchange rate between current and future purchasing power, as measured by the real interest rate. Simply put, the lender is concerned with how many more goods can be obtained in the future by forgoing consumption today, whereas the borrower wants to know how much future consumption must be sacrificed to obtain more goods today. This condition is the case regardless of whether the borrower and lender are located in the same or different countries. As a result, if the exchange rate between current and future goods—the real interest rate—varies from one country to the next, arbitrage between domestic and foreign capital markets, in the form of international capital flows, should occur. These flows will tend to equalize real interest rates across countries. By looking more closely at these and related parity conditions, we can see how they can be formalized and used for management purposes.

### 4.2 Purchasing Power Parity

Purchasing power parity (PPP) has been widely used by central banks as a guide to establishing new par values for their currencies when the old ones were clearly in disequilibrium. From a management standpoint, purchasing power parity is often used to forecast future exchange rates, for purposes ranging from deciding on the currency denomination of long-term debt issues to determining in which countries to build plants.

In its absolute version, purchasing power parity states that price levels should be equal worldwide when expressed in a common currency. In other words, a unit of home currency (HC) should have the same purchasing power around the world. This theory is just an application of the law of one price to national price levels rather than to individual prices. (That is, it rests on the assumption that free trade will equalize the price of any good in all countries; otherwise, arbitrage opportunities would exist.) However, absolute PPP ignores the effects on free trade of transportation costs, tariffs, quotas and other restrictions, and product differentiation.
The Big Mac index illustrates the law of one price and absolute purchasing power parity. It is calculated by comparing the prices of Big Macs worldwide (they are produced in more than 100 countries). The Big Mac PPP, put together by *The Economist*, is the exchange rate that would leave hamburgers costing the same overseas as in the United States. By comparing Big Mac PPPs with actual exchange rates, which is done in Exhibit 4.3, we can see whether a currency is over- or undervalued by this standard.

For example, a Big Mac in Britain cost £1.99 on April 22, 2003. Dividing this price through by its U.S. price of $2.71 implies a PPP exchange rate of £0.73/$:

\[
\frac{£1.99}{$2.71} = £0.73/$
\]

### EXHIBIT 4.3 *The Big Mac Hamburger Standard*

<table>
<thead>
<tr>
<th>Big Mac prices</th>
<th>In Local Currency (LC)</th>
<th>In Dollars</th>
<th>Implied PPP* Exchange Rate (LC/$)</th>
<th>Actual LC/$ Exchange Rate 04/22/03</th>
<th>Under (−)/Over (+) Valuation** Against the Dollar, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States*</td>
<td>2.71</td>
<td>2.71</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Argentina Peso</td>
<td>4.1.00</td>
<td>1.43</td>
<td>1.52</td>
<td>2.88</td>
<td>−47</td>
</tr>
<tr>
<td>Australia A$3.00</td>
<td>1.86</td>
<td>1.11</td>
<td>1.61</td>
<td>—</td>
<td>−31</td>
</tr>
<tr>
<td>Brazil Real4.55</td>
<td>1.48</td>
<td>1.68</td>
<td>3.07</td>
<td>—</td>
<td>−45</td>
</tr>
<tr>
<td>Britain £1.99</td>
<td>3.14</td>
<td>0.73</td>
<td>0.63</td>
<td>—</td>
<td>+16</td>
</tr>
<tr>
<td>Canada C$3.20</td>
<td>2.21</td>
<td>1.18</td>
<td>1.45</td>
<td>—</td>
<td>−18</td>
</tr>
<tr>
<td>Chile Peso1,400</td>
<td>1.95</td>
<td>5.15</td>
<td>7.16</td>
<td>—</td>
<td>−28</td>
</tr>
<tr>
<td>China Yuan9.90</td>
<td>1.20</td>
<td>3.67</td>
<td>8.28</td>
<td>−56</td>
<td></td>
</tr>
<tr>
<td>Denmark DKr27.75</td>
<td>4.10</td>
<td>10.26</td>
<td>6.78</td>
<td>+51</td>
<td></td>
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<tr>
<td>Euro area €2.71</td>
<td>2.97</td>
<td>1.21</td>
<td>1.10</td>
<td>+10</td>
<td></td>
</tr>
<tr>
<td>Hong Kong HK$11.50</td>
<td>1.47</td>
<td>4.23</td>
<td>7.80</td>
<td>−46</td>
<td></td>
</tr>
<tr>
<td>Hungary Forint490</td>
<td>2.18</td>
<td>180</td>
<td>224</td>
<td>−20</td>
<td></td>
</tr>
<tr>
<td>Indonesia Rupiah16,100</td>
<td>1.84</td>
<td>5,934</td>
<td>8,740</td>
<td>−32</td>
<td></td>
</tr>
<tr>
<td>Japan ¥262</td>
<td>2.19</td>
<td>96.97</td>
<td>120</td>
<td>−19</td>
<td></td>
</tr>
<tr>
<td>Malaysia M$5.04</td>
<td>1.33</td>
<td>1.86</td>
<td>3.80</td>
<td>−51</td>
<td></td>
</tr>
<tr>
<td>Mexico Pesos23.00</td>
<td>2.18</td>
<td>8.47</td>
<td>10.53</td>
<td>−20</td>
<td></td>
</tr>
<tr>
<td>New Zealand NZ$3.95</td>
<td>2.21</td>
<td>1.45</td>
<td>1.78</td>
<td>−18</td>
<td></td>
</tr>
<tr>
<td>Poland Zloty6.30</td>
<td>1.62</td>
<td>2.33</td>
<td>3.89</td>
<td>−40</td>
<td></td>
</tr>
<tr>
<td>Russia Ruble41.00</td>
<td>1.32</td>
<td>15.15</td>
<td>31.1</td>
<td>−51</td>
<td></td>
</tr>
<tr>
<td>Singapore S$3.30</td>
<td>1.86</td>
<td>1.22</td>
<td>1.78</td>
<td>−31</td>
<td></td>
</tr>
<tr>
<td>South Africa Rand13.95</td>
<td>1.84</td>
<td>5.13</td>
<td>7.56</td>
<td>−32</td>
<td></td>
</tr>
<tr>
<td>South Korea Won3,300</td>
<td>2.71</td>
<td>1,220</td>
<td>1,220</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sweden SKr30.00</td>
<td>3.60</td>
<td>11.08</td>
<td>8.34</td>
<td>+33</td>
<td></td>
</tr>
<tr>
<td>Switzerland SFr6.30</td>
<td>4.59</td>
<td>2.32</td>
<td>1.37</td>
<td>+69</td>
<td></td>
</tr>
<tr>
<td>Taiwan NT$370.00</td>
<td>2.01</td>
<td>29.81</td>
<td>34.8</td>
<td>−26</td>
<td></td>
</tr>
<tr>
<td>Thailand Baht59.00</td>
<td>1.38</td>
<td>21.74</td>
<td>42.7</td>
<td>−49</td>
<td></td>
</tr>
</tbody>
</table>

* Purchasing-power parity: local currency price divided by dollar price in the United States.
** Under/over valuation: (implied PPP rate – actual exchange rate)/implied PPP rate.
* Average of New York, Chicago, San Francisco, and Atlanta prices.
Source: McDonald’s.
The actual exchange rate on that date was £0.63. By this measure, the pound was 16 percent overvalued on April 22, 2003:

$$\frac{£0.73 - £0.63}{£0.63} = +16\%$$

Alternatively, with a dollar PPP of Y3.65/$ (Y9.90/$2.71), the Chinese yuan appeared to be undervalued by 56 percent \[(Y3.65/Y8.80) - 1 = -56\%\].

The Big Mac standard is somewhat misleading because you are buying not just the hamburger but the location. Included in the price of a Big Mac is the cost of real estate, local taxes, and local services, which differ worldwide and are not traded goods. When the items being compared contain a bundle of traded and nontraded goods and services, as in the case of a Big Mac, it should not be surprising that absolute PPP and the law of one price fail to hold.

The relative version of purchasing power parity, which is used more commonly now, states that the exchange rate between the home currency and any foreign currency will adjust to reflect changes in the price levels of the two countries. For example, if inflation is 5 percent in the United States and 1 percent in Japan, then the dollar value of the Japanese yen must rise by about 4 percent to equalize the dollar price of goods in the two countries.

Formally, if \(i_h\) and \(i_f\) are the rates of inflation for the home country and the foreign country, respectively; \(e_0\) is the dollar (HC) value of one unit of foreign currency at the beginning of the period; and \(e_1\) is the spot exchange rate in period 1, then

$$\frac{e_1}{e_0} = \frac{1 + i_h}{1 + i_f} \quad (4.2)$$

If Equation 4.2 holds, then

$$e_1 = e_0 \times \frac{1 + i_h}{1 + i_f} \quad (4.3)$$

The value of \(e_1\) appearing in Equation 4.3 is known as the PPP rate. For example, if the United States and Euroland are running annual inflation rates of 5 percent and 3 percent, respectively, and the spot rate is €1 = $1.07, then according to Equation 4.3 the PPP rate for the euro in one year should be

$$e_3 = 1.07 \times \frac{1.05}{1.03} = $1.0908$$

If purchasing power parity is expected to hold, then $1.0908/€ is the best prediction for the euro spot rate in one year.

**Illustration** Calculating the PPP Rate for the Swiss Franc

Suppose the current U.S. price level is at 112 and the Swiss price level is at 107, relative to base price levels of 100. If the initial value of the Swiss franc was $0.58, then according to PPP, the dollar value of the franc should have risen to approximately $0.6071 \[0.58 \times (112/107)\], an appreciation of 4.67 percent. On the other hand, if the Swiss price level now equals 119, then the franc should have depreciated by about 5.88 percent, to $0.5459 \[0.58 \times (112/119)\].
Purchasing power parity is often represented by the following approximation of Equation 4.3:

\[
\frac{e_1 - e_0}{e_0} = i_h - i_f
\]

(4.4)

That is, the exchange rate change during a period should equal the inflation differential for that same time period. In effect, PPP says that currencies with high rates of inflation should devalue relative to currencies with lower rates of inflation.

Equation 4.4 is illustrated in Exhibit 4.4. The vertical axis measures the percentage currency change, and the horizontal axis shows the inflation differential. Equilibrium is reached on the parity line, which contains all those points at which these two differentials are equal. At point A, for example, the 3 percent inflation differential is just offset by the 3 percent appreciation of the foreign currency relative to the home currency. Point B, on the other hand, depicts a situation of disequilibrium, where the inflation differential of 3 percent is greater than the appreciation of 1 percent in the HC value of the foreign currency.

The Lesson of Purchasing Power Parity

Purchasing power parity bears an important message: Just as the price of goods in one year cannot be meaningfully compared with the price of goods in another year without adjusting for interim inflation, so exchange rate changes may indicate nothing more than the reality that countries have different inflation rates. In fact, according to PPP, exchange rate movements should just cancel out changes in the foreign price level rela-
Only changes in the real exchange rate will affect the relative competitive positions of domestic firms and their foreign competitors.
The distinction between the nominal exchange rate and the real exchange rate has important implications for foreign exchange risk measurement and management. As we will see in Chapter 11, if the real exchange rate remains constant (i.e., if purchasing power parity holds), currency gains or losses from nominal exchange rate changes will generally be offset over time by the effects of differences in relative rates of inflation, thereby reducing the net impact of nominal devaluations and revaluations. Deviations from purchasing power parity, however, will lead to real exchange gains and losses. In the case of Japanese exporters, the real appreciation of the yen forced them to cut costs and develop new products less subject to pricing pressures. We will discuss their responses in more detail in Chapter 11.

Empirical Evidence

The strictest version of purchasing power parity—that all goods and financial assets obey the law of one price—is demonstrably false. The risks and costs of shipping goods internationally, as well as government-erected barriers to trade and capital flows, are at times high enough to cause exchange-adjusted prices to systematically differ between countries. On the other hand, there is clearly a relationship between relative inflation rates and changes in exchange rates. In particular, over time, as shown in Exhibit 4.5, those currencies with the largest relative decline (gain) in purchasing power saw the sharpest erosion (appreciation) in their foreign exchange values.

2 Dividing both current price levels by their base levels effectively indexes each to 100 as of the base period.
The general conclusion from empirical studies of PPP is that the theory holds up well in the long run, but not as well over shorter time periods. The difference between the short-run and long-run effects can be seen in Exhibit 4.6, which compares the actual dollar exchange rate for 12 countries with their PPP rates. Despite substantial short-run deviations from purchasing power parity, currencies have a distinct tendency to move toward their PPP-predicted rates. Another way to view this evidence is that, despite fluctuations, the real exchange rate tends to revert back to its predicted value of $e^0$. That is, if $e_1' > e_0$, then the real exchange rate should fall over time towards $e_0$, whereas if $e_1' < e_0$, the real exchange rate should rise over time towards $e_0$. Additional support for the existence of mean-reverting behavior of real exchange rates is provided by data spanning two centuries on the dollar-sterling and French franc-sterling real exchange rates. Mean reversion has important implications for currency risk management, which will be explored in Chapter 11.

A common explanation for the failure of PPP to hold is that goods prices are sticky, leading to short-term violations of the law of one price. Adjustment to PPP eventually occurs, but it does so with a lag. An alternative explanation for the failure of most tests to support PPP in the short run is that these tests ignore the problems caused by the combination of differently constructed price indices, relative price changes, and nontraded goods and services. Despite these problems, most tests of relative PPP as a long-term theory of exchange rate determination seem to support its validity.

3 Perhaps the best known of these studies is Henry J. Gailliot, "Purchasing Power Parity as an Explanation of Long-Term Changes in Exchange Rates," *Journal of Money, Credit, and Banking*, August 1971, pp. 348–357.

In summary, despite often lengthy departures from PPP, there is a clear correspondence between relative inflation rates and changes in the nominal exchange rate. However, for reasons that have nothing necessarily to do with market disequilibrium, the correspondence is not perfect.

### 4.3 The Fisher Effect

The interest rates that are quoted in the financial press are nominal rates. That is, they are expressed as the rate of exchange between current and future dollars. For example, a nominal interest rate of 8 percent on a one-year loan means that $1.08 must be repaid in one year for $1.00 loaned today. But what really matters to both parties to a loan agreement is the real interest rate, the rate at which current goods are being converted into future goods.

Looked at one way, the real rate of interest is the net increase in wealth that people expect to achieve when they save and invest their current income. Alternatively, it can be viewed as the added future consumption promised by a corporate borrower to a lender in return for the latter's deferring current consumption. From the company's standpoint, this exchange is worthwhile as long as it can find suitably productive investments.
However, because virtually all financial contracts are stated in nominal terms, the real interest rate must be adjusted to reflect expected inflation. The Fisher effect states that the nominal interest rate \( r \) is made up of two components: (1) a real required rate of return \( a \) and (2) an inflation premium equal to the expected amount of inflation \( i \). Formally, the Fisher effect is

\[
1 + \text{Nominal rate} = (1 + \text{Real rate}) \times (1 + \text{Expected inflation rate})
\]

or

\[
1 + r = (1 + a) \times (1 + i)
\]

Equation 4.7 is often approximated by the equation \( r = a + i \).

The Fisher equation says, for example, that if the required real return is 3 percent and expected inflation is 10 percent, then the nominal interest rate will be about 13 percent (13.3 percent, to be exact). The logic behind this result is that $1 next year will have the purchasing power of $0.90 in terms of today’s dollars. Thus, the borrower must pay the lender $0.103 to compensate for the erosion in the purchasing power of the $1.03 in principal and interest payments, in addition to the $0.03 necessary to provide a 3 percent real return.

The generalized version of the Fisher effect asserts that real returns are equalized across countries through arbitrage—that is, \( a_h = a_f \), where the subscripts \( h \) and \( f \) refer to home and foreign real rates, respectively. If expected real returns were higher in one currency than another, capital would flow from the second to the first currency. This process of arbitrage would continue, in the absence of government intervention, until expected real returns were equalized.

In equilibrium, then, with no government interference, it should follow that the nominal interest rate differential will approximately equal the anticipated inflation differential between the two currencies, or

\[
r_h - r_f = i_h - i_f
\]

where \( r_h \) and \( r_f \) are the nominal home and foreign currency interest rates, respectively. The exact form of this relationship is expressed by Equation 4.9:

\[
\frac{1 + r_h}{1 + r_f} = \frac{1 + i_h}{1 + i_f}
\]

Equation 4.9 can be converted into Equation 4.8 by subtracting 1 from both sides and assuming that \( r_f \) and \( i_f \) are relatively small.
Currencies with higher rates of inflation should have higher interest rates than currencies with lower inflation rates.

In effect, the generalized version of the Fisher effect says that currencies with high rates of inflation should bear higher interest rates than currencies with lower rates of inflation.

For example, if inflation rates in the United States and the United Kingdom are 4 percent and 7 percent, respectively, the Fisher effect says that nominal interest rates should be about 3 percent higher in the United Kingdom than in the United States. A graph of Equation 4.8 is shown in Exhibit 4.7. The horizontal axis shows the expected difference in inflation rates between the home country and the foreign country, and the vertical axis shows the interest differential between the two countries for the same time period. The parity line shows all points for which \( r_h - r_f = i_h - i_f \).

Point C, for example, is a position of equilibrium because the 2 percent higher rate of inflation in the foreign country \( (i_h - i_f = -2\%) \) is just offset by the 2 percent lower HC interest rate \( (r_h - r_f = -2\%) \). At point D, however, where the real rate of return in the home country is 1 percent lower than in the foreign country (an inflation differential of 2 percent versus an interest differential of 3 percent), funds should flow from the home country to the foreign country to take advantage of the real differential. This flow will continue until expected real returns are again equal.

**Empirical Evidence**

Exhibit 4.8 illustrates the relationship between interest rates and inflation rates for thirty-two countries as of November 2000. It is evident from the graph that nations with higher inflation rates generally have higher interest rates. Thus, the empirical evidence is consistent with the hypothesis that most of the variation in nominal interest rates across countries can be attributed to differences in inflationary expectations.

The proposition that expected real returns are equal between countries cannot be tested directly. However, many observers believe it unlikely that significant real interest rate differentials among countries are unlikely to survive for long.

**EXHIBIT 4.7 THE FISHER EFFECT**

<table>
<thead>
<tr>
<th>Inflation differential, home country relative to foreign country (%)</th>
<th>Interest differential, in favor of home country (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5</td>
<td>-5</td>
</tr>
<tr>
<td>-4</td>
<td>-4</td>
</tr>
<tr>
<td>-3</td>
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<td>-2</td>
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<td>-1</td>
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<td>2</td>
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<tr>
<td>3</td>
<td>3</td>
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<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Parity line

C

D
To the extent that arbitrage is permitted to operate unhindered, capital markets are integrated worldwide. **Capital market integration** means that real interest rates are determined by the global supply and global demand for funds. This is in contrast to **capital market segmentation**, where real interest rates are determined by local credit conditions.

The difference between capital market segmentation and capital market integration is depicted in Exhibit 4.9. With a segmented capital market, the real interest rate in the United States, $a_{us}$, is based on the national demand $D_{us}$ and national supply $S_{us}$ of credit. Conversely, the real rate in the rest of the world, $a_{rw}$, is based on the rest-of-world supply $S_{rw}$ and demand $D_{rw}$. In this example, the U.S. real rate is higher than the real rate outside the United States, or $a_{us} > a_{rw}$.

Once the U.S. market opens up, the U.S. real interest rate falls (and the rest-of-world rate rises) to the new world rate $a_{w}$, which is determined by the world supply $S_{w} = S_{us} + S_{rw}$.
Capital markets are becoming increasingly integrated worldwide.

Political risk and currency risk can cause real interest rates to differ across countries.

Real interest rates tend to be higher in developing countries.

112 Part I Environment of International Financial Environment

\[ S_{rw} = D_{rw} + D_{sw} \]

A real interest rate differential could exist without being arbitraged away if investors strongly preferred to hold domestic assets in order to avoid currency risk, even if the expected real return on foreign assets were higher. The evidence on this point is somewhat mixed. The data indicate a tendency toward convergence in real interest rates internationally, indicating that arbitrage does occur, but real rates still appear to differ from each other.\(^8\) Moreover, the estimated currency risk premium appears to be highly variable and unpredictable, leading to extended periods of apparent differences in real interest rates between nations.\(^9\)

These differences are displayed in Exhibit 4.10, which compares real interest rates (measured as the nominal interest rate minus the past year’s inflation rate as a surrogate for the expected inflation rate) as of November 2000 versus nominal rates for the same thirty-two countries shown in Exhibit 4.8. According to this exhibit, countries with higher nominal interest rates (implying higher expected inflation and greater currency risk) tend to have higher real interest rates, resulting in large real rate differentials among some countries.

In addition to currency and inflation risk, real interest rate differentials in a closely integrated world economy can stem from countries pursuing sharply differing tax policies or imposing regulatory barriers to the free flow of capital. In many developing countries, however, currency controls and other government policies impose political risk on foreign investors. In effect, political risk can drive a wedge between the returns available to domestic investors and those available to foreign investors. For example, if political risk in Brazil causes foreign investors to demand a 7 percent higher interest rate than they demand elsewhere, then foreign investors would consider a 10 percent expected real return in Brazil to be equivalent to a 3 percent expected real return in the United States. Hence, real interest rates in developing countries can exceed those in developed countries without presenting attractive arbitrage opportunities to foreign investors. The combination of a relative shortage of capital and high political risk in most developing countries is likely to

\(^6\) The net gain from the transfer of capital equals the higher returns on the capital imported to the United States less the lower returns foregone in the rest of the world. Returns on capital must be higher in the United States prior to the capital inflow because the demand for capital depends on the expected return on capital. Thus, a higher real interest rate indicates a higher real return on capital.

\(^7\) An offshore security is one denominated in the home currency but issued abroad. They are generally referred to as Eurosecurities.


cause real interest rates in these countries to exceed real interest rates in the developed countries. Indeed, the countries in Exhibit 4.10 with the highest real rates of interest are all developing countries.

Investors’ tolerance of economic mismanagement in developed nations also has fallen dramatically, as financial deregulation, abolition of foreign exchange controls, and the process of global portfolio diversification have swollen the volume of international capital flows. With modern technology enabling investors to move capital from one market to another at low cost and almost instantaneously, the pressure on central banks to “do the right thing” is intense. Conversely, those nations that must attract a disproportionate amount of global capital to finance their national debts and that have no credible policies to deal with their problems in a noninflationary way will be forced to pay a rising risk premium. “Canada’s High Real Interest Rate Comes Down” provides a good example of both these trends.

**EXHIBIT 4.10 • REAL INTEREST RATE VERSUS NOMINAL INTEREST RATE FOR THIRTY-TWO DEVELOPED AND DEVELOPING COUNTRIES AS OF NOVEMBER 2000**

**ILLUSTRATION Canada’s High Real Interest Rate Comes Down**

In early 1995, the Canadian dollar slipped to an eight-and-a-half-year low against the U.S. dollar. At the same time, with Canada’s inflation rate under 1 percent and its ten-year government bonds yielding 9.3 percent (about 1.5 percentage points more than ten-year U.S. Treasury bonds), Canada had the highest real long-term interest rates in the world. The weak Canadian dollar and high real interest rates stemmed from the same source—a lack of confidence in Canada’s longer-term inflation prospects.

Canada had a large current-account deficit, driven by large budget deficits, political uncertainty, and other structural problems that led to investor worries that the current low rate of inflation was only temporary. The persistently high budget deficits, in turn, reflected big spending on generous social-welfare programs and overly rigid labor markets, along with a lack of political will to attack these problems. At the same time,
Before we move to the next parity condition, a caveat is in order. We must keep in mind that there are numerous interest differentials just as there are many different interest rates in a market. The rate on bank deposits, for instance, will not be identical to that on Treasury bills. In computation of an interest differential, therefore, the securities on which this differential is based must be of identical risk characteristics save for currency risk. Otherwise, there is the danger of comparing apples with oranges (or at least temple oranges with navel oranges).

Adding Up Capital Markets Internationally

Central to understanding how we can add yen and euro and dollar capital markets together is to recognize that money is only a veil: All financial transactions, no matter how complex, ultimately involve exchanges of goods today for goods in the future. As we will see in Chapter 5, you supply credit (capital) when you consume less than you produce; you demand credit when you consume more than you produce. Thus, the supply of credit can be thought of as the excess supply of goods and the demand for credit as the excess demand for goods. When we add up the capital markets around the world, we are adding up the excess demands for goods and the excess supplies of goods. A car is still a car, whether it is valued in yen or dollars.

4.4 The International Fisher Effect

The key to understanding the impact of relative changes in nominal interest rates among countries on the foreign exchange value of a nation's currency is to recall the implications of PPP and the generalized Fisher effect. PPP implies that exchange rates will move to offset changes in inflation rate differentials. Thus, a rise in the U.S. inflation rate relative to...
those of other countries will be associated with a fall in the dollar’s value. It will also be associated with a rise in the U.S. interest rate relative to foreign interest rates. Combine these two conditions and the result is the international Fisher effect (IFE):

\[
\frac{1 + r_h}{1 + r_f} = \frac{\bar{e}_1}{e_0}
\]  

(4.10)

Here \(\bar{e}_1\) is the expected exchange rate in period 1.

According to Equation 4.10, the expected return from investing at home, \(1 + r_h\), should equal the expected HC return from investing abroad, \((1 + r_f)\bar{e}_1/e_0\). As discussed in the previous section, however, despite the intuitive appeal of equal expected returns, domestic and foreign expected returns might not equilibrate if the element of currency risk restrained the process of international arbitrage.

In effect, the IFE says that currencies with low interest rates are expected to appreciate relative to currencies with high interest rates.

### Illustration Using the IFE to Forecast U.S. and SFr Rates

In July, the one-year interest rate is 4 percent on Swiss francs and 13 percent on U.S. dollars.

1. If the current exchange rate is SFr 1 = $0.63, what is the expected future exchange rate in one year?

   **Solution.** According to the international Fisher effect, the spot exchange rate expected in one year equals \(0.63 \times 1.17/1.04 = 0.6845\).

2. If a change in expectations regarding future U.S. inflation causes the expected future spot rate to rise to $0.70, what should happen to the U.S. interest rate?

   **Solution.** If \(r_{us}\) is the unknown U.S. interest rate, and the Swiss interest rate stays at 4 percent (because there has been no change in expectations of Swiss inflation), then according to the international Fisher effect, \(0.70/0.63 = (1 + r_{us})/1.04\), or \(r_{us} = 15.56\%\).

If \(r_f\) is relatively small, Equation 4.11 provides a reasonable approximation to the international Fisher effect:

\[
r_h - r_f = \frac{\bar{e}_1 - e_0}{e_0}
\]

(4.11)

In effect, the IFE says that currencies with low interest rates are expected to appreciate relative to currencies with high interest rates.

A graph of Equation 4.11 is shown in Exhibit 4.11. The vertical axis shows the expected change in the home currency value of the foreign currency, and the horizontal axis shows the interest differential between the two countries for the same time period. The parity line shows all points for which \(r_h - r_f = (\bar{e}_1 - e_0)/e_0\).

Point E is a position of equilibrium because it lies on the parity line, with the 4 percent interest differential in favor of the home country just offset by the anticipated 4 percent appreciation in the HC value of the foreign currency. Point E, however, illustrates a

---

10 Subtracting 1 from both sides of Equation 4.10 yields

\[
\frac{\bar{e}_1 - e_0}{e_0} = \frac{r_h - r_f}{1 + r_f}
\]

Equation 4.11 follows if \(r_f\) is relatively small.
situation of disequilibrium. If the foreign currency is expected to appreciate by 3 percent in terms of the HC, but the interest differential in favor of the home country is only 2 percent, then funds would flow from the home to the foreign country to take advantage of the higher exchange-adjusted returns there. This capital flow will continue until exchange-adjusted returns are equal in the two nations.

Essentially what the IFE says is that arbitrage between financial markets—in the form of international capital flows—should ensure that the interest differential between any two countries is an unbiased predictor of the future change in the spot rate of exchange. This condition does not mean, however, that the interest differential is an especially accurate predictor; it just means that prediction errors tend to cancel out over time. Moreover, an implicit assumption that underlies IFE is that investors view foreign and domestic assets as perfect substitutes. To the extent that this condition is violated (see the discussion on the Fisher effect) and investors require a risk premium (in the form of a higher expected real return) to hold foreign assets, IFE will not hold exactly.

**Empirical Evidence**

As predicted, there is a clear tendency for currencies with high interest rates (for example, Mexico and Brazil) to depreciate and those with low interest rates (for example, Japan and Switzerland) to appreciate. The ability of interest differentials to anticipate currency changes is also supported by several empirical studies that indicate the long-run tendency for these differentials to offset exchange rate changes. The international Fisher effect also appears to hold even in the short run in the case of nations facing very rapid rates of inflation. Thus, at any given time, currencies bearing higher nominal interest rates can reasonably be expected to depreciate relative to currencies bearing lower interest rates.

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Despite this apparently convincing evidence for the international Fisher effect, a large body of empirical evidence now indicates that the IFE does not hold up very well in the short run for nations with low to moderate rates of inflation. One possible explanation for this result relies on the existence of a time-varying exchange risk premium. However, this explanation for the failure of the IFE to hold in the short run has been challenged by empirical evidence indicating that the currency risk premium, to the extent it exists, is very small.

A more plausible explanation for the IFE's failure in the short run relies on the nature of the Fisher effect. According to the Fisher effect, changes in the nominal interest differential can be due to changes in either the real interest differential or relative inflationary expectations. These two possibilities have opposite effects on currency values. For example, suppose that the nominal interest differential widens in favor of the United States. If this spread is due to a rise in the real interest rate in the United States relative to that of other countries, the value of the dollar will rise. Alternatively, if the change in the nominal interest differential is caused by an increase in inflationary expectations for the United States, the dollar's value will drop.

The key to understanding short-run changes in the value of the dollar or other currency, then, is to distinguish changes in nominal interest rate differentials that are caused by changes in real interest rate differentials from those caused by changes in relative inflation expectations. Historically, changes in the nominal interest differential have been dominated, at times, by changes in the real interest differential; at other times, they have been dominated by changes in relative inflation expectations. Consequently, there is no stable, predictable relationship between changes in the nominal interest differential and exchange rate changes.

**4.5 Interest Rate Parity Theory**

Spot and forward rates are closely linked to each other and to interest rates in different currencies through the medium of arbitrage. Specifically, the movement of funds between two currencies to take advantage of interest rate differentials is a major determinant of the spread between forward and spot rates. In fact, the forward discount or premium is closely related to the interest differential between the two currencies.

According to interest rate parity (IRP) theory, the currency of the country with a lower interest rate should be at a forward premium in terms of the currency of the country with the higher rate. More specifically, in an efficient market with no transaction costs, the interest differential should be (approximately) equal to the forward differential. When this condition is met, the forward rate is said to be at interest rate parity, and equilibrium prevails in the money markets.

Interest parity ensures that the return on a hedged (or “covered”) foreign investment will just equal the domestic interest rate on investments of identical risk, thereby eliminating the possibility of having a money machine. When this condition holds, the covered interest differential—the difference between the domestic interest rate and the hedged foreign rate—is zero. To illustrate this condition, suppose an investor with $1,000,000 to invest for 90 days is trying to decide between investing in U.S. dollars at 8 percent per annum (2 percent for 90 days) or in euros at 6 percent per annum (1.5 percent for 90 days). The current spot rate is €1.13110/$, and the 90-day forward rate is €1.1256/$. Exhibit 4.12 shows that regardless of the investor's currency choice, his

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hedged return will be identical. Specifically, $1,000,000 invested in dollars for 90 days will yield $1,000,000 × 1.02 = $1,020,000. Alternatively, if the investor chooses to invest in euros on a hedged basis, he will

1. Convert $1,000,000 to euros at the spot rate of €1.1311/$. This yields €1,131,100 available for investment.
2. Invest the principal of €1,131,100 at 1.5 percent for 90 days. At the end of 90 days, the investor will have €1,148,066.50.
3. Simultaneously with the other transactions, sell the €1,148,066.50 in principal plus interest forward at a rate of €1.12556/$ for delivery in 90 days. This transaction will yield €1,148,066.50/1.12556 = $1,020,000 in 90 days.

If the covered interest differential between two money markets is nonzero, there is an arbitrage incentive to move money from one market to the other. This movement of money to take advantage of a covered interest differential is known as covered interest arbitrage.

Covered interest differentials tend to disappear through the process known as covered interest arbitrage.

Suppose the interest rate on pounds sterling is 12 percent in London, and the interest rate on a comparable dollar investment in New York is 7 percent. The pound spot rate is $1.75, and the one-year forward rate is $1.68. These rates imply a forward discount on sterling of 4 percent [(1.68 − 1.75)/1.75] and a covered yield on sterling approximately equal to 8 percent (12% − 4%). Because there is a covered interest differential in favor of London, funds will flow from New York to London.

To illustrate the profits associated with covered interest arbitrage, we will assume that the borrowing and lending rates are identical and the bid-ask spread in the spot and forward markets is zero. Here are the steps the arbitrageur can take to profit from the discrepancy in rates based on a $1 million transaction. Specifically, as shown in Exhibit 4.13, the arbitrageur will...
The transactions associated with covered interest arbitrage will affect prices in both the money and foreign exchange markets. In the previous example, as pounds are bought spot and sold forward, boosting the spot rate and lowering the forward rate, the forward discount will tend to widen. Simultaneously, as money flows from New York, interest rates there will tend to increase; at the same time, the inflow of funds to London will depress interest rates there. The process of covered interest arbitrage will continue until interest parity is achieved, unless there is government interference.

If this process is interfered with, covered interest differentials between national money markets will not be arbitraged away. Interference often occurs because many governments regulate and restrict flows of capital across their borders. Moreover, just the risk of controls will be sufficient to yield prolonged deviations from interest rate parity.

The relationship between the spot and forward rates and interest rates in a free market can be shown graphically, as in Exhibit 4.14. Plotted on the vertical axis is the interest differential in favor of the home country. The horizontal axis plots the percentage forward discount (negative) or premium (positive) on the foreign currency relative to the home currency. The interest parity line joins those points for which the forward exchange rate is in equilibrium with the interest differential. For example, if the interest differential...
in favor of the foreign country is 2 percent, the currency of that country must be selling at a 2 percent forward discount for equilibrium to exist.

Point G indicates a situation of disequilibrium. Here, the interest differential is 2 percent, whereas the forward premium on the foreign currency is 3 percent. The transfer of funds abroad with exchange risks covered will yield an additional 1 percent annually. At point H, the forward premium remains at 3 percent, but the interest differential increases to 4 percent. Now reversing the flow of funds becomes profitable. The 4 percent higher interest rate more than makes up for the 3 percent loss on the forward exchange transaction, leading to a 1 percent increase in the interest yield.

In reality, the interest parity line is a band because transaction costs, arising from the spread on spot and forward contracts and brokerage fees on security purchases and sales, cause effective yields to be lower than nominal yields. For example, if transaction costs are 0.75 percent, a covered yield differential of only 0.5 percent will not be sufficient to induce a flow of funds. For interest arbitrage to occur, the covered differential must exceed the transaction costs involved.

The covered interest arbitrage relationship can be stated formally. Let \( e_0 \) be the current spot rate (dollar value of one unit of foreign currency) and \( f_1 \) the end-of-period forward rate. If \( r_h \) and \( r_f \) are the prevailing interest rates in New York and, say, London, respectively, then one dollar invested in New York will yield \( 1 + r_h \) at the end of the period; the same dollar invested in London will be worth \( (1 + r_f)f_1/e_0 \) dollars at maturity. This latter result can be seen as follows: One dollar will convert into \( 1/e_0 \) pounds that, when invested at \( r_f \), will yield \( (1 + r_f)/e_0 \) pounds at the end of the period. By selling the proceeds forward today, this amount will be worth \( (1 + r_f)f_1/e_0 \) dollars when the investment matures.

Funds will flow from New York to London if and only if

\[
1 + r_h < \frac{(1 + r_f)f_1}{e_0}
\]
Conversely, funds will flow from London to New York if and only if

\[ 1 + r_h > \frac{(1 + r_f)f_1}{e_0} \]

Interest rate parity holds when there are no covered interest arbitrage opportunities. On the basis of the previous discussion, this no-arbitrage condition can be stated as follows:

\[ \frac{1 + r_h}{1 + r_f} = \frac{f_1}{e_0} \]  

(4.12)

Illustration Using Interest Rate Parity to Calculate the $/¥ Forward Rate

The interest rate in the United States is 10 percent; in Japan, the comparable rate is 7 percent. The spot rate for the yen is $0.003800. If interest rate parity holds, what is the 90-day forward rate?

Solution. According to IRP, the 90-day forward rate on the yen, \( f_{90} \), should be $0.003828:

\[ f_{90} = 0.003800 \times \frac{1 + \left( \frac{0.10}{4} \right)}{1 + \left( \frac{0.07}{4} \right)} = 0.003828 \]

In other words, the 90-day forward Japanese yen should be selling at an annualized premium of about 2.95 percent \([4 \times (0.003828 - 0.003800)/0.0038]\).

Illustration Computing the Covered Interest Differential When Transaction Costs Exist

Suppose the annualized interest rate on 180-day dollar deposits is 6 7/16 – 5/16%, meaning that dollars can be borrowed at 6 7/16 percent (the ask rate) and lent at 6 5/16 percent (the bid rate). At the same time, the annualized interest rate on 180-day Thai baht deposits is 9 3/8 – 1/8%. Spot and 180-day forward quotes on Thai baht are B 31.5107 – 46/$ (bid of B 31.5107 and ask of B 31.5146) and B 32.1027 – 87/$, respectively. Is there an arbitrage opportunity? Compute the profit using B 10,000,000.

Solution. The only way to determine whether an arbitrage opportunity exists is to examine the two possibilities: Borrow dollars and lend Thai baht or borrow baht and lend dollars, both on a hedged basis. The key is to ensure that you are using the correct bid or ask interest and exchange rates. In this case, it turns out that there is an arbitrage opportunity.

14 Subtracting 1 from both sides of Equation 4.12 yields \((f_1 - e_0)/e_0 = (r_h - r_f)/(1 + r_f)\). Equation 4.13 follows if \(r_f\) is relatively small.
122 Part I • Environment of International Financial Environment

Transaction costs in the form of bid-ask spreads make the computations more difficult, but the principle is the same: Compute the covered interest differential to see whether there is an arbitrage opportunity.

Empirical Evidence

Interest rate parity is one of the best-documented relationships in international finance. In fact, in the Eurocurrency markets, the forward rate is calculated from the interest differential between the two currencies using the no-arbitrage condition. Deviations from interest parity do occur between national capital markets, however, owing to capital controls (or the threat of them), the imposition of taxes on interest payments to foreigners, and transaction costs. However, as we can see in Exhibit 4.15, these deviations tend to be small and short-lived.

4.6 The Relationship between the Forward Rate and the Future Spot Rate

Our current understanding of the workings of the foreign exchange market suggests that, in the absence of government intervention in the market, both the spot rate and the forward rate are influenced heavily by current expectations of future events. The two rates move in tandem, with the link between them based on interest differentials. New information, such as a change in interest rate differentials, is reflected almost immediately in both spot and forward rates.

Suppose a depreciation of the pound sterling is anticipated. Recipients of sterling will begin selling sterling forward, and sterling-area dollar earners will slow their sales of dollars in the forward market. These actions will tend to depress the price of forward sterling. At the same time, banks will probably try to even out their long (net purchaser)
positions in forward sterling by selling sterling spot. In addition, sterling-area recipients of dollars will tend to delay converting dollars into sterling, and earners of sterling will speed up their collection and conversion of sterling. In this way, pressure from the forward market is transmitted to the spot market, and vice versa.

Ignoring risk for the moment, equilibrium is achieved only when the forward differential equals the expected change in the exchange rate. At this point, there is no longer any incentive to buy or sell the currency forward. This condition is illustrated in Exhibit 4.16. The vertical axis measures the expected change in the home currency value of the foreign currency, and the horizontal axis shows the forward discount or premium on the foreign currency. Parity prevails at point I, for example, where the expected foreign currency depreciation of 2 percent is just matched by the 2 percent forward discount on the foreign currency. Point J, however, is a position of disequilibrium because the expected 4 percent depreciation of the foreign currency exceeds the 3 percent forward discount on the foreign currency. We would, therefore, expect to see speculators selling the foreign currency forward for home currency, taking a 3 percent discount in the expectation of covering their commitment with 4 percent fewer units of HC.

A formal statement of the unbiased forward rate (UFR) is that the forward rate should reflect the expected future spot rate on the date of settlement of the forward contract:

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**EXHIBIT 4.15 - UNCOVERED AND COVERED INTEREST RATE DIFFERENTIALS (U.S. $ VERSUS OTHER CURRENCIES)**

<table>
<thead>
<tr>
<th>Year</th>
<th>French franc</th>
<th>Deutsche mark</th>
<th>Yen</th>
<th>Sterling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>5%</td>
<td>-5%</td>
<td>-10%</td>
<td>-12%</td>
</tr>
<tr>
<td>1976</td>
<td>3%</td>
<td>0%</td>
<td>-5%</td>
<td>-8%</td>
</tr>
<tr>
<td>1978</td>
<td>1%</td>
<td>2%</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>1980</td>
<td>0%</td>
<td>3%</td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>1982</td>
<td>-1%</td>
<td>5%</td>
<td>4%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Uncovered interest rate differentials (three-month Eurodollar deposit rates minus three-month Eurodeposit rates in named currency)

Covered interest rate differentials (uncovered differentials minus three-month forward exchange rate premium)

where $e_1$ is the expected future exchange rate at time 1 (units of home currency per unit of foreign currency) and $f_1$ is the forward rate for settlement at time 1.

Equation 4.14 can be transformed into the equation reflected in the parity line appearing in Exhibit 4.16, which is that the forward differential equals the expected change in the exchange rate, by subtracting 1 ($e_0/e_0$) from both sides, where $e_0$ is the current spot rate (HC per unit of foreign currency): \[ f_1 - e_0 = e_1 - e_0 \] \[ \frac{f_1 - e_0}{e_0} = \frac{e_1 - e_0}{e_0} \] (4.15)

Market efficiency requires that people process information and form reasonable expectations; it does not require that $f_1 = e_1$. Market efficiency allows for the possibility that risk-averse investors will demand a risk premium on forward contracts, much the same as they demand compensation for bearing the risk of investing in stocks. In this case, the forward rate will not reflect exclusively the expectation of the future spot rate.

15 Note that this condition can be derived through a combination of the international Fisher effect and interest parity theory. Specifically, interest rate parity says that the interest differential equals the forward differential, whereas the IFE says that the interest differential equals the expected change in the spot rate. Things equal to the same thing are equal to each other, so the forward differential will equal the expected exchange rate change if both interest rate parity and the IFE hold.
The principal argument against the existence of a risk premium is that currency risk is largely diversifiable. If foreign exchange risk can be diversified away, no risk premium need be paid for holding a forward contract; the forward rate and expected future spot rate will be approximately equal. Ultimately, therefore, the unbiased nature of forward rates is an empirical, and not a theoretical, issue.

**Empirical Evidence**

A number of studies have examined the relation between forward rates and future spot rates. Of course, it would be unrealistic to expect a perfect correlation between forward and future spot rates because the future spot rate will be influenced by events, such as an oil crisis, that can be forecast only imperfectly, if at all.

Nonetheless, the general conclusion from early studies was that forward rates are unbiased predictors of future spot rates. But more recent studies, using more powerful econometric techniques, argue that the forward rate is a biased predictor, probably because of a risk premium. However, the premium appears to change signs—being positive at some times and negative at other times—and averages near zero. This result, which casts doubt on the risk premium story, should not be surprising given that testing the unbiased nature of the forward rate is equivalent to testing the international Fisher effect (assuming covered interest parity holds).

In effect, we wind up with the same conclusions: Over time, currencies bearing a forward discount (higher interest rate) depreciate relative to currencies with a forward premium (lower interest rate). That is, on average, the forward rate is unbiased. On the other hand, at any point in time, the forward rate appears to be a biased predictor of the future spot rate. More specifically, the evidence indicates that one can profit on average by buying currencies selling at a forward discount (that is, currencies whose interest rate is relatively high) and selling currencies trading at a forward premium (that is, currencies whose interest rate is relatively low). Nonetheless, research also suggests that this evidence of forward market inefficiency may be difficult to profit from on a risk-adjusted basis. One reason is the existence of what is known as the peso problem.

The *peso problem* refers to the possibility that during the time period studied, investors anticipated significant events that did not materialize, thereby invalidating statistical inferences based on data drawn from that period. The term derives from the experience of Mexico during the period 1955–1975. During this entire period, the peso was fixed at a rate of $0.125, yet continually sold at a forward discount because investors anticipated a large peso devaluation. This devaluation eventually occurred in 1976, thereby validating the prediction embedded in the forward rate (and relative interest rates). However, those who limited their analysis on the relation between forward and future spot rates to data drawn only from the 1955–1975 period would have falsely concluded that the forward rate was a biased predictor of the future spot rate.

In their comprehensive survey of the research on bias in forward rates, Froot and Thaler conclude, “Whether or not there is really money to be made based on the apparent inefficiency of foreign exchange markets, it is worth emphasizing that the risk-return trade-off for a single currency is not very attractive. … Although much of the risk in these [single currency] strategies may be diversifiable in principle, more complex diversified strategies may be much more costly, unreliable, or difficult to execute.”

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of bias suggests that the selective use of forward contracts—sell forward if the currency is at a forward premium and buy it forward if it is selling at a discount—may increase expected profits but at the expense of higher risk.

4.7 Currency Forecasting

Forecasting exchange rates has become an occupational hazard for financial executives of multinational corporations. The potential for periodic—and unpredictable—government intervention makes currency forecasting all the more difficult. But this difficulty has not dampened the enthusiasm for currency forecasts or the willingness of economists and others to supply them. Unfortunately, however, enthusiasm and willingness are not sufficient conditions for success.

Requirements for Successful Currency Forecasting

Currency forecasting can lead to consistent profits only if the forecaster meets at least one of the following four criteria.\(^1\) The successful forecaster

- Has exclusive use of a superior forecasting model
- Has consistent access to information before other investors
- Exploits small, temporary deviations from equilibrium
- Can predict the nature of government intervention in the foreign exchange market

The first two conditions are self-correcting. Successful forecasting breeds imitators, while early access to information is unlikely to be sustained in the highly informed world of international finance. The third situation is how foreign exchange traders actually earn their living, but deviations from equilibrium are not likely to last long. The fourth situation is the one worth searching out. Countries that insist on managing their exchange rates and are willing to take losses to achieve their target rates present speculators with potentially profitable opportunities. Simply put, consistently profitable predictions are possible in the long run only if it is not necessary to outguess the market to win.

As a general rule, in a fixed-rate system, the forecaster must focus on the governmental decision-making structure because the decision to devalue or revalue at a given time is clearly political. Under the Bretton Woods system, for example, many speculators did quite well by “stepping into the shoes of the key decision makers” to forecast their likely behavior. The basic forecasting methodology in a fixed-rate system, therefore, involves first ascertaining the pressure on a currency to devalue or revalue, and then determining how long the nation’s political leaders can, and will, persist with this particular level of disequilibrium. Exhibit 4.17 depicts a five-step procedure for performing this analysis. In the case of a floating-rate system, where government intervention is sporadic or nonexistent, currency prognosticators have the choice of using either market- or model-based forecasts, neither of which guarantees success.

Market-Based Forecasts

So far, we have identified several equilibrium relationships that should exist between exchange rates and interest rates. The empirical evidence on these relationships implies that, in general, the financial markets of developed countries efficiently incorporate expected currency changes in the cost of money and forward exchange. This means that currency forecasts can be obtained by extracting the predictions already embodied in interest and forward rates.

\(^{1}\) These criteria were suggested by Giddy and Dufey, “The Random Behavior of Flexible Exchange Rates.”
**Forward Rates** Market-based forecasts of exchange rate changes can be derived most simply from current forward rates. Specifically, \( f_1 \)—the forward rate for one period from now—will usually suffice for an unbiased estimate of the spot rate as of that date. In other words, \( f_1 \) should equal \( \bar{e}_1 \), where \( \bar{e}_1 \) is the expected future spot rate.
Interest Rates Although forward rates provide simple and easy-to-use currency forecasts, their forecasting horizon is limited to about one year because of the general absence of longer-term forward contracts. Interest rate differentials can be used to supply exchange rate predictions beyond one year. For example, suppose five-year interest rates on dollars and euros are 6 percent and 5 percent, respectively. If the current spot rate for the euro is $0.90 and the (unknown) value of the euro in five years is $e_5$, then $1.00 invested today in euros will be worth \((1.05)^5 e_5/0.90\) dollars at the end of five years; if invested in the dollar security, it will be worth \((1.06)^5\) in five years. The market’s forecast of $e_5$ can be found by assuming that investors demand equal returns on dollar and euro securities, or

\[
\frac{(1.05)^5 e_5}{0.90} = (1.06)^5
\]

Thus, the five-year euro spot rate implied by the relative interest rates is $e_5 = 0.9437 \times (0.90 \times 1.06^5/1.05^5)$.

Model-Based Forecasts

The two principal model-based approaches to currency prediction are known as fundamental analysis and technical analysis. Each approach has its advocates and detractors.

Fundamental Analysis

Fundamental analysis is the most common approach to generating model-based forecasts of future exchange rates. It relies on painstaking examination of the macroeconomic variables and policies that are likely to influence a currency’s prospects. The variables examined include relative inflation and interest rates, national income growth, and changes in money supplies. The interpretation of these variables and their implications for future exchange rates depend on the analyst’s model of exchange rate determination.

The simplest form of fundamental analysis involves the use of PPP. We have previously seen the value of PPP in explaining exchange rate changes. Its application in currency forecasting is straightforward.

**Illustration Using PPP to Forecast the South African Rand’s Future Spot Rate**

The U.S. inflation rate is expected to average about 4 percent annually, and the South African rate of inflation is expected to average about 9 percent annually. If the current spot rate for the rand is $0.008, what is the expected spot rate in two years?

Solution. According to PPP (Equation 4.3), the expected spot rate for the rand in two years is $0.008 \times (1.04/1.09)^2 = 0.00728$.

Most analysts use more complicated forecasting models whose analysis usually centers on how the different macroeconomic variables are likely to affect the demand and supply for a given foreign currency. The currency’s future value is then determined by estimating the exchange rate at which supply just equals demand—when any current-account imbalance is just matched by a net capital flow.

Forecasting based on fundamental analysis has inherent difficulties. First, you must be able to select the right fundamentals; then you must be able to forecast them—itself a problematic task (think about forecasting interest rates); finally, your forecasts of the fundamentals must differ from those of the market. Otherwise, the exchange rate will have already discounted the anticipated change in the fundamentals. Another difficulty that forecasters face is the variability in the lag between when changes in fundamentals are forecast to occur and when they actually affect the exchange rate.

Despite these difficulties, Robert Cumby developed a sophisticated regression model—incorporating forward premiums along with real variables such as relative
inflation rates and current-account balances—that yielded predictable return differentials (between investing in uncovered foreign deposits and domestic deposits) on the order of 10 percent to 30 percent per annum.20

**Technical Analysis**  Technical analysis is the antithesis of fundamental analysis in that it focuses exclusively on past price and volume movements—while totally ignoring economic and political factors—to forecast currency winners and losers. Success depends on whether technical analysts can discover price patterns that repeat themselves and are, therefore, useful for forecasting.

There are two primary methods of technical analysis: **charting** and **trend analysis**. Chartists examine bar charts or use more sophisticated computer-based extrapolation techniques to find recurring price patterns. They then issue buy or sell recommendations if prices diverge from their past pattern. Trend-following systems seek to identify price trends via various mathematical computations.

**Model Evaluation**

The possibility that either fundamental or technical analysis can be used to profitably forecast exchange rates is inconsistent with the efficient market hypothesis, which says that current exchange rates reflect all publicly available information. Because markets are forward-looking, exchange rates will fluctuate randomly as market participants assess and then react to new information, much as security and commodity prices in other asset markets respond to news. Thus, exchange rate movements are unpredictable; otherwise, it would be possible to earn arbitrage profits. Such profits could not persist in a market—such as the foreign exchange market—that is characterized by free entry and exit and an almost unlimited amount of money, time, and energy that participants are willing to commit in pursuit of profit opportunities.

In addition to the theoretical doubts surrounding forecasting models, a variety of statistical and technical assumptions underlying these models have been called into question as well. For all practical purposes, however, the quality of a currency forecasting model must be viewed in relative terms. That is, a model can be said to be “good” if it is better than alternative means of forecasting currency values. Ultimately, a currency forecasting model is “good” only to the extent that its predictions will lead to better decisions.

Certainly interest differentials and/or forward rates provide low-cost alternative forecasts of future exchange rates. At a minimum, any currency forecasting model should be able to consistently outperform the market’s estimates of currency changes. In other words, one relevant question is whether profitable decisions can be made in the forward and/or money markets by using any of these models.

Currency forecasters charge for their services, so researchers periodically evaluate the performance of these services to determine whether the forecasts are worth their cost. The evaluation criteria generally fall into two categories: accuracy and correctness. The accuracy measure focuses on the deviations between the actual and the forecasted rates, and the correctness measure examines whether or not the forecast predicts the right direction of the change in exchange rates.

An accurate forecast may not be correct in predicting the direction of change, and a correct forecast may not be very accurate. The two criteria are sometimes in conflict. Which of these two criteria should be used in evaluation depends on how the forecasts are to be used.

An analysis of forecasting errors—the difference between the forecast and actual exchange rate—will tell us little about the profit-making potential of econometric forecasts. Instead, we need to link these forecasts to actual decisions and then calculate the

resulting profits or losses. For example, if the forecasts are to be used to decide whether or not to hedge with forward contracts, the relative predictive abilities of the forecasting services can be evaluated by using the following decision rule:

\[
\begin{align*}
\text{If } f_1 &> \bar{e}_1, \text{ sell forward.} \\
\text{If } f_1 &< \bar{e}_1, \text{ buy forward.}
\end{align*}
\]

where \( f_1 \) is the forward rate and \( e_1 \) is the forecasted spot rate at the forward contract's settlement date. In other words, if the forecasted rate is below the forward rate, the currency should be sold forward; if the forecasted rate is above the forward rate, the currency should be bought forward.

The percentage profit (loss) realized from this strategy equals \( 100\left(\frac{f_1 - e_1}{e_1}\right) \) when \( f_1 > e_1 \), and equals \( 100\left(\frac{e_1 - f_1}{e_1}\right) \) when \( f_1 < \bar{e}_1 \), where \( e_1 \) is the actual spot rate being forecasted.

Despite the theoretical skepticism over successful currency forecasting, a study of fourteen forecast advisory services by Richard Levich indicates that the profits associated with using several of these forecasts seem too good to be explained by chance.\(^{21}\) Of course, if the forward rate contains a risk premium, these returns will have to be adjusted for the risks borne by speculators. It is also questionable whether currency forecasters would continue selling their information rather than act on it themselves if they truly believed it could yield excess risk-adjusted returns. That being said, it is hard to attribute expected return differentials of up to 30 percent annually (Cumby's results) to currency risk when the estimated equity risk premium on the U.S. stock exchange is only about 8 percent for a riskier investment.

Of course, if you take a particular data sample and run every possible regression, you are likely to find some apparently profitable forecasting model. But that does not mean it is a reliable guide to the future. To control for this tendency to “data mine,” you must do out-of-sample forecasting. That is, you must see if your model forecasts well enough to be profitable in time periods not included in the original data sample. Hence, the profitable findings of Cumby and others may stem from the fact that their results are based on the in-sample performance of their regressions. That is, they used the same data sample both to estimate their model and to check its forecasting ability. Indeed, Richard Meese and Kenneth Rogoff concluded that sophisticated models of exchange rate determination make

poor forecasts. Their conclusion is similar to that of Jeffrey Frankel, who—after reviewing the research on currency forecasting—stated that

*the proportion of exchange rate changes that are forecastable in any manner—by the forward discount, interest rate differential, survey data, or models based on macroeconomic fundamentals—appears to be not just low, but almost zero.*

Frankel's judgment is consistent with the existence of an efficient market in which excess risk-adjusted returns have a half-life measured in minutes, if not seconds.

**Forecasting Controlled Exchange Rates**

A major problem in currency forecasting is that the widespread existence of exchange controls, as well as restrictions on imports and capital flows, often masks the true pressures on a currency to devalue. In such situations, forward markets and capital markets are invariably nonexistent or subject to such stringent controls that interest and forward differentials are of little practical use in providing market-based forecasts of exchange rate changes. An alternative forecasting approach in such a controlled environment is to use *black-market exchange rates* as useful indicators of devaluation pressure on the nation's currency.

The black-market rate tends to be a good indicator of where the official rate is likely to go if the monetary authorities give in to market pressure. It seems to be most accurate in forecasting the official rate one month ahead and is progressively less accurate as a forecaster of the future official rate for longer time periods.

**4.8 Summary and Conclusions**

In this chapter, we examined five relationships, or parity conditions, that should apply to spot rates, inflation rates, and interest rates in different currencies: purchasing power parity (PPP), the Fisher effect (FE), the international Fisher effect (IFE), interest rate parity (IRP) theory, and the forward rate as an unbiased forecast of the future spot rate (UFR). These parity conditions follow from the law of one price, the notion that in the absence of market imperfections, arbitrage ensures that exchange-adjusted prices of identical traded goods and financial assets are within transaction costs worldwide.

The technical description of these five equilibrium relationships is summarized as follows:

- **Purchasing power parity**

  \[
  \frac{e_1}{e_0} = \frac{1 + i_h}{1 + i_f}
  \]

  where

  \( e_1 = \) the home currency value of the foreign currency at time 1
  
  \( e_0 = \) the home currency value of the foreign currency at time 0
  
  \( i_h = \) the domestic inflation rate
  
  \( i_f = \) the foreign inflation rate

---


1 + r = (1 + a)(1 + i)

where
r = the nominal rate of interest
a = the real rate of interest
i = the rate of expected inflation

● Generalized version of Fisher effect

\[
\frac{1 + r_h}{1 + r_f} = \frac{1 + i_h}{1 + i_f}
\]

where
r_h = the home currency interest rate
r_f = the foreign currency interest rate

● International Fisher effect

\[
\frac{1 + r_h}{1 + r_f} = \frac{e_{1}'}{e_0}
\]

where
\(e_{1}'\) = the expected home currency value of the foreign currency at time 1

● Interest rate parity

\[
\frac{1 + r_h}{1 + r_f} = \frac{f_1}{e_0}
\]

where
f_1 = the forward rate at time 0 for delivery of one unit of foreign currency at time 1

● Forward rate as an unbiased predictor of the future spot rate

\(f_1 = e_{1}'\)

Despite the mathematical precision with which these parity conditions are expressed, they are only approximations of reality. A variety of factors can lead to significant and prolonged deviations from parity. For example, both currency risk and inflation risk may cause real interest rates to differ across countries. Similarly, various shocks can cause the real exchange rate—defined as the nominal, or actual, exchange rate adjusted for changes in the relative purchasing power of each currency since some base period—to change over time. Moreover, the short-run relation between changes in the nominal interest differential and changes in the exchange rate is not so easily determined. The lack of definiteness in this relation stems from the differing effects on exchange rates of purely nominal interest rate changes and real interest rate changes.

We examined the concept of the real exchange rate in more detail as well. The real exchange rate at time 1, \(e_{1}'\), incorporates both the nominal exchange rate between two currencies and the inflation rates in both countries. It is defined as follows:
Real exchange rate

\[ e_{t+1} = \frac{P_f}{P_h} \]

where

- \( P_f \) = the foreign price level at time 1 indexed to 100 at time 0
- \( P_h \) = the home price level at time 1 indexed to 100 at time 0

We then analyzed a series of forecasting models that purport to outperform the market’s own forecasts of future exchange rates as embodied in interest and forward differentials. We concluded that the foreign exchange market is no different from any other financial market in its susceptibility to profitable predictions.

Those who have inside information about events that will affect the value of a currency or a security should benefit handsomely. Those who do not have this access will have to trust either to luck or to the existence of a market imperfection, such as government intervention, to assure themselves of above-average, risk-adjusted profits. Given the widespread availability of information and the many knowledgeable participants in the foreign exchange market, only the latter situation—government manipulation of exchange rates—holds the promise of superior risk-adjusted returns from currency forecasting. When governments spend money to control exchange rates, this money flows into the hands of private participants who bet against the government. The trick is to predict government actions.

### Questions

1. a. What is purchasing power parity?
   b. What are some reasons for deviations from purchasing power parity?
   c. Under what circumstances can purchasing power parity be applied?

2. One proposal to stabilize the international monetary system involves setting exchange rates at their purchasing power parity rates. Once exchange rates were correctly aligned (according to PPP), each nation would adjust its monetary policy so as to maintain them. What problems might arise from using the PPP rate as a guide to the equilibrium exchange rate?

3. Suppose the dollar/rupiah rate is fixed but Indonesian prices are rising faster than U.S. prices. Is the Indonesian rupiah appreciating or depreciating in real terms?

4. Comment on the following statement. “It makes sense to borrow during times of high inflation because you can repay the loan in cheaper dollars.”

5. Which is likely to be higher, a 150 percent ruble return in Russia or a 15 percent dollar return in the United States?

6. The interest rate in England is 12 percent; in Switzerland it is 5 percent. What are possible reasons for this interest rate differential? What is the most likely reason?

7. Over the period 1982–1988, Peru and Chile stand out as countries whose interest rates were not consistent with their inflation experience. Specifically, Peru’s inflation and interest rates averaged about 125 percent and 8 percent, respectively, over this period, whereas Chile’s inflation and interest rates averaged about 22 percent and 38 percent, respectively.
   a. How would you characterize the real interest rates of Peru and Chile (e.g., close to zero, highly positive, highly negative)?
   b. What might account for Peru’s low interest rate relative to its high inflation rate? What are the likely consequences of this low interest rate?
   c. What might account for Chile’s high interest rate relative to its inflation rate? What are the likely consequences of this high interest rate?
   d. During this same period, Peru had a small interest differential and yet a large average exchange rate change. How would you reconcile this experience with the international Fisher effect and with your answer to Part b?

8. Over the period 1982–1988, a number of countries (e.g., Pakistan, Hungary, Venezuela) had a small or negative interest rate differential and a large average depreciation against the dollar. How would you explain these data? Can you reconcile these data with the international Fisher effect?

9. What factors might lead to persistent covered interest arbitrage opportunities among countries?

10. In early 1989, Japanese interest rates were about 4 percentage points below U.S. rates. The wide difference between Japanese and U.S. interest rates prompted some U.S. real estate developers to borrow in yen to finance their projects. Comment on this strategy.
11. Recently, Japanese and German interest rates rose while U.S. rates fell. At the same time, the yen and euro fell against the U.S. dollar. What might explain the divergent trends in interest rates?

12. In late December 1990, one-year German Treasury bills yielded 9.1 percent, whereas one-year U.S. Treasury bills yielded 6.9 percent. At the same time, the inflation rate during 1990 was 6.3 percent in the United States, double the German rate of 3.1 percent.
   a. Are these inflation and interest rates consistent with the Fisher effect?
   b. What might explain this difference in interest rates between the United States and Germany?

13. The spot rate on the euro is $1.09, and the 180-day forward rate is $1.11. What are possible reasons for the difference between the two rates?

14. German government bonds, or Bunds, currently are paying higher interest rates than comparable U.S. Treasury bonds. Suppose the ECB eases the money supply to drive down interest rates. How is an American investor in Bunds likely to fare?

15. In 1993 and early 1994, Turkish banks borrowed abroad at relatively low interest rates to fund their lending at home. The banks earned high profits because rampant inflation in Turkey forced up domestic interest rates. At the same time, Turkey's central bank was intervening in the foreign exchange market to maintain the value of the Turkish lira. Comment on the Turkish banks' funding strategy.

Problems

1. From base price levels of 100 in 2000, Japanese and U.S. price levels in 2003 stood at 102 and 106, respectively.
   a. If the 2000 $:¥ exchange rate was $0.007692, what should the exchange rate be in 2003?
   b. In fact, the exchange rate in 2003 was ¥ 1 = $0.008696. What might account for the discrepancy? (Price levels were measured using the consumer price index.)

2. Two countries, the United States and England, produce only one good, wheat. Suppose the price of wheat is $3.25 in the United States and is £1.35 in England.
   a. According to the law of one price, what should the $:£ spot exchange rate be?
   b. Suppose the price of wheat over the next year is expected to rise to $3.50 in the United States and to £1.60 in England. What should the one-year $:£ forward rate be?
   c. If the U.S. government imposes a tariff of $0.50 per bushel on wheat imported from England, what is the maximum possible change in the spot exchange rate that could occur?

3. If expected inflation is 100 percent and the real required return is 5 percent, what should the nominal interest rate be according to the Fisher effect?

4. In early 1996, the short-term interest rate in France was 3.7 percent, and forecast French inflation was 1.8 percent. At the same time, the short-term German interest rate was 2.6 percent and forecast German inflation was 1.6 percent.
   a. Based on these figures, what were the real interest rates in France and Germany?
   b. To what would you attribute any discrepancy in real rates between France and Germany?

5. In July, the one-year interest rate is 12 percent on British pounds and 9 percent on U.S. dollars.
   a. If the current exchange rate is $1.63:£1, what is the expected future exchange rate in one year?
   b. Suppose a change in expectations regarding future U.S. inflation causes the expected future spot rate to decline to $1.52:£1. What should happen to the U.S. interest rate?

6. Suppose that in Japan the interest rate is 8 percent and inflation is expected to be 3 percent. Meanwhile, the expected inflation rate in France is 12 percent, and the English interest rate is 14 percent. To the nearest whole number, what is the best estimate of the one-year forward exchange premium (discount) at which the pound will be selling relative to the euro?

7. Chase Econometrics has just published projected inflation rates for the United States and Germany for the next five years. U.S. inflation is expected to be 10 percent per year, and German inflation is expected to be 4 percent per year.
   a. If the current exchange rate is $0.95/€, forecast the exchange rates for the next five years.
   b. Suppose that U.S. inflation over the next five years turns out to average 3.2 percent, German inflation averages 1.5 percent, and the exchange rate in five years is $0.99/€. What has happened to the real value of the euro over this five-year period?

8. During 1995, the Mexican peso exchange rate rose from Mex$5.33/U.S.$ to Mex$7.64/U.S.$ At the same time, U.S. inflation was approximately 3 percent in contrast to Mexican inflation of about 48.7 percent.
   a. By how much did the nominal value of the peso change during 1995?
   b. By how much did the real value of the peso change over this period?

9. Suppose three-year deposit rates on Eurodollars and Eurofrancs (Swiss) are 12 percent and 7 percent, respectively. If the current spot rate for the Swiss franc...
Chapter 4 • Parity Conditions in International Finance and Currency Forecasting

10. Assume that the interest rate is 16 percent on pounds sterling and 7 percent on euros. At the same time, inflation is running at an annual rate of 3 percent in Germany and 9 percent in England.
   a. If the euro is selling at a one-year forward premium of 10 percent against the pound, is there an arbitrage opportunity? Explain.
   b. What is the real interest rate in Germany? in England?
   c. Suppose that during the year the exchange rate changes from €1.80:£1 to €1.77:£1. What are the real costs to a German company of borrowing pounds? Contrast this cost to its real cost of borrowing euros.
   d. What are the real costs to a British firm of borrowing euros? Contrast this cost to its real cost of borrowing pounds?

11. Suppose the Eurosterling rate is 15 percent and the Eurodollar rate is 11.5 percent. What is the forward premium on the dollar? Explain.

12. Suppose the spot rates for the euro, pound sterling, and Swiss franc are $0.92, $1.13, and $0.38, respectively. The associated 90-day interest rates (annualized) are 8 percent, 16 percent, and 4 percent; the U.S. 90-day rate (annualized) is 12 percent. What is the 90-day forward rate on an ACU (ACU 1 = €1 + £1 + SFr 1) if interest parity holds?

13. Suppose that three-month interest rates (annualized) in Japan and the United States are 7 percent and 9 percent, respectively. If the spot rate is ¥142:$1 and the 90-day forward rate is ¥139:$1,
   a. Where would you invest?
   b. Where would you borrow?
   c. What arbitrage opportunity do these figures present?

14. Here are some prices in the international money markets:
   - Spot rate = $0.95: €
   - Forward rate (one year) = $0.97: €
   - Interest rate (€) = 7% per year
   - Interest rate ($) = 9% per year
   a. Assuming no transaction costs or taxes exist, do covered arbitrage profits exist in this situation? Describe the flows.
   b. Suppose now that transaction costs in the foreign exchange market equal 0.23 percent per transaction. Do unexploited covered arbitrage profit opportunities still exist?
   c. Suppose no transaction costs exist. Let the capital gains tax on currency profits equal 25 percent and the ordinary income tax on interest income equal 50 percent. In this situation, do covered arbitrage profits exist? How large are they? Describe the transactions required to exploit these profits.

15. Suppose today's exchange rate is $1.05/€. The six-month interest rates on dollars and euros are 6 percent and 3 percent, respectively. The six-month forward rate is $1.0478. A foreign exchange advisory service has predicted that the euro will appreciate to €1.8:£1 to €1.77:£1. What are the
   a. How would you use forward contracts to profit in the above situation?
   b. How would you use money-market instruments (borrowing and lending) to profit?
   c. Which alternatives (forward contracts or money market instruments) would you prefer? Why?
1. Using data from the OECD, compare the most recent PPP exchange rates for the pound, yen, and euro with their nominal exchange rates. What differences do you observe? What accounts for these differences?

2. Using OECD data, plot the PPP exchange rates for the pound, yen, Mexican peso, and Korean won. Have these PPP exchange rates gone up or down over time? What accounts for the changes in these PPP exchange rates over time?

3. Find the 90-day interest rates from the Financial Times Web site for the dollar, yen, euro, and pound. Are the yield differentials on these currencies consistent with the forward rates reported in the Wall Street Journal? What might account for any differences?

   a. Which of these currencies are forecast to appreciate and which to depreciate?
   b. Compare these forecasts to the forward rates for the same maturity. Are the predicted exchange rates greater or less than the corresponding forward rates?
   c. Compare these forecasts to the actual exchange rates. How accurate were these forecasts?
   d. If you had followed these forecasts (by buying forward when the forecasted exchange rate exceeded the forward rate and selling forward when it was below the forward rate), would you have made or lost money?

5. How have forward premiums and discounts relative to the dollar changed over annual intervals during the past five years for the Japanese yen, British pound, and euro? Use beginning-of-year data.