Exchange Rate Determination

chapter

15

LEARNING GOALS:

After reading this chapter, you should be able to:

- Understand the purchasing-power parity theory and why it does not work in the short run
- Understand how the monetary and the portfolio balance models of the exchange rate work
- Understand the causes of exchange rate overshooting
- Understand why exchange rates are so difficult to forecast

15.1 Introduction

In this chapter, we examine modern exchange rate theories. These theories are based on the monetary approach and the asset market or portfolio balance approach to the balance of payments that have been developed since the late 1960s. These theories view the exchange rate, for the most part, as a purely financial phenomenon. They also seek to explain the great short-run volatility of exchange rates and their tendency to overshoot their long-run equilibrium level, which have often been observed during the past four decades.

These modern exchange rate theories may be distinguished from traditional exchange rate theories (discussed in Chapters 16 and 17), which are based on trade flows and help explain exchange rate movements only in the long run or over the years. Since the advent of floating rates in 1973, international financial flows have increased tremendously and are now far larger than trade flows. Therefore, it is only natural that interest shifted toward monetary theories of exchange rate determination. Traditional exchange rate theories are still important, however, especially in explaining exchange rates in the long run.

We begin in Section 15.2 by presenting the purchasing-power parity theory, which provides the long-run framework for the monetary and asset market or portfolio balance approaches to exchange rate determination. Section 15.3 then examines the monetary approach to the balance of payments and exchange rate determination. Section 15.4 presents the portfolio balance approach to exchange rate determination. Section 15.5 examines exchange rate dynamics and seeks to explain the tendency of short-run exchange rates to overshoot their long-run equilibrium level. Finally, Section 15.6 presents empirical evidence on the monetary approach and the portfolio balance approach, and on exchange rate forecasting. The appendix to the chapter discusses a formal model of the monetary approach and portfolio balance model of exchange rate determination.

15.2 Purchasing-Power Parity Theory

In this section, we examine the purchasing-power parity (PPP) theory and evaluate its usefulness in explaining exchange rates. The purchasing-power parity (PPP) theory was elaborated and brought back into use by the Swedish economist *Gustav Cassel* in order to estimate the equilibrium exchange rates at which nations could return to the gold standard after the disruption of international trade and the large changes in relative commodity prices in the various nations caused by World War I. There is an absolute and a relative version of the PPP theory. These will be examined in turn.

15.2A Absolute Purchasing-Power Parity Theory

The absolute purchasing-power parity theory postulates that the equilibrium exchange rate between two currencies is equal to the ratio of the price levels in the two nations. Specifically:

$$R = \frac{P}{P^*} \tag{15-1}$$

where R is the exchange rate or spot rate and P and P^* are, respectively, the general price level in the home nation and in the foreign nation. For example, if the price of one bushel of wheat is \$1 in the United States and €1 in the European Monetary Union, then the exchange rate between the dollar and the pound should be $R = \$1/€1 = 1$. That is, according to the law of one price, a given commodity should have the same price (so that the purchasing power of the two currencies is at parity) in both countries when expressed in terms of the same currency. If the price of one bushel of wheat in terms of dollars were \$0.50 in the United States and \$1.50 in the European Monetary Union, firms would purchase wheat in the United States and resell it in the European Monetary Union, at a profit. This commodity arbitrage would cause the price of wheat to fall in the European Monetary Union and rise in the United States until the prices were equal, say \$1 per bushel, in both economies (in the absence of obstructions to the flow of trade or subsidies and abstracting from transportation costs). Commodity arbitrage thus operates just as does currency arbitrage in equalizing commodity prices throughout the market.

This version of the PPP theory can be very misleading. There are several reasons for this. First, it appears to give the exchange rate that equilibrates trade in goods and services while completely disregarding the capital account. Thus, a nation experiencing capital outflows would have a deficit in its balance of payments, while a nation receiving capital inflows would have a surplus if the exchange rate were the one that equilibrated international trade in goods and services. Second, this version of the PPP theory will not even give the exchange rate that equilibrates trade in goods and services because of the existence of many nontraded goods and services.

Nontraded goods include products, such as cement and bricks, for which the cost of transportation is too high for them to enter international trade, except perhaps in border areas. Most services, including those of mechanics, hair stylists, family doctors, and many others, also do not enter international trade. International trade tends to equalize the prices of traded goods and services among nations but not the prices of nontraded goods and services. Since the general price level in each nation includes both traded and nontraded commodities, and prices of the latter are not equalized by international trade, the absolute PPP theory will not lead to the exchange rate that equilibrates trade. Furthermore, the absolute PPP theory fails to take into account transportation costs or other obstructions to the free flow of international trade. As a result, the absolute PPP theory cannot be taken too seriously (see Case Studies 15-1 and 15-2). Whenever the purchasing-power parity theory is used, it is usually in its relative formulation.

15.2B Relative Purchasing-Power Parity Theory

The more refined relative purchasing-power parity theory postulates that the *change* in the exchange rate over a period of time should be proportional to the *relative* change in the price levels in the two nations over the same time period. Specifically, if we let the subscript 0 refer to the base period and the subscript 1 to a subsequent period, the relative PPP theory postulates that

$$R_1 = \frac{P_1/P_0}{P^*{}_1/P^*{}_0} \cdot R_0 \tag{15-2}$$

where R_1 and R_0 are, respectively, the exchange rates in period 1 and in the base period.

For example, if the general price level does not change in the foreign nation from the base period to period 1 (i.e., $P^*{}_1/P^*{}_0 = 1$), while the general price level in the home nation increases by 50 percent, the relative PPP theory postulates that the exchange rate (defined as the home-currency price of a unit of the foreign nation's currency) should be 50 percent higher (i.e., the home nation's currency should depreciate by 50 percent) in period 1 as compared with the base period.

Note that if the absolute PPP held, the relative PPP would also hold, but when the relative PPP holds, the absolute PPP need not hold. For example, while the very existence of capital flows, transportation costs, other obstructions to the free flow of international trade, and government intervention policies leads to the rejection of the absolute PPP, only a *change* in these would lead the relative PPP theory astray.

However, other difficulties remain with the relative PPP theory. One of these results from the fact (pointed out by *Balassa and Samuelson* in 1964) that the ratio of the price of nontraded to the price of traded goods and services is systematically higher in developed nations than in developing nations. The Balassa–Samuelson effect results from labor productivity in traded goods being higher in developed than in developing countries, but about the same in many nontraded goods and services sectors (for example, haircutting). To remain in nontraded goods and services sectors in developed nations, however, labor must receive wages comparable to the high wages in *traded*-goods sectors. This makes the price of nontraded goods and services systematically higher in developed than in developing

CASE STUDY 15-1 Absolute Purchasing-Power Parity in the Real World

Figure 15.1 shows the actual exchange rate of the dollar in terms of the German mark (i.e., DM/$ prevailing in the market—the colored curve) and the PPP exchange rate (measured by the ratio of the German to the U.S. consumer price index—the black curve) during the flexible exchange rate period since 1973. (Since the beginning of 1999, the fluctuation of the DM/$ reflects the fluctuation of the euro with respect to the dollar.) For the absolute PPP theory to hold, the two curves should coincide. As we can see from the figure, however, the curves diverge widely. The dollar was undervalued (the colored curve was below the black curve) from 1973 to 1980, 1986 to 2000, and 2003 to 2011, and was overvalued from 1981 to 1985 and 2001 and 2002. The figure shows that at its peak (at the beginning of 1985), the dollar was overvalued by nearly 40 percent in terms of marks. Only at the beginning of 1981 and 2001, and at the end of 1985 and 2002, do the curves cross and the two currencies were at parity.

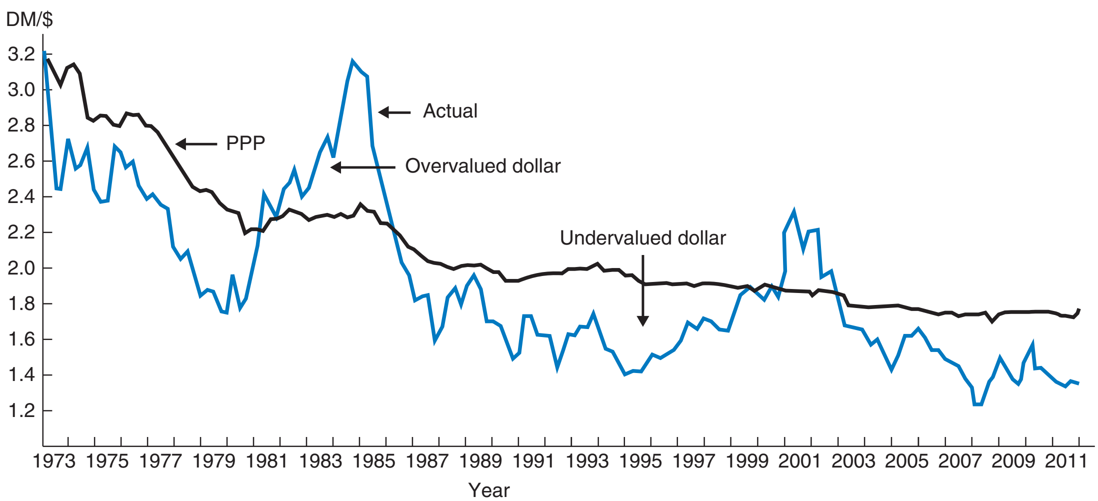

FIGURE 15.1. Actual and PPP Exchange Rate of the Dollar, 1973–2011.
The colored curve measures the dollar exchange rate (defined as DM/$) prevailing in the market, and the black curve measures the PPP exchange rate (measured by the ratio of the German to the U.S. consumer price index) from 1973 to 2011. The figure shows that the dollar was undervalued during 1973–1980, 1986–2000, and 2003–2011, and was overvalued during 1981–1985 and in 2001 and 2002. (Since the beginning of 1999, the fluctuation in DM/$ reflects the fluctuation of the euro with respect to the dollar.)
Source: International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, various issues).

nations. For example, the price of a haircut may be $10 in the United States but only $1 in Brazil.

Since the general price index includes the prices of both traded and nontraded goods and services, and prices of the latter are not equalized by international trade but are relatively higher in developed nations, the relative PPP theory will tend to predict overvalued exchange rates for developed nations and undervalued exchange rates for developing nations, with distortions being larger the greater the differences in the levels of development. This has been confirmed by *Rogoff* (1996) and *Choudri and Khan* (2005).

CASE STUDY 15-2 The Big Mac Index and the Law of One Price

According to the absolute PPP theory, the dollar price of a particular product—say, McDonald's Big Mac hamburger—should be the same in other countries as in the United States if exchange rates were equal to the ratio of the price level in the United States and other countries. From the second column in Table 15.1, however, we see that the dollar price of a Big Mac varied greatly across countries. On January 12, 2012, the Big Mac was most expensive in Norway ($6.79) and cheapest in India ($1.62), as compared with $4.20 in the United States.

The third column of the table gives the implied purchasing-power parity (PPP) of the dollar with respect to the various currencies. This is the exchange rate that would make the price of a hamburger the same in the various countries or regions as in the United States. For example, the price of £3.49 for a hamburger in the Euro area implies a dollar-euro exchange rate of 1.2034 (rounded off to 1.20 in Table 15.1) to equalize the price of a hamburger of $4.20 (£3.49 × 1.2034 = $4.20) in the two regions. This makes the actual dollar-euro exchange rate of $1.27/£ about 6 percent [(1.27 − 1.2034)/1.2034 = 5.53 percent, rounded off to 6 percent in Table 15.1] overvalued with respect to the dollar.

Since the dollar price of a Big Mac was $6.79 in Norway as compared with $4.20 in the United States, the Norwegian kroner was 62 percent ($6.79/$4.20) overvalued with respect to the U.S. dollar on January 12, 2012. The table also shows that the Swiss franc was also overvalued by 62 percent, the Swedish krone by 41 percent, and the Brazilian real by 35 percent. On the other hand, the British pound was 9 percent undervalued with respect to the U.S. dollar, the Mexican peso 36 percent, the Russian rouble 39 percent, the Chinese renminbi or yuan 42 percent, and the Indian rupee 61 percent. Norway was therefore the most expensive country for Americans to visit and India the least expensive (among the countries listed in the table).

TABLE 15.1. Big Mac Prices and Exchange Rates, January 12, 2012

	Big Mac Prices				
	In Local Currency	In U.S. Dollars	Implied PPP[a] of the Dollar	Actual Dollar Exchange Rate: Jan. 12, 2012	Under (−)/Over (+) against the Dollar, %
United States[b]	$4.20	$4.20	–	–	–
Argentina	Peso 20.0	$4.64	4.77	4.31	10
Australia	A$4.80	$4.54	1.14	0.97	18
Brazil	Real 10.25	$5.68	2.44	1.81	35
Britain[c]	£2.49	$3.82	1.65	1.54	−5
Canada	C$4.73	$4.63	113	1.02	10
Chile	Peso 2,050	$4.05	488	505	−3
China[d]	Yuan 15.4	$2.44	3.67	6.32	−42
Colombia	Preso 8,400	$4.54	2001	1852	8
Czech Republic	Koruna 70.22	$3.45	15.73	20.4	−18
Denmark	DK 31.5	$5.37	7.50	5.86	28
Egypt	Pound 15.5	$2.57	3.69	6.04	−39
Euro area[e]	3.49	$4.43	1.20	1.27[f]	5
Hong Kong	HK$16.5	$2.12	3.93	7.77	−45
Hungary	Forint 64.5	$2.63	153.67	245	−37
India	Rupee 84.0	$1.62	20.01	51.9	−61

(continued)

(continued)

CASE STUDY 15-2 Continued

TABLE 15.1. *(continued)*

	Big Mac Prices				
	In Local Currency	In U.S. Dollars	Implied PPP[a] of the Dollar	Actual Dollar Exchange Rate: Jan. 12, 2012	Under (−)/Over (+) against the Dollar, %
Indonesia	Rupiah 22.534	$2.46	5369	9160	−41
Israel	Shekel 15.9	$4.13	3.79	3.85	−2
Japan	Yen 320	$4.16	76.24	76.9	−1
Malaysia	Ringgit 7.35	$2.34	1.75	3.14	−44
Mexico	Peso 37	$2.70	8.82	13.68	−36
Norway	Kroner 41	$6.79	9.77	6.04	52
Pakistan	Rupee 260	$2.89	61.95	50.1	−31
Peru	Sol 10.0	$3.71	2.38	2.69	−12
Philippines	Peso 118	$2.68	28.11	44.0	−36
Poland	Zhoty 9.10	$2.58	2.17	3.52	−38
Russia	Rouble 81.0	$2.55	19.30	31.8	−39
Saudi Arabia	Riyal 10.0	$2.67	2.38	3.75	−36
Singapore	S$4.85	$3.75	1.16	1.29	−11
South Africa	Rand 19.55	$2.45	4.75	8.13	−42
South Korea	Won 3,700	$3.19	882	1158	−24
Sweden	SKr 41	$5.91	9.77	6.53	41
Switzerland	SFr 6.50	$6.81	1.55	0.56	52
Taiwan	NTS 75.0	$2.50	17.87	30.0	−40
Thailand	Baht 78	$2.46	18.58	31.8	−41
Turkey	Lire 6.60	$3.54	1.57	1.86	−16

[a] Purchasing-power parity: local price divided by price in the United States;
[b] Average of four cities;
[c] Dollars per pound;
[d] Average of 5 cities;
[e] Weighted average of prices in euro area;
[f] Dollars per euro.
Source: ''2012 Big Mac Index,'' *The Economist*, January 12, 2009.

Significant structural changes also lead to problems with the relative PPP theory. For example, the PPP theory indicated that the British pound was undervalued (i.e., the exchange rate of the pound was too high) immediately after World War I, when it was obvious that the opposite was the case (and the exchange rate of the pound should have been even higher). The reason was that the United Kingdom had liquidated many of its foreign investments during the war, so that the equilibrium exchange rate predicted by the relative PPP theory (which did not take into consideration the drop in earnings from foreign investments) would have left a large deficit in the U.K. balance of payments after the war. Case Study 15-3 provides a simple test of the relative PPP theory. More formal and rigorous tests are discussed in the next subsection.

CASE STUDY 15-3 Relative Purchasing-Power Parity in the Real World

Figure 15.2 shows the relationship between changes in relative national price levels and changes in exchange rates for 18 industrial nations from 1973 to 2011 (the period of flexible exchange rates). The horizontal axis measures the average inflation rate in each country minus the average inflation rate in the United States (so that positive values refer to a higher average inflation rate in the nation than in the United States). The vertical axis measures changes in the foreign exchange rate, defined as the *foreign*-currency price of the U.S. dollar. Thus, an increase in the foreign exchange rate refers to a depreciation of the *foreign* currency relative to the U.S. dollar, while a decrease in the exchange rate refers to an appreciation of the foreign currency.

According to the relative purchasing-power parity (PPP) theory, nations with higher inflation rates than in the United States should experience depreciating currencies, while nations with lower inflation rates should have appreciating currencies. The figure shows that this is indeed the case over the 38-year period examined. That is, countries with higher inflation rates than the United States experienced depreciating currencies with respect to the U.S. dollar, while countries with lower inflation rates experienced appreciating currencies. For the theory to hold perfectly, however, the plotted points in Figure 15.2 should fall on a straight line with a positive slope of 1. Since this is not the case, the relative PPP theory holds only approximately.

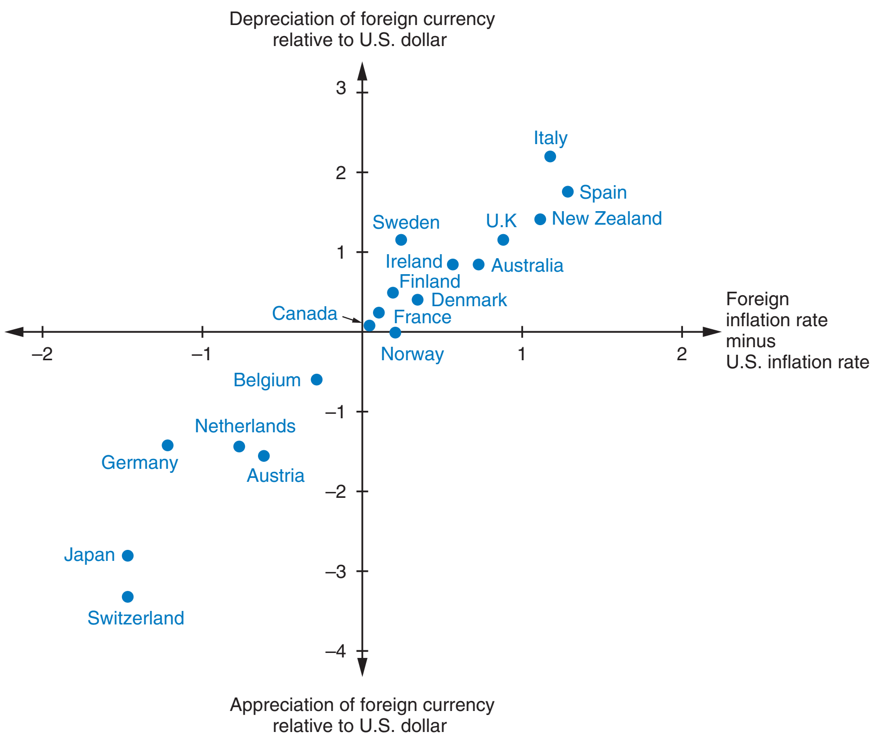

FIGURE 15.2. Inflation Differentials and Exchange Rates, 1973–2011.
Positive values along the horizontal axis refer to higher average inflation rates in the nation than in the United States. Positive values along the vertical axis refer to a depreciating currency relative to the U.S. dollar. Since nations with higher inflation rates generally experienced depreciating currencies the relative PPP theory seems to be broadly confirmed in the long run. Since 1999, changes in the exchange rates of EMU countries reflect the changes in the euro/dollar exchange rate.

Source: International Monetary Fund, *International Financial Statistics*, various issues.

15.2c Empirical Tests of the Purchasing-Power Parity Theory

The movement to a floating exchange rate system after 1973 stimulated a great resurgence of interest in the purchasing-power parity theory and led to numerous empirical studies to test the validity of the theory.

Frenkel (1978) provided empirical evidence on the long-run validity of the PPP theory during the high-inflation years of the 1920s, and so did *Kravis and Lipsey* (1978) for the 1950–1970 period, and *McKinnon* (1979) for the 1953–1977 period. On the other hand, *Frenkel* (1981) found that the PPP theory collapsed during the 1970s, especially in the latter part of the 1970s, and so did *Levich* (1985) and *Dornbusch* (1987) for the 1980s.

Frankel (1986 and 1990) has suggested that researchers should utilize data over many decades to properly test the PPP theory because deviations from purchasing-power parity die out only very slowly. Utilizing annual data on the dollar/pound exchange rate over the 1869–1984 period, *Frankel* showed that it took between four and five years for one-half of the deviations from PPP to die out and that only about 15 percent of the deviations from PPP were eliminated per year. *Lothian and Taylor* (1996), using data from 1790 to 1990 for the dollar/pound and the franc/pound exchange rates, confirmed Frankel's results, as did *Frankel and Rose* (1995) using annual data for 150 countries from 1948 to 1992, *MacDonald* (1999) using 1960 to 1996 data, *Taylor* (2002) using annual data for 20 countries (the G-7 countries and 13 other countries) over the 1882–1996 period, and by *Cashin and McDermott* (2002) for 20 industrial countries over the 1973–2002 period. *Taylor and Taylor* (2004) review this empirical evidence and support the above results and conclusions. *Cashin and McDermott* (2006) extend and confirm their earlier conclusions for 90 developed and developing countries over the 1973–2002 period.

Why do deviations from PPP die out so slowly? One possible explanation given by *Rogoff* (1996 and 1999) is that, despite all the globalization that has occurred during the past two or three decades, international commodity markets are still much less integrated than national commodity markets. This is due to the existence of transportation costs, actual or threatened trade protection, information costs, and very limited international labor mobility. As a consequence of various adjustment costs, exchange rates can move a great deal without triggering any immediate and large response in relative domestic prices.

We can therefore come to the following overall conclusions with regard to the empirical relevance of the PPP theory. (1) We expect the PPP to work well (i.e., the law of one price to hold) for highly traded *individual* commodities, such as wheat or steel of a particular grade, but less well for all traded goods together, and not so well for all goods (which include many nontraded commodities). (2) For any level of aggregation, the PPP theory works reasonably well over very long periods of time (many decades) but not so well over one or two decades, and not well at all in the short run. (3) PPP works well in cases of purely monetary disturbances and in very inflationary periods but not so well in periods of monetary stability, and not well at all in situations of major structural changes.

These conclusions are very important not only for the relevance of the PPP theory itself, but also because, as we will see in the rest of this chapter, the PPP theory occupies a central position in the monetary and in the asset market or portfolio balance approaches to the balance-of-payments and exchange rate determination.

15.3 Monetary Approach to the Balance of Payments and Exchange Rates

In this section we examine the monetary approach to the balance of payments. This approach was started toward the end of the 1960s by *Robert Mundell and Harry Johnson* and became fully developed during the 1970s. The monetary approach represents an extension of domestic monetarism (stemming from the Chicago school) to the international economy in that it views the balance of payments as an *essentially monetary phenomenon*. That is, money plays the crucial role in the long run both as a disturbance and as an adjustment in the nation's balance of payments. In Section 15.3A we examine the monetary approach under fixed exchange rates, in Section 15.3B we look at the monetary approach under flexible exchange rates, in Section 15.3C we show how exchange rates are determined according to the monetary approach, and in Section 15.3D we discuss the effect of expectations on exchange rates.

15.3A Monetary Approach under Fixed Exchange Rates

The monetary approach begins by postulating that the demand for *nominal* money balances is positively related to the level of *nominal* national income and is stable in the long run. Thus, the equation for the demand for money can be written as:

$$M_d = kPY \tag{15-3}$$

where M_d = quantity demanded of nominal money balances
k = desired ratio of nominal money balances to nominal national income
P = domestic price level
Y = real output

In Equation (15-3), PY is the nominal national income or output (GDP). This is assumed to be at or to tend toward full employment in the long run. The symbol k is the desired ratio of nominal money balances to nominal national income; k is also equal to $1/V$, where V is the velocity of circulation of money or the number of times a dollar turns over in the economy during a year. With V (and thus k) depending on institutional factors and assumed to be constant, M_d is a stable and positive function of the domestic price level and real national income.

For example, if GDP $= PY =$ \$1 billion and $V = 5$ (so that $k = 1/V = 1/5$), then $M_d = (1/5)PY = (1/5)$(\$1 billion) = \$200 million. Although not included in Equation (15-3), the demand for money is also related, but inversely, to the interest rate (i) or opportunity cost of holding inactive money balances rather than interest-bearing securities. Thus, M_d is directly related to PY and inversely related to i. (This more complete money demand function is formally presented in the appendix to this chapter.) To simplify the analysis, however, we assume for now that M_d is related only to PY, or the nation's nominal GDP, and will work with Equation (15-3).

On the other hand, the nation's supply of money is given by

$$M_s = m(D + F) \tag{15-4}$$

where M_s = the nation's total money supply
m = money multiplier
D = domestic component of the nation's monetary base
F = international or foreign component of the nation's monetary base

The domestic component of the nation's monetary base (D) is the domestic credit created by the nation's monetary authorities or the domestic assets backing the nation's money supply. The international or foreign component of the nation's money supply (F) refers to the international reserves of the nation, which can be increased or decreased through balance-of-payments surpluses or deficits, respectively. $D + F$ is called the monetary base of the nation, or *high-powered money*. Under a fractional-reserve banking system (such as we have today), each new dollar of D or F deposited in any commercial bank results in an increase in the nation's money supply by a multiple of $1. This is the money multiplier, m, in Equation (15-4).

For example, a new deposit of $1 in a commercial bank allows the bank to lend (i.e., to create demand deposits for borrowers) $0.80, if the legal reserve requirement (LRR) is 20 percent. The $0.80 lent by the first bank is usually used by the borrower to make a payment and ends up as a deposit in another bank of the system, which proceeds to lend 80 percent of it ($0.64), while retaining 20 percent ($0.16) as reserve. The process continues until the original $1 deposit has become the reserve base of a total of $1.00 + $0.80 + $0.64 + ... = $5 in demand deposits (which are part of the nation's total money supply). The figure of $5 is obtained by dividing the original deposit of $1 by the legal reserve requirement of 20 percent, or 0.2. That is, $1/0.2 = 5 = m. However, due to excess reserves and leakages, the real-world multiplier is likely to be smaller. In what follows, we assume for simplicity that the money multiplier (m) is constant over time.

Starting from a condition of equilibrium where $M_d = M_s$, an increase in the demand for money (resulting, say, from a once-and-for-all increase in the nation's GDP) can be satisfied either by an increase in the nation's domestic monetary base (D) or by an inflow of international reserves, or balance-of-payments surplus (F). If the nation's monetary authorities do not increase D, the excess demand for money will be satisfied by an increase in F. On the other hand, an increase in the domestic component of the nation's monetary base (D) and money supply (M_s), in the face of unchanged money demand (M_d), flows out of the nation and leads to a fall in F (a deficit in the nation's balance of payments). Thus, a surplus in the nation's balance of payments results from an excess in the stock of money demanded that is not satisfied by an increase in the domestic component of the nation's monetary base, while a deficit in the nation's balance of payments results from an excess in the stock of the money supply of the nation that is not eliminated by the nation's monetary authorities but is corrected by an outflow of reserves.

For example, an increase in the nation's GNP from $1 billion to $1.1 billion increases M_d from $200 million (1/5 of $1 billion) to $220 million (1/5 of $1.1 billion). If the nation's monetary authorities keep D constant, F will ultimately have to increase (a surplus in the nation's balance of payments) by $4 million, so that the nation's money supply also increases by $20 million (the $4 million increase in F times the money multiplier of $m = 5$). Such a balance-of-payments surplus could be generated from a surplus in the current account or the capital account of the nation. How this surplus arises is not important at this time, except to note that the excess demand for money will lead to a balance-of-payments surplus that increases M_s by the same amount. On the other hand, an excess in the stock of money supplied will lead to an outflow of reserves (a balance-of-payments deficit) sufficient to eliminate the excess supply of money in the nation.

The nation, therefore, has no control over its money supply under a fixed exchange rate system in the long run. That is, the size of the nation's money supply will be the one that is consistent with equilibrium in its balance of payments in the long run. Only a reserve-currency country, such as the United States, retains control over its money supply in the long run under a fixed exchange rate system because foreigners willingly hold dollars.

To summarize, a *surplus* in the nation's balance of payments *results* from an *excess in the stock of money demanded* that is not satisfied by domestic monetary authorities. On the other hand, a *deficit* in the nation's balance of payments *results* from an *excess in the stock of money supplied* that is not eliminated or corrected by the nation's monetary authorities. The nation's balance-of-payments surplus or deficit is temporary and self-correcting in the long run; that is, after the excess demand for or supply of money is eliminated through an inflow or outflow of funds, the balance-of-payments surplus or deficit is corrected and the international flow of money dries up and comes to an end. Thus, except for a currency-reserve country, such as the United States, the nation has no control over its money supply in the long run under a fixed exchange rate system.

15.3B Monetary Approach under Flexible Exchange Rates

Under a flexible exchange rate system, balance-of-payments disequilibria are immediately corrected by automatic changes in exchange rates without any international flow of money or reserves. Thus, under a flexible exchange rate system, the nation retains dominant control over its money supply and monetary policy. Adjustment takes place as a result of the change in domestic prices that accompanies the change in the exchange rate. For example, a deficit in the balance of payments (resulting from an excess money supply) leads to an automatic depreciation of the nation's currency, which causes prices and therefore the demand for money to rise sufficiently to absorb the excess supply of money and automatically eliminate the balance-of-payments deficit.

On the other hand, a surplus in the balance of payments (resulting from an excess demand for money) automatically leads to an appreciation of the nation's currency, which tends to reduce domestic prices, thus eliminating the excess demand for money and the balance-of-payments surplus. Whereas under fixed exchange rates, a balance-of-payments disequilibrium is defined as and results from an international flow of money or reserves (so that the nation has no control over its money supply in the long run), under a flexible exchange rate system, a balance-of-payments disequilibrium is immediately corrected by an automatic change in exchange rates and without any international flow of money or reserves (so that the nation retains dominant control over its money supply and domestic monetary policy).

The actual exchange value of a nation's currency in terms of the currencies of other nations is determined by the rate of growth of the money supply and real income in the nation relative to the growth of the money supply and real income in the other nations. For example, assuming zero growth in real income and the demand for money, as well as in the supply of money, in the rest of the world, the growth in the nation's money supply in excess of the growth in its real income and demand for money leads to an increase in prices and in the exchange rate (a depreciation of the currency) of the nation. Conversely,

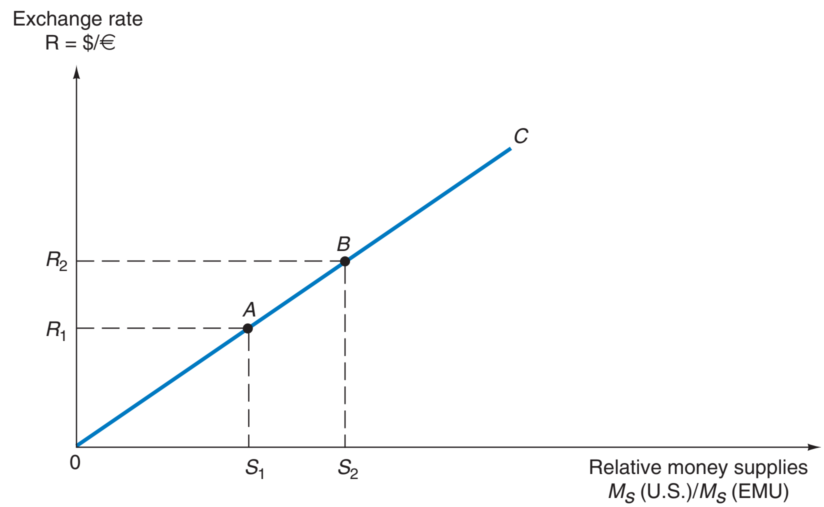

FIGURE 15.3. Relative Money Supplies and Exchange Rates.
Line OC shows the relationship between the money supply in the United States relative to the money supply in the European Monetary Union (EMU) [$S = M_s(\text{U.S.})/M_s(\text{EMU})$] and the dollar-euro exchange rate ($R = \$/€$). Line OC thus shows that a change from S_1 to S_2 causes a proportional change in R from R_1 to R_2.

an increase in the nation's money supply that falls short of the increase in its real income and demand for money tends to reduce prices and the exchange rate (an appreciation of the currency) of the nation. (The actual process by which exchange rates are determined under the monetary approach is examined in the next section.)

Thus, according to the monetary approach, a currency depreciation results from excessive money growth in the nation over time, while a currency appreciation results from inadequate money growth in the nation. Put differently, a nation facing greater inflationary pressure than other nations (resulting from more rapid growth of its money supply in relation to the growth in its real income and demand for money) will find its exchange rate rising (its currency depreciating—see Figure 15.3). On the other hand, a nation facing lower inflationary pressure than the rest of the world will find its exchange rate falling (its currency appreciating). According to *global monetarists*, the depreciation of the U.S. dollar and the appreciation of the German mark during the 1970s were due to excessive money growth and inflationary pressure in the United States, and to the much smaller rate of money growth and inflationary pressure in Germany than in the rest of the world.

With flexible exchange rates, the rest of the world is to some extent shielded from the monetary excesses of some nations. The nations with excessive money growth and depreciating currencies will now transmit inflationary pressures to the rest of the world primarily through their increased imports rather than directly through the export of money or reserves. This will take some time to occur and will depend on how much slack exists in the world economy and on structural conditions abroad.

Under a managed floating exchange rate system of the type in operation today, the nation's monetary authorities intervene in foreign exchange markets and either lose or accumulate international reserves to prevent an "excessive" depreciation or appreciation of the nation's currency, respectively. Under such a system, part of a balance-of-payments deficit is automatically corrected by a depreciation of the nation's currency, and part is corrected by a loss of international reserves (refer to Figure 14.2). As a result, the nation's money supply is affected by the balance-of-payments deficit, and domestic monetary policy loses some of its effectiveness. Under a managed float, the nation's money supply is similarly affected by excessive or inadequate growth of the money supply in other nations, although to a smaller extent than under a fixed exchange rate system. The operation of the present floating exchange rate system is discussed in detail in Chapters 20 and 21.

15.3c Monetary Approach to Exchange Rate Determination

In Section 14.3A, we defined the exchange rate as the domestic currency price of a unit of the foreign currency. With the dollar ($) as the domestic currency and the euro (€) as the foreign currency, the exchange rate (R) was defined as the number of dollars per euro, or R = $/€. For example, if R = $1/€1, this means that one dollar is required to purchase one euro, or if R = $1.20/€1, it would take $1.20 to get one euro.

If markets are competitive and if there are no tariffs, transportation costs, or other obstructions to international trade, then according to the law of one price postulated by the purchasing-power parity (PPP) theory, the price of a commodity must be the same in the United States as in the European Monetary Union (EMU). That is, P_X($) = RP_X(€). For example, if the price of a unit of commodity X is P_X = €1 in the EMU and R = $1.20/€1, then P_X = $1.20 in the United States. The same is true for every other traded commodity and for all commodities together (price indices). That is,

$$P = RP^*$$

and

$$R = \frac{P}{P^*} \tag{15-1}$$

where R is the exchange rate of the dollar, P is the index of dollar prices in the United States, and P^* is the index of euro prices in the EMU.

We can show how the exchange rate between the dollar and the euro is determined according to the monetary approach by starting with the nominal demand-for-money function of the United States (M_d, from Equation (15-3)) and for the EMU (M^*_d):

$$M_d = kPY \text{ and } M^*_d = k^*P^*Y^*$$

where k is the desired ratio of nominal money balances to nominal national income in the United States, P is the price level in the United States, and Y is real output in the United States, while the asterisked symbols have the same meaning for the EMU.

In equilibrium, the quantity of money demanded is equal to the quantity of money supplied. That is, $M_d = M_s$ and $M^*_d = M^*_s$. Substituting M_s for M_d and M^*_s for M^*_d in Equation (15-3), and dividing the resulting EMU function by the U.S. function, we get

$$\frac{M_s^*}{M_s} = \frac{k^*P^*Y^*}{kPY} \tag{15-5}$$

By then dividing both sides of Equation (15-5) by P^*/P and M^*_s/M_s we get

$$\frac{P}{P^*} = \frac{M_s k^* Y^*}{M_s^* k Y} \tag{15-6}$$

CASE STUDY 15-4 Monetary Growth and Inflation

Table 15.2 gives the percentage growth of the money supply (*M1*) and consumer prices for the G-7 (leading industrial countries) over the periods 1973–1985, 1986–1998, and 1999–2011. Although prices depend on many other factors in the real world, according to the monetary approach, prices and money supplies should move together in the long run. From the table, we see that the percentage growth of the money supply and the inflation rate were very similar for the United States, Japan, France, and Italy in the first subperiod (1973–1985), and similar for the United States, France, and Italy in the second subperiod (1986–1998). The money supply varied greatly from the rate of inflation for all countries during the third and less inflationary subperiod (1999–2011).

TABLE 15.2. Money Supply and Consumer Prices, 1973–2011 (percentage increase)

	1973–1985	1986–1998	1999–2011	1973–2011
United States				
Growth of money supply	80.4	40.9	61.3	171.1
Inflation rate	83.0	39.2	27.6	134.4
Japan				
Growth of money supply	75.3	74.3	72.9	174.8
Inflation rate	74.0	15.2	–3.4	83.9
Germany*				
Growth of money supply	76.5	96.3	83.4	189.9
Inflation rate	50.3	26.4	22.4	93.9
United Kingdom				
Growth of money supply	92.2	100.9	79.9	185.4
Inflation rate	119.8	50.0	47.3	170.9
France*				
Growth of money supply	102.5	35.9	83.4	183.1
Inflation rate	107.1	27.4	23.1	142.9
Italy*				
Growth of money supply	146.1	51.5	65.1	185.0
Inflation rate	139.9	53.1	27.3	177.0
Canada				
Growth of money supply	106.2	76.0	97.2	209.3
Inflation rate	91.1	32.7	25.8	136.6
Average of all above countries				
Growth of money supply	97.0	68.0	80.2	188.1
Inflation rate	95.0	34.9	24.3	134.2

*The growth of the money supply reflects the growth in the supply of euros for 1999–2011.
Source: International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, various issues).

But since $R = P/P^*$ (from Equation (15-1)), we have

$$R = \frac{M_s k^* Y^*}{M_s^* kY} \tag{15-7}$$

Since k^* and Y^* in the EMU and k and Y in the United States are assumed to be constant, R is constant as long as M_s and M^*_s remain unchanged. For example, if $k^*Y^*/kY = 0.3$ and $M_s/M^*_s = 4$, then $R = \$1.20/€1$. In addition, changes in R are proportional to changes in M_s and inversely proportional to changes in M^*_s. For example, if M_s increases by 10 percent in relation to M^*_s, R will increase (i.e., the dollar will depreciate) by 10 percent, and so on.

Several important things need to be noted with respect to Equation (15-7). First, it depends on the purchasing-power parity (PPP) theory and the law of one price (Equation (15-1)). Second, Equation (15-7) was derived from the demand for nominal money balances in the form of Equation (15-3), which does not include the interest rate. The relationship between interest rates and the exchange rate is examined in Section 15.3D, which deals with expectations. Third, the exchange rate adjusts to clear money markets in each country without any flow or change in reserves. Thus, for a small country (one that does not affect world prices by its trading), the PPP theory determines the price level under fixed exchange rates and the exchange rate under flexible rates. Case Study 15-4 shows the relationship between increases in the money supply and inflation rates (Equation (15-6)), while Case Study 15-5 shows the relationship between the nominal and the real exchange rate and provides a further test of the monetary approach under flexible exchange rates.

CASE STUDY 15-5 Nominal and Real Exchange Rates, and the Monetary Approach

Figure 15.4 shows the nominal and the real exchange rate index (with 1973 = 100) between the U.S. dollar ($) and the German mark (DM) from 1973 to 2011. The nominal exchange rate is defined as DM/$. (From the beginning of 1999, the fluctuation of the mark reflects the fluctuation of the euro with respect to the dollar.) The **real exchange rate** is the nominal exchange rate divided by the ratio of the consumer price index in Germany to the consumer price index in the United States. That is, (DM/$)/(PGerm/PUS) = (DM/$)(PUS/PGerm).

If the nominal exchange rate reflected changes in relative prices in the United States and Germany (as postulated by the PPP theory), then the real exchange rate should be the same as or remain in the same proportion to the nominal exchange rate. The figure shows, however, that while the nominal and real exchange rates did move together over time, they became increasingly different from 1973 to 1985, from 1995 to 2001, and in 2004–2006. Thus, this crucial element of the monetary approach (i.e., the PPP theory) did not seem to hold from 1973 to 1985, from 1995 to 2001, and in 2004–2006. From 1986 to 1994, 2002 to 2003, and 2007–2011, however, the nominal and real exchange rates (even as they remained widely different) did move pretty much together (see the figure).

(*continued*)

CASE STUDY 15-5 Continued

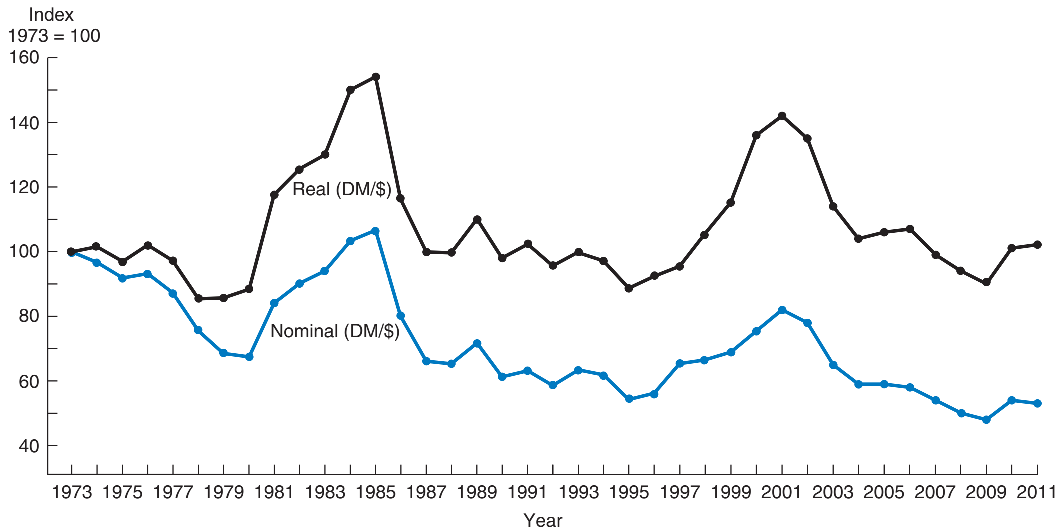

FIGURE 15.4. Nominal and Real Exchange Rate Indices between the Dollar and the Mark, 1973–2011. The figure shows the nominal and the real exchange rate indices (with 1973 = 100) between the dollar ($) and the German mark (DM) from 1973 to 2011. The nominal exchange rate is defined as DM/$. The real exchange rate is (DM/$)(PUS/PGerm). Since the nominal and real exchange rates became increasingly different from 1973 to 1985, 1995 to 2001, and 2004–2006, the PPP theory, as a crucial element of the monetary approach, did not seem to hold for these years. The two exchange rates did, however, move together from 1986 to 1994, 2002 to 2003, and 2007–2011.

Source: International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, various issues).

15.3D Expectations, Interest Differentials, and Exchange Rates

Exchange rates depend not only on the relative growth of the money supply and real income in various nations but also on inflation expectations and *expected* changes in exchange rates. If suddenly the rate of inflation is expected to be 10 percent higher in the United States than in the European Monetary Union than previously anticipated, the dollar will immediately depreciate by 10 percent with respect to the euro in order to keep prices equal in the United States and in the European Monetary Union, as required by the PPP theory and the law of one price. Thus, an increase in the expected rate of inflation in a nation leads to an immediate equal depreciation of the nation's currency.

An expected change in the exchange rate will also lead to an immediate actual change in the exchange rate by an equal percentage. To see why this is so, we go back to the theory of uncovered interest arbitrage (UIA) discussed in Section 14.6A. Since monetarists assume that domestic and foreign bonds are perfect substitutes (so that there is no additional risk in holding the foreign bond with respect to holding the domestic bond), the interest differential between two countries will always equal the expected change in the exchange rate between the two currencies. That is,

$$i - i^* = EA \tag{15-8}$$

where i is the interest rate in the home country (say, the United States), i^* is the interest rate in the foreign country (say, the European Monetary Union), and EA is the expected percentage appreciation per year of the foreign currency (the €) with respect to the home country's currency (the $).

For example, if $i = 6\%$ and $i^* = 5\%$, then the expectation must be that the euro will appreciate by 1 percent at an annual basis in order to make the returns on investing in the European Monetary Union equal to the return on investing in the United States and thus be at *uncovered interest parity*. That is, the one percentage point per year by which the interest rate is lower in the European Monetary Union than in the United States is just made up by the one percentage point expected appreciation of the euro at an annual basis, thus equalizing the returns on U.S. and EMU investments, as required by uncovered interest parity.

If, for whatever reason, the expected appreciation of the euro (depreciation of the dollar) increased from 1 percent to 2 percent at an annual basis, this would make the return on investing in the European Monetary Union 7 percent per year (5 percent in interest and 2 percent from the expected appreciation of the euro at an annual basis) as compared to 6 percent return on the U.S. investment. This would lead to an immediate capital outflow from the United States to the European Monetary Union and actual appreciation of the euro by 1 percent per year, so as to go back to the expectation that the euro will appreciate by only 1 percent per year in the future and to uncovered interest parity. The foregoing conclusion assumes that the interest differential in favor of the United States remains at 2 percent per year. If the interest differential changes, then the new expected appreciation of the euro will also be different, but it will always have to equal, at an annual basis, the interest differential so as to satisfy the uncovered interest arbitrage condition given by Equation (15-8).

If $i < i^*$ so that returns on investments are lower in the United States than in the European Monetary Union, then the euro will be expected to depreciate (and the dollar to appreciate) by the specific percentage per year required for the condition of uncovered interest parity to hold. Furthermore, any change in the expected depreciation of the euro (appreciation of the dollar) will have to be matched by an equal actual depreciation of the euro (appreciation of the dollar), at an annual basis, so as to satisfy the condition for uncovered interest parity. Like the purchasing-power parity (PPP) theory and the law of one price, the uncovered interest arbitrage condition is an integral part of the monetary approach and exchange rate determination. Case Study 15-6 provides an empirical test of the uncovered interest arbitrage condition.

CASE STUDY 15-6 Interest Differentials, Exchange Rates, and the Monetary Approach

Figure 15.5 shows the nominal exchange rate index between the U.S. dollar and the German mark (defined as DM/$, as in Figure 15.4) and the nominal interest rate differential between the United States and Germany from 1973 to 2011. The nominal interest rate differential (in percentage points) is defined as the U.S. treasury bill rate minus the German treasury bill rate. According to the monetary approach, an increase in the U.S. interest rate relative to the interest rate in Germany should lead to a depreciation of the dollar relative to the mark, while a decrease in the interest differential in favor of the United States should lead to an appreciation of the dollar (i.e., the two curves should move in opposite directions). The figure shows that this is true in 24 years of the 38-year period (1973–1982, 1985, 1987–1989, 1991, 1994–1995, 1998, 2000–2003, 2005–2006, 2008).

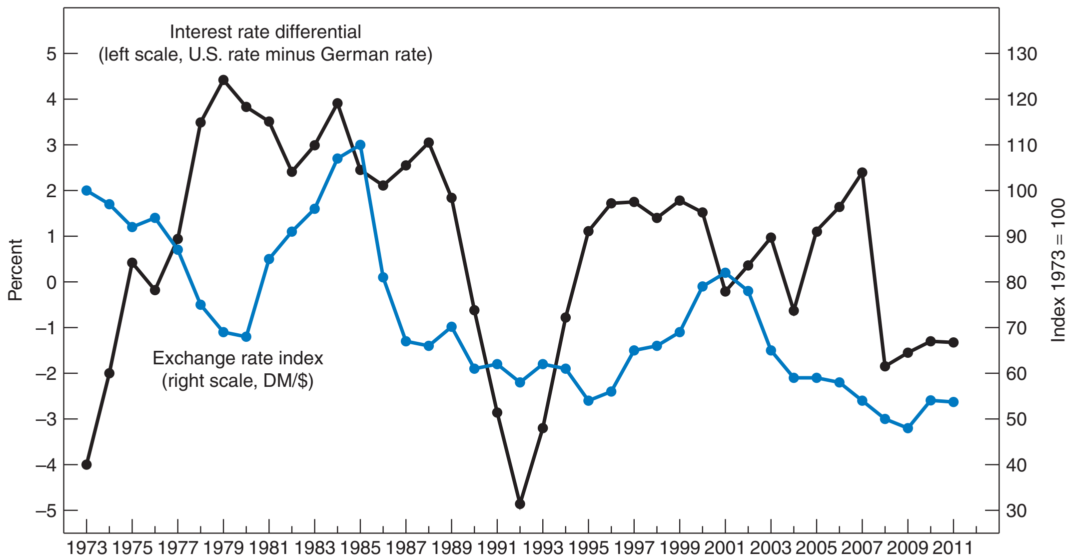

FIGURE 15.5. Nominal Interest Rate Differentials and Exchange Rate Movements, 1973–2011.
As predicted by the monetary approach, the U.S. dollar depreciated with respect to the German mark (the euro since 1999) when interest rates rose in the United States relative to Germany's (the two curves moved in opposite directions) in 24 out of the 38 years of the period examined.
Source: International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, various issues).

15.4 Portfolio Balance Model and Exchange Rates

In this section, we present the portfolio balance approach to the balance of payments and exchange rate determination. Section 15.4A shows a simple portfolio balance model. Section 15.4B presents an extended portfolio balance model that also includes expected exchange rate changes and risk. Section 15.4C then utilizes the model to examine portfolio adjustments.

15.4A Portfolio Balance Model

Until now, we have presented the monetary approach and have concentrated on the domestic demand for and supply of money. We have seen that when the quantity supplied of domestic money exceeds the quantity demanded by the nation's residents, there will be an outflow of domestic money (a deficit in the nation's balance of payments) under a fixed exchange rate system or a depreciation of the nation's currency under flexible exchange rates. On the other hand, when the quantity demanded of domestic money by the nation's residents exceeds the quantity supplied, there will be a capital inflow (a balance-of-payments surplus) under fixed exchange rates or an appreciation of the domestic currency under flexible rates. The monetary approach assumes that domestic and foreign bonds are perfect substitutes.

The portfolio balance approach (also called the *asset market approach*) differs from the monetary approach in that domestic and foreign bonds are assumed to be *imperfect substitutes*, and by postulating that the exchange rate is determined in the process of equilibrating or balancing the *stock* or total demand and supply of financial assets (of which money is only one) in each country. Thus, the portfolio balance approach can be regarded as a more realistic and satisfactory version of the monetary approach. The portfolio balance approach was developed since the mid-1970s, and many variants of the basic model have been introduced.

In the simplest asset market model, individuals and firms hold their financial wealth in some combination of domestic money, a domestic bond, and a foreign bond denominated in the foreign currency. The incentive to hold bonds (domestic and foreign) results from the yield or interest that they provide. However, they also carry the risk of default and the risk arising from the variability of their market value over time. Domestic and foreign bonds are not perfect substitutes, and foreign bonds pose some additional risk with respect to domestic bonds. Holding domestic money, on the other hand, is riskless but provides no yield or interest.

Thus, the opportunity cost of holding domestic money is the yield forgone on holding bonds. The higher the yield or interest on bonds, the smaller is the quantity of money that individuals and firms will want to hold. At any particular point in time, an individual will want to hold part of his or her financial wealth in money and part in bonds, depending on his or her particular set of preferences and degree of risk aversion. Individuals and firms *do* want to hold a portion of their wealth in the form of money (rather than bonds) in order to make business payments (the transaction demand for money). But the higher the interest on bonds, the smaller is the amount of money that they will want to hold (i.e., they will economize on the use of money).

The choice, however, is not only between holding domestic money, on the one hand, and bonds in general, on the other, but among holding domestic money, the domestic bond, and the foreign bond. The foreign bond denominated in the foreign currency carries the additional risk that the foreign currency may depreciate, thereby imposing a capital loss in terms of the holder's domestic currency. But holding foreign bonds also allows the individual to spread his or her risks because disturbances that lower returns in one country are not likely to occur at the same time in other countries (see Section 12.3A). Thus, a financial portfolio is likely to hold domestic money (to carry out business transactions), the domestic bond (for the return it yields), and the foreign bond (for the return and for the spreading of risks it provides). Given the holder's tastes and preferences, his or her wealth, the level of domestic and foreign interest rates, his or her expectations as to the future value of the foreign currency, rates of inflation at home and abroad, and so on, he or she will choose the portfolio that maximizes his or her satisfaction (i.e., that best fits his or her tastes).

A change in any of the underlying factors (i.e., the holder's preferences, his or her wealth, domestic and foreign interest rates, expectations, and so on) will prompt the holder to reshuffle his or her portfolio until he or she achieves the new desired (equilibrium) portfolio. For example, an increase in the domestic interest rate raises the demand for the domestic bond but reduces the demand for money and the foreign bond. As investors sell the foreign bond and exchange the foreign currency for the domestic currency in order to acquire more of the domestic bond, the exchange rate falls (i.e., the domestic currency appreciates with respect to the foreign currency). On the other hand, an increase in the foreign interest rate raises the demand for the foreign bond but reduces the demand for money and the domestic bond. As investors buy the foreign currency in order to acquire more of the foreign bond, the exchange rate rises (i.e., the domestic currency depreciates). Finally, an increase in wealth increases the demand for money, for the domestic bond, and for the foreign bond. But as investors buy the foreign currency to acquire more of the foreign bond, the exchange rate also rises (i.e., the domestic currency depreciates).

According to the portfolio balance approach, equilibrium in each financial market occurs when the quantity demanded of each financial asset equals its supply. It is because investors hold diversified and balanced (from their individual point of view) portfolios of financial assets that this model is called the portfolio balance approach. If investors demand more of the foreign bond either because the foreign interest rate rose relative to the domestic interest rate or because their wealth increased, the demand for the foreign currency increases and this causes an increase in the exchange rate (i.e., depreciation of the domestic currency). On the other hand, if investors sell foreign bonds either because of a reduction in the interest rate abroad relative to the domestic interest rate or because of a reduction in their wealth, the supply of the foreign currency increases and this causes a decrease in the exchange rate (i.e., appreciation of the domestic currency). Thus, we see that the exchange rate is determined in the process of reaching equilibrium in each financial market. A more formal presentation of this portfolio balance approach and exchange rate determination is presented in Section A15.2 of the appendix.

15.4B Extended Portfolio Balance Model

In this section, we extend the simple portfolio balance model just presented by specifying a more complete set of variables that determines the demand for money *(M)*, the demand for the domestic bond *(D)*, and the demand for the foreign bond *(F)* of residents of the home country. From our simple portfolio balance model presented previously we already know that *M, D*, and *F* depend on the domestic and the foreign interest rates (i and i^*). The additional variables on which *M, D*, and *F* depend that are now introduced are the expected change in the spot rate (in the form of the expected appreciation of the foreign currency or *EA*), the risk premium *(RP)* required to compensate domestic residents for the additional risk involved in holding the foreign bond, the level of real income or output *(Y)*, the domestic price level *(P)*, and the wealth *(W)* of the nation's residents.

We know from the uncovered interest parity condition (Equation (15-8)) discussed in Section 15.3C in connection with the monetary approach that

$$i - i^* = EA \qquad (15\text{-}8)$$

That is, the positive interest differential in favor of the home country (the United States) over the foreign country (the EMU) is equal to the expected appreciation (expressed on an annual percentage basis) of the foreign currency (€) in relation to the home-country currency ($). *EA* is now also included as an additional explanatory variable in the demand function for *M, D*, and *F* in the asset market model.

In addition, since the domestic and the foreign bond are now assumed to be imperfect substitutes, there is an extra risk in holding the foreign bond with respect to holding the domestic bond. This extra risk arises from *unexpected* changes in the exchange rate (currency risks) and/or limitations that foreign nations might impose on transferring earnings back home (country risks). The uncovered interest parity condition of Equation (15-8) must, therefore, be extended to include the risk premium *(RP)* that is required to compensate home-country residents for the extra risk involved in holding the foreign bond.

Thus, the condition for uncovered interest parity becomes

$$i - i^* = EA - RP$$

so that

$$i = i^* + EA - RP \tag{15-9}$$

Equation (15-9) postulates that the interest rate in the home country (i) must be equal to the interest rate in the foreign country (i^*) plus the expected appreciation of the foreign currency (*EA*) minus the risk premium on holding the foreign bond *(RP)*.

For example, if $i = 4\%$, $i^* = 5\%$, and $EA = 1\%$, then *RP* on the foreign bond must equal 2 percent in order to be at uncovered interest parity (i.e., $4\% = 5\% + 1\% - 2\%$). If the *RP* were only 1 percent, it would pay for home-country residents to buy more foreign bonds until the interest parity condition is satisfied, as explained in the next section. Of course, if the domestic bond is more risky than the foreign bond, *RP* is entered with a positive sign in Equation (15-9).

The extended portfolio balance model also includes the real income or output of the nation (GDP), the price level *(P)*, and the wealth *(W)* of the nation, as in the monetary approach. The extended demand functions for *M, D*, and *F* are thus given by Equations (15-10) to (15-12), with the sign on top of each variable referring to the postulated direct (+) or inverse (−) relationship between the independent or explanatory variables shown on the right-hand side of each equation and the dependent or left-hand variable in each equation.

$$M = f(\overset{-}{i}, \overset{-}{i^*}, \overset{-}{EA}, \overset{+}{RP}, \overset{+}{Y}, \overset{+}{P}, \overset{+}{W}) \tag{15-10}$$

$$D = f(\overset{+}{i}, \overset{-}{i^*}, \overset{-}{EA}, \overset{+}{RP}, \overset{-}{Y}, \overset{-}{P}, \overset{+}{W}) \tag{15-11}$$

$$F = f(\overset{-}{i}, \overset{+}{i^*}, \overset{+}{EA}, \overset{-}{RP}, \overset{-}{Y}, \overset{-}{P}, \overset{+}{W}) \tag{15-12}$$

Equation (15-10) postulates that the demand for (domestic) money by home-country residents (M) is inversely related to the interest rate in the home country *(i)*, the interest rate in the foreign country *(i^*)*, and the expected appreciation of the foreign currency *(EA)*. That is, the higher i, i^*, and *EA*, the lower will be M. Higher domestic or foreign interest rates increase the opportunity cost of holding money balances, and so home-country residents will demand a smaller quantity of money. Similarly, the greater the expected appreciation of the foreign currency, the greater the opportunity cost of holding money (since the expected return on the foreign bond, which is denominated in foreign currency, increases), and so M is also inversely related to EA. On the other hand, M is directly related to the risk premium required by home-country residents on holding the foreign bond (RP), the home-country real income (Y), prices (P), and wealth (W). That is, the greater the risk premium is on the foreign bond and the greater the real income, prices, and wealth are in the nation, the greater the demand is for money balances by the nation's residents.

Equation (15-11) postulates that the demand for the domestic bond (D) is directly related to i, RP, and W. That is, the greater the return on the domestic bond, the greater the demand for it. Similarly, the greater the risk premium on foreign bonds, the more home-country residents will hold domestic instead of foreign bonds. Furthermore, the greater the wealth of home-country residents, the more of the domestic and foreign bonds as well as money balances they will want to hold. On the other hand, D is inversely related to i^*, EA, Y, and P. That is, the higher i^* is, the more of the foreign instead of the domestic bond home-country residents will want to hold. Similarly, the higher Y and P are, the more home-country residents demand money balances instead of D and F. Finally, the greater the wealth of home-country residents is, the higher M, D, and F are.

Equation (15-12) postulates that F is inversely related to i, RP, Y, and P and positively related to i^*, EA, and W. That is, the higher i is, the less home-country residents will want to hold the foreign bond. A higher risk premium on the foreign bond will lead home-country residents to demand less of the foreign bond. A higher Y and P will lead home-country residents to demand more money balances and less of the foreign (and the domestic) bond. On the other hand, home-country residents will demand more of the foreign bond, the higher is the interest on the foreign bond, the greater the expected appreciation of the foreign currency, and the greater their wealth.

Setting the demand for money balances (M), the domestic bond (D), and the foreign bond (F) equal to their respective supplies, which are assumed to be exogenous (i.e., determined outside the model), we get the equilibrium quantity of money balances, domestic bonds, and foreign bonds, as well as the equilibrium rates of interest in the home and in the foreign nations, and the exchange rate between their currencies. All of these equilibrium values are obtained simultaneously. Furthermore, since all three assets (domestic money, domestic bonds, and foreign bonds) are substitutes for one another, any change in the value of any of the variables of the model will affect every other variable of the model. For example, any switch to or from money balances and/or domestic bonds into or from foreign bonds affects the exchange rate because they involve an exchange of currencies.

15.4c Portfolio Adjustments and Exchange Rates

In this section, we examine some portfolio adjustments to show how the extended portfolio balance model operates. Suppose that the home nation's monetary authorities engage in open market sales of government securities (bonds). This reduces the money supply (as people pay for the bonds with money balances), depresses the bond price, and increases the interest rate in the nation (i). The rise in i leads to a reduction in M and F and an increase in D (see the sign of i in Equations (15-10) to (15-12)). That is, domestic residents buy more of the domestic bond at the expense of domestic money balances and the foreign bond. Foreign residents (whose demand functions were not shown in the preceding model) also buy more of the nation's bond at the expense of their own bond and currency. The reduced demand for the foreign bond lowers its price and increases the foreign interest rate (i^*). The inflow of funds to the home country also moderates the increase in the interest rate in the nation (i). Furthermore, the sale of the foreign bond (F) and the purchase of the domestic bond (D) by domestic and foreign residents involve the sale of the foreign currency and purchase of the domestic currency, thus leading to an appreciation of the domestic currency and depreciation of the foreign currency under flexible exchange rates (a balance-of-payments surplus for the nation under fixed exchange rates).

The increase in i and i^*, as well as the appreciation of the domestic currency (depreciation of the foreign currency), may also lead to a larger expected future appreciation of the foreign currency (EA) and reduction in the risk premium on holding the foreign bond (RP), now that less of the foreign bond is held. In the end, however, when equilibrium is reestablished in all markets simultaneously, the uncovered interest parity condition (Equation (15-9)) will once again have to hold. The level of real GDP, prices, and wealth in the nation (i.e., Y, P, and W) and abroad $(Y^*$, P^*, and $W^*)$ are also likely to be affected by the change in i, i^*, EA, and RD, and these, in turn, will have further repercussions on all the other variables of the model. As we can see, tracing all the effects and repercussions of the original increase in the domestic interest rate can be extremely complicated. In the real world, the final equilibrium value of each variable of the model is usually obtained through computer simulations of the models of the domestic economy and the rest of the world. The usefulness of the model for us now is that it shows the relationship among all of the variables of the model and forces us to take an overall or comprehensive view of the economy as a whole in determining equilibrium exchange rates.

As another example of an exogenous change, suppose that the foreign currency is expected to appreciate (EA) more than previously believed in the future. The primary effect of this is to reduce M and D and increase F (see the sign of EA in Equations (15-10) to (15-12)). The reduction in M and D tends to reduce the interest rate in the nation (i), but the outflow of funds resulting from domestic residents purchasing more of the foreign bond moderates the reduction of i and reduces i^* (the foreign interest rate). The increase in F by domestic residents also increases the demand for the foreign currency and leads to an appreciation of the foreign currency (depreciation of the domestic currency), which moderates the expected appreciation of the foreign currency (EA). These changes are likely to affect the other variables and equations of the model for both domestic and foreign residents in the process of returning to equilibrium in all markets simultaneously. If instead of an increase in EA we had started with an increase in the risk premium (RP), the effects would have been the opposite of those discussed earlier (see the sign of the RP variable in Equations (15-10) to (15-12)).

Finally, consider the effect of an autonomous increase in the real income or GDP (Y) in the nation. From Equations (15-10) to (15-12), we see that the immediate effect of this would be to increase M and reduce D and F. The reduction in F will lead to an appreciation of the domestic currency (depreciation of the foreign currency) under flexible exchange rates or a balance-of-payments surplus for the nation under fixed exchange rates. These changes, in turn, will have further effects on all the other variables of the model until equilibrium is reestablished in all markets simultaneously. Once equilibrium is reestablished, the exchange rate will stop changing and/or the balance-of-payments disequilibrium will be eliminated. That is, according to the portfolio balance approach, an exogenous change in any of the variables of the model will bring about only temporary changes in exchange rates or in balance-of-payments disequilibria. Exchange rate changes or balance-of-payments disequilibria over long periods of time can only mean that either adjustments to disequilibria are very slow or that continuous exogenous changes are taking place.

15.5 Exchange Rate Dynamics

In this section, we examine exchange rate dynamics, or the change in the exchange rate over time as it moves toward a new equilibrium level after an exogenous change. We will examine exchange rate dynamics at an intuitive level in Section 15.5A and more formally with a figure in Section 15.5B.

15.5A Exchange Rate Overshooting

We have seen previously that changes in interest rates, expectations, wealth, and so on disturb equilibrium and lead investors to reallocate financial assets to achieve a new equilibrium or balanced portfolio. The adjustment involves a change in the *stock* of the various financial assets in the portfolio. Having been accumulated over a long period of time, the total *stock* of financial assets in investors' portfolios in the economy is very large in relation to the yearly *flows* (additions to the stock) through usual savings and investments. Not only is the total stock of financial assets in investors' portfolios very large at any point in time, but any changes in interest rates, expectations, or other forces that affect the benefits and costs of holding the various financial assets are likely to lead to an immediate or very rapid change in their stock as investors attempt to quickly reestablish equilibrium in their portfolios.

For example, an unanticipated increase in the nation's money supply leads to an immediate decline in the nation's interest rate. If all markets were originally in equilibrium, the decline in the nation's interest rate would lead investors to shift from domestic bonds to money balances and foreign bonds, as explained earlier. This stock adjustment can be very large and usually occurs immediately or over a very short time. This is to be contrasted to a change in the *flow* of merchandise trade that results from, say, a depreciation of the nation's currency and that takes place only gradually and over a longer period of time. (Previous contracts have to be honored, and new orders may take many months to fill.) Thus, *stock* adjustments in financial assets are usually much larger and quicker to occur than adjustments in trade *flows*.

The differences in the size and quickness of stock adjustments in financial assets as opposed to adjustments in trade flows have very important implications for the process by which exchange rates are determined and change (their dynamics) over time. For example, an unexpected increase in the nations' money supply and decline in domestic interest rates are likely to lead to a large and quick increase in the demand for the foreign currency as investors increase their stock of the foreign bond. This, in turn, leads to an immediate and large depreciation of the domestic currency, which is likely to swamp the smaller and more gradual changes in exchange rates resulting from changes in real markets, such as changes in trade flows. (Of course, the opposite would occur if the money supply increased and the interest rate declined abroad.) To be sure, in the long run, the effect on exchange rates of changes in real markets will prevail, but in the short or very short run (i.e., during the period of a day, week, or month), changes in exchange rates are likely to reflect mostly the effect of stock adjustments in financial assets and expectations. If the real sector responded immediately, as financial sectors do, there would be no exchange rate overshooting.

The preceding analysis can also help explain why, in the short run, exchange rates tend to overshoot or bypass their long-run equilibrium level as they move toward long-run equilibrium. Since adjustments in trade flows occur only gradually over time, most of the burden of adjustment in exchange rates must come from financial markets in the very short and short runs. Thus, the exchange rate must overshoot or bypass its long-run equilibrium level for equilibrium to be quickly reestablished in financial markets. Over time, as the cumulative contribution to adjustment coming from the real (e.g., trade) sector is felt, the exchange rate reverses its movement and the overshooting is eliminated. Exactly how this takes place is shown next.

15.5B Time Path to a New Equilibrium Exchange Rate

The model that examines the precise sequence of events that leads the exchange rate in the short run to overshoot its long-run equilibrium was introduced by *Rudi Dornbusch* in 1976 and can be visualized with Figure 15.6. Panel (a) shows that at time t_0 the Fed unexpectedly increases the U.S. money supply by 10 percent, from \$100 billion to \$110 billion, and keeps it at that higher level. Panel (b) shows that the 10 percent unanticipated increase in the U.S. money supply leads to an immediate decline in the U.S. interest rate—say, from 10 percent to 9 percent at time t_0. Panel (c) shows that the 10 percent increase in the U.S. money supply will have no immediate effect on U.S. prices. We assume that U.S. prices are "sticky" and rise only gradually over time until they are 10 percent higher than originally in the long run (from the price index of 100 to 110).

Finally, panel (d) shows that as investors shift from domestic bonds and money balances to foreign bonds and increase their demand of the foreign currency (to purchase more foreign bonds), the exchange rate *(R)* increases (i.e., the dollar depreciates). The dollar *immediately* depreciates by more than the 10 percent that is expected *in the long run* (because of the 10 percent increase in the domestic money supply). Panel (d) shows that *R* immediately rises (the dollar depreciates) by 16 percent, from \$1/€1 to \$1.16/€1 at time t_0. The question is why does the dollar immediately depreciate by more than 10 percent when, according to the PPP theory, we expect it to depreciate only by 10 percent (the same percentage by which the U.S. money supply has increased) in the long run?

To explain this we must go back to the uncovered interest parity (UIP) condition given by Equation (15-8). This postulates that the domestic interest rate (i) is equal to the foreign interest rate (i^*) plus the expected appreciation of the foreign currency *(EA)*. Since we assume (as in the monetary approach) that domestic and foreign bonds are perfect substitutes, there is no risk premium. If we further assume for simplicity that *EA* equals zero, then the uncovered interest parity condition means that $i = i^*$ before the increase in the U.S. money supply. But the unanticipated increase in the U.S. money supply leads to a reduction in the U.S. interest rate. Thus, the U.S. interest rate (i) now exceeds the foreign interest rate (i^*), and this must be balanced by the expectation of a future *depreciation* of the foreign currency (€) and appreciation of the dollar in order for the condition of uncovered interest parity to be once again satisfied.

The only way that we can expect the dollar to *appreciate* in the future and still end up with a net depreciation of 10 percent in the long run (to match the 10 percent increase in

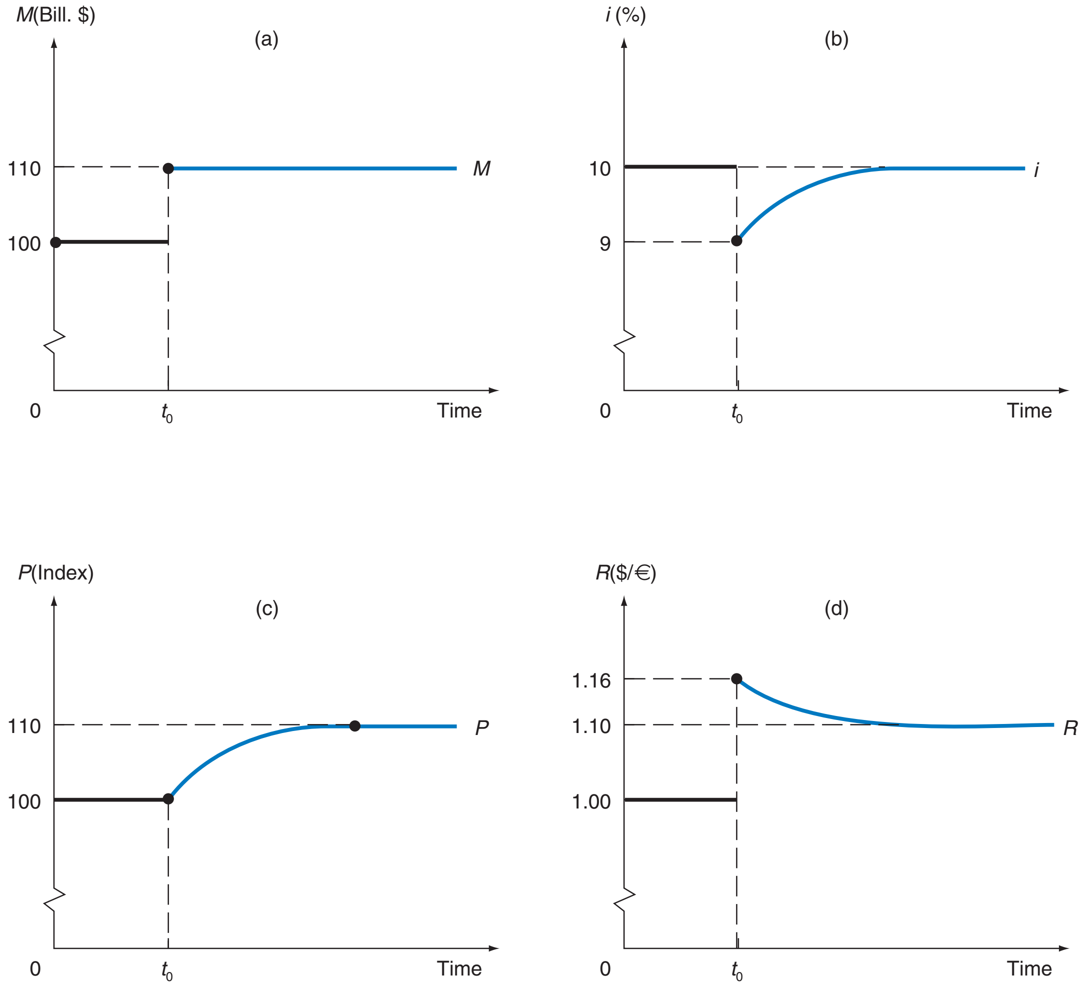

FIGURE 15.6. Exchange Rate Overshooting.
Panel (a) shows that the U.S. money supply unexpectedly increases by 10 percent from \$100 to \$110 billion at time t_0. In panel (b) the increase in the U.S. money supply immediately leads to a decline in the U.S. interest rate from 10 percent to 9 percent. Panel (c) shows that the U.S. price index rises by 10 percent from 100 to 110 only gradually over the long run. Panel (d) shows that the exchange rate of the dollar (*R*) immediately rises (the dollar depreciates) by 16 percent, from \$1/€1 to \$1.16/€1, thus overshooting its long-run equilibrium level of \$1.10/€1, toward which it will then gradually move by appreciating (*R* falling) in the long run. As U.S. prices rise, the U.S. interest rate also gradually rises back to its original level of 10 percent in the long run.

the U.S. money supply and prices) is for the dollar to immediately depreciate by more than 10 percent. Panel (d) shows that the dollar immediately depreciates (*R* rises) by 16 percent at time t_0 and then gradually appreciates (*R* falls) by 6 percent (measured from the original base of \$1.00) over time (thus removing the overshooting), so as to end up with a net depreciation of only 10 percent in the long run. In other words, after the initial excessive depreciation, the dollar appreciates in order to eliminate its undervaluation. Note also from panel (b) that over time, as U.S. prices rise by 10 percent, the U.S. nominal interest will also gradually rise until it reaches its original level of 10 percent in the long run.

It may seem to be a contradiction that the dollar appreciates by 6 percent over time (after its sudden 16 percent depreciation at time t_0) at the same time that prices are rising in the United States. But, as shown in panel (d), the dollar appreciation occurs only to remove the excessive depreciation at time t_0. Another way to look at this, which also brings trade into the picture, is to realize that the immediate depreciation of the dollar will lead to a gradual increase in the nation's exports and reduction in the nation's imports, which will result (everything else being equal) in an *appreciation* of the dollar over time. Since we know from the PPP theory that the dollar must depreciate by 10 percent in the long run, the only way to also expect that the dollar will appreciate in the future is for the dollar to immediately depreciate by more than 10 percent as a result of the unexpected 10 percent increase in the U.S. money supply.

Of course, if other disturbances occur before the exchange rate reaches its long-run equilibrium level, the exchange rate will be continually fluctuating, always moving toward its long-run equilibrium level but never quite reaching it. This seems to conform well with the recent real-world experience with exchange rates. Specifically, since 1971, and especially since 1973, exchange rates have been characterized by a great deal of volatility, overshooting, and subsequent correction, but always fluctuating in value (see Case Study 15-7).

15.6 Empirical Tests of the Monetary and Portfolio Balance Models and Exchange Rate Forecasting

In an influential paper *Frenkel* (1976) presented strong evidence in support of the monetary model during the German hyperinflation of the 1920s, and so did *Bilson* (1978) and *Dornbusch* (1979) for the inflationary period of the 1970s. From the late 1970s, however, empirical tests have rejected the monetary model. For example, *Frankel* (1993) showed that an increase in the German money supply led to an appreciation of the mark, rather than a depreciation, as predicted by the monetary model. Using more sophisticated estimating techniques, *MacDonald and Taylor* (1993), *MacDonald* (1999), and *Rapach and Wohar* (2002), however, did find some support for the monetary model (i.e., exchange rates do seem to converge toward their equilibrium level) in the long run.

Much less empirical work has been carried out on the portfolio balance model because of inadequate data, and the tests that have been conducted do not provide much empirical support for this model either. Two such tests were carried out by *Branson, Halttunen, and Masson* (1977) and *Frankel* (1984). *Frankel* estimated an equation for the exchange rate of the dollar with respect to the German mark, Japanese yen, French franc, and British pound for the 1973–1979 period and found that the effect (sign) of most of the explanatory variables of the model was the opposite of that postulated or predicted by the theory.

Another way of testing empirically the monetary and the portfolio balance models is to examine the ability of these models to accurately predict or forecast future exchange rates. In a landmark study, *Meese and Rogoff* (1983a) found that none of the exchange rate models outperforms the forecasting ability of the *forward rate* or the *random walk model*. The latter postulates that the best prediction or forecast of the exchange rate in the next period (say, in the next quarter) is given by the exchange rate in this quarter! Indeed, of the six tests conducted for the mark/dollar and the yen/dollar exchange rates, the random walk was the best predictor in four tests, the forward rate in two, and the monetary and asset market or portfolio balance models in none. Further work by the same authors (1983b), however,

CASE STUDY 15-7 Exchange Rate Overshooting of the U.S. Dollar

Figure 15.7 shows the volatility and overshooting of the U.S. dollar with respect to the Deutsche mark and the Japanese yen from 1961 to April 2012. The figure shows percentage changes from the previous month in units of the foreign currency per U.S. dollar. (Since the beginning of 1999, the fluctuation of the dollar/Deutsche mark exchange rate reflects the fluctuation of the euro with respect to the dollar.) Compare the small variation in the dollar exchange rates from 1961 to 1971 during the fixed exchange rate period with the wild fluctuations and overshooting since 1973 under the present flexible or managed exchange rate system.

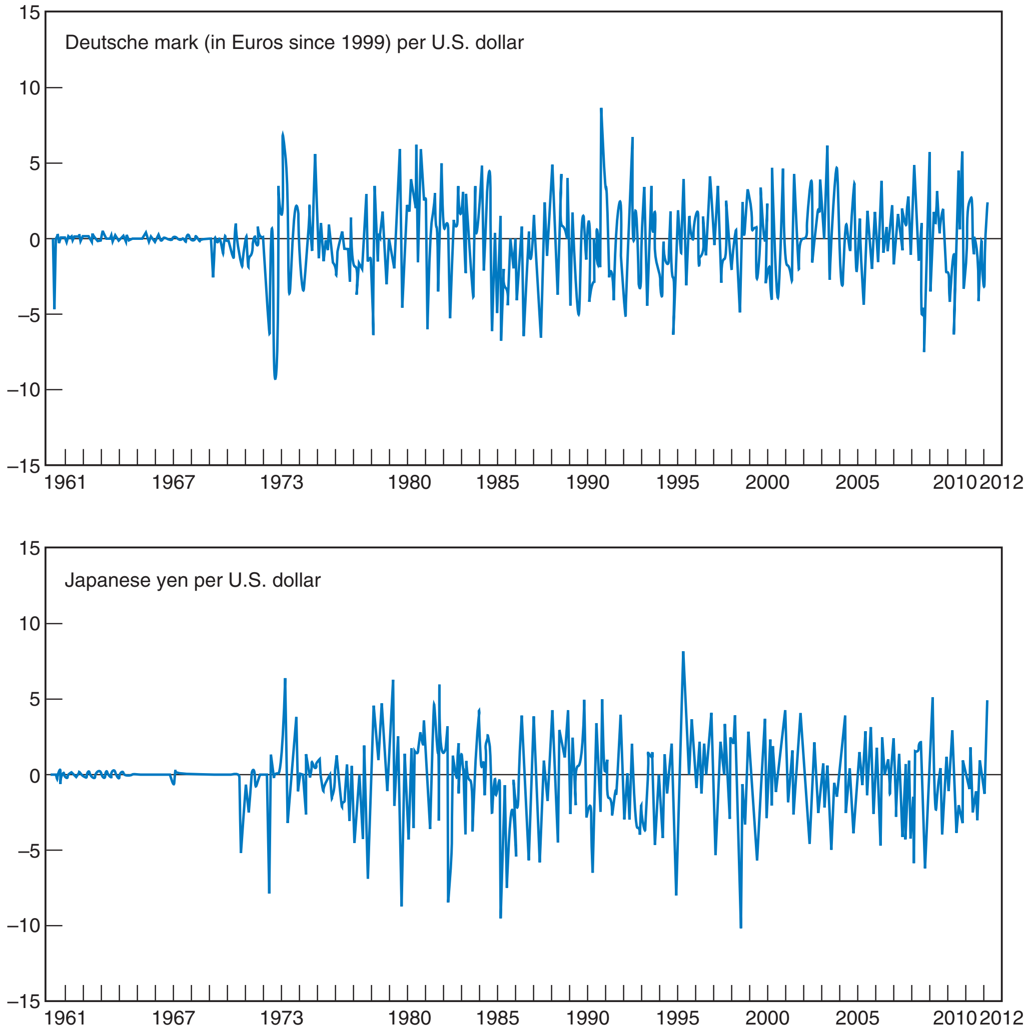

FIGURE 15.7. Overshooting of the Dollar Exchange Rates.
The wild fluctuations of the dollar exchange rate with respect to the Deutsche mark (DM) and the Japanese yen after 1973 are taken as an indication of exchange rate overshooting during the present managed exchange rate system. Since the beginning of 1999, the fluctuation of the DM/$ reflects the fluctuation of the euro with respect to the dollar.
Source: International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, various issues).

indicated that the monetary and asset market or portfolio balance models did outperform the simple random walk model for horizons beyond 12 months.

In a more recent study, *Mark* (1995) tested the monetary model used by *Meese and Rogoff* (1983), modified to include exchange rate overshooting, for the exchange rate of the U.S. dollar with respect to the Canadian dollar, mark, yen, and Swiss franc, for one-quarter, one-year, and three-year horizons, over the 1981–1991 period. *Mark* found that the modified model had the same size forecasting error as the simple random walk model for all four exchange rates for the one-quarter horizon. The modified model outperformed (i.e., it had a smaller forecasting error than) the random walk model for the dollar/yen and the dollar/Swiss franc exchange rates, but not for the other two exchange rates over a one-year horizon, and outperformed the random walk model for the three-year horizon for three of the four exchange rates (the only exception being the U.S. dollar/Canadian dollar exchange rate). Similar results were obtained by *Rapach and Wohar* (2002). *Frankel and Rose* (1995), *Lewis* (1995), *Rogoff* (1999), *Neely and Sarno* (2002), and *Engle and West* (2004), however, remain skeptical. In 2005, *Evans and Lyons* introduced a microbased model utilizing nonpublic information that seems to outperform the random walk and other models over horizons from one day to one month.

There are basically two reasons for the poor forecasting ability of our exchange rate models. First, exchange rates are strongly affected by new information or "news," which cannot be predicted (*Dornbusch*, 1980). Second, the expectations of exchange market participants often become self-reinforcing and self-fulfilling, at least for a while, thus leading to so-called *speculative bubbles*. That is, sometimes a movement of the exchange rate in a given direction leads to expectations that it will continue to move in the same direction regardless of the fundamentals. Eventually, however, the bubble will burst and the exchange rate movement will reverse itself, with the exchange rate overcompensating in the opposite direction and overshooting its long-run equilibrium level and subsequent large depreciation. An example of an exchange rate bubble was the sharp overvaluation of the dollar in the first half of the 1980s. Unpredictable news and bandwagon effects make exchange rates almost completely impossible to forecast over short (less than one-year) horizons. This was clearly the case for the euro/dollar exchange rate since its creation in January 1999 (see Case Study 15-8).

CASE STUDY 15-8 The Euro Exchange Rate Defies Forecasts

The euro (the currency of 17 of the 27 member countries of the European Union or EU—see Case Study 14-2) was introduced on January 1, 1999, at the value of $1.17; however, defying almost all predictions (that it would appreciate to between $1.25 to $1.30 by the end of the year), it declined almost continuously to the low of $0.82 at the end of October 2000 (see Figure 15.8). The euro then appreciated to $0.95 at the beginning of 2001, only to fall again to below $0.85 at the beginning of July 2001, despite higher interest rates in the European Monetary Union (EMU) or Eurozone, the recession in the United States, and the terrorist attacks on the World Trade Center in New York and the Pentagon in September 2001—again defying most experts' forecasts. Starting in February 2002, however, the euro appreciated almost continuously, reaching parity with the dollar in mid-2002, $1.36 at the end of 2004, the all-time high of $1.58 in July 2008, and it was $1.32 in March 2012. Only afterwards could experts "explain" the reasons for its movement.

(*continued*)

CASE STUDY 15-9 Continued

FIGURE 15.8. The Euro/U.S. Dollar Exchange Rate Since the Introduction of the Euro.
The euro depreciated almost continuously from the time of its introduction at the beginning of 1999 until October 2000 and remained below parity until the middle of 2002—defying most experts' forecasts. The euro reached the high of $1.36 in December 2004, $1.58 in July 2008, and it was $1.32 in March 2012.
Source: International Monetary Fund, *International Financial Statistics* (Washington, D.C., IMF, 2012).

More recently, *Engle*, *Mark, and West* (2007), *Wang and Wu* (2009), *Della Corte, Sarno, and Tsiakas* (2009), *Rime*, *Sarno, and Sojli* (2010), and *Evans* (2011) have shown that emphasizing the Taylor monetary rule and its effect on expectations seems to be able to account for some exchange rate volatility and reduce forecast intervals, but success in correctly forecasting exchange rates remains, for the most part, elusive.

Thus, we can conclude that in contrast to the exciting advances in the theoretical modeling of exchange rates, empirical results do not provide much support for these theories, except in the long run. This does not mean that these theories are wrong or that they are not useful. It simply means that they provide incomplete explanations of exchange rate determination. On an intuitive level, we do expect exchange rates to gravitate toward their PPP level in the long run, and we do expect uncovered interest arbitrage to hold when extended to include the expectation of exchange rate changes and risk premia. What is still needed, however, is better modeling of expectations and a greater synthesis and integration of monetary and real exchange rate theories. These topics are examined in Chapters 16 and 17.