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Fixed Exchange Rates and Foreign Exchange Intervention

I n the past several chapters we have developed a model that helps us understand how a country's exchange rate and national income are determined by the interaction of asset and output markets. Using that model, we saw how monetary and fiscal policies can be used to maintain full employment and a stable price level.

To keep our discussion simple, we assumed that exchange rates are *completely* flexible, that is, that national monetary authorities themselves do not trade in the foreign exchange market to influence exchange rates. In reality, however, the assumption of complete exchange rate flexibility is rarely accurate. As we mentioned earlier, the world economy operated under a system of *fixed* dollar exchange rates between the end of World War II and 1973, with central banks routinely trading foreign exchange to hold their exchange rates at internationally agreed levels. Industrialized countries now operate under a hybrid system of **managed floating exchange rates**—a system in which governments may attempt to moderate exchange rate movements without keeping exchange rates rigidly fixed. A number of developing countries have retained some form of government exchange rate fixing, for reasons that we discuss in Chapter 22.

In this chapter we study how central banks intervene in the foreign exchange market to fix exchange rates and how macroeconomic policies work when exchange rates are fixed. The chapter will help us understand the role of central bank foreign exchange intervention in the determination of exchange rates under a system of managed floating.

LEARNING GOALS

After reading this chapter, you will be able to:

• Understand how a central bank must manage monetary policy so as to fix its currency's value in the foreign exchange market.

• Describe and analyze the relationship among the central bank's foreign exchange reserves, its purchases and sales in the foreign exchange market, and the money supply.

- Explain how monetary, fiscal, and sterilized intervention policies affect the economy under a fixed exchange rate.
- Discuss causes and effects of balance of payments crises.
- Describe how alternative multilateral systems for pegging exchange rates work.

Why Study Fixed Exchange Rates?

A discussion of fixed exchange rates may seem outdated in an era when newspaper headlines regularly highlight sharp changes in the exchange rates of the major industrial-country currencies. There are four reasons why we must understand fixed exchange rates, however, before analyzing contemporary macroeconomic policy problems:

1. *Managed floating.* As previously noted, central banks often intervene in currency markets to influence exchange rates. So while the dollar exchange rates of the industrial countries' currencies are not currently fixed by governments, they are not always left to fluctuate freely, either. The system of floating dollar exchange rates is often referred to as a dirty float, to distinguish it from a clean float in which governments make no direct attempts to influence foreign currency values. (The model of the exchange rate developed in earlier chapters assumed a cleanly floating, or completely flexible, exchange rate.)[1] Because the present monetary system is a hybrid of the "pure" fixed and floating rate systems, an understanding of fixed exchange rates gives us insight into the effects of foreign exchange intervention when it occurs under floating rates.

2. *Regional currency arrangements.* Some countries belong to *exchange rate unions*, organizations whose members agree to fix their mutual exchange rates while allowing their currencies to fluctuate in value against the currencies of nonmember countries. Currently, for example, Latvia pegs its currency's value against the euro within the European Union's *Exchange Rate Mechanism*.

3. *Developing countries.* While industrial countries generally allow their currencies to float against the dollar, these economies account for less than a sixth of the world's countries. Many developing countries try to peg the values of their currencies, often in terms of the dollar, but sometimes in terms of a nondollar currency or some "basket" of currencies chosen by the authorities. Morocco pegs its currency to a basket, for example, while Barbados pegs to the U.S. dollar and Senegal pegs to the euro. No examination of the problems of developing countries would get very far without taking into account the implications of fixed exchange rates.[2]

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[1]It is questionable whether a truly clean float has ever existed in reality. Most government policies affect the exchange rate, and governments rarely undertake policies without considering the policies' exchange rate implications.

[2]The International Monetary Fund (IMF), an international agency that we will discuss in the next chapter, publishes a useful classification of its member countries' exchange rate arrangements. Arrangements as of end-April 2008 can be found at http://www.imf.org/external/np/mfd/er/2008/eng/0408.htm, and the IMF updates these data periodically. As of April 2008, 40 countries, including most major industrial countries and the 15 countries that then used the euro, had "independently floating" currencies. (The euro itself floats independently against the dollar and other major currencies, as we discuss in Chapter 20.) Forty-four countries engaged in "managed floating with no predetermined path for the exchange rate." Three more had exchange rates allowed to move within horizontal bands; eight (including China) had "crawling pegs," in which the exchange rate is forced to follow a smooth, predetermined path; and two (Costa Rica and Azerbaijan) operated "crawling bands" for their exchange rates. There were 68 countries with conventional fixed exchange rates of the type we will focus on in this chapter (mostly developing countries, but including European Union member Denmark). Finally, 10 did not have their own currencies and 13 had currency boards (a special type of fixed exchange rate scheme to which the analysis of this chapter largely applies). As you can see, there is a bewildering array of different exchange rate systems, and the case of fixed exchange rates remains quite important. Since April 2008, the Slovak Republic and Estonia have adopted the euro.

4. *Lessons of the past for the future.* Fixed exchange rates were the norm in many periods, such as the decades before World War I, between the mid-1920s and 1931, and again between 1945 and 1973. Today, economists and policy makers dissatisfied with floating exchange rates sometimes propose new international agreements that would resurrect a form of fixed-rate system. Would such plans benefit the world economy? Who would gain or lose? To compare the merits of fixed and floating exchange rates, we must understand the functioning of fixed rates.

Central Bank Intervention and the Money Supply

In Chapter 15 we defined an economy's money supply as the total amount of currency and checking deposits held by its households and firms and assumed that the central bank determined the amount of money in circulation. To understand the effects of central bank intervention in the foreign exchange market, we need to look first at how central bank financial transactions affect the money supply.[3]

The Central Bank Balance Sheet and the Money Supply

The main tool we use in studying central bank transactions in asset markets is the **central bank balance sheet,** which records the assets held by the central bank and its liabilities. Like any other balance sheet, the central bank balance sheet is organized according to the principles of double-entry bookkeeping. Any acquisition of an asset by the central bank results in a positive change on the assets side of the balance sheet, while any increase in the bank's liabilities results in a positive change on the balance sheet's liabilities side.

A balance sheet for the central bank of the imaginary country of Pecunia is shown below.

Central Bank Balance Sheet

Assets		Liabilities	
Foreign assets	$1,000	Deposits held by private banks	$500
Domestic assets	$1,500	Currency in circulation	$2,000

The assets side of the Bank of Pecunia's balance sheet lists two types of assets, *foreign assets* and *domestic assets.* Foreign assets consist mainly of foreign currency bonds owned by the central bank. These foreign assets make up the central bank's official international reserves, and their level changes when the central bank intervenes in the foreign exchange market by buying or selling foreign exchange. For historical reasons discussed later in this chapter, a central bank's international reserves also include any gold that it owns. The defining characteristic of international reserves is that they be either claims on foreigners or a universally acceptable means of making international payments (for example, gold). In the present example, the central bank holds $1,000 in foreign assets.

Domestic assets are central bank holdings of claims to future payments by its own citizens and domestic institutions. These claims usually take the form of domestic government bonds and loans to domestic private banks. The Bank of Pecunia owns $1,500

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[3]As we pointed out in Chapter 13, government agencies other than central banks may intervene in the foreign exchange market, but their intervention operations, unlike those of central banks, have no significant effect on national money supplies. (In the terminology introduced below, interventions by agencies other than central banks are automatically sterilized.) To simplify our discussion, we continue to assume, when the assumption is not misleading, that central banks alone carry out foreign exchange intervention.

in domestic assets. Its total assets therefore equal $2,500, the sum of foreign and domestic asset holdings.

The liabilities side of the balance sheet lists as liabilities the deposits of private banks and currency in circulation, both notes and coin. (Nonbank firms and households generally cannot deposit money at the central bank, while banks are generally required by law to hold central bank deposits as partial backing for their own liabilities.) Private bank deposits are liabilities of the central bank because the money may be withdrawn whenever private banks need it. Currency in circulation is considered a central bank liability mainly for historical reasons: At one time, central banks were obliged to give a certain amount of gold or silver to anyone wishing to exchange domestic currency for one of those precious metals. The balance sheet above shows that Pecunia's private banks have deposited $500 at the central bank. Currency in circulation equals $2,000, so the central bank's total liabilities amount to $2,500.

The central bank's total assets equal its total liabilities plus its net worth, which we have assumed in the present example to be zero. Because changes in central bank net worth are not important to our analysis, we will ignore them.[4]

The additional assumption that net worth is constant means that the changes in central bank assets we will consider *automatically* cause equal changes in central bank liabilities. When the central bank purchases an asset, for example, it can pay for it in one of two ways. A cash payment raises the supply of currency in circulation by the amount of the bank's asset purchase. A payment by check promises the check's owner a central bank deposit equal in value to the asset's price. When the recipient of the check deposits it in her account at a private bank, the private bank's claims on the central bank (and thus the central bank's liabilities to private banks) rise by the same amount. In either case, the central bank's purchase of assets automatically causes an equal increase in its liabilities. Similarly, asset sales by the central bank involve either the withdrawal of currency from circulation or the reduction of private banks' claims on the central bank, and thus a fall in central bank liabilities to the private sector.

An understanding of the central bank balance sheet is important because changes in the central bank's assets cause changes in the domestic money supply. The preceding paragraph's discussion of the equality between changes in central bank assets and liabilities illustrates the mechanism at work.

When the central bank buys an asset from the public, for example, its payment— whether cash or check—directly enters the money supply. The increase in central bank liabilities associated with the asset purchase thus causes the money supply to expand. The money supply shrinks when the central bank sells an asset to the public because the cash or check the central bank receives in payment goes out of circulation, reducing the central bank's liabilities to the public. Changes in the level of central bank asset holdings cause the money supply to change in the same direction because they require equal changes in the central bank's liabilities.

The process we have described may be familiar to you from studying central bank open-market operations in earlier courses. By definition, open-market operations involve the purchase or sale of domestic assets, but official transactions in foreign assets have the same direct effect on the money supply. You will also recall that when the central bank buys assets, for example, the accompanying increase in the money supply is generally *larger*

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[4]There are several ways in which a central bank's net worth could change. For example, the government might allow its central bank to keep a fraction of the interest earnings on its assets, and this interest flow would raise the bank's net worth if reinvested. Such changes in net worth tend to be small enough empirically that they can usually be ignored for purposes of macroeconomic analysis. However, see end-of-chapter problem 20.

than the initial asset purchase because of multiple deposit creation within the private banking system. This *money multiplier* effect, which magnifies the impact of central bank transactions on the money supply, reinforces our main conclusion: *Any central bank purchase of assets automatically results in an increase in the domestic money supply, while any central bank sale of assets automatically causes the money supply to decline.*[5]

Foreign Exchange Intervention and the Money Supply

To see in greater detail how foreign exchange intervention affects the money supply, let's look at an example. Suppose the Bank of Pecunia goes to the foreign exchange market and sells $100 worth of foreign bonds for Pecunian money. The sale reduces official holdings of foreign assets from $1,000 to $900, causing the assets side of the central bank balance sheet to shrink from $2,500 to $2,400.

The payment the Bank of Pecunia receives for these foreign assets automatically reduces its liabilities by $100 as well. If the Bank of Pecunia is paid with domestic currency, the currency goes into its vault and out of circulation. Currency in circulation therefore falls by $100. (A problem at the end of the chapter considers the identical money supply effect of payment by check.) As a result of the foreign asset sale, the central bank's balance sheet changes as follows:

Central Bank Balance Sheet After $100 Foreign Asset Sale (Buyer Pays with Currency)

Assets		Liabilities	
Foreign assets	$900	Deposits held by private banks	$500
Domestic assets	$1,500	Currency in circulation	$1,900

After the sale, assets still equal liabilities, but both have declined by $100, equal to the amount of currency the Bank of Pecunia has taken out of circulation through its intervention in the foreign exchange market. The change in the central bank's balance sheet implies a decline in the Pecunian money supply.

A $100 *purchase* of foreign assets by the Bank of Pecunia would cause its liabilities to increase by $100. If the central bank paid for its purchase in cash, currency in circulation would rise by $100. If it paid by writing a check on itself, private bank deposits at the Bank of Pecunia would ultimately rise by $100. In either case, there would be a rise in the domestic money supply.

Sterilization

Central banks sometimes carry out equal foreign and domestic asset transactions in opposite directions to nullify the impact of their foreign exchange operations on the domestic money supply. This type of policy is called **sterilized foreign exchange intervention**. We can understand how sterilized foreign exchange intervention works by considering the following example.

Suppose once again that the Bank of Pecunia sells $100 of its foreign assets and receives as payment a $100 check on the private bank Pecuniacorp. This transaction causes the central bank's foreign assets and its liabilities to decline simultaneously by $100, and there is therefore a fall in the domestic money supply. If the central bank wishes to negate the effect of its foreign asset sale on the money supply, it can *buy* $100 of domestic assets, such as

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[5]For a detailed description of multiple deposit creation and the money multiplier, see Frederic S. Mishkin, *The Economics of Money, Banking, and Financial Markets*, 9th ed., Chapter 14 (Boston: Addison Wesley, 2010).

government bonds. This second action increases the Bank of Pecunia's domestic assets *and* its liabilities by $100 and thus completely cancels the money supply effect of the $100 sale of foreign assets. If the central bank buys the government bonds with a check, for example, the two transactions (a $100 sale of foreign assets and a $100 purchase of domestic assets) have the following net effect on its balance sheet.

Central Bank Balance Sheet Before Sterilized $100 Foreign Asset Sale

Assets		Liabilities	
Foreign assets	$1,000	Deposits held by private banks	$500
Domestic assets	$1,500	Currency in circulation	$2,000

Central Bank Balance Sheet After Sterilized $100 Foreign Asset Sale

Assets		Liabilities	
Foreign assets	$900	Deposits held by private banks	$500
Domestic assets	$1,600	Currency in circulation	$2,000

The $100 decrease in the central bank's foreign assets is matched with a $100 increase in domestic assets, and the liabilities side of the balance sheet does not change. The sterilized foreign exchange sale therefore has no effect on the money supply.

Table 18-1 summarizes and compares the effects of sterilized and nonsterilized foreign exchange interventions.

The Balance of Payments and the Money Supply

In our discussion of balance of payments accounting in Chapter 13, we defined a country's balance of payments (or official settlements balance) as net purchases of foreign assets by the home central bank less net purchases of domestic assets by foreign central banks. Looked at differently, the balance of payments equals the current account plus capital account balances *less* the nonreserve component of the financial account balance, that is, the international payments gap that central banks must finance through their reserve transactions. A home balance of payments deficit, for example, means the country's net foreign reserve liabilities are increasing: Some combination of reserve sales by the home central bank and reserve purchases by foreign central banks is covering a home current plus capital account deficit not fully matched by net private sales of assets to

TABLE 18-1	**Effects of a $100 Foreign Exchange Intervention: Summary**		
Domestic Central Bank's Action	**Effect on Domestic Money Supply**	**Effect on Central Bank's Domestic Assets**	**Effect on Central Bank's Foreign Assets**
Nonsterilized foreign exchange purchase	+$100	0	+$100
Sterilized foreign exchange purchase	0	−$100	+$100
Nonsterilized foreign exchange sale	−$100	0	−$100
Sterilized foreign exchange sale	0	+$100	−$100

foreigners, or a home current account surplus that falls short of net private purchases of financial claims on foreigners.

What we have learned in this section illustrates the important connection between the balance of payments and the growth of money supplies at home and abroad. *If central banks are not sterilizing and the home country has a balance of payments surplus, for example, any associated increase in the home central bank's foreign assets implies an increased home money supply. Similarly, any associated decrease in a foreign central bank's claims on the home country implies a decreased foreign money supply.*

The extent to which a measured balance of payments disparity will affect home and foreign money supplies is, however, quite uncertain in practice. For one thing, we have to know how the burden of balance of payments adjustment is divided among central banks, that is, how much financing of the payments gap is done through home official intervention and how much through foreign. This division depends on various factors, such as the macroeconomic goals of the central banks and the institutional arrangements governing intervention (discussed later in this chapter). Second, central banks may be sterilizing to counter the monetary effects of reserve changes. Finally, as we noted at the end of Chapter 13, some central bank transactions indirectly help to finance a foreign country's balance of payments deficit, but they do not show up in the latter's published balance of payments figures. Such transactions may nonetheless affect the monetary liabilities of the bank that undertakes them.

How the Central Bank Fixes the Exchange Rate

Having seen how central bank foreign exchange transactions affect the money supply, we can now look at how a central bank fixes the domestic currency's exchange rate through foreign exchange intervention.

To hold the exchange rate constant, a central bank must always be willing to trade currencies at the fixed exchange rate with the private actors in the foreign exchange market. For example, to fix the yen/dollar rate at ¥120 per dollar, the Bank of Japan must be willing to buy yen with its dollar reserves, and in any amount the market desires, at a rate of ¥120 per dollar. The bank must also be willing to buy any amount of dollar assets the market wants to sell for yen at that exchange rate. If the Bank of Japan did not remove such excess supplies or demands for yen by intervening in the market, the exchange rate would have to change to restore equilibrium.

The central bank can succeed in holding the exchange rate fixed only if its financial transactions ensure that asset markets remain in equilibrium when the exchange rate is at its fixed level. The process through which asset market equilibrium is maintained is illustrated by the model of simultaneous foreign exchange and money market equilibrium used in previous chapters.

Foreign Exchange Market Equilibrium Under a Fixed Exchange Rate

To begin, we consider how equilibrium in the foreign exchange market can be maintained when the central bank fixes the exchange rate permanently at the level E^0. The foreign exchange market is in equilibrium when the interest parity condition holds, that is, when the domestic interest rate, R, equals the foreign interest rate, R^*, plus $(E^e - E)/E$, the expected rate of depreciation of the domestic currency against foreign currency. However, when the exchange rate is fixed at E^0 and market participants expect it to remain fixed, the expected rate of domestic currency depreciation is *zero*. The interest parity condition therefore implies that E^0 is today's equilibrium exchange rate only if

$$R = R^*.$$

Because no exchange rate change is expected by participants in the foreign exchange market, they are content to hold the available supplies of domestic and foreign currency deposits only if these offer the same interest rate.[6]

To ensure equilibrium in the foreign exchange market when the exchange rate is fixed permanently at E^0, the central bank must therefore hold R equal to R^*. Because the domestic interest rate is determined by the interaction of real money demand and the real money supply, we must look at the money market to complete our analysis of exchange rate fixing.

Money Market Equilibrium Under a Fixed Exchange Rate

To hold the domestic interest rate at R^*, the central bank's foreign exchange intervention must adjust the money supply so that R^* equates aggregate real domestic money demand and the real money supply:

$$M^s/P = L(R^*, Y).$$

Given P and Y, the above equilibrium condition tells what the money supply must be if a permanently fixed exchange rate is to be consistent with asset market equilibrium at a foreign interest rate of R^*.

When the central bank intervenes to hold the exchange rate fixed, it must *automatically* adjust the domestic money supply so that money market equilibrium is maintained with $R = R^*$. Let's look at an example to see how this process works. Suppose the central bank has been fixing E at E^0 and that asset markets initially are in equilibrium. Suddenly output rises. A necessary condition for holding the exchange rate permanently fixed at E^0 is that the central bank restore current asset market equilibrium at that rate, *given* that people expect E^0 to prevail in the future. So we frame our question as: What monetary measures keep the current exchange rate constant given unchanged expectations about the future exchange rate?

A rise in output raises the demand for domestic money, and this increase in money demand normally would push the domestic interest rate upward. To prevent the appreciation of the home currency that would occur (given that people expect an exchange rate of E^0 in the future), the central bank must intervene in the foreign exchange market by buying foreign assets. This foreign asset purchase eliminates the excess demand for domestic money because the central bank issues money to pay for the foreign assets it buys. The bank automatically increases the money supply in this way until asset markets again clear with $E = E^0$ and $R = R^*$.

If the central bank does not purchase foreign assets when output increases but instead holds the money stock constant, can it still keep the exchange rate fixed at E^0? The answer is no. If the central bank did not satisfy the excess demand for money caused by a rise in output, the domestic interest rate would begin to rise above the foreign rate, R^*, to balance the home money market. Traders in the foreign exchange market, perceiving that domestic currency deposits were offering a higher rate of return (given expectations), would begin to bid up the price of domestic currency in terms of foreign currency. In the absence of central bank intervention, the exchange rate thus would fall below E^0. To prevent this

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[6]Even when an exchange rate is currently fixed at some level, market participants may expect the central bank to change it. In such situations, the home interest rate must equal the foreign interest rate plus the expected depreciation rate of the domestic currency (as usual) for the foreign exchange market to be in equilibrium. We examine this type of situation later in this chapter, but for now we assume that no one expects the central bank to alter the exchange rate.

appreciation, the central bank must sell domestic currency and buy foreign assets, thereby increasing the money supply and preventing any excess money demand from pushing the home interest rate above R^*.

A Diagrammatic Analysis

The preceding mechanism of exchange rate fixing can be pictured using a diagrammatic tool developed earlier. Figure 18-1 shows the simultaneous equilibrium of the foreign exchange and domestic money markets when the exchange rate is fixed at E^0 and is expected to remain fixed at E^0 in the future.

Money market equilibrium is initially at point 1 in the lower part of the figure. The diagram shows that for a given price level, P, and a given national income level, Y^1, the money supply must equal M^1 when the domestic interest rate equals the foreign rate, R^*. The upper part of the figure shows the equilibrium of the foreign exchange market at point $1'$. If the expected future exchange rate is E^0, the interest parity condition holds when $R = R^*$ only if today's exchange rate also equals E^0.

To see how the central bank must react to macroeconomic changes to hold the exchange rate permanently at E^0, let's look again at the example of an increase in income. A rise in

Figure 18-1

Asset Market Equilibrium with a Fixed Exchange Rate, E^0

To hold the exchange rate fixed at E^0 when output rises from Y^1 to Y^2, the central bank must purchase foreign assets and thereby raise the money supply from M^1 to M^2.
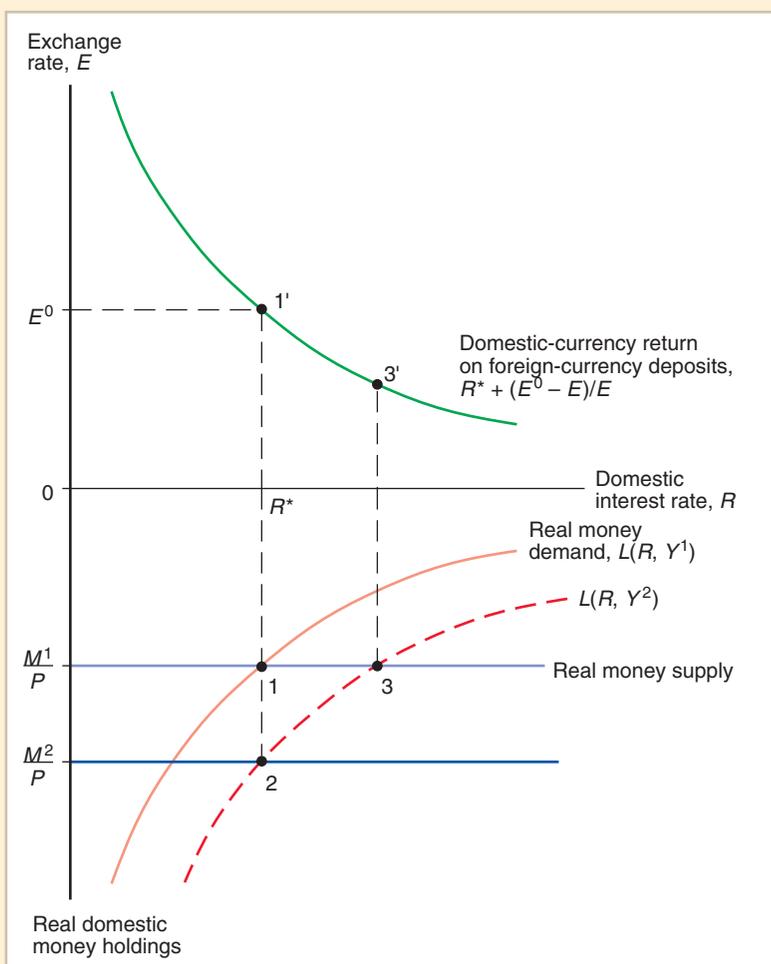
income (from Y^1 to Y^2) raises the demand for real money holdings at every interest rate, thereby shifting the aggregate money demand function in Figure 18-1 downward. As noted above, a necessary condition for maintaining the fixed rate is to restore *current* asset market equilibrium given that E^0 is still the expected future exchange rate. So we can assume that the downward-sloping curve in the figure's top panel doesn't move.

If the central bank were to take no action, the new money market equilibrium would be at point 3. Because the domestic interest rate is above R^* at point 3, the currency would have to appreciate to bring the foreign exchange market to equilibrium at point 3′.

The central bank cannot allow this appreciation of the domestic currency to occur if it is fixing the exchange rate, so it will buy foreign assets. As we have seen, the increase in the central bank's foreign assets is accompanied by an expansion of the domestic money supply. The central bank will continue to purchase foreign assets until the domestic money supply has expanded to M^2. At the resulting money market equilibrium (point 2 in the figure), the domestic interest rate again equals R^*. Given this domestic interest rate, the foreign exchange market equilibrium remains at point 1′, with the equilibrium exchange rate still equal to E^0.

Stabilization Policies with a Fixed Exchange Rate

Having seen how the central bank uses foreign exchange intervention to fix the exchange rate, we can now analyze the effects of various macroeconomic policies. In this section we consider three possible policies: monetary policy, fiscal policy, and an abrupt change in the exchange rate's fixed level, E^0.

The stabilization policies we studied in the last chapter have surprisingly different effects when the central bank fixes the exchange rate rather than allows the foreign exchange market to determine it. By fixing the exchange rate, the central bank gives up its ability to influence the economy through monetary policy. Fiscal policy, however, becomes a more potent tool for affecting output and employment.

As in the last chapter, we use the *DD-AA* model to describe the economy's short-run equilibrium. You will recall that the *DD* schedule shows combinations of the exchange rate and output for which the output market is in equilibrium, the *AA* schedule shows combinations of the exchange rate and output for which the asset markets are in equilibrium, and the short-run equilibrium of the economy as a whole is at the intersection of *DD* and *AA*. To apply the model to the case of a permanently fixed exchange rate, we add the assumption that the expected future exchange rate equals the rate at which the central bank is pegging its currency.

Monetary Policy

Figure 18-2 shows the economy's short-run equilibrium as point 1 when the central bank fixes the exchange rate at the level E^0. Output equals Y^1 at point 1, and, as in the last section, the money supply is at the level where a domestic interest rate equal to the foreign rate (R^*) clears the domestic money market. Now suppose that, hoping to increase output, the central bank attempts to increase the money supply through a purchase of domestic assets.

Under a floating exchange rate, the increase in the central bank's domestic assets would push the original asset market equilibrium curve AA^1 rightward to AA^2 and would therefore result in a new equilibrium at point 2 and a currency depreciation. To prevent this depreciation and hold the rate at E^0, the central bank sells foreign assets for domestic money in the foreign exchange market. The money the bank receives goes out of circulation, and the asset market equilibrium curve shifts back toward its initial position as the

Figure 18-2

Monetary Expansion Is Ineffective under a Fixed Exchange Rate

Initial equilibrium is shown at point 1, where the output and asset markets simultaneously clear at a fixed exchange rate of E^0 and an output level of Y^1. Hoping to increase output to Y^2, the central bank decides to increase the money supply by buying domestic assets and shifting AA^1 to AA^2. Because the central bank must maintain E^0, however, it has to sell foreign assets for domestic currency, an action that decreases the money supply immediately and returns AA^2 back to AA^1. The economy's equilibrium therefore remains at point 1, with output unchanged at Y^1
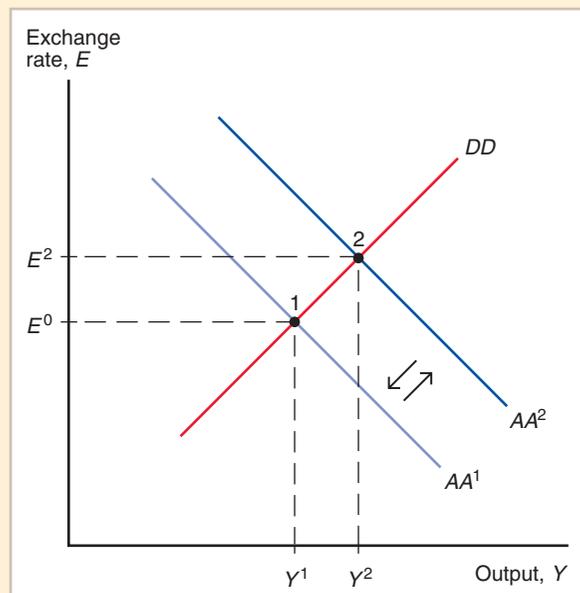
home money supply falls. Only when the money supply has returned to its original level, so that the asset market schedule is again AA^1, is the exchange rate no longer under pressure. The attempt to increase the money supply under a fixed exchange rate thus leaves the economy at its initial equilibrium (point 1). *Under a fixed exchange rate, central bank monetary policy tools are powerless to affect the economy's money supply or its output.*

This result is very different from our finding in Chapter 17 that a central bank can use monetary policy to raise the money supply and (apart from liquidity traps) output when the exchange rate floats. So it is instructive to ask why the difference arises. By purchasing domestic assets under a floating rate, the central bank causes an initial excess supply of domestic money that simultaneously pushes the domestic interest rate downward and weakens the currency. Under a fixed exchange rate, however, the central bank will resist any tendency for the currency to depreciate by selling foreign assets for domestic money and thus removing the initial excess supply of money its policy move has caused. Because any increase in the domestic money supply, no matter how small, will cause the domestic currency to depreciate, the central bank must continue selling foreign assets until the money supply has returned to its original level. In the end, the increase in the central bank's domestic assets is exactly offset by an equal *decrease* in the bank's official international reserves. Similarly, an attempt to decrease the money supply through a sale of domestic assets would cause an equal *increase* in foreign reserves that would keep the money supply from changing in the end. Under fixed rates, monetary policy can affect the composition of the central bank's assets but nothing else.

By fixing an exchange rate, then, the central bank loses its ability to use monetary policy for the purpose of macroeconomic stabilization. However, the government's second key stabilization tool, fiscal policy, is more effective under a fixed rate than under a floating rate.

Fiscal Policy

Figure 18-3 illustrates the effects of expansionary fiscal policy, such as a cut in the income tax, when the economy's initial equilibrium is at point 1. As we saw in Chapter 17, fiscal expansion shifts the output market equilibrium schedule to the right. DD^1 therefore shifts to

Figure 18-3

Fiscal Expansion under a Fixed Exchange Rate

Fiscal expansion (shown by the shift from DD^1 to DD^2) and the intervention that accompanies it (the shift from AA^1 to AA^2) move the economy from point 1 to point 3.
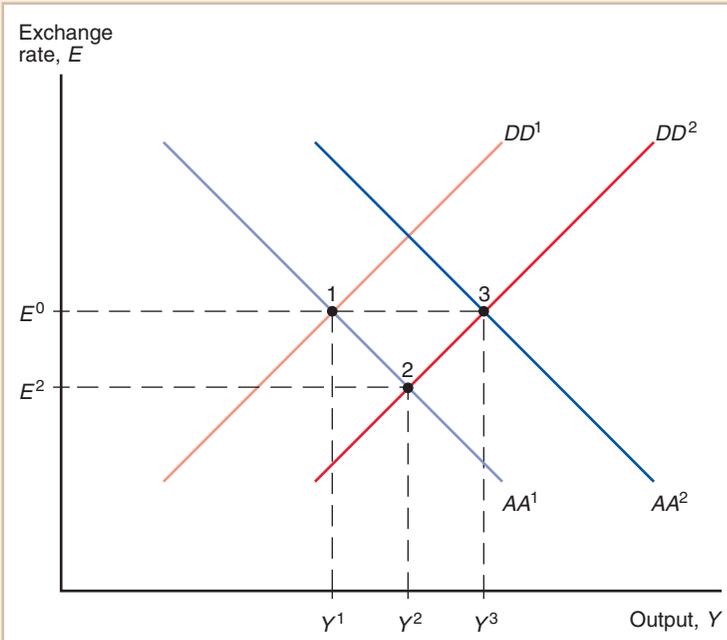
DD^2 in the figure. If the central bank refrained from intervening in the foreign exchange market, output would rise to Y^2 and the exchange rate would fall to E^2 (a currency appreciation) as a result of a rise in the home interest rate (assuming unchanged expectations).

How does central bank intervention hold the exchange rate fixed after the fiscal expansion? The process is the one we illustrated in Figure 18-1. Initially, there is an excess demand for money because the rise in output raises money demand. To prevent the excess money demand from pushing up the home interest rate and appreciating the currency, the central bank must buy foreign assets with money, thereby increasing the money supply. In terms of Figure 18-3, intervention holds the exchange rate at E^0 by shifting AA^1 rightward to AA^2. At the new equilibrium (point 3), output is higher than originally, the exchange rate is unchanged, and official international reserves (and the money supply) are higher.

Unlike monetary policy, fiscal policy can affect output under a fixed exchange rate. Indeed, it is even more effective than under a floating rate! Under a floating rate, fiscal expansion is accompanied by an appreciation of the domestic currency that makes domestic goods and services more expensive in world markets and thus tends to counteract the policy's positive direct effect on aggregate demand. To prevent this appreciation, a central bank that is fixing the exchange rate is forced to expand the money supply through foreign exchange purchases. The additional expansionary effect of this accompanying increase in the money supply explains why fiscal policy is more potent under a fixed rate than under a floating rate.

Changes in the Exchange Rate

A country that is fixing its exchange rate sometimes decides on a sudden change in the foreign currency value of the domestic currency. This might happen, for example, if the country is quickly losing foreign exchange reserves because of a big current account deficit that far exceeds private financial inflows. A **devaluation** occurs when the central bank raises the domestic currency price of foreign currency, E, and a **revaluation** occurs

Figure 18-4

Effect of a Currency Devaluation

When a currency is devalued from E^0 to E^1, the economy's equilibrium moves from point 1 to point 2 as both output and the money supply expand.

Exchange rate, E

DD

E^1

2

1

E^0

AA^2

AA^1

Y^1 Y^2 Output, Y
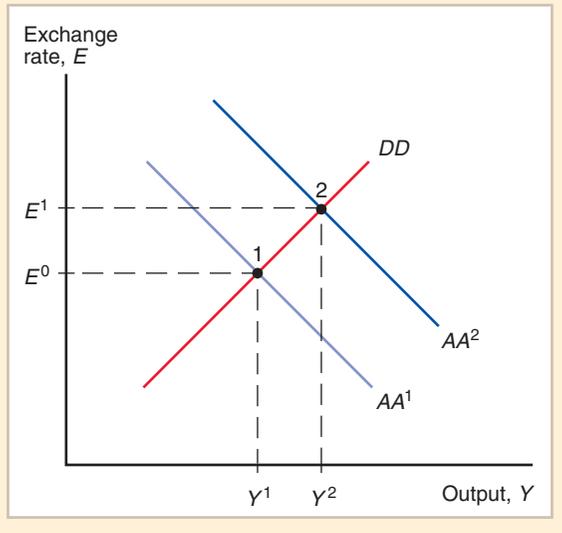
when the central bank lowers E. All the central bank has to do to devalue or revalue is announce its willingness to trade domestic against foreign currency, in unlimited amounts, at the new exchange rate.[7]

Figure 18-4 shows how a devaluation affects the economy. A rise in the level of the fixed exchange rate, from E^0 to E^1, makes domestic goods and services cheaper relative to foreign goods and services (given that P and $P*$ are fixed in the short run). Output therefore moves to the higher level Y^2, shown by point 2 on the DD schedule. Point 2, however, does not lie on the initial asset market equilibrium schedule AA^1. At point 2, there is initially an excess demand for money due to the rise in transactions accompanying the output increase. This excess money demand would push the home interest rate above the world interest rate if the central bank did not intervene in the foreign exchange market. To maintain the exchange rate at its new fixed level, E^1, the central bank must therefore buy foreign assets and expand the money supply until the asset market curve reaches AA^2 and passes through point 2. Devaluation therefore causes a rise in output, a rise in official reserves, and an expansion of the money supply.[8]

The effects of devaluation illustrate the three main reasons why governments sometimes choose to devalue their currencies. First, devaluation allows the government to fight

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[7]We usually observe a subtle distinction between the terms *devaluation* and *depreciation* (and between *revaluation* and *appreciation*). Depreciation (appreciation) is a rise in E (a fall in E) when the exchange rate floats, while devaluation (revaluation) is a rise in E (a fall in E) when the exchange rate is fixed. Depreciation (appreciation) thus involves the active voice (as in "the currency appreciated"), while devaluation (revaluation) involves the passive voice (as in "the currency was devalued"). Put another way, devaluation (revaluation) reflects a deliberate government decision, while depreciation (appreciation) is an outcome of government actions and market forces acting together.

[8]After the home currency is devalued, market participants expect that the new, higher exchange rate, rather than the old rate, will prevail in the future. The change in expectations alone shifts AA^1 the right, but without central bank intervention, this change by itself is insufficient to move AA^1 all the way to AA^2. At point 2, as at point 1, $R = R*$ if the foreign exchange market clears. Because output is higher at point 2 than at point 1, however, real money demand is also higher at the former point. With P fixed, an expansion of the money supply is therefore necessary to make point 2 a position of money market equilibrium, that is, a point on the new AA schedule. Central bank purchases of foreign assets are therefore a necessary part of the economy's shift to its new fixed exchange rate equilibrium.

domestic unemployment despite the lack of effective monetary policy. If government spending and budget deficits are politically unpopular, for example, or if the legislative process is slow, a government may opt for devaluation as the most convenient way of boosting aggregate demand. A second reason for devaluing is the resulting improvement in the current account, a development the government may believe to be desirable. The third motive behind devaluations, one we mentioned at the start of this subsection, is their effect on the central bank's foreign reserves. If the central bank is running low on reserves, a sudden, one-time devaluation (one that nobody expects to be repeated) can be used to draw in more reserves.

Adjustment to Fiscal Policy and Exchange Rate Changes

If fiscal and exchange rate changes occur when there is full employment and the policy changes are maintained indefinitely, they will ultimately cause the domestic price level to move in such a way that full employment is restored. To understand this dynamic process, we discuss the economy's adjustment to fiscal expansion and devaluation in turn.

If the economy is initially at full employment, fiscal expansion raises output, and this rise in output above its full-employment level causes the domestic price level, P, to begin rising. As P rises, home output becomes more expensive, so aggregate demand gradually falls, returning output to the initial, full-employment level. Once this point is reached, the upward pressure on the price level comes to an end. There is no real appreciation in the short run, as there is with a floating exchange rate, but regardless of whether the exchange rate is floating or fixed, the real exchange rate appreciates *in the long run* by the same amount.[9] In the present case, real appreciation (a fall in EP^*/P) takes the form of a rise in P rather than a fall in E.

At first glance, the long-run price level increase caused by a fiscal expansion under fixed rates seems inconsistent with Chapter 15's conclusion that for a given output level and interest rate, the price level and the money supply move proportionally in the long run. In fact, there is no inconsistency, because fiscal expansion *does* cause a money supply increase by forcing the central bank to intervene in the foreign exchange market. To fix the exchange rate throughout the adjustment process, the central bank ultimately must increase the money supply by intervention purchases in proportion to the long-run increase in P.

The adjustment to a devaluation is similar. In fact, since a devaluation does not change long-run demand or supply conditions in the output market, the increase in the long-run price level caused by a devaluation is proportional to the increase in the exchange rate. A devaluation under a fixed rate has the same long-run effect as a proportional increase in the money supply under a floating rate. Like the latter policy, devaluation is neutral in the long run, in the sense that its only effect on the economy's long-run equilibrium is a proportional rise in all nominal prices and in the domestic money supply.

Balance of Payments Crises and Capital Flight

Until now we have assumed that participants in the foreign exchange market believe that a fixed exchange rate will be maintained at its current level forever. In many practical situations, however, the central bank may find it undesirable or infeasible to maintain the current fixed exchange rate. The central bank may be running short on foreign reserves, for example, or it may face high domestic unemployment. Because market participants know the

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[9]To see this, observe that the long-run equilibrium real exchange rate, EP^*/P, must in either case satisfy the same equation, $Y^f = D(EP^*/P, Y^f - T, I, G)$, where Y^f, as in Chapter 17, is the full-employment output level.

central bank may respond to such situations by devaluing the currency, it would be unreasonable for them to expect the current exchange rate to be maintained forever.

The market's belief in an impending change in the exchange rate gives rise to a **balance of payments crisis,** a sharp change in official foreign reserves sparked by a change in expectations about the future exchange rate. In this section we use our model of asset market equilibrium to examine how balance of payments crises can occur under fixed exchange rates. (In later chapters we will describe a broader range of financial crises.)

Figure 18-5 shows the asset markets in equilibrium at points 1 (the money market) and $1'$ (the foreign exchange market) with the exchange rate fixed at E^0 and expected to remain there indefinitely. M^1 is the money supply consistent with this initial equilibrium. Suppose a sudden deterioration in the current account, for example, leads the foreign exchange market to expect the government to devalue in the future and adopt a new fixed exchange rate, E^1, that is higher than the current rate, E^0. The figure's upper part shows this change in expectations as a rightward shift in the curve that measures the expected domestic currency return on foreign currency deposits. Since the current exchange rate still is E^0, equilibrium in the foreign exchange market (point $2'$) requires a rise in the domestic interest rate to $R^* + (E^1 - E^0)/E^0$, which now equals the expected domestic currency return on foreign currency assets.

Figure 18-5

Capital Flight, the Money Supply, and the Interest Rate

To hold the exchange rate fixed at E^0 after the market decides it will be devalued to E^1, the central bank must use its reserves to finance a private financial outflow that will shrink the money supply and raise the home interest rate.
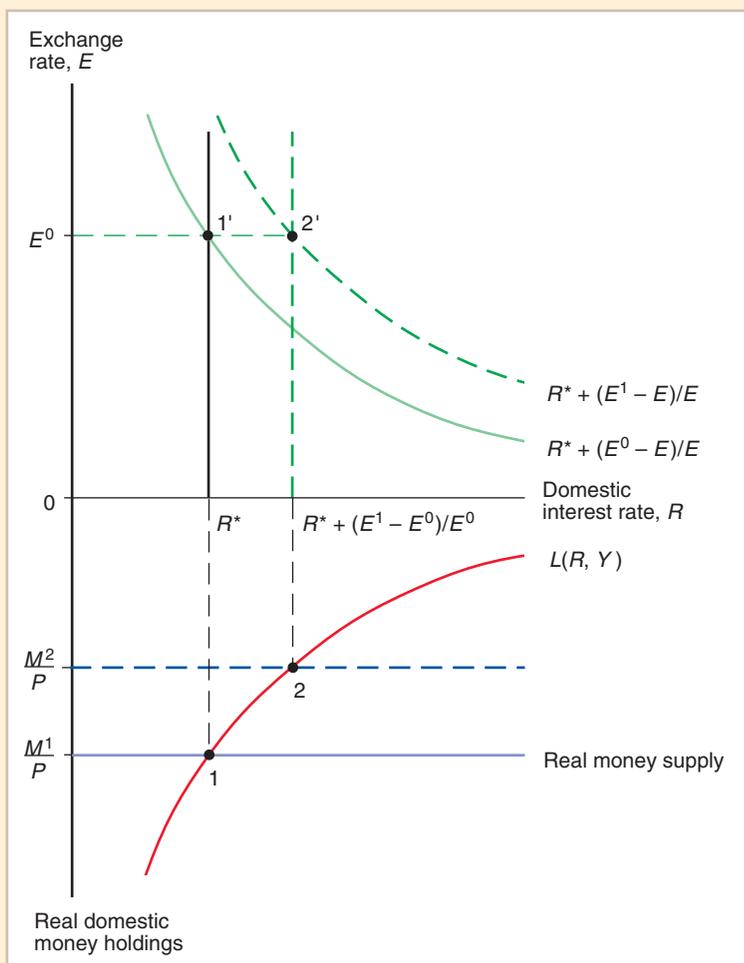
Initially, however, the domestic interest rate remains at R^*, which is below the new expected return on foreign assets. This differential causes an excess demand for foreign currency assets in the foreign exchange market; to continue holding the exchange rate at E^0, the central bank must sell foreign reserves and thus shrink the domestic money supply. The bank's intervention comes to an end once the money supply has fallen to M^2, so that the money market is in equilibrium at the interest rate $R^* + (E^1 - E^0)/E^0$, which clears the foreign exchange market (point 2). *The expectation of a future devaluation causes a balance of payments crisis marked by a sharp fall in reserves and a rise in the home interest rate above the world interest rate. Similarly, an expected revaluation causes an abrupt rise in foreign reserves together with a fall in the home interest rate below the world rate.*

The reserve loss accompanying a devaluation scare is often labeled **capital flight**. Residents flee the domestic currency by selling it to the central bank for foreign exchange; they then invest the foreign currency abroad. At the same time, foreigners convert holdings of home assets into their own currencies and repatriate the proceeds. When fears of devaluation arise because the central bank's reserves are low to begin with, capital flight is of particular concern to the government. By pushing reserves even lower, capital flight may force the central bank to devalue sooner and by a larger amount than planned.[10]

What causes currency crises? Often a government is following policies that are not consistent with maintaining a fixed exchange rate over the longer term. Once market expectations take those policies into account, the country's interest rates inevitably are forced up. For example, a country's central bank may be buying bonds from the domestic government to allow the government to run continuing fiscal deficits. Since these central bank purchases of domestic assets cause ongoing losses of central bank foreign exchange reserves, reserves will fall toward a point at which the central bank may find itself without the means to support the exchange rate. As the possibility of a collapse rises over time, so will domestic interest rates, until the central bank indeed runs out of foreign reserves and the fixed exchange rate is abandoned. (Appendix 2 to this chapter presents a detailed model of this type, and shows that the collapse of the currency peg can be caused by a sharp *speculative attack* in which currency traders suddenly acquire all of the central bank's remaining foreign reserves.) The only way for the central bank to avoid this fate is to stop bankrolling the government deficit, hopefully forcing the government to live within its means.

In the last example, exhaustion of foreign reserves and an end of the fixed exchange rate are inevitable, given macroeconomic policies. The financial outflows that accompany a currency crisis only hasten an inevitable collapse, one that would have occurred anyway, albeit in slower motion, even if private financial flows could be banned. Not all crises are of this kind, however. An economy can be vulnerable to currency speculation even without being in such bad shape that a collapse of its fixed exchange rate regime is inevitable. Currency crises that occur in such circumstances often are called **self-fulfilling currency crises,** although it is important to keep in mind that the government may ultimately be responsible for such crises by creating or tolerating domestic economic weaknesses that invite speculators to attack the currency.

As an example, consider an economy in which domestic commercial banks' liabilities are mainly short-term deposits, and in which many of the banks' loans to businesses are likely to go unpaid in the event of a recession. If speculators suspect there will be a devaluation, interest rates will climb, raising banks' borrowing costs sharply while at the same

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[10]If aggregate demand depends on the real interest rate (as in the *IS-LM* model of intermediate macroeconomics courses), capital flight reduces output by shrinking the money supply and raising the real interest rate. This possibly contractionary effect of capital flight is another reason why policy makers hope to avoid it.

time causing a recession and reducing the value of bank assets. To prevent domestic banks from going out of business, the central bank may well lend money to the banks, in the process losing foreign reserves and possibly its ability to go on pegging the exchange rate. In this case, it is the emergence of devaluation expectations among currency traders that pushes the economy into crisis and forces the exchange rate to be changed.

For the rest of this chapter, we continue to assume that no exchange rate changes are expected by the market when exchange rates are fixed. But we draw on the preceding analysis repeatedly in later chapters when we discuss various countries' unhappy experiences with fixed exchange rates.

Managed Floating and Sterilized Intervention

Under managed floating, monetary policy is influenced by exchange rate changes without being completely subordinate to the requirements of a fixed rate. Instead, the central bank faces a trade-off between domestic objectives such as employment or the inflation rate and exchange rate stability. Suppose the central bank tries to expand the money supply to fight domestic unemployment, for example, but at the same time carries out foreign asset sales to restrain the resulting depreciation of the home currency. The foreign exchange intervention will tend to *reduce* the money supply, hindering but not necessarily nullifying the central bank's attempt to reduce unemployment.

Discussions of foreign exchange intervention in policy forums and newspapers often appear to ignore the intimate link between intervention and the money supply that we explored in detail above. In reality, however, these discussions often assume that foreign exchange intervention is being *sterilized*, so that opposite domestic asset transactions prevent it from affecting the money supply. Empirical studies of central bank behavior confirm this assumption and consistently show central banks to have practiced sterilized intervention under flexible and fixed exchange rate regimes alike.

In spite of widespread sterilized intervention, there is considerable disagreement among economists about its effects. In this section we study the role of sterilized intervention in exchange rate management.

Perfect Asset Substitutability and the Ineffectiveness of Sterilized Intervention

When a central bank carries out a sterilized foreign exchange intervention, its transactions leave the domestic money supply unchanged. A rationale for such a policy is difficult to find using the model of exchange rate determination previously developed, for the model predicts that without an accompanying change in the money supply, the central bank's intervention will not affect the domestic interest rate and therefore will not affect the exchange rate.

Our model also predicts that sterilization will be fruitless under a fixed exchange rate. The example of a fiscal expansion illustrates why a central bank might wish to sterilize under a fixed rate and why our model says that such a policy will fail. Recall that to hold the exchange rate constant when fiscal policy becomes more expansive, the central bank must buy foreign assets and expand the home money supply. The policy raises output but it eventually also causes inflation, which the central bank may try to avoid by sterilizing the increase in the money supply that its fiscal policy has induced. As quickly as the central bank sells domestic assets to reduce the money supply, however, it will have to *buy* more foreign assets to keep the exchange rate fixed. The ineffectiveness of monetary policy under a fixed exchange rate implies that sterilization is a self-defeating policy.

Brazil's 1998–1999 Balance of Payments Crisis

Brazil suffered runaway inflation in the 1980s. After many failed stabilization attempts, the country introduced a new currency, the *real* (pronounced ray-AL), in 1994. Initially pegged to the U.S. dollar, the real was subsequently allowed to crawl upward, depreciating against the dollar at a moderate rate. Because the rate of crawl of the exchange rate was below the difference between Brazilian and foreign inflation, the real experienced a real appreciation (so to speak), lowering the economy's competitiveness in foreign markets. In turn, high interest rates, bank failures, and unemployment slowed inflation, which dropped from an annual rate of 2,669 percent in 1994 to only 10 percent in 1997.

Rapid economic growth did not return, however, and the government's fiscal deficit remained worryingly high. A major part of the problem was the very high interest rate the government had to pay on its debt, a rate that reflected the market's skepticism that the limited and controlled crawl depreciation of the real against the dollar could be maintained. In the fall of 1998, skepticism intensified. As the figure on the page 481 shows, interest rates spiked upward, and the central bank's foreign reserves began rapidly to bleed away.
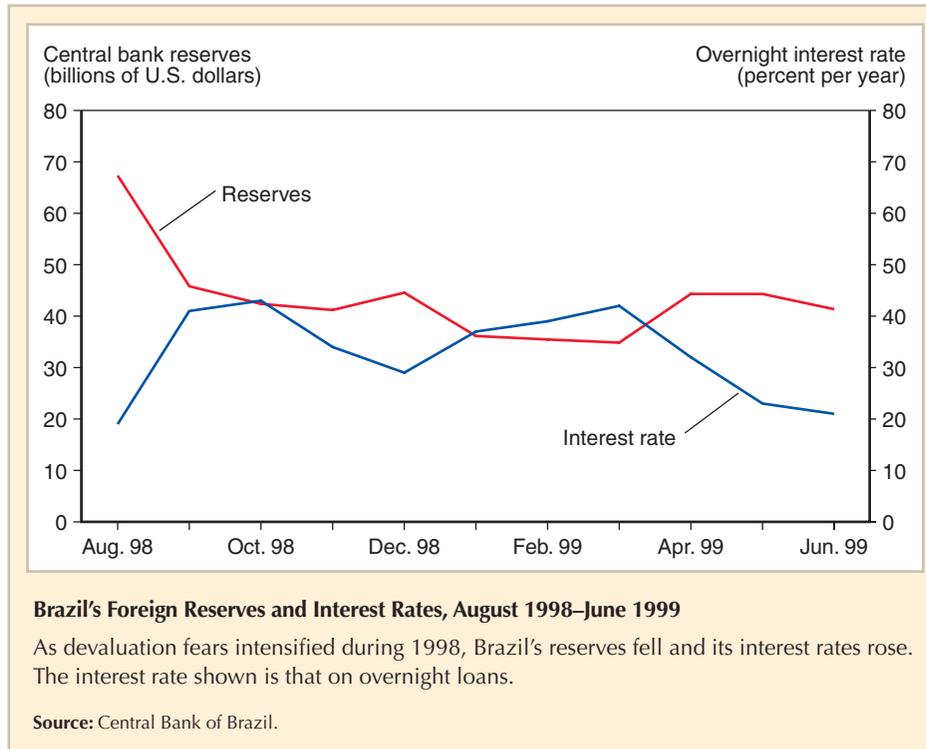
Concerned that a Brazilian collapse would destabilize neighboring countries, the IMF put together a stabilization fund of more than $40 billion to help Brazil defend the real. But markets remained pessimistic and the plan failed. In January 1999, Brazil devalued the real by 8 percent and then allowed it to float and to lose a further 40 percent of its value. Recession followed as the government struggled to prevent a free fall of the currency. Fortunately, inflation did not take off, and the resulting recession proved short-lived as

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The key feature of our model that leads to these results is the assumption that the foreign exchange market is in equilibrium only when the expected returns on domestic and foreign currency bonds are the same.[11] This assumption is often called **perfect asset substitutability**. Two assets are perfect substitutes when, as our model assumed, investors don't care how their portfolios are divided between them, provided both yield the same expected rate of return. With perfect asset substitutability in the foreign exchange market, the exchange rate is therefore determined so that the interest parity condition holds. When this is the case, there is nothing a central bank can do through foreign exchange intervention that it could not do as well through purely domestic open-market operations.

In contrast to perfect asset substitutability, **imperfect asset substitutability** exists when it is possible for assets' expected returns to differ in equilibrium. As we saw in Chapter 14, the main factor that may lead to imperfect asset substitutability in the foreign exchange market is *risk*. If bonds denominated in different currencies have different degrees of risk, investors may be willing to earn lower expected returns on bonds that are less risky. Correspondingly, they will hold a very risky asset only if its expected return is relatively high.

In a world of perfect asset substitutability, participants in the foreign exchange market care only about expected rates of return; since these rates are determined by monetary

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[11]We are assuming that all interest-bearing (nonmoney) assets denominated in the same currency, whether illiquid time deposits or government bonds, are perfect substitutes in portfolios. The single term "bonds" will generally be used to refer to all these assets.

Brazil's Foreign Reserves and Interest Rates, August 1998–June 1999

As devaluation fears intensified during 1998, Brazil's reserves fell and its interest rates rose. The interest rate shown is that on overnight loans.

Source: Central Bank of Brazil.

Brazil's export competitiveness was restored. Six months after the crisis, interest rates were lower and reserves higher. Brazil was relatively lucky. Many other developing economies have suffered more severely from balance of payments crises, as we will see in Chapter 22.

policy, actions such as sterilized intervention that do not affect the money supply also do not affect the exchange rate. Under imperfect asset substitutability, however, both risk *and* return matter, so central bank actions that alter the riskiness of domestic currency assets can move the exchange rate even when the money supply does not change. To understand how sterilized intervention can alter the riskiness of domestic currency assets, however, we must modify our model of equilibrium in the foreign exchange market.

Foreign Exchange Market Equilibrium Under Imperfect Asset Substitutability

When domestic and foreign currency bonds are perfect substitutes, the foreign exchange market is in equilibrium only if the interest parity condition holds:

$$R = R^* + (E^e - E)/E. \tag{18-1}$$

When domestic and foreign currency bonds are *imperfect* substitutes, the condition above does not hold in general. Instead, equilibrium in the foreign exchange market requires that the domestic interest rate equal the expected domestic currency return on foreign bonds *plus* a **risk premium, ρ,** that reflects the difference between the riskiness of domestic and foreign bonds:

$$R = R^* + (E^e - E)/E + \rho. \tag{18-2}$$

Appendix 1 to this chapter develops a detailed model of foreign exchange market equilibrium with imperfect asset substitutability. The main conclusion of that model is that the risk premium on domestic assets rises when the stock of domestic government bonds available to be held by the public rises and falls when the central bank's domestic assets rise. It is not hard to grasp the economic reasoning behind this result. Private investors become more vulnerable to unexpected changes in the home currency's exchange rate as the stock of domestic government bonds they hold rises. Investors will be unwilling to assume the increased risk of holding more domestic government debt, however, unless they are compensated by a higher expected rate of return on domestic currency assets. An increased stock of domestic government debt will therefore raise the difference between the expected returns on domestic and foreign currency bonds. Similarly, when the central bank buys domestic assets, the market need no longer hold them; private vulnerability to home currency exchange rate risk is thus lower, and the risk premium on home currency assets falls.

This alternative model of foreign market equilibrium implies that the risk premium depends positively on the stock of domestic government debt, denoted by B, less the domestic assets of the central bank, denoted by A:

$$\rho = \rho(B - A). \tag{18-3}$$

The risk premium on domestic bonds therefore rises when $B - A$ rises. This relation between the risk premium and the central bank's domestic asset holdings allows the bank to affect the exchange rate through sterilized foreign exchange intervention. It also implies that official operations in domestic and foreign assets may differ in their asset market impacts.[12]

## The Effects of Sterilized Intervention with Imperfect Asset Substitutability

Figure 18-6 modifies our earlier picture of asset market equilibrium by adding imperfect asset substitutability to illustrate how sterilized intervention can affect the exchange rate. The lower part of the figure, which shows the money market in equilibrium at point 1, does not change. The upper part of the figure is also much the same as before, except that the downward-sloping schedule now shows how the *sum* of the expected domestic currency return on foreign assets *and* the risk premium depends on the exchange rate. (The curve continues to slope downward because the risk premium itself is assumed not to depend on the exchange rate.) Equilibrium in the foreign exchange market is at point $1'$, which corresponds to a domestic government debt of B and central bank domestic asset holdings of A^1. At that point, the domestic interest rate equals the risk-adjusted domestic currency return on foreign deposits (as in equation (18-2)).

Let's use the diagram to examine the effects of a sterilized purchase of foreign assets by the central bank. By matching its purchase of foreign assets with a sale of domestic assets, the central bank holds the money supply constant at M^s and avoids any change in the lower part of Figure 18-6. As a result of its domestic asset sale, however, the central bank's domestic assets are lower (they fall to A^2) and the stock of domestic assets that the market must hold, $B - A^2$, is therefore higher than the initial stock $B - A^1$. This increase pushes the risk premium ρ upward and shifts to the right the negatively sloped schedule in the upper part of the figure. The foreign exchange market now settles at point $2'$, and the domestic currency depreciates to E^2.

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[12]The stock of central bank domestic assets is often called *domestic credit*.

Figure 18-6

Effect of a Sterilized Central Bank Purchase of Foreign Assets Under Imperfect Asset Substitutability

A sterilized purchase of foreign assets leaves the money supply unchanged but raises the risk-adjusted return that domestic currency deposits must offer in equilibrium. As a result, the return curve in the upper panel shifts up and to the right. Other things equal, this depreciates the domestic currency from E^1 to E^2.
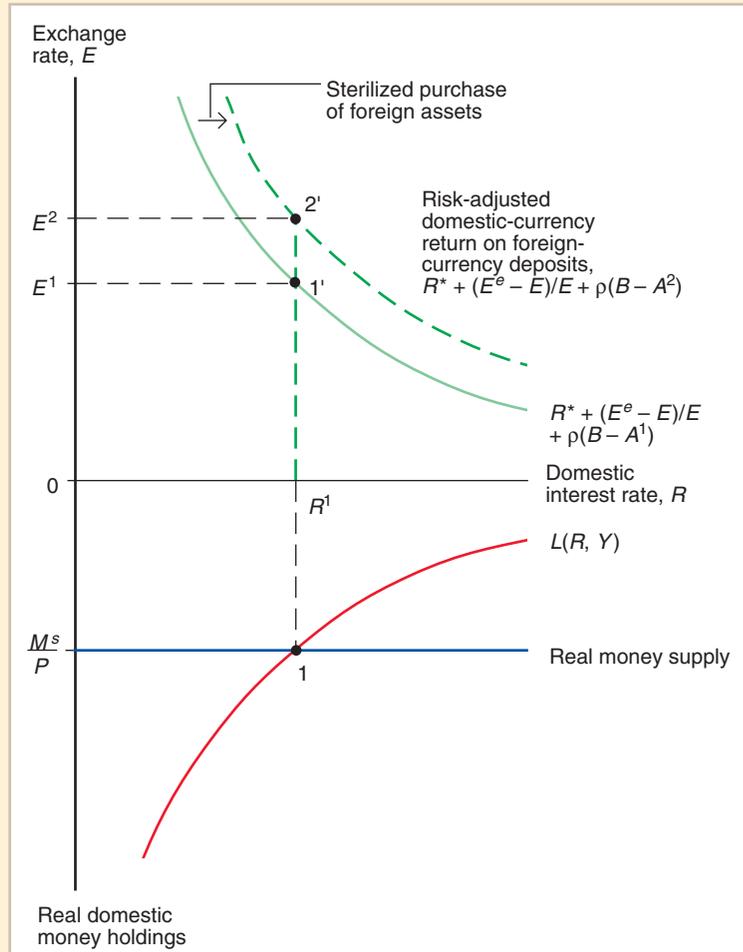
With imperfect asset substitutability, even sterilized purchases of foreign exchange cause the home currency to depreciate. Similarly, sterilized sales of foreign exchange cause the home currency to appreciate. A slight modification of our analysis shows that the central bank can also use sterilized intervention to hold the exchange rate fixed as it varies the money supply to achieve domestic objectives such as full employment. In effect, the exchange rate and monetary policy can be managed independently of each other in the short run when sterilized intervention is effective.

Evidence on the Effects of Sterilized Intervention

Little evidence has been found to support the idea that sterilized intervention exerts a major influence over exchange rates independent of the stances of monetary and fiscal policies.[13] As we noted in Chapter 14, however, there is also considerable evidence against the view that bonds denominated in different currencies are perfect substitutes.[14] Some economists

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[13]For evidence on sterilized intervention, see the Further Readings entry by Sarno and Taylor, as well as the December 2000 issue of the *Journal of International Financial Markets, Institutions, and Money*.
[14]See the paper by Froot and Thaler in this chapter's Further Readings.

conclude from these conflicting results that while risk premiums are important, they do not depend on central bank asset transactions in the simple way our model assumes. Others contend that the tests that have been used to detect the effects of sterilized intervention are flawed. Given the meager evidence that sterilized intervention has a reliable effect on exchange rates, however, a skeptical attitude is probably in order.

Our discussion of sterilized intervention has assumed that it does not change the market's exchange rate expectations. If market participants are unsure about the *future* direction of macroeconomic policies, however, sterilized intervention may give an indication of where the central bank expects (or desires) the exchange rate to move. This **signaling effect of foreign exchange intervention**, in turn, can alter the market's view of future monetary or fiscal policies and cause an immediate exchange rate change even when bonds denominated in different currencies are perfect substitutes.

The signaling effect is most important when the government is unhappy with the exchange rate's level and declares in public that it will alter monetary or fiscal policies to bring about a change. By simultaneously intervening on a sterilized basis, the central bank sometimes lends credibility to this announcement. A sterilized purchase of foreign assets, for example, may convince the market that the central bank intends to bring about a home currency depreciation because the bank will lose money if an appreciation occurs instead. Even central banks must watch their budgets!

However, a government may be tempted to exploit the signaling effect for temporary benefits even when it has no intention of changing monetary or fiscal policy to bring about a different long-run exchange rate. The result of crying, "Wolf!" too often is the same in the foreign exchange market as elsewhere. If governments do not follow up on their exchange market signals with concrete policy moves, the signals soon become ineffective. Thus, intervention signaling cannot be viewed as a policy weapon to be wielded independently of monetary and fiscal policy.[15]

Reserve Currencies in the World Monetary System

Until now, we have studied a single country that fixes its exchange rate in terms of a hypothetical single foreign currency by trading domestic for foreign assets when necessary. In the real world there are many currencies, and it is possible for a country to fix the exchange rates of its domestic currency against some foreign currencies while allowing them to float against others.

This section and the next adopt a global perspective and study the macroeconomic behavior of the world economy under two possible systems for fixing the exchange rates of *all* currencies against each other.

The first such fixed-rate system is very much like the one we have been studying. In it, one currency is singled out as a **reserve currency**, the currency central banks hold in their international reserves, and each nation's central bank fixes its currency's exchange rate against the reserve currency by standing ready to trade domestic money for reserve assets at that rate. Between the end of World War II and 1973, the U.S. dollar was the main reserve currency and almost every country pegged the dollar exchange rate of its money.

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[15]For discussion of the role played by the signaling effect, see Owen F. Humpage, "Intervention and the Dollar's Decline," *Federal Reserve Bank of Cleveland Economic Review* 24 (Quarter 2, 1988), pp. 2–16; Kathryn M. Dominguez and Jeffrey A. Frankel, *Does Foreign Exchange Intervention Work?* (Washington, D.C.: Institute for International Economics, 1993); and Richard T. Baillie, Owen F. Humpage, and William P. Osterberg, "Intervention from an Information Perspective," *Journal of International Financial Markets, Institutions, and Money* 10 (December 2000), pp. 407–421.

The second fixed-rate system (studied in the next section) is a **gold standard**. Under a gold standard, central banks peg the prices of their currencies in terms of gold and hold gold as official international reserves. The heyday of the international gold standard was between 1870 and 1914, although many countries attempted unsuccessfully to restore a permanent gold standard after the end of World War I in 1918.

Both reserve currency standards and the gold standard result in fixed exchange rates between *all* pairs of currencies in the world. But the two systems have very different implications about how countries share the burden of balance of payments financing and about the growth and control of national money supplies.

The Mechanics of a Reserve Currency Standard

The workings of a reserve currency system are illustrated by the system based on the U.S. dollar set up at the end of World War II. Under that system, every central bank fixed the dollar exchange rate of its currency through foreign exchange market trades of domestic currency for dollar assets. The frequent need to intervene meant that each central bank had to have on hand sufficient dollar reserves to meet any excess supply of its currency that might arise. Central banks therefore held a large portion of their international reserves in the form of U.S. Treasury bills and short-term dollar deposits, which pay interest and can be turned into cash at relatively low cost.

Because each currency's dollar price was fixed by its central bank, the exchange rate between any two currencies was automatically fixed as well through arbitrage in the foreign exchange market. How did this process work? Consider the following example based on the French franc and the deutsche mark, which were the currencies of France and Germany prior to the introduction of the euro. Let's suppose the French franc price of dollars was fixed at FFr 5 per dollar while the deutsche mark price of dollars was fixed at DM 4 per dollar. The exchange rate between the franc and the DM had to remain constant at DM 0.80 per franc = (DM 4 per dollar) ÷ (FFr 5 per dollar), even though no central bank was directly trading francs for DM to hold the relative price of those two currencies fixed. At a DM/FFr rate of DM 0.85 per franc, for example, you could have made a sure profit of $6.25 by selling $100 to the former French central bank, the Bank of France, for ($100) × (FFr 5 per dollar) = FFr 500, selling your FFr 500 in the foreign exchange market for (FFr 500) × (DM 0.85 per franc) = DM 425, and then selling the DM to the German Bundesbank (Germany's central bank until 1999) for (DM 425) ÷ (DM 4 per dollar) = $106.25. With everyone trying to exploit this profit opportunity by selling francs for DM in the foreign exchange market, however, the DM would have appreciated against the franc until the DM/FFr rate reached DM 0.80 per franc. Similarly, at a rate of DM 0.75 per franc, pressure in the foreign exchange market would have forced the DM to depreciate against the franc until the rate of DM 0.80 per franc was reached.

Even though each central bank tied its currency's exchange rate only to the dollar, market forces automatically held all other exchange rates—called cross rates—constant at the values implied by the dollar rates. Thus the post–World War II exchange rate system was one in which exchange rates between any two currencies were fixed.[16]

The Asymmetric Position of the Reserve Center

In a reserve currency system, the country whose currency is held as reserves occupies a special position because it never has to intervene in the foreign exchange market. The reason is

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[16] The rules of the postwar system actually allowed currencies' dollar values to move as much as 1 percent above or below the "official" values. This meant cross rates could fluctuate by as much as 4 percent.

that if there are N countries with N currencies in the world, there are only $N-1$ exchange rates against the reserve currency. If the $N-1$ nonreserve currency countries fix their exchange rates against the reserve currency, there is no exchange rate left for the reserve center to fix. Thus the center country need never intervene and bears none of the burden of financing its balance of payments.

This set of arrangements puts the reserve-issuing country in a privileged position because it can use its monetary policy for macroeconomic stabilization even though it has fixed exchange rates. We saw earlier in this chapter that when a country must intervene to hold an exchange rate constant, any attempt to expand its money supply is bound to be frustrated by losses of international reserves. But because the reserve center is the one country in the system that can enjoy fixed exchange rates without the need to intervene, it is still able to use monetary policy for stabilization purposes.

What would be the effect of a purchase of domestic assets by the central bank of the reserve currency country? The resulting expansion in its money supply would momentarily push its interest rate below those prevailing abroad, and thereby cause an excess demand for foreign currencies in the foreign exchange market. To prevent their currencies from appreciating against the reserve currency, all other central banks in the system would be forced to buy reserve assets with their own currencies, expanding their money supplies and pushing their interest rates down to the level established by the reserve center. Output throughout the world, as well as at home, would expand after a purchase of domestic assets by the reserve country.

Our account of monetary policy under a reserve currency system points to a basic asymmetry. The reserve country has the power to affect its own economy, as well as foreign economies, by using monetary policy. Other central banks are forced to relinquish monetary policy as a stabilization tool, and instead must passively "import" the monetary policy of the reserve center because of their commitment to peg their currencies to the reserve currency.

This inherent asymmetry of a reserve system places immense economic power in the hands of the reserve country and is therefore likely to lead eventually to policy disputes within the system. Such problems helped cause the breakdown of the postwar "dollar standard" in 1973, a topic we discuss in Chapter 19.

The Gold Standard

An international gold standard avoids the asymmetry inherent in a reserve currency standard by avoiding the "Nth currency" problem. Under a gold standard, each country fixes the price of its currency in terms of gold by standing ready to trade domestic currency for gold whenever necessary to defend the official price. Because there are N currencies and N prices of gold in terms of those currencies, no single country occupies a privileged position within the system: Each is responsible for pegging its currency's price in terms of the official international reserve asset, gold.

The Mechanics of a Gold Standard

Because countries tie their currencies to gold under a gold standard, official international reserves take the form of gold. Gold standard rules also require each country to allow unhindered imports and exports of gold across its borders. Under these arrangements, a gold standard, like a reserve currency system, results in fixed exchange rates between all currencies. For example, if the dollar price of gold is pegged at \$35 per ounce by the Federal Reserve while the pound price of gold is pegged at £14.58 per ounce by Britain's central bank, the Bank of England, the dollar/pound exchange rate must be constant at (\$35 per ounce) ÷ (£14.58 per ounce) = \$2.40 per pound. The same arbitrage process

that holds cross exchange rates fixed under a reserve currency system keeps exchange rates fixed under a gold standard as well.[17]

Symmetric Monetary Adjustment Under a Gold Standard

Because of the inherent symmetry of a gold standard, no country in the system occupies a privileged position by being relieved of the commitment to intervene. By considering the international effects of a purchase of domestic assets by one central bank, we can see in more detail how monetary policy works under a gold standard.

Suppose the Bank of England decides to increase its money supply through a purchase of domestic assets. The initial increase in Britain's money supply will put downward pressure on British interest rates and make foreign currency assets more attractive than British assets. Holders of pound deposits will attempt to sell them for foreign deposits, but no *private* buyers will come forward. Under floating exchange rates, the pound would depreciate against foreign currencies until interest parity had been reestablished. This depreciation cannot occur when all currencies are tied to gold, however. Why not? Because central banks are obliged to trade their currencies for gold at fixed rates, unhappy holders of pounds can sell these to the Bank of England for gold, sell the gold to other central banks for their currencies, and use these currencies to purchase deposits that offer interest rates higher than the interest rate on pounds. Britain therefore experiences a private financial outflow and foreign countries experience an inflow.

This process reestablishes equilibrium in the foreign exchange market. The Bank of England loses foreign reserves since it is forced to buy pounds and sell gold to keep the pound price of gold fixed. Foreign central banks gain reserves as they *buy* gold with their currencies. Countries share equally in the burden of balance of payments adjustment. Because official foreign reserves are declining in Britain and increasing abroad, the British money supply is falling, pushing the British interest rate back up, and foreign money supplies are rising, pushing foreign interest rates down. Once interest rates have again become equal across countries, asset markets are in equilibrium and there is no further tendency for the Bank of England to lose gold or for foreign central banks to gain it. The total world money supply (not the British money supply) ends up being higher by the amount of the Bank of England's domestic asset purchase. Interest rates are lower throughout the world.

Our example illustrates the symmetric nature of international monetary adjustment under a gold standard. Whenever a country is losing reserves and seeing its money supply shrink as a consequence, foreign countries are gaining reserves and seeing their money supplies expand. In contrast, monetary adjustment under a reserve currency standard is highly asymmetric. Countries can gain or lose reserves without inducing any change in the money supply of the reserve currency country, and only the latter country has the ability to influence domestic and world monetary conditions.[18]

Benefits and Drawbacks of the Gold Standard

Advocates of the gold standard argue that it has another desirable property besides symmetry. Because central banks throughout the world are obliged to fix the money

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[17]In practice, the costs of shipping gold and insuring it in transit determined narrow "gold points" within which currency exchange rates could fluctuate.

[18]Originally, gold coins were a substantial part of the currency supply in gold standard countries. A country's gold losses to foreigners therefore did not have to take the form of a fall in central bank gold holdings: Private citizens could melt gold coins into ingots and ship them abroad, where they were either reminted as foreign gold coins or sold to the foreign central bank for paper currency. In terms of our earlier analysis of the central bank balance sheet, circulating gold coins are considered to make up a component of the monetary base that is not a central bank liability. Either form of gold export would thus result in a fall in the domestic money supply and an increase in foreign money supplies.

price of gold, they cannot allow their money supplies to grow more rapidly than real money demand, since such rapid monetary growth eventually raises the money prices of all goods and services, including gold. A gold standard therefore places automatic limits on the extent to which central banks can cause increases in national price levels through expansionary monetary policies. These limits can make the real values of national monies more stable and predictable, thereby enhancing the transaction economies arising from the use of money (see Chapter 15). No such limits to money creation exist under a reserve currency system; the reserve currency country faces no automatic barrier to unlimited money creation.

Offsetting this potential benefit of a gold standard are some drawbacks:

1. The gold standard places undesirable constraints on the use of monetary policy to fight unemployment. In a worldwide recession, it might be desirable for all countries to expand their money supplies jointly even if this were to raise the price of gold in terms of national currencies.

2. Tying currency values to gold ensures a stable overall price level only if the relative price of gold and other goods and services is stable. For example, suppose the dollar price of gold is $35 per ounce while the price of gold in terms of a typical output basket is one-third of a basket per ounce. This implies a price level of $105 per output basket. Now suppose that there is a major gold discovery in South America and the relative price of gold in terms of output falls to one-fourth of a basket per ounce. With the dollar price of gold unchanged at $35 per ounce, the price level would have to rise from $105 to $140 per basket. In fact, studies of the gold standard era do reveal surprisingly large price level fluctuations arising from such changes in gold's relative price.[19]

3. An international payments system based on gold is problematic because central banks cannot increase their holdings of international reserves as their economies grow unless there are continual new gold discoveries. Every central bank would need to hold some gold reserves to fix its currency's gold price and serve as a buffer against unforeseen economic mishaps. Central banks might thereby bring about world unemployment as they attempted to compete for reserves by selling domestic assets and thus shrinking their money supplies.

4. The gold standard could give countries with potentially large gold production, such as Russia and South Africa, considerable ability to influence macroeconomic conditions throughout the world through market sales of gold.

Because of these drawbacks, few economists favor a return to the gold standard today. As early as 1923, the British economist John Maynard Keynes characterized gold as a "barbarous relic" of an earlier international monetary system.[20] While most central banks continue to hold some gold as part of their international reserves, the price of gold now plays no special role in influencing countries' monetary policies.

The Bimetallic Standard

Up until the early 1870s, many countries adhered to a **bimetallic standard** in which the currency was based on both silver and gold. The United States was bimetallic from 1837

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[19]See, for example, Richard N. Cooper, "The Gold Standard: Historical Facts and Future Prospects," *Brookings Papers on Economic Activity* 1 (1982), pp. 1–45.

[20]See Keynes, "Alternative Aims in Monetary Policy," reprinted in his *Essays in Persuasion* (New York: W. W. Norton & Company, 1963). For a dissenting view on the gold standard, see Robert A. Mundell, "International Monetary Reform: The Optimal Mix in Big Countries," in James Tobin, ed., *Macroeconomics, Prices and Quantities* (Washington, D.C.: Brookings Institution, 1983), pp. 285–293.

until the Civil War, although the major bimetallic power of the day was France, which abandoned bimetallism for gold in 1873.

In a bimetallic system, a country's mint will coin specified amounts of gold *or* silver into the national currency unit (typically for a fee). In the United States before the Civil War, for example, 371.25 grains of silver (a grain being 1/480th of an ounce) or 23.22 grains of gold could be turned into, respectively, a silver or a gold dollar. That mint parity made gold worth $371.25/23.22 = 16$ times as much as silver.

The mint parity could differ from the market relative price of the two metals, however, and when it did, one or the other might go out of circulation. For example, if the price of gold in terms of silver were to rise to 20:1, a depreciation of silver relative to the mint parity of 16:1, no one would want to turn gold into gold dollar coins at the mint. More dollars could be obtained by instead using the gold to buy silver in the market, and then having the silver coined into dollars. As a result, gold would tend to go out of monetary circulation when its relative market price rose above the mint relative price, and silver coin would tend to disappear in the opposite case.

The advantage of bimetallism was that it might reduce the price level instability resulting from use of one of the metals alone. Were gold to become scarce and expensive, cheaper and relatively abundant silver would become the predominant form of money, thereby mitigating the deflation that a pure gold standard would imply. Notwithstanding this advantage, by the late 19th century most of the world had followed Britain, the leading industrial power of the day, onto a pure gold standard.

The Gold Exchange Standard

Halfway between the gold standard and a pure reserve currency standard is the **gold exchange standard**. Under a gold exchange standard, central banks' reserves consist of gold *and* currencies whose prices in terms of gold are fixed, and each central bank fixes its exchange rate to a currency with a fixed gold price. A gold exchange standard can operate like a gold standard in restraining excessive monetary growth throughout the world, but it allows more flexibility in the growth of international reserves, which can consist of assets besides gold. A gold exchange standard is, however, subject to the other limitations of a gold standard listed above.

The post–World War II reserve currency system centered on the dollar was, in fact, originally set up as a gold exchange standard. While foreign central banks did the job of pegging exchange rates, the U.S. Federal Reserve was responsible for holding the dollar price of gold at $35 an ounce. By the mid-1960s, the system operated in practice more like a pure reserve currency system than a gold standard. For reasons explained in the next chapter, President Richard M. Nixon unilaterally severed the dollar's link to gold in August 1971, shortly before the system of fixed dollar exchange rates was abandoned.

Case Study

The Demand for International Reserves

The chapter explained that a central bank's assets are divided between domestic currency assets, such as domestic government bonds, and foreign currency assets, the bank's international reserves. Historically and up to the present day, international reserves have been prized by central banks because they can be traded to foreigners for goods and services even in circumstances, such as financial crises and wars, when the value of domestic assets may come into doubt. Gold played the role of international

reserve asset *par excellence* under the gold standard—and while the U.S. dollar is the main reserve asset today, economists debate how long that unique American privilege can last. Because central banks and governments may alter their policies to affect national holdings of international reserves, it is important to understand the factors that influence countries' demands for international reserves.

A good starting point for thinking about international reserves is the model in the chapter in which domestic and foreign bonds are perfect substitutes, the exchange rate is fixed, and confidence in the fixed exchange rate is absolute. In that model, our result that monetary policy is ineffective also implies that individual central banks can painlessly acquire all the international reserves they need! They do so simply by an open-market sale of domestic assets, which immediately causes an equal inflow of foreign assets but no change in the home interest rate or in other domestic economic conditions. In real life, matters may not be so easy, because the circumstances in which countries need reserves are precisely those in which the above conditions of perfect confidence in creditworthiness and in the exchange rate peg are likely to be violated. As a result, central banks manage their reserves in a *precautionary* manner, holding a stock that they believe will be sufficient in future times of crisis.[21]

As usual there are costs as well as benefits of acquiring and holding reserves, and the level of reserves that a central bank wishes to hold will reflect a balance between those costs and benefits. Some monetary authorities (such as that of Hong Kong) value reserves so highly that the entire money supply is backed by foreign assets—there are no domestic monetary assets at all. In most cases, however, central banks hold both domestic and foreign assets, with the optimal level of reserves determined by the trade-off between costs and benefits.

Starting in the mid-1960s, economists developed and sought empirical verification of formal theories of the demand for international reserves. In that setting, with international capital markets much more limited than they are today (see Chapter 21), a major threat to reserves was a sudden drop in export earnings, and central banks measured reserve levels in terms of the number of months of import needs those reserves could cover. Accordingly, the variability levels of exports, imports, and international financial flows, all of which could cause reserves to fluctuate too close to zero, were viewed as prime determinants of the demand for international reserves. In this theory, higher variability would raise the demand for reserves. An additional variable raising the average demand for reserves might be the adjustment cost countries would suffer if they suddenly had to raise exports or reduce imports to generate a trade surplus, or raise interest rates to draw in foreign capital. Higher economic openness could make such adjustments easier, thereby reducing the demand for reserves, but might also make an economy more vulnerable to foreign trade shocks, thereby raising desired reserve holdings.[22]

On the other hand, the main cost of holding reserves is their interest cost. A central bank that switches from domestic bonds to foreign reserves loses the interest on the domestic bonds and instead earns the interest on the reserve currency, for example, on dollars. If markets harbor any fears that the domestic currency could be devalued, then domestic bonds will offer a higher interest rate than foreign reserves, implying that it is

[21]A different problem arises under a system like the gold standard, where the global stock of international reserves may be limited (in contrast to a reserve currency system). The difficulty is that all countries cannot simultaneously increase their reserve holdings, so efforts by many countries to do so at the same time will affect global economic conditions. An end-of-chapter exercise asks you to think about this case.
[22]An early influential study was by H. Robert Heller, "Optimal International Reserves," *Economic Journal* 76 (June 1966), pp. 296–311.

costly to switch the central bank's portfolio toward reserves. Of course, if the reserve currency does appreciate against domestic currency, the central bank will gain, with a corresponding loss if the reserve currency depreciates.

In addition, reserves may offer lower interest simply because of their higher liquidity. This interest cost of holding relatively liquid reserves is analogous to the interest cost of holding money, which we reviewed in Chapter 15.

It was argued in the 1960s that countries with more flexible exchange rates would find it easier to generate an export surplus if reserves ran low—they could allow their currencies to depreciate, perhaps avoiding the recession that might otherwise be needed to create a trade balance surplus. When industrial countries moved to floating exchange rates in the early 1970s, many economists therefore expected that the demand for international reserves would drop sharply.

Figure 18-7 shows, however, that nothing of the sort happened. For industrial countries, the growth rate of international reserves has not declined since the 1960s. For developing countries, the growth rate of reserves has, if anything, risen (though the sharp upsurge in the mid–2000s is to some degree a reflection of huge reserve purchases by China).[23] Accelerating reserve growth has taken place despite the adoption of more flexible exchange rates by many developing countries.
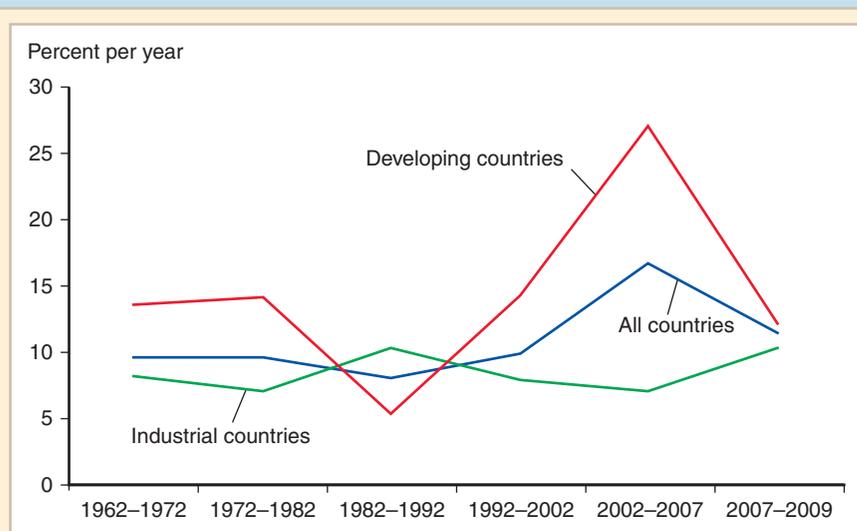
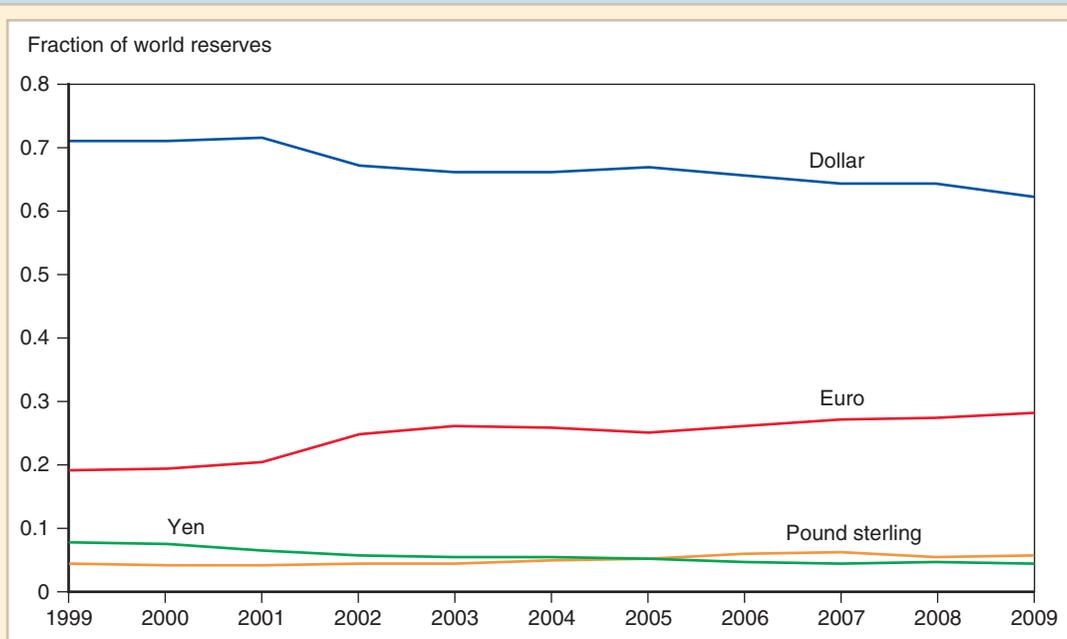**Figure 18-7**

Growth Rates of International Reserves

Annualized growth rates of international reserves did not decline sharply after the early 1970s. Recently, developing countries have added large sums to their reserve holdings, but their pace of accumulation slowed dramatically during the crisis years of 2007–2009.

Source: *Economic Report of the President, 2010.*

[23]Reserves in Figure 18-7 are measured in Special Drawing Rights (SDRs), an artificial reserve asset created by the IMF in 1969 to counter fears of a global shortage of nondollar reserve assets. An SDR was worth about $1.50 in July 2010. On the history and role of the SDR, see the IMF website at http://www.imf.org/external/np/exr/facts/sdr.htm. The growth rate of dollar reserves looks broadly similar to Figure 18-7.

One explanation for this development, which we will discuss further in later chapters, is that the growth of global capital markets has vastly increased the potential variability of financial flows across national borders, and especially across the borders of crisis-prone developing countries.[24] The sharp decline in developing-country reserve growth in the 1982–1992 period, shown in the figure, reflects an international debt crisis during the years 1982–1989. In that crisis, foreign lending sources dried up and many developing countries were forced to draw on their reserves. We see another decline in reserve growth during the crisis years of 2007–2009. These episodes illustrate why developing countries have added so eagerly to their reserve holdings. Even a developing country with a floating exchange rate might need to pay off foreign creditors and domestic residents with dollars to avoid a financial crisis and a currency collapse.

Nothing about this explanation contradicts earlier theories. The demand for international reserves still reflects the variability in the balance of payments. The rapid

Figure 18-8

Currency Composition of Global Reserve Holdings

While the euro's role as a reserve currency has increased over time, the dollar remains the overwhelming favorite.

Source: International Monetary Fund, Currency Composition of Foreign Exchange Reserves (as of June 30, 2010), at http://www.imf.org/external/np/sta/cofer/eng/index.htm. These data cover only the countries that report reserve composition to the IMF, the major omission being China.

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[24]Recent works on the modern determinants of the demand for international reserves includes those of Robert Flood and Nancy Marion, "Holding International Reserves in an Era of High Capital Mobility," *Brookings Trade Forum* 2001, pp. 1–47; Joshua Aizenman and Jaewoo Lee, "International Reserves: Precautionary versus Mercantilist Views, Theory and Evidence," *Open Economies Review* 18 (April 2007), pp. 191–214; and Maurice Obstfeld, Jay C. Shambaugh, and Alan M. Taylor, "Financial Stability, the Trilemma, and International Reserves," *American Economic Journal: Macroeconomics* 2 (April 2010), pp. 57–94.

globalization of financial markets in recent years has, however, caused a big increase in potential variability and in the potential risks that that variability poses.

Countries can and do choose to hold international reserves in currencies other than the U.S. dollar. They tend to hold only those currencies that are most likely to retain their value over time and to be readily accepted by foreign exporters and creditors. Thanks to the large and generally prosperous geographical region it serves, the euro, introduced in 1999, is the strongest challenger to the dollar's role.

Figure 18-8 shows the importance of four major currencies in countries' international reserve holdings. Since the euro's birth in 1999, its share in global reserves has risen from 18 to 27 percent, while the dollar's share has declined from 71 to 62 percent. Britain's pound sterling was the world's leading reserve currency up until the 1920s. That currency, however, now makes up only about 4 percent of global reserves, while the Japanese yen's share, about three times that of sterling during the mid-1990s, is now lower.

Upon its introduction in 1999, some economists speculated that the euro would overtake the dollar as the main international reserve currency. Despite the apparent trend away from the dollar shown in Figure 18-8, that day seems distant. Yet history certainly shows how leading reserve currencies can be toppled by newcomers.[25]

SUMMARY

1. There is a direct link between central bank intervention in the foreign exchange market and the domestic money supply. When a country's central bank purchases foreign assets, the country's money supply automatically increases. Similarly, a central bank sale of foreign assets automatically lowers the money supply. The *central bank balance sheet* shows how foreign exchange intervention affects the money supply because the central bank's liabilities, which rise or fall when its assets rise or fall, are the base of the domestic money supply process. The central bank can negate the money supply effect of intervention through *sterilization*. With no sterilization, there is a link between the balance of payments and national money supplies that depends on how central banks share the burden of financing balance of payments gaps.

2. A central bank can fix the exchange rate of its currency against foreign currency if it is willing to trade unlimited amounts of domestic money against foreign assets at that rate. To fix the exchange rate, the central bank must intervene in the foreign exchange market whenever necessary to prevent the emergence of an excess demand or supply of domestic currency assets. In effect, the central bank adjusts its foreign assets—and thus, the domestic money supply—to ensure that asset markets are always in equilibrium under the fixed exchange rate.

3. A commitment to fix an exchange rate forces the central bank to sacrifice its ability to use monetary policy for stabilization. A purchase of domestic assets by the central bank

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[25]Although written before 1999, a still useful account of the dollar's general dominance in global finance is the article by Frankel in Further Readings. A more recent assessment of the dollar's reserve status by Eichengreen, also listed in Further Readings, reaches similar conclusions. For a formal statistical study, see Menzie Chinn and Jeffrey A. Frankel, "Will the Euro Eventually Surpass the Dollar as Leading International Reserve Currency?" in Richard H. Clarida, ed., *G7 Current Account Imbalances: Sustainability and Adjustment* (Chicago: University of Chicago Press, 2007), pp. 283–322.

causes an equal fall in its official international reserves, leaving the money supply and output unchanged. Similarly, a sale of domestic assets by the bank causes foreign reserves to rise by the same amount but has no other effects.

4. Fiscal policy, unlike monetary policy, has a more powerful effect on output under fixed exchange rates than under floating rates. Under a fixed exchange rate, fiscal expansion does not, in the short run, cause a real appreciation that "crowds out" aggregate demand. Instead, it forces central bank purchases of foreign assets and an expansion of the money supply. *Devaluation* also raises aggregate demand and the money supply in the short run. (*Revaluation* has opposite effects.) In the long run, fiscal expansion causes a real appreciation, an increase in the money supply, and a rise in the home price level, while devaluation causes the long-run levels of the money supply and prices to rise in proportion to the exchange rate change.

5. *Balance of payments crises* occur when market participants expect the central bank to change the exchange rate from its current level. If the market decides a devaluation is coming, for example, the domestic interest rate rises above the world interest rate and foreign reserves drop sharply as private capital flows abroad. *Self-fulfilling currency crises* can occur when an economy is vulnerable to speculation. In other circumstances an exchange rate collapse may be the inevitable result of inconsistent government policies.

6. A system of *managed floating* allows the central bank to retain some ability to control the domestic money supply, but at the cost of greater exchange rate instability. If domestic and foreign bonds are *imperfect substitutes*, however, the central bank may be able to control both the money supply and the exchange rate through sterilized foreign exchange intervention. Empirical evidence provides little support for the idea that sterilized intervention has a significant direct effect on exchange rates. Even when domestic and foreign bonds are *perfect substitutes*, so that there is no *risk premium*, sterilized intervention may operate indirectly through a *signaling effect* that changes market views of future policies.

7. A world system of fixed exchange rates in which countries peg the prices of their currencies in terms of a *reserve currency* involves a striking asymmetry: The reserve currency country, which does not have to fix any exchange rate, can influence economic activity both at home and abroad through its monetary policy. In contrast, all other countries are unable to influence their output or foreign output through monetary policy. This policy asymmetry reflects the fact that the reserve center bears none of the burden of financing its balance of payments.

8. A *gold standard*, in which all countries fix their currencies' prices in terms of gold, avoids the asymmetry inherent in a reserve currency standard and also places constraints on the growth of countries' money supplies. (A related arrangement was the *bimetallic standard* based on both silver and gold.) But the gold standard has serious drawbacks that make it impractical as a way of organizing today's international monetary system. Even the dollar-based *gold exchange standard* set up after World War II ultimately proved unworkable.

KEY TERMS

balance of payments
  crisis, p. 477
bimetallic standard, p. 488
capital flight, p. 478
central bank balance
  sheet, p. 465
devaluation, p. 474
gold exchange standard, p. 489

gold standard, p. 485
imperfect asset substitutability,
  p. 480
managed floating exchange
  rates, p. 463
perfect asset substitutability,
  p. 480
reserve currency, p. 484

revaluation, p. 474
risk premium, p. 481
self-fulfilling currency crises,
  p. 478
signaling effect of foreign
  exchange intervention, p. 484
sterilized foreign exchange
  intervention, p. 467

PROMLEMS

PROBLEMS

1. Show how an expansion in the central bank's domestic assets ultimately affects its balance sheet under a fixed exchange rate. How are the central bank's transactions in the foreign exchange market reflected in the balance of payments accounts?

2. Do the exercises in the previous problem for an increase in government spending.

3. Describe the effects of an unexpected devaluation on the central bank's balance sheet and on the balance of payments accounts.

4. Explain why a devaluation improves the current account in this chapter's model. (Hint: Consider the *XX* curve developed in the last chapter.)

5. The following paragraphs appeared in the *New York Times* on September 22, 1986 (see "Europeans May Prop the Dollar," p. D1):[26]

> To keep the dollar from falling against the West German mark, the European central banks would have to sell marks and buy dollars, a procedure known as intervention. But the pool of currencies in the marketplace is vastly larger than all the governments' holdings.
>
> Billions of dollars worth of currencies are traded each day. Without support from the United States and Japan, it is unlikely that market intervention from even the two most economically influential members of the European Community—Britain and West Germany—would have much impact on the markets. However, just the stated intention of the Community's central banks to intervene could disrupt the market with its psychological effect.
>
> Economists say that intervention works only when markets turn unusually erratic, as they have done upon reports of the assassination of a President, or when intervention is used to push the markets along in a direction where they are already headed anyway.

   a. Do you agree with the statement in the article that Germany had little ability to influence the exchange rate of the DM?

   b. Do you agree with the last paragraph's evaluation of the efficacy of intervention?

   c. Describe how "just the stated intention" to intervene could have a "psychological effect" on the foreign exchange market.

   d. Try your hand at rewriting the above paragraphs in more precise language so that they reflect what you learned in this chapter.

6. Can you think of reasons why a government might willingly sacrifice some of its ability to use monetary policy so that it can have more stable exchange rates?

7. How does fiscal expansion affect the current account under a fixed exchange rate?

8. Explain why temporary and permanent fiscal expansions do not have different effects under fixed exchange rates, as they do under floating exchange rates.

9. Devaluation is often used by countries to improve their current accounts. Since the current account equals national saving less domestic investment, however (see Chapter 13), this improvement can occur only if investment falls, saving rises, or both. How might devaluation affect national saving and domestic investment?

10. Using the *DD-AA* model, analyze the output and balance of payments effects of an import tariff under fixed exchange rates. What would happen if all countries in the world simultaneously tried to improve employment and the balance of payments by imposing tariffs?

11. When a central bank devalues after a balance of payments crisis, it usually gains for-eign reserves. Can this financial inflow be explained using our model? What would happen if the market believed that *another* devaluation would occur in the near future?

12. Suppose that under the postwar "dollar standard" system, foreign central banks had held dollar reserves in the form of green dollar bills hidden in their vaults rather than in the form of U.S. Treasury bills. Would the international monetary adjustment mechanism have been symmetric or asymmetric? (Hint: Think about what happens to the U.S. and Japanese money supplies, for example, when the Bank of Japan sells yen for dollar bills that it then keeps.)

13. "When domestic and foreign bonds are perfect substitutes, a central bank should be indif-ferent about using domestic or foreign assets to implement monetary policy." Discuss.

14. U.S. foreign exchange intervention is sometimes done by an Exchange Stabilization Fund, or ESF (a branch of the Treasury Department), which manages a portfolio of U.S. government and foreign currency bonds. An ESF intervention to support the yen, for example, would take the form of a portfolio shift out of dollar and into yen assets. Show that ESF interventions are automatically sterilized and thus do not alter money supplies. How do ESF operations affect the foreign exchange risk premium?

15. Use a diagram like Figure 18-6 to explain how a central bank can alter the domestic interest rate, while holding the exchange rate fixed, under imperfect asset substitutability.

16. On page 467 in the text, we analyzed how the sale of $100 worth of its foreign assets affects the central bank's balance sheet. The assumption in that example was that the buyer of the foreign assets paid in the form of domestic currency cash. Suppose instead that the buyer pays with a check drawn on her account at Pecuniacorp, a pri-vate domestic bank. Using a balance sheet like the ones presented in the text, show how the transaction affects the central bank's balance sheet and the money supply.

17. We observed in the text that "fixed" exchange-rate systems can result not in absolutely fixed exchange rates but in narrow bands within which the exchange rate can move. For example, the gold points (mentioned in footnote 17) produced such bands under a gold standard. (Typically those bands were on the order of plus or minus 1 percent of the "central" exchange parity.) To what extent would such bands for the exchange rate allow the domestic interest rate to move independently of a foreign rate? Show that the answer depends on the maturity or *term* of the interest rate. To help your intuition, assume plus or minus 1 percent bands for the exchange rate, and consider, alternatively, rates on three-month deposits, on six-month deposits, and on one-year deposits. With such narrow bands, would there be much scope for independence in ten-year loan rates?

18. In a three-country world, a central bank fixes one exchange rate but lets the others float. Can it use monetary policy to affect output? Can it fix both exchange rates?

19. In the Case Study on international reserves (pages 489–493), we asserted that except in the case of a reserve currency system, an attempt by all central banks simultane-ously to raise their international reserve holdings through open-market sales of domestic assets could have a contractionary effect on the world economy. Explain by contrasting the case of a gold standard–type system and a reserve currency system.

20. If a country changes its exchange rate, the value of its foreign reserves, measured in the domestic currency, also changes. This latter change may represent a domestic currency gain or loss for the central bank. What happens when a country devalues its currency against the reserve currency? When it revalues? How might this factor affect the potential cost of holding foreign reserves? Make sure to consider the role of inter-est parity in formulating your answer.

21. Analyze the result of a permanent devaluation by an economy caught in a liquidity trap of the sort described in Chapter 17.

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Equilibrium in the Foreign Exchange Market with Imperfect Asset Substitutability

This appendix develops a model of the foreign exchange market in which risk factors may make domestic currency and foreign currency assets imperfect substitutes. The model gives rise to a risk premium that can separate the expected rates of return on domestic and foreign assets.

Demand

Because individuals dislike risky situations in which their wealth may vary greatly from day to day, they decide how to allocate wealth among different assets by looking at the riskiness of the resulting portfolio as well as at the expected return the portfolio offers. Someone who puts her wealth entirely into British pounds, for example, may expect a high return, but the wealth can be wiped out if the pound unexpectedly depreciates. A more sensible strategy is to invest in several currencies even if some have lower expected returns than the pound, and thus reduce the impact on wealth of bad luck with any one currency. By spreading risk among several currencies, an individual can reduce the variability of her wealth.

Considerations of risk make it reasonable to assume that an individual's demand for interest-bearing domestic currency assets increases when the interest they offer (R) rises relative to the domestic currency return on foreign currency assets $[R^* + (E^e - E)/E]$. Put another way, an individual will be willing to increase the riskiness of her portfolio by investing more heavily in domestic currency assets only if she is compensated by an increase in the relative expected return on those assets.

We summarize this assumption by writing individual i's demand for domestic currency bonds, B_i^d, as an increasing function of the rate-of-return difference between domestic and foreign bonds,

$$B_i^d = B_i^d[R - R^* - (E^e - E)/E].$$

Of course, B_i^d also depends on other factors specific to individual i, such as her wealth and income. The demand for domestic currency bonds can be negative or positive, and in the former case, individual i is a net borrower in the home currency, that is, a *supplier* of domestic currency bonds.

To find the *aggregate* private demand for domestic currency bonds, we need only add up individual demands B_i^d for all individuals i in the world. This summation gives the aggregate demand for domestic currency bonds, B^d, which is also an increasing function of the expected rate-of-return difference in favor of domestic currency assets. Therefore,

$$\text{Demand} = B^d[R - R^* - (E^e - E)/E]$$

$$= \text{sum for all } i \text{ of } B_i^d[R - R^* - (E^e - E)/E].$$

Since some private individuals may be borrowing, and therefore supplying bonds, B^d should be interpreted as the private sector's *net* demand for domestic currency bonds.

Supply

Since we are interpreting B^d as the private sector's *net* demand for domestic currency bonds, the appropriate supply variable to define market equilibrium is the net supply of domestic currency bonds to the private sector, that is, the supply of bonds that are not the liability of any private individual or firm. Net supply therefore equals the value of domestic currency *government* bonds held by the public, B, less the value of domestic currency assets held by the central bank, A:

$$\text{Supply} = B - A.$$

A must be subtracted from B to find the net supply of bonds because purchases of bonds by the central bank reduce the supply available to private investors. (More generally, we would also subtract from B domestic currency assets held by foreign central banks.)

Equilibrium

The risk premium, ρ, is determined by the interaction of supply and demand. The risk premium is defined as

$$\rho = R - R^* - (E^e - E)/E,$$

that is, as the expected return difference between domestic and foreign bonds. We can therefore write the private sector's net demand for domestic currency bonds as an increasing function of ρ. Figure 18A1-1 shows this relationship by drawing the demand curve for domestic currency bonds with a positive slope.

The bond supply curve is vertical at $B - A^1$ because the net supply of bonds to the market is determined by decisions of the government and central bank and is independent of the risk premium. Equilibrium occurs at point 1 (at a risk premium of ρ^1), where the private sector's net demand for domestic currency bonds equals the net supply. Notice that for given values of R, R^*, and E^e, the equilibrium shown in the diagram can also be viewed as determining the exchange rate, since $E = E^e/(1 + R - R^* - \rho)$.

Figure 18A1-1

The Domestic Bond Supply and the Foreign Exchange Risk Premium under Imperfect Asset Substitutability

An increase in the supply of domestic currency bonds that the private sector must hold raises the risk premium on domestic currency assets.
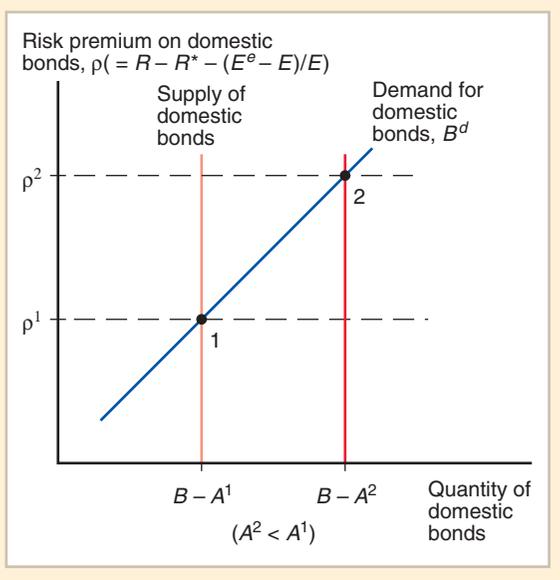
Figure 18A1-1 also shows the effect of a central bank sale of domestic assets that lowers its domestic asset holdings to $A^2 < A^1$. This sale raises the net supply of domestic currency bonds to $B - A^2$ and shifts the supply curve to the right. The new equilibrium occurs at point 2, at a risk premium of $\rho^2 > \rho^1$. Similarly, an increase in the domestic currency government debt, B, would raise the risk premium.

The model therefore establishes that the risk premium is an increasing function of $B - A$, just as we assumed in the discussion of sterilized intervention that led to equation (18-3).

You should recognize that our discussion of risk premium determination is an oversimplification in a number of ways, not least because of the assumption that the home country is small, so that all foreign variables can be taken as given. In general, however, actions taken by foreign governments may also affect the risk premium, which of course can take *negative* as well as positive values. That is, policies or events that make foreign bonds progressively riskier will eventually make investors willing to hold domestic currency bonds at an expected rate of return *below* that on foreign currency bonds.

One way to capture this possibility would be to generalize equation (18-3) in the text and express the risk premium instead as

$$\rho = \rho(B - A, B^* - A^*),$$

where $B^* - A^*$ is the net stock of foreign currency bonds that the public must hold. In this extended formulation, a rise in $B - A$ still raises ρ, but a rise in $B^* - A^*$ causes ρ to fall by making foreign bonds relatively riskier.

The Timing of Balance of Payments Crises

In the text we modeled a balance of payments crisis as a sudden loss of confidence in the central bank's promise to hold the exchange rate fixed in the future. As previously noted, a currency crisis often is not the result of arbitrary shifts in market sentiment, contrary to what exasperated policy makers embroiled in crises often contend. Instead, an exchange rate collapse can be the inevitable result of government policies inconsistent with maintaining a fixed exchange rate permanently. In such cases, simple economic theory may allow us to predict the date of a crisis through a careful analysis of the government policies and the market's rational response to them.[27]

It is easiest to make the main points using the assumptions and notations of the monetary approach to the balance of payments (as developed in Online Appendix A to this chapter) and the monetary approach to the exchange rate (Chapter 16). To simplify, we will assume that output prices are perfectly flexible and that output is constant at its full-employment level. We will also assume that market participants have perfect foresight concerning the future.

The precise timing of a payments crisis cannot be determined independently of government policies. In particular, we have to describe not only how the government is behaving today, but also how it plans to react to future events in the economy. Two assumptions about official behavior are made: (1) The central bank is allowing the stock of domestic credit, A, to expand steadily, and will do so forever. (2) The central bank is currently fixing the exchange rate at the level E^0, but will allow the exchange rate to float freely forever if its foreign reserves, F^*, ever fall to zero. Furthermore, the authorities will defend E^0 to the bitter end by selling foreign reserves at that price as long as they have any to sell.
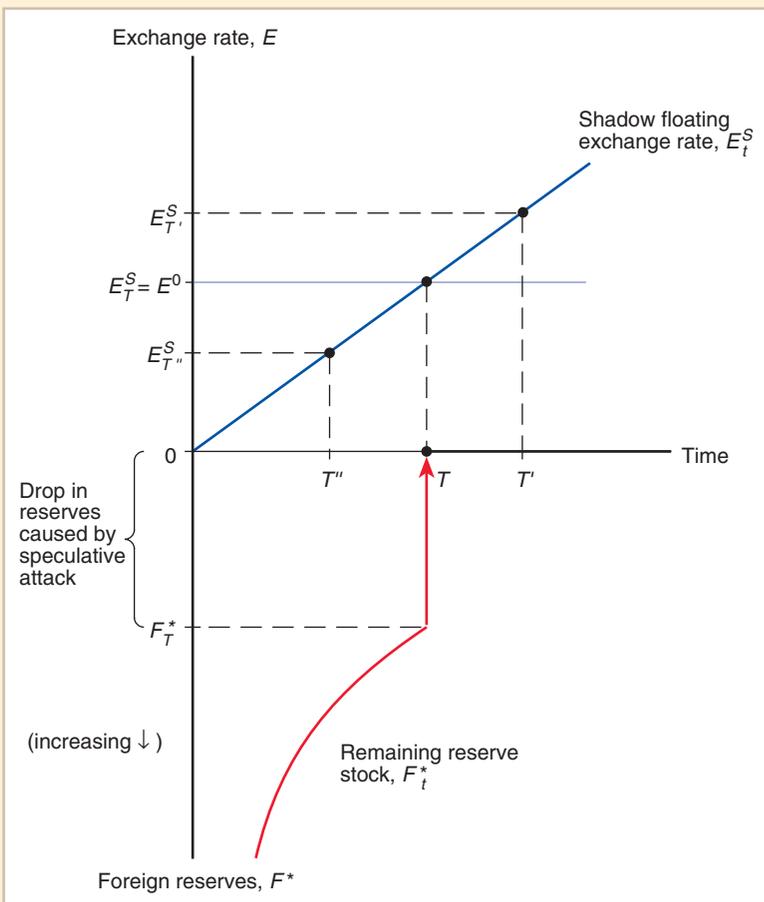
The problem with the central bank's policies is that they are inconsistent with maintaining a fixed exchange rate indefinitely. The monetary approach suggests that foreign reserves will fall steadily as domestic assets continually rise. Eventually, therefore, reserves will have to run out and the fixed exchange rate E^0 will have to be abandoned. In fact, speculators will force the issue by mounting a speculative attack and buying all of the central bank's reserves while reserves are still at a positive level.

We can describe the timing of this crisis with the help of a definition and a diagram. The *shadow* floating exchange rate at time t, denoted E_t^S, is the exchange rate that would prevail at time t if the central bank held no foreign reserves, allowed the currency to float, but continued to allow domestic credit to grow over time. We know from the monetary approach that the result would be a situation of *ongoing inflation* in which E_t^S trends upward over time in proportion to the domestic credit growth rate. The upper panel of Figure 18A2-1 shows this upward trend in the shadow floating rate, together with the level E^0 at which the

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[27]Alternative models of balance of payments crises are developed in Paul Krugman, "A Model of Balance-of-Payments Crises," *Journal of Money, Credit and Banking* 11 (August 1979), pp. 311–325; Robert P. Flood and Peter M. Garber, "Collapsing Exchange Rate Regimes: Some Linear Examples," *Journal of International Economics* 17 (August 1984), pp. 1–14; and Maurice Obstfeld, "Rational and Self-Fulfilling Balance-of-Payments Crises," *American Economic Review* 76 (March 1986), pp. 72–81. See also the paper by Obstfeld in Further Readings.

exchange rate is initially pegged. The time T indicated on the horizontal axis is defined as the date on which the shadow exchange rate reaches E^0.

The lower panel of the figure shows how reserves behave over time when domestic credit is steadily growing. (An increase in reserves is a move down from the origin along the vertical axis.) We have shown the path of reserves as a kinked curve that falls gradually until time T, at which point reserves drop in a single stroke to zero. This precipitous reserve loss (of size F_T^*) is the speculative attack that forces the end of the fixed exchange rate, and we now argue that such an attack must occur precisely at time T if asset markets are to clear at each moment.

We are assuming that output Y is fixed, so reserves will fall over time at the same rate that domestic credit grows, as long as the domestic interest rate R (and thus the demand for domestic money) doesn't change. What do we know about the behavior of the interest rate? We know that while the exchange rate is convincingly fixed, R will equal the foreign interest rate R^* because no depreciation is expected. Thus, reserves fall gradually over time, as shown in Figure 18A2-1, as long as the exchange rate remains fixed at E^0.

Imagine now that reserves first hit zero at a time such as T', which is *later* than time T. Our shadow exchange rate E^S is defined as the equilibrium floating rate that prevails when foreign reserves are zero, so if reserves first hit zero at time T', the authorities abandon E^0 forever and the exchange rate jumps immediately to the higher level $E_{T'}^S$.

There is something wrong with this "equilibrium," however: Each market participant knows that the home currency will depreciate very sharply at time T' and will try to profit by buying foreign reserves from the central bank, at the lower price E^0, just an instant *before* T'. Thus the central bank will lose all of its reserves before T', contrary to our assumption that reserves first hit zero *at* T'. So we have not really been looking at an equilibrium after all.

Do we get to an equilibrium by assuming instead that speculators buy out the official reserve stock at a time like T'' that is *earlier* than time T? Again the answer is no, as you can see by considering the choices facing an individual asset holder. He knows that if central bank reserves reach zero at time T'', the currency will appreciate from E^0 to $E^S_{T''}$ as the central bank leaves the foreign exchange market. It therefore will behoove him not to join any speculative attack that pushes reserves to zero at time T''; in fact, he would prefer to *sell* as much foreign currency as possible to the central bank just before time T'' and then buy it back at the lower market-determined price that would prevail after a crisis. Since every market participant would find it in his or her interest to act in this way, however, a speculative attack simply can't occur before time T. No speculator would want to buy central bank reserves at the price E^0, knowing that an immediate discrete capital loss was at hand.

Only if foreign reserves hit zero precisely at time T are asset markets continually in equilibrium. As noted above, time T is defined by the condition

$$E^S_T = E^0,$$

which states that if reserves suddenly drop to zero at time T, the exchange rate remains initially at its pegged level, and only subsequently floats upward.

The absence of any foreseen initial jump in the exchange rate, either upward or downward, removes the opportunities for arbitrage (described above) that prevent speculative attacks at times like T' or T''. In addition, the money market remains in equilibrium at time T, even though the exchange rate doesn't jump, because the two factors offset each other exactly. As reserves drop sharply to zero, the money supply falls. We also know that at the moment the fixed exchange rate is abandoned, people will expect the currency to begin depreciating over time. The domestic interest rate R will therefore move upward to maintain interest parity, reducing real money demand in line with the fall in the real money supply.

We have therefore tied down the exact date on which a balance of payments crisis forces the authorities off the fixed exchange rate. Note once again that in our example, a crisis must occur at *some* point, because profligate monetary policies make one inevitable. The fact that a crisis occurs while the central bank's foreign reserves are still positive might suggest to superficial observers that ill-founded market sentiment is leading to a premature panic. This is not the case here. The speculative attack we have analyzed is the only outcome that does not confront market participants with arbitrage opportunities.[28] However, there are alternative self-fulfilling crisis models in which attacks can occur even when the exchange rate could have been sustained indefinitely in the absence of an attack.

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[28]Our finding that reserves fall to zero in a single attack comes from our assumptions that the market can foresee the future perfectly and that trading takes place continuously. If we were instead to allow some discrete uncertainty—for example, about the rate of domestic credit growth—the domestic interest rate would rise as a collapse became more probable, causing a series of "speculative" money demand reductions prior to the final depletion of foreign reserves. Each of these preliminary attacks would be similar to the type of crisis described in the chapter.