16 THE FOREIGN EXCHANGE MARKET AND TRADE ELASTICITIES

The foreign exchange market is where domestic money (for example, dollars) is traded for foreign money (for example, pounds sterling). The exchange rate is usually defined as the price of the foreign currency in terms of the domestic currency, though it could as easily have been the reverse,[1] and this convention will be followed here. Note that a *depreciation,* a decrease in the value of the domestic currency, is an *increase* in the exchange rate, because it is an increase in the price of foreign currency. Some find it counterintuitive that a decrease in the value of the currency is called an increase in the exchange rate. Yet just as economists often talk about an increase in the prices of commodities (inflation) rather than the equivalent depreciation of money's purchasing power over commodities, so it is often intuitive to talk about an increase in the price of foreign currency rather than the equivalent decrease in the value of the domestic currency.

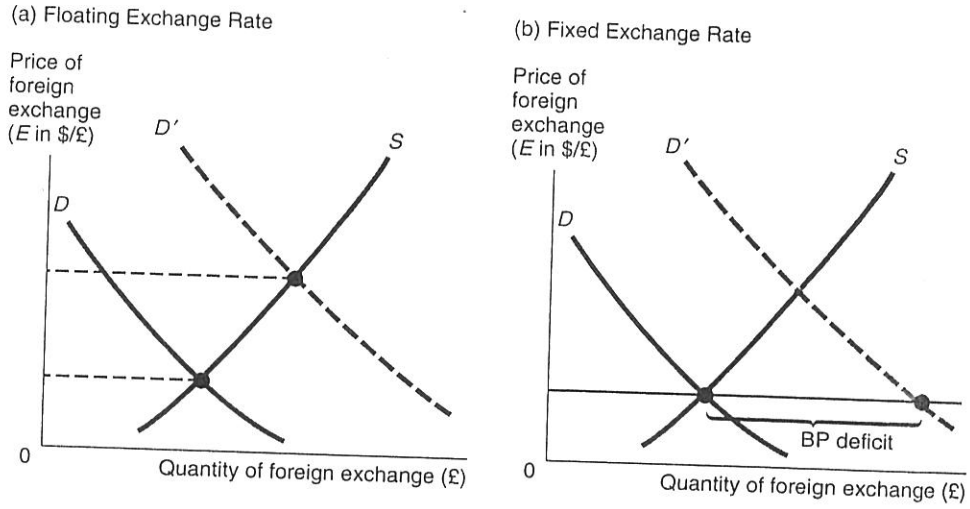
We are simplifying when we speak of *the* exchange rate for a country. In reality, each country has many exchange rates, one for every other currency in the world. The United States, for example, has the dollar/yen rate, the dollar/pound rate, and so on. Although these exchange rates tend to be correlated, the measure of the movements in the home country's currency depends on which exchange rate is used. To get a good idea of the value of the currency overall, it is necessary to use an exchange rate index, known as the *effective exchange rate,* which computes a weighted average of the exchange rates against each of the individual countries. Typically the weights used are the countries' shares in trade.

16.1 THE FLOW OF SUPPLY AND DEMAND FOR FOREIGN EXCHANGE

In the foreign exchange market, as in other markets, supply and demand are central. The proceeds from exports, and other credit items in the balance of payments, generate the supply of foreign exchange or foreign currency. Import spending and other debit items generate the demand for foreign exchange. In Figure 16.1 we measure the quantities of foreign exchange supplied and demanded on the horizontal axis, and the price of foreign exchange—the exchange rate E—on the vertical axis. We can think of the supply and demand for foreign exchange as functions of the currency's price—the exchange rate—just as the supply and demand for any

[1]In the United Kingdom, for example, the practice is to speak in terms of the dollar/pound rate, an exception to the general rule because the pound is the domestic currency.

Figure 16.1
Increase in Demand for Foreign Currency
When the demand for foreign currency shifts out from D to D', the result depends on the exchange rate regime. Panel (a) illustrates a floating exchange rate: An increase in the price of foreign currency is necessary to equilibrate the private market. Panel (b) illustrates a fixed exchange rate: The central bank intervenes by supplying the excess amount demanded out of its foreign exchange reserves.



commodity are functions of its price. Unless otherwise specified, supply and demand refer to private sources (i.e., transactions on the current account and private capital account, not official reserve transactions by the central bank). In Figure 16.1 the supply curve and demand curve are (for the moment) simply assumed to slope the conventional ways: upward and downward, respectively.

The behavior of the exchange rate varies considerably depending on which *regime* is in effect: floating exchange rates or fixed exchange rates. Under pure floating, the exchange rate is whatever it must be to equilibrate supply and demand in the private market. Consider an increase in the demand for foreign exchange, an outward shift of the curve in Figure 16.1(a) from D to D'. Such an outward shift in the demand for foreign currency could result, for example, from an increase in demand for imports or from an increase in investors' demand for foreign assets. Under floating, the increased demand for foreign currency causes an increase in its price, the exchange rate, just as an increase in demand for a commodity causes an increase in the price of the commodity.

With a completely fixed or "pegged" exchange rate, on the other hand, the central bank stands ready to buy or sell foreign currency whenever private supply and demand are not equal at the fixed rate. The official exchange rate would only by coincidence be the rate that precisely equates private supply and demand. Under this regime, an increase in demand, illustrated in Figure 16.1(b), would result in an excess demand for foreign currency that must be met by sales of foreign currency by the central bank. From our discussion of the balance-of-payments accounts, we know that the country runs a balance-of-payments deficit. The central bank keeps the domestic currency from depreciating by buying up the excess sup-

ply of the domestic currency. Obviously, the central bank can continue this only as long as it has foreign exchange reserves. (The other country's central bank also could use its own currency to buy up the unwanted domestic currency, if it were willing to do so.) There are policy changes, which will be examined later, that the domestic government can make to reduce the deficit instead of financing it, but such policies generally take time to have an effect. If the deficit continues, eventually the central bank will run out of foreign exchange reserves and will be forced to withdraw support from the domestic currency. The central bank must then either (1) set a new, higher exchange rate at which it will stand ready to sell foreign exchange from then on, or (2) cease foreign exchange operations and allow the market to determine the rate. The first option constitutes a *devaluation* of the currency, the second the floating of the currency.[2]

Deriving Supply and Demand for Foreign Exchange from Exports and Imports

What determines the supply and demand for foreign exchange? Three assumptions together will provide a preliminary answer to this question. We are, in effect, going to derive the shapes of the curves in Figure 16.1.

Assumption 1. Assume (until Part V of this book) that *there are no net capital flows* ($KA = 0$). Thus, the private supply and demand for foreign exchange are determined entirely by the trade account. Most of the results in this part of the book would be unaffected if it were assumed that capital flows were constant or exogenous, without necessarily being zero. In the 1950s, capital flows indeed consisted largely of government loans (for example, lending to Europe under the Marshall Plan after World War II) and foreign direct investments that were not very responsive to short-term factors such as the interest rate.

Furthermore, assume now that two goods are traded: an importable good and an exportable good. Thus, the first assumption is that the balance of payments is simply sales of the export minus spending on the import.

Assumption 2. Assume (through the remainder of this chapter) that *domestic residents look only at prices expressed in domestic currency*. Thus, in the case of domestic consumers, the demand for imports depends only on the price of the import expressed in domestic currency. In the case of domestic firms, the supply of exports depends only on the price of the export expressed in domestic currency. Similarly, assume that *foreign residents look only at prices expressed in foreign currency* when choosing the demand for the home country's exports (in the case of foreign consumers) or the supply of imports to the home country (in the case of foreign firms). Changes in demand due to changes in income are ignored. This assumption, representing the defining characteristic of the "elasticity approach" to devaluation, will be relaxed in Chapter 17.

[2]The appendix to this chapter shows how stability in the foreign exchange market depends on the slopes of the supply and demand curves in Figure 16.1(a). This analysis holds whether or not the curves are derived from exports and imports, as in the next subsection. Chapter 21 will discuss the mechanics of how foreign exchange is actually bought and sold, most of it by banks.

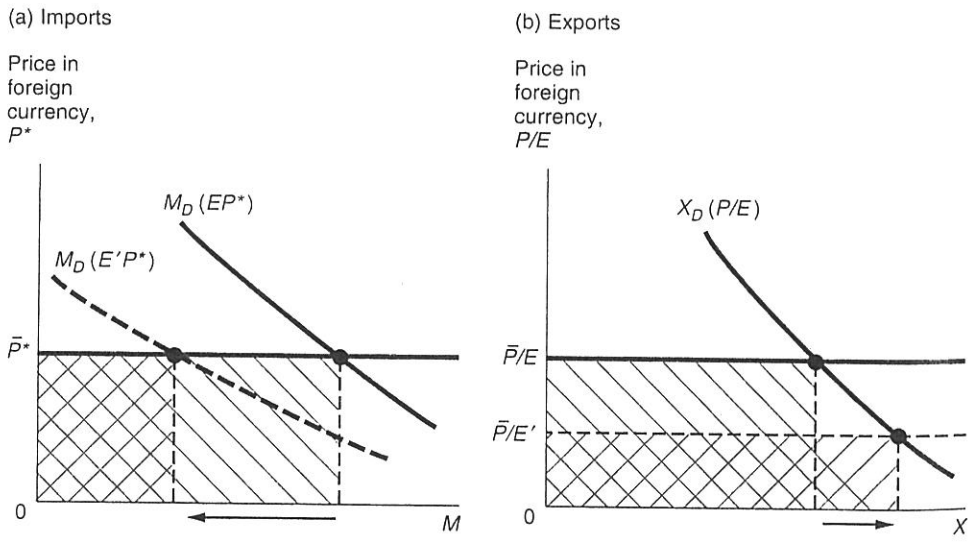
Assumption 3. Finally, assume for now that firms set a price for their product and then meet any forthcoming demand. In other words, assume that *supply is infinitely elastic*. This assumption can be regarded as a special Keynesian case that is only a realistic description of the short run. In light of Assumption 2, the price at which domestic firms supply exportables with infinite elasticity must be set in domestic currency—call it P—and the price at which foreign firms supply the home country with importables must be set in foreign currency—call it P^*. Assumption 3 will be relaxed later as well.

By Assumption 3, output levels are determined by demand. The demand for imports, M_D, is a decreasing function of the import's price expressed in domestic currency, which is the fixed price in foreign currency times the exchange rate.

$$M = M_D(E\bar{P}^*)$$

If a Range Rover costs £20,000 and the exchange rate is \$2.00/£, then the price to an American is (\$2.00/£)(£20,000) = \$40,000. Americans will buy fewer Range Rovers when the dollar price goes up, without distinguishing whether it is the exchange rate or the pound price that has changed. Figure 16.2 graphs prices in terms of foreign currency to facilitate calculation of export revenue and import spending. Thus, the import demand curve is drawn for a given exchange rate, E. A change in E would shift the entire M_D curve. The demand for exports, X_D, is a decreasing function of their price expressed in foreign currency, which is the fixed price in domestic currency divided by the exchange rate.

Figure 16.2
Effect of a Devaluation on Trade
Panel (a) shows how a devaluation lowers the quantity of imports. Panel (b) shows how the devaluation raises the quantity of exports. The effects on import spending and export revenue, respectively, are shown by the areas of the shaded rectangles.



$$X = X_D(\overline{P}/E)$$

If a Ford costs \$20,000 and the exchange rate is \$2.00/£, then the price in Britain is \$20,000/(\$2.00/£) = £10,000. British buyers will buy fewer Fords when the pound price goes up, regardless of whether it is the dollar price that rose or the exchange rate that fell.

A devaluation, an increase in E, lowers the price of exports to foreigners. This is a movement down the curve, increasing the quantity of exports demanded, X_D, in Figure 16.2(b). The devaluation also raises the price of imports to domestic residents, reducing their demand, M_D. This is represented in Figure 16.2(a) as a proportionate downward shift of the entire import demand curve, because the curve was drawn contingent on the exchange rate.[3]

Now consider the market for foreign exchange. Assumption 1 means that the demand for foreign exchange is identical to import spending: In the absence of borrowing, foreign exchange must be obtained on the market to pay for imports. Import spending is quantity times the foreign currency price. The supply of foreign exchange is identical to export revenue: All foreign exchange earned through exports is cashed in on the foreign exchange market. Export revenue is export quantity times foreign currency price. So the demand for foreign currency prior to the devaluation is P^*M, the shaded rectangular area in Figure 16.2(a), and the supply is $(P/E)X$, the shaded area in Figure 16.2(b). The net supply of foreign exchange is

$$(\overline{P}/E)X - \overline{P}^*M$$

which is also the trade balance measured in foreign currency, TB^*.

The appendix to this chapter considers the question of stability in the foreign exchange market: Does an increase in the exchange rate increase the net supply of foreign exchange? This question is identical to the question, Does a devaluation improve the trade balance? The two questions are the same because no capital flows have been assumed. Domestic consumers cannot borrow abroad to get the foreign exchange they need for imports, so the trade balance is the same as the net supply of foreign exchange. We will now derive the condition under which the answer to the two questions is yes.

The Marshall-Lerner Condition

The effect of a devaluation on the trade balance can be decomposed into three factors. (1) A devaluation reduces the real quantity of imports (the number of Range

[3]If the vertical axes had been expressed in domestic currency instead of foreign currency, the devaluation would have been an upward movement along the import demand curve and an upward shift of the export demand curve, instead of the other way around. (The effect on the quantities would have been the same as in Figure 16.2.) The general rule is that a devaluation is a movement *along* the curve that describes the behavior of the people (domestic or foreign residents) whose currency is on the vertical axis; it *shifts* the curve that describes the behavior of the people whose currency is not on the axis.

Rovers imported, in the example) and, because their nominal price is fixed in foreign currency, clearly reduces the amount of foreign exchange spent on imports; the rectangular area in Figure 16.2(a) shrinks. This factor helps improve the trade balance. (2) The devaluation also increases the real quantity of exports. This factor also helps the trade balance. (3) Any given quantity of exports earns less foreign exchange than before, because their nominal price is set in domestic currency. This factor *hurts* the trade balance.

The net effect on foreign currency export revenue is unclear. The size of the rectangular area in Figure 16.2(b) may either increase or decrease, depending on the elasticity of export demand. If the demand response (factor 2) is small enough, export revenue may actually fall. This will be the case if the elasticity of export demand is less than 1. Export revenue could fall, and yet be outweighed by a reduction in imports, so that the total trade balance would still improve. However, if the demand response on the import side (factor 1) is also small enough, the trade balance will actually worsen: The net supply of foreign exchange will fall. (The various cases are explored further in the appendix.)

At this point a fourth assumption is added to those required by the elasticities approach.

Assumption 4. Assume that *the economy is initially in a position of balanced trade* ($TB = 0$). Given this, the necessary and sufficient condition for the devaluation to improve the trade balance, or for the foreign exchange market to be stable, is the Marshall-Lerner condition. The supplement to Chapter 4 includes a derivation of the Marshall-Lerner condition. Here, with price levels fixed in each country, the exchange rate plays the role of the price of foreign goods in terms of domestic. The condition is

$$\epsilon_X + \epsilon_M > 1$$

where ϵ_X and ϵ_M are the elasticities of demand for exports and imports, respectively. For example, if exports have an elasticity of exactly one, a devaluation leaves export revenue unchanged in foreign currency (the second and third factors just described cancel out); then, if import demand has any elasticity, the devaluation reduces imports, thereby improving the trade balance. Alternatively, if imports are more-than-unit elastic and exports have any elasticity, or if both elasticities are greater than one-half, then the third factor will be outweighed by the first two and the trade balance again will improve.[4]

We have discussed the supply and demand for foreign exchange, but we could as easily have discussed the demand and supply of *domestic* exchange. Assuming again that the starting point is a position of balanced trade, the Marshall-Lerner condition applies unchanged to the question of the trade balance expressed in domestic currency.[5]

[4]The proof of the Marshall-Lerner condition in the present context (i.e., where the exchange rate takes the role of the relative price) is given in the supplement to this chapter.

[5]The proof of the Marshall-Lerner condition in terms of domestic currency is left to the student in problem 5a at the end of the chapter.

The model can be generalized in two directions. First, Assumption 4 can be relaxed. In particular, note that in practice a country seldom devalues unless it starts from a position of deficit, rather than balanced trade: $TB < 0$, or $EP^*M > PX$. Now, it makes a difference whether the trade balance is measured in terms of domestic currency or foreign currency. If trade is measured in terms of domestic currency, the necessary condition for a devaluation to improve the trade balance is more stringent: The elasticities must be higher than those given by the Marshall-Lerner condition.[6] The economic reason is that, given the relatively large initial value for imports, M, the valuation effect on import spending is more negative. For example, the export elasticity could be as high as one, and yet if the import elasticity—even though positive—is not high enough, the trade balance could worsen. A 10 percent devaluation may raise exports 10 percent, yet this accomplishes little if exports initially were a small number; meanwhile, the already large import bill increases by almost 10 percent.

Another generalization involves relaxing Assumption 3—that firms exhibit infinitely elastic supply. The supplement to this chapter (second half) considers this general case.

According to general equilibrium theory, consumer demand should be a function not of nominal prices but of *relative prices and real income*. The elasticities approach is frequently criticized for the partial equilibrium nature of Assumption 1. (Partial equilibrium means that some important variables are held constant.) For example, an increase in demand for a country's exports should raise its real income and thus raise its demand for imports, but in the elasticities model there are no such effects. Chapter 17 begins to remedy this deficiency by introducing income as a variable in the import demand function.[7]

16.2 EMPIRICAL EFFECTS OF DEVALUATION ON THE TRADE BALANCE

Clearly, much depends on the magnitude of the import and export elasticities. Are they large enough in practice for a devaluation to improve the trade balance? It is now time to turn to the empirical evidence.

Elasticity Pessimism

In the 1940s a view known as elasticity pessimism arose, suggesting that actual trade elasticities were too low to satisfy the Marshall-Lerner condition. Several factors contributed to this view. First, floating exchange rates in the 1930s were

[6]You are asked to show this in problem 5b at the end of the chapter.

[7]Restrictive conditions under which the elasticities approach is theoretically correct after all are adduced by Rudiger Dornbusch, "Exchange Rates and Fiscal Policy in a Popular Model of International Trade," *American Economic Review* (December 1975). These conditions include the requirement that exports and imports are a sufficiently small proportion of income relative to non-traded goods. In general, however, a devaluation has further effects beyond those covered in this chapter, via the relative price of non-traded goods, as will be seen in Chapter 20. The partial equilibrium nature of the elasticities approach was also shown by Ronald Jones, "Stability Conditions in International Trade: A General Equilibrium Analysis," *International Economic Review*, 2, 2 (May 1961): 199–209.

unstable, in that they were highly variable. The appendix to this chapter shows that the Marshall-Lerner condition is also the necessary condition for a stable foreign exchange market under floating rates. Thus, highly variable exchange rates seemed to imply low trade elasticities. Second, many countries on fixed exchange rates found their trade balance worsening after a devaluation, rather than improving.

Both of these points are still made with respect to the current floating rate period. The second point acquired new force when oil assumed such significance in most countries' imports after 1973. Because the demand for oil is relatively inelastic in the short run, many small countries discovered that a devaluation against the dollar raised their oil import bill proportionately when expressed in domestic currency, thus worsening their trade balance. When a deficit country is advised to devalue its currency, it often argues that its elasticities are too low for a devaluation to help.

A third factor that originally contributed to the rise of elasticity pessimism was that early econometric estimates of the demand elasticities were low, frequently less than one-half. However, there were a number of problems with these estimates. They ignored the possible simultaneous existence of an upward-sloping supply relationship, problems of aggregation, errors in the measurement of the variables, and the crucial role of *time lags*.[8] Some studies measure only relatively short-run elasticities, but there is abundant evidence that the factor of time is important. Elasticities are higher in the long run, which makes the Marshall-Lerner condition more likely to hold.

The J-Curve

Some studies that allow for lags of import demand in response to changes in relative prices have found that only about 50 percent of the full quantity adjustment takes place in the first three years; 90 percent occurs in the first five years. For example, although the dollar began a big appreciation in 1980, U.S. exports did not fall absolutely until 1982. The trade deficit then set records in each of the next several years. The magnitude of these deficits is attributed primarily to the continued appreciation of the dollar. The dollar peaked in March 1985 and then depreciated over the subsequent two years, but because of these lags, the favorable effect on the quantities of exports and imports did not begin to show up until the end of 1986, and the effect on the dollar trade balance did not begin to show up until the end of 1987.

In the case of the 1981–1985 appreciation and 1985–1986 depreciation of the dollar, contrary to what we have assumed, dollar prices of imports did not respond immediately or fully to the exchange rate—because many importers, rather than passing exchange rate changes immediately through to import prices, at first

[8]Faulty measurement of prices is particularly common in foreign trade. For example, importers in some countries under-invoice, that is, understate the price of their imports so as to minimize the import duty they must pay. Also, where laws require exporters to turn over all their foreign exchange earnings to the government, exporters might understate their prices in order to retain some of the scarce foreign exchange for themselves. Such measurement errors in the price data make it more difficult to discern a statistical relationship.

absorbed in their profit margins much of the difference between foreign currency prices and domestic currency prices. The delayed pass-through to import prices added an extra lag at the beginning, before the elasticities could even begin to come into play. The case of the United States is unusual in that only a small portion of an exchange rate change tends to be immediately passed through to import prices.

There are a number of reasons why demand elasticities rise over time, and why the quantities demanded are slow to respond even after the change in the exchange rate is passed through to import prices. First, there is a lag due to imperfect dissemination of information, during which importers recognize that relative prices have changed.

Second, there is a lag in deciding to place a new import order. In the case of firms' imports of inputs, it may take months or years before inventories are depleted or machinery is worn out and replacements are needed. Also, a firm may be tied to a particular supplier, through implicit or explicit contracts. In the case of consumers' imports, changing habits takes time. For example, when the price of energy jumped upward in 1973, the continued strong demand caused many observers to assert that energy demand was essentially inelastic. With the passage of time, however, energy demand fell considerably. The adjustment process required not only overcoming the momentum of old patterns of consumption but also changing where people live and what kind of cars they drive.

Third, after a new import order has been placed, there may be production and delivery lags before it is filled. Much internationally traded merchandise is still transported by ship, requiring weeks or months in transit. Payment is typically not made before delivery, even though the contract may have been signed months earlier.

The fourth reason why trade quantities respond more fully with the passage of time, and the reason that can potentially draw out the process the longest, is that producers sometimes relocate their factories to the country where costs are lower because of an exchange rate advantage, regardless of whether it is the home country of the producer or the country where the goods are sold. For example, when the yen appreciated strongly in 1985–1995, some Japanese firms that had previously been exporting with great success, found that they were losing out to competition from countries with lower cost. To compete more effectively, they moved some operations to other countries with lower-valued currencies. Thus, sales in the world market that were previously counted under Japan's exports came to be counted under the host countries' exports.

Obviously, the response of export and import quantities after an exchange rate change is greater in the long run than in the short run, as companies are able to relocate their plant and equipment. The transition costs are large. For this reason, a company is unlikely to relocate until the change in the exchange rate has endured enough to convince the company that the fluctuation is not transitory. Such an endurance test may take as long as five or ten years. Indeed, even after the exchange rate has returned to old levels, a company that decided to move operations abroad when the dollar was high might never move back, after having incurred the costs of moving. The word *hysteresis* is used to describe such not-easily-reversed reactions.

The tendency of the elasticities to rise over time results in the commonly observed phenomenon of the J-curve. The trade balance following a devaluation is observed

first to worsen and then to improve, in the J-like pattern of Figure 16.3. (The figure assumes an initial trade balance of zero.) At the moment of the devaluation, quantities have had no time to adjust and the Marshall-Lerner condition fails. In fact, if quantities do not respond at all initially, then only the negative valuation effect remains: The trade balance worsens by the initial level of exports times the percentage decrease in their foreign currency value caused by the devaluation.[9] However, as time passes, export demand begins to pick up and import demand begins to fall. A point is reached where the curve crosses the zero axis, which means that the elasticities are high enough to sum to one and the trade balance is back at zero. After that point, the Marshall-Lerner condition holds and the trade balance moves into surplus. The surplus must run for a while if the reserves accumulated are to outweigh the reserves lost during the initial period of deficit.

All this assumes that exporters in the home country continue to supply whatever quantity is demanded at the same fixed price. This may get increasingly harder, especially if they are operating close to full capacity. The exporters in the devaluing country will be tempted to raise their prices in response to the increasing demand. Alternatively, their workers may demand higher wages in response to the greater cost of imported consumer goods, and the firms will be "forced" to pass through the higher labor costs in the form of higher prices. However, we will stay with the fixed-price assumption until Chapter 19.

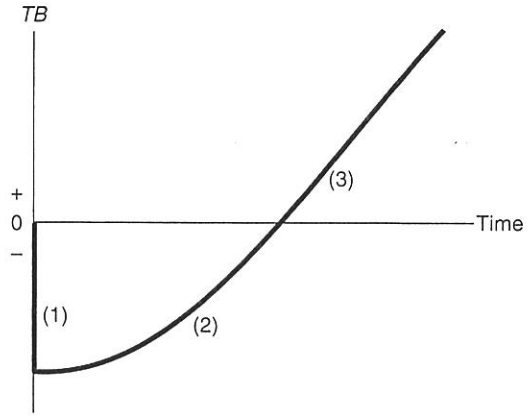
16.3 SUMMARY

The exchange rate is defined as the price of foreign exchange in terms of domestic currency. Under a floating exchange rate system, the central bank does not intervene in the foreign exchange market, and the exchange rate is determined by supply and demand in the market: An increase in the demand for foreign exchange causes an increase in the price of foreign exchange (a depreciation of the domestic currency). Under a fixed exchange rate system, an increase in demand for foreign exchange means that the central bank has to supply the difference—the net demand for foreign exchange, which is the balance-of-payments deficit—out of its foreign exchange reserves.

This chapter adopted the first and simplest model of what determines the balance of payments. Part IV does not include capital flows; this chapter looked only at the effect of the exchange rate on the trade balance, holding constant the level of income, interest rate, price level, and other macroeconomic variables that will be introduced in subsequent chapters. A devaluation of the currency (or, under floating exchange rates, a depreciation) increases the quantity of exports

[9]If it takes time before the exchange rate change is passed through to domestic prices of imports, the initial worsening in the trade balance is spread over a longer period. The downward sweep of the J would then be more round than as shown in the figure.

Figure 16.3
The J Curve
In the aftermath of a devaluation, the trade balance (1) worsens initially, due to the perverse valuation effect, then (2) gradually improves over time as the elasticities rise, and finally (3) surpasses its starting point when the Marshall-Lerner condition is satisfied.



demanded by foreign residents and decreases the quantity of imports, working to improve the trade balance. A third effect that works to worsen the trade balance, however, is the higher cost in domestic currency of any given quantity of imports that have prices set in foreign currency. Only if the sum of the import and export elasticities is high enough, as in the Marshall-Lerner condition, will the quantity effects dominate and the trade balance improve after the devaluation.

Empirically, the elasticities do appear to be high enough for a devaluation to improve the trade balance, but only after enough time has passed. In the short run, the trade balance often worsens, which gives rise to the J-curve pattern of response.

CHAPTER PROBLEMS

1. The newspaper reports that the dollar/euro exchange rate has risen. (The euro is the new European currency.)
   a. Does this news mean that the value of the dollar has risen or fallen? The value of the euro?
   b. Does this mean that the dollar/yen rate is more likely to have gone up than down?
   c. Does this mean that the euro/yen rate is more likely to have gone up than down? (*Hint*: If neither the dollar/yen rate nor the euro/yen rate has changed, what does that imply for the dollar/euro rate?)
2. Assume that the United States is currently exporting 10 million calculators at a price of $10 apiece and importing .002 million BMWs at a price of 100,000 euro apiece, and that the current exchange rate is 50 cents per euro. Calculate in a table the effect of a 10 percent devaluation of the dollar on each of 12 variables under each of four sets of assumptions about the elasticities (assuming infinitely elastic supply and no income effects). You may round off.

		Before the Devaluation (a)	After the 10% Devaluation (b)	(c)	(d)	(e)
			Export Elasticity: 0	½	1	4
			Import Elasticity: 0	0	½	1
(1) Export quantity		10m				
(2) Import quantity		.002m				
Expressed in $	(3) Export price	$10				
	(4) Import price					
	(5) Export earnings					
	(6) Import spending					
	(7) Trade balance					
Expressed in euro	(8) Export price	100,000 euro				
	(9) Import price					
	(10) Export earnings					
	(11) Import spending					
	(12) Trade balance					

3. a. In the example from Problem 2, comment on the trade balances in (b) and (c) versus those in (d) and (e).
   b. In which case is spending on imports in dollars very close to what it was before the devaluation? Why?
   c. In which case are earnings from exports in euros very close to what they were before the devaluation? Why?
   d. Starting from a position of importing .003 million BMWs, with everything else remaining the same, what would be the initial trade balance in dollars? For given elasticities, for example, (d), would the devaluation cause the trade balance to improve (i.e., the trade deficit decrease) by more than, less than, or the same amount as in Problem 2? (A numerical answer is not necessary, but is fine if you can't do it intuitively.)
4. The trade balance expressed in domestic currency, with prices normalized to 1, is $TB = X(E) - EM(E)$.
   a. Illustrate the effect of a devaluation graphically, that is, repeat Figure 16.2, but with domestic-currency prices on the vertical axis.
   b. If the import elasticity is greater than 1 and the export elasticity is greater than 0, then the Marshall-Lerner condition holds. Is this condition sufficient to imply that TB, the trade balance expressed in domestic currency, improves? (You may assume the starting point is $TB = 0$.) Explain why, in terms of export revenue and import spending.

Extra Credit

5. a. If you know calculus, prove that the Marshall-Lerner condition is still the correct condition necessary and sufficient for a devaluation to improve TB, the trade balance expressed in *domestic* currency, starting from $TB = 0$.
   b. Starting from $TB < 0$, is the Marshall-Lerner condition too strong or too weak for a devaluation to improve the trade balance?
   c. The trade balance expressed in domestic currency is equal to the exchange rate times the trade balance expressed in foreign currency: $TB = E\ TB^*$.
      (i) Does it follow that if the trade balance is in surplus when expressed in foreign currency, then it is also in surplus when expressed in domestic currency?
      (ii) Does it follow that $dTB/dE = E\ dTB^*/dE$? Why not?
      (iii) If initially $TB < 0$, which is greater: the lefthand side in the preceding question or the righthand side?
      (iv) Which side is greater if initially $TB > 0$?
      (v) Which is greater if initially $TB = 0$?
   d. Assume we start from a position of deficit, and the elasticities sum approximately to one.
      (i) Notice from the supplement to Chapter 16 that if $E\ M > X$ initially, the Marshall-Lerner condition is more than sufficient to imply $dTB^*/dE > 0$. E.g., if both elasticities are ½, that is enough for a devaluation to improve the trade balance in foreign currency. On the other hand, from (b) above we know that $dTB/dE < 0$ under these conditions. Can the trade balance improve in terms of foreign currency while worsening in terms of domestic currency? (Refer to your answers to questions c (ii) and c (iii).)
      (ii) If a devaluation brings the trade deficit back to zero in terms of foreign currency, then it must also do so in terms of domestic currency, because E times zero is zero. There is an apparent contradiction between this fact and the answer to (i). What is it? How do you reconcile the apparent contradiction?
6. It is possible (if old-fashioned) to stay within the partial equilibrium elasticities approach and yet relax the assumption that supply is infinitely elastic. The Bickerdicke-Robinson-Metzler condition for a devaluation to improve the trade balance is

$$\frac{\epsilon_M\epsilon_X(1 + \sigma_M + \sigma_X) - \sigma_M\sigma_X(1 - \epsilon_M - \epsilon_X)}{(\sigma_M + \epsilon_M)(\sigma_X + \epsilon_X)} > 0$$

where σ_M and σ_X are the supply elasticities of imports and exports, respectively.

a. Prove that in the limit, as σ_M and σ_X go to infinity, the formula reduces to the Marshall-Lerner condition.
b. Does the presence of the supply elasticity terms make the condition more or less stringent than the Marshall-Lerner condition?

SUGGESTIONS FOR FURTHER READING

Bergsten, C. Fred, ed. *International Adjustment and Financing, The Lessons of 1985–1991* (Washington: Institute for International Economics, 1991). Did the dollar depreciation of 1985–1987 reduce international trade imbalances as promised? At least one contributor, Paul Krugman, answers yes.

APPENDIX

STABILITY OF THE FOREIGN EXCHANGE MARKET

The focus now turns from the comparative statics of the foreign exchange market, considered in Section 16.1, to the question of stability under a floating exchange rate. The theoretical question of whether a market equilibrium is stable (as in Chapter 4) is not the same as the question of whether the market price moves around a lot. The theoretical question is the following: If an equilibrium price is displaced slightly, will it tend to return to its original value?

Think of foreign exchange traders as individuals who buy from and sell foreign exchange to each other on the floor of centralized exchanges in New York and elsewhere, or, in the case of the trading divisions of banks, on a network of telephones and computer terminals. Assume that whenever foreign exchange traders find that demand exceeds supply, they raise the exchange rate; whenever supply exceeds demand, they lower it. Consider the following three cases.

1. Assume that the demand curve slopes down and the supply curve slopes up, as in Figure 16.A.1(a). If the curves are derived from import spending and export earnings, respectively, this first case is the one where the elasticity of demand for exports is greater than one. In response to an increase in demand, from D to D', the traders raise the exchange rate. This raises export revenue, reduces the excess demand for foreign exchange, and thus constitutes a move toward the new equilibrium. The market is stable.
2. Next, assume that the demand curve slopes down and the supply curve slopes down also, but more steeply, as in Figure 16.A.1(b). Again, in response to an increase in demand, the traders raise the exchange rate, causing a move toward equilibrium. Again the market is stable. This is the case where the elasticity of demand for exports is less than one (so the increase in the exchange rate *lowers* export revenue)

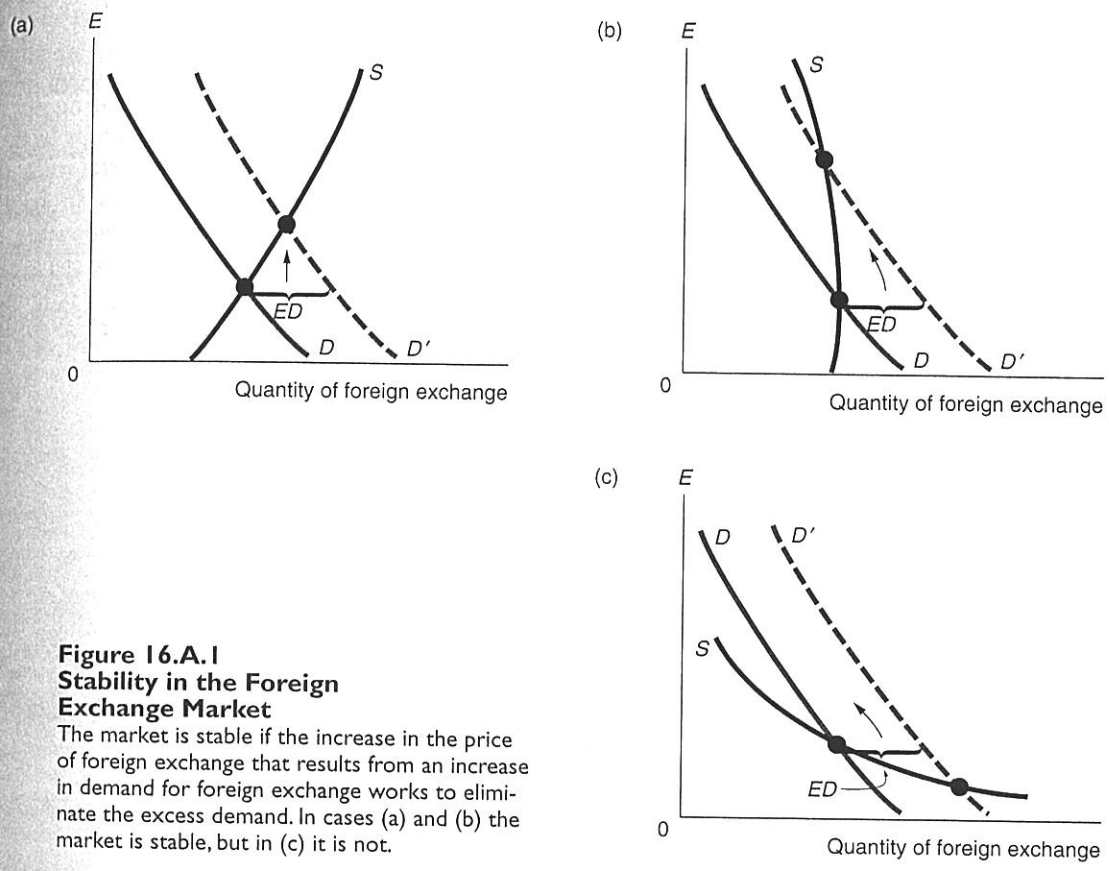


Figure 16.A.1
Stability in the Foreign Exchange Market
The market is stable if the increase in the price of foreign exchange that results from an increase in demand for foreign exchange works to eliminate the excess demand. In cases (a) and (b) the market is stable, but in (c) it is not.

but the sum of the two elasticities is nevertheless high enough to satisfy the Marshall-Lerner condition.

3. Finally, assume that both curves slope down, but the supply curve is less steep, as in Figure 16.A.1(c). This is the case where the Marshall-Lerner condition fails. This time, when the traders respond to the increase in demand by raising the exchange rate, they cause a move *away* from the new equilibrium. At the higher exchange rate, excess demand is even greater, so the traders raise the exchange rate again, and the situation is farther still from equilibrium. The market is unstable.

These examples show that the required condition for stability is that the supply curve slopes up or, if sloping downward, is steeper than the demand curve.

As a practical matter, a floating exchange rate usually will not shoot off to infinity. One possibility is that there are two stable equilibria surrounding an unstable one, much as is shown in Figure 4.A.1. Even if the market is stable in the technical sense, however, it may be unstable in the sense that the market-clearing price is highly variable. Very small changes in demand may produce large jumps in the exchange rate. High variability in the exchange rate may create uncertainty and imply high costs for importers and exporters. These are often cited as an argument against floating exchange rates. This chapter showed that if the demands for exports and imports are relatively inelastic, then the curves representing the supply and demand for foreign exchange will be relatively steep. Resulting exchange rates may be highly variable if the exchange rate is called upon to clear the trade balance.[10]

[10]It has been argued that the trade elasticities facing the United States may have become lower in the 1980s than they were previously. The reason is that exchange rates move around more than they used to, so that firms now regard a given movement in the exchange rate as less likely to be permanent and thus pay less attention to it (much as insects become more resistant to some insecticides the more they are used). Paul Krugman, *Exchange Rate Instability* (Cambridge, MA: M.I.T. Press, 1988). With lower trade elasticities, it is then hypothesized that larger swings in exchange rates will be required to eliminate given trade imbalances than used to be necessary.