6 Exchange Rates and Trade

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Our discussion of purchasing power parity in chapter 5 documented the large short-run fluctuations in the real exchange rate. In this chapter we will consider the effect of such fluctuations on the balance of trade. Since exchange rates are much more volatile than prices, nominal exchange-rate movements lead to changes in the relative price of foreign goods. This change in relative prices affects the foreign demand for domestic goods as well as the domestic demand for imports.

### Learning Goals

After reading this chapter, you will understand:

- how the real exchange rate affects imports and exports
- the Marshall-Lerner condition
- the J-curve
- how trade-balance effects can be incorporated into the monetary approach

## 6.1 Trade Balance Response to the Real Exchange Rate

We begin our analysis of the effects of the exchange rate on the balance of trade with two simplifying assumptions. First, let us momentarily hold constant real income. Second, let us initially hold constant all prices except the nominal exchange rate. Specifically, the domestic currency prices of domestically produced goods will remain unchanged, as will the foreign currency price of foreign produced goods. This is equivalent to saying that the supply of any good is infinitely elastic at its home country price. Exogenous income and prices are “ceteris paribus” assumptions that will simplify our initial analysis.

Consider our demand for imports, \( M^d(SP^*/P,Y) \). As illustrated in Figure 6.1, the demand depends negatively on the relative price of the foreign good, which is the real exchange rate. (It also depends positively on real income, an effect we ignore for now but will return to in the future.) Thus if the domestic currency depreciates, there is a rise in the relative
cost of imports and a decline in import demand. This reduces our total expenditures on imports, measured in foreign exchange.

Figure 6.1: Imports and the Demand for Foreign Exchange ($S_2 > S_1$)

Now consider foreign demand for our goods, $X^d(SP*/P,Y*)$. This demand depends negatively on the relative price of the domestic good, and therefore depends positively on the real exchange rate. (It also depends positively on real foreign income, an effect we ignore for now.) Thus if the domestic currency depreciates, foreigners experience a fall in the relative cost of their imports (domestic exports), and we see a rise in the demand for domestic exports.

Figure 6.2: Exports and the Supply of Foreign Exchange ($S_2 > S_1$)

Since a depreciation of the domestic currency leads to a rise in the quantity of exports and a fall in the quantity of imports, it may seem natural that such a depreciation improves
the balance of trade. However, that is not necessarily the case. The balance of trade is a measure of the value of exports relative to the value of imports, not of the quantity of exports relative to the quantity of imports. A change in the exchange rate has a price effect on relative values that can offset the changes in quantities.

To see this, let us focus on a common policy situation for countries that have pegged their exchange rate to another currency. When foreign exchange reserves are running low, it is often proposed that a devaluation of the domestic currency can help replenish these reserves. The idea is that selling more abroad while importing less will raise net foreign exchange receipts. But figure 6.2 shows us that a devaluation of the domestic currency can reduce the value of exports. While it is true that there is an increase in the quantity of exports, there is also a reduction in the amount of foreign exchange earned from each unit of exports. The net effect is a rise in the foreign exchange value of exports only if the quantity of exports increases faster than the price falls. That is, exports are earning more foreign exchange only if export demand is elastic.

Of course an improvement in net foreign exchange earnings does not depend entirely on the increase in exports; the reduction in imports also contributes. Consider the domestic trade balance measured in foreign currency:

\[ TB^{FX} = \frac{P}{S}X - P^*M \]  

(6.1)

Given the foreign and domestic prices, we see that a change in the exchange rate has three effects on the trade balance: the quantity of imports changes, the quantity of exports changes, and the foreign exchange value of each unit of exports changes. The last effect is called the valuation effect or the price effect: \( P/S \) is the foreign exchange earned by each unit of exports, and a change in \( S \) will change this quantity directly.
6.1. TRADE BALANCE RESPONSE TO THE REAL EXCHANGE RATE

6.1.1 Marshall-Lerner Condition

For a depreciation of the domestic currency to increase foreign exchange earnings, we need quantity effects of falling imports and rising exports together to be larger than the valuation effect of the rise in $S$. The Marshall-Lerner condition is a precise statement of this requirement: given an initial position of balance trade, a depreciation will improve the trade balance if the export and import elasticities of demand sum to more than unity.

$$\epsilon_X + \epsilon_M > 1 \quad (6.2)$$

Here $\epsilon_X$ is the real exchange rate elasticity of demand for exports and $\epsilon_M$ is the real exchange rate elasticity of demand for imports.

The intuition for the Marshall-Lerner condition is straightforward. Suppose X and M were completely unresponsive to changes in relative prices. Then a 1% rise in the exchange rate would lead to a 1% fall in the value of our exports, deteriorating the trade balance. This fall can be obviously be offset by a 1% rise in the quantity of exports. If we begin with balanced trade, so that the value of imports equals the value of exports, then for the same reason the price effect could be offset by a 1% decrease in the value of imports, which can be achieved by a 1% decrease in the quantity of imports.

The policy application for countries with pegged exchange rates is not immediate however. Devaluation is generally considered when the trade balance is in deficit, not when it is in balance. In these circumstances, the value of imports is initially larger than the value of exports. While a 1% increase in the exchange rate may still be offset by a 1% increase in the quantity of exports, it can now be offset by less than a 1% decrease in the value of imports. The condition for an improvement is relaxed: the sum of the elasticities may be smaller. A 1% fall in the quantity of imports, which surely reduces the value of imports by 1%, has a larger effect on the trade balance than a one percent rise in $S$, which reduces the (smaller) value of exports by 1%.
Algebra

To make the algebra as simple as possible, we will work with the trade balance measured in terms of the domestic good: $TB = X - QM$.

$$TB(Q, Y, Y^*) = \frac{S}{P} TB^{FX}$$

$$= X(Q, Y^*) - QM(Q, Y) \quad (6.3)$$

Differentiating with respect to the real exchange rate $Q$, we get

$$\frac{\partial TB}{\partial Q} = X_Q - QM_Q - M$$

$$= M \left( X_Q \frac{Q}{QM} - M_Q \frac{Q}{M} - 1 \right)$$

$$= M \left( \epsilon_x \frac{X}{QM} + \epsilon_m - 1 \right) \quad (6.4)$$

$$= M \left( \epsilon_x \frac{TB}{QM} + \epsilon_x + \epsilon_m - 1 \right)$$

where $\epsilon_x$ is the real exchange rate elasticity of exports and $\epsilon_m$ is the real exchange rate elasticity of imports. From an initial position of trade balance (so that $X = QM$), this simplifies to

$$\frac{\partial TB}{\partial Q} = M(\epsilon_x + \epsilon_m - 1) \quad (6.5)$$

which is positive iff the Marshall-Lerner condition is satisfied.

When we attempt to apply this analysis to the devaluation of a pegged exchange rate, we must recall that devaluation is most commonly considered in situations of balance of payments difficulties. This makes the more general condition (6.4) of considerable interest. Note that when the trade balance is in deficit (so that $X < QM$) satisfaction of the Marshall-Lerner condition is not sufficient to improve the trade balance. The intuition lies in the larger price effect, which in this setting falls on import prices.
Figure 6.3: U.S. Current Account and Real Exchange Rate ($Q$)
Figure 6.4: U.S. Trade Balance (No Oil) vs. Real Exchange Rate ($1/Q$)


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6.1. TRADE BALANCE RESPONSE TO THE REAL EXCHANGE RATE

Link to Houthakker-Magee Critique

Consider two countries with growing income and an initial balance of trade. Then

\[ X(Q, Y^*) = QM(Q, Y) \tag{6.6} \]

In order to maintain trade balance, we need the left and right sides to grow at equal rates. That is, we need the rate of growth of exports to equal the rate of growth of the real value of imports. Letting \( \xi_x \) be the income elasticity of exports, the growth rate of the left side is

\[ \dot{X} = \xi_x \dot{Y}^* + \epsilon_x \dot{Q} \tag{6.7} \]

Letting \( \xi_m \) be the income elasticity of imports, the growth rate of the right side is

\[ \dot{M} = \xi_m \dot{Y} - \epsilon_m \dot{Q} \tag{6.8} \]

To maintain trade balance we need

\[ \dot{X} = \dot{M} + \dot{Q} \tag{6.9} \]

or equivalently (as we saw above)

\[ \xi_x \dot{Y}^* + \epsilon_x \dot{Q} = \xi_m \dot{Y} - \epsilon_m \dot{Q} + \dot{Q} \tag{6.10} \]

From this we can solve for the real exchange rate growth rate that is required to maintain trade balance:

\[ \dot{Q} = \frac{\xi_x \dot{Y}^* - \xi_m \dot{Y}}{1 - \epsilon_x - \epsilon_m} \tag{6.11} \]

We see that there will be a trend in the real exchange rate unless

\[ \frac{\xi_x}{\xi_m} = \frac{\dot{Y}}{\dot{Y}^*} \tag{6.12} \]
Johnson (1958) noted the implication that trade can become increasingly unbalanced at a given real exchange rate. Houthakker and Magee (1969) provide an early empirical analysis suggesting that income elasticities of some countries are indeed divergent enough for this to be the case. For example, they find Japan’s income elasticity of exports to be nearly three times its import elasticity, while in the UK the income elasticity of exports is only half the import elasticity.
6.2. ELASTICITY DYNAMICS AND THE J-CURVE

Foreign Exchange

We can use our derivation of the Marshall-Lerner condition to determine the impact of a domestic currency depreciation on our earnings of foreign exchange. Note that

\[ TB^{FX} = P^* \frac{TB}{Q} \]

Given the foreign price level, it should be clear that with an initial trade balance of zero the Marshall-Lerner condition is again necessary and sufficient for a depreciation to improve foreign exchange earnings: \( TB > 0 \) implies \( TB^{FX} > 0 \).

However, an interesting difference emerges when we consider the impact of a domestic currency depreciation in the presence of a balance of trade deficit: recall from our earlier discussion that the Marshall-Lerner condition is sufficient to ensure that a depreciation will raise our foreign exchange earnings.

6.2 Elasticity Dynamics and the J-Curve

Are actual trade balance elasticities high enough to satisfy the Marshall-Lerner condition? The view known as elasticity pessimism answers “no” (Prais, 1962). The view became popular in the 1940s when in many countries devaluation failed to initiate trade balance improvements. Countries dependent on oil imports lent some support to elasticity pessimism in the 1970s. Oil was generally priced in dollars, and the demand for oil is inelastic in the short run. Devaluation against the dollar by oil dependent economies led to little change in the dollar value of their oil bill. Measured in domestic currency, the trade balance deteriorated.

Further, some early econometric estimates of the demand elasticities were low, lending some support to this view (Prais, 1962). Houthakker and Magee (1969) provide an early empirical analysis suggesting that import and export responses to relative prices are much more difficult to detect than responses to income. They suggest that this traces to simultaneity
Figure 6.6: CA and a Real Appreciation Shock (Impulse Response)
Source: Kappler et al. (2013)
problems and to inadequacies of the available import and export price indices. These estimates have since been criticized for many shortcomings including their partial equilibrium assumptions, neglect of endogenous price responses (BRM), measurement error (especially in price data, which are often misinvoiced), aggregation problems, and neglect of elasticity dynamics. The last critique has received special attention.

6.2.1 The J-Curve

Intuition suggests that given more time, consumers and producers will offer a larger response to a given price change. The evidence is supportive: import and export elasticities appear larger in the long run than in the short run. By the early 1970s, Junz and Rhomberg (1965), Magee (1973), and many others had shown empirically that trade balance elasticities were duration dependent. Both theoretical and empirical investigations have continued to support this conclusion. For example, given a real depreciation, some research suggests that only half of the eventual quantity adjustments are completed in the first three years. Even after five years the adjustment is not quite complete.

Think of the U.S. experience in the 1980s. The dollar began a massive appreciation in 1980 which continued until 1985, at which point an equally dramatic depreciation began. The trade balance did respond to these real exchange rate movements, but with a two to three year lag. Other countries exhibit similar elasticity dynamics.

In the presence of elasticity dynamics, we can imagine that the Marshall-Lerner condition is violated in the short run yet satisfied over a longer period of time. In such circumstances we would see a J-curve: a currency depreciation would initially cause a trade balance deterioration, but eventually the trade balance would recover and improve. Belief in the J-curve is widespread, but it has proved quite difficult to reliably document.

Magee (1973) provides the basic theoretical framework. He distinguishes three periods following an exchange rate fluctuation: the currency contract period during which movement in the trade balance is largely determined by the currency denomination of previous con-
tractual arrangements, the pass-through period during which the domestic price of foreign goods adjusts to the exchange rate changes, and the subsequent period of quantity responses to the changes in relative prices. Later theoretical elaborations highlight production and delivery lags, distribution bottlenecks, adjustment costs, decision lags, lags in distinguishing permanent and transitory changes in relative prices, intertemporal substitution effects resulting from anticipated price changes, and implicitly contracted long term trade relationships (Magee, 1973; Gerlach, 1989; Marquez, 1991). It is natural to expect habitual consumer expenditure patterns to play their role as well. Finally, firms are increasingly able to relocate their production facilities internationally.¹ The consistent prediction is that the long run real exchange rate elasticity of the trade balance exceeds the short run elasticity.

The unexpected adverse trade balance movements following the 1967 U.K. and 1971 U.S. devaluations led many early researchers to a more extreme position. For example, Dornbusch and Krugman (1976) argue that short-run elasticities may be small enough to violate the elasticity condition and generate a “J-curve”: a perverse, negative short run response of the trade balance to a real depreciation, followed by an eventual improvement.

The events of the 1980s renewed interest in the J-curve, but the existence as well as the

---

¹For example, during the dollar appreciation of the early 1980s, U.S. companies moved production abroad. With the subsequent depreciation, some companies returned to domestic production. In addition, foreign firms shifted production to the U.S. (Japanese auto manufacturing may be the best known example.) Note that if some U.S. companies may continue to operate their new foreign production, despite the dollar reversal. Such permanent change in response to temporary shocks is known as hysteresis.
duration of any perverse effect remains in dispute. Moffett (1989) and Noland (1989) find protracted perverse responses of the U.S. and the Japanese trade balances. Marquez (1991) finds a perverse effect averaging five quarters for the U.S., while Artus (1975) finds only a one quarter perverse effect for the UK. Other work finds no indication of a perverse effect. Koch and Rosensweig (1990) do not detect an initial perverse response of the U.S. trade balance, although they suggest the possibility that delays in pass through may generate a delayed perverse effect. Felmingham (1988) confirms that the real exchange rate elasticity of the Australian trade balance increases over time, but he finds a normal trade balance response even in the first quarter following a real exchange rate change. Finally, Rose and Yellen (1989) argue that evidence of a perverse response of the U.S. trade balance stems from a neglect of aggregation, non-stationarity, and simultaneity problems.

Rose (1990) considers the elasticity issue for thirty developing countries. He tries to explain changes in the real trade balance for these countries with changes in the real exchange rate, domestic real income, and foreign real income. He finds it impossible for most countries to reject the hypothesis that the real exchange rate has no effect whatsoever on the real multi-lateral trade balance.

In sum, both empirical and theoretical investigations indicate that elasticity dynamics are an important determinant of the response of the trade balance to real exchange rate changes. Whether the short run elasticity is small enough to generate a J-curve is more controversial.

6.3 A Simple “Classical” Model

We have discussed the dependence of the trade balance on the real exchange rate. Now it is time to incorporate this into a model of exchange rate determination.

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2It is crucial to note that he uses an instrument for the real exchange rate and does not report results for the actual real exchange rate. Lags of the regressors are included to accommodate elasticity dynamics. Rose (1990) also includes an error correction term. He presents both annual (1970–1988) and quarterly (1977–1987) results. Real income is only available annually for these countries, so he proxies real income with real money.
### Table 6.1: Import and Export Elasticities over Time

<table>
<thead>
<tr>
<th>Country</th>
<th>$\eta$ Impact</th>
<th>$\eta$ Short-run</th>
<th>$\eta$ Long-run</th>
<th>$\eta^*$ Impact</th>
<th>$\eta^*$ Short-run</th>
<th>$\eta^*$ Long-run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0.39</td>
<td>0.71</td>
<td>1.37</td>
<td>0.03</td>
<td>0.36</td>
<td>0.80</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.18</td>
<td>0.59</td>
<td>1.55</td>
<td>—</td>
<td>—</td>
<td>0.70</td>
</tr>
<tr>
<td>Britain</td>
<td>—</td>
<td>—</td>
<td>0.31</td>
<td>0.60</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Canada</td>
<td>0.08</td>
<td>0.40</td>
<td>0.71</td>
<td>0.72</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.82</td>
<td>1.13</td>
<td>1.13</td>
<td>0.55</td>
<td>0.93</td>
<td>1.14</td>
</tr>
<tr>
<td>France</td>
<td>0.20</td>
<td>0.48</td>
<td>1.25</td>
<td>—</td>
<td>0.49</td>
<td>0.60</td>
</tr>
<tr>
<td>Germany</td>
<td>—</td>
<td>—</td>
<td>1.41</td>
<td>0.57</td>
<td>0.77</td>
<td>0.77</td>
</tr>
<tr>
<td>Italy</td>
<td>—</td>
<td>0.56</td>
<td>0.64</td>
<td>0.94</td>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>Japan</td>
<td>0.59</td>
<td>1.01</td>
<td>1.61</td>
<td>0.16</td>
<td>0.72</td>
<td>0.97</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.24</td>
<td>0.49</td>
<td>0.89</td>
<td>0.71</td>
<td>1.22</td>
<td>1.22</td>
</tr>
<tr>
<td>Norway</td>
<td>0.40</td>
<td>0.74</td>
<td>1.49</td>
<td>—</td>
<td>0.01</td>
<td>0.71</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.27</td>
<td>0.73</td>
<td>1.59</td>
<td>—</td>
<td>—</td>
<td>0.94</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.28</td>
<td>0.42</td>
<td>0.73</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>United States</td>
<td>0.18</td>
<td>0.48</td>
<td>1.67</td>
<td>—</td>
<td>1.06</td>
<td>1.06</td>
</tr>
</tbody>
</table>


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Table 6.1: Import and Export Elasticities over Time
6.3. A SIMPLE “CLASSICAL” MODEL

The flexprice monetary approach model treats the real exchange rate as exogenous, so it cannot help us understand variations in the real exchange rate. We have seen that absolute PPP is clearly violated, and that even relative PPP is violated at least in the short run. This suggests that if we wish to develop an exchange rate model capable of making short run predictions, we will need to accommodate PPP violations. We approaches the problem in two steps. First, in this section we develop the Classical version of the Mundell-Fleming model, where net exports are less than perfectly elastic with respect to variations in the real exchange rate. This allows real shocks, including fiscal policy shocks, to influence the real exchange rate. The second step will be taken in chapter 7, where we allow for “sticky prices” in the short run. Sticky prices imply that even monetary policy can influence the real exchange rate in the short run.

Let us begin with the long-run model. It will be Classical in structure, treating nominal money, real income, and the real interest rate as exogenous constants. The money market is in constant equilibrium, once again represented by (6.13).

\[
\frac{H}{P} = L(i, Y) \tag{6.13}
\]

On the left is the real money supply. On the right is real money demand, also known as liquidity preference. In figure 6.9, we we draw the combinations of price level and spot rate such that (6.13) holds. Since we are asking that liquidity preference equal the real money supply, we label this the “LM curve”.

In our simple monetary approach model, goods market equilibrium was simply a matter of purchasing power parity. Now however we recognize that the real exchange rate—as the relative price of foreign goods—influences the demand for a country’s output. That is, aggregate demand is influenced by the real exchange rate, as well as by the interest rate,
income, and fiscal policy.\(^3\)

\[ Y = AD(i, Y, G, SP^* / P) \] (6.14)

Note that the aggregate demand function includes the influence of the real exchange rate. Since the exchange rate is an endogenous variable, the real exchange rate now adjusts to achieve goods market equilibrium.

We will use (6.13) and (6.14) to determine the price level and the spot rate. For now, all other variables are treated as exogenously fixed. This is represented by figure 6.9. Looking at (6.13), we see that there is a unique price level that clears the money market. So the LM curve is vertical. The IS curve represents goods market equilibrium. The slope of the IS curve is determined by the real exchange rate that clears the goods market. That is, if \( Q_o \) is the real exchange rate that satisfies (6.14), then the slope of the IS curve is \( Q_o / P^* \).

Due to the exogeneity of real income and the proportional response of \( P \) and \( S \) to \( H \), this model offers a particularly simple characterization of flexible exchange rates. Changes in the money supply have no real effects. A fiscal expansion, in contrast, causes a real appreciation.

Intuitively, the story is fairly simple. Consider monetary policy. Money is neutral in this Classical economy: changes in the nominal money supply do not affect any real variables. When we double the money supply in a Classical model the price level must double: since \( Y \) and \( i \) are given, the money supply increase shows up directly in the price level. Ceteris paribus, the higher prices reduce the demand for our goods via a deterioration in the trade balance, but this generates an excess supply in the goods market. The exchange rate must depreciate (the relative price of our goods must fall) to remove this excess supply and thereby restore equilibrium in the goods market.

If you are bothered by the lack of an explicit causal story, which would clarify the forces

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\(^3\)For the moment, we will ignore the role of wealth as determinant of aggregate spending. In chapter 10, we will add wealth considerations to this monetary approach model in order to develop the “portfolio balance approach”. We also momentarily ignore the role of expectations. This allows us to treat the interest rate \( i \) as exogenously given. In the background it depends on the real interest rate and inflation expectations. Further, the domestic interest rate \( i \) is linked to the foreign interest rate \( i^* \) by the international capital markets. We will explore these links later.
behind the exchange rate movement, that is natural. In order to get a better feel for how such outcomes might be generated in a natural fashion, we need a model where the dynamics are explicit. We will introduce such a model in chapter 9. However, the comparative statics are readily represented in figure 6.9.

![Figure 6.8: Money Supply Increase](image)

Now consider fiscal policy. Figure 6.10 represents the effects of a fiscal expansion. A fiscal expansion drives up demand, but output is unchanged. You might expect this to drive up the price level, reducing real balances and increasing the interest rate. But since capital is highly mobile, such an interest rate differential would lead to immense capital inflows. Such capital inflows would appreciate the exchange rate and shift demand away from domestic production, removing the pressure on prices. So the effect of fiscal policy falls entirely on the exchange rate and the trade balance. A fiscal expansion causes a real exchange rate appreciation that crowds out enough private demand to restore goods market equilibrium.

It is worth emphasizing that in this long-run model neither assumes nor implies purchasing power parity. For example, fiscal policy is one of the determinants of the long-run real exchange rate. Purchasing power parity requires that in the long run only relative prices are relevant to the determination of the exchange rate—a property that Edison (1987) calls *exclusiveness*.\(^4\) This simple Classical model violates exclusiveness because aggregate demand

\(^4\)Edison (1987) reports violations of exclusiveness in almost a century of USD/GBP exchange rates.
is one determinant of the real exchange rate.

6.3.1 Algebra

We can restate (6.13) and (6.14) in log-linear form as equations (6.15) and (6.16).

\[ h - p = \phi y - \lambda i \]  \hspace{1cm} (6.15)  
\[ y = \rho (s + p^* - p) - \sigma i + g \]  \hspace{1cm} (6.16)

The Classical version of the Mundell-Fleming model is based on the structural equations (6.15) and (6.16). Keep in mind that a model is more than a structure; it is also a specification of the endogenous variables. In the Classical Mundell-Fleming model, \( p \) is and \( s \) are endogenous.\(^5\)

\(^5\)Somewhat disturbingly, in one case (p.382) the violation is attributed to relative money supplies. Recall from footnote 3 we are putting off consideration of a number of factors: wealth effects, the role of expectations, and interest rate determination.
We can solve for $s$ and $p$ as follows.

\[
p = h + \lambda i - \phi y \tag{6.17}
\]

\[
s = h + \lambda i - \phi y - p^* + \frac{1}{\rho} (y - g + \sigma i)
\]

\[
= h - p^* - \frac{1}{\rho} g + \left( \frac{\sigma}{\rho} + \lambda \right) i + \left( \frac{1}{\rho} - \phi \right) y \tag{6.18}
\]

Note the recursive structure of the model: to solve for the price level, we only need equation (6.15). We can then plug this solution for $p$ into equation (6.16) to solve for the exchange rate.\(^6\)

You can see that money remains neutral in this model: if we double the money supply, the price level and nominal exchange rate also double.\(^7\)

### 6.4 Trade-Weighted Effective Exchange Rates

We like to speak of the effects of a change in “the” exchange rate. Of course every country has a multitude of exchange rates, one for every convertible currency in the world. Now changes in these exchange rates tend to be highly correlated, but they are not perfectly correlated. As a result, different exchange rates suggest different pictures of the change in the domestic currency’s value. For example, the U.S. dollar may rise against the yen at the same time it falls against the Canadian dollar.

One reason for divergence among a country’s exchange rates may be differing foreign inflation rates. That is, there may be a lot of nominal exchange rate movement without much real exchange rate movement. The purchasing power parity doctrine carries this observation

\(^6\)This recursive structure is readily seen as a zero restriction in the matrix representation of this system:

\[
\begin{bmatrix}
1 & 0 \\
-\rho & \rho
\end{bmatrix}
\begin{bmatrix}
p \\
s
\end{bmatrix}
= \begin{bmatrix}
h - \phi y + \lambda i \\
y + \sigma i - g - \rho p^*
\end{bmatrix}
\]

\[
\begin{bmatrix}
p \\
s
\end{bmatrix}
= \frac{1}{\rho} \begin{bmatrix}
\rho & 0 \\
\rho & 1
\end{bmatrix}
\begin{bmatrix}
h - \phi y + \lambda i \\
y + \sigma i - g - \rho p^*
\end{bmatrix}
\]

\(^7\)Recall doubling $H$ implies adding ln 2 to $h$. Likewise for the exchange rate and price level.
to the extreme: nominal exchange rate movements do not cause any real exchange rate movements. As we have seen in our discussion of purchasing power parity, however, nominal exchange rate movements do in fact produce real exchange rate movements. So differing inflation rates is not the whole explanation of divergence among a country’s exchange rates.

If all of a country’s exchange rates behaved identically, there would be little harm in speaking of “the” exchange rate. Divergence makes this a riskier practice. Rather than pick a single exchange rate as representative of the value of the domestic currency, economists use a constructed measure known as the real effective exchange rate. The real effective exchange rate computes a weighted average of a country’s exchange rates, where the weights are generally the foreign countries’ trade shares. This is what we will generally mean by “the” real exchange rate.

For example, a widely cited index for the United States is published by the Board of Governors of the Federal Reserve System. It gives 10 nations’ currencies exchange-rate weights based on the nations’ importance in world trade. Is is therefore referred to as a trade-weighted index.

To construct an effective exchange rate, we need to select a currency basket, a set of weights, and a base year. The currency basket is the set of currencies that will be included in the effective exchange rate calculation. In a trade-weighted effective exchange rate, these will generally be the currencies of the country’s most important trading partners. The weights will then reflect the relative importance of the currency basket members. There are two common choices: bilateral weights and multilateral weights. Bilateral weights are the most intuitive: a country in the currency basket receives a weight equal to its share of the home country’s total trade with currency basket countries. A country’s multilateral weight is based instead on its share of total trade among the currency basket countries.

Let $S^b_i$ be the base year spot rate for country $i$. Let $S^c_i$ be the current year spot rate for
country $i$. Then the effective exchange rate in the current year is

$$EER^c = \sum_i w_i \frac{S^c_i}{S^b_i}$$

The effective exchange rate in the base year is always one. Similarly, the real effective exchange rate is

$$REER^c = \sum_i w_i \frac{Q^c_i}{Q^b_i}$$

Multilateral effective exchange rate indices are the most popular. The IMF publishes multilateral-weighted nominal and real effective exchange rates in *International Financial Statistics*. The *Federal Reserve Bulletin* publishes a multilateral-weighted nominal effective exchange rate. Another popular nominal effective exchange rate is the J.P. Morgan index, published by the *Financial Times* and by the *Wall Street Journal*. For the U.S., the Federal Reserve Bank of Atlanta publishes an index based on 1984 bilateral trade weights for 18 currencies, as well as subindices for Europe and for the Pacific Rim (also based on bilateral weights).

### 6.4.1 Properties of Effective Exchange Rates

Construction of an effective exchange rate involves many of the principles of price index construction. To construct a price index, we need to select a basket of goods, a set of weights, and a base year. Similarly, to construct an effective exchange rate, we need to select a currency basket, a set of weights, and a base year. Effective exchange rates also some basic properties with price indices. If we increase any single exchange rate, the index should increase. If we double every spot rate, the index should double.\(^8\)

\(^8\)That is, the effective exchange rate index should be homogeneous of degree one in the constituent exchange rates.
6.4.2 Calculating a Bilateral Effective Exchange Rate

Here is a simple example of the construction of a bilateral effective exchange rate. Suppose the home country trades with two other countries. Let the home country’s exports from country A and country B be \( X_A \) and \( X_B \), while its imports are \( M_A \) and \( M_B \). The bilateral weight for country A will be

\[
w_A = \frac{X_A + M_A}{X_A + M_A + X_B + M_B}
\]

Similarly, the weight on country B will be

\[
w_B = \frac{X_B + M_B}{X_A + M_A + X_B + M_B}
\]

Note that the weights must sum to one. In a fixed-weight index, the weights are calculated only for the base year.

6.4.3 Composite Reserve Currencies

There are two well known artificial units of account based on baskets of national currency: the Special Drawing Right (SDR) of the International Monetary Fund, and the European Currency Unit (Ecu) of the European Monetary System. The construction of composite currencies closely resembles the construction of effective exchange rates. A fixed basket of currencies is given a set of weights based largely on trade flows.

Special Drawing Rights

For example, consider the SDR. From 1970–1980, the SDR was a weighted average of the currencies of the 16 largest trading countries. Basket composition and currency weights are reviewed twice per decade. A five-currency SDR was created in January 1981, at which point the SDR became a weighted sum of the USD, DEM, JPY, FFR, and GBP. Naturally the
6.4. TRADE-WEIGHTED EFFECTIVE EXCHANGE RATES

DEM and FFR were replaced once Germany and France adopted the EUR, leading officially to a four currency basket in 2001 (although the DEM and FFR had already been replaced by their EUR equivalents in 1999). The weights are based on the multilateral export volumes and relative importance as reserve currencies and are adjusted about twice a decade as amendments to IMF Rule O-1. The USD has the largest weight in the basket, followed by the EUR, JPY, and GBP.

<table>
<thead>
<tr>
<th>Currency</th>
<th>Amount</th>
<th>$^1</th>
<th>USD value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUR</td>
<td>0.4100</td>
<td>1.35930</td>
<td>0.557313</td>
</tr>
<tr>
<td>JPY</td>
<td>18.400</td>
<td>93.12000</td>
<td>0.197595</td>
</tr>
<tr>
<td>GBP</td>
<td>0.0903</td>
<td>1.54220</td>
<td>0.139261</td>
</tr>
<tr>
<td>USD</td>
<td>0.6320</td>
<td>1.00000</td>
<td>0.632000</td>
</tr>
<tr>
<td>SDR</td>
<td>1.526169</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$ EUR-USD, USD-JPY, and GBP-USD.


Table 6.2: SDR-USD Exchange Rate on 13 April 2010

Table 6.2 illustrates a typical SDR-USD exchange rate computation. There are four constituent currencies. The SDR is considered to contain a fixed amount of each constituent currency. Suppose we want to know the dollar value of an SDR: then we just need to add up how much it would cost to buy these amounts of all the constituent currencies. For example, if it takes USD 1.292 to buy EUR 1 then it must take USD 0.550392 to buy EUR 0.426. The dollar value of the SDR is just the sum of the dollar values of the fixed amounts of the constituent currencies.

**European Currency Unit**

The European Currency Unit, or ECU, was the precursor to the euro. In 1979, the European Monetary System introduced the ECU as the official unit of account for the European Union, with ISO currency code XEU. From 1979 until 1991 the currency basket and weights varied, but in 1991 the Maastricht treaty froze the composition and weights. Calculation of the USD-XEU exchange rate followed the same procedure as the calculation of the USD-SDR.
exchange rate. Note that the dollar was not a constituent of the XEU, which as a result was seen as a hedge against the dollar. Further, EMS stabilization efforts keep the XEU relatively stable vis a vis the constituent national currencies. Perhaps as a result, the XEU won considerable private acceptance. Each XEU was replaced by one EUR in January 1999.

**Problems for Review**

1. Get the Federal Reserve Board’s effective exchange rate for the dollar from the Federal Reserve Bank of St. Louis at [http://www.stls.frb.org/publ/usfd](http://www.stls.frb.org/publ/usfd). What is the base year? Has the dollar appreciated or depreciated since the base year?

2. Given constant income and price levels, graphically illustrate the effect of a rise in the exchange rate on the trade balance measured in foreign exchange.

3. Given constant income and price levels, what is the effect of an exchange rate depreciation on the “real” trade balance?

4. Update the exchange rates in table 6.2 to determine the current USD value of an SDR. Also, find the cost of an SDR in EUR, JPY, and GBP.

5. In the Classical revision of the Mundell-Fleming model, provide intuition and graphical analysis for the comparative static effects of an increase in each one of the following: $y$, $i^*$, and $g$.

6. In 1994 the two largest trading partners of the U.S. were Japan and Canada. Consider the following table:

<table>
<thead>
<tr>
<th></th>
<th>Canada</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>US exports</td>
<td>$114,869</td>
<td>$131,115</td>
</tr>
<tr>
<td>US imports</td>
<td>$51,517</td>
<td>$119,135</td>
</tr>
</tbody>
</table>
Given that the currency basket countries are Canada and Japan, show the bilateral trade weights for 1994 are 0.39 and 0.61.

7. Starting from a position of trade-balance deficit, satisfaction of the Marshall-Lerner condition is sufficient to improve the trade balance measured in foreign exchange but not to improve the real trade balance. Explain why.

**Advanced Problems:**

8. How do the comparative statics in problem 5 change if expenditures depend on real balances?

9. Refering to equation 6.4, provide a fully commented derivation of the Marshall-Lerner condition for a currency depreciation to improve the trade balance. Note that $TB^{FX} = P^* TB/Q$, and derive the related condition for the trade balance measured terms of foreign exchange. How do these differ if trade is not initially balanced?

10. In a “Keynesian” version of the Mundell-Fleming model, do the comparative statics algebra for a change in $h$ and for a change in $g$. Provide the intuition behind your results.


