Chapter 10

Exchange Rate Determination and Forecasting

During January 2006, the value of the dollar in terms of the Japanese yen hovered around ¥117.00/\$. On February 7, 2011, it was ¥82.38/\$. In 5 years, the dollar lost about 30% of its value relative to the yen. What drives such extraordinary changes in relative currency valuations, and can we predict their direction and magnitude? On the one hand, the answer must be yes because financial institutions devote substantial resources to producing forecasts for their clients, and forecasting firms successfully market currency forecasts. However, the answer may be no because economic models often fail to explain exchange rate movements after the fact.

Corporations use currency forecasts in a variety of contexts: quantifying foreign exchange risk, setting prices for their products in foreign markets, valuing foreign projects, developing international operational strategies, and managing working capital. International portfolio managers use exchange rate forecasts to evaluate the desirability of investing in particular foreign equity and bond markets and whether to hedge the associated currency risks.

Should managers purchase currency forecasts? If markets are relatively efficient, it should be difficult to produce better short-term forecasts than forward exchange rates portend or better long-term forecasts than uncovered interest rate parity predicts. Yet, we saw evidence in Chapter 7 that these parity conditions do not always hold, especially in the short run. Therefore, currency forecasts are potentially valuable. This motivates our discussion of the two essential techniques that are used to forecast exchange rates: fundamental analysis and technical analysis. Because of the dramatic currency crises in a number of developing countries with pegged systems in the 1990s, forecasts in these systems are of special interest, and we discuss them separately.

10.1 Parity Conditions and Exchange Rate Forecasts

The covered interest rate parity (CIRP) relationship, discussed in Chapter 6, links forward rates, spot rates, and interest rate differentials. Uncovered interest rate parity (UIRP), discussed in Chapter 7, which is sometimes referred to as the *international Fisher relationship* (named for the eminent American economist Irving Fisher), links expected exchange rate changes and interest rate differentials, whereas the unbiasedness hypothesis links forward rates and expected future exchange rates. Purchasing power parity (PPP), discussed in Chapter 8, provides a link between inflation rates and rates of change of exchange rates. To close the loop between expected future exchange rate changes, forward rates, interest rates, and rates of inflation, we need another well-known relationship: the *Fisher hypothesis*. After discussing the Fisher hypothesis, we demonstrate how all the parity conditions together lead to a world in which currency forecasting is not necessary. This hypothetical world constitutes an interesting benchmark for judging the potential value of currency forecasts.

The Fisher Hypothesis

Interest Rates and Inflation

The interest rates we have discussed thus far are nominal interest rates. That is, they promise a nominal or money rate of return. For example, if the 1-year dollar interest rate is 3%, you receive \$1.03 in 1 year for every dollar you deposit today. Fisher (1930) noted that nominal interest rates should reflect expectations of the rate of inflation. This is easy to understand.

Your happiness with the 3% return will depend on how prices evolve over the year. If prices increase by less than 3%, the purchasing power of your \$1.03 is greater than the purchasing power of your \$1.00 today. You experience a positive real return. Conversely, if prices increase by more than 3%, your purchasing power is lower. You realize a negative real return. Thus, if you expect prices to increase by more than 3% over the course of the year, you are reluctant to accept a 3% deposit rate because the 3% return is insufficient to maintain the purchasing power of the money you are lending.

Recall from Chapter 8 that if $P(t)$ denotes the U.S. price level at time t, $\frac{\$1}{P(t)}$ is the purchasing power of 1 dollar. Inflation, the rate of increase of the price level, drives down the purchasing power of the money. Lending money to receive future nominal interest exposes the lender to the risk of loss of purchasing power during the time of the loan because of inflation.

Real Rates of Return

As a lender, you care about the real return on your investment, which is the return that measures your increase in purchasing power between two periods of time. If you invest \$1, you sacrifice $\frac{\$1}{P(t)}$ real goods now. But in 1 year, you get back $\frac{1+i}{P(t+1)}$ in real goods, where i is the nominal rate of interest. We calculate the *ex post* real return, denoted by r^{ep}, by dividing the real amount you get back by the real amount that you invest:

$$1 + r^{ep} = \frac{\left(\dfrac{1+i}{P(t+1)}\right)}{\left(\dfrac{1}{P(t)}\right)} = \frac{(1+i)}{\left(\dfrac{P(t+1)}{P(t)}\right)} = \frac{1+i}{1+\pi} \tag{10.1}$$

where $P(t+1)/P(t)$ is 1 plus the rate of inflation between time t and $t+1$, $\pi(t+1)$. If we subtract 1 from each side of Equation (10.1), we have

$$r^{ep} = \frac{(1+i)}{(1+\pi)} - \frac{(1+\pi)}{(1+\pi)} = \frac{i-\pi}{1+\pi}$$

which is often approximated as

$$r^{ep} \approx i - \pi \tag{10.2}$$

Equation (10.2) states that the *ex post* real interest rate equals the nominal interest rate minus the actual rate of inflation.[1] Hence, if the nominal interest rate is 3% and the actual rate of inflation is 2%, the *ex post* real interest rate is 1%.

The Ex Ante *Real Interest Rate*

Because the inflation rate is uncertain at the time an investment is made, the real rate of return on a loan is uncertain. By taking the expected value of both sides of Equation (10.2), conditional on the information set at the time of the loan, we derive the lender's expected real rate of return, which is also called the **expected real interest rate**, or the *ex ante* real interest rate, which we denote r^e:

$$r^e = E_t[r^{ep}] = i(t) - E_t[\pi(t+1)] \tag{10.3}$$

If we rearrange the terms in Equation (10.3), we have

$$i(t) = r^e + E_t[\pi(t+1)] = r^e + \pi^e \tag{10.4}$$

where we define π^e as expected inflation, $E_t[\pi(t+1)]$.

Equation (10.4) states that the nominal interest rate is the sum of the expected real interest rate and the **expected rate of inflation**. This decomposition of the nominal interest rate is often referred to as the **Fisher hypothesis**, or the *Fisher equation*.

Example 10.1 The Expected Real Interest Rate in Mexico

Suppose the nominal interest rate in Mexico is 10%, and the expected rate of inflation in Mexico is 7%. What is the expected real rate of return in Mexico?

From Equation (10.3), we have

$$r^e = 10\% - 7\% = 3\%$$

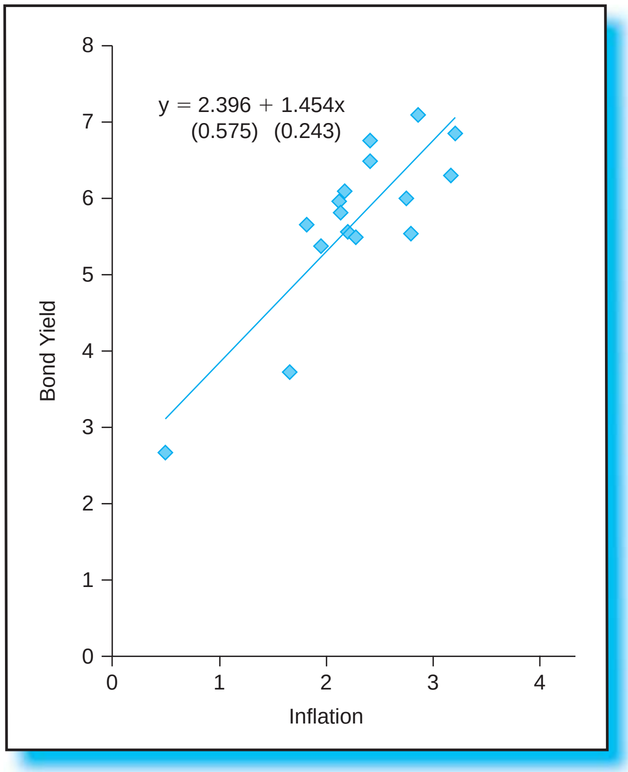
By investing pesos at a nominal interest rate of 10% when the expected rate of inflation is 7%, the investor expects to earn a 3% real rate of return. The investor expects to have 3% more purchasing power over goods and services at the end of the year for every peso invested.

If expected real interest rates are similar across countries, countries with high expected inflation rates will have high nominal interest rates, and countries with low expected inflation rates will have low nominal interest rates. The real interest rate is important because it influences investment decisions. Firms borrow money and invest in projects only if the expected real rate of return on the investment is greater than the real interest rate.

The Fisher hypothesis is a reasonable approximation for thinking about a long-run link between inflation and interest rates. Exhibit 10.1 graphs average long-term government bond yields on the vertical axis versus average inflation rates on the horizontal axis for 16 countries between 1990 and 2010. As the Fisher hypothesis suggests, the relationship is clearly positive, and the slope of the regression line is insignificantly different from 1. That is, for each additional 1% of inflation, the nominal government bond yield is about 1% higher. Hence, for long-term averages, real interest rates appear to be equal across countries. The intercept on the vertical axis of 2.40% is also a reasonable estimate of the real interest rate. We discuss this graph in more detail later.

[1]There is no approximation in going from Equation (10.1) to Equation (10.2) if one uses continuously compounded interest rates and rates of inflation. See the appendix to Chapter 2 for a review of continuous compounding.

Exhibit 10.1 Average Long-Term Government Bond Yields and Inflation Rates



Notes: The vertical axis measures average government bond yields for 1990–2010. The horizontal axis measures the average annual inflation rate over the same period. The diamonds represent 16 countries: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Sweden, Switzerland, the United States, and the United Kingdom. The line represents a regression of yield (y) on inflation (π). The standard error of the estimate is between parentheses. Data are from the International Monetary Fund's International Financial Statistics.

The International Parity Conditions

The covered interest rate parity (CIRP), uncovered interest rate parity (UIRP), and purchasing power parity (PPP) relationships, together with the Fisher hypothesis, are sometimes referred to as the **international parity conditions**. To review these conditions, consider the numeric example in Exhibit 10.2, which examines exchange rates, interest rates, and expected inflation rates for the United Kingdom and Switzerland. Exchange rates are measured as Swiss francs per British pound, CHF/GBP, and the horizon is 1 year.

CIRP

At the bottom of Exhibit 10.2, the nominal interest differential is 2%. From covered interest parity, we can relate the interest differential to the forward premium:

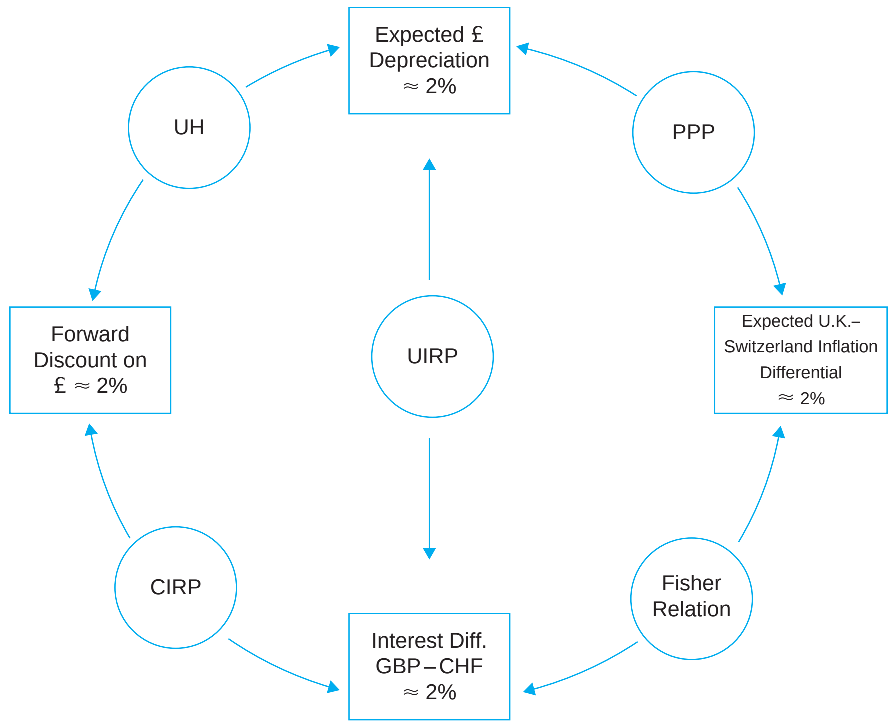
$$\text{Forward premium} = \frac{\text{Forward rate} - \text{Spot rate}}{\text{Spot rate}}$$

Exhibit 10.2 An Example of International Parity Conditions: The United Kingdom and Switzerland

Nominal Interest Rates:
U.K.: $i^{GBP} = 5.00\%$. Switzerland: $i^{CHF} = 3.00\%$
Exchange Rates:
Spot Rate: S = CHF2.50/GBP Forward Rate: F = CHF2.4524/GBP

$$\text{Forward Premium: } \left[\frac{2.4524}{2.50} - 1\right] = -1.90\%$$

Expected Exchange Rate Change: –1.90%
Expected Inflation: U.K. = 2.94%; Switzerland = 0.98%



Notes: UH = unbiasedness hypothesis; PPP = purchasing power parity; CIRP = covered interest rate parity; UIRP = uncovered interest rate parity (international Fisher relation).

The 1-year forward premium is −1.90%. Because the U.K. interest rate is higher, its currency is at a discount in the forward market to prevent arbitrage.

UIRP or Unbiasedness

If the forward rate is an unbiased predictor of the future spot rate, the forward discount on the pound means that the market expects the pound to depreciate by the amount of the forward discount, which brings us to the top of the diagram. We could have also moved to the top directly by observing that the higher pound interest rate means British investors in Swiss francs must expect a capital gain on holding Swiss francs to increase their expected return up to the higher pound return.

PPP

Relative PPP requires that the expected change in the exchange rate reflects the differential in inflation rates, so if the British pound is expected to weaken versus the Swiss franc, British inflation is expected to be higher than Swiss inflation by about 2%. This brings us to the right-hand side of Exhibit 10.2, where the inflation differential is 1.96% (also about 2%). (The small difference in percentage calculations arises because we are using inflation rates calculated in simple percentage terms. The percentage changes are identical if the computations use continuously compounded rates.)

To see this, remember from Chapter 8 that relative PPP predicts

$$\frac{S(t+1)}{S(t)} - 1 = \frac{1 + \pi(\text{SW})}{1 + \pi(\text{U.K.})} - 1 = \frac{\pi(\text{SW}) - \pi(\text{U.K.})}{1 + \pi(\text{U.K.})}$$

Because of the presence of U.K. inflation in the denominator, the inflation differential is slightly larger than the percentage rate of change of the exchange rate. Now we know that inflation is the fundamental reason for the higher British nominal interest rates observed in the first place. U.K. expected inflation is higher than Swiss expected inflation, which brings us back to the bottom of the exhibit if expected real interest rates are equal through the Fisher relationship.

Real Interest Rates and the Parity Conditions

Real Interest Rate Parity

What are the real interest rates in the United Kingdom and Switzerland? According to Equation (10.3), the real interest rate is

$$r^e = i - \pi^e$$

Plugging in the numbers for both the United Kingdom and Switzerland gives real interest rates of about 2% in both cases.[2] This is no coincidence. If the parity conditions all hold simultaneously, real interest rates are equal across countries. If uncovered interest rate parity and PPP hold, the nominal interest rate differential between the United Kingdom and Switzerland reflects only an expected inflation differential. Then, by rearranging terms, we find that the real return is the same in each country.

In a world where all the parity conditions hold, multinational business would be rather simple. International pricing would be easy because prices in foreign countries would move in line with domestic prices after converting currencies. The expected real cost of borrowing would be the same everywhere in the world. Finally, if a company wanted to know what the future exchange rate was likely to be—for example, to help quantify its transaction exposure—the best predictor for the future exchange would be the forward rate because the unbiasedness hypothesis holds. International investors would not need to worry about predicting currency values either. A higher nominal interest rate in one country would simply reflect the fact that the country's currency was expected to depreciate.

Testing Real Interest Rate Parity

Unfortunately, the world is not as simple as just described. From the empirical evidence discussed in previous chapters, we know that the international parity conditions, except CIRP, are best viewed as long-run relationships. In the short run, there are significant deviations from these conditions. Because PPP deviations are sizable and prolonged, identical nominal returns

[2]The small differences arise because Exhibit 10.2 does not make approximations so that $r^e = \dfrac{i - \pi^e}{1 + \pi^e}$.

represent very different real returns for investors in different countries. Our discussion of the forward bias in Chapter 7 implies that returns in different currencies can have different currency risk premiums. In the long run, we know that PPP holds better and that high interest rate currencies depreciate relative to low interest rate currencies. Hence, it would seem more likely that real interest rate parity holds in the long run. Real returns across countries can also differ because of political risks or the threat of capital controls, which prevent investors from taking advantage of higher returns in other countries. This is particularly true in developing countries.

Studies have found that real interest rate parity holds neither in the short nor the long run. Consider Exhibit 10.1, which at first blush seems largely consistent with real interest rate parity. The world interest rate is 2.40%, and if the slope of the regression line is actually 1, each percent of additional expected inflation implies an extra percent of nominal bond yield, keeping real interest rates the same across countries. However, the estimated slope coefficient is 1.45 instead of 1.00. This suggests that higher inflation countries have higher real interest rates. For example, if a country has an expected inflation rate of 3%, the regression line predicts a nominal bond yield of $2.40\% + 1.45 \times 3\% = 6.75\%$, and a real rate of $6.75\% - 3\% = 3.75\%$. Now, consider a country with an expected inflation rate of 5%. Following the same computations, we find that the country's real rate is 4.65%, almost 1% higher than the real rate of the low-inflation country.

Of course, real interest rate differentials between countries reflect differential risks, but they also offer multinational businesses opportunities—for example, opportunities to reduce costs of funds or to invest excess cash more profitably. Knowing the source of an observed real interest rate differential is important to making the right decisions. When the parity conditions break down, forecasting becomes important. The next section reviews the types of forecasting techniques managers use.

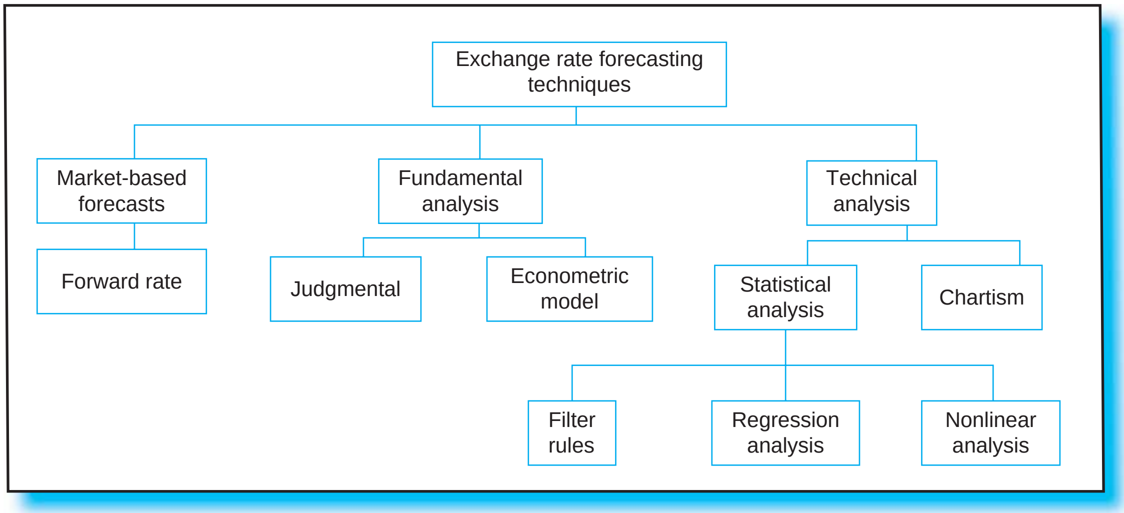
10.2 Currency Forecasting Techniques

While there may be as many exchange rate forecasting techniques as there are exchange rate forecasters, Exhibit 10.3 organizes them into meaningful categories. The parity conditions suggest the forward rate as a predictor. If no forward market exists for a particular currency, nominal interest rates and UIRP can be used to extract a market-based forecast. Other forecasting techniques do not rely directly on the predictions embodied in forward rates and interest rates and can be split into two main categories: *fundamental analysis* and *technical analysis*. We briefly describe these in turn and end this section with a discussion of how to evaluate the quality of a forecast. Sections 10.3 and 10.4 then provide more detail about these two forecasting techniques.

Fundamental Exchange Rate Forecasting

Some forecasters predict exchange rates using **fundamental analysis** typically based on formal economic models of exchange rate determination, which link exchange rates to macroeconomic fundamentals such as money supplies, inflation rates, productivity growth rates, and the current account. The models involve parameters that govern the relationship between the exchange rate and the fundamentals. For example, if the current account deficit as a percentage of gross domestic product (GDP) increases by x%, the model predicts that the domestic currency will depreciate relative to the foreign currency by b multiplied by x%. The parameter b has to be determined, and this is typically accomplished by estimating the relationship from the data using econometric techniques such as regression analysis. Alternatively, some forecasters simply examine economic information and use educated analysis

Exhibit 10.3 Categories of Exchange Rate Forecasting Techniques



to derive an exchange rate forecast based on their judgment of future macroeconomic relationships. Fundamental analysis is typically concerned with multiyear forecasts because the fundamental economic forces operate at longer horizons.

Exchange Rate Forecasting with Technical Analysis

Technical analysis is usually used for short-term forecasts. Technical analysts use only past exchange rate data, and perhaps some other financial data, such as the volume of currency trade, to predict future exchange rates. Consequently, all the information about the future exchange rate is assumed to be present in past trading behavior and past exchange rate trends.

The original technical analysts were called *chartists* because they studied graphs of past exchange rates. Now, technical analysis refers to the use of any type of financial data to predict future exchange rates outside the confines of a fundamental model. Some technical analysts employ sophisticated econometric techniques to discover what they hope are predictable patterns in exchange rates. Therefore, we distinguish between chartists and *statistical technical analysts*.

Why Technical Analysis Might Work

Technical analysis is often derided in academic circles because it is not based on any economic theory and is thought to be inconsistent with efficient markets. Nevertheless, it is important to discuss technical analysis for four reasons.

First, forex dealers and currency fund managers make extensive use of technical analysis (see, for example, Gehrig and Menkhoff, 2006). Second, fundamental analysis has some inherent problems. Fundamental forecasters must pick the right exchange rate model. Then, the model's fundamental variables must be forecast. Moreover, the macroeconomic inputs to fundamental analysis are not all available at frequent intervals. Some variables are measured weekly, some monthly, and some only quarterly or even annually, and the measurements are often poor (recall the discussion of the statistical discrepancy in the balance of payments in Chapter 4) and are frequently subject to revision. The data used by technical analysts are of much higher quality and are available much more frequently, often on a daily or even intra-daily basis.

The third reason technical analysis may have forecasting ability is that the forward rate may not be an unbiased predictor of the future spot rate, even in an efficient market. Chapter 7 argues that rational risk premiums can separate forward rates from expected future spot rates.

Moreover, we see differences of opinion on the future direction of exchange rates, even among relatively specialized foreign exchange experts. Consequently, it is conceivable that technical analysis might uncover a predictable component in exchange rate changes not present in forward rates.

A fourth reason technical analysis may have value is that if a sufficiently large segment of the trading world is using technical analysis, demands and supplies to trade currencies will be buffeted by these traders even if they are irrational. A truly rational trader would therefore need to know technical analysis to understand why irrational traders are doing what they are doing.

Evaluating Forecasts

What constitutes a good forecast? In general, it depends on how the forecast will be used. Ultimately, exchange rate forecasts are "good" when they lead to "good" decisions. Next, we distinguish three dimensions of the forecast quality.

Accuracy

One dimension is the accuracy of the forecast. Suppose that today is time t, and we are forecasting over a k-period horizon (say k months). Let $S(t+k)$ be the actual exchange rate at time $t+k$, and let $\hat{S}(t+k)$ be the forecast at time t. The closer $\hat{S}(t+k)$ is to $S(t+k)$, the more accurate the forecast, and the smaller the forecast error:

$$e(t+k) = S(t+k) - \hat{S}(t+k)$$

Of course, we cannot judge a forecaster by just one forecast because he or she may have just been lucky. Instead, we need a substantial record of forecasts and realizations to allow statistical analysis. We cannot judge the accuracy of the forecasting record by simply taking the average forecast error because huge errors with opposite signs could end up with a small average error.

The two summary measures most frequently used to judge accuracy of forecasts are the **mean absolute error (MAE)** and the **root mean squared error (RMSE)**:

$$\text{MAE} = \frac{1}{T}\sum_{t=1}^{T} |e(t+k)|$$

$$\text{RMSE} = \sqrt{\frac{1}{T}\sum_{t=1}^{T} e(t+k)^2}$$

where T is the total number of available observations. The MAE is the average of the absolute values of the forecast errors. The RMSE is the square root of the average squared forecast errors. It has the same units as the standard deviation of exchange rate changes.

In comparing forecasts, a number of obvious benchmarks come to mind. For example, we could simply replace the forecast with the current exchange rate or with the current forward rate for maturity k. We hope that a forecaster's MAE or RMSE is smaller than such simple forecasts. If it weren't, why would we need to pay money for it?

Forecast accuracy is economically meaningful in a number of settings. For example, suppose Liberty Shipping, a U.S. firm, is evaluating a foreign investment project that will generate foreign currency profits. Liberty Shipping must forecast the future dollar cash flows generated by the project by converting future foreign currency profits into future dollars that will be discounted at an appropriate discount rate to determine whether the investment project will be profitable. Suppose that its calculations lead Liberty Shipping to accept the project and make the investment. Then, however, a currency crisis erupts in the country in which Liberty Shipping invested, and the currency depreciates significantly. If local competition prevents Liberty Shipping from passing through the currency loss in the form of higher local prices, the currency crisis will depress the company's dollar earnings, and the investment decision will have been a disaster. Here accuracy matters. A more accurate assessment of the future would have led Liberty Shipping to forgo the investment.

Even if the foreign currency appreciates after the investment is made and the investment decision looks good, forecasting accuracy still matters. A better exchange rate forecast might have caused the firm to invest more in the foreign country. Pricing decisions and long-term strategic planning are other examples in which the accuracy of exchange rate forecasts matters a great deal. Note that in many of these cases, firms may be more concerned with predicting the real exchange rate rather than the nominal exchange rate.

Being on the Right Side of the Forward Rate

There are situations in which accuracy may not be the most relevant quality measure. Simply being on the right side of the forward rate is enough. If the forecast relative to the forward rate suggests a long position in the forward market, and the future exchange rate is indeed above the forward rate, the forecast was on the right side of the forward rate. Conversely, if the forecast relative to the forward rate suggests a short position in the forward market, and the future exchange rate is below the forward rate, the forecast was not on the right side of the forward rate. We illustrate this with an example.

Example 10.2 Currency Forecasts at Fancy Foods

Chapter 3 introduced the situation of Fancy Foods, which owes Porky Pies £1,000,000 in 90 days. The current exchange rate is \$1.50/£, and the forward rate is \$1.53/£. To decide whether to hedge its currency exposure, suppose Fancy Foods can enlist the services of two forecasting companies, Forexia and Trompe Le Monde. Forexia predicts that the exchange rate will be \$1.65/£, whereas Trompe Le Monde predicts that the exchange rate will be \$1.51/£. After 90 days, the exchange rate turns out to be \$1.55/£. Which forecast is more accurate? Which forecast is more economically useful to Fancy Foods?

To find out, let's examine how Fancy Foods uses forecasts in its hedging decision. Suppose Fancy Foods hedges when the forecast of the future spot rate is above the forward rate, and it does not hedge when the forecast is less than the forward rate because it thinks the dollar cost of the pounds will be lower than if it uses the forward rate. The following table summarizes the situation:

	Forexia	**Trompe Le Monde**
Forecast	\$1.65/£	\$1.51/£
Forecast Relative to Forward Rate (forward rate: £1.53/\$)	Higher	Lower
Decision	Hedge	Do not hedge
Forecast Error	−\$0.10/£	\$0.04/£
Ex Post Cost Relative to Forward Rate	Zero	Positive

So, although Trompe Le Monde's forecast turns out to be more accurate, it leads Fancy Foods not to hedge because it predicts an exchange rate lower than the forward rate. Because the pound actually appreciates to a level above the forward rate, not hedging proves costly. Not hedging would cost Fancy Foods $£1{,}000{,}000 \times \$(1.55 - 1.53)/£ = \$20{,}000$. The prediction of Forexia, which is quite inaccurate, would lead Fancy Foods to hedge, which *ex post* leads to a lower pound cost than if the pounds had to be purchased at the future spot rate.

Example 10.2 shows that it is often more important to be on the correct side of the forward rate than to be accurate. It is also important to realize that the relevant benchmark is the forward rate, not the current spot rate, because the forward rate is the currently available rate for future transactions.

To evaluate a forecasting record, the percentage of times the forecaster was on the correct side of the forward rate seems to be a natural indicator. Because just flipping a coin could lead to a 50% correct record, this "percentage correct signals" statistic should be strictly larger than 50% for the forecaster's services to add value to your decision-making process. We can view this as a test of market timing ability.[3]

Profitability

Technical analysts assert that the percentage-correct-signals metric does not accurately measure how well they perform. They claim that they can give valuable advice and should not be required to be right more than 50% of the time. This is true because the overall size of the profits and losses a company earns as a result of the advice matters, too. A technical forecaster's performance may be characterized by a relatively small number of successful forecasts in which large profits are made and a relatively large number of incorrect predictions in which small losses are incurred. As long as you do not lose too much money when you are wrong and you make a lot of money when you are right, you can be wrong more than 50% of the time and still be valuable.

To evaluate forecasters on this basis, we can simply compute the profits or losses made based on a forecaster's advice and compare those returns to the returns on alternative investments that do not require forecasts. Again, it is important to determine that the profits are not simply due to chance. We illustrate this later in the chapter. We are now ready to examine fundamental and technical forecasts in more detail.

10.3 Fundamental Exchange Rate Forecasting

This section examines forecasting techniques that rely on models of exchange rate determination and fundamental economic factors. From the parity conditions, we know that exchange rates are likely to be influenced by interest differentials, relative price levels, and inflation rates. Interest rates and the current account are the most talked-about fundamental factors, judging from countless articles in the financial press.

We first review the poor performance of fundamental models of exchange rates in predicting future exchange rates. This poor performance is not surprising from the perspective of two main approaches to exchange rate determination: the **asset market approach** and an equilibrium

[3]Henriksson and Merton (1981) developed market timing tests for stock market returns, where forecasters predict the stock market to go up or down. However, stock returns are expected to be positive, so always predicting the market to go up is likely to lead to a better-than-50%-correct forecasting record. Similarly, if it rains on 80% of the days, a weather forecaster has an 80% success rate by always forecasting rain. Analogously, if during the period that you record the forecasting performance, the forward rate is consistently below the spot rate, a forecaster who ends up with a 100% correct forecasting record may have superior forecasting knowledge or may have simply failed to change his forecast, and this laziness led to the perfect record. Because the market direction did not change, there is little information on timing the market in this sample. Henriksson and Merton show how to correct for such a bias. Basically, you should add the proportion of correct forecasts conditional on the eventual spot rate being above the forward rate to the proportion of correct forecasts conditional on the eventual spot rate being below the forward rate. If the sum of these proportions is higher than 1, there is evidence of market timing ability. Indeed, our lazy forecaster, who just got lucky, would end up with a score of 1.0 and would not be dubbed a forecasting genius with such a test.

model linking current accounts, real exchange rates, and interest rates. We discuss each in turn. We also discuss an increasingly popular method to forecast exchange rates over longer horizons, building on PPP.

Forecasting Performance of Fundamental Exchange Rate Models

Forecasting Models and Benchmarks

In a famous 1983 article, Meese and Rogoff analyze the forecasting power of fundamental models of exchange rate determination. The models link the current spot rate to relative money supplies, interest differentials, relative industrial production, inflation differentials, and the difference in cumulated trade balances, which represents the level of net foreign assets. They estimate the parameters of these models and use them to predict future exchange rate values. Because the fundamental information is not known when the forecast is made, these predictions would normally necessitate forecasting the fundamentals first, so that the forecast is truly "out of sample." However, Meese and Rogoff use actual values for the future fundamentals combined with the parameters to predict the exchange rate. This approach gives the fundamental models an advantage relative to the other models considered, which use only current information to predict future exchange rates. As benchmarks, they considered several alternative models, including the random walk $[\hat{S}(t+k) = S(t)]$, where, again, the caret symbol denotes a forecast today for horizon k, the unbiasedness hypothesis $[\hat{S}(t+k) = F(t, k)]$, and several statistical models that link the current exchange rate to past exchange rates and past values of other variables.

Computing the root mean squared error (RMSE) for the predictions at various horizons, Meese and Rogoff found that the random walk model beat all the other models in the majority of the cases considered. Particularly surprising was that the fundamental models did not even perform better at longer horizons. This result has been confirmed by a large number of researchers over the years and continues to puzzle international economists (see Rogoff, 2009).

Recent research by Meese and Prins (2011) points to the importance of order flow in the short-run determination of exchange rates and market fundamentals in the longer run. They find that market fundamentals do a poor job of explaining the time series movements of exchange rates, especially at short horizons, whereas fundamentals perform better cross-sectionally and at longer horizons.

Given the poor performance of fundamental models in forecasting exchange rates, we provide only a cursory overview of the major models. However, fundamental models still provide useful insights, and, as we will see, it may not be so surprising that they are beaten by a random walk model in forecasting exchange rates.

The Asset Market Approach to Exchange Rate Determination

UIRP and the Exchange Rate

Let's revisit the theory of Chapter 7 to see what it has to say about the *level* of the exchange rate:

$$S(t) = \frac{1 + i^*(t)}{1 + i(t)} E_t[S(t+1)] \quad (10.5)$$

where the exchange rate is expressed in domestic currency per foreign currency, i^* is the foreign interest rate, and i is the domestic interest rate. Everything else equal, an increase in the domestic (foreign) interest rate lowers (increases) $S(t)$; that is, the domestic currency appreciates (depreciates). However, "everything else equal" involves keeping expected values of the future exchange rate constant. Of course, changes in interest rates likely also affect exchange rate expectations. More intuition can be gained rewriting Equation (10.5) as

$$\ln[S(t)] = i^*(t) - i(t) + E_t[\ln[S(t+1)]] \quad (10.6)$$

where $\ln[S(t)]$ is the logarithm of the level of the exchange rate. This equation uses the continuously compounded form of uncovered interest rate parity.[4] Equation (10.6) also will determine the exchange rate next period, and so on into the future, which suggests that not only current but also expected future values of interest rates may affect the current exchange rate.

The Exchange Rate as an Asset Price

Just as the equity value of a firm is the expected discounted value of all future cash flows accruing to the firm's shareholders, the exchange rate is easily linked to current and future fundamentals. The asset market approach to exchange rate determination recognizes that the exchange rate is the relative price of two monies, and it notes that monies are assets, which makes the exchange rate an asset price. Hence, exchange rates should fluctuate quite randomly, and the value of an exchange rate of, say, dollars per euro should be determined by people's willingness to hold the outstanding supplies of dollar-denominated and euro-denominated assets. These demands, in turn, depend on the expectations of the future values of these assets.

To capture this idea, we view the exchange rate as a weighted average of the current fundamental and its expected future value. The equity price of a stock can also be thought of as the value of the current cash flow (the dividend) and the discounted expected value of the future equity price, the price at which you can sell the stock in the future.

$$\ln[S(t)] = (1 - a)\,\text{fund}(t) + aE_t[\ln[S(t+1)]] \quad (10.7)$$

In Equation (10.7), $\text{fund}(t)$ is the generic name we use to indicate the value of market fundamentals at time t, and the coefficient a is a discount factor that is less than 1 but may be very near 1.

Equation (10.7) states that the exchange rate depends on current fundamentals and on what people think the exchange rate will be in the next period. If we iterate Equation (10.7) one step forward to solve for $\ln[S(t+1)]$ and plug the result back into that equation, we obtain the following:

$$\ln[S(t)] = (1 - a)\,\text{fund}(t) + aE_t[(1 - a)\,\text{fund}(t+1) + aE_{t+1}[\ln[S(t+2)]]] \quad (10.8)$$

Because expectations at time t of expectations at some future time reduce to expectations at time t, as in $E_t[E_{t+1}[\ln[S(t+2)]]] = E_t[\ln[S(t+2)]]$, iterating Equation (10.8) forward leads to:[5]

$$\ln[S(t)] = (1 - a)\,\text{fund}(t) + (1 - a)\sum_{j=1}^{\infty} a^j E_t[\text{fund}(t+j)] \quad (10.9)$$

Hence, the current exchange rate embeds all information about current and expected future fundamentals, and the exchange rate changes as the fundamentals change or as we get news about future fundamentals. Note that even a small change in current fundamentals may induce a large change in the exchange rate if it also changes the expected value of all future

[4] To derive this equation, simply go back to Chapter 6, Equation (6.5), and replace $\ln[F]$ by $E_t[\ln[S(t+1)]]$.

[5] This property of expectations is known as the *law of iterated expectations*, and it follows from the fact that we necessarily have less information now (at time t) than we will have in the future (at time $t+1$).

fundamentals. Thus the value of the exchange rate may move a lot in response to what seems to be a small piece of news.

The Monetary Approach

While many exchange rate models fit this framework, the best-known asset market model is the monetary exchange rate model. In this model, the menu of assets is fairly simple. There are distinct demands for non-interest-bearing domestic and foreign currencies. The demand for nominal money arises from the demand for **real money balances**. That is, people are only concerned with the real value of the nominal money they are holding.

The fundamentals in this model are a simple function of relative money supplies and relative real income levels in the two countries. The model implies that the domestic currency weakens if the domestic money supply increases today or if news arrives that leads people to believe that the future domestic money supply will increase. In contrast, the domestic currency strengthens if the foreign money supply increases today or if news arrives that causes people to think that foreign money supplies will be higher in the future. These effects arise directly from the influence an increased supply of money has on prices with the demand for money held constant. Higher prices in turn weaken the currency because PPP is assumed to hold. The domestic currency also weakens if domestic real income falls, if foreign real income rises, or if news arrives that causes people to expect lower domestic real growth or faster foreign real growth. Real income positively affects the demand for real money balances because the higher the real income, the greater the number of monetary transactions required to support the real transactions of an economy. Hence, a decrease in real income lowers the demand for real balances and given a fixed money supply, causes an increase in prices to lower the *real* money supply. The increase in prices therefore weakens the currency through the PPP channel.

Sticky Prices and Overshooting

The predictions of the monetary model are quite reasonable at long horizons, but as a short-run theory, the monetary model's reliance on PPP is questionable. An important extension of the monetary model relaxes the assumption of PPP, assuming that nominal prices of goods are "sticky" and do not adjust immediately to an increase in the money supply or to other shocks that hit the economy (see Dornbusch, 1976). Models with sticky prices predict more volatility in nominal and real exchange rates than occurs in the monetary model because asset prices, including the exchange rate, do all of the immediate adjusting to the shocks that hit the economy, whereas nominal goods prices only adjust slowly over time.

Consider how the economy responds to a permanent increase in the money supply in such a model. According to the monetary model, in the long run, an increase in the money supply causes a depreciation of the domestic currency by the same percentage that the money supply increases. What happens in the short run? Because asset prices are flexible, the asset markets will remain in equilibrium. Now, we know that an increase in the nominal money supply with goods prices fixed must increase the supply of real balances. For the money market to remain in equilibrium, the demand for real balances must increase. This can be accomplished by an increase in real income, but real income is unlikely to adjust quickly. Another channel is a decrease in the nominal interest. A lower interest rate positively affects the demand for money because it decreases the opportunity cost of holding real money balances.

Thus, the increase in the money supply causes the domestic interest rate to fall (and fall below the foreign interest rate). Because the monetary exchange rate model also assumes uncovered interest rate parity, the domestic currency must be expected to appreciate when the domestic interest rate is less than the foreign interest rate. But if people are rational, they know that, in the long run, the domestic currency will be weaker than it was before the increase in the money supply. The only path for the exchange rate that allows for a long-run depreciation of the domestic currency and an expected appreciation in the short run is for the domestic currency to immediately weaken by more than it will weaken in the long run. Thus, the exchange rate overshoots its new equilibrium: The exchange rate (in domestic currency per unit of foreign currency) jumps up when the money supply is increased and subsequently falls over time toward its new higher equilibrium value.

Why the Random Walk Works

Engel and West (2005) point out that the random walk model outperforming fundamental models of the exchange rate may not necessarily imply that these models are false. While their arguments are sophisticated, Equation (10.7) hints at the main argument. If the discount factor is close to 1, the equation implies that $\ln[S(t)] \approx E_t[\ln(S(t+1))]$. But that is the random walk model! The authors argue that, in many practical cases, the discount factor is indeed close to 1 and that, moreover, the fundamentals themselves behave like random walks. Together, this implies that the current exchange rate adequately reflects the expected value of future fundamental values. However, for this to be true, the exchange rate should also predict future fundamental values. Engel et al. (2007) show that this is indeed the case. They also document that novel forecasting techniques that efficiently exploit the information across fundamentals in multiple countries predict exchange rates out of sample better than the random walk model. Finally, at longer horizons, such as 3 to 4 years in the future, fundamental models do have predictive power for exchange rates (see, for example, Mark, 1995).

News and Exchange Rates

One implication of Engel and West's interpretation of the performance of the monetary exchange rate model is that *exchange rate changes* are unpredictable, but they should still reflect news about fundamentals. If there is news about the money supply or real income, and it does not change the exchange rate in the required direction, this would be strong evidence against the fundamentals model. Several authors have used high-frequency data on exchange rates and macroeconomic announcements to investigate how exchange rates react to macroeconomic news (see Andersen et al., 2003, 2007; and Faust et al., 2007). The studies are careful to measure the *announcement news* by subtracting from the reported number an estimate of its expected value according to a survey by Money Market Services (MMS). Every week, MMS records forecasts by some 40 money managers at financial institutions regarding all macroeconomic indicators. One prediction of the monetary exchange rate model is borne out in the data. The dollar indeed appreciates relative to positive news about U.S. real income, as revealed by news about U.S. GDP, retail sales, and construction spending. Currency markets also prove efficient in that the news is incorporated into prices quickly (typically in less than 15 minutes). However, the studies reveal a somewhat strange reaction to news about inflation and increases in the money supply: The dollar appreciates, whereas it should depreciate according to the monetary exchange rate model. One interpretation is that the appreciation reflects anticipation of an aggressive monetary policy response to the higher inflation; that is, if monetary policy sharply raises interest rates in response to positive inflation news, the exchange rate should indeed be expected to appreciate (see Clarida and Waldman, 2008).

The Real Exchange Rate, the Real Interest Rate Differential, and the Current Account

The popular press often mentions that high real interest rates go hand in hand with "strong" real exchange rates. We first show that such a relationship is implied by a real version of uncovered interest rate parity and "mean-reverting" real exchange rates. We also assess whether the relationship holds up empirically. The popular press also often mentions a strong link between the current account and exchange rates, suggesting that a current account deficit should put downward pressure on the exchange rate. However, even casual observation suggests that this link does not always hold. After all, the United States has run a current account deficit for a very long time and has had spells during which the dollar appreciated strongly even while the current account worsened. We briefly describe an equilibrium model that simultaneously determines the level of the (real) exchange rate and the current account balance.

Converting UIRP to Real Terms

To see why the level of the real exchange rate should be related to the differential between the real interest rates on different currencies, we need to convert uncovered interest rate parity from a relationship between nominal interest rates and nominal rates of depreciation into a relationship between real interest rates and expected real rates of depreciation. To do so, let's rearrange Equation (10.6) and subtract the expected inflation differential between the home and foreign countries, $E_t[\pi(t+1) - \pi^*(t+1)]$, from both sides of the uncovered interest rate parity expression:

$$i(t) - E_t[\pi(t+1)] - (i^*(t) - E_t[\pi^*(t+1)])$$
$$= E_t[\ln[S(t+1)]] - \ln[S(t)] - E_t[\pi(t+1) - \pi^*(t+1)]$$

Note that the inflation rates should be continuously compounded, as we are working with logarithmic exchange rates. Of course, $\ln[S(t+1)] - \ln[S(t)]$ will be close in practice to the simple percentage change in the exchange rate, which we usually define as $s(t+1)$.

From the definitions of the real interest rate and of the rate of change of the real exchange rate, this equation reduces to the following:

$$r^e(t) - r^{e*}(t) = E_t[\ln[RS(t+1)] - \ln[RS(t)]] \quad \textbf{(10.10)}$$

where $r^e(t)$ denotes the domestic real interest rate, $r^{e*}(t)$ denotes the foreign real interest rate, and $\ln[RS(t)]$ denotes the logarithm of the real exchange rate. Equation (10.10) indicates that when the foreign real interest rate is greater than the domestic real interest rate, the right-hand side of Equation (10.10) is negative and the domestic currency is expected to appreciate in real terms.

To link the expected real interest rate differential to the *level* of the real exchange rate instead of the expected rate of change of the real exchange rate, we must explain the idea of mean reversion.

Mean Reversion

A mean-reverting process is always expected to move back or be pulled toward its unconditional mean. A random walk is a good example of a process that is *not* mean reverting. Whether the exchange rate is unusually high or low does not matter in forecasting future exchange rates; your best predictor remains the current exchange rate. In a mean-reverting process, whether the current exchange rate is above or below the long-run mean is what drives the direction of the forecast. When you are above the mean, you should be expected to be pulled back toward the mean, so the forecast of the expected exchange rate change should be *negative*. When you are experiencing unusually low real exchange rates, you should expect to be pulled toward the mean, so your forecast of the change in the real exchange rate should be positive. Let's use $\overline{RS}$ as our estimate of the long-run mean for the logarithm of the real exchange rate. This could be the long-run historical average, but may also be implied by a theoretical model. The idea of mean reversion implies

$$E_t[\ln[RS(t+1)] - \ln[RS(t)]] = \kappa[\ln(RS(t) - \overline{RS}] \quad \textbf{(10.11)}$$

and κ is a negative number. Substituting Equation (10.10) into Equation (10.11) gives

$$r^e(t) - r^{e*}(t) = \kappa[\ln[RS(t)] - \overline{RS}] \quad \textbf{(10.12)}$$

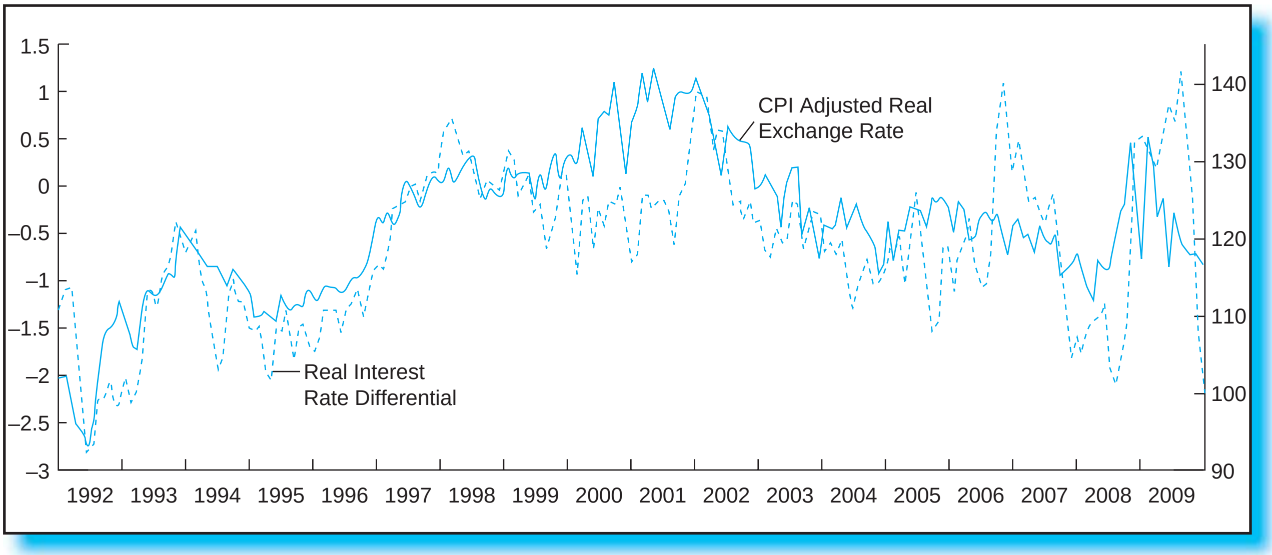
Equation (10.12) indicates that when the real exchange rate is above its long-run equilibrium—that is, when $[\ln[RS(t)] - \overline{RS}] > 0$ and the domestic currency is weak (recall that the exchange rate is expressed in domestic currency per foreign currency)—the real interest rate in the home country is smaller than the real interest rate in the foreign country because κ is negative. Hence, we have demonstrated that when the dollar is weak in real terms relative to foreign currencies, the real interest rate on dollar assets should be below the real interest rate on the foreign currency assets. Conversely, when real interest rates in the United States are relatively high, the dollar should be strong in real terms and expected to depreciate.

Empirical Evidence

Academic researchers who have examined the relationship between the real value of the dollar and the real interest rate differential have found the relationship to be weak.[6] In Exhibit 10.4, we look at recent evidence for the dollar from 1992 to 2010. The solid line in Exhibit 10.4 represents an equally weighted real exchange rate of the dollar relative to 15 major currencies expressed as foreign currency per dollar. Hence, increases (decreases) in the real exchange rate in Exhibit 10.4 represent real appreciations (depreciations) of the dollar relative to foreign currencies. The dotted line in Exhibit 10.4 represents the U.S. real interest rate defined from long-term bond yields minus an equally weighted average of the real interest rates on the other 15 countries' long-term bonds. Our estimate for expected inflation is simply current annual inflation.

It is apparent from Exhibit 10.4 that when the U.S. real interest rate seems relatively high compared to foreign real interest rates, the dollar is relatively strong in real terms. Also, conversely, when the U.S. real interest rate differential is relatively low, the dollar is relatively weak. The correlation between the two time series is 0.70.

Exhibit 10.4 The Real Exchange Rate and the Real Interest Differential



Notes: The solid line is the real exchange rate calculated as an equally weighted average of the real exchange rates of 15 currencies versus the U.S. dollar using consumer price indexes (CPIs) as the price levels. The dotted line is the U.S. real interest rate minus the equally weighted average real interests of the 15 countries. The countries are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Sweden, Switzerland, and the United Kingdom. Data are from the International Monetary Fund's International Financial Statistics.

[6] For example, Meese and Rogoff (1988) and Edison and Pauls (1993) perform various statistical tests that are designed to find the relation between real exchange rates and the real interest rate differential. Each pair of authors concludes that the relation is very weak. Baxter (1994) finds statistical support for a long-run relation but not a short-run relation between the level of the real exchange rates and real interest rate differentials. The more recent evidence remains mixed; see, for instance, Chakrabarti (2006), who finds no link, and Sollis and Wohar (2006), who do find a link.

The Real Exchange Rate and the Balance of Payments

Now that we have successfully linked real interest rate differentials and the level of the real exchange rate, albeit more in the long run than the short run, we are in a position to discuss how other important market fundamentals help to simultaneously determine the real exchange rate and the current account of the balance of payments. Recall from Chapter 4 that the balance of payments is an identity in which the sum of the current account and the capital account must be zero. Hence, the value of the current account surplus or deficit equals the value of the capital account deficit or surplus, respectively. The real exchange rate and other variables adjust to ensure that the balance of payments balances. Hence, economic shocks to the accounts of the balance of payments affect the real exchange rate.

These shocks may come from the "real" side of the balance of payments, the trade balance, which records exports and imports, and from the "financial" side of the balance of payments, the capital account, which records purchases and sales of assets. Models of the real exchange rate recognize that real exchange rates affect these two parts of the balance of payments differently, as we now discuss in detail.[7]

The Trade Balance and Real Exchange Rates

When currencies strengthen in real terms, foreign goods become less expensive than domestic goods. Hence, a real appreciation is typically associated with a deterioration of the trade balance—that is, a rise of imports relative to exports. Conversely, a real depreciation of a country's currency enhances a country's competitiveness in world markets and improves the trade balance. In this case, exports typically increase relative to imports.

Remember that the current account of the balance of payments is the trade balance plus the flows of income that are generated by a country's net international investment position—that is, by its net foreign assets. We conclude that the current account is related negatively to the country's real exchange rate through its effect on the trade balance.

The Capital Account and Real Exchange Rates

The real exchange rate also influences the capital account, which measures changes in a country's net foreign assets. A country with a capital account deficit (surplus) is acquiring (losing) net foreign assets. Remember, also, that the excess of a country's gross national income over its gross national expenditure is related by an identity to the rate of change of net foreign assets. Thus, the economic forces that determine a country's desired excess of income over expenditures determine the country's acquisition or loss of net foreign assets. When a country's income exceeds its expenditures, or when savings exceeds investment, the country builds up net foreign assets. This requires that the country run a capital account deficit and a current account surplus.

One of the most important variables that affects a country's aggregate saving and investment is the real interest rate. Because higher real interest rates increase saving and decrease real investment, higher real interest rates are associated with capital account deficits and current account surpluses. From the previous section, we know that higher real interest rates are also associated with temporarily higher real exchange rates so that the currency can be expected to depreciate in real terms over time. This is also important for the demand for assets because it ensures that the perceived rate of return on assets denominated in different currencies is the same. Thus, we have another relationship between the real exchange rate and the balance of payments, but this time, real appreciations are associated with current account surpluses.

[7]An interesting formal model that simultaneously determines both the real exchange rate and the current account is the seminal analysis of Mussa (1984).

Equilibrium

Clearly, the current account and the real exchange rate are determined in a complex equilibrium. On the one hand, a real appreciation of the home currency causes imports to rise relative to exports, which lowers the current account surplus. On the other hand, a real appreciation of the home currency is associated with an expected real depreciation and thus with a higher real interest rate at home than abroad. The increase in the real interest rate decreases investment and increases saving, which creates a larger current account surplus. Just as supply and demand for any good force an equilibrium price and quantity, the opposing forces of the real exchange rate on the current account through a "goods" channel and a "savings and investment" channel lead to an equilibrium real exchange rate and an equilibrium current account balance. Hence, a particular current account balance may be consistent with various levels of the real exchange rate. Also, variables that shift demand between domestic and foreign goods and variables that affect savings and investment will cause the equilibrium to change.

Let's give a few examples of how certain economic variables can affect the equilibrium. An increase in government spending or a decrease in taxes that causes a budget deficit increases aggregate demand in the economy. The real interest rate increases to reduce private investment and encourage private saving. The domestic currency strengthens in real terms to allow increased purchases from abroad, and the current account turns to deficit. Thus, although an observer who only sees the high real interest rate might think the country is attracting capital, the capital account is actually in surplus.

These effects of government spending are consistent with the experience of the United States in the early 1980s. When President Reagan increased government spending and decreased taxes, real interest rates increased, the dollar experienced a massive real appreciation, and U.S. current account deficits grew to unprecedented levels.

How would new information that signals increases in future GDP affect the equilibrium? The news encourages firms to invest more today; likewise, consumers feel wealthier, so they want to consume more. To ration investment and consumption, it will again be the case that for every possible current account balance, a stronger domestic currency is required. In equilibrium, there will be a real appreciation and a current account deficit. The counterpart of the current account deficit is an inflow of foreign capital, which finances some of the investment and allows consumption to be higher than it otherwise could be. An example of this effect is the sustained strength of the dollar from 1995 through 2000 and the corresponding large U.S. current account deficits. These effects were thought to be the result of the attractive growth potential associated with the U.S. economy during the information technology boom.

PPP-Based Forecasts

In Chapter 8, we showed that purchasing power parity (PPP) is a reasonably good long-term model for the exchange rate. It is fair to say that PPP-based models, with some whistles and bells, are currently the most popular fundamental exchange rate models. Most brokers and banks have developed "fair value" exchange rate models. Typically, rather than relying completely on PPP, which predicts a real exchange rate of exactly 1, they attempt to adjust this value for various effects, such as the productivity trends described in Chapter 8. This is particularly important for developing countries, which otherwise may have persistently undervalued exchange rates. The models then use the deviation between the current value and the fair value of the exchange rate to predict the direction of change.

A number of academic studies have examined the forecasting prowess of related models. Jordà and Taylor (2009), for example, define the fundamental real exchange rate simply to be its long-run mean. Their evidence suggests that a 10% real overvaluation leads to a 2% monthly nominal depreciation prediction, everything else equal, and they find some evidence that the effect becomes stronger if the deviation becomes very large. Yet, when they use this information in a trading strategy, it performs poorly. However, they claim that using fundamental information in this way is helpful in reducing the tail risks of a carry strategy, even during the disastrous 2008 period. Clements et al. (2010) also find that PPP deviations have forecasting power for nominal exchange rates at medium to long horizons using the Big Mac index to define the theoretical real exchange rate. They also stress that many countries show very persistent over- or undervaluations, so that the theory must be adjusted for an expected long-run real exchange rate (also taken to be the historical average). They also demonstrate that when the real exchange rate reverts back to its long-run mean, it is primarily the nominal exchange rate that adjusts, not relative price levels. Wu and Hu (2009) find evidence that a PPP model adjusted for the Harrod-Balassa-Samuelson effect (productivity differences across countries, see Chapter 8) beats the random walk model in out-of-sample forecasts, especially at medium and long forecasting horizons.

10.4 Technical Analysis

Whereas fundamental forecasters use macroeconomic data to forecast future exchange rates, technical analysts focus entirely on financial data. Next, we examine different technical forecasting methods in order of increasing sophistication: chartism, filter rules, regression analysis, and non-linear analysis. Active currency managers tend to primarily use technical analysis, and we end the section discussing their performance.

Pure Technical Analysis: Chartism

Chartists graphically record the actual trading history of an exchange rate and then try to infer possible future trends based on that information alone. Exhibit 10.5 graphs a daily exchange rate series, which we use to introduce some chartist terminology.

A **support level** is any chart formation in which the price has trouble falling below a particular level. A **resistance level** is any chart formation in which the price of an instrument has trouble rising above a particular level. Support levels and resistance levels define a trading range, which might be short term, medium term, or long term. When a trading range is broken, a sudden rise or fall in prices is expected and is called a **breakout**.

Chartists argue that a number of different patterns in data clearly signal future trends. One well-known pattern is the "head and shoulders," which indicates a pending fall in the exchange rate once "the neckline is pierced." Clearly, chartists do not believe in efficient financial markets but in markets that are driven by irrational whims that induce prolonged trends of rising or falling prices that are predictable.

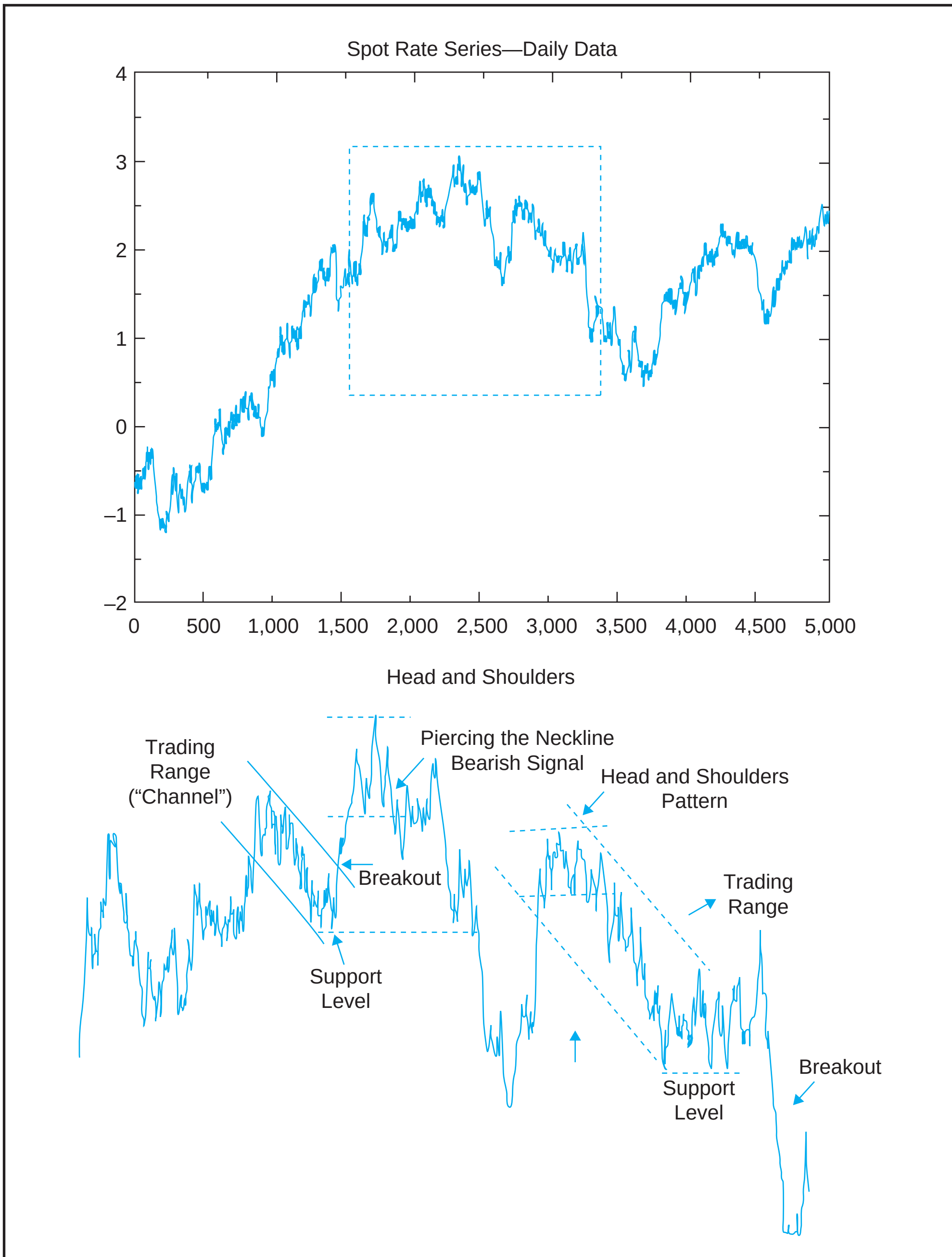
Potentially Spurious Patterns

Because chartists rely on graphs to detect trends rather than on statistics, the patterns they identify may be spurious. For example, Exhibit 10.5 does not represent data corresponding to an actual exchange rate. The data are an artificial series based on the random walk model that we generated using a random number generator. The **random walk** model implies that $E_t[S(t+1)] = S(t)$. Thus, the model states that the best predictor for the future exchange rate is today's exchange rate, and the best prediction for the change in the exchange rate is zero.

Trading on a Random Walk

If exchange rates truly follow random walks, potentially profitable trading strategies nonetheless do present themselves. For example, whenever the forward rate does not equal the current spot rate, the forward rate would not be equal to the expected future spot rate, and you would have an incentive to speculate in the forward market. For example, if the euro is at a discount relative to the dollar $(F(t) < S(t))$, and if the $\$/€$ exchange rate follows a random

Exhibit 10.5 Exchange Rate Patterns Described by Chartists



Notes: The top graph shows a daily exchange rate series (about 250 days per year) over a time span of 20 years. The graph appears to display some clear trends. The bottom panel investigates these short-term trends more closely by lifting the part in the box at the top and blowing it up. The apparent trends are then interpreted using chartist jargon.

walk, there is an expected profit to be made from buying euros forward. This is true because the future exchange rate at which you expect to sell euros for dollars in the future, which would be the current spot rate, is higher than the forward rate at which you can buy future euros with dollars today. Random walk behavior of exchange rates is consistent with the regression evidence from Chapter 7 regarding the unbiasedness hypothesis. That evidence suggests that investing in a currency trading at a forward discount is profitable.

Does Charting Work?

The recommendations of chartists are very subjective. As you see from the graph in Exhibit 10.5, it is possible for the eye to pick up what seem to be predictable patterns that are simply not there. Moreover, it is difficult to statistically analyze the predictions chartists make. For example, we must formalize what it means to see a head-and-shoulders pattern or another rule in a formula that can be applied to the data. One interesting study by Chang and Osler (1999) compared the profitability of the head-and-shoulders pattern with other trend-predicting rules. Although Chang and Osler found that trading on the head-and-shoulders patterns is profitable, the profitability is dominated by other, simpler trading rules, which we discuss next.

Filter Rules

Filter rules are popular methods for detecting trends in exchange rates. In general, filter rules are trading strategies based on the past history of an asset price that provide signals to an investor as to when to buy and sell currencies. We investigate two often-used techniques, which we describe from the perspective of a dollar-based investor who is examining exchange rates in dollars per foreign currency.

x% Rules

An x% rule states that you should go long (buy) in foreign currency after the foreign currency has appreciated relative to the dollar by x% above its most recent trough (or support level) and that you should go short (sell) in foreign currency whenever the currency falls x% below its most recent peak (or resistance level). Common x% rules are 1%, 2%, and so forth. Panel B of Exhibit 10.6 illustrates this rule for an upward trend of the currency.

Moving-Average Crossover Rules

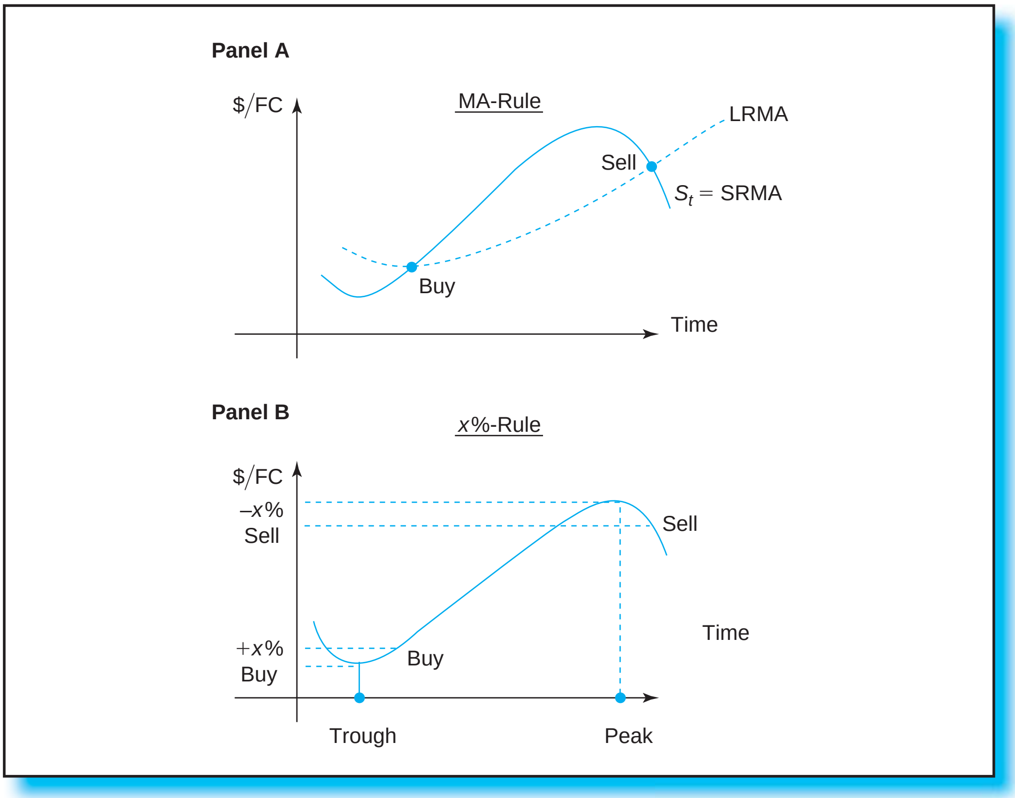
Moving-average crossover rules use moving averages of the exchange rate. An n-day moving average is just the sample average of the last n trading days, including the current rate. A (y, z) moving-average crossover rule uses averages over a short period $(y$ days$)$ and over a long period $(z$ days$)$. The strategy states that you should go long (short) in the foreign currency when the short-term moving average crosses the long-term moving average from below (above). Common rules use 1 and 5 days (1, 5), 1 and 20 days (1, 20), and 5 and 20 days (5, 20). Panel A of Exhibit 10.6 shows how the short-run moving-average line, which in this case is the exchange rate itself because we are using a 1-day rule, more rapidly picks up the upward trend in the left-hand portion of the graph and cuts through the long-run moving-average line from below, signaling a buy.

Filter Rule Profitability

How well do filter rules work? Early studies found that technical trading rules generated statistically significant profits, which were unlikely to be generated by chance (see, for example, LeBaron, 1999). However, the sample period in these studies was dominated by long swings in the value of the dollar, which appreciated substantially in the first half of the 1980s before depreciating substantially in the second half of the 1980s.[8] Newer work by Pukthuanthong-Le et al. (2007) finds that the era of easy profits from simple trend-following strategies is over, at least for the major currencies. These authors show that the average profits generated by three moving-average rules for the Japanese yen, Deutsche mark, British pound, and Swiss franc over the 1975 to 1994 period are highly statistically significantly different from zero. The

[8]Engel and Hamilton (1990) developed a statistical model that clearly identifies these long swings.

Exhibit 10.6 How Filter Rules Work



Notes: In Panel A, the solid line represents the actual exchange rate, $S(t)$, which serves as the short-run moving average (SRMA). The dashed line is the long-run moving average (LRMA), averaging the current and past exchange rates. In Panel B, we graph only the exchange rate and illustrate the use of an x% filter rule.

profits range from 6.20% per year for the Swiss franc to 13.94% for the yen, and the standard error for these averages is about 2.7%. For most currencies, we can be very confident that these profits are different from zero.[9] The Canadian dollar generated positive but insignificant profits. Over the 1995 to 1999 period, the yen is the only currency with positive (and significant) profits, and for the 2000 to 2006 period, no currencies generate significantly positive profits. The authors interpret these results as indicating that foreign exchange markets have become more efficient over time, although it is puzzling that this process would have taken so long. They also demonstrate that over the 2000 to 2006 period, less liquid currencies, such as the New Zealand dollar, and emerging market currencies, such as the Brazilian real, the South African rand, and the Russian ruble, do generate significant profits when simple moving-average rules are followed. The Mexican peso generates positive but insignificant profits.

Regression Analysis

The evidence against the unbiasedness hypothesis presented in Chapter 7 suggests that interest rate differentials may contain information about future exchange rates that can be profitably exploited. Both academic analysts and foreign exchange professionals have explored

[9]To establish the confidence level formally as in Chapter 7, we divide the average by its standard error, square the resulting statistic, and check where this value lies in a chi-square distribution with 1 degree of freedom. For example, the statistic for the Swiss franc profits is $(6.20/2.7)^2 = 5.27$. Given a chi-square distribution with 1 degree of freedom, we have 97.8% confidence that the profits are different from zero.

regression models that link future exchange rate changes to interest rate differentials and other easily available information (such as past exchange rates) to predict future exchange. Essentially, the regression uses future returns on forward market positions [$fmr(t)$; see Chapter 7] as the dependent variable and current information, such as the forward premium [$fp(t)$], and other variables as the independent variables. The fitted value of the regression can then be interpreted as the expected return on a long forward position.

In a trading strategy, the regression framework is used each trading period to find a value for the expected forward market return. If the expected return is positive (negative), the strategy goes long (short) in the foreign currency.

Non-Linear Models

Increased computing and mathematical and statistical sophistication have led researchers and practitioners to use more complex models to forecast exchange rates. Going beyond simple linear regression models as discussed earlier, researchers have, for example, tried to model the idea that as currencies move further from fundamentals (such as their PPP values) or as the volatility of the exchange rate increases, interest rate differentials may work less well as predictors of future exchange rate changes (see, respectively, Jordà and Taylor, 2009; and Clarida et al., 2009). Going beyond simply prespecifying the trading rules, more recent studies have applied sophisticated computer techniques, such as genetic algorithms, to search for optimal trading rules. Without going into details, these techniques apply a Darwinian-like, natural selection process to filter rules applied to past data that eventually breeds the "best" trading rules. (The *Point–Counterpoint* feature in this chapter discusses these kinds of "non-linear" forecasting techniques in more detail.) Neely et al. (1997) found that adhering to such trading rules was, indeed, profitable. In a subsequent study conducted in 2001, Neely and Weller found that additional information about central bank interventions further improved profitability.

Point–Counterpoint

Chaos, Genetic Engineering, and Neural Networks

"Come on, Ante. It will not be that bad," Freedy implored. Ante could not shake off the dreadful prospect of seeing Covis Estello at their high school reunion. Although the brothers acknowledged that Covis was smart, they had often made fun of him in high school, frequently calling him Mr. Super-Geek. Now, Ante was holding an article from the newspaper describing Mr. Estello's prowess in developing systems to trade currencies. Estello's expertise was apparently in the area of chaos theory and neural network systems, and he had reputedly "trained" different models using "genetic algorithms."

"I have no clue what he's doing, but he seems to be able to predict currency values, and he is clearly way richer than we will ever be," Ante lamented.

Freedy sighed and cautioned, "Come on, you know predicting currency values is incredibly difficult. I actually think he may just be lucky. Foreign exchange markets are very efficient. It's very hard to make abnormal returns in these markets. I think Covis used some mathematical hocus-pocus to convince investors to give him money, took some risks with other peoples' money, and got lucky. If I'm right, we'll soon see an article titled, 'The Rise and Fall of Estello.'"

"Well, that won't happen before our class reunion, and besides, to me his profits demonstrate that markets are totally inefficient," retorted Ante. "Clearly, super-nerd Covis must have devised some complex system to find trends in exchange rates, and now he is making oodles of money while we are studying efficient markets!"

At that moment, Suttle Trooth agitatedly rushed into the room. "Hey guys, did you read the article about Covis? What a success story! Come on, Ante, aren't you happy with our old friend's success?" Suttle smirked as he saw Ante frowning. Freedy immediately asked, "Please explain to us what all this math junk is about. If the foreign exchange market is efficient, how can Covis make so much money?"

Suttle relaxed and said, "Well, these are very complex issues. If markets are efficient, you're right that it would be quite difficult to make tons of money trading currencies. There certainly wouldn't be any easy trends to exploit. But even if we believe in efficient markets, the theories we studied in school make a number of doubtful or at least brave assumptions. First of all, speculating in currency markets exposes you to risk, and any profits may just be compensation for bearing currency risk. Remember, the risk premium can move around and change signs. If that is the case, predictable patterns in exchange rates, picked up by Estello's system, may just reflect time-varying risk premiums—that is, he goes long in currencies that are especially risky. If this is the case, it would not be surprising that one of these days he may suffer a serious loss.

"Second," continued Suttle, "economists often assume that all traders have the same information, act in their self-interest, and agree on the model generating exchange rates and the market fundamentals. We all know that this is not literally true. For example, some commercial banks use the superior information they have from the flow of forex orders they take from their multinational clients. This might help them get an idea of short-run patterns. In U.S. equity markets, such trading by brokers is called front-running, and it is illegal, but in the unregulated currency markets, anything goes. Other economic models have so-called 'noise traders' who trade based on reasons other than their private information. Smart people can exploit the 'noise traders' who systematically lose money. Noise traders could be acting irrationally, but they could also be a central bank that is not profit maximizing and therefore could be exploited.

"Work in psychology and economics now shows all sorts of behavioral biases that may lead to non-rational trading behavior that more rational traders could exploit. Furthermore, we know that exchange rates are influenced by monetary policy, and many relevant elements of policy making are really not publicly known. It is possible that some experts learn more about these policies or they can predict policy changes better than others. Finally, even if you are right in the long run, the market might turn against you in the short run. A trader must have sufficient capital to ride out a string of losses, or he may go broke before the profits start rolling in."

"But how exactly does Covis make money?" Freedy interjected.

Suttle answered, "Well, I do not know much about the mathematical models he uses except for the fact that they are inherently non-linear—that is, they involve cubic and quadratic functions and the like. A chaos system, which is one of the models mentioned in the article, is actually a deterministic system with no news or shocks at all. The future is thought to be a deterministic, non-linear function of the past. If you can figure out the relationship, you can perfectly predict the future. Although chaos theory seems to have some useful applications in biology and physics (it's apparently great in explaining fluid dynamics), I haven't seen any really useful applications in economics and finance.

"News is what drives asset prices! Moreover, chaos systems are extremely sensitive to initial conditions and yield vastly different predictions, depending on small perturbations to initial conditions. How will Covis ever know he has found the right system? A small data error could lead him astray. However, I see more of a future in these neural network systems," continued Suttle. "A neural network is another kind of non-linear model, where depending on the outcome of some criterion (say above or below 0), a particular function gets switched on. From what I can tell, genetic algorithms are tools to help determine the best trading rules for a given set of historic data. They are really a computer research procedure that uses the Darwinian principle. Essentially, the computer randomly generates a number of potential trading rules. The best trading rules ('survival of the fittest') have the best chance of surviving to the next round (they 'reproduce'). These rules are mixed with some randomly generated new rules (there is 'mutation'). Eventually, the program identifies trading rules that are very profitable.

"What is problematic about all these models," continued Suttle, "is that they require lots of parameters. For a particular sample of data, it will always be the case that some non-linear function describes the data very well. The key issue is whether it works in the real world with real trading and real money. And even if it does work well for a while, is it really skill, or is it simply luck? That may take years to figure out. Hence, I'm not so sure that Covis has any particular skill. The jury is still out. Moreover, if he is successful, and there is something in the data the market participants did not know, his trading will make markets more efficient, which will kill the profit opportunity. Undervalued currencies will be bought and overvalued currencies will be sold."

Freedy shouted, "See, I told you, in the end, markets are efficient! Unfortunately, Ante, Covis will still be the man at the school's reunion." Ante just sighed.

Evaluating Forecasting Services

One way to ascertain whether profits are being made in the foreign exchange market using technical analysis is to look at the forecasting records of actual forecasting services. Forex advisory services are a diverse lot. All of them generate exchange rate forecasts, but their clienteles, techniques, and forecast horizons differ. Unfortunately, there exists scant empirical evidence on the forecasting ability of such services. However, that is changing because currencies are more and more viewed as an asset class and the number of active currency traders, mostly organized as hedge funds, has grown considerably over the past decade. Because many of these currency traders report returns to various indices, we can analyze their performance. If such funds fail to forecast exchange rates, they should not consistently produce high returns!

Pojarliev and Levich (2008) conducted a study on the returns earned by currency managers reporting to the Barclay Currency Traders Index (BCTI) between January 1990 and December 2006. All of these returns are reported net of fees. Hedge funds typically charge a fixed fee of 2% and a variable fee of 20% on the performance over a benchmark (which can be zero or the Treasury bill return). The study first tries to establish what techniques the currency managers use: Do they use the carry strategy, do they follow trends, or do they trade based on fundamentals? To do so, the investigators use historical data to create returns to carry-trade, trend-following, and fundamental strategies for the major currencies, and they use regression analysis to investigate whether the returns of the various managers correlate with these benchmark returns. The majority of the funds (and the average index) appear to follow trend-following strategies; many also show positive carry exposure, but there is not much of a link with the return on fundamental strategies. The average excess return earned over 34 different managers with relatively long track records between 2001 and 2006 is 5.45%, and the average (annual) Sharpe ratio is 0.47, which is higher than the Sharpe ratio generated by the equity market. Pojarliev and Levich also check whether the managers outperform the benchmark returns. Deutsche Bank, among others, has introduced easily tradable funds that mimic the simple strategies represented by the benchmarks. For an investor, it would make little sense to pay the heavy fees hedge funds charge for exposure to an index that can be bought for a small fixed fee. Pojarliev and Levich find that only eight of the 34 managers significantly outperform a combination of benchmark indices that best describes their investment style.

Taylor Rules Currencies[10]

FX Concepts is one of the largest currency hedge funds in the world, with assets under management of close to $15 billion. John R. Taylor founded FX Concepts in 1981 as a currency forecast firm, selling forecasts to banks and pension funds. His firm gained notoriety when he correctly predicted the precipitous decline of the dollar at the end of 1985. In 1989, he started an investment fund, investing in developed market currencies using mostly sophisticated trend-following systems. During the turmoil in Europe's currency markets in 1992, Mr. Taylor's fund returned 43%. Nevertheless, later in the 1990s, Mr. Taylor experienced firsthand that trend-following systems for developed currencies have a tougher time making money, as he experienced more and more competition from other active currency traders. Since the early 2000s, FX Concepts expanded its strategies to include one focusing on the carry trade and one focusing on volatility movements. The firm also expanded the set of traded currencies to include emerging markets. FX Concepts now trades over 30 currency pairs relative to the dollar in its Global Currency Program. Both the generation of currency forecasts and the construction of the portfolios use quantitative techniques. FX Concepts has now also ventured into commodities and fixed-income securities, but trading currencies and forecasting currency values remain its core business activities.

10.5 Predicting Devaluations

So far, we have discussed currency forecasting for floating exchange rates; however, more than 70% of currency systems in the world do not fit into this category. We now focus our discussion on the special forecasting problems that arise in pegged systems, but we note that many of these ideas also apply to the target zones and currency boards discussed in Chapter 5.

In a pegged system, one must forecast whether there will be devaluation, and, if so, how large it will be. We first review the major theories on why pegged systems break down. Then, we discuss various forecasting techniques, both in situations where good financial data are available and in cases where they are lacking. We also recount the currency devaluations that occurred in Europe in 1992, Mexico in 1994 to 1995, and Southeast Asia in 1997 and the havoc they wrought.

What Causes a Currency Crisis?

The failure of a pegged exchange rate is typically the result of a successful speculative attack leading the currency to experience a large devaluation [which happened many times during the European Monetary System (EMS)] or to be floated (as happened in Mexico in 1994). For multinational businesses, such occurrences are very important not only because the companies have direct currency exposures in the devaluing countries, but also because currency crises are usually accompanied by economic upheaval. This can lower the value of the local assets that the companies own, affect their production, and adversely affect their local and worldwide sales. There are two main reasons pegged currencies succumb to speculative pressures.

Macroeconomic Conditions

The seminal work of Krugman (1979) and Flood and Garber (1984) argues that if a government follows policies inconsistent with its currency peg, a speculative attack is unavoidable.

[10]We rely on information from FX Concepts's Web site and the article by Nielsen (2008).

Speculators will attack the system and attempt to profit by selling the local currency and buying the foreign currency. The country's central bank will lose foreign reserves defending the peg until a critical level of low reserves is reached, at which point the bank is forced to abandon the peg. Whereas initial models focused on expansionary monetary policies, expansionary fiscal policies can also lead to speculative attacks.

These models argue that devaluations are predictable. Growing budget deficits, fast money growth, and rising wages and prices should precede them. If prices rise faster in the local economy than foreign prices are rising while the nominal exchange rate remains unchanged, the local currency is appreciating in real terms. Hence, currency overvaluations should also be a signal of an imminent crisis. The combination of government budget deficits and real exchange rate overvaluations also usually leads to large current account deficits. Consequently, if the theory is correct, speculative pressures should be predictable from economic data.

Self-Fulfilling Expectations

The second explanation for why pegged currencies succumb to speculative pressures recognizes that speculative attacks sometimes seem to come out of the blue. The crisis may be a self-fulfilling prophecy caused by the "animal spirits" of investors, as the famous economist John Maynard Keynes once phrased it.

Although the formal models outlining these ideas are too abstract to recount here, consider the following argument: Suppose a significant group of investors simply starts speculating against a currency, which causes a substantial capital outflow from the country under attack. Other investors, seeing the capital outflow, think the currency will collapse, so they, too, sell the currency, leading to yet more capital outflow. If the central bank becomes overwhelmed, and the country's currency is devalued, this validates the fears of investors, even though there was no fundamental economic reason for dropping the peg.[11]

More recent studies on the issue recognize that deteriorating fundamentals may still play a role. For example, the worsening of the country's employment rate may make defending the nation's currency more costly and may eventually lead to a crisis. However, the actual occurrence and timing of the crisis are still determined by the animal spirits of speculators.

Contagion

The phenomenon known as **contagion** is an increase in the probability that a speculative attack on a currency will occur merely as a result of other currency crises. For example, in September 1992, the British pound first devalued and then left the EMS altogether. The pound suffered a large depreciation in value relative to most European currencies. A few months later, speculators attacked the Irish punt, which was still in the EMS, and the Irish authorities were forced to devalue as well. Because Ireland did not appear to be experiencing any economic problems, many market observers ascribed the Irish devaluation to contagion from the United Kingdom.

If speculative attacks are merely self-fulfilling prophesies, contagion is easy to understand. If speculators successfully attack one currency, they may as well try another. Nevertheless, contagion may be a rational response and even predictable for a variety of reasons. For example, when the British pound devalues but the Irish punt does not devalue, the Irish punt experiences a real appreciation relative to the pound. Because a real appreciation adversely affects the competitive position of Irish exporters, it causes economic and political

[11]Technically, such self-fulfilling attacks are possible in models with multiple equilibriums. There is a stable equilibrium in which the government follows the right policies consistent with the peg, but there is also another equilibrium in which the speculators attack the currency and the government accommodates the lower exchange rate. See, for example, Obstfeld (1986) for the theory, Jeanne (1997) for an empirical test, and Kaminsky (2006) for a survey of the literature.

pressure to devalue [see Glick and Rose (1999) for a general analysis of how international trade helps spread currency crises].

Another situation in which contagion is rational but the first crisis is not the cause of the second crisis arises when two currencies are attacked sequentially because the second country is experiencing similar negative macroeconomic conditions or is following similar inconsistent policies.

Empirical Evidence on the Predictability of Currency Crises

The theory on currency crises clearly suggests that certain macroeconomic signals predict devaluations or currency crises. What macroeconomic variables have proved useful predictors of devaluations? Although the many empirical studies do not always agree, a number of economic variables consistently show up as useful predictors. These include PPP-based measures of currency overvaluation, current account balances and monetary growth rates (see Eichengreen et al., 1995; and Kaminsky et al., 1998).

A number of economists and investment banks have built econometric models to predict currency crashes using similar economic variables. The model is estimated using data from various countries on past devaluations. The input of current values of the macroeconomic variables associated with a country then delivers the probability of a devaluation occurring. Some models in this class [for instance, that by Bekaert and Gray (1998)] combine financial data, such as interest rate differentials, and other macroeconomic information, such as cumulative inflation differentials. If liquid financial markets exist, information about forward rates or interest rates, currency option prices, and so on may prove useful in terms of forecasting devaluations. After all, the market prices should rapidly reflect all new economic information.

Finally, the recent global crisis, which started in the banking system, has renewed interest in the links between banking and currency crises. Kaminsky and Reinhart (1999) find that problems in the banking sector typically precede currency crises, as do Burnside et al. (2001) specifically for the Asian crisis. Kaminsky and Reinhart also claim that financial liberalization and the removal of capital controls play a systematic role, but Glick and Hutchison (2005) marshal empirical evidence that capital controls fail to stave off speculative attacks.

The Rocky 1990s: Currency Crises Galore

In 1992, speculators attacked a number of currencies in Europe, severely undermining and casting doubt on the progress toward monetary union in Europe. An exasperated Michel Sapin, French finance minister, was quoted in the *New York Times* on September 24, 1992, as saying, “I will fight, we will fight, France and Germany will fight this speculation, which is based on no economic fundamentals. During the French Revolution such speculators were known as ‘agioteurs’ and they were beheaded.”

But this was only the beginning of the very rocky decade. At the end of 1994, the Mexican peso collapsed, and in its wake, other emerging market currencies and stock markets wobbled. In 1997, several Southeast Asian countries were forced to abandon their pegs relative to the dollar. We now chronicle these watershed events.

1991 to 1993 Currency Turmoil in Europe

As discussed in Chapter 5, in December 1991, representatives from the European Community (EC) countries signed the Treaty of Maastricht, which mapped out the road to a monetary union. While the euro was eventually successfully introduced in 1999, the Exchange Rate Mechanism (ERM) currencies and currencies in its periphery, looking to join at a later stage, witnessed several currency crises before and after the signing of the Maastricht Treaty. Exhibit 10.7 provides a detailed time line of the events showing 2 tumultuous years, with a

Exhibit 10.7 A Rocky Start to EMU

November 1991: Devaluation of the Finnish markka relative to the ECU
December 1991: Signing of the Maastricht Treaty
June 2, 1992: Denmark referendum rejects Maastricht Treaty
September 8, 1992: Finnish markka drops ECU peg
September 16, 1992: Black Wednesday, British pound forced out of ERM
September 17, 1992: Italian lira suspended from ERM; devaluations of Spanish peseta and Portuguese escudo
September 20, 1992: French referendum (narrowly) accepts Maastricht Treaty; Spain reimposes previously lifted capital controls
November–December 1992: Maastricht Treaty now ratified by all countries, except Britain and Denmark; Swedish and Norwegian kronor ECU pegs dropped; peseta and escudo further devalued
January 1993: Devaluation of Irish punt
May 1993: Peseta and escudo devalue once more; Danish referendum accepts Maastricht Treaty
July 1993: Heavy speculative pressure against weak ERM currencies, including the French franc
August 1993: Britain ratifies Maastricht; ERM bands widened to 15%
End of 1993: Speculative pressures ease

plethora of successful and unsuccessful speculative attacks. These events constitute a good case study of what factors may drive currency crises, and they may hold lessons for the future.

A big factor driving these events was the uncertainty surrounding the ratification of the Maastricht Treaty, which had to take place in several European countries. The first referendum in Denmark rejected the Treaty, showing that many European citizens had serious doubts about the desirability of monetary union. In several crises, trade links played a role. For example, Finland, Sweden, and Norway had adopted pegs to the European currency unit (ECU), hoping to strengthen their application for EC membership and signaling their determination to keep inflation down. In November 1991, the collapse of the former Soviet Union obliterated a large portion of Finland's foreign trade, and the markka devalued by 12.3%. The 10% devaluation of the Irish punt on January 30, 1993, was likely partially caused by the major pound depreciation following Black Wednesday, Britain being Ireland's major trade partner. It is possible that the disappearance of capital controls played a role as well. On January 1, 1993, Ireland lifted capital controls and started to rely on interest rates as its main defense mechanism against speculative attacks. From then onward, the punt faced almost continuous speculative pressure. Portugal made use of its remaining capital controls (which would have to be lifted as part of the road to monetary union), and Spain reintroduced capital controls in September 1992 to defend their currencies. However, both the escudo and the peseta were devalued multiple times.

Perhaps the most important lesson of this episode is the difficulty of keeping fixed exchange rates in a region where different countries experience very different economic shocks. The main culprit of the currency troubles undoubtedly was the 1990 reunification of East and West Germany. Germany struggled to absorb the Eastern Länder into the German economy. Inflation surged from increased demand and from wage increases in the former East Germany that exceeded growth in productivity. Moreover, the German money supply increased dramatically from the conversion of Ostmarks, the money of East Germany, into Deutsche marks at a one-for-one exchange rate, even though the purchasing power of the Ostmark was significantly less than that of the Deutsche mark. Sizable budget deficits arose when the government chose to finance the costs of the transition without raising taxes.

The Ostmark conversion, the loose fiscal policy, and the emergence of inflation worried the Bundesbank, Germany's largely independent central bank that has been obsessed with maintaining price stability ever since the hyperinflation of the 1920s. The Bundesbank stepped hard on the brakes and implemented a tight monetary policy of low money growth and high interest rates. The high interest rates in Germany caused a capital inflow and drove up the value of the mark.

The other countries in the EMS were confronted with a dilemma: either raise interest rates to stay in the EMS and appreciate versus the dollar and other major currencies along with the Deutsche mark while seeing their economies suffer in the short run or keep interest rates low to stimulate their economies and risk future devaluation and possible failure of the European Monetary Union (EMU). With Britain in deep recession and other economies heading there, participants in the financial markets began to sense a dwindling belief in the commitment to the EMU. Therefore, it is not surprising that economic news would be a major determinant of the extent of speculative pressures. When there were signs of the Bundesbank beginning to ease interest rates in May 1993, coupled with positive economic figures, speculative pressures on the French franc dissipated, leading to a virtual convergence of French short- and long-term interest rates to German levels. Ultimately, the Bundesbank stubbornly sticking to its high-interest-rate monetary policy and the release of disconcerting macroeconomic statistics caused a full-blown crisis in July and August of 1993 that led to the widening of the ERM bands from 2.25% to 15%.

1994 to 1995: The Mexican Crisis and the Tequila Effect

As we discussed in Chapter 5, in the mid-1990s, Mexico operated a crawling band exchange rate system. However, on December 20, 1994, the ceiling of the band was raised by approximately 13% in an attempt to stop the heavy losses of foreign exchange reserves sustained since mid-November. But the losses continued, and on December 22, 1994, the government effectively floated the peso.

Unfortunately, this currency crisis was only the beginning. Investors around the world and Mexican residents dumped Mexican bonds and equities, putting enormous pressure on the exchange rate. The peso halved in value, as did the equity market. Interest rates spiked up. What was worse, in the course of 1994, the Mexican government had, as a signal of its commitment to the exchange rate band, issued bonds called Tesobonos. Tesobonos are Mexican Treasury bills denominated in dollars but paid in pesos. In effect, Tesobonos protect investors from currency risk. At the end of 1994, the value of the Tesobonos outstanding was more than three times the value of the remaining foreign currency reserves of the Bank of Mexico, and despite very high Tesobonos interest rates, private foreign investors were reluctant to invest in Mexico. Mexico faced a very acute liquidity crisis, which threatened to affect other emerging markets as well.

With the private sector no longer willing to provide funds to Mexico, the IMF and the Clinton administration, drawing on funds from the U.S. Treasury's Exchange Stabilization Fund, put together a bailout package worth some $50 billion that saved Mexico. Notably, the U.S. Congress had voted down support for Mexico. The Mexican currency crisis was a watershed event for emerging markets. Since the early 1990s, many emerging markets had witnessed large portfolio inflows from the developed world. The currency crisis in Mexico and its adverse effects on equity markets seemed to cause foreign capital to dry up not only for Mexico but also for other emerging markets, from Latin America to Asia and Eastern Europe. This spillover of the Mexican crisis to other countries came to be known as the Tequila Effect and caused many economists and policymakers to reevaluate the benefits of unbridled capital flows. Nevertheless, Mexico managed to rebound rather quickly, and the loans provided in the bailout package were duly repaid.

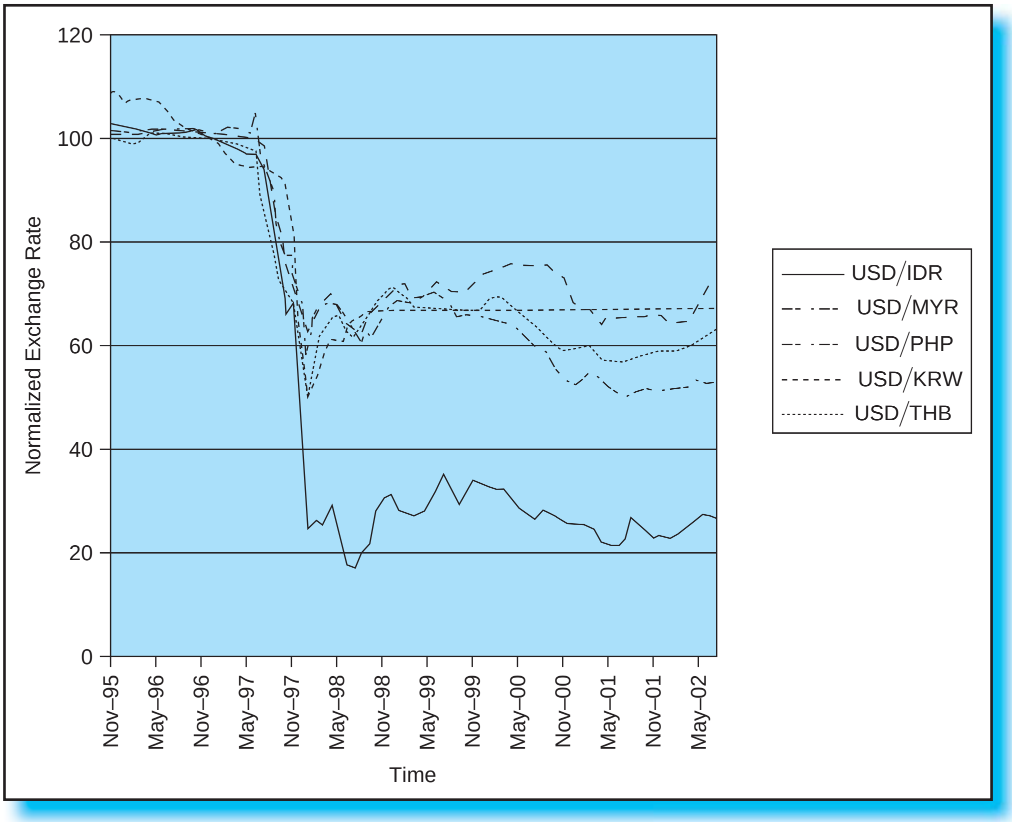
1997: The Southeast Asian Crisis

Since 1980, the countries of Southeast Asia, the so-called Asian Tigers, had engineered an economic miracle, growing their real GDPs by over 7% per year. But there were some uncanny parallels between their macroeconomic fundamentals and those of Mexico just before the crisis. Mexico had been running large current account deficits in the years preceding the currency crisis. For some of the Asian Tigers, their high economic growth also went hand-in-hand with growing current account imbalances. The current account imbalances were worst for Thailand, followed by Malaysia, the Philippines, Korea, and Indonesia. The other Asian countries—Taiwan, Singapore, China, and Hong Kong—on the other hand, ran current account surpluses or very small deficits. These countries all had relatively fixed exchange rate systems in place. Whereas Hong Kong was the only country running a currency board with dollars, other countries were formally pegging their exchange rate to a basket of currencies. However, the effective weight of the U.S. dollar in the basket was so high that the countries were essentially pegged to the U.S. dollar.

We show the historic evolution of some of these currencies relative to the dollar in Exhibit 10.8 in which the values of the currencies are normalized to equal 100 in January 1997. All five currencies were within 10% of 100 during 1995 to 1996. In fact, the Malaysian ringgit moved in a 10% range of MYR(2.5 to 2.7)/USD for most of the years between 1990 and 1997. The Thai baht was effectively fixed in a narrow range of THB(25.2 to 25.6)/USD from 1990 until 1997. In the Philippines, the peso was practically fixed at PHP26.2/USD from spring 1995 until the beginning of 1997. The other countries followed more flexible exchange rate regimes.

Exhibit 10.8 indicates that these currencies experienced sharp depreciations in the second half of 1997. Thailand was the first country to be hit by the crisis. Intervention could not stem the outflow of capital in the first half of 1997, and by early July, the authorities

Exhibit 10.8 Asian Exchange Rates



Notes: The exchange rates are normalized to equal 100 in January 1997. The currencies are the U.S. dollar values of the Indonesian rupiah (IDR), the Malaysian ringgit (MYR), the Philippine peso (PHP), the Korean won (KRW), and the Thai baht (THB).

were forced to let the baht float (or, rather, sink). Indonesia quickly became engulfed in the regional financial crisis, and its authorities allowed the rupiah to float freely in mid-August 1997. Sharp currency depreciations also occurred in Malaysia and the Philippines. Korea was the last to be hit by the crisis. Despite repeated exchange market intervention in the summer and autumn and a firming of interest rates, the Korean won's slide could not be arrested. By late November, the country seemed on the brink of defaulting on its short-term external liabilities.

All the countries facing currency crises were very heavily exposed to short-term foreign currency–denominated debt (typically dollars), but Korea was by far the most exposed. In June 1997, outstanding, short-term, foreign currency–denominated debt was more than 300% of Korea's official reserves. In Thailand and Indonesia, this ratio was also well over 100%. Of course, once the crisis hit and the currency depreciated, the value of the debt burden in local currency exploded.

The currency crises in Southeast Asia had wide repercussions, leading to corporate restructuring and bankruptcies. Rich businesspeople became poor overnight, fueling a thriving market for secondhand luxury goods. More importantly, economic growth was hampered, especially in Thailand and Korea, and unemployment rose. The Asian currency crises became real economic crises, causing the Asian miracle to come to a screeching halt.

Different Paths During The Financial Crisis: The Icelandic Króna Versus the Latvian Lat[12]

During the global financial crisis of 2007 to 2010, many currencies experienced large depreciations relative to the dollar and other safe haven currencies. Imagine a currency speculator looking at the economies of Iceland and Latvia after the collapse of Lehman Brothers in September 2008 as the severity of the global financial crisis became ever clearer. It was obvious that these economies would not weather the global financial crisis unscathed. In fact, the economic statistics in both countries contained multiple indications of overheated economies, ready for a hard landing in the dire economic times to come. Would these economies follow the same path, and more importantly, could money be made speculating against their currencies?

Latvia joined the European Union in 2004 and had been growing at break-neck speed. GDP grew by 10.4% per year during 2004 to 2007, and wages had exploded. Because Latvia eventually wanted to join the euro zone, its currency, the lat, was pegged to the euro. High Latvian inflation thus resulted in a substantial real appreciation of the lat, just as happened in Argentina in 2001. The consumption boom and loss of competitiveness contributed to large current account deficits, which were easily financed by inflows of foreign capital. A sudden stop of these capital inflows, though, would imply a drastic reorganization of the economy. As the financial crisis began to unfold, the lat was thus viewed as a prime candidate for devaluation versus the euro, and the success of a speculative attack surely appeared high.

Iceland's problems were mostly of their own making. After Iceland liberalized its banking system in 2001, three Icelandic banks, Kaupthing, Glitnir, and Landsbanki, went on a lending spree, borrowing in international markets and lending both in domestic and international markets. The economy boomed, and by 2007, the United Nations ranked Iceland first on its index of most developed countries, with a GDP per capita of close to $70,000. Its nickname of "the Nordic Tiger" seemed wholly appropriate. As in Latvia, the economic boom put pressure on wages and made Reykjavik look like a gold rush town. To finance their lending spree, the Icelandic banks attracted lots of European deposits, offering high yields on online accounts. Best known among these was the Icesave product from Landsbanki that offered British and Dutch residents high interest rates on pound and euro deposits, respectively.

The Icelandic króna was a freely floating currency, and during the boom years from 2001 to 2007, the euro strengthened only 1.6% per year versus the króna. As the crisis began to unfold in the first half of 2008, though, the króna price of the euro increased 31%. The Central Bank of Iceland reported in 2008 that foreign debt of the three banks was over five times Iceland's GDP. By September 2008,

[12]For additional details on the Icelandic banking crisis, see Beim (2009).

Iceland's external debt reached close to 14 times its export revenue. Clearly, a full-blown financial and economic crisis would be kind to neither Iceland nor the króna.

The crisis did hit with a vengeance in both countries. Yet, the outcome for currency speculators betting on a devaluation of the lat and depreciation of the króna could not have been more different. Anyone buying euros with krónur on September 12, 2008, the Friday before Lehman collapsed, would have made 13.7% by the end of the month when the exchange rate hit ISK145/EUR and Glitner Bank was nationalized. Holding that position for another week would have proved very beneficial because during the first week of October, financial markets began to doubt whether the other Icelandic banks could survive and depositors began a run on the banks. When Landsbanki collapsed on October 6, 2008, the Icelandic deposit insurance scheme could not cover the bank's total deposits, and the Icelandic government chose to fully cover only domestic deposits.[13] The króna began to depreciate rapidly, and by October 9, 2008, the last reported spot trade was at ISK340/EUR before the Icelandic authorities halted trading in the currency because no international banks would serve as counterparties. The Icelandic government imposed exchange controls and capital controls, which have not yet been lifted at the time of writing (although there is a plan to do so in the near future). Eurostat reports that Iceland's per capita GDP fell 9.2% in 2009. The major depreciation of the króna may help Iceland's economy recover because all Icelandic products and services, including tourism, are now on sale.

The financial crisis also threw Latvia into a severe recession. GDP fell 4.2% in 2008 and 18% more in 2009. Capital flows dried up, but the lat did not budge. The government refused to devalue and intervened to defend the currency. Despite losing massive official reserves, the government stood firm, and speculators betting against the lat have so far been thwarted. Without a devaluation of the lat, Latvia's economy will face severe adjustment costs, including large reductions in nominal wages to regain its international competitiveness.

10.6 Summary

This chapter focuses on the determination and forecasting of exchange rates. The main points of the chapter are as follows:

1. Currency forecasts are useful in the international aspects of project evaluation, strategic planning, pricing, working capital management, and the analysis of portfolio investments.
2. The Fisher hypothesis states that the nominal interest rate equals the real interest rate plus the expected rate of inflation.
3. When all the international parity conditions hold, currency forecasting models have little value: The forward rate is the best predictor for the future spot rate, the current real exchange rate is the best predictor of the future real exchange rate, and costs of funding and returns to investment are equalized in real terms across countries (that is, real interest rates are equalized across countries).
4. Empirical evidence rejects the notion of the equality of real interest rates across countries.
5. The two main forecasting techniques are fundamental analysis and technical analysis.
6. Fundamental analysis links exchange rates to fundamental macroeconomic variables such as GDP growth and the current account either through a formal model or through judgmental analysis.
7. Technical analysis uses financial data, such as past exchange rate data, to predict future exchange rates.
8. The root mean squared error (RMSE) can be used to judge the accuracy of forecasts. The percentage of correct signals relative to the forward rate can be used to judge the usefulness of hedging. The profits generated by using the forecasts can also be used to gauge their quality.
9. The asset market approach to exchange rate determination views the exchange rate as an asset price. Its value then depends on current fundamentals

[13]The British and Dutch governments decided to compensate their citizens who lost money in the Icelandic deposit schemes and are now suing the Icelandic government. The British government even froze Icelandic assets under the provision of an anti-terrorist law because they viewed the actions of the Icelandic government to be an attempt to harm the United Kingdom. In January 2011, several former Landsbanki executives were arrested in Iceland on allegations of market manipulation.

(such as relative money supplies and output levels of countries) and expected values of future economic fundamentals. Any change in current fundamentals or news about future fundamentals changes the exchange rate.

10. Two of the most often-mentioned determinants of exchange rates are real interest rate differentials and current account balances. These variables are simultaneously determined.
11. The complexity of the relationships that determine the current account and the exchange rate may explain why fundamental exchange rate models perform rather poorly in forecasting future exchange rates.
12. Chartists record the actual trading history of an exchange rate and try to infer possible trends based on that information alone. It is unlikely that the naked eye can pick up trends in a randomly fluctuating series.
13. Filter rules, such as *x*% and moving-average rules, are trading rules designed to detect trend behavior in exchange rates. Although early empirical studies focusing on data from the 1980s found strong trends in exchange rates, more recent work has a more difficult time uncovering trend behavior.
14. More sophisticated technical analysis uses regression analysis or other econometric techniques to link exchange rates to financial data, such as forward premiums. Whether the trading strategies based on this analysis are profitable and demonstrate market inefficiency has not been resolved.
15. When an exchange rate is pegged, multinational businesses must assess the probability and magnitude of a possible devaluation. Poor macroeconomic fundamentals, such as an overvalued currency, high money growth rates, and large current account deficits, are warning signs of an imminent devaluation. To make devaluation predictions, formal models employ macroeconomic information, financial information (such as interest rate differentials), or both.

Questions

1. What is the difference between the *ex ante* and the *ex post* real interest rate?
2. Suppose that the international parity conditions all hold and a country has a higher nominal interest rate than the United States. Characterize the forward premium (or discount) on the dollar, the country's inflation rate compared to the United States, the expected rate of currency appreciation or depreciation versus the dollar, and the country's real interest rate compared to the U.S. real interest rate.
3. How do fundamental analysis and technical analysis differ?
4. Would technical analysis be useful if the international parity conditions held? Why or why not?
5. Describe three statistics you should obtain from a currency-forecasting service in order to judge the quality of its currency forecasts.
6. Does a large increase in the domestic money supply always lead to a depreciation of the currency?
7. Is a current account deficit always associated with a strong real exchange rate (that is, one in which the currency is overvalued compared to the PPP prediction)?
8. Describe how three macroeconomic fundamentals affect exchange rates.
9. Which simple statistical model yields some of the best exchange rate predictions available? What does this imply for the value of models of exchange rate determination to multinational businesses?
10. What is chartism?
11. What is an *x*% filter rule?
12. What is a moving-average crossover rule?
13. Have currency traders been successful in exploiting their exchange rate forecasts?
14. Are devaluations of pegged exchange rates totally unexpected?
15. Construct a list of a country's economic statistics you would assemble to help determine the probability of a devaluation of its currency within the coming year.

Problems

1. Suppose the 1-year nominal interest rate in Zooropa is 9%, and Zooropa's expected inflation rate is 4%. What is the real interest rate in Zooropa?
2. You were recently hired by the Doolittle Corporation corporate treasury to help oversee its expansion into Europe. Blake Francis, the CFO, wants to hire a foreign exchange forecasting company. Blake has asked you to evaluate three different companies, and he has obtained information on their past performances. Out of a total of 50 forecasts for the

$/€ rate, the companies reported the number of times they correctly forecast appreciations and depreciations:

	Correct Down Forecasts	Correct Up Forecasts
Morrissey Forex Advisors	20	5
Pixie Exchange Land	20	4
FOREX Cures	12	12

There are a total of 35 dollar appreciations (down periods) and 15 dollar depreciations (up periods) in the sample. Blake wants to know two things:

a. Can anything be said about the companies' forecasting ability with the available data?
b. What additional information should Blake try to obtain in order to form a better judgment?

3. Mini-Case: Currency Turmoil in Zooropa

Fad Gadget has never worked so hard in his entire life. It is near midnight, and he is still poring over statistics and tables. Fad recently joined Smashing Pumpkins, a relatively young but fast-growing British firm that produces and distributes an intricate device that turns fresh pumpkins into pumpkin pie in about 30 minutes. Recently, the firm has started exporting to Zooropa. Some of the largest and tastiest pumpkins are grown in Zooropa, and its population boasts the highest per capita pumpkin consumption in the world. A recent analysis of the pumpkin market in Zooropa has left the company's senior managers very impressed with the profit potential.

Although Zooropa consists of 10 politically independent countries, their currencies are linked through a system called the Currency Rate Linkage System (CRLS) that works exactly like the former Exchange Rate Mechanism (ERM) of the EMS before the currency turmoil started in September 1992. The anchor currency is the banshee of Enigma, the leading country in Zooropa.

Initial contacts with importers in Zooropean countries indicated that they typically insist on payment in their own local currency. About a week ago, Cab Voltaire, the CEO of Smashing Pumpkins, expressed concerns about this development and asked Fad to lead a research team to further examine the present state of the currency system of Zooropa. Cab viewed the outlook for the banshee relative to the pound quite favorably and did not predict any substantial depreciation of the banshee against any other major currency. However, the precarious economic situation of some of the countries in Zooropa and the growing importance of speculative pressures in Zooropa's currency markets last week suddenly made him suspicious about the possibility of realignments within the system. He even doubted the long-term viability of the system. Cab instructed Fad to examine the following issues:

- Which currencies in the system exhibit the highest realignment risk?
- If a currency realigns and gets devalued, what are the effects on our sales and profit margins in this particular country? Can we take the realignment possibility into account in our pricing?
- Suppose a currency is forced to leave the CRLS. What are the effects on exchange rates, interest rates, and the outlook for sales in that country? What is the likelihood of this occurring for the different countries?

Fad Gadget felt nervous. A meeting was scheduled with Cab the day after tomorrow. He wanted to write a thorough and insightful report. At the last management meeting, he had the uneasy feeling that some senior managers doubted his abilities. Some managers were naturally suspicious of a young Australian newcomer with his MBA. His earring and punk hairdo did not exactly help either. His team of analysts had already assembled a table with relevant macroeconomic and financial data (see Exhibit 10.9). "If only I could use this to rank the different countries according to realignment risk," he thought. Place yourself in Fad Gadget's shoes and see what your ranking is.

4. Web Problem: Go to www.oanda.com/currency/big-mac-index. Oanda reports the last available Big Mac index but then updates the exchange rates on a regular basis to compare them with the PPP-based exchange rates. What are currently the most undervalued and overvalued exchange rates? How would you use this information in forecasting exchange rates?

5. Mini Case: Valuing Currency Management: TOM Versus U.S. Commerce Bank

On February 19, 2009, an arbitral tribunal found that U.S. Commerce Bank (USCB) Analytics, a wholly owned subsidiary of USCB Corporation, a large U.S.–based bank, had breached an exclusivity provision of its joint venture (JV) agreement with Trend Ontledings Maatschappij (TOM), a Dutch currency management business. Consequently, TOM claimed USCB was obligated to compensate the firm for lost earnings that would have accrued to TOM during the life of the JV.

Exhibit 10.9 Zooropa in Numbers

Country	Currency's CRLS Position	Currency's Over/ Undervaluation %	Reserves, Import Coverage	Budget Deficit as % of GDP	Inflation Rate, %	GDP Growth, %
Sinead	−6	−10	9	−1.9	3.6	2.4
Carmen	−36	−12	3.1	−2.3	2.7	2.0
Marquee	16	11	8.2	−4.9	5.7	2.0
Fries	−3	11	11.7	−5.4	9.5	2.8
Ney	−22	−2	2.5	−2.1	2.2	2.1
Helpisink	31	−18	1.3	−5.5	2.1	1.6
Benfica	30	−16	1.5	−3.4	3.5	1.6
Che ora	−90	3	2.6	−4.6	3.6	−0.8
Vachement	27	2	0.5	−11.3	5.2	1.3

Notes: The CRLS position measures the general strength or weakness of a currency within the target zone. A value of −100 means that the currency is at its lower bound and is weak relative to all other currencies in the zone. A value of 100 means that the currency is at its upper bound and is strong relative to all other currencies in the zone. The currency's over-/undervaluation is relative to the prediction of purchasing power parity (PPP). It is computed by taking the percentage deviation from the prediction of PPP of the currency versus the banshee, the central rate in the system. A positive number means the currency is overvalued relative to PPP. Import coverage calculates the ratio of foreign exchange reserves at the central bank to average monthly imports. This indicates how many months of imports could be purchased by the foreign exchange reserves held at the central bank. The inflation rate and GDP growth rate are in percentage per annum.

Established in 2006, the JV was to last for a minimum of 4 years. USCB was responsible for marketing the JV to third-party clients including central banks, institutional investors, and corporate clients. TOM was responsible for providing the investment management expertise by delivering a low-return, low-volatility, alpha currency investment product. TOM had a long history of quantitative trading in the currency markets. In the 1970s, TOM was thought to be the first firm to apply computerized trading to exchange rate markets. Successful partnerships with a number of U.S. banks in the 1980s and early 1990s made Geert Rijkaard, TOM's founder, one of the richest men in the world. Because the firm's strategy focused on European currencies relative to the dollar, the arrival of the euro in 1999 led to a suspension of TOM's trading activities. However, after adapting its models to focus on the euro/dollar pair, TOM started trading again in 2004 and began actively looking for partners that could help market the product.

However, as a result of the contract breach, TOM had terminated the JV on July 30, 2007. TOM claimed that it was owed in excess of $300 million from USCB. Both parties assembled teams of experts to make their cases to the tribunal. The tribunal would then use the information provided by these experts as the basis for making a decision as to the amount of damages owed to TOM.

Although all names used here are fictitious, the story is based on a real-world case. A Columbia CaseWorks case written by Bekaert (2011) provides more details. It lays out the analysis by TOM's team to motivate the $300 million damages number, relying largely on the detailed business plan at the time the JV was formed. The case further describes several key exhibits assembled by USCB's team. Its first task at hand was to simply figure out what kind of currency manager TOM was: Does it follow trends, trade on fundamentals, or run a carry strategy? The team also believed it would be important to study the relative investment performance of the JV and did so using actual data from the Barclay Currency Traders Index. Given the large number of currency funds that were available to investors, the JV's ability to win clients and grow its AUM would undoubtedly be closely linked to its performance, both in absolute terms and relative to other currency funds. Finally, simply generating a plausible track record of returns suitable for use in projections raised interesting issues. For example, TOM's team had resorted to using paper returns (meaning returns from a trading strategy that had not been used in actual trading yet) to pull together a long return record. To learn more about this case, please go to www4.gsb.columbia.edu/caseworks/ and look for the Valuing Currency Management case.

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