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## Chapter 4

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### Foreign Exchange Markets and Rates of Return

People trade one national currency for another for one reason: they want to do something with the other currency. What they might do consists of one of two things: either they wish to spend the money, acquiring goods and services, or they wish to invest the money.

This chapter introduces the foreign exchange market for currency trades. It highlights some of the more obvious, although sometimes confusing, features and then turns attention to the motivations of foreign investors. One of the prime motivations for investing in another country is because one hopes to make more money on an investment abroad. How an investor calculates and compares those rates of returns are explored in this chapter.

## 4.1 The Forex: Participants and Objectives

### LEARNING OBJECTIVE

1. Learn who participates in foreign exchange markets and why.

The foreign exchange market (Forex) is not a market like the New York Stock Exchange, where daily trades of stock are conducted in a central location. Instead, the Forex refers to the activities of major international banks that engage in currency trading. These banks act as intermediaries between the true buyers and sellers of currencies (i.e., governments, businesses, and individuals). These banks will hold foreign currency deposits and stand ready to exchange these for domestic currency upon demand. The exchange rate (ER) will be determined independently by each bank but will essentially be determined by supply and demand in the market. In other words, the bank sets the exchange rate at each moment to equalize its supply of foreign currency with the market demand. Each bank makes money by collecting a transactions fee for its “exchange services.”

It is useful to categorize two distinct groups of participants in the Forex, those whose transactions are recorded on the current account (importers and exporters) and those whose transactions are recorded on the financial account (investors).

### Importers and Exporters

Anyone who imports or exports goods and services will need to exchange currencies to make the transactions. This includes tourists who travel abroad; their transactions would appear as services in the current account. These businesses and individuals will engage in currency trades daily; however, these transactions are small in comparison to those made by investors.

### International Investors, Banks, Arbitrageurs, and Others

Most of the daily currencies transactions are made by investors. These investors, be they investment companies, insurance companies, banks, or others, are making currency transactions to realize a greater return on their investments or holdings. Many of these companies are responsible for managing the savings of others. Pension plans and mutual funds buy and sell billions of dollars worth of assets daily. Banks, in the temporary possession of the deposits of others, do the same. Insurance companies manage large portfolios that act as their capital to be used to

pay off claims on accidents, casualties, and deaths. More and more of these companies look internationally to make the most of their investments.

It is estimated by the Bank of International Settlements that over \$3 trillion (or \$3,000 billion) worth of currency is traded every day. Only about \$60 to \$100 billion of trade in goods and services takes place daily worldwide. This suggests that many of the currency exchanges are done by international investors rather than importers and exporters.

### Investment Objectives

Investors generally have three broad concerns when an investment is made. They care about how much money the investment will earn over time, they care about how risky the investment is, and they care about how liquid, or convertible, the asset is.

1. **Rate of return (RoR)**<sup>1</sup>. The percentage change in the value of an asset over some period.

Investors purchase assets as a way of saving for the future. Anytime an asset is purchased, the purchaser is forgoing current consumption for future consumption. To make such a transaction worthwhile the investors hope (sometimes expect) to have more money for future consumption than the amount they give up in the present. Thus investors would like to have as high a rate of return on their investments as possible.

**Example 1:** Suppose a Picasso painting is purchased in 1996 for \$500,000. One year later, the painting is resold for \$600,000. The rate of return is calculated as

$$\frac{(600,000 - 500,000)}{500,000} \times 100 = \frac{100,000}{500,000} \times 100 = 0.20 \times 100 = 20\%.$$

**Example 2:** \$1,000 is placed in a savings account for one year at an annual interest rate of 10 percent. The interest earned after one year is  $\$1,000 \times 0.10 = \$100$ . Thus the value of the account after one year is \$1,100. The rate of return is

$$\frac{1100 - 1000}{1000} \times 100 = \frac{100}{1000} \times 100 = 0.10 \times 100 = 10\%.$$

1. The percentage change in the value of an asset over some period.

This means that the rate of return on a domestic interest-bearing account is merely the interest rate.

2. **Risk.** The second primary concern of investors is the riskiness of the assets. Generally, the greater the expected rate of return, the greater the risk. Invest in an oil wildcat endeavor and you might get a 1,000 percent return on your investment—that is, if you strike oil. The chances of doing so are likely to be very low, however. Thus a key concern of investors is how to manage the trade-off between risk and return.
3. **Liquidity.** Liquidity essentially means the speed with which assets can be converted to cash. Insurance companies need to have assets that are fairly liquid in the event that they need to pay out a large number of claims. Banks also need to be able to make payouts to their depositors, who may request their money back at any time.

### KEY TAKEAWAYS

- Participants in the foreign exchange markets can be classified into traders and investors.
- Traders export or import goods and services whose transactions appear on the current account of the balance of payments.
- Investors purchase or sell assets whose transactions appear on the financial account of the balance of payments.
- The three main concerns for any investor are first to obtain a high rate of return, second to minimize the risk of default, and third to maintain an acceptable degree of liquidity.
- The rate of return on an asset is the percentage change in its value over a period.

## EXERCISE

1. **Jeopardy Questions.** As in the popular television game show, you are given an answer to a question and you must respond with the question. For example, if the answer is “a tax on imports,” then the correct question is “What is a tariff?”
  - a. This group enters the foreign exchange market to make transactions that will be recorded on the current account.
  - b. This group enters the foreign exchange market to make transactions that will be recorded on the financial account.
  - c. The percentage change in the value of an asset over some period.
  - d. The term used to describe the ease with which an asset can be converted to cash.
  - e. The term used to describe the possibility that an asset will not return what is originally expected.
  - f. A list of three main objectives for international investors.
  - g. The rate of return on a share of stock whose value rises during the year from \$5.50 per share to \$6.50 per share.
  - h. The rate of return on a commercial office building that was purchased one year ago for \$650,000 and sold today for \$600,000.

## 4.2 Exchange Rate: Definitions

### LEARNING OBJECTIVE

1. Learn some of the basic definitions regarding currency markets and exchange rates.

Anyone who has ever traveled to another country has probably had to deal with an exchange rate between two currencies. (I say “probably” because a person who travels from, say, Italy to Spain continues to use euros.) In a sense, exchange rates are very simple. However, despite their simplicity they never fail to generate confusion. To overcome that confusion this chapter begins by offering straightforward definitions and several rules of thumb that can help with these problems.

The **exchange rate (ER)**<sup>2</sup> represents the number of units of one currency that exchanges for a unit of another. There are two ways to express an exchange rate between two currencies (e.g., between the U.S. dollar [\$] and the British pound [£]). One can either write \$/£ or £/\$. These are reciprocals of each other. Thus if  $E$  is the \$/£ exchange rate and  $V$  is the £/\$ exchange rate, then  $E = 1/V$ .

For example, on January 6, 2010, the following exchange rates prevailed:

$$E_{\$/\pounds} = 1.59, \text{ which implies } V_{\pounds/\$} = 0.63,$$

and

$$V_{\yen/\$} = 92.7, \text{ which implies } E_{\$/\yen} = 0.0108.$$

### Currency Value

It is important to note that the value of a currency is always given in terms of another currency. Thus the value of a U.S. dollar in terms of British pounds is the £/\$ exchange rate. The value of the Japanese yen in terms of dollar is the \$/¥ exchange rate.

2. Represents the number of units of one currency that exchanges for a unit of another.

Note that we always express the value of all items in terms of something else. Thus the value of a quart of milk is given in dollars, not in quarts of milk. The value of car

is also given in dollar terms, not in terms of cars. Similarly, the value of a dollar is given in terms of something else, usually another currency. Hence, the rupee/dollar exchange rate gives us the value of the dollar in terms of rupees.

This definition is especially useful to remember when one is dealing with unfamiliar currencies. Thus the value of the euro (€) in terms of British pounds is given as the £/€ exchange rate.

Similarly, the peso/euro exchange rate refers to the value of the euro in terms of pesos.

**Currency appreciation**<sup>3</sup> means that a currency *appreciates* with respect to another when *its value rises* in terms of the other. The dollar appreciates with respect to the yen if the ¥/\$ exchange rate rises.

**Currency depreciation**<sup>4</sup>, on the other hand, means that a currency *depreciates* with respect to another when *its value falls* in terms of the other. The dollar depreciates with respect to the yen if the ¥/\$ exchange rate falls.

Note that if the ¥/\$ rate rises, then its reciprocal, the \$/¥ rate, falls. Since the \$/¥ rate represents the value of the yen in terms of dollars, this means that when the dollar appreciates with respect to the yen, the yen must depreciate with respect to the dollar.

The rate of appreciation (or depreciation) is the percentage change in the value of a currency over some period.

**Example 1:** U.S. dollar (US\$) to the Canadian dollar (C\$)

On January 6, 2010,  $E_{C\$/US\$} = 1.03$ .

On January 6, 2009,  $E_{C\$/US\$} = 1.19$ .

Use the percentage change formula, (new value - old value)/old value:

$$\frac{(1.03 - 1.19)}{1.19} = \frac{-0.16}{1.19} = -0.134.$$

Multiply by 100 to write as a percentage to get

3. A currency *appreciates* with respect to another when *its value rises* in terms of the other.

4. A currency *depreciates* with respect to another when *its value falls* in terms of the other.



$$-0.134 \times 100 = -13.4\%.$$

Since we have calculated the change in the value of the U.S. dollar in terms of Canadian dollar, and since the percentage change is negative, this means that the dollar has depreciated by 13.4 percent with respect to the C\$ during the previous year.

**Example 2:** U.S. dollar (\$) to the Pakistani rupee (R)

On January 6, 2010,  $E_{R/\$} = 84.7$ .

On January 6, 2010,  $E_{R/\$} = 79.1$ .

Use the percentage change formula, (new value - old value)/old value:

$$\frac{(84.7 - 79.1)}{79.1} = + \frac{5.6}{79.1} = +0.071.$$

Multiply by 100 to write as a percentage to get

$$+0.071 \times 100 = +7.1\%.$$

Since we have calculated the change in the value of the U.S. dollar, in terms of rupees, and since the percentage change is positive, this means that the dollar has appreciated by 7.1 percent with respect to the Pakistani rupee during the past year.

## Other Exchange Rate Terms

**Arbitrage**<sup>5</sup> generally means buying a product when its price is low and then reselling it after its price rises in order to make a profit. Currency arbitrage means buying a currency in one market (e.g., New York) at a low price and reselling, moments later, in another market (e.g., London) at a higher price.

The **spot exchange rate**<sup>6</sup> refers to the exchange rate that prevails *on the spot*, that is, for trades to take place immediately. (Technically, it is for trades that occur within two days.)

The **forward exchange rate**<sup>7</sup> refers to the rate that appears on a contract to exchange currencies either 30, 60, 90, or 180 days in the future.

5. The process of buying a product when its price is low and then reselling it after its price rises to make a profit.

6. The exchange rate that prevails *on the spot*, that is, for trades to take place immediately.

7. The rate that appears on a contract to exchange currencies either 30, 60, 90, or 180 days in the future.

For example, a corporation might sign a contract with a bank to buy euros for U.S. dollars sixty days from now at a predetermined ER. The predetermined rate is called the sixty-day forward rate. Forward contracts can be used to reduce exchange rate risk.

For example, suppose an importer of BMWs is expecting a shipment in sixty days. Suppose that upon arrival the importer must pay €1,000,000 and the current spot ER is 1.20 \$/€.

Thus if the payment were made today it would cost \$1,200,000. Suppose further that the importer is fearful of a U.S. dollar depreciation. He doesn't currently have the \$1,200,000 but expects to earn more than enough in sales over the next two months. If the U.S. dollar falls in value to, say, 1.30 \$/€ within sixty days, how much would it cost the importer in dollars to purchase the BMW shipment?

The shipment would still cost €1,000,000. To find out how much this is in dollars, multiply €1,000,000 by 1.30 \$/€ to get \$1,300,000.

Note that this is \$100,000 more for the cars simply because the U.S. dollar value changed.

One way the importer could protect himself against this potential loss is to purchase a forward contract to buy euros for U.S. dollars in sixty days. The ER on the forward contract will likely be different from the current spot ER. In part, its value will reflect market expectations about the degree to which currency values will change in the next two months. Suppose the current sixty-day forward ER is 1.25 \$/€, reflecting the expectation that the U.S. dollar value will fall. If the importer purchases a sixty-day contract to buy €1,000,000, it will cost him \$1,250,000 (i.e.,  $\$1,000,000 \times 1.25$  \$/€). Although this is higher than what it would cost if the exchange were made today, the importer does not have the cash available to make the trade today, and the forward contract would protect the importer from an even greater U.S. dollar depreciation.

8. When the forward exchange rate is such that a forward trade costs more (or buys less foreign currency) than a trade on the spot market today.

9. When the forward exchange rate is such that a forward trade costs less (or buys more foreign currency) than a trade on the spot market today.

10. The process of protecting oneself from the riskiness of exchange rate movements; one method is by entering into a forward contract.

When the forward ER is such that a forward trade costs more than a spot trade today costs, there is said to be a **forward premium**<sup>8</sup>. If the reverse were true, such that the forward trade were cheaper than a spot trade, then there is a **forward discount**<sup>9</sup>.

A currency trader is **hedging**<sup>10</sup> if he or she enters into a forward contract to protect oneself from a downside loss. However, by hedging the trader also forfeits the potential for an upside gain. Suppose in the story above that the spot ER falls rather

than rises. Suppose the ER fell to 1.10 \$/€. In this case, had the importer waited, the €1,000,000 would only have cost \$1,100,000 (i.e.,  $\$1,000,000 \times 1.10 \text{ \$/€}$ ). Thus hedging protects against loss but at the same time eliminates potential unexpected gain.

### KEY TAKEAWAYS

- An exchange rate denominated  $x/y$  gives the value of  $y$  in terms of  $x$ . When an exchange rate denominated  $x/y$  rises, then  $y$  has appreciated in value in terms of  $x$ , while  $x$  has depreciated in terms of  $y$ .
- Spot exchange rates represent the exchange rate prevailing for currency trades today. Forward, or future, exchange rates represent the exchange values on trades that will take place in the future to fulfill a predetermined contract.
- Currency arbitrage occurs when someone buys a currency at a low price and sells shortly afterward at a higher price to make a profit.
- Hedging refers to actions taken to reduce the risk associated with currency trades.

## EXERCISES

1. **Jeopardy Questions.** As in the popular television game show, you are given an answer to a question and you must respond with the question. For example, if the answer is “a tax on imports,” then the correct question is “What is a tariff?”
  - a. The term used to describe an increase in the value of the yen.
  - b. This currency value is expressed by the euro/peso exchange rate.
  - c. This has happened to the value of the U.S. dollar if the dollar/euro exchange rate rises from 1.10 \$/€ to 1.20 \$/€.
  - d. The term used to describe the process of buying low and selling high to make a profit.
  - e. The term used to describe the exchange rate that appears on a contract to exchange currencies either 30, 60, 90, or 180 days in the future.
  - f. The term used to describe the exchange rate that prevails for (almost) immediate trades.
  - g. The term used to describe process of protecting oneself from the riskiness of exchange rate movements.
  
2. Use the exchange rate data in the table to answer the following questions. The first two exchange rates are the spot rates on those dates. The third exchange rate is the one-year forward exchange rate as of February 2004.

	February 4, 2003	February 4, 2004	Forward February 4, 2005
United States–Europe	1.08 \$/€	1.25 \$/€	1.24 \$/€
South Africa–United States	8.55 rand/\$	6.95 rand/\$	7.42 rand/\$

- a. Calculate the rate of change in the euro value relative to the dollar between 2003 and 2004.
- b. Calculate the rate of change in the dollar value relative to the euro between 2003 and 2004.

- c. Calculate the rate of change in the dollar value relative to the South African rand between 2003 and 2004.
- d. Calculate the expected change in the dollar value relative to the euro between 2004 and 2005.
- e. Calculate the expected change in the dollar value relative to the rand between 2004 and 2005.

### 4.3 Calculating Rate of Returns on International Investments

#### LEARNING OBJECTIVE

1. Learn how to calculate the rate of return (RoR) for a domestic deposit and a foreign deposit.

Suppose that an investor holding U.S. dollars must decide between two investments of equal risk and liquidity. Suppose one potential investment is a one-year **certificate of deposit (CD)**<sup>11</sup> issued by a U.S. bank while a second potential investment is a one-year CD issued by a British bank. For simplicity we'll assume that interest is calculated on both CDs using a simple interest rather than with a compounding formula. A CD is a type of deposit that provides a higher rate of interest to the depositor in return for a promise to keep the money deposited for a fixed amount of time. The time period could be six months, one year, two years, or any other period decided by the bank. If the depositor wants to withdraw the money earlier, she must pay a penalty.

Since we imagine that an investor wants to obtain the highest rate of return (RoR) possible, given acceptable risk and liquidity characteristics, that investor will choose the investment with the highest rate of return. If the investor acted naively, she might simply compare interest rates between the two investments and choose the one that is higher. However, this would not necessarily be the best choice. To see why, we need to walk through the calculation of rates of return on these two investments.

First, we need to collect some data, which we will do in general terms rather than use specific values. Examples with actual values are presented in a later section.

Let  $E_{\$/\pounds}$  = the spot ER.

$E_{\$/\pounds}^e$  = the expected ER one year from now.

$i_{\$}$  = the one-year interest rate on a CD in the United States (in decimal form).

$i_{\pounds}$  = the one-year interest rate on a CD in Britain (in decimal form).

11. A type of deposit that provides a higher rate of interest to the depositor in return for a promise to keep the money deposited for a fixed amount of time.

### U.S. Rate of Return

The rate of return on the U.S. CD is simply the interest rate on that deposit. More formally,

$$RoR_{\$} = i_{\$}.$$

This is because the interest rate describes the percentage increase in the value of the deposit over the course of the year. It is also simple because there is no need to convert currencies.

### British Rate of Return

The rate of return on the British CD is more difficult to determine. If a U.S. investor, with dollars, wants to invest in the British CD, she must first exchange dollars for pounds on the spot market and then use the British pound (£) to purchase the British CD. After one year, she must convert pounds back to dollars at the exchange rate that prevails then. The rate of return on that investment is the percentage change in dollar value during the year. To calculate this we can follow the procedure below.

Suppose the investor has  $P$  dollars to invest ( $P$  for principal).

**Step 1:** Convert the dollars to pounds.

$\frac{P}{E_{\$/\pounds}}$  is the number of pounds the investor will have at the beginning of the year.

**Step 2:** Purchase the British CD and earn interest in pounds during the year.

$\frac{P}{E_{\$/\pounds}} (1 + i_{\pounds})$  is the number of pounds the investor will have at the end of the year. The first term in parentheses returns the principal. The second term is the interest payment.

**Step 3:** Convert the principal plus interest back into dollars in one year.

$\frac{P}{E_{\$/\pounds}} (1 + i_{\pounds}) E_{\$/\pounds}^e$  is the number of dollars the investor can expect to have at the end of the year.

The rate of return in dollar terms from this British investment can be found by calculating the expected percentage change in the value of the investor's dollar assets over the year, as shown below:

$$RoR_{\pounds} = \frac{\frac{P}{E_{\$/\pounds}} (1 + i_{\pounds}) E_{\$/\pounds}^e - P}{P} .$$

After factoring out the  $P$ , this reduces to

$$RoR_{\pounds} = \frac{E_{\$/\pounds}^e}{E_{\$/\pounds}} (1 + i_{\pounds}) - 1.$$

Thus the rate of return on the foreign investment is more complicated because the set of transactions is more complicated. For the U.S. investment, the depositor simply deposits the dollars and earns dollar interest at the rate given by the interest rate. However, for the foreign deposit, the investor must first convert currency, then deposit the money abroad earning interest in foreign currency units, and finally reconvert the currency back to dollars. The rate of return depends not only on the foreign interest rate but also on the spot exchange rate and the expected exchange rate one year in the future.

Note that according to the formula, the rate of return on the foreign deposit is positively related to changes in the foreign interest rate and the expected foreign currency value and negatively related to the spot foreign currency value.



## KEY TAKEAWAYS

- For a dollar investor, the rate of return on a U.S. deposit is equal to the interest rate:  $RoR_{\$} = i_{\$}$ .
- For a dollar investor, the rate of return on a foreign deposit depends on the foreign interest rate, the spot exchange rate, and the exchange rate expected to prevail at the time the deposit is redeemed: In particular,

$$RoR_{\pounds} = \frac{E_{\$/\pounds}^c}{E_{\$/\pounds}} (1 + i_{\pounds}) - 1.$$

## EXERCISE

1. **Jeopardy Questions.** As in the popular television game show, you are given an answer to a question and you must respond with the question. For example, if the answer is “a tax on imports,” then the correct question is “What is a tariff?”
  - a. These three variables influence the rate of return on a foreign deposit.
  - b. For a U.S. dollar investor, this is the rate of return on a U.S. dollar deposit yielding 3 percent per year.
  - c. The term used to describe the exchange rate predicted to prevail at some point in the future.
  - d. The term for the type of bank deposit that offers a higher yield on a deposit that is maintained for a predetermined period of time.

## 4.4 Interpretation of the Rate of Return Formula

### LEARNING OBJECTIVE

1. Break down the rate of return on foreign deposits into three distinct components.

Although the derivation of the rate of return formula is fairly straightforward, it does not lend itself easily to interpretation or intuition. By applying some algebraic “tricks,” it is possible to rewrite the British rate of return formula in a form that is much more intuitive.

**Step 1:** Begin with the British rate of return formula derived in [Chapter 4 "Foreign Exchange Markets and Rates of Return", Section 4.3 "Calculating Rate of Returns on International Investments"](#):

$$RoR_{\pounds} = \frac{E_{\$/\pounds}^e}{E_{\$/\pounds}} (1 + i_{\pounds}) - 1.$$

**Step 2:** Factor out the term in parentheses. Add  $i_{\pounds}$  and then subtract it as well. Mathematically, a term does not change in value if you add and subtract the same value:

$$RoR_{\pounds} = \frac{E_{\$/\pounds}^e}{E_{\$/\pounds}} + i_{\pounds} \frac{E_{\$/\pounds}^e}{E_{\$/\pounds}} - 1 + i_{\pounds} - i_{\pounds}.$$

**Step 3:** Change the  $(-1)$  in the expression to its equivalent,  $-\frac{E_{\$/\pounds}}{E_{\$/\pounds}}$ . Also change  $-i_{\pounds}$  to its equivalent,  $-i_{\pounds} \frac{E_{\$/\pounds}}{E_{\$/\pounds}}$ . Since  $\frac{E_{\$/\pounds}}{E_{\$/\pounds}} = 1$ , these changes do not change the value of the rate of return expression:

$$RoR_{\pounds} = \frac{E_{\$/\pounds}^e}{E_{\$/\pounds}} + i_{\pounds} \frac{E_{\$/\pounds}^e}{E_{\$/\pounds}} - \frac{E_{\$/\pounds}}{E_{\$/\pounds}} + i_{\pounds} - i_{\pounds} \frac{E_{\$/\pounds}}{E_{\$/\pounds}}.$$

**Step 4:** Rearrange the expression:

$$RoR_{\text{£}} = i_{\text{£}} + \frac{E_{\$/\text{£}}^e}{E_{\$/\text{£}}} - \frac{E_{\$/\text{£}}}{E_{\$/\text{£}}} + i_{\text{£}} \frac{E_{\$/\text{£}}^e}{E_{\$/\text{£}}} - i_{\text{£}} \frac{E_{\$/\text{£}}}{E_{\$/\text{£}}} .$$

**Step 5:** Simplify by combining terms with common denominators:

$$RoR_{\text{£}} = i_{\text{£}} + \frac{E_{\$/\text{£}}^e - E_{\$/\text{£}}}{E_{\$/\text{£}}} + i_{\text{£}} \frac{E_{\$/\text{£}}^e - E_{\$/\text{£}}}{E_{\$/\text{£}}} .$$

**Step 6:** Factor out the percentage change in the exchange rate term:

$$RoR_{\text{£}} = i_{\text{£}} + (1 + i_{\text{£}}) \frac{E_{\$/\text{£}}^e - E_{\$/\text{£}}}{E_{\$/\text{£}}} .$$

This formula shows that the expected rate of return on the British asset depends on two things, the British interest rate and the expected percentage change in the value of the pound. Notice that if  $\frac{E_{\$/\text{£}}^e - E_{\$/\text{£}}}{E_{\$/\text{£}}}$  is a positive number, then the expected \$/£ ER is greater than the current spot ER, which means that one expects a pound appreciation in the future. Furthermore,  $\frac{E_{\$/\text{£}}^e - E_{\$/\text{£}}}{E_{\$/\text{£}}}$  represents the expected rate of appreciation of the pound during the following year. Similarly, if  $\frac{E_{\$/\text{£}}^e - E_{\$/\text{£}}}{E_{\$/\text{£}}}$  were negative, then it corresponds to the expected rate of depreciation of the pound during the subsequent year.

The expected rate of change in the pound value is multiplied by  $(1 + i_{\text{£}})$ , which generally corresponds to a principal and interest component in a rate of return calculation.

To make sense of this expression, it is useful to consider a series of simple numerical examples.

Suppose the following values prevail,

$i_{\text{£}}$	5% per year
$E_{\$/\text{£}}^e$	1.1 \$/£
$E_{\$/\text{£}}$	1.0 \$/£

Plugging these into the rate of return formula yields

$$RoR_{\pounds} = 0.05 + (1 + 0.05) \frac{1.10 - 1.00}{1.00}, \infty$$

which simplifies to

$$RoR_{\pounds} = 0.05 + (1 + 0.05) \times 0.10 = .155 \text{ or } 15.5\%.$$

Note that because of the exchange rate change, the rate of return on the British asset is considerably higher than the 5 percent interest rate.

To decompose these effects suppose that the British asset yielded no interest whatsoever.

This would occur if the individual held pound currency for the year rather than purchasing a CD. In this case, the rate of return formula reduces to

$$RoR_{\pounds} = 0.0 + (1 + 0.0) \times 0.10 = .10 \text{ or } 10\%.$$

This means that 10 percent of the rate of return arises solely because of the pound appreciation. Essentially an investor in this case gains because of currency arbitrage over time. Remember that arbitrage means buying something when its price is low, selling it when its price is high, and thus making a profit on the series of transactions. In this case, the investor buys pounds at the start of the year, when their price (in terms of dollars) is low, and then resells them at the end of the year when their price is higher.

Next, suppose that there was no exchange rate change during the year, but there was a 5 percent interest rate on the British asset. In this case, the rate of return becomes

$$RoR_{\pounds} = 0.05 + (1 + 0.05) \times 0.0 = .05 \text{ or } 5\%.$$

Thus with no change in the exchange rate, the rate of return reduces to the interest rate on the asset.

Finally, let's look back at the rate of return formula:

$$RoR_{\pounds} = i_{\pounds} + (1 + i_{\pounds}) \frac{E_{\$/\pounds}^e - E_{\$/\pounds}}{E_{\$/\pounds}}.$$

The first term simply gives the contribution to the total rate of return that derives solely from the interest rate on the foreign asset. The second set of terms has the percentage change in the exchange rate times one plus the interest rate. It corresponds to the contribution to the rate of return that arises solely due to the exchange rate change. The one plus interest rate term means that the exchange rate return can be separated into two components, a principal component and an interest component.

Suppose the exchange rate change is positive. In this case, the principal that is originally deposited will grow in value by the percentage exchange rate change. But the principal also accrues interest and as the £ value rises, the interest value, in dollar terms, also rises.

Thus the second set of terms represents the percentage increase in the value of one's principal and interest that arises solely from the change in the exchange rate.

### KEY TAKEAWAYS

- The rate of return on a foreign deposit consists of three components: the interest rate itself, the change in the value of the principal due to the exchange rate change, and the change in the value of the interest due to the exchange rate change.
- Another formula, but one that is equivalent to the one in the previous section, for the rate of return on a foreign deposit is

$$RoR_{\text{£}} = i_{\text{£}} + (1 + i_{\text{£}}) \frac{E_{\$/\text{£}}^c - E_{\$/\text{£}}}{E_{\$/\text{£}}}$$

## EXERCISES

1. Consider the following data. Suppose the expected exchange rates are the average expectations by investors for exchange rates in one year. Imagine that the interest rates are for equally risky assets and are annual rates.

	United States	Australia	Singapore
Current Exchange Rate	-	1.80 A\$/US\$	1.75 S\$/US\$
Expected Exchange Rate	-	1.90 A\$/US\$	1.65 S\$/US\$
Current Interest Rate (%)	2.0	4.0	1.0

- Calculate the rate of return for a U.S. dollar investor investing in the Australian deposit for one year.
  - Calculate the rate of return for a U.S. dollar investor investing in the Singapore deposit for one year.
  - Among these three options (United States, Australia, and Singapore), which is the best place for the investor to invest? Which is the worst place?
2. The covered interest parity condition substitutes the forward exchange rate for the expected exchange rate. The condition is labeled “covered” because the forward contract assures a certain rate of return (i.e., without risk) on foreign deposits. The table below lists a spot exchange rate, a ninety-day forward rate, and a ninety-day money market interest rate in Germany and Canada. Use this information to answer the following questions.

	Germany	Canada
Spot Exchange Rate	0.5841 \$/DM	0.7451 US\$/C\$
90-Day Forward Exchange Rate	0.5807 \$/DM	0.7446 US\$/C\$
90-Day Interest Rate (%)	1.442	0.875

What would the U.S. ninety-day interest rate have to be for the United States to have the highest rate of return for a U.S. investor? (Use the exact formulas to calculate the rates of return.)

## 4.5 Applying the Rate of Return Formulas

### LEARNING OBJECTIVE

1. Learn how to apply numerical values for exchange rates and interest rates to the rate of return formulas to determine the best international investment.

Use the data in the tables below to calculate in which country it would have been best to purchase a one-year interest-bearing asset. These numbers were taken from the *Economist*, Weekly Indicators, December 17, 2005, p. 90, <http://www.economist.com>.

### Example 1

Consider the following data for interest rates and exchange rates in the United States and Britain:

$i_{\$}$	2.37% per year
$i_{\pounds}$	4.83% per year
$E_{\$/\pounds}^{04}$	1.96 $\$/\pounds$
$E_{\$/\pounds}^{05}$	1.75 $\$/\pounds$

We imagine that the decision is to be made in 2004, looking forward into 2005. However, we calculate this in hindsight after we know what the 2005 exchange rate is. Thus we plug in the 2005 rate for the expected exchange rate and use the 2004 rate as the current spot rate. Thus the ex-post (i.e., after the fact) rate of return on British deposits is given by

$$RoR_{\pounds} = 0.0483 + (1 + 0.0483) \frac{1.75 - 1.96}{1.96},$$

which simplifies to

$$RoR_{\pounds} = 0.0483 + (1 + 0.0483)(-0.1071) = -0.064 \text{ or } -6.4\%.$$



A negative rate of return means that the investor would have lost money (in dollar terms) by purchasing the British asset.

Since  $RoR_{\$} = 2.37\% > RoR_{£} = -6.4\%$ , the investor seeking the highest rate of return should have deposited her money in the U.S. account.

### Example 2

Consider the following data for interest rates and exchange rates in the United States and Japan.

$i_{\$}$	2.37% per year
$i_{¥}$	0.02% per year
$E_{¥/\$}^{04}$	104 ¥/\$
$E_{¥/\$}^{05}$	120 ¥/\$

Again, imagine that the decision is to be made in 2004, looking forward into 2005. However, we calculate this in hindsight after we know what the 2005 exchange is. Thus we plug in the 2005 rate for the expected exchange rate and use the 2004 rate as the current spot rate. Note also that the interest rate in Japan *really* was 0.02 percent. It was virtually zero.

Before calculating the rate of return, it is necessary to convert the exchange rate to the yen equivalent rather than the dollar equivalent. Thus

$$E_{\$/¥}^{04} = \frac{1}{104} = 0.0096 \text{ and } E_{\$/¥}^{05} = \frac{1}{120} = 0.0083.$$

Now, the ex-post (i.e., after the fact) rate of return on Japanese deposits is given by

$$RoR_{¥} = 0.0002 + (1 + 0.0002) \frac{0.0083 - 0.0096}{0.0096},$$

which simplifies to

$$RoR_{¥} = 0.0002 + (1 + 0.0002)(-0.1354) = -0.1352 \text{ or } -13.52\%.$$

A negative rate of return means that the investor would have lost money (in dollar terms) by purchasing the Japanese asset.

Since  $RoR_{\$} = 2.37\% > RoR_{¥} = -13.52\%$ , the investor seeking the highest rate of return should have deposited his money in the U.S. account.

### Example 3

Consider the following data for interest rates and exchange rates in the United States and South Korea. Note that South Korean currency is in won (W).

$i_{\$}$	2.37% per year
$i_{W}$	4.04% per year
$E_{W/\$}^{04}$	1,059 W/\$
$E_{W/\$}^{05}$	1,026 W/\$

As in the preceding examples, the decision is to be made in 2004, looking forward to 2005. However, since the previous year interest rate is not listed, we use the current short-term interest rate. Before calculating the rate of return, it is necessary to convert the exchange rate to the won equivalent rather than the dollar equivalent. Thus

$$E_{\$/W}^{04} = \frac{1}{1059} = 0.000944 \text{ and } E_{\$/W}^{05} = \frac{1}{1026} = 0.000975.$$

Now, the ex-post (i.e., after the fact) rate of return on Italian deposits is given by

$$RoR_W = 0.0404 + (1 + 0.0404) \frac{0.000975 - 0.000944}{0.000944},$$

which simplifies to

$$RoR_W = 0.0404 + (1 + 0.0404)(0.0328) = 0.0746 \text{ or } +7.46\%.$$

In this case, the positive rate of return means an investor would have made money (in dollar terms) by purchasing the South Korean asset.

Also, since  $RoR_{\$} = 2.37$  percent  $<$   $RoR_{W} = 7.46$  percent, the investor seeking the highest rate of return should have deposited his money in the South Korean account.

#### KEY TAKEAWAY

- An investor should choose the deposit or asset that promises the highest expected rate of return assuming equivalent risk and liquidity characteristics.

## EXERCISES

1. Consider the following data collected on February 9, 2004. The interest rate given is for a one-year money market deposit. The spot exchange rate is the rate for February 9. The expected exchange rate is the one-year forward rate. Express each answer as a percentage.

$i_{C\$}$	2.5%
$E_{US\$/C\$}$	0.7541 US\$/C\$
$E_{US\$/C\$}^e$	0[0].7468 US\$/C\$

- a. Use both RoR formulas (one from [Chapter 4 "Foreign Exchange Markets and Rates of Return", Section 4.3 "Calculating Rate of Returns on International Investments"](#), the other from [Chapter 4 "Foreign Exchange Markets and Rates of Return", Section 4.4 "Interpretation of the Rate of Return Formula"](#), Step 5) to calculate the expected rate of return on the Canadian money market deposit and show that both formulas generate the same answer.
- b. What part of the rate of return arises only due to the interest earned on the deposit?
- c. What part of the rate of return arises from the percentage change in the value of the principal due to the change in the exchange rate?
- d. What component of the rate of return arises from the percentage change in the value of the interest payments due to the change in the exchange rate?
2. Consider the following data collected on February 9, 2004. The interest rate given is for a one-year money market deposit. The spot exchange rate is the rate for February 9. The expected exchange rate is the one-year forward rate. Express each answer as a percentage.

$i_{£}$	4.5%
$E_{\$/£}$	1.8574 \$/£
$E_{\$/£}^e$	1.7956 \$/£

- a. Use both RoR formulas (one from Chapter 4 "Foreign Exchange Markets and Rates of Return", Section 4.3 "Calculating Rate of Returns on International Investments", the other from Chapter 4 "Foreign Exchange Markets and Rates of Return", Section 4.4 "Interpretation of the Rate of Return Formula", Step 5) to calculate the expected rate of return on the British money market deposit and show that both formulas generate the same answer.
- b. What part of the rate of return arises only due to the interest earned on the deposit?
- c. What part of the rate of return arises from the percentage change in the value of the principal due to the change in the exchange rate?
- d. What component of the rate of return arises from the percentage change in the value of the interest payments due to the change in the exchange rate?