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FUNDAMENTALS OF CORPORATE FINANCE

CANADIAN EDITION

Interest Rates and Valuing Cash Flows

PART 2

Valuation Principle Connection. In this part of the text, we introduce the basic tools for making financial decisions. Chapter 3 presents the most important idea in this book, the *Valuation Principle.* The Valuation Principle states that we can use market prices to determine the value of an investment opportunity to the firm. As we progress through our study of corporate finance, we will demonstrate that the Valuation Principle is the one unifying principle that underlies all of finance and links all of the ideas throughout this book.

For a financial manager, evaluating financial decisions involves computing the net present value of a project's future cash flows. We use the Valuation Principle's Law of One Price to derive a central concept in financial economics—the *time value of money*. In Chapter 4, we explain how to value any series of future cash flows and derive a few useful shortcuts for valuing various types of cash flow patterns. Chapter 5 discusses how interest rates are quoted in the market and how to handle interest rates that compound more frequently than once per year. We apply the Valuation Principle to demonstrate that the return required from an investment will depend on the rate of return of investments with maturity and risk similar to the cash flows being valued. This observation leads to the important concept of the *cost of capital* of an investment decision. In Chapter 6, we demonstrate an application of the time value of money tools using interest rates: valuing the bonds issued by corporations and governments.

Chapter 3
The Valuation Principle: The Foundation of Financial Decision Making

Chapter 4
***NPV* and the Time Value of Money**

Chapter 5
Interest Rates

Chapter 6
Bonds

3 The Valuation Principle: The Foundation of Financial Decision Making

LEARNING OBJECTIVES

- Identify the role of financial managers in decision making
- Recognize the role competitive markets play in determining the value of a good
- Understand the Valuation Principle and how it can be used to identify decisions that increase the value of the firm
- Assess the effect of interest rates on today's value of future cash flows
- Use the net present value decision rule to make investment decisions
- Understand the Law of One Price

notation

NPV	net present value	*r*	interest rate
PV	present value		

INTERVIEW WITH Karrilyn Wilcox,

Marshall & Stevens Valuation Consulting

Saint Mary's University, 2007

"Without my strong background in Finance, I would not be where I am today."

Karrilyn Wilcox, an employee at Marshall & Stevens Valuation Consulting practice in New York City, provides clients with valuation and financial advisory services. Her finance background comes into play regularly. "I need to understand the industry and economy the business operates in, in order to more effectively forecast the business's financial statements, which are the basis of discounted cash flow analysis."

Having graduated from Saint Mary's University in Halifax in 2007 with a Bachelor of Commerce degree, Karrilyn understands well the importance of interest rates and their effect on today's value of future cash flows. "For instance, if we are valuing a business in a different country with high interest rates and sovereign risk, we need to understand the impact this has on the valuation. For one thing, it would be inappropriate to use the same discount rate as another company that operates in the same industry and has the same capital structure and credit rating but operates in a low interest rate environment with little sovereign risk."

Karrilyn credits her finance courses with providing her with the tools to perform her job, and for having set her on an exciting career path. "Without my strong background in finance, I would not be where I am today."

In September 2010, Research In Motion (RIM) decided to directly enter the tablet computer market dominated by Apple's iPad by unveiling the BlackBerry PlayBook. How did RIM's managers decide this was the right decision for the company?

Every decision has future consequences that will affect the value of the firm. These consequences will generally include both benefits and costs. For example, in addition to the upfront cost of developing the PlayBook's hardware and software, RIM will also incur ongoing costs associated with future software development, marketing efforts, and customer support for PlayBook buyers. The benefits to RIM include the revenues from PlayBook sales, but also maintaining revenues from BlackBerry users who might otherwise switch to iPhones after purchasing iPads. This decision will increase RIM's value if these benefits outweigh the costs.

More generally, a decision is good for the firm's investors if it increases the firm's value by providing benefits whose value exceeds the costs. But comparing costs and benefits is often complicated because they occur at different points in time, or are in different currencies, or have different risks associated with them. To make a valid comparison, we must use the tools of finance to express all costs and benefits in common terms. In this chapter, we introduce the central concept of finance, and the unifying theme of this book, the *Valuation Principle*. The Valuation Principle states that we can use current market prices to determine the value today of the different costs and benefits associated with a decision. The Valuation Principle allows us to apply the concept of *net present value* (*NPV*) to compare the costs and benefits of a project in terms of a common unit—namely, dollars today. We will then be able to evaluate a decision by answering this question: *Does the cash value today of its benefits exceed the cash value today of its costs?* In addition, we will see that the difference between the cash values of the benefits and costs indicates the net amount by which the decision will increase the value of the firm and therefore the wealth of its investors. The Valuation Principle also leads to the important concept of the *Law of One Price*, which will prove to be a key tool in understanding the value of stocks, bonds, and other securities that are traded in the market.

3.1 Managerial Decision Making

A financial manager's job is to make decisions on behalf of the firm's investors. For example, a manager of a manufacturing company has to decide how much to produce. By increasing production, more units can be sold, but the price per unit will probably be lower. Does it make sense to increase production? A manager of another company might expect an increase in demand for her products. Should she raise prices or increase production? If the decision is to increase production and a new facility is required, is it better to rent or purchase the facility? When should managers give their workers a pay increase? These are a few examples of the kinds of choices managers face every day.

Our objective in this book is to explain how to make decisions that increase the value of the firm to its investors. In principle, the idea is simple and intuitive: For good decisions, the benefits exceed the costs. Of course, real-world opportunities are usually complex, and so the costs and benefits are often difficult to quantify. Quantifying them often involves using skills from other management disciplines, as in the following examples:

Marketing: to determine the increase in revenues resulting from an advertising campaign
Economics: to determine the increase in demand from lowering the price of a product
Organizational behaviour: to determine the effect of changes in management structure on productivity
Strategy: to determine a competitor's response to a price increase
Operations: to determine production costs after the modernization of a manufacturing plant

For the remainder of this text, we will assume that we can rely on experts in these different areas to provide this information so that the costs and benefits associated with a decision have already been identified. With that task done, the financial manager's job is to compare the costs and benefits and determine the best decision to make for the value of the firm.

Your Personal Financial Decisions

While the focus of this text is on the decisions a financial manager makes in a business setting, you will soon see that concepts and skills you will learn here apply to personal decisions as well. As a normal part of life, we all make decisions that trade off benefits and costs across time. Going to university, purchasing this book, saving for a new car or house down payment, taking out a car loan or home loan, buying shares of stock, and deciding between jobs are just a few examples of such decisions that you have faced or could face in the not-too-distant future. In this chapter, we develop the *Valuation Principle* as the foundation of all financial decision making—whether in a business or in a personal context—and begin to show how it is a unifying theme applicable to all the financial concepts you will learn.

Concept Check

1. What defines a good decision?
2. What is the financial manager's role in decision making for the firm?

3.2 Cost-Benefit Analysis

As we have already seen, the first step in decision making is to identify the costs and benefits of a decision. The next step is quantifying the costs and benefits. Any decision in which the value of the benefits exceeds the costs will increase the value of the firm. To evaluate the costs and benefits of a decision, we must value the effects in the same terms—cash today. Let's make this concrete with a simple example.

Suppose a jewellery manufacturer has the opportunity to trade 200 ounces of silver for 10 ounces of gold today. An ounce of silver differs in value from an ounce of gold. Consequently, it is incorrect to compare 200 ounces to 10 ounces and conclude that the larger quantity is better. Instead, to compare the costs of the silver and benefit of the gold, we first need to quantify their values in equivalent terms—cash today.

Consider the silver. What is its cash value today? Suppose silver can be bought and sold for a current market price of $25 per ounce. Then the 200 ounces of silver we give up has a cash value of[1]

$$(200 \text{ ounces of silver}) \times (\$25/\text{ounce of silver}) = \$5000$$

If the current market price for gold is $1300 per ounce, then for the 10 ounces of gold we receive a cash value of

$$(10 \text{ ounces of gold}) \times (\$1300/\text{ounce of gold}) = \$13{,}000$$

We have now quantified the decision. The jeweller's opportunity has a benefit of $13,000 and a cost of $5000. The net benefit of the decision is $13,000 − $5000 = $8000 today. The net value of the decision is positive, so by accepting the trade, the jewellery firm will be richer by $8000.

EXAMPLE 3.1

Comparing Costs and Benefits

Problem

Suppose you work as a customer account manager for an importer of frozen seafood. A customer is willing to purchase 300 kilograms of frozen shrimp today for a total price of $1500, including delivery. You can buy frozen shrimp on the wholesale market for $3 per kilogram today, and arrange for delivery at a cost of $100 today. Will taking this opportunity increase the value of the firm?

Solution

Plan

To determine whether this opportunity will increase the value of the firm, we need to value the benefits and the costs using market prices. We have market prices for our costs:

Wholesale price of shrimp: $3/kilogram Delivery cost: $100

We have a customer offering the following market price for 300 kilograms of shrimp delivered: $1500. All that is left is to compare the prices.

Execute

The benefit of the transaction is $1500 today. The costs are 300 kilograms × $3/kilogram = $900 today for the shrimp, and $100 today for delivery, for a total cost of $1000 today. If you are certain about these costs and benefits, the right decision is obvious: you should seize this opportunity because the firm will gain $1500 − $1000 = $500.

Evaluate

Thus, taking this opportunity contributes $500 to the value of the firm, in the form of cash that can be paid out immediately to the firm's investors.

[1] You might worry about commissions or other transactions costs (such as transportation costs) that are incurred when buying or selling silver, in addition to the market price. For now, we will ignore transactions costs and discuss their effect later.

Concept Check

3. How do we determine whether a decision increases the value of the firm?
4. When costs and benefits are in different units or goods, how can we compare them?

3.3 Valuation Principle

In the previous examples, the right decisions for the firms were clear because the costs and benefits were easy to evaluate and compare. They were easy to evaluate because we were able to use current market prices to convert them into equivalent cash values. Once we can express costs and benefits in terms of "cash today," it is a straightforward process to compare them and determine whether the decision will increase the firm's value.

Note that in both examples we used market prices to assess the values of the different commodities involved. What about the firm's other possible uses for those commodities? For example, consider the jewellery manufacturer with the opportunity to trade silver for gold. When evaluating the trade, we did not concern ourselves with whether the jeweller thought that the price was fair or whether the jeweller would actually have a use for the silver or gold. Suppose, for example, that the jeweller thinks the current price of silver is too high. Does this matter—would he value the silver at less than $5000? The answer is no—he can always sell the silver at the current market price and receive $5000 right now, so he would never place a lower value on the silver. Similarly, he also will not pay more than $5000 for the silver. Even if he really needs silver or for some reason thinks the price of silver is too low, he can always buy 200 ounces of silver for $5000 and so would not pay more than that amount. Thus, independent of his own views or preferences, the value of the silver to the jeweller is $5000.

Note that the jeweller can both buy and sell silver at its current market price. His personal preferences or use for the silver and his opinion of the fair price are therefore irrelevant in evaluating the value of this opportunity. This observation highlights an important general principle related to goods trading in a **competitive market**, a market in which a good can be bought *and* sold at the same price. Whenever a good trades in a competitive market, that price determines the value of the good. This point is one of the central and most powerful ideas in finance. It will underlie almost every concept that we develop throughout the text.

competitive market
A market in which a good can be bought *and* sold at the same price.

EXAMPLE 3.2

Competitive Market Prices Determine Value

Problem

You have just won a radio contest and are disappointed to find out that the prize is four tickets to the Celine Dion concert (face value $80 each). Not being a fan of Celine (as you were traumatized by having to watch the movie *Titanic* several times when you were younger), you have no intention of going to the show. However, it turns out that there is a second choice: two tickets to Justin Bieber's sold-out show (face value $50 each). You notice that on eBay, tickets to the Celine Dion show are being bought and sold for $60 apiece and tickets to Justin Bieber's show are being bought and sold at $100 each. What should you do?

Solution

Plan

Market prices, not your personal preferences (nor the face value of the tickets), are relevant here:

4 Celine Dion tickets at $60 apiece
2 Justin Bieber tickets at $100 apiece

You need to compare the market value of each option and choose the one with the highest market value.

Execute

The Celine Dion tickets have a total value of \$240 (4 × \$60) versus the \$200 total value of the Justin Bieber tickets (2 × \$100). Instead of taking the tickets to Justin Bieber, you should accept the Celine Dion tickets, sell them on eBay, and use the proceeds as you wish.

Evaluate

Even though Celine Dion's music brings back traumatic *Titanic* memories, you should still take the opportunity to get the Celine Dion tickets. As we emphasized earlier, whether this opportunity is attractive depends on its net value using market prices. Because the value of the Celine Dion tickets is \$40 more than the value of the Justin Bieber tickets, the opportunity is appealing.

Once we use market prices to evaluate the costs and benefits of a decision in terms of cash today, it is then a simple matter to determine the best decision for the firm. The best decision makes the firm and its investors wealthier, because the value of its benefits exceeds the value of its costs. We call this idea the Valuation Principle:

valuation principle The value of a commodity or an asset to the firm or its investors is determined by its competitive market price.

The Valuation Principle:
The value of a commodity or an asset to the firm or its investors is determined by its competitive market price.

The Valuation Principle provides the basis for decision making throughout this text. In the remainder of this chapter, we first apply it to decisions whose costs and benefits occur at different points in time and develop the main tool of project evaluation, the *net present value rule*. We then consider its consequences for the prices of assets in the market and develop the concept of the *Law of One Price*.

When Competitive Market Prices Are Not Available

Competitive market prices allow us to calculate the value of a decision without worrying about the tastes or opinions of the decision maker. When competitive prices are not available, we can no longer do this. Prices at retail stores, for example, are one-sided: you can buy at the posted price, but you cannot sell the good to the store at that same price. We cannot use these one-sided prices to determine an exact cash value. They determine the maximum value of the good (since it can always be purchased at that price), but an individual may value it for much less depending on his or her preferences for the good.

Let's consider an example. It has long been common for banks to try to entice people to open accounts by offering them something for free in exchange (it used to be a toaster). Suppose a bank is offering new customers a free iPod nano if they open a new chequing account and make two deposits. Assume the retail price of that model of nano was \$159. Because there is no competitive market to trade iPods, the value of the nano depends on whether you were going to buy one or not.

If you planned to buy a nano anyway, then the value to you of the nano is \$159, the price you would otherwise pay for it. In this case, the value of the bank's offer is \$159. But suppose you do not want or need a nano. If you were to get it from the bank and then sell it, the value of taking the deal would be whatever price you could get for the nano. For example, if you could sell the nano for \$100 to your friend, then the bank's offer is worth \$100 to you. Thus, depending on your desire to own a new nano, the bank's offer is worth somewhere between \$100 (you don't want a nano) and \$159 (you definitely want one).

EXAMPLE 3.3

Applying the Valuation Principle

Problem

You are the operations manager at your firm. Due to a pre-existing contract, you have the opportunity to acquire 200 barrels of oil and 3000 pounds of copper for a total of $25,000. The current market price of oil is $90 per barrel and copper is $3.50 per pound. You are not sure that you need all of the oil and copper, so you are wondering if you should take this opportunity. How valuable is it? Would your decision change if you believed the value of oil or copper would plummet over the next month?

Solution

Plan

We need to quantify the costs and benefits using market prices. We are comparing $25,000 with

200 barrels of oil at $90 per barrel
3000 pounds of copper at $3.50 per pound

Execute

Using the competitive market prices we have:

$$(3000 \text{ pounds of copper}) \times (\$3.50/\text{pound today}) = \$10{,}500 \text{ today}$$

$$(200 \text{ barrels}) \times (\$90/\text{barrel today}) = \$18{,}000 \text{ today}$$

The value of the opportunity is the value of the oil plus the value of the copper less the cost of the opportunity, or $\$18{,}000 + \$10{,}500 - \$25{,}000 = \$3500$ today. Because the value is positive, we should take it. This value depends only on the *current* market prices for oil and copper. If we do not need all of the oil and copper, we can sell the excess at current market prices. Even if we thought the value of oil or copper was about to plummet, the value of this investment would be unchanged. (We can always exchange them for dollars immediately at the current market prices.)

Evaluate

Since we are transacting today, only the current prices in a competitive market matter. Our own use for or opinion about the future prospects of oil or copper does not alter the value of the decision today. This decision is good for the firm, and will increase its value by $3500.

Concept Check

5. How should we determine the value of a good?
6. If crude oil trades in a competitive market, would an oil refiner that has a use for the oil value it differently than another investor would?

3.4 The Time Value of Money and Interest Rates

For most financial decisions, unlike in the examples presented so far, costs and benefits occur at different points in time. For example, typical investment projects incur costs up front and provide benefits in the future. In this section, we show how to account for this time difference when using the Valuation Principle to make a decision.

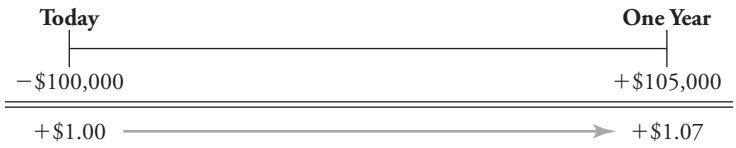
The Time Value of Money

Consider a firm's investment opportunity with the following cash flows:

Cost:	\$100,000 today
Benefit:	\$105,000 in one year

Because both are expressed in dollar terms, are the cost and benefit directly comparable? Calculating the project's net value as \$105,000 − \$100,000 = \$5000 is incorrect because it ignores the *timing* of the costs and benefits. That is, it treats money today as equivalent to money in one year. In general, a dollar today is worth *more* than a dollar in one year. To see why, note that if you have \$1 today, you can invest it. For example, if you deposit it in a bank account paying 7% interest, you will have \$1.07 at the end of one year. We call the difference in value between money today and money in the future the **time value of money**. We now develop the tools needed to value our \$100,000 investment opportunity correctly.

time value of money The difference in value between money today and money in the future; also, the observation that two cash flows at two different points in time have different values.



The Interest Rate: Converting Cash Across Time

By depositing money into a savings account, we can convert money today into money in the future with no risk. Similarly, by borrowing money from the bank, we can exchange money in the future for money today. The rate at which we can exchange money today for money in the future is determined by the current interest rate. In the same way that a currency exchange rate allows us to convert money from one currency to another, the interest rate allows us to convert a currency from one point in time to the same currency at another point in time. In essence, an interest rate is an exchange rate across time. It tells us the market price today of money in the future.

Suppose the current annual interest rate is 7%. By investing \$1 today, we can convert this \$1 into \$1.07 in one year. Similarly, by borrowing at this rate, we can exchange \$1.07 in one year for \$1 today. More generally, we define the **interest rate**, r, for a given period as the interest rate at which one currency can be borrowed or lent over that period. In our example, the interest rate is 7% and we can exchange \$1 today for $(1 + 0.7)$ dollars in the future. In general, we can exchange \$1 today for $(1 + r)$ dollars in the future, and vice versa. We refer to $(1 + r)$ as the **interest rate factor** for cash flows; it defines how we convert cash flows across time, and has units of "\$ in one year/\$ today."

interest rate The rate at which one currency can be borrowed or lent over a given period.

interest rate factor One plus the interest rate, the rate of exchange between dollars today and dollars in the future. It has units of "\$ in one year/\$ today."

As with other market prices, the interest rate ultimately depends on supply and demand. In particular, at the market-determined interest rate, the supply of savings equals the demand for borrowing. Regardless of how it is determined, once we know the interest rate, we can apply the Valuation Principle and use it to evaluate other decisions in which costs and benefits are separated in time.

Value of \$100,000 Investment in One Year. Let's reevaluate the investment we considered earlier, this time taking into account the time value of money. If the interest rate is 7%, then we can express the cost of the investment as

$$\begin{aligned}\text{Cost} &= (\$100{,}000 \text{ today}) \times (1.07 \text{ \$ in one year/\$ today}) \\ &= \$107{,}000 \text{ in one year}\end{aligned}$$

future value The value of a cash flow that is moved forward in time.

This $107,000 amount is called a **future value**. For a one period case, the future value is calculated as follows:

$$FV_1 = C_0 \times (1 + r) \tag{3.1}$$

where FV_1 is the future value after one period, C_0 is the amount invested or borrowed now (at time 0), and r is the interest rate.

Think of this $107,000 amount as the opportunity cost of spending $100,000 today: The firm gives up the $107,000 it would have had in one year if it had left the money in the bank. Alternatively, by borrowing the $100,000 from the same bank, the firm would owe $107,000 in one year.

	Today	One Year
Investment	−$100,000	+$105,000
Bank	−$100,000	+$107,000

We have used a market price, the interest rate, to put both the costs and benefits in terms of "dollars in one year," so now we can use the Valuation Principle to compare them and compute the investment's net value by subtracting the cost of the investment from the benefit in one year:

$$\$105{,}000 - \$107{,}000 = -\$2000 \text{ in one year}$$

In other words, the firm could earn $2000 more in one year by putting the $100,000 in the bank rather than making this investment. Because the net value is negative, we should reject the investment: if we took it, the firm would be $2000 poorer in one year than if we did not.

Value of $100,000 Investment Today. The previous calculation expressed the value of the costs and benefits in terms of a future value amount: dollars in one year. Alternatively, we can use the interest rate factor to convert to a present value amount: dollars today. Consider the benefit of $105,000 in one year. What is the equivalent amount in terms of dollars today? That is, how much would we need to have in the bank today so that we would end up with $105,000 in the bank in one year? We find this amount by dividing by the interest rate factor:

$$\begin{aligned}\text{Benefit} &= (\$105{,}000 \text{ in one year}) \div (1.07\ \$ \text{ in one year}/\$ \text{ today}) \\ &= \$98{,}130.84 \text{ today}\end{aligned}$$

present value (*PV*) The value of a cost or benefit computed in terms of cash today.

This $98,130.84 amount is called a **present value (*PV*)**. For a one-period case, the present value is calculated as follows:

$$PV_0 = C_1 \div (1 + r) = \frac{C_1}{(1 + r)} = C_1 \times \frac{1}{(1 + r)} \tag{3.2}$$

where PV_0 is the present value now (at time 0), C_1 is the cash flow in one year (at time 1), and r is the interest rate.

This $98,130.84 is also the amount the bank would lend to us today if we promised to repay $105,000 in one year.[2] Thus, it is the competitive market price at which we can "buy" or "sell" $105,000 in one year.

[2]We are assuming the bank is willing to lend at the same 7% interest rate, which would be the case if there were no risk associated with the cash flow.

Now we are ready to compute the net value of the investment by subtracting the cost from the benefit:

$$\$98{,}130.84 - \$100{,}000 = -\$1869.16 \text{ today}$$

Once again, the negative result indicates that we should reject the investment. Taking the investment would make the firm $1869.16 poorer today because it gave up $100,000 for something worth only $98,130.84.

Present Versus Future Value. This calculation demonstrates that our decision is the same whether we express the value of the investment in terms of the future value amount (dollars in one year) or the present value amount (dollars today): we should reject the investment. Indeed, if we convert from dollars today to dollars in one year,

$$(-\$1869.16 \text{ today}) \times (1.07 \text{ \$ in one year/\$ today}) = -\$2000 \text{ in one year}$$

we see that the two results are equivalent, but expressed as values at different points in time.

discount factor $\frac{1}{(1+r)}$ is the rate of exchange between dollars in the future and dollars today. It has the units of "$ today/$ in one year."

discount rate The appropriate rate to discount a stream of cash flows to determine their value at an earlier time.

Discount Factors and Rates. In the preceding calculation, we can interpret

$$\frac{1}{1+r} = \frac{1}{1.07} = 0.93458$$

as the *price* today of $1 in one year. In other words, for just under 93.5 cents, you can "buy" $1 to be delivered in one year. Note that the value is less than $1—money in the future is worth less today, and so its price reflects a discount. Because it provides the discount at which we can purchase money in the future, the amount $\frac{1}{(1+r)}$ is called the one-year **discount factor**. The interest rate is also referred to as the **discount rate** for an investment.

EXAMPLE 3.4

Comparing Revenues at Different Points in Time

Problem

The launch of Sony's PlayStation 3 was delayed until November 2006, giving Microsoft's Xbox 360 a full year on the market without competition. Imagine that it is November 2005 and you are the marketing manager for the PlayStation. You estimate that if PlayStation 3 were ready to be launched immediately, you could sell $2 billion worth of the console in its first year. However, if your launch is delayed a year, you believe that Microsoft's head start will reduce your first-year sales by 20%. If the interest rate is 8%, what is the cost of a delay of the first year's revenues in terms of dollars in 2005?

Solution

Plan

Revenues if released today: $2 billion. Revenue decrease if delayed: 20%. Interest rate: 8%.

We need to compute the revenues if the launch is delayed and compare them to the revenues from launching today. In order to make a fair comparison, however, we need to convert the future revenues of the PlayStation if they are delayed into an equivalent present value of those revenues today.

Execute

If the launch is delayed to 2006, revenues will drop by 20% of $2 billion, or $400 million, to $1.6 billion. To compare this amount to revenues of $2 billion if launched in 2005, we must convert it using the interest rate of 8%:

$$\$1.6 \text{ billion in } 2006 \div (\$1.08 \text{ in } 2006/\$1 \text{ in } 2005) = \$1.481 \text{ billion in } 2005$$

Therefore, the cost of a delay of one year is

$$\$2 \text{ billion} - \$1.481 \text{ billion} = \$0.519 \text{ billion } (\$519 \text{ million}).$$

Evaluate

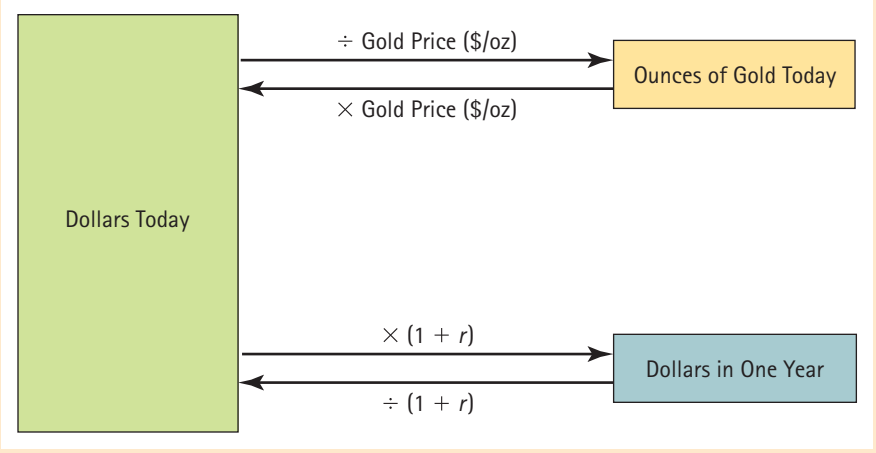
Delaying the project for one year was equivalent to giving up $519 million in revenue. In this example, we focused only on the effect on the first year's revenues. However, delaying the launch delays the entire revenue stream by one year, so the total cost would be calculated in the same way by summing the cost of delay for each year of revenues.

We can use the interest rate to determine values in the same way we used competitive market prices. Figure 3.1 illustrates how we use competitive market prices and interest rates to convert between dollars today and other goods, or dollars in the future. Once we quantify all the costs and benefits of an investment in terms of dollars today, we can rely on the Valuation Principle to determine whether the investment will increase the firm's value.

FIGURE 3.1

Converting Between Dollars Today and Gold or Dollars in the Future

We can convert dollars today to different goods or points in time by using the competitive market price or interest rate. Once values are in equivalent terms, we can use the Valuation Principle to make a decision.



Concept Check

7. How do you compare costs at different points in time?
8. Is the value today of money to be received in one year higher when interest rates are high or when interest rates are low?

3.5 The *NPV* Decision Rule

In Section 3.4, we converted between cash today and cash in the future using the interest rate. As long as we convert costs and benefits to the same point in time, we can use the Valuation Principle to make a decision. In practice, however, most corporations prefer to measure values in terms of their present value—that is, in terms of cash today. In this section, we apply the Valuation Principle to derive the concept of the *net present value* or *NPV*, which we can use to define the "golden rule" of financial decision making, the *NPV decision rule*.

Net Present Value

net present value (*NPV*) The difference between the present value of a project's or investment's benefits and the present value of its costs.

When the value of a cost or benefit is computed in terms of cash today, we refer to it as the present value (*PV*). Similarly, we define the **net present value (*NPV*)** of a project or investment as the difference between the present value of its benefits and the present value of its costs:

Net Present Value

$$NPV = PV(\text{Benefits}) - PV(\text{Costs}) \tag{3.3}$$

Let's consider a simple example. Suppose your firm is offered the following investment opportunity: in exchange for $500 today, you will receive $550 in one year. If the interest rate is 8% per year, then

$$\begin{aligned} PV(\text{Benefit}) &= (\$550 \text{ in one year}) \div (1.08\ \$ \text{ in one year}/\$ \text{ today}) \\ &= \$509.26 \text{ today} \end{aligned}$$

This *PV* is the amount you would need to put in the bank today to generate $550 in one year ($509.26 × 1.08 = $550). In this case, *the present value is the value today of the benefit that is to be received in one year.*

Once the costs and benefits are in present value terms, we can compute the investment's *NPV*:

$$NPV = \$509.26 - \$500 = \$9.26 \text{ today}$$

But what if you don't have the $500 needed to cover the initial cost of the project? Does the project still have the same value? Because we computed the value using competitive market prices, it should not depend on your tastes or the amount of cash you have in the bank. If you don't have the $500, suppose you borrow $509.26 from the bank at the 8% interest rate and then take the project. What are your cash flows in this case?

$$\text{Today: } \$509.26 \text{ (loan)} - \$500 \text{ (invested in the project)} = \$9.26$$

$$\text{In one year: } \$550 \text{ (from project)} - \$509.26 \times 1.08 \text{ (loan balance)} = \$0$$

This transaction leaves you with exactly $9.26 extra cash in your pocket today and no future net obligations. So taking the project is similar to having an extra $9.26 in cash up front. Thus, the *NPV* expresses the value of an investment decision as an amount of cash received today. *As long as the NPV is positive, the decision increases the value of the firm and is a good decision regardless of your current cash needs or preferences regarding when to spend the money.*

The *NPV* Decision Rule

As shown in the last example, the Valuation Principle implies that we should undertake projects with a positive *NPV*. That is, good projects are those for which the present value of the benefits exceeds the present value of the costs. As a result, the value of the firm increases and investors are wealthier. Projects with negative *NPV*s have costs that exceed their benefits. Accepting them is equivalent to losing money today.

***NPV* decision rule** When choosing among investment alternatives, take the alternative with the highest *NPV*. Choosing this alternative is equivalent to receiving its *NPV* in cash today.

We capture this logic in the ***NPV* decision rule**:

When choosing among investment alternatives, take the alternative with the highest NPV. Choosing this alternative is equivalent to receiving its NPV in cash today.

Because *NPV* is expressed in terms of cash today, using the *NPV* decision rule is a simple way to apply the Valuation Principle. Decisions that increase wealth are superior to those that decrease wealth. We don't need to know anything about the investor's preferences to reach this conclusion. As long as we have correctly captured all of the cash flows of a project, being wealthier increases our options and makes us better off, whatever our preferences are.

We now look at some common ways the *NPV* decision rule is applied in practice.

Accepting or Rejecting a Project. A common financial decision is whether to accept or reject a project. Because rejecting the project generally has $NPV = 0$ (there are no new costs or benefits from not doing the project), the *NPV* decision rule implies that we should

- accept positive-*NPV* projects, because accepting them is equivalent to receiving their *NPV* in cash today, and
- reject negative-*NPV* projects, because accepting them would reduce the value of the firm, whereas rejecting them has no cost ($NPV = 0$).

If the *NPV* is exactly zero, then you will neither gain nor lose by accepting the project instead of rejecting it, which also has an *NPV* of zero. It is not a bad project because it does not reduce the firm's value, but it does not add value to the firm either.

EXAMPLE 3.5

The *NPV* Is Equivalent to Cash Today

Problem

After saving $1500 waiting tables, you are about to buy a 50-inch plasma TV. You notice that the store is offering a "one-year same as cash" deal. You can take the TV home today and pay nothing until one year from now, when you will owe the store the $1500 purchase price. If your savings account earns 5% per year, what is the *NPV* of this offer? Show that its *NPV* represents cash in your pocket.

Solution

Plan

You are getting something (the TV) worth $1500 today and in exchange will need to pay $1500 in one year. Think of it as getting back the $1500 you thought you would have to spend today to get the TV. We treat it as a positive cash flow.

Cash flows:

Today	In one year
+$1500	$1500

The discount rate for calculating the present value of the payment in one year is your interest rate of 5%. You need to compare the present value of the cost ($1500 in one year) to the benefit today (a $1500 TV).

Execute

$$NPV = +1500 - \frac{1500}{(1.05)} = 1500 - 1428.57 = \$71.43$$

You could take $1428.57 of the $1500 you had saved for the TV and put it in your savings account. With interest, in one year it would grow to $1428.57 × (1.05) = $1500, enough to pay the store. The extra $71.43 is money in your pocket to spend as you like.

Evaluate

By taking the delayed payment offer, we have extra net cash flows of $71.43 today. If we put $1428.57 in the bank, it will be just enough to offset our $1500 obligation in the future. Therefore, this offer is equivalent to receiving $71.43 today, without any future net obligations.

Choosing Among Alternatives. Managers also use the *NPV* decision rule to choose among projects. Suppose you own a coffee stand across from the campus and you hire someone to operate it for you. You will be graduating next year and have started to consider selling it. An investor has offered to buy the business from you for $20,000 whenever you are ready. Your interest rate is 10% and you are considering three alternatives:

1. Sell the business now.
2. Operate normally for one more year and then sell the business (requiring you to spend $5000 on supplies and labour now, but earn $10,000 at the end of the year).
3. Be open only in the mornings for one more year and then sell the business (requiring you to spend $3000 on supplies and labour now, but earn $6000 at the end of the year).

The cash flows and *NPVs* are given in Table 3.1.

TABLE 3.1

Cash Flows and *NPV*s for Coffee Stand Alternatives

	Now	One Year	*NPV*
Sell	+$20,000	0	$20,000
Operate Normally	−$5000	+$10,000 +$20,000	$-\$5000 + \frac{\$30,000}{1.10} = \$22,273$
Mornings Only	−$3000	+$6000 +$20,000	$-\$3000 + \frac{\$26,000}{1.10} = \$20,636$

Among these three alternatives, you would choose the one with the highest *NPV*: operate normally for one year and then sell.

NPV and Cash Needs

When we compare projects with different patterns of present and future cash flows, we may have preferences regarding when to receive the cash. Some people may need cash today; others may prefer to save for the future. In our coffee stand example, operating normally for one more year and then selling has the highest *NPV*. However, this option does require an initial outlay for supplies (as opposed to selling the coffee stand and receiving $20,000 today). Suppose we would prefer to avoid the negative cash flow today. Would selling the business be a better choice in that case?

As was true for the jeweller in Section 3.2 considering trading silver for gold, the answer is again no. As long as we are able to borrow and lend at the interest rate, operating for one more year is superior, whatever our preferences regarding the timing of the cash flows. To see why, suppose we borrow $25,000 at the rate of 10% (in one year, we will owe $25,000 × [1.10] = $27,500) and operate the stand normally for one more year. Our total cash flows are shown in Table 3.2. Compare these cash flows to those for selling. The combination of borrowing and operating for a year generates the same initial cash flow as selling. Notice, however, that there is a higher final cash flow ($2500 versus $0). Thus, we are better off operating for a year and borrowing $25,000 today than we would be selling immediately.

TABLE 3.2

Cash Flows from Combining One More Year of Operating with Borrowing

	Cash Flow Today	Cash Flow in One Year
Operate Normally	−$5000	$30,000
Borrow	$25,000	−$25,000 × (1.10) = −$27,500
Total	$20,000	$2500
Sell Today	$20,000	0

This example illustrates the following general principle:

Regardless of our preferences for cash today versus cash in the future, we should always maximize NPV first. We can then borrow or lend to shift cash flows through time and find our most preferred pattern of cash flows.

Concept Check

9. What is the *NPV* decision rule? How is it related to the Valuation Principle?
10. Why doesn't the *NPV* decision rule depend on the investor's preferences?

3.6 The Law of One Price

Up to this point, we have emphasized the importance of using competitive market prices to compute the *NPV*. But is there always only one such price? What if the same good trades for different prices in different markets? Consider gold. Gold trades in many different markets, with the largest markets in New York and London. Gold can trade easily in many markets because investors are not literally transacting in the gold bars themselves (which are quite heavy!), but are trading ownership rights to gold that is stored securely elsewhere.[3] To value an ounce of gold, we could look up the competitive price in either of these markets. But suppose gold is trading for $1200 per ounce in New York and $1300 per ounce in London. Which price should we use?

In fact, situations such as this one, where the same asset is trading with different prices, should not occur in a competitive market. Let's see why. Recall that these are competitive market prices, at which you can both buy *and* sell. Thus, you can make money in this situation simply by buying gold for $1200 per ounce in New York and then

[3]Many countries store their gold reserves five floors under the Federal Reserve Bank of New York building in New York City. If a trade occurs, the physical gold is actually moved, but it is moved only a few feet from one country's compartment to another. Thus, transportation costs are insignificant even to these types of trades. If you plan to visit New York, you can make an advance booking for a tour of the gold vault (see the Federal Reserve Bank of New York website, www.ny.frb.org/aboutthefed/visiting.html).

immediately selling it for $1300 per ounce in London. You will make $1300 − $1200 = $100 per ounce for each ounce you buy and sell. Trading 1 million ounces at these prices, you would make $100 million with no risk or investment! This is a case where that old adage, "Buy low, sell high," can be followed perfectly.

Of course, you will not be the only one making these trades. Everyone who sees these prices will want to trade as many ounces as possible. Within seconds, the market in New York would be flooded with buy orders, and the market in London would be flooded with sell orders. Although a few ounces (traded by the lucky individuals who spotted this opportunity first) might be exchanged at these prices, the price of gold in New York would quickly rise in response to the excess demand, and the price in London would rapidly fall in response to the excess supply. Prices would continue to change until they were equalized somewhere in the middle, such as $1250 per ounce. This example illustrates an *arbitrage opportunity*, the focus of this section.

Arbitrage

arbitrage The practice of buying and selling equivalent goods or portfolios to take advantage of a price difference.

arbitrage opportunity Any situation in which it is possible to make a profit without taking any risk or making any investment.

The practice of buying and selling equivalent goods in different markets to take advantage of a price difference is known as **arbitrage**. More generally, we refer to any situation in which it is possible to make a profit without taking any risk or making any investment as an **arbitrage opportunity**. Because an arbitrage opportunity has positive *NPV*, whenever an arbitrage opportunity appears in financial markets, the Valuation Principle indicates that investors will race to take advantage of it. Those investors who spot the opportunity first and who can trade quickly will have the ability to exploit it. Once they place their trades, prices will respond due to the interaction of supply and demand forces, causing the arbitrage opportunity to evaporate.

Arbitrage opportunities are like money lying in the street; once spotted, they will quickly disappear. Thus, the normal state of affairs in markets should be that no arbitrage opportunities exist.

Law of One Price

In a competitive market, the price of gold at any point in time will be the same in London and New York. The same logic applies more generally whenever equivalent investment opportunities trade in two different competitive markets. If the prices in the two markets differ, investors will profit immediately by buying in the market where the price is cheap and selling in the market where it is expensive. In doing so, supply and

An Old Joke

There is an old joke that many finance professors enjoy telling their students. It goes like this:

> *A finance professor and a student are walking down a street. The student notices a $100 bill lying on the pavement and leans down to pick it up. The finance professor immediately intervenes and says, "Don't bother; there is no free lunch. If that were a real $100 bill lying there, somebody would already have picked it up!"*

This joke makes fun of the principle of no arbitrage in competitive markets. But have you ever *actually* found a real $100 bill lying on the pavement? Herein lies the real lesson behind the joke.

This joke sums up the point of focusing on markets in which no arbitrage opportunities exist. Free $100 bills lying on the pavement, like arbitrage opportunities, are extremely rare for two reasons: (1) Because $100 is a large amount of money, people are especially careful not to lose it, and (2) in the rare event when someone does inadvertently drop $100, the likelihood of your finding it before someone else does is extremely small.

demand forces will equalize the prices. As a result, prices will not differ (at least not for long). This important property is the **Law of One Price**:

Law of One Price
In competitive markets, securities or portfolios with the same cash flows must have the same price.

If equivalent investment opportunities trade simultaneously in different competitive markets, then they must trade for the same price in both markets.

The Law of One Price will prove to be a powerful tool later in the text when we value securities such as stocks or bonds. We will show that any financial security can be thought of as a claim to future cash flows. The Law of One Price implies that if there is another way to recreate the future cash flows of the financial security, then the price of the financial security and the cost of recreating it must be the same. Recall that earlier we defined the present value of a cash flow to be the cost of recreating it in a competitive market. Thus, we have the following key implication of the Law of One Price for financial securities:

The price of a security should equal the present value of the future cash flows obtained from owning that security.

EXAMPLE 3.6

Pricing a Security Using the Law of One Price

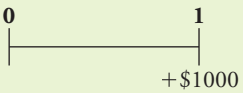
Problem

You are considering purchasing a security, a "bond," that pays $1000 without risk in one year, and has no other cash flows. If the interest rate is 5%, what should its price be?

Solution

Plan

The security produces a single cash flow in one year:



The Law of One Price tells you that the value of a security that pays $1000 in one year is the present value of that $1000 cash flow, calculated as the cash flow discounted at the interest rate. The 5% interest rate implies that $1.05 in one year is worth $1 today.

Execute

The present value of the $1000 cash flow is:

$$1000 \text{ in one year} \div \frac{1.05 \text{ \$ in one year}}{\text{\$ today}} = \$952.38 \text{ today}$$

Therefore, the price must be $952.38.

Evaluate

Because we can receive $1000 in one year for a "price" of $952.38 by simply investing at the interest rate (i.e., $952.38 $\times$ 1.05 = $1000), the Law of One Price tells you that the price of the security must equal this "do it yourself" price, which is the present value of its cash flow evaluated using market interest rates. To see why this must be so, consider what would happen if the price were different. If the price were $950, you could borrow $950 at 5% interest and buy the bond. In one year, you would collect the $1000 from the bond and pay off your loan ($950 $\times$ 1.05 = $997.50), pocketing the difference. In fact, you would try to do the same thing for as many bonds as possible. But everyone else would also want to take advantage of this arbitrage by buying the bond, and so, due to the excess demand, its price would quickly rise. Similarly, if the price were above $952.38, everyone would sell the bond, invest the proceeds at 5%, and in one year would have more than the $1000 needed to pay the buyer of the security. The selling, and resulting excess supply, would cause the price of the bond to drop until this arbitrage was no longer possible—when it reaches $952.38. This powerful application of the Law of One Price shows that the price you pay for a security's cash flows cannot be different from their present value.

Transactions Costs

In our examples up to this point, we have ignored the costs of buying and selling goods or securities. In most markets, there are additional costs that you will incur when trading assets, called **transactions costs**. As discussed in Chapter 1, when you trade securities in markets such as the TSX, NYSE, and NASDAQ, you must pay two types of transactions costs. First, you must pay your broker a commission on the trade. Second, because you will generally pay a slightly higher price when you buy a security (the ask price) than you will receive when you sell (the bid price) it, you will also pay the bid-ask spread. For example, a share of Research In Motion stock (ticker symbol RIM) might be quoted as follows:

Bid: \$49.80 Ask: \$49.90

We can interpret these quotes as if the competitive price for RIM were \$49.85, but there is a transaction cost of \$0.05 per share when buying or selling.

What consequence do these transaction costs have for no-arbitrage prices and the Law of One Price? Earlier we stated that the price of gold in New York and London must be identical in competitive markets. Suppose, however, that total transactions costs of \$5 per ounce are associated with buying gold in one market and selling it in the other. Then, if the price of gold is \$1326 per ounce in New York and \$1330 per ounce in London, the "Buy low, sell high" strategy no longer works:

Cost: \$1326 per ounce (buy gold in New York) + \$5 (transactions costs)

Benefit: \$1330 per ounce (sell gold in London)

NPV: \$1330 − \$1326 − \$5 = −\$1 per ounce

Indeed, there is no arbitrage opportunity in this case until the prices diverge by more than \$5, the amount of the transactions costs.

In general, we need to modify our previous conclusions about prices and values by appending the phrase "up to transactions costs." In this example, there is only one competitive price for gold—up to a discrepancy of the \$5 transactions cost.

Fortunately, for most financial markets, these costs are small. For example, on the TSX, many actively traded stocks have bid-ask spreads of only between 1 and 10 cents per share. Less actively traded shares (such as those on the TSX Venture Exchange), though, do have larger spreads—this can be thought of as a less liquid or less competitive market. As a first approximation, we can ignore these spreads in our analysis. Only in situations in which the *NPV* is small (relative to the transactions costs) will any discrepancy matter. In that case, we will need to carefully account for all transaction costs to decide whether the *NPV* is positive or negative.

To summarize, when there are transactions costs, arbitrage keeps prices of equivalent goods and securities close to each other. Prices can deviate but not by more than the amount of the transactions costs.

transactions costs
Expenses such as broker commission and the bid-ask spread investors must pay in most markets in order to trade securities.

In the rest of the text, we will explore the details of implementing the Law of One Price to value securities. Specifically, we will determine the cash flows associated with stocks, bonds, and other securities, and learn how to compute the present value of these cash flows by taking into account their timing and risk.

11. If the Law of One Price were violated, how could investors profit?

12. What implication does the Law of One Price have for the price of a financial security?

MyFinanceLab

Here is what you should know after reading this chapter. MyFinanceLab will help you identify what you know, and where to go when you need to practice.

Key Points and Equations	Terms	Online Practice Opportunities
3.1 Managerial Decision Making ◗ To evaluate a decision, we must value the incremental costs and benefits associated with that decision. A good decision is one for which the value of the benefits exceeds the value of the costs.		MyFinanceLab Study Plan 3.1
3.2 Cost-Benefit Analysis ◗ To compare costs and benefits that occur at different points in time, we must put all costs and benefits in common terms. Typically, we convert costs and benefits into cash today.		MyFinanceLab Study Plan 3.2
3.3 Valuation Principle ◗ A competitive market is one in which a good can be bought and sold at the same price. We use prices from competitive markets to determine the cash value of a good. ◗ The Valuation Principle states that the value of a commodity or an asset to the firm or its investors is determined by its competitive market price. The benefits and costs of a decision should be evaluated using those market prices. When the value of the benefits exceeds the value of the costs, the decision will increase the market value of the firm.	competitive market, p. 70 Valuation Principle, p. 71	MyFinanceLab Study Plan 3.3
3.4 The Time Value of Money and Interest Rates ◗ The time value of money is the difference in value between money today and money in the future. ◗ The rate at which we can exchange money today for money in the future by borrowing or investing is the current market interest rate. ◗ The present value (*PV*) of a cash flow is its value in terms of cash today.	discount factor, p. 75 discount rate, p. 75 future value, p. 74 interest rate, p. 73 interest rate factor, p. 73 present value (*PV*), p. 74 time value of money, p. 73	MyFinanceLab Study Plan 3.4
3.5 The *NPV* Decision Rule ◗ The net present value (*NPV*) of a project is *PV*(Benefits) – *PV*(Costs). ◗ A good project is one with a positive net present value. ◗ The *NPV* decision rule states that when choosing from among a set of alternatives, choose the one with the highest *NPV*. The *NPV* of a project is equivalent to the cash value today of the project.	net present value (*NPV*), p. 77 *NPV* decision rule, p. 78	MyFinanceLab Study Plan 3.5

◗ Regardless of our preferences for cash today versus cash in the future, we should always first maximize *NPV*. We can then borrow or lend to shift cash flows through time and find our most preferred pattern of cash flows.		
3.6 The Law of One Price ◗ Arbitrage is the process of trading to take advantage of equivalent goods that have different prices in different competitive markets. ◗ The Law of One Price states that if equivalent goods or securities trade simultaneously in different competitive markets, they will trade for the same price in each market. This law is equivalent to saying that no arbitrage opportunities should exist. ◗ The price of a security should equal the present value of the expected future cash flows obtained from owning that security.	arbitrage, p. 81 arbitrage opportunity, p. 81 Law of One Price, p. 82 transactions costs, p. 83	MyFinanceLab Study Plan 3.6

Review Questions

1. What makes an investment decision a good one?
2. How important are our personal preferences in valuing an investment decision?
3. Why are market prices useful to a financial manager?
4. How does the Valuation Principle help a financial manager make decisions?
5. Can we directly compare dollar amounts received at different points in time?
6. How is the net present value decision rule related to cost-benefit analysis?
7. If there is more than one project to take, how should the financial manager choose among them?
8. What is the relation between arbitrage and the Law of One Price?

Problems

All problems in this chapter are available in MyFinanceLab. An asterisk (*) indicates problems with a higher level of difficulty.

Cost-Benefit Analysis

1. Honda Motor Company is considering offering a $2000 rebate on its minivan, lowering the vehicle's price from $30,000 to $28,000. The marketing group estimates that this rebate will increase sales over the next year from 40,000 to 55,000 vehicles. Suppose Honda's profit margin with the rebate is $6000 per vehicle. If the change in sales is the only consequence of this decision, what are its costs and benefits? Is it a good idea?
2. You are an international shrimp trader. A food producer in the Czech Republic offers to pay you 2 million Czech koruna today in exchange for a year's supply of frozen

shrimp. Your Thai supplier will provide you with the same supply for 3 million Thai baht today. If the current competitive market exchange rates are 25.50 koruna per dollar and 41.25 baht per dollar, what is the value of this deal?

3. Suppose your employer offers you a choice between a $5000 bonus and 100 shares of the company's stock. Whichever one you choose will be awarded today. The stock is currently trading for $63 per share.
   a. Suppose that if you receive the stock bonus, you are free to trade it. Which form of the bonus should you choose? What is its value?
   b. Suppose that if you receive the stock bonus, you are required to hold it for at least one year. What can you say about the value of the stock bonus now? What will your decision depend on?

Valuation Principle

4. Bubba is a shrimp farmer. In an ironic twist, Bubba is allergic to shellfish, so he cannot eat any shrimp. Each day he has a one-tonne supply of shrimp. The market price of shrimp is $10,000 per tonne.
   a. What is the value of a tonne of shrimp to him?
   b. Would this value change if he were not allergic to shrimp? Why or why not?
5. Brett has almond orchards, but he is sick of almonds and prefers to eat walnuts instead. The owner of the walnut orchard next door has offered to swap this year's crop with him in an even exchange. Assume he produces 1000 tonnes of almonds and his neighbour produces 800 tonnes of walnuts. If the market price of almonds is $100 per tonne and the market price of walnuts is $1.10 per tonne:
   a. Should he make the exchange?
   b. Does it matter whether he prefers almonds or walnuts? Why or why not?

The Time Value of Money and Interest Rates

6. You have $100 and a bank is offering 5% interest on deposits. If you deposit the money in the bank, how much will you have in one year?
7. You expect to have $1000 in one year. A bank is offering loans at 6% interest per year. How much can you borrow today?
8. A friend asks to borrow $55 from you and in return will pay you $58 in one year. If your bank is offering a 6% interest rate on deposits and loans:
   a. How much would you have in one year if you deposited the $55 instead?
   b. How much money could you borrow today if you pay the bank $58 in one year?
   c. Should you lend the money to your friend or deposit it in the bank?
9. Suppose the interest rate is 4%.
   a. Having $200 today is equivalent to having what amount in one year?
   b. Having $200 in one year is equivalent to having what amount today?
   c. Which would you prefer, $200 today or $200 in one year? Does your answer depend on when you need the money? Why or why not?

The *NPV* Decision Rule

10. Your storage firm has been offered $100,000 in one year to store some goods for one year. Assume your costs are $95,000, payable immediately, and the interest rate is 8%. Should you take the contract?
11. You run a construction firm. You have just won a contract to build a government office building. Building it will require an investment of $10 million today and $5 million in one year. The government will pay you $20 million in one year upon the building's completion. Suppose the interest rate is 10%.

a. What is the *NPV* of this opportunity?
b. How can your firm turn this *NPV* into cash today?

12. Your firm has identified three potential investment projects. The projects and their cash flows are shown here:

Project	Cash Flow Today ($)	Cash Flow in One Year ($)
A	−10.00	20.00
B	5.00	5.00
C	20.00	−10.00

Suppose all cash flows are certain and the interest rate is 10%.
a. What is the *NPV* of each project?
b. If the firm can choose only one of these projects, which should it choose?
c. If the firm can choose any two of these projects, which should it choose?

13. Your computer manufacturing firm must purchase 10,000 keyboards from a supplier. One supplier demands a payment of $100,000 today plus $10 per keyboard payable in one year. Another supplier will charge $21 per keyboard, also payable in one year. The interest rate is 6%.
a. What is the difference in their offers in terms of dollars today? Which offer should your firm take?
b. Suppose your firm does not want to spend cash today. How can it take the first offer and not spend $100,000 of its own cash today?

The Law of One Price

14. Suppose Bank One offers an interest rate of 5.5% on both savings and loans, and Bank Two offers an interest rate of 6% on both savings and loans.
a. What arbitrage opportunity is available?
b. Which bank would experience a surge in the demand for loans? Which bank would receive a surge in deposits?
c. What would you expect to happen to the interest rates the two banks are offering?

15. If the cost of buying a CD and ripping the tracks to your iPod (including your time) is $25, what is the most Apple could charge on iTunes for a whole 15-track CD?

16. Some companies cross-list their shares, meaning that their stock trades on more than one stock exchange. For example, Research In Motion, the maker of BlackBerry mobile devices, trades on both the TSE and NASDAQ. If its price in Toronto is 100 Canadian dollars per share and anyone can exchange Canadian dollars (CAD) for U.S. dollars (USD) at the rate of 0.95 USD/CAD, what must RIM's price be on NASDAQ?

***17.** Use the concept of arbitrage and the fact that interest rates are positive to prove that time travel will never be possible.