PART 2

Chapter 4

Financial Markets and Net Present Value: First Principles of Finance

EXECUTIVE SUMMARY

Finance refers to the process by which special markets deal with cash flows over time. These markets are called *financial markets.* Making investment and financing decisions requires an understanding of the basic economic principles of financial markets. This introductory chapter describes a financial market as one that makes it possible for individuals and corporations to borrow and lend. As a consequence, financial markets can be used by individuals to adjust their patterns of consumption over time and by corporations to adjust their patterns of investment spending over time. The main point of this chapter is that individuals and corporations can use the financial markets to help them make investment decisions. We introduce one of the most important ideas in finance: net present value.

By far the most important economic decisions are those that involve investments in real assets. We don't mean savings decisions, which are decisions not to consume some of this year's income, but decisions regarding actual investments: building a machine or a whole factory or a Tim Hortons, for example. These decisions determine the economic future for a society. Economists use the word *capital* to describe the total stock of machines and equipment that a society possesses and uses to produce goods and services. Investment decisions are decisions about whether or not to increase this stock of capital.

The investment decisions made today determine how much additional capital society will add to its current stock of capital. That capital then can be used in the future to produce goods and services for the society. Some of the forms that capital takes are obvious, like steel mills and computers. But many kinds of capital are things that you probably never would have considered as part of a country's capital stock. Public roads, for example, are a form of capital, and the decisions to build them are investment decisions. Perhaps most important, the decision you are making to invest in an education is no different in principle from these other investment decisions. Your decision to invest in education is a decision to build your human capital, just as a company's decision to build a new factory is a decision to invest in physical capital.[1] The total of all the capital possessed by a society is a measure of its wealth. The purpose of this chapter is to develop the basic principles that guide rational investment decision making. We show that a particular investment decision should be made if it is superior to available alternatives in the financial markets.

[1]If you have any doubt about the importance of human capital as part of a country's wealth, think about the conditions of Germany and Japan at the end of World War II. The physical capital of these countries had been destroyed, and even the basic social capital like roads, sewer systems, and factories was in rubble. Even though these countries might have appeared to be economically crippled beyond repair, a look below the surface would have revealed a different picture. A huge part of the wealth of these countries consisted of the human capital inherent in their literate and skilled populations. Building on this substantial base of capital by a long-term policy of investment has brought Germany and Japan to a very high standard of living.

4.1 The Financial Market Economy

Financial markets develop to facilitate borrowing and lending between individuals. Here we talk about how this happens. Suppose we describe the economic circumstances of two people: Tom and Leslie. Both Tom and Leslie have current income of $100,000. Tom is a very patient person, and some people call him a miser. He wants to consume only $50,000 of current income and save the rest. Leslie is a very impatient person, and some people call her extravagant. She wants to consume $150,000 this year. Tom and Leslie have different intertemporal consumption preferences.

Such preferences are personal matters and have more to do with psychology than with finance. However, it seems that Tom and Leslie could strike a deal: Tom could give up some of his income this year in exchange for future income that Leslie can promise to give him. Tom can *lend* $50,000 to Leslie, and Leslie can *borrow* $50,000 from Tom. This deal illustrates the useful role of financial markets in allowing borrowing and lending.

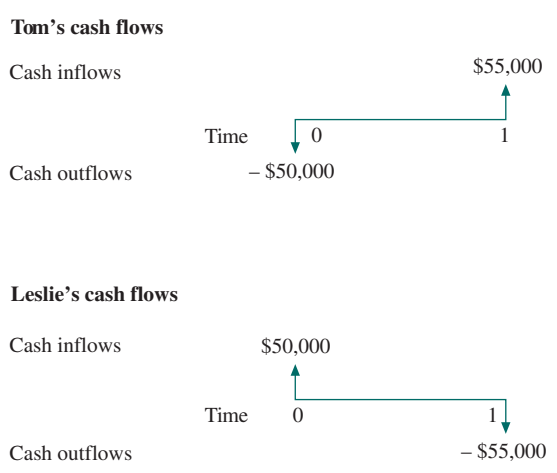
Suppose that they do strike this deal, with Tom giving up $50,000 this year in exchange for $55,000 next year. This is illustrated in Figure 4.1 with the basic cash flow time chart, a representation of the timing and amount of the cash flows. The cash flows that are received are represented by an arrow pointing up from the point on the time line at which the cash flow occurs. The cash flows paid out are represented by an arrow pointing down. In other words, for each dollar Tom trades away or lends, he gets a commitment to get it back as well as to receive 10 percent more.

In the language of finance, 10 percent is the annual rate of interest on the loan. When a dollar is lent out, the repayment of $1.10 can be thought of as being made up of two parts. First, the lender gets the dollar back; that is the *principal repayment.* Second, the lender receives an *interest payment,* which is $0.10 in this example.

Now, not only have Tom and Leslie struck a deal, but as a by-product of their bargain they have created a financial instrument, the IOU. This piece of paper entitles whoever receives it to present it to Leslie next year and redeem it for $55,000. Financial instruments that entitle whoever possesses them to receive payment are called *bearer instruments* because whoever bears them can use them. Presumably there could be more such IOUs in the economy written by many different lenders and borrowers like Tom and Leslie.

FIGURE 4.1

Tom's and Leslie's Cash Flows



The Anonymous Market

If the borrower does not care whom she has to pay back, and if the lender does not care whose IOUs he is holding, we could just as well drop Tom's and Leslie's names from their contract. All we need is a record book, in which we could record the fact that Tom has lent $50,000 and Leslie has borrowed $50,000 and that the terms of the loan, the interest rate, are 10 percent. Perhaps another person could keep the records for borrowers and lenders—for a fee, of course. In fact—and this is one of the virtues of such an arrangement—Tom and Leslie wouldn't even need to meet. Instead of needing to find and trade with each other, they could each trade with the recordkeeper. The recordkeeper could deal with thousands of such borrowers and lenders, none of whom would need to meet the other.

Institutions that perform this sort of market function, matching borrowers and lenders or traders, are called **financial intermediaries.** Chartered banks are modern examples of financial intermediaries. A bank's depositors lend the bank money, and the bank makes loans from the funds it has on deposit. In essence, the bank is an intermediary between the depositors and the ultimate borrowers. To make the market work, we must be certain that the market clears. By *market clearing* we mean that the total amount that people like Tom wish to lend to the market, say $11 million, equals the total amount that people like Leslie wish to borrow.

Market Clearing

If the lenders wish to lend more than the borrowers want to borrow, then presumably the interest rate is too high. Because there would not be enough borrowing for all of the lenders at, say, 15 percent, there are really only two ways that the market could be made to clear. One is to ration the lenders. For example, if the lenders wish to lend $20 million when interest rates are at 15 percent and the borrowers wish to borrow only $8 million, the market could take, say, 8/20 of each dollar, or $0.40, from each of the lenders and distribute it to the borrowers. This is one possible scheme for making the market clear, but it is not one that would be sustainable in a free and competitive marketplace. Why not?

To answer this important question, we return to our lender, Tom. Tom sees that interest rates are 15 percent and, not surprisingly, rather than simply lending the $50,000 that he was willing to lend when rates were 10 percent, Tom decides that at the higher rates he would like to lend more, say, $80,000. But since the lenders want to lend more money than the borrowers want to borrow, the recordkeepers tell Tom that they won't be able to take all of his $80,000; rather, they will take only 40 percent of it, or $32,000. With the interest rate at 15 percent, people are not willing to borrow enough to match up with all of the loans that are available at that rate.

Tom is not very pleased with that state of affairs, but he can do something to improve his situation. Suppose that he knows that Leslie is borrowing $20,000 in the market at the 15 percent interest rate. That means that Leslie must repay $20,000 on her loan next year plus the interest of 15 percent of $20,000, or $0.15 \times \$20{,}000 = \$3{,}000$. Suppose that Tom goes to Leslie and offers to lend her the $20,000 for 14 percent. Leslie is happy because she will save 1 percent on the deal and will need to pay back only $2,800 in interest next year. This is $200 less than if she had borrowed from the recordkeepers. Tom is happy, too, because he has found a way to lend some of the money that the recordkeepers would not take. The net result of this transaction is that the recordkeepers have lost Leslie as a customer. Why should she borrow from them when Tom will lend her the money at a lower interest rate?

Tom and Leslie are not the only ones cutting side deals in the marketplace, and it is clear that the recordkeepers will not be able to maintain the 15 percent rate. The interest rate must fall if they are to stay in business.

Suppose, then, that the market clears at the rate of 10 percent. At this rate the amount of money that the lenders wish to lend, $11 million, is exactly equal to the amount that the borrowers desire. We refer to the interest rate that clears the market, 10 percent in our example, as the **equilibrium rate of interest.**

In this section we have shown that, in the market for loans, bonds or IOUs are traded. These are *financial instruments.* The interest rate on these loans is such that the total demand for such loans by borrowers equals the total supply of loans by lenders. At a higher interest rate, lenders wish to supply more loans than are demanded, and if the interest rate is lower than this equilibrium level, borrowers demand more loans than lenders are willing to supply.

? Concept Questions

- **What is an interest rate?**
- **What do we mean when we say a market clears?**
- **What is an equilibrium rate of interest?**

4.2 Making Consumption Choices Over Time

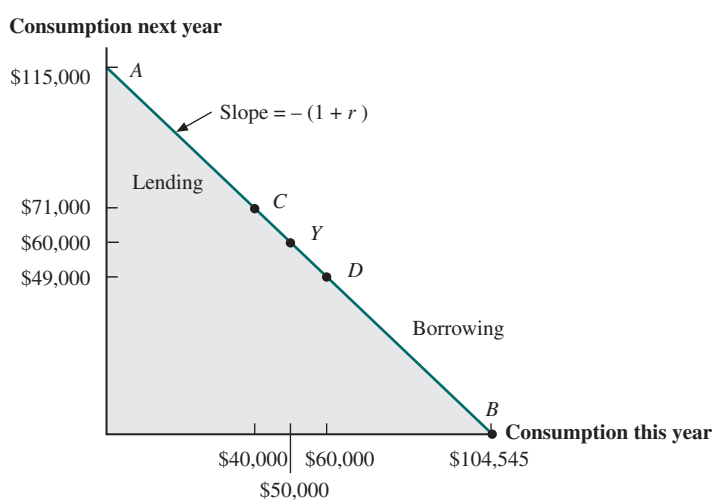
Figure 4.2 illustrates the situation faced by an individual in the financial market. This person is assumed to have an income of $50,000 this year and an income of $60,000 next year. The market allows him not only to consume $50,000 worth of goods this year and $60,000 next year, but also to borrow and lend at the equilibrium interest rate. The line *AB* in Figure 4.2 shows all of the consumption possibilities open to the person through borrowing or lending, and the shaded area contains all of the feasible choices. Notice that the lender chooses to consume less than $50,000 and the borrower more than this amount.

We will use the letter *r* to denote the interest rate—the equilibrium rate—in this market. The rate is risk-free because we assume that no default can take place. Look at point *A* on the vertical axis of Figure 4.2. Point *A* represents consumption next year (on the vertical axis) of:

$$A = \$60{,}000 + \$50{,}000 \times (1 + r)$$

FIGURE 4.2

Intertemporal Consumption Opportunities



For example, if the rate of interest is 10 percent, then point *A* is

$$\begin{aligned} A &= \$60{,}000 + \$50{,}000 \times (1 + 0.1) \\ &= \$60{,}000 + \$55{,}000 \\ &= \$115{,}000 \end{aligned}$$

Point *A* is the maximum amount of wealth that this person can spend in the second year. He gets to point *A* by lending the full income that is available this year, \$50,000, and consuming none of it. In the second year, then, he will have the second year's income of \$60,000 plus the proceeds from the loan that he made in the first year, \$55,000, for a total of \$115,000.

Following the same logic, point *B* is a distance of

$$B = \$50{,}000 + \$60{,}000/(1 + r)$$

along the horizontal axis. If the interest rate is 10 percent, point *B* will be

$$\begin{aligned} B &= \$50{,}000 + \$60{,}000/(1 + 0.1) \\ &= \$50{,}000 + \$54{,}545 \\ &= \$104{,}545 \text{ (rounded off to the nearest dollar)} \end{aligned}$$

Why do we divide next year's income of \$60,000 by $(1 + r)$ or 1.1 in the preceding computation? Point *B* represents the maximum amount available for this person to consume this year. To achieve that maximum he would borrow as much as possible and repay the loan from the income, \$60,000, that he was going to receive next year. Because \$60,000 will be available to repay the loan next year, we are asking how much he could borrow this year at an interest rate of *r* and still be able to repay the loan. The answer is

$$\$60{,}000/(1 + r)$$

because if he borrows this amount, he must repay it next year with interest. Thus, next year he must repay

$$[\$60{,}000/(1 + r)] \times (1 + r) = \$60{,}000$$

no matter what the interest rate, *r,* is. In our example we found that he could borrow \$54,545 and, sure enough,

$$\$54{,}545 \times 1.1 = \$60{,}000$$

(after rounding off to the nearest dollar).

Furthermore, by borrowing and lending different amounts, the person can achieve any point on the line *AB.* For example, at point *C* he has chosen to lend \$10,000 of today's income. This means that at point *C* he will have

$$\text{Consumption this year at point } C = \$50{,}000 - \$10{,}000 = \$40{,}000$$

and

$$\text{Consumption next year at point } C = \$60{,}000 + \$10{,}000 \times (1 + r) = \$71{,}000$$

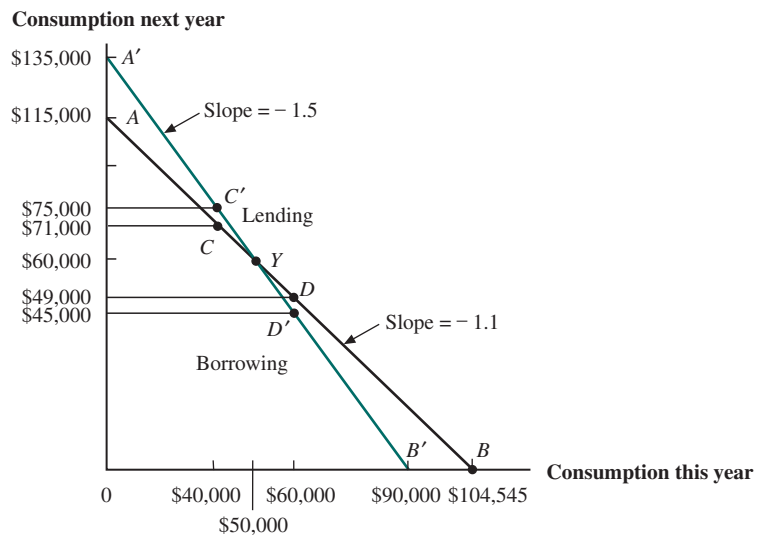
when the interest rate is 10 percent.

Similarly, at point *D,* the individual has decided to borrow \$10,000 and repay the loan next year. At point *D,* then,

$$\text{Consumption this year at point } C = \$50{,}000 + \$10{,}000 = \$60{,}000$$

FIGURE 4.3

The Effect of Different Interest Rates on Consumption Opportunities



and

$$\text{Consumption next year at point } D = \$60{,}000 - \$10{,}000 \times (1 + r) = \$49{,}000$$

at an interest rate of 10 percent.

In fact, this person can consume at any point on the line *AB*. This line has a slope of $-(1 + r)$, which means that, for each dollar that is added to the *x*-coordinate along the line, $(1 + r)$ dollars are subtracted from the *y*-coordinate. Moving along the line from point *A,* the initial point of $50,000 this year and $60,000 next year, toward point *B* gives the person more consumption today and less next year. In other words, moving toward point *B* is borrowing. Similarly, moving up toward point *A,* he is consuming less today and more next year and he is lending. The line is a straight line because the individual has no effect on the interest rate. This is one of the assumptions of perfectly competitive financial markets.

Where in Figure 4.2 will the person actually be? The answer to that question depends on the individual's tastes and personal situation, just as it did before there was a market. If the person is impatient, he might wish to borrow money at a point such as *D,* and if he is patient, he might wish to lend some of this year's income and enjoy more consumption next year at, for example, a point such as *C*.

Notice that whether we think of someone as patient or impatient depends on the interest rate he or she faces in the market. Suppose that our individual was impatient and chose to borrow $10,000 and move to point *D*. Now suppose that we raise the interest rate to 20 percent or even 50 percent. Suddenly our impatient person may become very patient and might prefer to lend some of this year's income to take advantage of the very high interest rate. The general result is depicted in Figure 4.3. We can see that lending at point C' yields much greater future income and consumption possibilities than before.[2]

? Concept Questions

- **How does an individual change consumption across periods through borrowing and lending?**
- **How do interest rate changes affect one's degree of impatience?**

[2]Those familiar with consumer theory might be aware of the surprising case where raising the interest rate actually makes people borrow more or lowering the rate makes them lend more. The latter case might occur, for example, if the decline in the interest rate made the lenders have so little consumption next year that they have no choice but to lend out even more than they did before, just to subsist. Nothing we do depends on excluding such cases, but it is much easier to ignore them, and the resulting analysis fits the real markets much more closely.

4.3 The Competitive Market

In the previous analysis we assumed the individual moves freely along the line *AB,* and we ignored—and assumed that the individual ignores—any effect his borrowing or lending decisions might have on the equilibrium interest rate itself. What would happen, though, if the total amount of loans outstanding in the market when the person was doing no borrowing or lending was $10 million, and if our person then decided to lend, say, $5 million? His lending would be half as much as the rest of the market put together, and it would not be unreasonable to think that the equilibrium interest rate would fall to induce more borrowers into the market to take his additional loans. In such a situation the person has some power in the market to influence the equilibrium rate significantly, and he would take this power into consideration in making his decisions.

In modern financial markets, however, the total amount of borrowing and lending is not $10 million; rather, as we say in Chapter 1, it is far higher. In such a huge market no one investor or even any single company can have a significant effect (although a government might). We assume, then, in all of our subsequent discussions and analyses that the financial market is perfectly competitive. By that we mean no individuals or firms think they have any effect whatsoever on the interest rates that they face no matter how much borrowing, lending, or investing they do. In the language of economics, individuals who respond to rates and prices by acting as though they have no influence on them are called *price takers,* and this assumption is sometimes called the *price-taking assumption.* It is the condition of **perfectly competitive financial markets** (or, more simply, *perfect markets*). The following conditions characterize perfect financial markets:

1. Trading is costless. Access to the financial markets is free.
2. Information about borrowing and lending opportunities is readily available.
3. There are many traders, and no single trader can have a significant impact on market prices.

In Chapter 14 we introduce the concept of efficient markets. Although efficient markets are less than perfectly competitive, available evidence suggests that most of the time, the three conditions above are a good approximation for financial markets.

How Many Interest Rates Are There in a Competitive Market?

An important point about this one-year market where no defaults can take place is that only one interest rate can be quoted in the market at any one time. Suppose that some competing recordkeepers decide to set up a rival market. To attract customers, their business plan is to offer lower interest rates, say, 9 percent, to attract borrowers away from the first market and soon have all of the business.

Their business plan will work, but it will do so beyond their wildest expectations. They will indeed attract the borrowers, all $11 million worth of them! But the matter doesn't stop there. By offering to borrow and lend at 9 percent when another market is offering 10 percent, they have created the proverbial money machine.

The world of finance is populated by sharp-eyed inhabitants who would not let this opportunity slip by them. Any one of these, whether a borrower or a lender, would go to the new market and borrow everything he could at the 9 percent rate. At the same time he was borrowing in the new market, he would also be striking a deal to lend in the old market at

the 10 percent rate. If he could borrow $100 million at 9 percent and lend it at 10 percent, he could net 1 percent, or $1 million, next year. He would repay the $109 million he owed to the new market from the $110 million he would receive when the 10 percent loan he had made in the original market was repaid, pocketing $1 million.

This process of striking a deal in one market and an offsetting deal in another simultaneously and at more favourable terms is called *arbitrage*; the individuals who do it are called *arbitrageurs.* Of course, someone must be paying for all of this free money, and it must be the recordkeepers because the borrowers and the lenders are all making money. Our intrepid, entrepreneurial recordkeepers will lose their proverbial shirts and go out of business. The moral of this is clear: As soon as different interest rates are offered for essentially the same risk-free loans, arbitrageurs will take advantage of the situation by borrowing at the low rate and lending at the high rate. The gap between the two rates will be closed quickly, and for all practical purposes there will be only one rate available in the market.

? Concept Questions

- **What is the most important feature of a competitive financial market?**
- **What conditions are likely to lead to this?**
- **What is arbitrage and why does it result in one rate for riskless loans?**

4.4 The Basic Principle

We have already shown how people use the financial markets to adjust their patterns of consumption over time to fit their particular preferences. By borrowing and lending, they can greatly expand their range of choices. They need only to have access to a market with an interest rate at which they can borrow and lend.

In the previous section we saw how these savings and consumption decisions depend on the interest rate. The financial markets also provide a benchmark against which proposed investments can be compared, and the interest rate is the basis for a test that any proposed investment must pass. The financial markets give the individual, the corporation, or even the government a standard of comparison for economic decisions. This benchmark is critical when investment decisions are being made.

The way we use the financial markets to aid us in making investment decisions is a direct consequence of our basic assumption that individuals can never be made worse off by increasing the range of choices open to them. People always can make use of the financial markets to adjust their savings and consumption by borrowing or lending. An investment project is worth undertaking only if it increases the range of choices in the financial markets. To do this, the project must be at least as desirable as what is available in the financial markets.[3] If it were not as desirable as what the financial markets have to offer, people could simply use the financial markets instead of undertaking the investment. This point will govern us in all of our investment decisions. It is the *first principle of investment decision making,* and it is the foundation on which all of our rules are built.

? Concept Questions

- **Describe the basic financial principle of investment decision making.**

[3]You might wonder what to do if an investment is exactly as desirable as an alternative in the financial markets. In principle, if there is a tie, it doesn't matter whether or not we take on the investment. In practice, we've never seen an exact tie.

4.5 Practising the Principle

Let us apply the basic principle of investment decision making to some concrete situations.

A Lending Example

Consider a person who is concerned only about this year and next. She has an income of $100,000 this year and expects to make the same amount next year. The interest rate is 10 percent. This individual is thinking about investing in a piece of land that costs $70,000. She is certain that next year the land will be worth $75,000, a sure $5,000 gain. Should she undertake the investment? This situation is described in Figure 4.4 with the cash flow time chart.

A moment's thought should be all it takes to convince her that this is not an attractive business deal. By investing $70,000 in the land, she will have $75,000 available next year. Suppose, instead, that she puts the same $70,000 into a loan in the financial market. At the 10 percent rate of interest, this $70,000 would grow to

$$(1 + 0.1) \times \$70{,}000 = \$77{,}000$$

next year.

It would be foolish to buy the land when the same $70,000 investment in the financial market would beat it by $2,000 (that is, $77,000 from the loan minus $75,000 from the land investment).

Figure 4.5 illustrates this situation. Notice that the $70,000 loan gives no less income today and $2,000 more next year. This example illustrates some amazing features of the financial markets. It is remarkable to consider all of the information that we did *not* use when arriving at the decision not to invest in the land. We did not need to know how much income the person has this year or next year. We also did not need to know whether the person preferred more income this year or next.

We did not need to know any of these other facts, and, more importantly, the person making the decision did not need to know them either. She only needed to be able to compare the investment with a relevant alternative available in the financial market. When the proposed investment fell short of that standard—by $2,000 in the previous example—regardless of what the individual wanted to do, she knew that she should not buy the land.

A Borrowing Example

Let us sweeten the deal a bit. Suppose that instead of being worth $75,000 next year, the land will be worth $80,000. What should our investor do now? This case is a bit more difficult. After all, even if the land seems like a good deal, this person's income this year is $100,000. Does she really want to make a $70,000 investment this year? Won't that leave only $30,000 for consumption?

The answers to these questions are yes, the individual should buy the land; yes, she does want to make a $70,000 investment this year; and, most surprising of all, even though

FIGURE 4.4
Cash Flows for Investment in Land

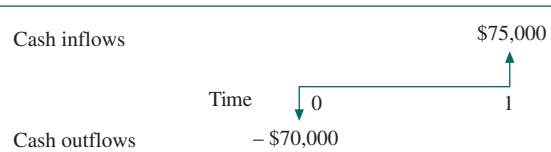
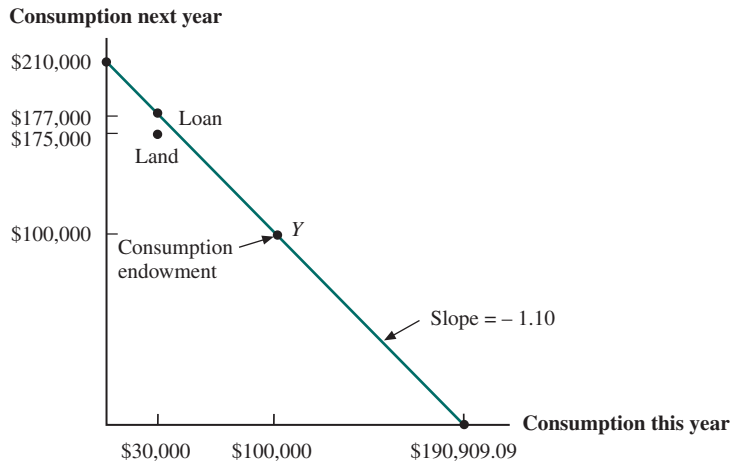


FIGURE 4.5

Consumption Opportunities with Borrowing and Lending



her income is $100,000, making the $70,000 investment will not leave her with $30,000 to consume this year! Now let us see how finance lets us get around the basic laws of arithmetic.

The financial markets are the key to solving our problem. First, the financial markets can be used as a standard of comparison against which any investment project must measure up. Second, they can be used as a tool to help the individual actually undertake investments. These twin features of the financial markets enable us to make the right investment decision.

Suppose that the person borrows the $70,000 initial investment that is needed to purchase the land. Next year she must repay this loan. Because the interest rate is 10 percent, she will owe the financial market $77,000 next year. This is depicted in Figure 4.6. Because

FIGURE 4.6

Cash Flows of Borrowing to Purchase the Land

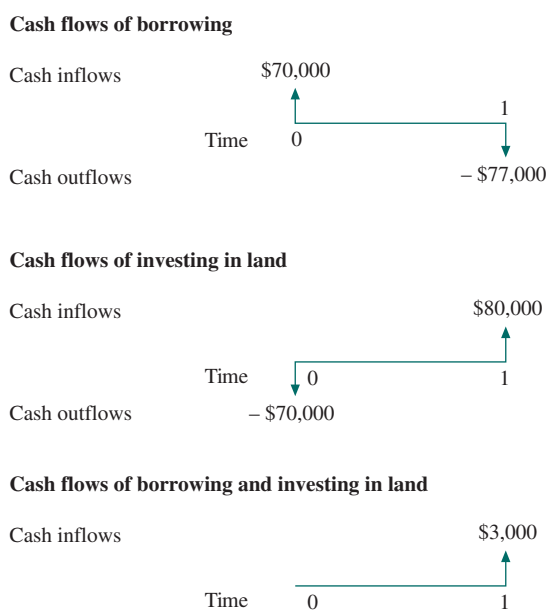
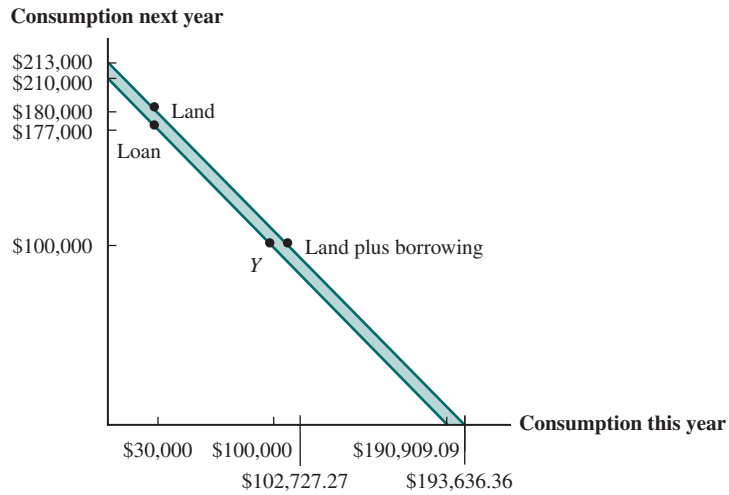


FIGURE 4.7

Consumption Opportunities with Investment Opportunity and Borrowing and Lending



the land will be worth $80,000 next year, she will be able to sell it, pay off her debt of $77,000, and have $3,000 extra cash.

If she wishes, this person can now consume an extra $3,000 worth of goods and services next year. This possibility is illustrated in Figure 4.7. In fact, even if she wants to do all of her consuming this year, she is still better off taking the investment. All she must do is take out a loan this year and repay it from the proceeds of the land next year and profit by $3,000.

Furthermore, instead of borrowing just the $70,000 that she needed to purchase the land, she could have borrowed $72,727.27. She could have used $70,000 to buy the land and consumed the remaining $2,727.27. We will call $2,727.27 the net present value of the transaction. Notice that it is equal to $3,000 × 1/1.1. How did we figure out that this was the exact amount that she could borrow? It was easy: If $72,727.27 is the amount that she borrows, then, because the interest rate is 10 percent, she must repay

$$\$72{,}727.27 \times (1 + 0.1) = \$80{,}000$$

next year, and that is exactly what the land will be worth. The line through the investment position in Figure 4.7 illustrates this borrowing possibility.

The amazing thing about both of these cases, one where the land is worth $75,000 next year and the other where it is worth $80,000 next year, is that we needed only to compare the investment with the financial markets to decide whether it was worth undertaking or not. This is one of the more important points in all of finance. It is true regardless of the consumption preferences of the individual. This is one of a number of *separation theorems* in finance. It states that the value of an investment to an individual is not dependent on consumption preferences. In our examples we showed that the person's decision to invest in land was not affected by consumption preferences. However, these preferences dictated whether the person borrowed or lent.

? Concept Questions

- **Describe how the financial markets can be used to evaluate investment alternatives.**
- **What is the separation theorem? Why is it important?**

4.6 Illustrating the Investment Decision

Figure 4.2, discussed earlier, describes the possibilities open to a person who has an income of $50,000 this year and $60,000 next year and faces a financial market in which the interest rate is 10 percent. But at that moment, the person has no investment possibilities beyond the 10 percent borrowing and lending that is available in the financial market.

Suppose that we give this person the chance to undertake an investment project that will require a $30,000 outlay of cash this year and that will return $40,000 to the investor next year. Refer to Figure 4.2 and determine how you could include this new possibility in that figure and how you could use the figure to help you decide whether to undertake the investment.

Now look at Figure 4.8. In Figure 4.8 we have labelled the original point with $50,000 this year and $60,000 next year as point *A*. We have also added a new point *B,* with $20,000 available for consumption this year and $100,000 next year. The difference between point *A* and point *B* is that at point *A* the person is just where we started him off, and at point *B* the person has also decided to undertake the investment project. As a result of this decision, the person at point *B* has

$$\$50{,}000 - \$30{,}000 = \$20{,}000$$

left for consumption this year, and

$$\$60{,}000 + \$40{,}000 = \$100{,}000$$

available next year. These are the coordinates of point *B*.

We must use our knowledge of the individual's borrowing and lending opportunities in order to decide whether to accept or reject the investment. This is illustrated in Figure 4.9. Figure 4.9 is similar to Figure 4.8, but in it we have drawn a line through point *A* that shows the possibilities open to the person if he stays at point *A* and does not take the investment. This line is exactly the same as the one in Figure 4.2. We have also drawn a parallel line through point *B* that shows the new possibilities that are available to the person if he undertakes the investment. The two lines are parallel because the slope of each is determined by the same interest rate, 10 percent. It does not matter whether the person takes the investment and goes to point *B* or does not and stays at point *A;* in the financial market, each dollar of lending is a dollar less available for consumption this year and moves him to the left by a dollar along the *x*-axis. Because the interest rate is 10 percent, the $1 loan repays $1.10 and it moves him up by $1.10 along the *y*-axis.

FIGURE 4.8

Consumption Choices with Investment Opportunities but No Financial Markets

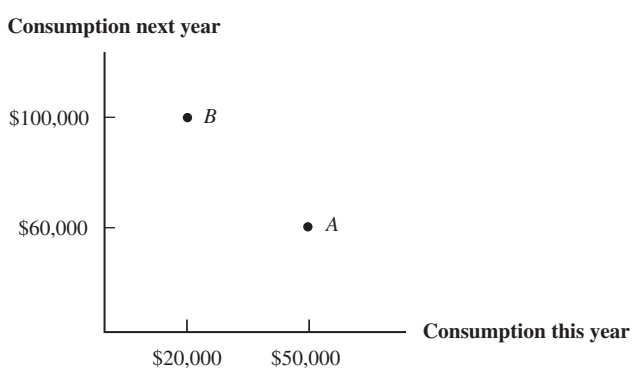
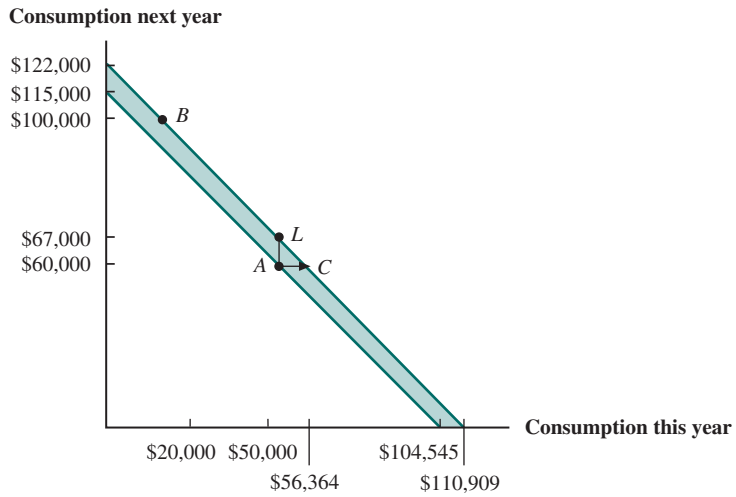


FIGURE 4.9

Consumption Choices with Investment Opportunities and Financial Markets



It is easy to see from Figure 4.9 that the investment has made the person better off. The line through point *B* is higher than the line through point *A*. Thus, no matter what pattern of consumption this person wanted this year and next, he could have more in each year if he undertook the investment.

For example, suppose that our individual wanted to consume everything this year. If he did not take the investment, the point where the line through point *A* intersected the *x*-axis would give the maximum amount of consumption he could enjoy this year—$104,545. To recall how we found this figure, review the analysis of Figure 4.2. But in Figure 4.9 the line that goes through point *B* intersects the *x*-axis at a higher point than the line that goes through point *A*. Along this line the person can have the $20,000 that is left after investing $30,000, plus all that he can borrow and repay with both next year's income and the proceeds from the investment. The total amount available to consume today is therefore

$$\$50{,}000 - \$30{,}000 + (\$60{,}000 + \$40{,}000)/(1 + 0.1)$$

$$= \$20{,}000 + \$100{,}000/(1.1)$$

$$= \$110{,}909$$

The additional consumption available this year from undertaking the investment and using the financial market is the difference on the *x*-axis between the points where these two lines intersect:

$$\$110{,}909 - \$104{,}545 = \$6{,}364$$

This difference is an important measure of what the investment is worth to the person. It answers a variety of questions. For example, it is the answer to the question: How much money would we need to give the investor this year to make him just as well off as he is with the investment?

Because the line through point *B* is parallel to the line through point *A* but has been moved over by $6,364, we know that if we were to add this amount to the investor's current income this year at point *A* and take away the investment, he would wind up on the line through point *B* and with the same possibilities. If we do this, the person will have $56,364 this year and $60,000 next year, which is the situation of the point on the line through point *B* that lies to the right of point *A* in Figure 4.9. This is point *C*.

We could also ask a different question: How much money would we need to give the investor next year to make him just as well off as he is with the investment?

This is the same as asking how much higher the line through point *B* is than the line through point *A*. In other words, what is the difference in Figure 4.9 between the point where the line through *A* intercepts the *y*-axis and the point where the line through *B* intercepts the *y*-axis?

The point where the line through *A* intercepts the *y*-axis shows the maximum amount the person could consume next year if all of his current income were lent out and the proceeds of the loan were consumed along with next year's income.

As we showed in our analysis of Figure 4.2, this amount is $115,000. How does this compare with what the person can have next year if he takes the investment? By taking the investment we saw that the person would be at point *B,* where he has $20,000 left this year and would have $100,000 next year. By lending the $20,000 that is left this year and adding the proceeds of this loan to the $100,000, we find the line through *B* intercepts the *y*-axis at

$$\$20{,}000 \times (1.1) + \$100{,}000 = \$122{,}000$$

The difference between this amount and $115,000 is

$$\$122{,}000 - \$115{,}000 = \$7{,}000$$

which is the answer to the question of how much we would need to give the person next year to make him as well off as he is with the investment.

There is a simple relationship between these two numbers. If we multiply $6,364 by 1.1 we get $7,000! Consider why this must be so. The $6,364 is the amount of extra cash we must give the person this year to substitute for having the investment. In a financial market with a 10 percent rate of interest, however, $1 this year is worth exactly the same as $1.10 next year. Thus, $6,364 this year is the same as $6,364 × 1.1 next year. In other words, the person does not care whether he has the investment, $6,364, this year or $6,364 × 1.1 next year. But we already showed that the investor is equally willing to have the investment and to have $7,000 next year. This must mean that

$$\$6{,}364 \times 1.1 = \$7{,}000$$

You can also verify this relationship between these two variables by using Figure 4.9. Because the lines through *A* and *B* have the same slope of −1.1, the difference of $7,000 between where they intersect on the *y*-axis and $6,364 between where they intersect on the *x*-axis must be in the ratio of 1.1 to 1.

Now we can show you how to evaluate the investment opportunity on a stand-alone basis. Here are the relevant facts: The individual must give up $30,000 this year to get $40,000 next year. These cash flows are illustrated in Figure 4.10.

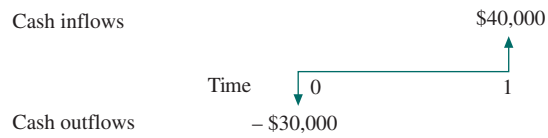
The investment rule that follows from the previous analysis is the net present value (NPV) rule. Here we convert all consumption values to the present and add them up:

$$\begin{aligned}\text{Net present value} &= -\$30{,}000 + \$40{,}000 \times (1/1.1)\\ &= -\$30{,}000 + \$36{,}364\\ &= \$6{,}364\end{aligned}$$

The future amount, $40,000, is called the *future value (FV).*

The net present value of an investment is a simple criterion for deciding whether or not to undertake it. NPV answers the question of how much cash an investor would need to have today as a substitute for making the investment. If the net present value is positive, the investment is worth taking on because doing so is essentially the same as receiving a

FIGURE 4.10
Cash Flows for the Investment Project



cash payment equal to the net present value. If the net present value is negative, taking on the investment today is equivalent to giving up some cash today, and the investment should be rejected.

We use the term *net present value* to emphasize that we are already including the current cost of the investment in determining its value and not simply measuring what it will return. For example, if the interest rate is 10 percent and an investment of $30,000 today will produce a total cash return of $40,000 in one year's time, the *present value* of the $40,000 by itself is

$$\$40{,}000/1.1 = \$36{,}364$$

but the *net present value* of the investment is $36,364 minus the original investment:

$$\text{Net present value} = \$36{,}364 - \$30{,}000 = \$6{,}364$$

The present value of a future cash flow is the value of that cash flow after considering the appropriate market interest rate. The net present value of an investment is the present value of the investment's future cash flows, minus the initial cost of the investment. We have just decided that our investment is a good opportunity. It has a positive net present value because it is worth more than it costs.

In general, the above can be stated in terms of the **net present value rule:**

> An investment is worth making if it has a positive NPV. If an investment's NPV is negative, it should be rejected.

? Concept Questions

- **Give the definitions of net present value, future value, and present value.**
- **What information does a person need to compute an investment's net present value?**

4.7 Corporate Investment Decision Making

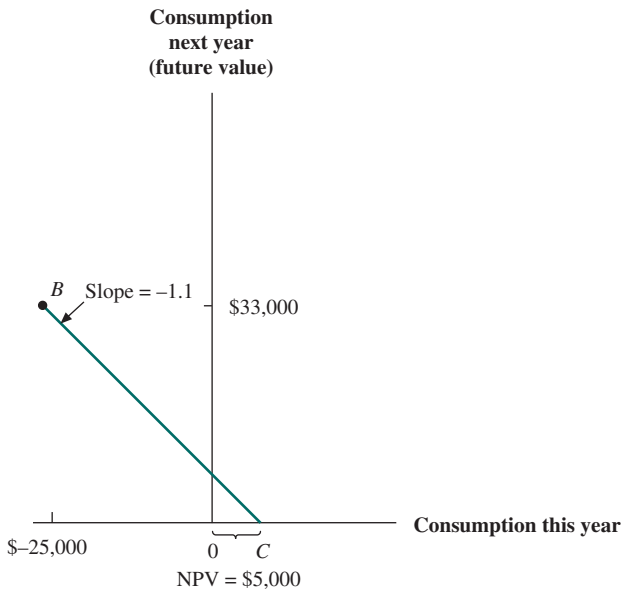
Up to now, everything we have done has been from the perspective of the individual investor. How do corporations and firms make investment decisions? Are their decisions governed by a much more complicated set of rules and principles than the simple NPV rule that we have developed for individuals?

We discussed corporate decision making, corporate governance, and stakeholder issues in Chapter 1 and will return to these issues later in the book. Still, it is remarkable how well our central ideas and the NPV rule hold up even when applied to corporations.

We may view firms as means by which many investors can pool their resources to make large-scale business decisions. Suppose, for example, that you own 1 percent of some firm. Now suppose further that this firm is considering whether or not to undertake some investment. If that investment passes the NPV rule, that is, if it has a positive NPV, then 1 percent of the NPV belongs to you. If the firm takes on this investment, the value of the whole firm will rise by the NPV and your investment in the firm will rise by 1 percent of the NPV of the investment. Similarly, the other shareholders in the firm will profit by having the firm take on the positive NPV project because the value of their shares in the firm will also

FIGURE 4.11

Consumption Choices, the NPV Rule, and the Corporation



increase. This means that the shareholders in the firm will be unanimous in wanting the firm to increase its value by taking on the positive NPV project. If you follow this line of reasoning, you will also be able to see why the shareholders would oppose the firm's taking on any projects with a negative NPV because this would lower the value of their shares.

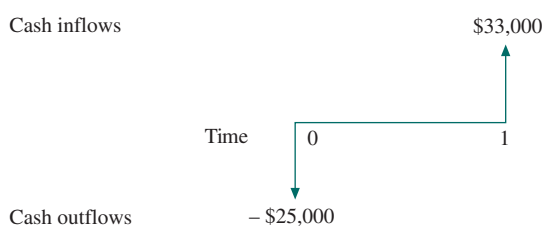
One difference between the firm and the individual is that the firm has no consumption endowment. In terms of our one-period consumption diagram, the firm starts at the origin. Figure 4.11 illustrates the situation of a firm with investment opportunity *B*. *B* is an investment that has a future value of $33,000 and will cost $25,000 now. If the interest rate is 10 percent, the NPV of *B* can be determined using the NPV rule. This is marked as point *C* in Figure 4.11. The cash flows of this investment are depicted in Figure 4.12.

One common objection to this line of reasoning is that people differ in their tastes and that they won't necessarily agree to take on or reject investments by the NPV rule. For instance, suppose that you and we each own some shares in a company. Further suppose that we are older than you and might be anxious to spend our money. Being younger, you might be more patient than we are and more willing to wait for a good long-term investment to pay off.

Because of the financial markets we all agree that the company should take on investments with positive NPVs and reject those with negative NPVs. If there were no financial markets, then, being impatient, we might want the company to do little or no investing so that we could have as much money as possible to consume now, and, being patient, you might prefer the company to make some investments. With financial markets, we are both satisfied by having the company follow the NPV rule.

FIGURE 4.12

Corporate Investment Cash Flows



To see why this is so, suppose that the company takes on a positive NPV investment. Let us assume that this investment has a net payoff of $1 million next year. That means that the value of the company will increase by $1 million next year; consequently, if you own 1 percent of the company's shares, the value of your shares will increase by 1 percent of $1 million, or $10,000, next year. Because you are patient, you might be prepared to wait for your $10,000 until next year. Being impatient, we do not want to wait—and with financial markets, we do not need to wait. We can simply borrow against the extra $10,000 we will have tomorrow and use the loan to consume more today.

In fact, if there is also a market for the firm's shares, we do not even need to borrow. After the company takes on a positive NPV investment, our shares in the company increase in value today. This is because owning the shares today entitles investors to their portion of the extra $1 million the company will have next year. This means that the shares would rise in value today by the present value of $1 million. Because you want to delay your consumption, you could wait until next year and sell your shares then to have extra consumption next year. Being impatient, we might sell our shares now and use the money to consume more today. If we owned 1 percent of the company's shares, we could sell our shares for an extra amount equal to the present value of $10,000.

In reality, shareholders in big companies do not vote on every investment decision, and their managers must have rules to follow. We have seen that all shareholders in a company will be made better off—no matter what their levels of patience or impatience—if managers follow the NPV rule. This is a marvellous result because it makes it possible for many different owners to delegate decision-making powers to the managers. They need only to tell the managers to follow the NPV rule, and if the managers do so, they will be doing exactly what the shareholders want them to do. Sometimes this form of the NPV rule is stated as having the managers maximize the value of the company. As we argued, the current value of the shares of the company will increase by the NPV of any investments that the company undertakes. This means that the managers of the company can make the shareholders as well off as possible by taking on all positive NPV projects and rejecting projects with negative NPVs.

Separating investment decision making from the owners is a basic requirement of the modern large firm. An important **separation theorem** in financial markets says that all investors will want to accept or reject the same investment projects by using the NPV rule, regardless of their personal preferences. Investors can delegate the operations of the firm and require that managers use the NPV rule. Of course, much remains for us to discuss about this topic. For example, what ensures that managers will actually do what is best for their shareholders?

We discussed this interesting topic in Chapter 1, and we take it up again later in the book. For now, though, we will no longer consider our perspective to be that of the lone investor. Instead, thanks to the separation theorem, we will use the NPV rule for companies as well as for investors. Our justification of the NPV rule depends on the conditions necessary to derive the separation theorem. These conditions are the ones that result in competitive financial markets. The analysis we have presented has been restricted to risk-free cash flows in one time period. However, the separation theorem also can be derived for risky cash flows that extend beyond one period.

For the reader interested in studying further about the separation theorem, we include several suggested readings at the end of this chapter that build on the material we have presented.

? Concept Questions

- **In terms of the net present value rule, what is the essential difference between the individual and the corporation?**

4.8 SUMMARY AND CONCLUSIONS

Finance is a subject that builds understanding from the ground up. Whenever you encounter a new problem or issue in finance, you can always return to the basic principles of this chapter for guidance.

1. Financial markets exist because people want to adjust their consumption over time. They do so by borrowing and lending.
2. Financial markets provide the key test for investment decision making. Whether a particular investment decision should or should not be taken depends only on this test: If there is a superior alternative in the financial markets, the investment should be rejected; if not, the investment is worth taking. The most important thing about this principle is that the investor need not use his preferences to decide whether the investment should be taken. Regardless of the individual's preference for consumption this year versus next, regardless of how patient or impatient the individual is, making the proper investment decision depends only on comparing it with the alternatives in the financial markets.
3. The net present value of an investment helps us make the comparison between the investment and the financial market. If the NPV is positive, our rule tells us to undertake the investment. This illustrates the second major feature of the financial markets and investment. Not only does the NPV rule tell us which investments to accept and which to reject, but the financial markets also provide us with the tools for acquiring the funds to make the investments. In short, we use the financial markets to decide both what to do and how to do it.
4. The NPV rule can be applied to corporations as well as to individuals. The separation theorem developed in this chapter says that all of the owners of the firm would agree that the firm should use the NPV rule even though each might differ in personal tastes for consumption and savings.

In the next chapter we learn more about the NPV rule by using it to examine a wide array of problems in finance.

KEY TERMS

Equilibrium rate of interest 78
Financial intermediaries 77
Net present value rule 89
Perfectly competitive financial market 81
Separation theorem 91

SUGGESTED READING

Two books that have good discussions of the consumption and savings decisions of individuals and the beginnings of financial markets are:

E. F. Fama and M. H. Miller. *The Theory of Finance.* Ch. 1. New York: Holt, Rinehart & Winston, 1971.

J. Hirshleifer. *Investment, Interest and Capital.* Ch. 1. Englewood Cliffs, N.J.: Prentice Hall, 1970.

The seminal work on the net present value rule is:

J. G. Fisher. *The Theory of Interest.* New York: Augustus M. Kelly, 1965. (This is a reprint of the 1930 edition.)

A rigorous treatment of the net present value rule along the lines of Irving Fisher can be found in:

J. Hirshleifer. "On the Theory of Optimal Investment Decision." *Journal of Political Economy* 66 (August 1958).

QUESTIONS & PROBLEMS

Making Consumption Choices

4.1 Currently, Jack Morris makes $85,000 per annum. Next year his income will be $108,000. Jack is a big spender and he wants to consume $135,000 a year. The equilibrium interest rate is 7 percent. What will be Jack's consumption potential next year if he consumes $135,000 this year?

4.2 Rich Pettit is a miser. His current income is $55,000; next year he will earn $38,000. He plans to consume only $20,000 this year. The current interest rate is 9 percent. What will Rich's consumption potential be next year?

The Competitive Market

4.3 What is the basic reason that financial markets develop?

4.4 Suppose that the equilibrium interest rate is 5.5 percent. What would happen in the market if a group of financial intermediaries attempted to control interest rates at 4 percent?

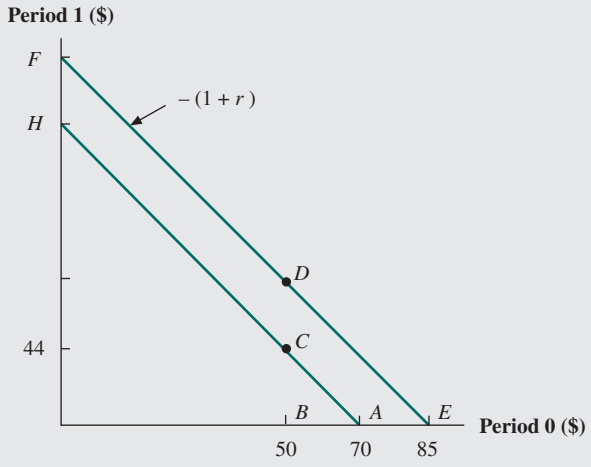
Illustrating the Investment Decision

4.5 The following figure depicts the financial situation of Ms. J. Fawn. In period 0 her labour income and current consumption are $50; later, in period 1, her labour income and consumption will be $44. She has an opportunity to make the investment represented by point *D*. By borrowing and lending, she will be able to reach any point along the line *FDE*.

a. What is the market rate of interest? (Hint: The new market interest rate line *EF* is parallel to *AH*.)

b. What is the NPV of point *D?*

c. If Ms. Fawn wishes to consume the same quantity in each period, how much should she consume in period 0?

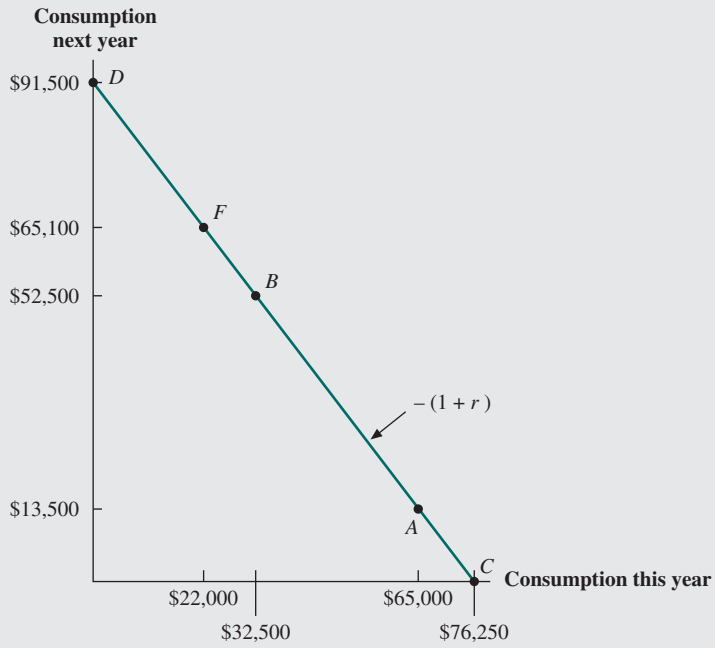


4.6 Enrique Rodrigues has $65,000 this year. He faces the investment opportunities represented by point *B* in the following figure. He wants to consume $22,000 this year and $69,000 next year. This pattern of consumption is represented by point *F*.

a. What is the market interest rate?

b. How much must Enrique invest in financial assets and productive assets today if he follows an optimum strategy?

c. What is the NPV of his investment in nonfinancial assets?



4.7 To answer this question, refer to the figure below. The Badvest Corporation is an all-equity firm with *BD* in cash on hand. It has an investment opportunity at point *C,* and it plans to invest *AD* in real assets today. Thus, the firm will need to raise *AB* by a new issue of equity.

a. What is the present value of the investment?

b. What is the rate of return on the old equity? Measure this rate of return from before the investment plans are announced to afterwards.

c. What is the rate of return on the new equity?