

6. Suppose Tiemo could pay \$5 billion per year. How long would it take to pay off the debt, assuming interest continued to be charged at 8.54% APY?
7. Suppose Tiemo could pay \$2 billion per year. How long would it take to pay off the debt, assuming interest continued to be charged at 8.54% APY?

*Postscript:* To the burghers' relief, the judgment was thrown out on appeal. This no doubt restored the confidence of the good burghers of Tiemo in the American system of justice!

## APPENDIX: THE THEORETICAL BASIS FOR THE NPV RULE

The NPV rule is based on how capital markets help allocate resources efficiently. The crucial variable is the "interest rate," which is often referred to as the opportunity cost of capital. The *opportunity cost of capital* is the price to "rent" money. It is the return the users of funds (for example, borrowers) must pay suppliers of funds (for example, lenders) for the use of their capital. The opportunity cost of capital is important, because it determines who will lend, who will borrow, and the amount of total capital supplied and used.

In Chapter 14, we will formally describe an environment called a *perfect capital market environment*. For now, think of a perfect capital market as a streamlined capital market that glosses over the complexities of real capital markets. In a perfect capital market environment, all prices are fair, so all financial assets have a zero NPV. The expected return of every financial asset equals its required return. Our analysis assumes that there is a single capital market where all users and suppliers of capital can make transactions.

We develop the concepts here as though there is a single opportunity cost of capital we call *the* interest rate. This unique rate is determined through competition among suppliers (lenders) and users (borrowers) of funds. It is the key to how the capital market allocates resources efficiently.

In practice, it seems as though there are many different rates. This is because each market return depends on the risk associated with it and on how long the money will be used. From the Principle of Risk-Return Trade-Off, we know that the higher the risk, the higher the required return. But such differences in risk and return do not affect value. That is the nature of the trade-off. Otherwise, if there were differences in value, there wouldn't be a trade-off—everyone would take the choice with the highest value and not the others. To avoid the complication created by risk-return trade-offs, our analysis assumes that all assets are riskless.

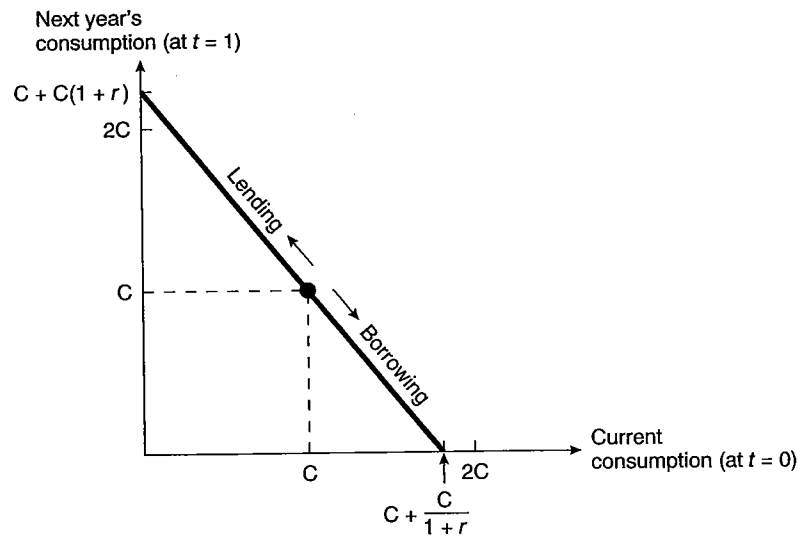
Concerning how long the money will be used, recall from our discussion of the term structure of interest rates in Chapter 3 that generally the longer the commitment, the higher the required return. Like differences in risk, differences in *maturity* lead to alternatives (trade-offs) that are equal in value. Therefore, our final simplifying assumption is that all assets last one year.

### *The Price of Impatience and the Value of Waiting*

If the interest rate is 10% per year and you lend \$10,000 today, you'll get \$11,000 (your principal plus \$1000 interest) one year from today. But if you lend the \$10,000 today, you can't spend it today. You give up that opportunity. In return for waiting a year, however, you'll be able to spend \$11,000, thereby getting an extra \$1000 to spend. In this sense, the 10% interest rate measures the *opportunity cost*. It is the price of impatience and the value of waiting.

Figure 4-A1 shows how the capital market allows people to trade off spending (consumption) now against spending (consumption) in the future. Suppose you have income of  $C$  today and  $C$  a year from today. Without a capital market, you could spend no more than  $C$  today, and no more than  $C$  a year from today, assuming there was no way to store any unused

Corporate Financial Management / Emery & Finnerty



**FIGURE 4-A1**  
All possible  
consumption  
(spending)  
combinations now  
and next year.

cash. Being so limited could be very inconvenient, especially if you didn't have a regular cash flow each year.

The capital market expands your choices between spending today and spending in the future. The line in Figure 4-A1 shows all the possible combinations of spending today (measured along the horizontal axis) and spending a year from today (measured along the vertical axis). The slope of the line is the rate at which you can trade off current consumption for future consumption, and vice versa. Mathematically, the slope equals  $-(1 + r)$ , where  $r$  is the interest rate. Given your income, you could spend  $C$  today and  $C$  next year (at  $t = 1$ ). Alternatively, you could lend your entire current income  $C$ , spend nothing today, and spend  $C + C(1 + r)$  next year. At the opposite extreme, you could borrow the present value of your future income,  $C/(1 + r)$ , spend  $C + C/(1 + r)$  today, and spend nothing next year. Of course, combinations along the line between these two extremes are also possible.

Here is an example to help you see the point. Suppose  $C = \$10,000$  and  $r = 10\%$ . You can spend  $\$10,000$  today and  $\$10,000$  next year if you don't borrow or lend. Alternatively, you can lend all of this year's income and get to spend  $\$21,000$  ( $10,000 + 11,000$ ) next year. At the other extreme, you can borrow  $\$9090.91$  ( $= 10,000/1.1$ ), spend  $\$19,090.91$  now, and have nothing to spend next year. By borrowing or lending, you can take any position along the line in Figure 4-A1.<sup>8</sup>

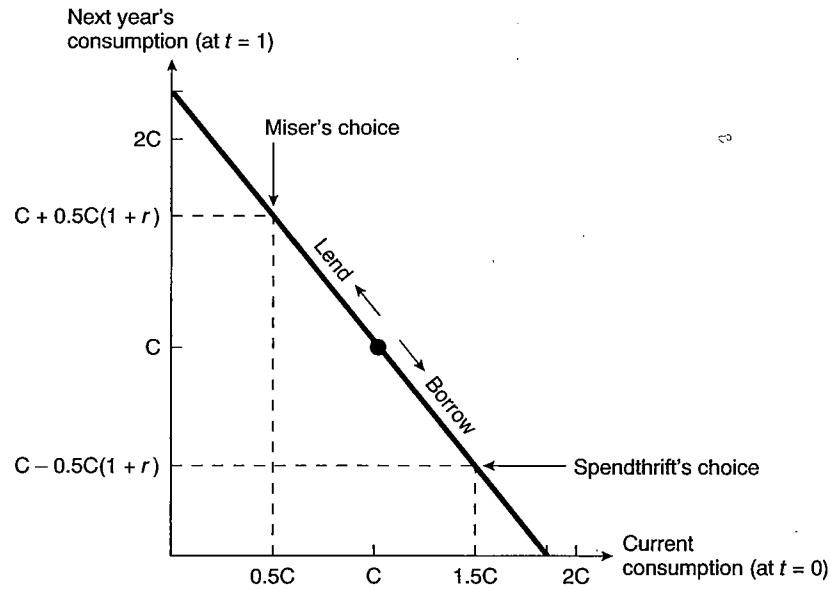
### Smoothing Consumption Patterns

People don't all have the same spending needs and preferences. The capital markets allow people to spend in whatever way they choose, within the limits of their income. In terms of Figure 4-A1, you can be anywhere along the line, but not above it, because you have only  $\$10,000$  per year of income.<sup>9</sup>

Consider two people with the same income  $C$  today and  $C$  next year (at  $t = 1$ ). Call them Miser and Spendthrift. Miser would like to spend  $0.5C$  today and  $C + 0.5C(1 + r)$  next year.

<sup>8</sup> Note that the slope of the line is  $-(1 + r) = -1.1$ , which equals  $-21,000/19,090.91$ .

<sup>9</sup> If you've had some economic theory, you may recognize the line in Figure 4-A1 as an individual's *consumption-possibilities curve*. We could superimpose an *indifference curve* to find the consumption point where the individual would be best off. This point is where the consumption-possibilities curve is tangent to the indifference curve. This is where the marginal rate of time preference (trading off spending now for spending in the future) equals the interest rate.



**FIGURE 4-A2**  
Miser's and Spendthrift's consumption (spending) choices.

How can she do this? She lends  $0.5C$  and gets back  $0.5C(1 + r)$  next year. Spendthrift, on the other hand, would like to spend  $1.5C$  today and  $C - 0.5C(1 + r)$  next year. Thus he borrows  $0.5C$  today but must pay back  $0.5C(1 + r)$  next year. Figure 4-A2 illustrates Miser's and Spendthrift's consumption (spending) choices.

The capital market lets all individuals have their own preferred spending pattern, within the limit of their total wealth.

### *All Possible Investment Opportunities*

Another way of viewing spending choices is to express them as capital market investment opportunities. By default, this year's spending is, in essence, an investment decision. The less you spend now, the more you invest, and the more you will have next year.

Figure 4-A3 shows the current decision as an investment decision. The line proceeding up and to the right from the origin is a line of all possible investment amounts. If you invest all your current income,  $C$ , then next year you will have the investment's future value,  $C(1 + r)$ . Likewise, an investment of  $0.5C$  will return  $0.5C(1 + r)$ , and so on. Thus this capital market investment-opportunities line has a slope of  $(1 + r)$ .

In addition to capital market investment opportunities, market participants can invest in real assets. Figure 4-A4 presents a real asset investment-opportunities curve, with the opportunities ranked by their expected return from largest to smallest. It shows the combinations of investment today and return next year to be had from investing in real assets.<sup>10</sup> Note that the real asset investment-opportunities curve in Figure 4-A4 is not a straight line. This is because of diminishing returns from investing in real assets. Recall the Principle of Valuable Ideas. Quite simply, some ideas create more value than others. In the extreme, some ideas are actually costly; they will not return enough to be worthwhile.

The opportunity to invest in real assets greatly expands the set of investment possibilities beyond those shown in Figure 4-A3. More significantly, comparing capital market and

<sup>10</sup> It might occur to you that the smoothness of the real asset investment-opportunities curve assumes that investment opportunities can be broken into "very small" pieces. That is, the curve isn't "lumpy" the way it would be if opportunities were large and indivisible, as they typically are.

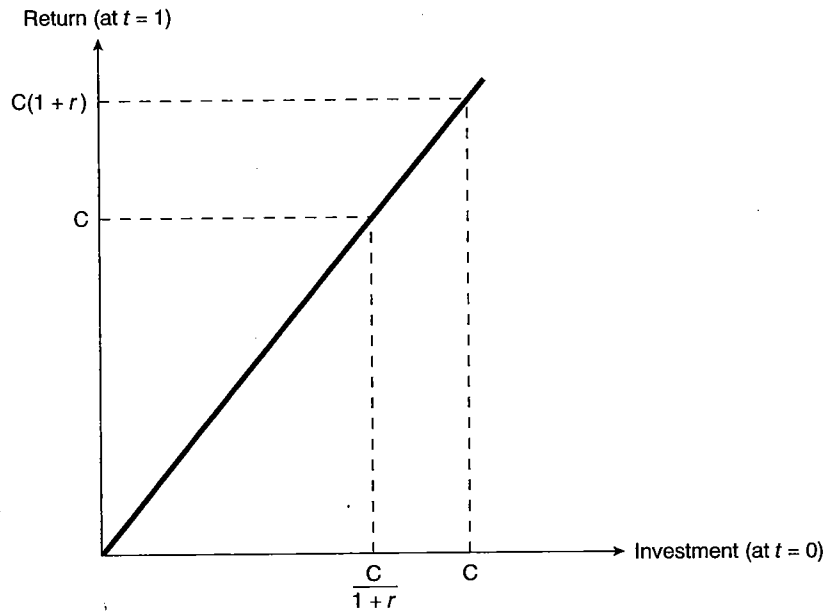


FIGURE 4-A3  
The capital market investment-opportunities line.

real asset investment opportunities simultaneously leads us to a very important result: a rule for choosing investments in real assets.

Because of self-interested behavior, people will invest in the most profitable real asset investment opportunity first, in the next most profitable opportunity second, and so on. In Figure 4-A4, the scale is represented in millions of dollars, so the first \$1 million of investment produces a return of \$2.5 million. Investing the second \$1 million produces a return of \$2.25 million. Investing additional \$1 million amounts would produce successively smaller returns. But how much should the *total* amount of investment be?

If you can earn  $r$  per period by investing in the capital market, why would you ever invest in a real asset investment opportunity of identical risk that returned less than  $r$ ? The an-

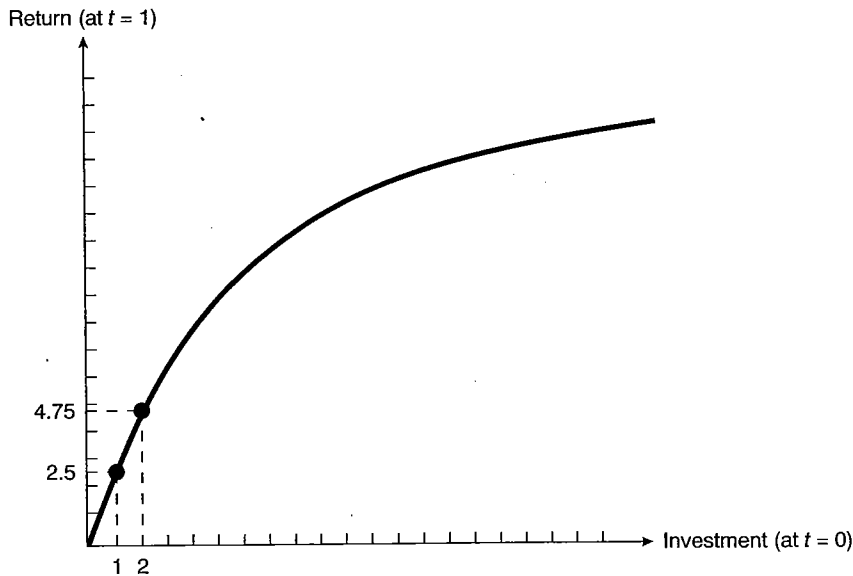


FIGURE 4-A4  
The real asset investment-opportunities curve (in millions of dollars).

