Investment, Strategy, and Economic Rents

Why is a manager who has learned about discounted cash flows (DCF) like a baby with a hammer? Answer: Because to a baby with a hammer, everything looks like a nail.

Our point is that you should not focus on the arithmetic of DCF and thereby ignore the forecasts that are the basis of every investment decision. Senior managers are continuously bombarded with requests for funds for capital expenditures. All these requests are supported with detailed DCF analyses showing that the projects have positive NPVs.[1] How, then, can managers distinguish the NPVs that are truly positive from those that are merely the result of forecasting errors? We suggest that they should ask some probing questions about the possible sources of economic gain.

To make good investment decisions, you need to understand your firm's competitive advantages. This is where corporate strategy and finance come together. Good strategy positions the firm to generate the most value from its assets and growth opportunities. The search for good strategy starts with understanding how your firm stacks up versus your competitors, and how they will respond to your initiatives. Are your cash-flow forecasts realistic in your competitive environment? What effects will your competitors' actions have on the NPVs of your investments?

The first section in this chapter reviews certain common pitfalls in capital budgeting, notably the tendency to apply DCF when market values are already available and no DCF calculations are needed. The second section covers the *economic rents* that underlie all positive-NPV investments. The third section presents a case study describing how Marvin Enterprises, the gargle blaster company, analyzed the introduction of a radically new product.

11-1 Look First to Market Values

Let us suppose that you have persuaded all your project sponsors to give honest forecasts. Although those forecasts are unbiased, they are still likely to contain errors, some positive and others negative. The average error will be zero, but that is little consolation because you want to accept only projects with *truly* superior profitability.

Think, for example, of what would happen if you were to jot down your estimates of the cash flows from operating various lines of business. You would probably find that about half *appeared* to have positive NPVs. This may not be because you personally possess any superior skill in operating jumbo jets or running a chain of laundromats but because you

[1] Here is another riddle. Are projects proposed because they have positive NPVs, or do they have positive NPVs because they are proposed? No prizes for the correct answer.

have inadvertently introduced large errors into your estimates of the cash flows. The more projects you contemplate, the more likely you are to uncover projects that *appear* to be extremely worthwhile.

What can you do to prevent forecast errors from swamping genuine information? We suggest that you begin by looking at market values.

The Cadillac and the Movie Star

The following parable should help to illustrate what we mean. Your local Cadillac dealer is announcing a special offer. For $55,001 you get not only a brand-new Cadillac but also the chance to shake hands with your favorite movie star. You wonder how much you are paying for that handshake.

There are two possible approaches to the problem. You could evaluate the worth of the Cadillac's overhead camshafts, disappearing windshield wipers, and other features and conclude that the Cadillac is worth $56,000. This would seem to suggest that the dealership is willing to pay $999 to have a movie star shake hands with you. Alternatively, you might note that the market price for Cadillacs is $55,000, so that you are paying $1 for the handshake. As long as there is a competitive market for Cadillacs, the latter approach is more appropriate.

Security analysts face a similar problem whenever they value a company's stock. They must consider the information that is already known to the market about a company, *and* they must evaluate the information that is known only to them. The information that is known to the market is the Cadillac; the private information is the handshake with the movie star. Investors have already evaluated the information that is generally known. Security analysts do not need to evaluate this information again. They can *start* with the market price of the stock and concentrate on valuing their private information.

While lesser mortals would instinctively accept the Cadillac's market value of $55,000, the financial manager is trained to enumerate and value all the costs and benefits from an investment and is therefore tempted to substitute his or her own opinion for the market's. Unfortunately this approach increases the chance of error. Many capital assets are traded in a competitive market, so it makes sense to *start* with the market price and then ask why these assets should earn more in your hands than in your rivals'.

EXAMPLE 11.1 ● Investing in a New Department Store

We encountered a department store chain that estimated the present value of the expected cash flows from each proposed store, including the price at which it could eventually sell the store. Although the firm took considerable care with these estimates, it was disturbed to find that its conclusions were heavily influenced by the forecasted selling price of each store. Management disclaimed any particular real estate expertise, but it discovered that its investment decisions were unintentionally dominated by its assumptions about future real estate prices.

Once the financial managers realized this, they always checked the decision to open a new store by asking the following question: "Let us assume that the property is fairly priced. What is the evidence that it is best suited to one of our department stores rather than to some other use?" In other words, *if an asset is worth more to others than it is to you, then beware of bidding for the asset against them.*

Let us take the department store problem a little further. Suppose that the new store costs \$100 million.[2] You forecast that it will generate after-tax cash flow of \$8 million a year for 10 years. Real estate prices are estimated to grow by 3% a year, so the expected value of the real estate at the end of 10 years is $100 \times (1.03)^{10} = \$134$ million. At a discount rate of 10%, your proposed department store has an NPV of \$1 million:

$$\text{NPV} = -100 + \frac{8}{1.10} + \frac{8}{(1.10)^2} + \cdots + \frac{8 + 134}{(1.10)^{10}} = \$1 \text{ million}$$

Notice how sensitive this NPV is to the ending value of the real estate. For example, an ending value of \$120 million implies an NPV of −\$5 million.

It is helpful to imagine such a business as divided into two parts—a real estate subsidiary that buys the building and a retailing subsidiary that rents and operates it. Then figure out how much rent the real estate subsidiary would have to charge, and ask whether the retailing subsidiary could afford to pay the rent.

In some cases a fair market rental can be estimated from real estate transactions. For example, we might observe that similar retail space recently rented for \$10 million a year. In that case we would conclude that our department store was an unattractive use for the site. Once the site had been acquired, it would be better to rent it out at \$10 million than to use it for a store generating only \$8 million.

Suppose, on the other hand, that the property could be rented for only \$7 million per year. The department store could pay this amount to the real estate subsidiary and still earn a net operating cash flow of $8 - 7 = \$1$ million. It is therefore the best *current* use for the real estate.[3]

Will it also be the best *future* use? Maybe not, depending on whether retail profits keep pace with any rent increases. Suppose that real estate prices and rents are expected to increase by 3% per year. The real estate subsidiary must charge $7 \times 1.03 = \$7.21$ million in year 2, $7.21 \times 1.03 = \$7.43$ million in year 3, and so on.[4] Figure 11.1 shows that the store's income fails to cover the rental after year 5.

If these forecasts are right, the store has only a five-year economic life; from that point on the real estate is more valuable in some other use. If you stubbornly believe that the department store is the best long-term use for the site, you must be ignoring potential growth in income from the store.[5]

There is a general point here as illustrated in Example 11.1. Whenever you make a capital investment decision, think what bets you are placing. Our department store example involved at least two bets—one on real estate prices and another on the firm's ability to run a successful department store. But that suggests some alternative strategies. For instance, it

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[2] For simplicity we assume the \$100 million goes entirely to real estate. In real life there would also be substantial investments in fixtures, information systems, training, and start-up costs.

[3] The fair market rent equals the profit generated by the real estate's *second*-best use.

[4] This rental stream yields a 10% rate of return to the real estate subsidiary. Each year it gets a 7% "dividend" and 3% capital gain. Growth at 3% would bring the value of the property to \$134 million by year 10.

The present value (at $r = .10$) of the growing stream of rents is

$$\text{PV} = \frac{7}{r - g} = \frac{7}{.10 - .03} = \$100 \text{ million}$$

This PV is the initial market value of the property.

[5] Another possibility is that real estate rents and values are expected to grow at less than 3% a year. But in that case the real estate subsidiary would have to charge more than \$7 million rent in year 1 to justify its \$100 million real estate investment (see footnote 4). That would make the department store even less attractive.

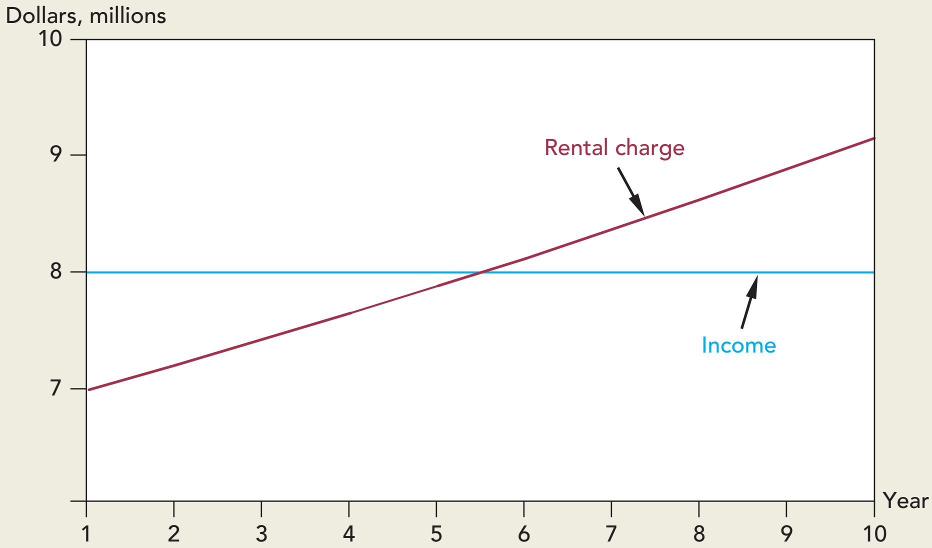

FIGURE 11.1

Beginning in year 6, the department store's income fails to cover the rental charge.

would be foolish to make a lousy department store investment just because you are optimistic about real estate prices. You would do better to buy real estate and rent it out to the highest bidders. The converse is also true. You shouldn't be deterred from going ahead with a profitable department store because you are pessimistic about real estate prices. You would do better to sell the real estate and *rent* it back for the department store. We suggest that you separate the two bets by first asking, "Should we open a department store on this site, assuming that the real estate is fairly priced?" and then deciding whether you also want to go into the real estate business.

Here is another example of how market prices can help you make better decisions, see below.

EXAMPLE 11.2 ● Opening a Gold Mine

Kingsley Solomon is considering a proposal to open a new gold mine. He estimates that the mine will cost $400 million to develop and that in each of the next 10 years it will produce .1 million ounces of gold at a cost, after mining and refining, of $480 an ounce. Although the extraction costs can be predicted with reasonable accuracy, Mr. Solomon is much less confident about future gold prices. His best guess is that the price will rise by 5% per year from its current level of $800 an ounce. At a discount rate of 10%, this gives the mine an NPV of −$70 million:

$$\begin{aligned} \text{NPV} &= -400 + \frac{.1(840 - 480)}{1.10} + \frac{.1(882 - 480)}{(1.10)^2} + \cdots + \frac{.1(1303 - 480)}{(1.10)^{10}} \\ &= -\$70 \text{ million} \end{aligned}$$

Therefore the gold mine project is rejected.

Unfortunately, Mr. Solomon did not look at what the market was telling him. What is the PV of an ounce of gold? Clearly, if the gold market is functioning properly, it is the current price—$800 an ounce. Gold does not produce any income, so $800 is the discounted value of the expected future gold price.[6] Since the mine is expected to produce a total of 1 million ounces (.1 million ounces per year for 10 years), the present value of the revenue stream is $1 \times 800 = \$800$ million.[7] We assume that 10% is an appropriate discount rate for the relatively certain extraction costs. Thus

$$\text{NPV} = -\text{initial investment} + \text{PV revenues} - \text{PV costs}$$
$$= -400 + 800 - \sum_{t=1}^{10} \frac{.1 \times 480}{(1.10)^t} = \$105 \text{ million}$$

It looks as if Kingsley Solomon's mine is not such a bad bet after all.[8]

Mr. Solomon's gold, in Example 11.2, was just like anyone else's gold. So there was no point in trying to value it separately. By taking the PV of the gold sales as given, Mr. Solomon was able to focus on the crucial issue: Were the extraction costs sufficiently low to make the venture worthwhile? That brings us to another of those fundamental truths: If others are producing a good or service profitably and (like Mr. Solomon) you can make it more cheaply, then you don't need any NPV calculations to know that you are probably onto a good thing.

We confess that our example of Kingsley Solomon's mine is somewhat special. Unlike gold, most commodities are not kept solely for investment purposes, and therefore you cannot automatically assume that today's price is equal to the present value of the future price.[9]

However, here is another way that you may be able to tackle the problem. Suppose that you are considering investment in a new copper mine and that someone offers to buy the

[6] Investing in an ounce of gold is like investing in a stock that pays no dividends: The investor's return comes entirely as capital gains. Look back at Section 4-2, where we showed that P_0, the price of the stock today, depends on DIV_1 and P_1, the expected dividend and price for next year, and the opportunity cost of capital r:

$$P_0 = \frac{\text{DIV}_1 + P_1}{1 + r}$$

But for gold $\text{DIV}_1 = 0$, so

$$P_0 = \frac{P_1}{1 + r}$$

In words, *today's price is the present value of next year's price.* Therefore, we don't have to know either P_1 or r to find the present value. Also since $\text{DIV}_2 = 0$,

$$P_1 = \frac{P_2}{1 + r}$$

and we can express P_0 as

$$P_0 = \frac{P_1}{1 + r} = \frac{1}{1 + r}\left(\frac{P_2}{1 + r}\right) = \frac{P_2}{(1 + r)^2}$$

In general,

$$P_0 = \frac{P_t}{(1 + r)^t}$$

This holds for any asset that pays no dividends, is traded in a competitive market, and costs nothing to store. Storage costs for gold or common stocks are very small compared to asset value.

We also assume that guaranteed future delivery of gold is just as good as having gold in hand today. This is not quite right. As we will see in Chapter 26, gold in hand can generate a small "convenience yield."

[7] We assume that the extraction rate does not vary. If it can vary, Mr. Solomon has a valuable operating option to increase output when gold prices are high or to cut back when prices fall. Option pricing techniques are needed to value the mine when operating options are important. See Chapter 22.

[8] As in the case of our department store example, Mr. Solomon is placing two bets: one on his ability to mine gold at a low cost and the other on the price of gold. Suppose that he really does believe that gold is overvalued. That should not deter him from running a low-cost gold mine as long as he can place separate bets on gold prices. For example, he might be able to enter into a long-term contract to sell the mine's output or he could sell gold futures. (We explain *futures* in Chapter 26.)

[9] A more general guide to the relationship of current and future commodity prices was proposed by Hotelling, who pointed out that if there are constant returns to scale in mining any mineral, the expected rise in the price of the mineral *less* extraction costs should equal the cost of capital. If the expected growth were faster, everyone would want to postpone extraction; if it were slower, everyone would want to exploit the resource today. For a review of Hotelling's principle, see S. Devarajan and A. C. Fisher, "Hotelling's 'Economics of Exhaustible Resources': Fifty Years Later," *Journal of Economic Literature* 19 (March 1981), pp. 65–73.

mine's future output at a fixed price. If you accept the offer—and the buyer is completely creditworthy—the revenues from the mine are certain and can be discounted at the risk-free interest rate.[10] That takes us back to Chapter 9, where we explained that there are two ways to calculate PV:

- Estimate the expected cash flows and discount at a rate that reflects the risk of those flows.
- Estimate what sure-fire cash flows would have the same values as the risky cash flows. Then discount these *certainty-equivalent* cash flows at the risk-free interest rate.

When you discount the fixed-price revenues at the risk-free rate, you are using the certainty-equivalent method to value the mine's output. By doing so, you gain in two ways: You don't need to estimate future mineral prices, and you don't need to worry about the appropriate discount rate for risky cash flows.

But here's the question: What is the minimum fixed price at which you could agree today to sell your future output? In other words, what is the certainty-equivalent price? Fortunately, for many commodities there is an active market in which firms fix today the price at which they will buy or sell copper and other commodities in the future. This market is known as the *futures market,* which we will cover in Chapter 26. Futures prices are certainty equivalents, and you can look them up in the daily newspaper. So you don't need to make elaborate forecasts of copper prices to work out the PV of the mine's output. The market has already done the work for you; you simply calculate future revenues using the price in the newspaper of copper futures and discount these revenues at the risk-free interest rate.

Of course, things are never as easy as textbooks suggest. Trades in organized futures exchanges are largely confined to deliveries over the next year or so, and therefore your newspaper won't show the price at which you could sell output beyond this period. But financial economists have developed techniques for using the prices in the futures market to estimate the amount that buyers would agree to pay for more-distant deliveries.[11]

Our two examples of gold and copper producers are illustrations of a universal principle of finance:

When you have the market value of an asset, *use it,* at least as a starting point in your analysis.

11-2 Economic Rents and Competitive Advantage

Profits that more than cover the cost of capital are known as *economic rents.* Economics 101 teaches us that in the long run competition eliminates economic rents. That is, in a long-run competitive equilibrium, no competitor can expand and earn more than the cost of capital on the investment. Economic rents are earned when an industry has not settled down to equilibrium or when your firm has something valuable that your competitors don't have.

Suppose that demand takes off unexpectedly and that your firm is well-placed to expand production capacity quicker and cheaper than your competitors. This stroke of luck is pretty sure to generate economic rents, at least temporarily as other firms struggle to catch up.

Some competitive advantages are longer lived. They include patents or proprietary technology; reputation, embodied in respected brand names, for example; economies of scale that customers can't match; protected markets that competitors can't enter; and strategic assets that competitors can't easily duplicate.

[10] We assume that the *volume* of output is certain (or does not have any market risk).

[11] After reading Chapter 26, check out E. S. Schwartz, "The Stochastic Behavior of Commodity Prices: Implications for Valuation and Hedging," *Journal of Finance* 52 (July 1997), pp. 923–973; and A. J. Neuberger, "Hedging Long-Term Exposures with Multiple Short-Term Contracts," *Review of Financial Studies* 12 (1999), pp. 429–459.

Here's an example of strategic assets. Think of the difference between railroads and trucking companies. It's easy to enter the trucking business but nearly impossible to build a brand-new, long-haul railroad.[12] The interstate lines operated by U.S. railroads are strategic assets. With these assets in place, railroads were able to increase revenues and profits rapidly from 2005 to 2007, when shipments surged and energy prices increased. The high cost of diesel fuel was more burdensome for trucks, which are less fuel efficient than railroads. Thus high energy prices actually handed the railroads a competitive advantage.

Corporate strategy aims to find and exploit sources of competitive advantage. The problem, as always, is how to do it. John Kay advises firms to pick out distinctive capabilities—existing strengths, not just ones that would be nice to have—and then to identify the product markets where the capabilities can generate the most value added. The capabilities may come from durable relationships with customers or suppliers, from the skills and experience of employees, from brand names and reputation, and from the ability to innovate.[13]

Michael Porter identifies five aspects of industry structure (or "five forces") that determine which industries are able to provide sustained economic rents.[14] These are the rivalry among existing competitors, the likelihood of new competition, the threat of substitutes, and the bargaining power both of suppliers and customers.

With increasing global competition, firms cannot rely so easily on industry structure to provide high returns. Therefore, managers also need to ensure that the firm is positioned *within* its industry so as to secure a competitive advantage. Michael Porter suggests three ways that this can be done—by cost leadership, by product differentiation, and by focus on a particular market niche.[15]

In today's world successful strategies that combine different mixes of cost leadership, product differentiation, and focus appear to be the key to developing a unique position in an industry.[16] Think, for example, of IKEA. It blends elements of all three strategies. It keeps costs low by manufacturing its furniture in low-cost countries and requiring customers to collect and assemble the furniture themselves. It differentiates itself by its distinctive Scandinavian design and by displaying all of its items in its warehouses. And it has a clear focus on a group of customers, who are typically young and price-conscious.

You can see how business strategy and finance reinforce each other. Managers who have a clear understanding of their firm's competitive strengths are better placed to separate those projects that truly have a positive NPV from those that do not. Therefore when you are presented with a project that appears to have a positive NPV, do not just accept the calculations at face value. They may reflect simple estimation errors in forecasting cash flows. Probe behind the cash-flow estimates, and *try to identify the source of economic rents.* A positive NPV for a new project is believable only if you believe that your company has some special advantage.

Thinking about competitive advantage can also help ferret out negative-NPV calculations that are negative by mistake. For example, if you are the lowest-cost producer of a profitable product in a growing market, then you should invest to expand along with the market. If your calculations show a negative NPV for such an expansion, then you have probably made a mistake.

We will work through shortly an extended example that shows how a firm's analysis of its competitive position confirmed that its investment had a positive NPV. But first we look at an example in which the analysis helped a firm to ferret out a negative-NPV transaction and avoid a costly mistake.

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[12] The Dakota, Minnesota & Eastern Railroad is proposing to build a new line to transport coal from Wyoming to the Midwest U.S., but construction would require government subsidies.

[13] John Kay, *Why Firms Succeed* (New York: Oxford University Press, 1995).

[14] See M. E. Porter, *Competitive Strategy: Techniques for Analyzing Industries and Competitors* (New York: The Free Press, 1980).

[15] See M. E. Porter, *Competitive Advantage: Creating and Sustaining Superior Advantage* (New York: The Free Press, 1985).

[16] R. M. Grant, *Contemporary Strategy Analysis,* 4th ed. (Oxford: Blackwell, 2002), p. 248.

EXAMPLE 11.3 ● How One Company Avoided a $100 Million Mistake

A U.S. chemical producer was about to modify an existing plant to produce a specialty product, polyzone, which was in short supply on world markets.[17] At prevailing raw material and finished-product prices the expansion would have been strongly profitable. Table 11.1 shows a simplified version of management's analysis. Note the assumed constant spread between selling price and the cost of raw materials. Given this spread, the resulting NPV was about $64 million at the company's 8% real cost of capital—not bad for a $100 million outlay.

Then doubt began to creep in. Notice the outlay for transportation costs. Some of the project's raw materials were commodity chemicals, largely imported from Europe, and much of the polyzone production would be exported back to Europe. Moreover, the U.S. company had no long-run technological edge over potential European competitors. It had a head start perhaps, but was that really enough to generate a positive NPV?

Notice the importance of the price spread between raw materials and finished product. The analysis in Table 11.1 forecasted the spread at a constant $1.20 per pound of polyzone for 10 years. That had to be wrong: European producers, who did not face the U.S. company's transportation costs, would see an even larger NPV and expand capacity. Increased competition would almost surely squeeze the spread. The U.S. company decided to calculate the *competitive* spread—the spread at which a European competitor would see polyzone capacity as zero NPV. Table 11.2 shows management's analysis. The resulting spread of about $.95 per pound was the best *long-run* forecast for the polyzone market, other things constant of course.

How much of a head start did the U.S. producer have? How long before competitors forced the spread down to $.95? Management's best guess was five years. It prepared Table 11.3, which is identical to Table 11.1 except for the forecasted spread, which would shrink to $.95 by the start of year 5. Now the NPV was negative.

The project might have been saved if production could have been started in year 1 rather than 2 or if local markets could have been expanded, thus reducing transportation costs. But these changes were not feasible, so management canceled the project, albeit with a sigh of relief that its analysis had not stopped at Table 11.1.

	Year 0	Year 1	Year 2	Years 3–10
Investment	100			
Production, millions of pounds per year[a]	0	0	40	80
Spread, $ per pound	1.20	1.20	1.20	1.20
Net revenues	0	0	48	96
Production costs[b]	0	0	30	30
Transport[c]	0	0	4	8
Other costs	0	20	20	20
Cash flow	−100	−20	−6	38
NPV (at r = 8%) = $63.56 million				

TABLE 11.1 NPV calculation for proposed investment in polyzone production by a U.S. chemical company (figures in $ millions except as noted).

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Note: For simplicity, we assume no inflation and no taxes. Plant and equipment have no salvage value after 10 years.
[a]Production capacity is 80 million pounds per year.
[b]Production costs are $.375 per pound after start up ($.75 per pound in year 2, when production is only 40 million pounds).
[c]Transportation costs are $.10 per pound to European ports.

[17] This is a true story, but names and details have been changed to protect the innocent.

	Year 0	Year 1	Year 2	Years 3–10
Investment	100			
Production, millions of pounds per year	0	0	40	80
Spread, $ per pound	.95	.95	.95	.95
Net revenues	0	0	38	76
Production costs	0	0	30	30
Transport	0	0	0	0
Other costs	0	20	20	20
Cash flow	−100	−20	−12	+26
NPV (at r = 8%) = 0				

TABLE 11.2 What is the competitive spread to a European producer? About $.95 per pound of polyzone. Note that European producers face no transportation costs. Compare Table 11.1 (figures in $ millions except as noted).

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	Year 0	Year 1	Year 2	Year 3	Year 4	Years 5–10
Investment	100					
Production, millions of pounds per year	0	0	40	80	80	80
Spread, $ per pound	1.20	1.20	1.20	1.20	1.10	0.95
Net revenues	0	0	48	96	88	76
Production costs	0	0	30	30	30	30
Transport	0	0	4	8	8	8
Other costs	0	20	20	20	20	20
Cash flow	−100	−20	−6	38	30	18
NPV (at r = 8%) = −9.8						

TABLE 11.3 Recalculation of NPV for polyzone investment by U.S. company (figures in $ millions except as noted). If expansion by European producers forces competitive spreads by year 5, the U.S. producer's NPV falls to –$9.8 million. Compare Table 11.1.

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This is a perfect example of the importance of thinking through sources of economic rents. Positive NPVs are suspect without some long-run competitive advantage. When a company contemplates investing in a new product or expanding production of an existing product, it should specifically identify its advantages or disadvantages over its most dangerous competitors. It should calculate NPV from those competitors' points of view. If competitors' NPVs come out strongly positive, the company had better expect decreasing prices (or spreads) and evaluate the proposed investment accordingly.

11-3 Marvin Enterprises Decides to Exploit a New Technology—an Example

To illustrate some of the problems involved in predicting economic rents, let us leap forward several years and look at the decision by Marvin Enterprises to exploit a new technology.[18]

One of the most unexpected developments of these years was the remarkable growth of a completely new industry. By 2032 annual sales of gargle blasters totaled $1.68 billion, or 240 million units. Although it controlled only 10% of the market, Marvin

[18] We thank Stewart Hodges for permission to adapt this example from a case prepared by him, and we thank the BBC for permission to use the term *gargle blasters*.

Enterprises was among the most exciting growth companies of the decade. Marvin had come late into the business, but it had pioneered the use of integrated microcircuits to control the genetic engineering processes used to manufacture gargle blasters. This development had enabled producers to cut the price of gargle blasters from $9 to $7 and had thereby contributed to the dramatic growth in the size of the market. The estimated demand curve in Figure 11.2 shows just how responsive demand is to such price reductions.

Table 11.4 summarizes the cost structure of the old and new technologies. While companies with the new technology were earning 20% on their initial investment, those with first-generation equipment had been hit by the successive price cuts. Since all Marvin's investment was in the 2028 technology, it had been particularly well placed during this period.

Rumors of new developments at Marvin had been circulating for some time, and the total market value of Marvin's stock had risen to $460 million by January 2033. At that point Marvin called a press conference to announce another technological breakthrough. Management claimed that its new third-generation process involving mutant neurons enabled the firm to reduce capital costs to $10 and manufacturing costs to $3 per unit. Marvin proposed to capitalize on this invention by embarking on a huge $1 billion expansion program that would add 100 million units to capacity. The company expected to be in full operation within 12 months.

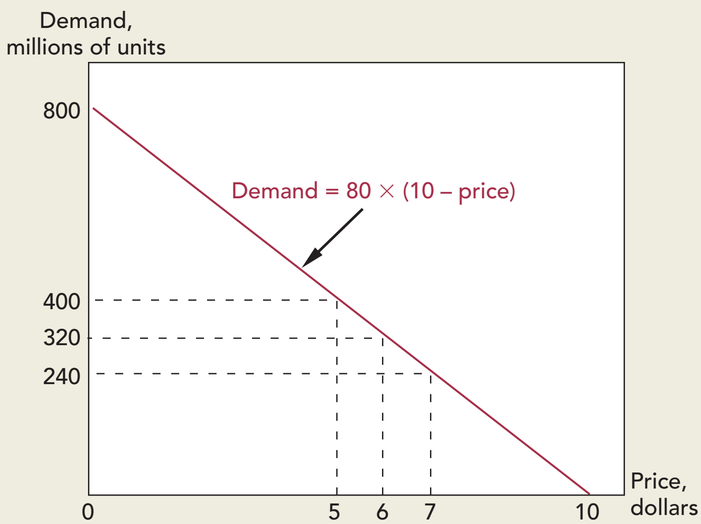


FIGURE 11.2

The demand "curve" for gargle blasters shows that for each $1 cut in price there is an increase in demand of 80 million units.

	Capacity, Millions of Units				
Technology	**Industry**	**Marvin**	**Capital Cost per Unit ($)**	**Manufacturing Cost per Unit ($)**	**Salvage Value per Unit ($)**
First generation (2020)	120	—	17.50	5.50	2.50
Second generation (2028)	120	24	17.50	3.50	2.50

TABLE 11.4 Size and cost structure of the gargle blaster industry before Marvin announced its expansion plans.

Note: Selling price is $7 per unit. One unit means one gargle blaster.

Before deciding to go ahead with this development, Marvin had undertaken extensive calculations on the effect of the new investment. The basic assumptions were as follows:

1. The cost of capital was 20%.
2. The production facilities had an indefinite physical life.
3. The demand curve and the costs of each technology would not change.
4. There was no chance of a fourth-generation technology in the foreseeable future.
5. The corporate income tax, which had been abolished in 2023, was not likely to be reintroduced.

Marvin's competitors greeted the news with varying degrees of concern. There was general agreement that it would be five years before any of them would have access to the new technology. On the other hand, many consoled themselves with the reflection that Marvin's new plant could not compete with an existing plant that had been fully depreciated.

Suppose that you were Marvin's financial manager. Would you have agreed with the decision to expand? Do you think it would have been better to go for a larger or smaller expansion? How do you think Marvin's announcement is likely to affect the price of its stock?

You have a choice. You can go on *immediately* to read *our* solution to these questions. But you will learn much more if you stop and work out your own answer first. Try it.

Forecasting Prices of Gargle Blasters

Up to this point in any capital budgeting problem we have always given you the set of cash-flow forecasts. In the present case you have to *derive* those forecasts.

The first problem is to decide what is going to happen to the price of gargle blasters. Marvin's new venture will increase industry capacity to 340 million units. From the demand curve in Figure 11.2, you can see that the industry can sell this number of gargle blasters only if the price declines to $5.75:

$$\begin{aligned}\text{Demand} &= 80 \times (10 - \text{price}) \\ &= 80 \times (10 - 5.75) = 340 \text{ million units}\end{aligned}$$

If the price falls to $5.75, what will happen to companies with the 2020 technology? They also have to make an investment decision: Should they stay in business, or should they sell their equipment for its salvage value of $2.50 per unit? With a 20% opportunity cost of capital, the NPV of staying in business is

$$\begin{aligned}\text{NPV} &= -\text{investment} + \text{PV}(\text{price} - \text{manufacturing cost}) \\ &= -2.50 + \frac{5.75 - 5.50}{.20} = -\$1.25 \text{ per unit}\end{aligned}$$

Smart companies with 2020 equipment will, therefore, see that it is better to sell off capacity. No matter what their equipment originally cost or how far it is depreciated, it is more profitable to sell the equipment for $2.50 per unit than to operate it and lose $1.25 per unit.

As capacity is sold off, the supply of gargle blasters will decline and the price will rise. An equilibrium is reached when the price gets to $6. At this point 2020 equipment has a zero NPV:

$$\text{NPV} = -2.50 + \frac{6.00 - 5.50}{.20} = \$0 \text{ per unit}$$

How much capacity will have to be sold off before the price reaches $6? You can check that by going back to the demand curve:

$$\begin{aligned}\text{Demand} &= 80 \times (10 - \text{price}) \\ &= 80 \times (10 - 6) = 320 \text{ million units}\end{aligned}$$

Therefore Marvin's expansion will cause the price to settle down at \$6 a unit and will induce first-generation producers to withdraw 20 million units of capacity.

But after five years Marvin's competitors will also be in a position to build third-generation plants. As long as these plants have positive NPVs, companies will increase their capacity and force prices down once again. A new equilibrium will be reached when the price reaches \$5. At this point, the NPV of new third-generation plants is zero, and there is no incentive for companies to expand further:

$$\text{NPV} = -10 + \frac{5.00 - 3.00}{.20} = \$0 \text{ per unit}$$

Looking back once more at our demand curve, you can see that with a price of \$5 the industry can sell a total of 400 million gargle blasters:

$$\text{Demand} = 80 \times (10 - \text{price}) = 80 \times (10 - 5) = 400 \text{ million units}$$

The effect of the third-generation technology is, therefore, to cause industry sales to expand from 240 million units in 2032 to 400 million five years later. But that rapid growth is no protection against failure. By the end of five years any company that has only first-generation equipment will no longer be able to cover its manufacturing costs and will be *forced* out of business.

The Value of Marvin's New Expansion

We have shown that the introduction of third-generation technology is likely to cause gargle blaster prices to decline to \$6 for the next five years and to \$5 thereafter. We can now set down the expected cash flows from Marvin's new plant:

	Year 0 (Investment)	Years 1–5 (Revenue – Manufacturing Cost)	Year 6, 7, 8, . . . (Revenue – Manufacturing Cost)
Cash flow per unit (\$)	–10	6 – 3 = 3	5 – 3 = 2
Cash flow, 100 million units (\$ millions)	–1,000	600 – 300 = 300	500 – 300 = 200

Discounting these cash flows at 20% gives us

$$\text{NPV} = -1{,}000 + \sum_{t=1}^{5} \frac{300}{(1.20)^t} + \frac{1}{(1.20)^5}\left(\frac{200}{.20}\right) = \$299 \text{ million}$$

It looks as if Marvin's decision to go ahead was correct. But there is something we have forgotten. When we evaluate an investment, we must consider *all* incremental cash flows. One effect of Marvin's decision to expand is to reduce the value of its existing 2028 plant. If Marvin decided not to go ahead with the new technology, the \$7 price of gargle blasters would hold until Marvin's competitors started to cut prices in five years' time. Marvin's decision, therefore, leads to an immediate \$1 cut in price. This reduces the present value of its 2028 equipment by

$$24 \text{ million} \times \sum_{t=1}^{5} \frac{1.00}{(1.20)^t} = \$72 \text{ million}$$

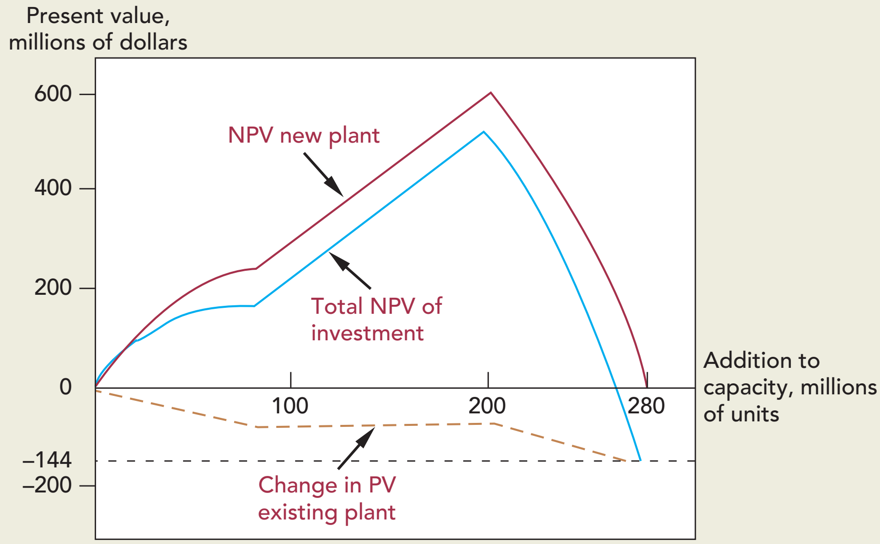
Considered in isolation, Marvin's decision has an NPV of \$299 million. But it also reduces the value of existing plant by \$72 million. The net present value of Marvin's venture is, therefore, 299 − 72 = \$227 million.

Alternative Expansion Plans

Marvin's expansion has a positive NPV, but perhaps Marvin would do better to build a larger or smaller plant. You can check that by going through the same calculations as above.

FIGURE 11.3

Effect on net present value of alternative expansion plans. Marvin's 100-million-unit expansion has a total NPV of $227 million (total NPV = NPV new plant + change in PV existing plant = 299 – 72 = 227). Total NPV is maximized if Marvin builds 200 million units of new capacity. If Marvin builds 280 million units of new capacity, total NPV is –$144 million.



First you need to estimate how the additional capacity will affect gargle blaster prices. Then you can calculate the net present value of the new plant and the change in the present value of the existing plant. The total NPV of Marvin's expansion plan is

$$\text{Total NPV} = \text{NPV of new plant} + \text{change in PV of existing plant}$$

We have undertaken these calculations and plotted the results in Figure 11.3. You can see how total NPV would be affected by a smaller or larger expansion.

When the new technology becomes generally available in 2038, firms will construct a total of 280 million units of new capacity.[19] But Figure 11.3 shows that it would be foolish for Marvin to go that far. If Marvin added 280 million units of new capacity in 2033, the discounted value of the cash flows from the new plant would be zero *and* the company would have reduced the value of its old plant by $144 million. To maximize NPV, Marvin should construct 200 million units of new capacity and set the price just below $6 to drive out the 2020 manufacturers. Output is, therefore, less and price is higher than either would be under free competition.[20]

The Value of Marvin Stock

Let us think about the effect of Marvin's announcement on the value of its common stock. Marvin has 24 million units of second-generation capacity. In the absence of any third-generation technology, gargle blaster prices would hold at $7 and Marvin's existing plant would be worth

$$\begin{aligned}\text{PV} &= 24 \text{ million} \times \frac{7.00 - 3.50}{.20} \\ &= \$420 \text{ million}\end{aligned}$$

[19] Total industry capacity in 2038 will be 400 million units. Of this, 120 million units are second-generation capacity, and the remaining 280 million units are third-generation capacity.

[20] Notice that we are assuming that all customers have to pay the same price for their gargle blasters. If Marvin could charge each customer the maximum price that that customer would be willing to pay, output would be the same as under free competition. Such direct price discrimination is illegal and in any case difficult to enforce. But firms do search for indirect ways to differentiate between customers. For example, stores often offer free delivery, which is equivalent to a price discount for customers who live at an inconvenient distance.

Marvin's new technology reduces the price of gargle blasters initially to $6 and after five years to $5. Therefore the value of existing plant declines to

$$\text{PV} = 24 \text{ million} \times \left[\sum_{t=1}^{5} \frac{6.00 - 3.50}{(1.20)^t} + \frac{5.00 - 3.50}{.20 \times (1.20)^5} \right]$$
$$= \$252 \text{ million}$$

But the *new* plant makes a net addition to shareholders' wealth of $299 million. So after Marvin's announcement its stock will be worth

$$252 + 299 = \$551 \text{ million}$$[21]

Now here is an illustration of something we talked about in Chapter 4: Before the announcement, Marvin's stock was valued in the market at $460 million. The difference between this figure and the value of the existing plant represented the present value of Marvin's growth opportunities (PVGO). The market valued Marvin's ability to stay ahead of the game at $40 million even before the announcement. After the announcement PVGO rose to $299 million.[22]

The Lessons of Marvin Enterprises

Marvin Enterprises may be just a piece of science fiction, but the problems that it confronts are very real. Whenever Intel considers developing a new microprocessor or Genzyme considers developing a new drug, these firms must face up to exactly the same issues as Marvin. We have tried to illustrate the *kind* of questions that you should be asking when presented with a set of cash-flow forecasts. Of course, no economic model is going to predict the future with accuracy. Perhaps Marvin can hold the price above $6. Perhaps competitors will not appreciate the rich pickings to be had in the year 2038. In that case, Marvin's expansion would be even more profitable. But would you want to bet $1 billion on such possibilities? We don't think so.

Investments often turn out to earn far more than the cost of capital because of a favorable surprise. This surprise may in turn create a temporary opportunity for further investments earning more than the cost of capital. But anticipated and more prolonged rents will naturally lead to the entry of rival producers. That is why you should be suspicious of any investment proposal that predicts a stream of economic rents into the indefinite future. Try to estimate *when* competition will drive the NPV down to zero, and think what that implies for the price of your product.

Many companies try to identify the major growth areas in the economy and then concentrate their investment in these areas. But the sad fate of first-generation gargle blaster manufacturers illustrates how rapidly existing plants can be made obsolete by changes in technology. It is fun being in a growth industry when you are at the forefront of the new technology, but a growth industry has no mercy on technological laggards.

Therefore, do not simply follow the herd of investors stampeding into high-growth sectors of the economy. Think of the fate of the dot.com companies in the "new economy" of the late 1990s. Optimists argued that the information revolution was opening up opportunities for companies to grow at unprecedented rates. The pessimists pointed out that competition in e-commerce was likely to be intense and that competition would ensure that the benefits of the information revolution would go largely to consumers. The Finance in Practice Box, which contains an extract from an article by Warren Buffett, emphasizes that rapid growth is no guarantee of superior profits.

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[21] To finance the expansion, Marvin is going to have to sell $1,000 million of new stock. Therefore the *total* value of Marvin's stock will rise to $1,551 million. But investors who put up the new money will receive shares worth $1,000 million. The value of Marvin's old shares after the announcement is therefore $551 million.

[22] The market value of Marvin stock will be greater than $551 million if investors expect the company to expand again within the five-year period. In other words, PVGO after the expansion may still be positive. Investors may expect Marvin to stay one step ahead of its competitors or to successfully apply its special technology in other areas.

FINANCE IN PRACTICE

Warren Buffett on Growth and Profitability

I thought it would be instructive to go back and look at a couple of industries that transformed this country much earlier in this century: automobiles and aviation. Take automobiles first: I have here one page, out of 70 in total, of car and truck manufacturers that have operated in this country. At one time, there was a Berkshire car and an Omaha car. Naturally I noticed those. But there was also a telephone book of others.

All told, there appear to have been at least 2,000 car makes, in an industry that had an incredible impact on people's lives. If you had foreseen in the early days of cars how this industry would develop, you would have said, "Here is the road to riches." So what did we progress to by the 1990s? After corporate carnage that never let up, we came down to three U.S. car companies—themselves no lollapaloozas for investors. So here is an industry that had an enormous impact on America—and also an enormous impact, though not the anticipated one, on investors. Sometimes, incidentally, it's much easier in these transforming events to figure out the losers. You could have grasped the importance of the auto when it came along but still found it hard to pick companies that would make you money. But there was one obvious decision you could have made back then—it's better sometimes to turn these things upside down—and that was to short horses. Frankly, I'm disappointed that the Buffett family was not short horses through this entire period. And we really had no excuse: Living in Nebraska, we would have found it super-easy to borrow horses and avoid a "short squeeze."

U.S. Horse Population
1900: 21 million
1998: 5 million

The other truly transforming business invention of the first quarter of the century, besides the car, was the airplane—another industry whose plainly brilliant future would have caused investors to salivate. So I went back to check out aircraft manufacturers and found that in the 1919–39 period, there were about 300 companies, only a handful still breathing today. Among the planes made then—we must have been the Silicon Valley of that age—were both the Nebraska and the Omaha, two aircraft that even the most loyal Nebraskan no longer relies upon.

Move on to failures of airlines. Here's a list of 129 airlines that in the past 20 years filed for bankruptcy. Continental was smart enough to make that list twice. As of 1992, in fact—though the picture would have improved since then—the money that had been made since the dawn of aviation by all of this country's airline companies was zero. Absolutely zero.

Sizing all this up, I like to think that if I'd been at Kitty Hawk in 1903 when Orville Wright took off, I would have been farsighted enough, and public-spirited enough—I owed this to future capitalists—to shoot him down. I mean, Karl Marx couldn't have done as much damage to capitalists as Orville did.

I won't dwell on other glamorous businesses that dramatically changed our lives but concurrently failed to deliver rewards to U.S. investors: the manufacture of radios and televisions, for example. But I will draw a lesson from these businesses: The key to investing is not assessing how much an industry is going to affect society, or how much it will grow, but rather determining the competitive advantage of any given company and, above all, the durability of that advantage. The products or services that have wide, sustainable moats around them are the ones that deliver rewards to investors.

Source: C. Loomis, "Mr. Buffett on the Stock Market," *Fortune* (November 22, 1999), pp. 110–115.

We do not wish to imply that good investment opportunities don't exist. For example, good opportunities frequently arise because the firm has invested money in the past, which gives it the option to expand cheaply in the future. Perhaps the firm can increase its output just by adding an extra production line, whereas its rivals would need to construct an entirely new factory.

Marvin also reminds us to include a project's impact on the rest of the firm when estimating incremental cash flows. By introducing the new technology immediately, Marvin reduced the value of its existing plant by $72 million.

Sometimes the losses on existing plants may completely offset the gains from a new technology. That is why we may see established, technologically advanced companies deliberately slowing down the rate at which they introduce new products. But this can be a dangerous game to play if it opens up opportunities for competitors. For example, for many years Bausch & Lomb was the dominant producer of contact lenses and earned large profits from glass contact lenses that needed to be sterilized every night. Because its existing business generated high returns, the company was slow to introduce disposable lenses. This delay opened up an opportunity for competitors and enabled Johnson & Johnson to introduce disposable lenses.

Marvin's economic rents were equal to the difference between its costs and those of the marginal producer. The costs of the marginal 2020-generation plant consisted of the manufacturing costs plus the opportunity cost of not selling the equipment. Therefore, if the salvage value of the 2020 equipment were higher, Marvin's competitors would incur higher costs and Marvin could earn higher rents. We took the salvage value as given, but it in turn depends on the cost savings from substituting outdated gargle blaster equipment for some other asset. In a well-functioning economy, assets will be used so as to minimize the *total* cost of producing the chosen set of outputs. The economic rents earned by any asset are equal to the total extra costs that would be incurred if that asset were withdrawn.

When Marvin announced its expansion plans, many owners of first-generation equipment took comfort in the belief that Marvin could not compete with their fully depreciated plant. Their comfort was misplaced. Regardless of past depreciation policy, it paid to scrap first-generation equipment rather than keep it in production. Do not expect that numbers in your balance sheet can protect you from harsh economic reality.

SUMMARY

All good financial managers want to find and undertake positive-NPV projects. They calculate NPVs carefully. But NPVs can be positive for two reasons: (1) The company really can expect to earn economic rents, or (2) there are biases or errors in cash-flow forecasts. Good managers are wary of these "false positives" and try to keep the odds stacked in their favor by investing in areas where the company has clear competitive advantages. They give careful attention to corporate strategy, which attempts to identify distinct capabilities and deploy them in markets where economic rents can be generated. They avoid expansion where competitive advantages are absent and economic rents are unlikely. They do not project favorable current product prices into the future without checking whether entry or expansion by competitors will drive future prices down.

Our story of Marvin Enterprises illustrates the origin of rents and how they determine a project's cash flows and net present value.

Any present value calculation, including our calculation for Marvin Enterprises, is subject to error. That's life: There's no other sensible way to value most capital investment projects. But some assets, such as gold, real estate, crude oil, ships, and airplanes, as well as financial assets, such as stocks and bonds, are traded in reasonably competitive markets. When you have the market value of such an asset, *use it,* at least as a starting point for your analysis.

FURTHER READING

The following papers discuss capital investment and strategy:

P. Barwise, P. Marsh, and R. Wensley, "Must Finance and Strategy Clash?" *Harvard Business Review,* September–October 1989, pp. 2–7.

M. Porter, "What Is Strategy?" *Harvard Business Review,* November–December 1996, pp. 61–78.

S. C. Myers, "Finance Theory and Financial Strategy," *Midland Corporate Finance Journal* 5 (Spring 1987), pp. 6–13. Reprinted from *Interfaces* (January–February 1984).

The following book describes how to identify economic rents and positive NPVs:

S. Woolley, *Sources of Value*, Cambridge University Press, 2009.

PROBLEM SETS

BASIC

1. True or false?

a. A firm that earns the opportunity cost of capital is earning economic rents.

b. A firm that invests in positive-NPV ventures expects to earn economic rents.

c. Financial managers should try to identify areas where their firms can earn economic rents, because it is there that positive-NPV projects are likely to be found.

d. Economic rent is the equivalent annual cost of operating capital equipment.

2. Demand for concave utility meters is expanding rapidly, but the industry is highly competitive. A utility meter plant costs $50 million to set up, and it has an annual capacity of 500,000 meters. The production cost is $5 per meter, and this cost is not expected to change. The machines have an indefinite physical life and the cost of capital is 10%. What is the competitive price of a utility meter?

a. $5

b. $10

c. $15

3. Your brother-in-law wants you to join him in purchasing a building on the outskirts of town. You and he would then develop and run a Taco Palace restaurant. Both of you are extremely optimistic about future real estate prices in this area, and your brother-in-law has prepared a cash-flow forecast that implies a large positive NPV. This calculation assumes sale of the property after 10 years.

What further calculations should you do before going ahead?

4. On the London Metals Exchange the price for copper to be delivered in one year is $3,450 a ton. (*Note:* Payment is made when the copper is delivered.) The risk-free interest rate is .5% and the expected market return is 8%.

a. Suppose that you expect to produce and sell 100,000 tons of copper next year. What is the PV of this output? Assume that the sale occurs at the end of the year.

b. If copper has a beta of 1.2, what is the expected price of copper at the end of the year? What is the certainty-equivalent price?

5. New-model commercial airplanes are much more fuel-efficient than older models. How is it possible for airlines flying older models to make money when its competitors are flying newer planes? Explain briefly.

INTERMEDIATE

6. Suppose that you are considering investing in an asset for which there is a reasonably good secondary market. Specifically, your company is Delta Airlines, and the asset is a Boeing

757—a widely used airplane. How does the presence of a secondary market simplify your problem in principle? Do you think these simplifications could be realized in practice? Explain.

7. There is an active, competitive leasing (i.e., rental) market for most standard types of commercial jets. Many of the planes flown by the major domestic and international airlines are not owned by them but leased for periods ranging from a few months to several years.

Gamma Airlines, however, owns two long-range DC-11s just withdrawn from Latin American service. Gamma is considering using these planes to develop the potentially lucrative new route from Akron to Yellowknife. A considerable investment in terminal facilities, training, and advertising will be required. Once committed, Gamma will have to operate the route for at least three years. One further complication: The manager of Gamma's international division is opposing commitment of the planes to the Akron–Yellowknife route because of anticipated future growth in traffic through Gamma's new hub in Ulan Bator.

How would you evaluate the proposed Akron–Yellowknife project? Give a detailed list of the necessary steps in your analysis. Explain how the airplane leasing market would be taken into account. If the project is attractive, how would you respond to the manager of the international division?

8. Suppose the current price of gold is $650 an ounce. Hotshot Consultants advises you that gold prices will increase at an average rate of 12% for the next two years. After that the growth rate will fall to a long-run trend of 3% per year. What is the price of 1 million ounces of gold produced in eight years? Assume that gold prices have a beta of 0 and that the risk-free rate is 5.5%.

9. We characterized the interstate rail lines owned by major U.S. railroads as "strategic assets" that generated increased profits from 2005 to 2007. In what conditions would you expect these assets to generate economic rents? Keep in mind that railroads compete with trucking companies as well as other railroads. Trucking companies have some advantages, including flexibility.

10. Thanks to acquisition of a key patent, your company now has exclusive production rights for barkelgassers (BGs) in North America. Production facilities for 200,000 BGs per year will require a $25 million immediate capital expenditure. Production costs are estimated at $65 per BG. The BG marketing manager is confident that all 200,000 units can be sold for $100 per unit (in real terms) until the patent runs out five years hence. After that the marketing manager hasn't a clue about what the selling price will be.

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What is the NPV of the BG project? Assume the real cost of capital is 9%. To keep things simple, also make the following assumptions:

- The technology for making BGs will not change. Capital and production costs will stay the same in real terms.
- Competitors know the technology and can enter as soon as the patent expires, that is, in year 6.
- If your company invests immediately, full production begins after 12 months, that is, in year 1.
- There are no taxes.
- BG production facilities last 12 years. They have no salvage value at the end of their useful life.

11. How would your answer to Problem 10 change if technological improvements reduce the cost of new BG production facilities by 3% per year?

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Thus a new plant built in year 1 would cost only 25 $(1 - .03)$ = $24.25 million; a plant built in year 2 would cost $23.52 million; and so on. Assume that production costs per unit remain at $65.

12. Go to the "live" Excel spreadsheets versions of Tables 11.1–11.3 at **www.mhhe.com/bma**. Reevaluate the NPV of the proposed polyzone project under each of the following assumptions. What's the right management decision in each case?

a. Spread in year 4 holds at $1.20 per pound.

b. The U.S. chemical company can start up polyzone production at 40 million pounds in year 1 rather than year 2.

c. The U.S. company makes a technological advance that reduces its annual production costs to $25 million. Competitors' production costs do not change.

13. Photographic laboratories recover and recycle the silver used in photographic film. Stikine River Photo is considering purchase of improved equipment for their laboratory at Telegraph Creek. Here is the information they have:

- The equipment costs $100,000 and will cost $80,000 per year to run.
- It has an economic life of 10 years but can be depreciated over five years by the straight-line method (see Section 6-2).
- It will recover an additional 5,000 ounces of silver per year.
- Silver is selling for $20 per ounce. Over the past 10 years, the price of silver has appreciated by 4.5% per year in real terms. Silver is traded in an active, competitive market.
- Stikine's marginal tax rate is 35%. Assume U.S. tax law.
- Stikine's company cost of capital is 8% in real terms.
- The nominal interest rate is 6%.

What is the NPV of the new equipment? Make additional assumptions as necessary.

14. The Cambridge Opera Association has come up with a unique door prize for its December (2013) fund-raising ball: Twenty door prizes will be distributed, each one a ticket entitling the bearer to receive a cash award from the association on December 31, 2014. The cash award is to be determined by calculating the ratio of the level of the Standard and Poor's Composite Index of stock prices on December 31, 2014, to its level on June 30, 2014, and multiplying by $100. Thus, if the index turns out to be 1,000 on June 30, 2014, and 1,200 on December 31, 2014, the payoff will be 100 × (1,200/1,000) = $120.

After the ball, a black market springs up in which the tickets are traded. What will the tickets sell for on January 1, 2014? On June 30, 2014? Assume the risk-free interest rate is 10% per year. Also assume the Cambridge Opera Association will be solvent at year-end 2014 and will, in fact, pay off on the tickets. Make other assumptions as necessary.

Would ticket values be different if the tickets' payoffs depended on the Dow Jones Industrial index rather than the Standard and Poor's Composite?

15. You are asked to value a large building in northern New Jersey. The valuation is needed for a bankruptcy settlement. Here are the facts:

- The settlement *requires* that the building's value equal the PV of the *net cash proceeds* the railroad would receive if it cleared the building and sold it for its highest and best nonrailroad use, which is as a warehouse.
- The building has been appraised at $1 million. This figure is based on actual recent selling prices of a sample of similar New Jersey buildings used as, or available for use as, warehouses.
- If rented today as a warehouse, the building could generate $80,000 per year. This cash flow is calculated *after* out-of-pocket operating expenses and *after* real estate taxes of $50,000 per year:

Gross rents	$180,000
Operating expenses	50,000
Real estate taxes	50,000
Net	$80,000

Gross rents, operating expenses, and real estate taxes are uncertain but are expected to grow with inflation.

- However, it would take one year and $200,000 to clear out the railroad equipment and prepare the building for use as a warehouse. The $200,000 would have to be invested immediately.
- The property will be put on the market when ready for use as a warehouse. Your real estate adviser says that properties of this type take, on average, one year to sell after they are put on the market. However, the railroad could rent the building as a warehouse while waiting for it to sell.
- The opportunity cost of capital for investment in real estate is 8% in *real* terms.
- Your real estate adviser notes that selling prices of comparable buildings in northern New Jersey have declined, in real terms, at an average rate of 2% per year over the last 10 years.
- A 5% sales commission would be paid by the railroad at the time of the sale.
- The railroad pays no income taxes. It would have to pay property taxes.

CHALLENGE

16. The manufacture of polysyllabic acid is a competitive industry. Most plants have an annual output of 100,000 tons. Operating costs are $.90 a ton, and the sales price is $1 a ton. A 100,000-ton plant costs $100,000 and has an indefinite life. Its current scrap value of $60,000 is expected to decline to $57,900 over the next two years.

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Phlogiston, Inc., proposes to invest $100,000 in a plant that employs a new low-cost process to manufacture polysyllabic acid. The plant has the same capacity as existing units, but operating costs are $.85 a ton. Phlogiston estimates that it has two years' lead over each of its rivals in use of the process but is unable to build any more plants itself before year 2. Also it believes that demand over the next two years is likely to be sluggish and that its new plant will therefore cause temporary overcapacity.

You can assume that there are no taxes and that the cost of capital is 10%.

a. By the end of year 2, the prospective increase in acid demand will require the construction of several new plants using the Phlogiston process. What is the likely NPV of such plants?

b. What does that imply for the price of polysyllabic acid in year 3 and beyond?

c. Would you expect existing plant to be scrapped in year 2? How would your answer differ if scrap value were $40,000 or $80,000?

d. The acid plants of United Alchemists, Inc., have been fully depreciated. Can it operate them profitably after year 2?

e. Acidosis, Inc., purchased a new plant last year for $100,000 and is writing it down by $10,000 a year. Should it scrap this plant in year 2?

f. What would be the NPV of Phlogiston's venture?

17. The world airline system is composed of the routes X and Y, each of which requires 10 aircraft. These routes can be serviced by three types of aircraft—A, B, and C. There are 5 type A aircraft available, 10 type B, and 10 type C. These aircraft are identical except for their operating costs, which are as follows:

	Annual Operating Cost ($ millions)	
Aircraft Type	**Route X**	**Route Y**
A	1.5	1.5
B	2.5	2.0
C	4.5	3.5

The aircraft have a useful life of five years and a salvage value of $1 million.

The aircraft owners do not operate the aircraft themselves but rent them to the operators. Owners act competitively to maximize their rental income, and operators attempt to minimize their operating costs. Airfares are also competitively determined. Assume the cost of capital is 10%.

a. Which aircraft would be used on which route, and how much would each aircraft be worth?
b. What would happen to usage and prices of each aircraft if the number of type A aircraft increased to 10?
c. What would happen if the number of type A aircraft increased to 15?
d. What would happen if the number of type A aircraft increased to 20?

State any additional assumptions you need to make.

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18. Taxes are a cost, and, therefore, changes in tax rates can affect consumer prices, project lives, and the value of existing firms. The following problem illustrates this. It also illustrates that tax changes that appear to be "good for business" do not always increase the value of existing firms. Indeed, unless new investment incentives increase consumer demand, they can work only by rendering existing equipment obsolete.

The manufacture of bucolic acid is a competitive business. Demand is steadily expanding, and new plants are constantly being opened. Expected cash flows from an investment in a new plant are as follows:

	0	1	2	3
1. Initial investment	100			
2. Revenues		100	100	100
3. Cash operating costs		50	50	50
4. Tax depreciation		33.33	33.33	33.33
5. Income pretax		16.67	16.67	16.67
6. Tax at 40%		6.67	6.67	6.67
7. Net income		10	10	10
8. After-tax salvage				15
9. Cash flow (7 + 8 + 4 − 1)	−100	+43.33	+43.33	+58.33
NPV at 20% = 0				

Assumptions:
1. Tax depreciation is straight-line over three years.
2. Pretax salvage value is 25 in year 3 and 50 if the asset is scrapped in year 2.
3. Tax on salvage value is 40% of the difference between salvage value and depreciated investment.
4. The cost of capital is 20%.

a. What is the value of a one-year-old plant? Of a two-year-old plant?
b. Suppose that the government now changes tax depreciation to allow a 100% writeoff in year 1. How does this affect the value of existing one- and two-year-old plants? Existing plants must continue using the original tax depreciation schedule.
c. Would it now make sense to scrap existing plants when they are two rather than three years old?
d. How would your answers change if the corporate income tax were abolished entirely?

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MINI-CASE

Ecsy-Cola[23]

Libby Flannery, the regional manager of Ecsy-Cola, the international soft drinks empire, was reviewing her investment plans for Central Asia. She had contemplated launching Ecsy-Cola in the ex-Soviet republic of Inglistan in 2013. This would involve a capital outlay of $20 million in 2012 to build a bottling plant and set up a distribution system there. Fixed costs (for manufacturing, distribution, and marketing) would then be $3 million per year from 2012 onward. This would be sufficient to make and sell 200 million liters per year—enough for every man, woman, and child in Inglistan to drink four bottles per week! But there would be few savings from building a smaller plant, and import tariffs and transport costs in the region would keep all production within national borders.

The variable costs of production and distribution would be 12 cents per liter. Company policy requires a rate of return of 25% in nominal dollar terms, after local taxes but before deducting any costs of financing. The sales revenue is forecasted to be 35 cents per liter.

Bottling plants last almost forever, and all unit costs and revenues were expected to remain constant in nominal terms. Tax would be payable at a rate of 30%, and under the Inglistan corporate tax code, capital expenditures can be written off on a straight-line basis over four years.

All these inputs were reasonably clear. But Ms. Flannery racked her brain trying to forecast sales. Ecsy-Cola found that the "1–2–4" rule works in most new markets. Sales typically double in the second year, double again in the third year, and after that remain roughly constant. Libby's best guess was that, if she went ahead immediately, initial sales in Inglistan would be 12.5 million liters in 2014, ramping up to 50 million in 2016 and onward.

Ms. Flannery also worried whether it would be better to wait a year. The soft drink market was developing rapidly in neighboring countries, and in a year's time she should have a much better idea whether Ecsy-Cola would be likely to catch on in Inglistan. If it didn't catch on and sales stalled below 20 million liters, a large investment probably would not be justified.

Ms. Flannery had assumed that Ecsy-Cola's keen rival, Sparky-Cola, would not also enter the market. But last week she received a shock when in the lobby of the Kapitaliste Hotel she bumped into her opposite number at Sparky-Cola. Sparky-Cola would face costs similar to Ecsy-Cola. How would Sparky-Cola respond if Ecsy-Cola entered the market? Would it decide to enter also? If so, how would that affect the profitability of Ecsy-Cola's project?

Ms. Flannery thought again about postponing investment for a year. Suppose Sparky-Cola were interested in the Inglistan market. Would that favor delay or immediate action?

Maybe Ecsy-Cola should announce its plans before Sparky-Cola had a chance to develop its own proposals. It seemed that the Inglistan project was becoming more complicated by the day.

QUESTIONS

1. Calculate the NPV of the proposed investment, using the inputs suggested in this case. How sensitive is this NPV to future sales volume?
2. What are the pros and cons of waiting for a year before deciding whether to invest? (*Hint:* What happens if demand turns out high and Sparky-Cola also invests? What if Ecsy-Cola invests right away and gains a one-year head start on Sparky-Cola?)

[23] We thank Anthony Neuberger for suggesting this topic.