

CHAPTER 5

MEASURING RETURN ON INVESTMENTS

In Chapter 4, we developed a process for estimating costs of equity, debt, and capital and presented an argument that the cost of capital is the minimum acceptable hurdle rate when considering new investments. We also argued that an investment has to earn a return greater than this hurdle rate to create value for the owners of a business. In this chapter, we turn to the question of how best to measure the return on a project. In doing so, we will attempt to answer the following questions:

- What is a project? In particular, how general is the definition of an investment and what are the different types of investment decisions that firms have to make?
- In measuring the return on a project, should we look at the cash flows generated by the project or at the accounting earnings?
- If the returns on a project are unevenly spread over time, how do we consider (or should we not consider) differences in returns across time?

We will illustrate the basics of investment analysis using four hypothetical projects: an online book ordering service for Bookscape, a new theme park in Brazil for Disney, a plant to manufacture linerboard for Aracruz Celulose and an acquisition of a US company by Tata Chemicals.

What Is a Project?

Investment analysis concerns which projects a company should accept and which it should reject; accordingly, the question of what makes up a project is central to this and the following chapters. The conventional project analyzed in capital budgeting has three criteria: (1) a large up-front cost, (2) cash flows for a specific time period, and (3) a salvage value at the end,

Salvage Value: The estimated liquidation value of the assets invested in the projects at the end of the project life.

which captures the value of the assets of the project when the project ends. Although such projects undoubtedly form a significant proportion of investment decisions, especially for manufacturing firms, it would be a mistake to assume that investment analysis stops there. If a project is defined more broadly to include any decision that results in using the

scarce resources of a business, then everything from strategic decisions and acquisitions to decisions about which air conditioning system to use in a building would fall within its reach.

Defined broadly then, any of the following decisions would qualify as projects:

1. Major strategic decisions to enter new areas of business (such as Disney's foray into real estate or Deutsche Bank's into investment banking) or new markets (such as Disney television's expansion into Latin America).
2. Acquisitions of other firms are projects as well, notwithstanding attempts to create separate sets of rules for them.
3. Decisions on new ventures within existing businesses or markets, such as the one made by Disney to expand its Orlando theme park to include the Animal Kingdom or the decision to produce a new animated movie.
4. Decisions that may change the way existing ventures and projects are run, such as programming schedules on the Disney channel or changing inventory policy at Bookscape.
5. Decisions on how best to deliver a service that is necessary for the business to run smoothly. A good example would be Deutsche Bank's choice of what type of financial information system to acquire to allow traders and investment bankers to do their jobs. While the information system itself might not deliver revenues and profits, it is an indispensable component for other revenue generating projects.

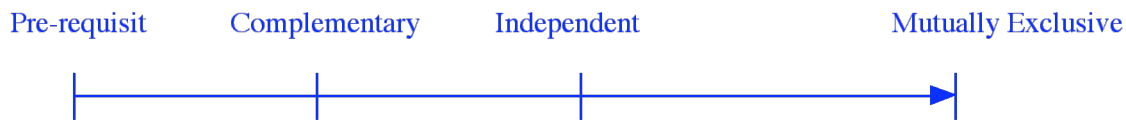
Investment decisions can be categorized on a number of different dimensions. The first relates to how the project affects other projects the firm is considering and analyzing. Some

Mutually Exclusive Projects: A group of projects is said to be mutually exclusive when acceptance of one of the projects implies that the rest have to be rejected.

projects are independent of other projects, and thus can be analyzed separately, whereas other projects are mutually exclusive—that is, taking one project will mean rejecting other projects. At the other extreme, some projects are prerequisites for other projects down the road and others are complementary. In general, projects can be categorized as falling somewhere on the continuum between prerequisites and mutually exclusive, as depicted in Figure 5.1.

Figure 5.1 The Project Continuum

Figure 5.1: The Project Continuum



The second dimension that can be used to classify a project is its ability to generate revenues or reduce costs. The decision rules that analyze revenue-generating projects attempt to evaluate whether the earnings or cash flows from the projects justify the investment needed to implement them. When it comes to cost-reduction projects, the decision rules examine whether the reduction in costs justifies the up-front investment needed for the projects.

Illustration 5.1: Project Descriptions.

In this chapter and parts of the next, we will use four hypothetical projects to illustrate the basics of investment analysis.

- The first project we will look at is a proposal by Bookscape to add an *online book ordering and information service*. Although the impetus for this proposal comes from the success of other online retailers like Amazon.com, Bookscape's service will be more focused on helping customers research books and find the ones they need rather than on price. Thus, if Bookscape decides to add this service, it will have to hire and train well-qualified individuals to answer customer queries, in addition to investing in the computer equipment and phone lines that the service will require. This project analysis will help illustrate some of the issues that come up when private businesses look at investments and also when businesses take on projects that have risk profiles different from their existing ones.
- The second project we will analyze is a *proposed theme park for Disney in Rio De Janeiro, Brazil*. Rio Disneyworld, which will be patterned on Disneyland Paris and Walt Disney World in Florida, will require a huge investment in infrastructure and take several years to complete. This project analysis will bring several issues to the forefront, including questions of how to deal with projects when the cash flows are in a foreign currency and what to do when projects have very long lives.

- The third project we will consider is a *plant in Brazil to manufacture linerboard* for Aracruz Celulose. Linerboard is a stiffened paper product that can be transformed into cardboard boxes. This investment is a more conventional one, with an initial investment, a fixed lifetime, and a salvage value at the end. We will, however, do the analysis for this project from an equity standpoint to illustrate the generality of investment analysis. In addition, in light of concerns about inflation in Brazil, we will do the analysis entirely in real terms.
- The final project that we will examine is Tata Chemical's proposed acquisition of Sensient Technologies, a publicly traded US firm that manufactures color, flavor and fragrance additives for the food business. We will extend the same principles that we use to value internal investments to analyze how much Tata Chemicals can afford to pay for the US company and the value of any potential synergies in the merger.

We should also note that while these projects are hypothetical, they are based upon real projects that these firms have taken in the past.

Hurdle Rates for Firms versus Hurdle Rates for Projects

In the previous chapter we developed a process for estimating the costs of equity and capital for firms. In this chapter, we will extend the discussion to hurdle rates in the context of new or individual investments.

Using the Firm's Hurdle Rate for Individual Projects

Can we use the costs of equity and capital that we have estimated for the firms for these projects? In some cases we can, but only if all investments made by a firm are similar in terms of their risk exposure. As a firm's investments become more diverse, the firm will no longer be able to use its cost of equity and capital to evaluate these projects. Projects that are riskier have to be assessed using a higher cost of equity and capital than projects that are safer. In this chapter, we consider how to estimate project costs of equity and capital.

What would happen if a firm chose to use its cost of equity and capital to evaluate all projects? This firm would find itself overinvesting in risky projects and under investing in safe projects. Over time, the firm will become riskier, as its safer businesses find themselves unable to compete with riskier businesses.

Cost of Equity for Projects

In assessing the beta for a project, we will consider three possible scenarios. The first scenario is the one where all the projects considered by a firm are similar in their exposure to risk; this homogeneity makes risk assessment simple. The second scenario is one in which a firm is in multiple businesses with different exposures to risk, but projects within each business have the same risk exposure. The third scenario is the most complicated wherein each project considered by a firm has a different exposure to risk.

1. Single Business; Project Risk Similar within Business

When a firm operates in only one business and all projects within that business share the same risk profile, the firm can use its overall cost of equity as the cost of equity for the project. Because we estimated the cost of equity using a beta for the firm in Chapter 4, this would mean that we would use the same beta to estimate the cost of equity for each project that the firm analyzes. The advantage of this approach is that it does not require risk estimation prior to every project, providing managers with a fixed benchmark for their project investments. The approach is restricting, though, because it can be usefully applied only to companies that are in one line of business and take on homogeneous projects.

2. Multiple Businesses with Different Risk Profiles: Project Risk Similar within Each Business

When firms operate in more than one line of business, the risk profiles are likely to be different across different businesses. If we make the assumption that projects taken within each business have the same risk profile, we can estimate the cost of equity for each business separately and use that cost of equity for all projects within that business. Riskier businesses will have higher costs of equity than safer businesses, and projects taken by riskier businesses will have to cover these higher costs. Imposing the firm's cost of equity on all projects in all businesses will lead to overinvesting in risky businesses (because the cost of equity will be set too low) and under investing in safe businesses (because the cost of equity will be set too high).

How do we estimate the cost of equity for individual businesses? When the approach requires equity betas, we cannot fall back on the conventional regression

approach (in the CAPM) or factor analysis (in the APM) because these approaches require past prices. Instead, we have to use one of the two approaches that we described in the last section as alternatives to regression betas—bottom-up betas based on other publicly traded firms in the same business, or accounting betas, estimated based on the accounting earnings for the division.

3. Projects with Different Risk Profiles

As a purist, you could argue that each project's risk profile is, in fact, unique and that it is inappropriate to use either the firm's cost of equity or divisional costs of equity to assess projects. Although this may be true, we have to consider the trade-off. Given that small differences in the cost of equity should not make a significant difference in our investment decisions, we have to consider whether the added benefits of analyzing each project individually exceed the costs of doing so.

When would it make sense to assess a project's risk individually? If a project is large in terms of investment needs relative to the firm assessing it and has a very different risk profile from other investments in the firm, it would make sense to assess the cost of equity for the project independently. The only practical way of estimating betas and costs of equity for individual projects is the bottom-up beta approach.

Cost of Debt for Projects

In the previous chapter, we noted that the cost of debt for a firm should reflect its default risk. With individual projects, the assessment of default risk becomes much more difficult, because projects seldom borrow on their own; most firms borrow money for all the projects that they undertake. There are three approaches to estimating the cost of debt for a project:

- One approach is based on the argument that because the borrowing is done by the firm rather than by individual projects, the cost of debt for a project should be the cost of debt for the firm considering the project. This approach makes the most sense when the projects being assessed are small relative to the firm taking them and thus have little or no appreciable effect on the firm's default risk.
- Look at the project's capacity to generate cash flows relative to its financing costs and estimate default risk and cost of debt for the project. You can also estimate

this default risk by looking at other firms that take similar projects, and use the typical default risk and cost of debt for these firms. This approach generally makes sense when the project is large in terms of its capital needs relative to the firm and has different cash flow characteristics (both in terms of magnitude and volatility) from other investments taken by the firm and is capable of borrowing funds against its own cash flows.

- The third approach applies when a project actually borrows its own funds, with lenders having no recourse against the parent firm, in case the project defaults. This is unusual, but it can occur when investments have significant tangible assets of their own and the investment is large relative to the firm considering it. In this case, the cost of debt for the project can be assessed using its capacity to generate cash flows relative to its financing obligations. In the last chapter, we used the bond rating of a firm to come up with the cost of debt for the firm. Although projects may not be rated, we can still estimate a rating for a project based on financial ratios, and this can be used to estimate default risk and the cost of debt.

Financing Mix and Cost of Capital for Projects

To get from the costs of debt and equity to the cost of capital, we have to weight each by their relative proportions in financing. Again, the task is much easier at the firm level, where we use the current market values of debt and equity to arrive at these weights. We may borrow money to fund a project, but it is often not clear whether we are using the debt capacity of the project or the firm's debt capacity. The solution to this problem will again vary depending on the scenario we face.

- When we are estimating the financing weights for small projects that do not affect a firm's debt capacity, the financing weights should be those of the firm before the project.
- When assessing the financing weights of large projects, with risk profiles different from that of the firm, we have to be more cautious. Using the firm's financing mix to compute the cost of capital for these projects can be misleading, because the project being analyzed may be riskier than the firm as a whole and thus incapable of carrying the firm's debt ratio. In this case, we would argue for the

use of the average debt ratio of the other firms in the business in assessing the cost of capital of the project.

- The financing weights for stand-alone projects that are large enough to issue their own debt should be based on the actual amounts borrowed by the projects. For firms with such projects, the financing weights can vary from project to projects, as will the cost of debt.

In summary, the cost of debt and debt ratio for a project will reflect the size of the project relative to the firm, and its risk profile, again relative to the firm. Table 5.1 summarizes our analyses.

Table 5.1 Cost of Debt and Debt Ratio: Project Analyses

<i>Project Characteristics</i>	<i>Cost of Debt</i>	<i>Debt Ratio</i>
Project is small and has cash flow characteristics similar to the firm	Firm's cost of debt	Firm's debt ratio
Project is large and has cash flow characteristics different from the firm	Cost of debt of comparable firms (if non-recourse debt) or the firm (if backed by the firm's creditworthiness)	Average debt ratio of comparable firms
Stand-alone project	Cost of debt for project (based on actual or synthetic ratings)	Debt ratio for project

Illustration 5.2: Estimating Hurdle Rates for Individual Projects

Using the principles of estimation that we just laid out, we can estimate the hurdle rates for the projects that we are analyzing in this chapter.

- *Bookscape Online Information and Ordering Service*: Because the beta and cost of equity that we estimated for Bookscape as a company reflect its status as a book store, we will re-estimate the beta for this online project by looking at publicly traded Internet retailers. The unlevered total beta of internet retailers is 4.25,¹ and we assume that this project will be funded with the same mix of debt and equity (D/E = 53.47%, Debt/Capital = 34.84%) that Bookscape uses in the rest of the business. We will assume that Bookscape's tax rate (40%) and pretax cost of debt (6%) apply to this project.

¹The unlevered market beta for internet retailers is 1.70, and the average correlation of these stocks with the market is 0.40. The unlevered total beta is therefore $1.70/0.4 = 4.25$.

$$\text{Levered Beta}_{\text{Online Service}} = 4.25 [1 + (1 - 0.4) (0.5357)] = 5.61$$

$$\text{Cost of Equity}_{\text{Online Service}} = 3.5\% + 5.61 (6\%) = 37.18\%$$

$$\text{Cost of Capital}_{\text{Online Service}} = 37.18\% (0.6516) + 6\% (1 - 0.4) (0.3484) = 25.48\%$$

This is much higher than the cost of capital we computed for Bookscape in chapter 4, but it reflects the higher risk of the online retail venture.

- *Rio Disney*: We did estimate a cost of equity of 6.62% for the Disney theme park business in the last chapter, using a bottom-up levered beta of 0.7829 for the business. The only concern we would have with using this cost of equity for this project is that it may not adequately reflect the additional risk associated with the theme park being in an emerging market (Brazil). To account for this risk, we compute the US \$ cost of equity for the theme park using a risk premium that includes a country risk premium for Brazil:²

$$\text{Cost of Equity in US\$} = 3.5\% + 0.7829 (6\% + 3.95\%) = 11.29\%$$

Using this estimate of the cost of equity, Disney's theme park debt ratio of 35.32% and its after-tax cost of debt of 3.72% (see chapter 4), we can estimate the cost of capital for the project:

$$\text{Cost of Capital in US\$} = 11.29\% (0.6468) + 3.72\% (0.3532) = 8.62\%$$

- *Aracruz Paper Plant*: We estimated the cost of equity and capital for Aracruz's paper business in Chapter 4 in real, U.S. dollar, and nominal BR terms. We reproduce those estimates in table 5.2:

Table 5.2: Costs of Equity and Capital: Aracruz

	Cost of equity	Cost of capital
US \$	20.82%	12.84%
R\$	26.75%	18.37%
Real	18.45%	10.63%

In analyzing projects, we will pick the appropriate discount rate based upon whether we are looking at cash flows prior to debt payments (cost of capital) or after debt payments (cost of equity) and the currency in which we are making our estimates.

²We computed this country risk premium for Brazil in chapter 4, in the context of computing the cost of capital for Aracruz. We multiplied the default spread for Brazil (2.50%) by the relative volatility of Brazil's equity index to the Brazilian government bond. (34%/21.5%)
Country risk premium for Brazil = 2.50% (34/21.5) = 3.95%

- *Sensient Technologies Acquisition*: The costs of capital that we estimated for Tata Chemicals and its divisions in chapter 4 cannot be used in assessing the value of Sensient Technologies for four reasons:
 - a. Currency: The cost of capital for Tata Chemicals was estimated in rupee terms, whereas our assessment of Sensient will be done in US dollars.
 - b. Country risk: In estimating the cost of capital for Tata Chemicals, we incorporated an additional country risk premium for India, to reflect the fact that the operations are almost entirely in India. Sensient Technologies operates primarily in the United States and have very little emerging market exposure. Consequently, we should be using a mature market premium (of 6%) in estimating its cost of equity.
 - c. Business risk: To estimate the beta for Tata Chemicals, we looked at the betas of publicly traded emerging market companies in the diversified chemicals and fertilizers businesses. While Sensient Technologies is classified as a specialty chemical company, its revenues are derived almost entirely from the food processing business. Consequently, we feel that the unlevered beta of food processing companies in the United States is a better measure of risk; in January 2009, we estimated an unlevered beta of 0.65 for this sector.
 - d. Cost of debt and debt ratio: In this acquisition, Tata Chemicals plans to assume the existing debt of Sensient Technologies and to preserve Sensient's existing debt ratio. Sensient currently has a debt to capital ratio of 28.57% (translating into a debt to equity ratio of 40%) and faces a pre-tax cost of debt of 5.5%.

Using the US corporate tax rate of 37% (to reflect the fact that Sensient's income will be taxed in the US), we compute the cost of capital for Sensient in US dollar terms:

$$\text{Levered Beta} = 0.65 (1 + (1 - .37) (.40)) = 0.8138$$

$$\text{Cost of Equity} = 3.5\% + 0.8138 (6\%) = 8.38\%$$

$$\text{Cost of capital} = 8.38\% (1 - .2857) + 5.5\% (1 - .37) (.2857) = 6.98\%$$

In Practice: Exchange Rate Risk, Political Risk, and Foreign Projects

When computing the cost of capital for the Rio Disney project, we adjusted the cost of capital for the additional risk associated with investing in Brazil. Although it may

seem obvious that a Brazilian investment is more risky to Disney than an investment in the United States, the question of whether discount rates should be adjusted for country risk is not an easy one to answer. It is true that a Brazilian investment will carry more risk for Disney than an investment in the United States, both because of exchange rate risk (the cash flows will be in Brazilian Reals and not in U.S. dollars) and because of political risk (arising from Brazil's emerging market status). However, this risk should affect the discount rate only if it cannot be diversified away by the marginal investors in Disney.

To analyze whether the risk in Brazil is diversifiable to Disney, we went back to our assessment of the marginal investors in the company in Chapter 3, where we noted that they were primarily diversified institutional investors. Not only does exchange rate risk affect different companies in their portfolios very differently—some may be hurt by a strengthening dollar and others may be helped—but these investors can hedge exchange rate risk, if they so desire. If the only source of risk in the project were exchange rate, we would be inclined to treat it as diversifiable risk and not adjust the cost of capital. The issue of political risk is more confounding. To the extent that political risk is not only more difficult to hedge but is also more likely to carry a nondiversifiable component, especially when we are considering risky emerging markets, the cost of capital should be adjusted to reflect it.

In short, whether we adjust the cost of capital for foreign projects will depend both on the firm that is considering the project and the country in which the project is located. If the marginal investors in the firm are diversified and the project is in a country with relatively little or no political risk, we would be inclined not to add a risk premium on to the cost of capital. If the marginal investors in the firm are diversified and the project is in a country with significant political risk, we would add a political risk premium to the cost of capital. If the marginal investors in the firm are not diversified, we would adjust the discount rate for both exchange rate and political risk.

Measuring Returns: The Choices

On all of the investment decisions just described, we have to choose between alternative approaches to measuring returns on the investment made. We will present our argument for return measurement in three steps. First, we will contrast accounting

earnings and cash flows and argue that cash flows are much better measures of true return on an investment. Second, we will note the differences between total and incremental cash flows and present the case for using incremental cash flows in measuring returns. Finally, we will argue that returns that occur earlier in a project life should be weighted more than returns that occur later in a project life and that the return on an investment should be measured using time-weighted returns.

A. Accounting Earnings versus Cash Flows

The first and most basic choice we have to make when it comes to measuring returns is the one between the accounting measure of income on a project—measured in accounting statements, using accounting principles and standards—and the cash flow generated by a project, measured as the difference between the cash inflows in each period and the cash outflows.

Why Are Accounting Earnings Different from Cash Flows?


Accountants have invested substantial time and resources in coming up with ways of measuring the income made by a project. In doing so, they subscribe to some generally accepted accounting principles. Generally accepted accounting principles require the recognition of revenues when the service for which the firm is getting paid has been performed in full or substantially and has received in return either cash or a receivable that is both observable and measurable. For expenses that are directly linked to the production of revenues (like labor and materials), expenses are recognized in the same period in which revenues are recognized. Any expenses that are not directly linked to the production of revenues are recognized in the period in which the firm consumes the services. Although the objective of distributing revenues and expenses fairly across time is worthy, the process of accrual accounting creates an accounting earnings number that can be very different from the cash flow generated by a project in any period. There are three significant factors that account for this difference.

1. Operating versus Capital Expenditure

Accountants draw a distinction between expenditures that yield benefits only in the immediate period or periods (such as labor and material for a manufacturing firm) and those that yield benefits over multiple periods (such as land, buildings, and long-lived

plant). The former are called *operating expenses* and are subtracted from revenues in computing the accounting income, whereas the latter are *capital expenditures* and are not subtracted from revenues in the period that they are made. Instead, the expenditure is spread over multiple periods and deducted as an expense in each period; these expenses are called depreciation (if the asset is a tangible asset like a building) or amortization (if the asset is an intangible asset, such as a patent or a trademark).

Although the capital expenditures made at the beginning of a project are often the largest part of investment, many projects require capital expenditures during their lifetime. These capital expenditures will reduce the cash available in each of these periods.

 **5.1. What Are Research and Development Expenses?**

Research and development (R&D) expenses are generally considered to be operating expenses by accountants. Based on our categorization of capital and operating expenses, would you consider R&D expenses to be

- a. operating expenses.
- b. capital expenses.
- c. operating or capital expenses, depending on the type of research being done.

Why?

2. *Noncash Charges*

The distinction that accountants draw between operating and capital expenses leads to a number of accounting expenses, such as depreciation and amortization, which are not cash expenses. These noncash expenses, though depressing accounting income, do not reduce cash flows. In fact, they can have a significant positive impact on cash flows if they reduce the tax paid by the firm since some noncash charges reduce taxable income and the taxes paid by a business. The most important of such charges is depreciation, which, although reducing taxable and net income, does not cause a cash outflow. In effect, depreciation and amortization is added back to net income to arrive at the cash flows on a project.

For projects that generate large depreciation charges, a significant portion of the cash flows can be attributed to the tax benefits of depreciation, which can be written as follows

$$\text{Tax Benefit of Depreciation} = \text{Depreciation} * \text{Marginal Tax Rate}$$

Although depreciation is similar to other tax-deductible expenses in terms of the tax benefit it generates, its impact is more positive because it does not generate a concurrent cash outflow.

Amortization is also a noncash charge, but the tax effects of amortization can vary depending on the nature of the amortization. Some amortization charges, such as the amortization of the price paid for a patent or a trademark, are tax-deductible and reduce both accounting income and taxes. Thus they provide tax benefits similar to depreciation. Other amortization, such as the amortization of the premium paid on an acquisition (called goodwill), reduces accounting income but not taxable income. This amortization does not provide a tax benefit.

Although there are a number of different depreciation methods used by firms, they can be classified broadly into two groups. The first is *straight line depreciation*, whereby equal amounts of depreciation are claimed each period for the life of the project. The second group includes *accelerated depreciation methods*, such as double-declining balance depreciation, which result in more depreciation early in the project life and less in the later years.

3. *Accrual versus Cash Revenues and Expenses*

The accrual system of accounting leads to revenues being recognized when the sale is made, rather than when the customer pays for the good or service. Consequently, accrual revenues may be very different from cash revenues for three reasons. First, some customers, who bought their goods and services in prior periods, may pay in this period; second, some customers who buy their goods and services in this period (and are therefore shown as part of revenues in this period) may defer payment until the future. Finally, some customers who buy goods and services may never pay (bad debts). In some cases, customers may even pay in advance for products or services that will not be delivered until future periods.

A similar argument can be made on the expense side. Accrual expenses, relating to payments to third parties, will be different from cash expenses, because of payments made for material and services acquired in prior periods and because some materials and services acquired in current periods will not be paid for until future periods. Accrual taxes will be different from cash taxes for exactly the same reasons.

When material is used to produce a product or deliver a service, there is an added consideration. Some of the material used may have been acquired in previous periods and was brought in as inventory into this period, and some of the material that is acquired in this period may be taken into the next period as inventory.

Accountants define working capital as the difference between current assets (such as inventory and accounts receivable) and current liabilities (such as accounts payable and taxes payable). We will use a slight variant, and define non-cash working capital as the difference between non-cash current assets and non-debt current liabilities; debt is not considered part of working capital because it is viewed as a source of capital. The reason we leave cash out of the working capital computation is different. We view cash, for the most part, to be a non-wasting asset, insofar as firms earn a fair rate of return on the cash. Put another way, cash that is invested in commercial paper or treasury bills is no longer a wasting asset and should not be considered part of working capital, even if it is viewed as an integral part of operations. Differences between accrual earnings and cash earnings, in the absence of noncash charges, can be captured by changes in the non-cash working capital. A decrease in non-cash working capital will increase cash flows, whereas an increase will decrease cash flows.

In Practice: The Payoff to Managing Working Capital

Firms that are more efficient in managing their working capital will see a direct payoff in terms of cash flows. Efficiency in working capital management implies that the firm has reduced its net working capital needs without adversely affecting its expected growth in revenues and earnings. Broadly defined, there are four ways net working capital can be reduced:

1. Firms need to maintain an inventory of both produce goods and to meet customer demand, but minimizing this inventory while meeting these objectives can produce a lower net working capital. In fact, recent advances in technology that use information

systems for just-in-time production have helped U.S. firms reduce their inventory needs significantly.

2. Firms that sell goods and services on credit can reduce their net working capital needs by inducing customers to pay their bills faster and by improving their collection procedures.
3. Firms can also look for suppliers who offer more generous credit terms because accounts payable can be used to finance inventory and accounts receivable.

While lowering the amount invested in working capital will increase cash flows, that positive effect has to be weighed off against any potential negative effects including lost sales (because of insufficient inventory or more stringent credit terms) and higher costs (because suppliers may demand higher prices if you take longer to pay).

From Accounting Earnings to Cash Flows

The three factors outlined can cause accounting earnings to deviate significantly from the cash flows. To get from after-tax operating earnings, which measures the earnings to the firm, to cash flows to all investors in the firm, we have to

- *Add back all noncash charges*, such as depreciation and amortization, to the operating earnings.
- *Subtract out* all cash outflows that represent *capital expenditures*.
- *Net out the effect of changes in noncash working capital*, that is, changes in accounts receivable, inventory, and accounts payable. If noncash working capital increased, the cash flows will be reduced by the change, whereas if it decreased, there is a cash inflow.

The first two adjustments change operating earnings to account for the distinction drawn by accountants between operating, financing and capital expenditures, whereas the last adjustment converts accrual revenues and expenses into cash revenues and expenses.

$$\text{Cash Flow to Firm} = \text{Earnings before interest and taxes} (1 - t) + \text{Depreciation \& Amortization} - \text{Change in Noncash Working Capital} - \text{Capital Expenditures}$$

The cash flow to the firm is a pre-debt, after-tax cash flow that measures the cash generated by a project for all claim holders in the firm after reinvestment needs have been met.

To get from net income, which measures the earnings of equity investors in the firm, to cash flows to equity investors requires the additional step of considering the net cash flow created by repaying old debt and taking on new debt. The difference between new debt issues and debt repayments is called the net debt, and it has to be added back to arrive at cash flows to equity. In addition, other cash flows to nonequity claim holders in the firm, such as preferred dividends, have to be netted from cash flows.

$$\text{Cash Flow to Equity} = \text{Net Income} + \text{Depreciation \& Amortization} - \text{Change in Noncash Working Capital} - \text{Capital Expenditures} + (\text{New Debt Issues} - \text{Debt Repayments}) - \text{Preferred Dividends}$$

The cash flow to equity measures the cash flows generated by a project for equity investors in the firm, after taxes, debt payments, and reinvestment needs.



5.2. Earnings and Cash Flows

If the earnings for a firm are positive, the cash flows will also be positive.

- a. True
- b. False

Why or why not?



Earnings Management: A Behavioral Perspective

Accounting standards allow some leeway for firms to move earnings across periods by deferring revenues or expenses or choosing a different accounting method for recording expenses. Companies not only work at holding down expectations on the part of analysts following them but also use their growth and accounting flexibility to move earnings across time to beat expectations and to smooth out earning. It should come as no surprise that firms such as Microsoft and Intel consistently beat analyst estimates of earnings. Studies indicate that the tools for accounting earnings management range the spectrum and include choices on when revenues get recognized, how inventory gets valued, how leases and option expenses are treated and how fair values get estimated for

assets. Earnings can also be affected by decisions on when to invest in R&D and how acquisitions are structured.

In response to earnings management, FASB has created more stringent rules but the reasons why companies manage earnings may have behavioral roots. One study, for instance, finds that the performance anxiety created among managers by frequent internal auditing can lead to more earnings management. Thus, more rules and regulations may have the perverse impact of increasing earnings management. In addition, surveys indicate that managerial worries about personal reputation can induce them to try to meet earnings benchmarks set by external entities (such as equity research analysts) Finally, there is evidence that managers with ‘short horizons’ are more likely to manage earnings, with the intent of fooling investors.

The phenomenon of managing earnings has profound implications for a number of actions that firms may take, from how they sell their products and services to what kinds of projects they invest in or the firms they acquire and how they account for such investments. A survey of CFOs uncovers the troubling finding that more than 40% of them will reject an investment that will create value for a firm, if the investment will result in the firm reporting earnings that fall below analyst estimates.

The Case for Cash Flows

When earnings and cash flows are different, as they are for many projects, we must examine which one provides a more reliable measure of performance. Accounting earnings, especially at the equity level (net income), can be manipulated at least for individual periods, through the use of creative accounting techniques. A book titled *Accounting for Growth*, which garnered national headlines in the United Kingdom and cost the author, Terry Smith, his job as an analyst at UBS Phillips & Drew, examined twelve legal accounting techniques commonly used to mislead investors about the profitability of individual firms. To show how creative accounting techniques can increase reported profits, Smith highlighted such companies as Maxwell Communications and Polly Peck, both of which eventually succumbed to bankruptcy.

The second reason for using cash flow is much more direct. No business that we know of accepts earnings as payment for goods and services delivered; all of them require cash. Thus, a project with positive earnings and negative cash flows will drain

cash from the business undertaking it. Conversely, a project with negative earnings and positive cash flows might make the accounting bottom line look worse but will generate cash for the business undertaking it.

B. Total versus Incremental Cash Flows

The objective when analyzing a project is to answer the question: Will investing in this project make the entire firm or business more valuable? Consequently, the cash flows we should look at in investment analysis are the cash flows the project creates for the firm or business considering it. We will call these incremental cash flows.

Differences between Incremental and Total Cash Flows

The total and the incremental cash flows on a project will generally be different for two reasons. First, some of the cash flows on an investment may have occurred already and therefore are unaffected by whether we take the investment or not. Such cash flows are called sunk costs and should be removed from the analysis. The second is that some of the projected cash flows on an investment will be generated by the firm, whether this investment is accepted or rejected. Allocations of fixed expenses, such as general and administrative costs, usually fall into this category. These cash flows are not incremental, and the analysis needs to be cleansed of their impact.

1. Sunk Costs

There are some expenses related to a project that are incurred before the project analysis is done. One example would be expenses associated with a test market done to assess the potential market for a product prior to conducting a full-blown investment analysis. Such expenses are called *sunk costs*. Because they will not be recovered if the project is rejected, sunk costs are not incremental and therefore should not be considered as part of the investment analysis. This contrasts with their treatment in accounting statements, which do not distinguish between expenses that have already been incurred and expenses that are still to be incurred.

One category of expenses that consistently falls into the sunk cost column in project analysis is research and development (R&D), which occurs well before a product is even considered for introduction. Firms that spend large amounts on R&D, such as

Merck and Intel, have struggled to come to terms with the fact that the analysis of these expenses generally occur after the fact, when little can be done about them.

Although sunk costs should not be treated as part of investment analysis, a firm does need to cover its sunk costs over time or it will cease to exist. Consider, for example, a firm like McDonald's, which expends considerable resources in test marketing products before introducing them. Assume, on the ill-fated McLean Deluxe (a low-fat hamburger introduced in 1990), that the test market expenses amounted to \$30 million and that the net present value of the project, analyzed after the test market, amounted to \$20 million. The project should be taken. If this is the pattern for every project McDonald's takes on, however, it will collapse under the weight of its test marketing expenses. To be successful, the *cumulative* net present value of its successful projects will have to exceed the *cumulative* test marketing expenses on both its successful and unsuccessful products.



The Psychology of Sunk Costs

While the argument that sunk costs should not alter decisions is unassailable, studies indicate that ignoring sunk costs does not come easily to managers. In an experiment, Arkes and Blumer presented 48 people with a hypothetical scenario: Assume that you are investing \$10 million in research project to come up with a plane that cannot be detected by radar. When the project is 90% complete (\$ 9 million spent), another firm begins marketing a plane that cannot be detected by radar and is faster and cheaper than the one you are working on. Would you invest the last 10% to complete the project? Of the group, 40 individuals said they would go ahead. Another group of 60 was asked the question, with the same facts about the competing firm and its plane, but with the cost issue framed differently. Rather than mention that the firm had already spent \$ 9 million, they were asked whether they would spend an extra million to continue with this investment. Almost none of this group would fund the investment.³ Other studies confirm this finding, which has been labeled the *Concorde fallacy*.

³ Arkes, H. R. & C. Blumer, 1985, *The Psychology of Sunk Cost*. *Organizational Behavior and Human Decision Processes*, 35, 124-140.

Rather than view this behavior as irrational, we should lecturing managers to ignore sunk costs in their decisions will accomplish little. The findings in these studies indicate one possible way of bridging the gap. If we can frame investment analysis primarily around incremental earnings and cash flows, with little emphasis on past costs and decisions (even if that is provided for historical perspective), we are far more likely to see good decisions and far less likely to see good money thrown after bad. It can be argued that conventional accounting, which mixes sunk costs and incremental costs, acts as an impediment in this process.

2. *Allocated Costs*

An accounting device created to ensure that every part of a business bears its fair share of costs is *allocation*, whereby costs that are not directly traceable to revenues generated by individual products or divisions are allocated across these units, based on revenues, profits, or assets. Although the purpose of such allocations may be fairness, their effect on investment analyses have to be viewed in terms of whether they create incremental cash flows. An allocated cost that will exist with or without the project being analyzed does not belong in the investment analysis.

Any increase in administrative or staff costs that can be traced to the project is an incremental cost and belongs in the analysis. One way to estimate the incremental component of these costs is to break them down on the basis of whether they are fixed or variable and, if variable, what they are a function of. Thus, a portion of administrative costs may be related to revenue, and the revenue projections of a new project can be used to estimate the administrative costs to be assigned to it.

Illustration 5.3: Dealing with Allocated Costs

Case 1: Assume that you are analyzing a retail firm with general and administrative (G&A) costs currently of \$600,000 a year. The firm currently has five stores and the G&A costs are allocated evenly across the stores; the allocation to each store is \$120,000. The firm is considering opening a new store; with six stores, the allocation of G&A expenses to each store will be \$100,000.

In this case, assigning a cost of \$100,000 for G&A costs to the new store in the investment analysis would be a mistake, because it is not an incremental cost—the total G&A cost will be \$600,000, whether the project is taken or not.

Case 2: In the previous analysis, assume that all the facts remain unchanged except for one. The total G&A costs are expected to increase from \$600,000 to \$660,000 as a consequence of the new store. Each store is still allocated an equal amount; the new store will be allocated one-sixth of the total costs, or \$110,000.

In this case, the allocated cost of \$110,000 should not be considered in the investment analysis for the new store. The *incremental* cost of \$60,000 ($\$660,000 - \$600,000$), however, should be considered as part of the analysis.

In Practice: Who Will Pay for Headquarters?

As in the case of sunk costs, the right thing to do in project analysis (i.e., considering only direct incremental costs) may not add up to create a firm that is financially healthy. Thus, if a company like Disney does not require individual movies that it analyzes to cover the allocated costs of general administrative expenses of the movie division, it is difficult to see how these costs will be covered at the level of the firm.

In 2008, Disney's corporate shared costs amounted to \$471 million. Assuming that these general administrative costs serve a purpose, which otherwise would have to be borne by each of Disney's business, and that there is a positive relationship between the magnitude of these costs and revenues, it seems reasonable to argue that the firm should estimate a fixed charge for these costs that every new investment has to cover, even though this cost may not occur immediately or as a direct consequence of the new investment.

The Argument for Incremental Cash Flows

When analyzing investments it is easy to get tunnel vision and focus on the project or investment at hand, acting as if the objective of the exercise is to maximize the value of the individual investment. There is also the tendency, with perfect hindsight, to require projects to cover all costs that they have generated for the firm, even if such costs will not be recovered by rejecting the project. The objective in investment analysis is to maximize the value of the business or firm taking the investment. Consequently, it is the

cash flows that an investment will add on in the future to the business, that is, the incremental cash flows, that we should focus on.

Illustration 5.4: Estimating Cash Flows for an Online Book Ordering Service: Bookscape

As described in Illustration 5.1, Bookscape is considering investing in an online book ordering and information service, which will be staffed by two full-time employees. The following estimates relate to the costs of starting the service and the subsequent revenues from it.

1. The initial investment needed to start the service, including the installation of additional phone lines and computer equipment, will be \$1 million. These investments are expected to have a life of four years, at which point they will have no salvage value. The investments will be depreciated straight line over the four-year life.
2. The revenues in the first year are expected to be \$1.5 million, growing 20% in year two, and 10% in the two years following.
3. The salaries and other benefits for the employees are estimated to be \$150,000 in year one, and grow 10% a year for the following three years.
4. The cost of the books is assumed to be 60% of the revenues in each of the four years.
5. The working capital, which includes the inventory of books needed for the service and the accounts receivable (associated with selling books on credit) is expected to amount to 10% of the revenues; the investments in working capital have to be made at the beginning of each year. At the end of year four, the entire working capital is assumed to be salvaged.
6. The tax rate on income is expected to be 40%, which is also the marginal tax rate for Bookscape.

Based on this information, we estimate the operating income for Bookscape Online in Table 5.3:

Table 5.3 Expected Operating Income on Bookscape Online

	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
Revenues	\$1,500,000	\$1,800,000	\$1,980,000	\$2,178,000
<i>Operating expenses</i>				
Labor	\$150,000	\$165,000	\$181,500	\$199,650

Materials	\$900,000	\$1,080,000	\$1,188,000	\$1,306,800
Depreciation	\$250,000	\$250,000	\$250,000	\$250,000
<i>Operating Income</i>	<i>\$200,000</i>	<i>\$305,000</i>	<i>\$360,500</i>	<i>\$421,550</i>
Taxes	\$80,000	\$122,000	\$144,200	\$168,620
<i>After-tax Operating Income</i>	<i>\$120,000</i>	<i>\$183,000</i>	<i>\$216,300</i>	<i>\$252,930</i>

To get from operating income to cash flows, we add back the depreciation charges and subtract out the working capital requirements (which are the changes in working capital from year to year) in table 5.4. We also show the initial investment of \$1 million as a cash outflow right now (year zero) and the salvage value of the entire working capital investment in year four.

Table 5.4 From Operating Income to After-Tax Cash Flows

	0 (Now)	1	2	3	4
After-tax operating income		\$120,000	\$183,000	\$216,300	\$252,930
+ Depreciation		\$250,000	\$250,000	\$250,000	\$250,000
– Change in working capital	\$150,000	\$30,000	\$18,000	\$19,800	\$ 0
+ Salvage value					\$217,800
After-tax cash flows	-\$1,150,000	\$340,000	\$415,000	\$446,500	\$720,730

Note that there is an initial investment in working capital, which is 10% of the first year's revenues, invested at the beginning of the year. Each subsequent year has a change in working capital that represents 10% of the revenue change from that year to the next. In year 4, the cumulative investment in working capital over the four years (\$ 217,800) is salvaged, resulting in a positive cash flow.⁴



5.3. The Effects of Working Capital

In the analysis, we assumed that Bookscape would have to maintain additional inventory for its online book service. If, instead, we had assumed that Bookscape could use its existing inventory (i.e., from its regular bookstore), the cash flows on this project will

- increase.
- decrease.
- remain unchanged.

⁴ Salvaging working capital is essentially the equivalent of having a going out of business sale, where all the inventory is sold at cost and all accounts receivable are collected.

Explain.

Illustration 5.5: Estimating Earnings, Incremental Earnings and Incremental Cash Flows: Disney Theme Park

The theme parks to be built near Rio, modeled on Disneyland Paris, will include a Magic Kingdom to be constructed, beginning immediately, and becoming operational at the beginning of the second year, and a second theme park modeled on Epcot at Orlando to be constructed in the second and third year and becoming operational at the beginning of the fifth year. The following is the set of assumptions that underlie the investment analysis.

1. The cash flows will be estimated in nominal dollars, even though the actual cash flows will be in Brazilian Reals (R\$).
2. The cost of constructing Magic Kingdom will be \$3 billion, with \$2 billion to be spent right now and \$1 billion to be spent a year from now. Disney has already spent \$0.5 billion researching the proposal and getting the necessary licenses for the park; none of this investment can be recovered if the park is not built. This amount was capitalized and will be depreciated straight line over the next 10 years to a salvage value of zero.
3. The cost of constructing Epcot II will be \$1.5 billion, with \$1 billion spent at the end of the second year and \$0.5 billion at the end of the third year.
4. The revenues at the two parks and the resort properties at the parks are assumed to be the following, based on projected attendance figures until the tenth year and an expected inflation rate of 2% (in U.S. dollars). Starting in year ten, the revenues are expected to grow at the inflation rate. Table 5.5 summarizes the revenue projections:

Table 5.5 Revenue Projections: Rio Disney

<i>Year</i>	<i>Magic Kingdom</i>	<i>Epcot II</i>	<i>Resort Properties</i>	<i>Total</i>
1	\$0	\$0	\$0	\$0
2	\$1,000	\$0	\$250	\$1,250
3	\$1,400	\$0	\$350	\$3,000
4	\$1,700	\$300	\$500	\$4,250
5	\$2,000	\$500	\$625	\$5,625
6	\$2,200	\$550	\$688	\$6,563
7	\$2,420	\$605	\$756	\$7,219

8	\$2,662	\$666	\$832	\$7,941
9	\$2,928	\$732	\$915	\$8,735
10	\$2,987	\$747	\$933	\$9,242
Beyond	Revenues grow 2% a year forever			

Note that the revenues at the resort properties are set at 25% of the revenues at the theme parks.

- 5. The direct operating expenses are assumed to be 60% of the revenues at the parks and 75% of revenues at the resort properties.
- 6. The depreciation on fixed assets will be calculated as a percent of the remaining book value of these assets at the end of the previous year. In addition, the parks will require capital maintenance investments each year, specified as a percent of the depreciation that year. Table 5.6 lists both these statistics by year:⁵

Table 5.6 Depreciation and Capital Maintenance Percentages

<i>Year</i>	<i>Depreciation as % of Book Value</i>	<i>Capital Maintenance as % of Depreciation</i>
1	0.00%	0.00%
2	12.50%	50.00%
3	11.00%	60.00%
4	9.50%	70.00%
5	8.00%	80.00%
6	8.00%	90.00%
7	8.00%	100.00%
8	8.00%	105.00%
9	8.00%	110.00%
10	8.00%	110.00%

The capital maintenance expenditures are low in the early years, when the parks are still new but increase as the parks age since old attractions have to go through either major renovations or be replaced with new attractions. After year ten, both depreciation and capital expenditures are assumed to grow at the inflation rate (2%).

- 7. Disney will also allocate corporate G&A costs to this project, based on revenues; the G&A allocation will be 15% of the revenues each year. It is worth noting that a recent analysis of these expenses found that only one-third of these expenses are variable

⁵Capital maintenance expenditures are capital expenditures to replace fixed assets that break down or become obsolete. This is in addition to the regular maintenance expenses that will be necessary to keep the parks going, which are included in operating expenses.

(and a function of total revenue) and that two-thirds are fixed. After year ten, these expenses are also assumed to grow at the inflation rate of 2%.

8. Disney will have to maintain noncash working capital (primarily consisting of inventory at the theme parks and the resort properties, netted against accounts payable) of 5% of revenues, with the investments being made at the *end of each year*.
9. The income from the investment will be taxed at Disney's marginal tax rate of 38%.

The projected operating earnings at the theme parks, starting in the first year of operation (which is the second year) are summarized in Exhibit 5.1. Note that the project has no revenues until year two, when the first park becomes operational and that the project is expected to have an operating loss of \$150 million in that year. We have assumed that the firm will have enough income in its other businesses to claim the tax benefits from these losses (38% of the loss) in the same year. If this had been a stand-alone project, we would have had to carry the losses forward into future years and reduce taxes in those years.

The estimates of operating earnings in exhibit 5.1 are distorted because they do mix together expenses that are incremental with expenses that are not. In particular, there are two points of contention:

- a. Pre-project investment: We included the depreciation on the pre-project investment of \$ 500 million in the total depreciation for the project. This depreciation, however, can be claimed by Disney, irrespective of whether it goes ahead with the new theme park investment.
- b. Allocated G&A Expenses: While we considered the entire allocated expense in computing earnings, only one-third of this expense is incremental. Thus, we are understating the earnings on this project.

In exhibit 5.2a, we compute the incremental earnings for Rio Disney, using only the incremental depreciation and G&A expenses. Note that the incremental earnings are more positive than the unadjusted earnings in exhibit 5.1. In exhibit 5.2, we also estimate the incremental after-tax cash flow to Disney, prior to debt payments by:

- Adding back the incremental depreciation each year, because it is a noncash charge.
- Subtracting out the maintenance capital expenditures in addition to the primary capital expenditures because these are cash outflows.

- Subtracting out the incremental investment in working capital each year, which represent the change in working capital from the prior year. In this case, we have assumed that the working capital investments are made at the end of each year.

The investment of \$3 billion in Rio Magic Kingdom is shown at time 0 (as \$2 billion) and in year one (as \$1 billion). The expenditure of \$0.5 billion costing pre-project investments is not considered because it has already been made (sunk cost). Note that we could have arrived at the same estimates of incremental cash flows, starting with the unadjusted operating income and correcting for the non-incremental items (adding back the fixed portion of G&A costs and subtracting out the tax benefits from non-incremental depreciation). Exhibit 5.2b provides the proof.

5.4. Different Depreciation Methods for Tax Purposes and for Reporting

The depreciation that we used for the project is assumed to be the same for both tax and reporting purposes. Assume now that Disney uses more accelerated depreciation methods for tax purposes and straight-line depreciation for reporting purposes. In estimating cash flows, we should use the depreciation numbers from the

- a. tax books.
- b. reporting books.

Explain.


 Capbudg.xls: This spreadsheet allows you to estimate the cash flows to the firm on a project.

Exhibit 5.1 Estimated Operating Earnings at Rio Disney (in millions of US dollars)

	0	1	2	3	4	5	6	7	8	9	10
<i>Magic Kingdom - Revenues</i>		\$0	\$1,000	\$1,400	\$1,700	\$2,000	\$2,200	\$2,420	\$2,662	\$2,928	\$2,987
<i>Epcot Rio - Revenues</i>		\$0	\$0	\$0	\$300	\$500	\$550	\$605	\$666	\$732	\$747
<i>Resort & Properties - Revenues</i>		\$0	\$250	\$350	\$500	\$625	\$688	\$756	\$832	\$915	\$933
Total Revenues			\$1,250	\$1,750	\$2,500	\$3,125	\$3,438	\$3,781	\$4,159	\$4,575	\$4,667
<i>Magic Kingdom – Direct Expenses</i>		\$0	\$600	\$840	\$1,020	\$1,200	\$1,320	\$1,452	\$1,597	\$1,757	\$1,792
<i>Epcot Rio – Direct Expenses</i>		\$0	\$0	\$0	\$180	\$300	\$330	\$363	\$399	\$439	\$448
<i>Resort & Property – Direct Expenses</i>		\$0	\$188	\$263	\$375	\$469	\$516	\$567	\$624	\$686	\$700
Total Direct Expenses			\$788	\$1,103	\$1,575	\$1,969	\$2,166	\$2,382	\$2,620	\$2,882	\$2,940
Depreciation & Amortization		\$50	\$425	\$469	\$444	\$372	\$367	\$364	\$364	\$366	\$368
Allocated G&A Costs		\$0	\$188	\$263	\$375	\$469	\$516	\$567	\$624	\$686	\$700
Operating Income		-\$50	-\$150	-\$84	\$106	\$315	\$389	\$467	\$551	\$641	\$658
Taxes		-\$19	-\$57	-\$32	\$40	\$120	\$148	\$178	\$209	\$244	\$250
Operating Income after Taxes		-\$31	-\$93	-\$52	\$66	\$196	\$241	\$290	\$341	\$397	\$408
Capital Expenditures											
Pre-Project investments	\$500										
Depreciation: Pre-Project		\$50	\$50	\$50	\$50	\$50	\$50	\$50	\$50	\$50	\$50
Magic Kingdom: Construction	\$2,000	\$1,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Epcot Rio: Construction	\$0	\$0	\$1,000	\$500	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Capital Maintenance		\$0	\$188	\$252	\$276	\$258	\$285	\$314	\$330	\$347	\$350
Depreciation on fixed assets		\$0	\$375	\$419	\$394	\$322	\$317	\$314	\$314	\$316	\$318
Book Value of New Fixed Assets	\$2,000	\$3,000	\$3,813	\$4,145	\$4,027	\$3,962	\$3,931	\$3,931	\$3,946	\$3,978	\$4,010
Book Value of Working Capital			\$63	\$88	\$125	\$156	\$172	\$189	\$208	\$229	\$233

Book value of fixed assets_t = Book value of fixed assets_{t-1} + New Investment_t + Capital Maintenance_t – Depreciation_t

Depreciation on fixed assets_t = Book value of fixed assets_{t-1} * Depreciation as % of prior year's book value of fixed assets

Depreciation & Amortization_t = Depreciation: Pre-project investment_t + Depreciation on fixed assets

Exhibit 5.2a: Incremental Cash Flows at Rio Disney (in millions of US dollars)

Incremental Operating Income and Cash Flow											
	0	1	2	3	4	5	6	7	8	9	10
Revenues		\$0	\$1,250	\$1,750	\$2,500	\$3,125	\$3,438	\$3,781	\$4,159	\$4,575	\$4,667
-Direct Expenses		\$0	\$788	\$1,103	\$1,575	\$1,969	\$2,166	\$2,382	\$2,620	\$2,882	\$2,940
- Incremental Depreciation		\$0	\$375	\$419	\$394	\$322	\$317	\$314	\$314	\$316	\$318
- Incremental G&A		\$0	\$63	\$88	\$125	\$156	\$172	\$189	\$208	\$229	\$233
Incremental Operating Income		\$0	\$25	\$141	\$406	\$678	\$783	\$896	\$1,017	\$1,148	\$1,175
- Taxes		\$0	\$10	\$53	\$154	\$258	\$298	\$340	\$386	\$436	\$447
Incremental after-tax Operating income		\$0	\$16	\$87	\$252	\$420	\$485	\$555	\$630	\$712	\$729
+ Incremental Depreciation		\$0	\$375	\$419	\$394	\$322	\$317	\$314	\$314	\$316	\$318
- Capital Expenditures	\$2,000	\$1,000	\$1,188	\$752	\$276	\$258	\$285	\$314	\$330	\$347	\$350
- Change in non-cash Working Capital		\$0	\$63	\$25	\$38	\$31	\$16	\$17	\$19	\$21	\$5
Cashflow to firm	-\$2,000	-\$1,000	-\$860	-\$270	\$332	\$453	\$502	\$538	\$596	\$660	\$692

Exhibit 5.2b: Another way of computing Incremental Cash Flows at Rio Disney

	0	1	2	3	4	5	6	7	8	9	10
Operating income (from Exhibit 5.1)		-\$50	-\$150	-\$84	\$106	\$315	\$389	\$467	\$551	\$641	\$658
- Taxes		-\$19	-\$57	-\$32	\$40	\$120	\$148	\$178	\$209	\$244	\$250
Operating Income after Taxes		-\$31	-\$93	-\$52	\$66	\$196	\$241	\$290	\$341	\$397	\$408
+ Depreciation & Amortization		\$50	\$425	\$469	\$444	\$372	\$367	\$364	\$364	\$366	\$368
- Pre-project Depreciation * tax rate		\$19	\$19	\$19	\$19	\$19	\$19	\$19	\$19	\$19	\$19
- Capital Expenditures	\$2,000	\$1,000	\$1,188	\$752	\$276	\$258	\$285	\$314	\$330	\$347	\$350
- Change in Working Capital	\$0	\$0	\$63	\$25	\$38	\$31	\$16	\$17	\$19	\$21	\$5
+ Non-incremental Allocated Expense (1-t)		\$0	\$78	\$109	\$155	\$194	\$213	\$234	\$258	\$284	\$289
Cashflow to Firm	-\$2,000	-\$1,000	-\$860	-\$270	\$332	\$453	\$502	\$538	\$596	\$660	\$692

Illustration 5.6: Estimating Cash Flows to Equity for a New Plant: Aracruz

Aracruz Celulose is considering a plan to build a state-of-the-art plant to manufacture linerboard. The plant is expected to have a capacity of 750,000 tons and will have the following characteristics:

1. It will require an initial investment of 250 million BR. At the end of the fifth year, an additional investment of 50 million BR will be needed to update the plant.
2. Aracruz plans to borrow 100 million BR at a real interest rate of 6.3725%, using a ten-year term loan (where the loan will be paid off in equal annual increments).
3. The plant will have a life of ten years. During that period, the depreciable portion of the plant (and the additional investment in year five), not including salvage value, will be depreciated using double declining balance depreciation, with a life of ten years.⁶ At the end of the tenth year, the plant is expected to be sold for its salvage value of 75 million BR.
4. The plant will be partly in commission in a couple of months but will have a capacity of only 650,000 tons in the first year and 700,000 tons in the second year before getting to its full capacity of 750,000 tons in the third year.
5. The capacity utilization rate will be 90% for the first three years and rise to 95% after that.
6. The price per ton of linerboard is currently \$400 and is expected to keep pace with inflation for the life of the plant.
7. The variable cost of production, primarily labor and material, is expected to be 45% of total revenues; there is a fixed cost of 50 million BR, which will grow at the inflation rate.
8. The working capital requirements are estimated to be 15% of total revenues, and the investments have to be made at the beginning of each year. At the end of the tenth year, it is anticipated that the entire working capital will be salvaged.
9. Aracruz's corporate tax rate of 34% will apply to this project as well.

⁶With double declining balance depreciation, we double the straight line rate (which would be 10 percent a year, in this case with a ten-year life) and apply that rate to the remaining depreciable book value. We apply this rate to the investment in year five as well. We switch to straight line depreciation in the 6th year because straight line depreciation yields a higher value (and depreciates down to salvage value).

Before we estimate the net income on this project, we have to consider the debt payments each year and break them down into interest and principal payments. Table 5.7 summarizes the results.

Table 5.7 Debt Payments: Aracruz Paper Plant

Year	Beginning Debt	Interest expense	Principal Repaid	Total Payment	Ending Debt
1	R\$ 100,000	R\$ 6,373	R\$ 7,455	R\$ 13,828	R\$ 92,545
2	R\$ 92,545	R\$ 5,897	R\$ 7,930	R\$ 13,828	R\$ 84,615
3	R\$ 84,615	R\$ 5,392	R\$ 8,436	R\$ 13,828	R\$ 76,179
4	R\$ 76,179	R\$ 4,855	R\$ 8,973	R\$ 13,828	R\$ 67,206
5	R\$ 67,206	R\$ 4,283	R\$ 9,545	R\$ 13,828	R\$ 57,661
6	R\$ 57,661	R\$ 3,674	R\$ 10,153	R\$ 13,828	R\$ 47,508
7	R\$ 47,508	R\$ 3,027	R\$ 10,800	R\$ 13,828	R\$ 36,708
8	R\$ 36,708	R\$ 2,339	R\$ 11,488	R\$ 13,828	R\$ 25,220
9	R\$ 25,220	R\$ 1,607	R\$ 12,220	R\$ 13,828	R\$ 12,999
10	R\$ 12,999	R\$ 828	R\$ 12,999	R\$ 13,828	R\$ 0

^a Interest Expense = Beginning debt * Pre-tax interest rate on debt

Note that although the total payment remains the same each year, the break down into interest and principal payments changes from year to year.

Exhibit 5.3 summarizes the net income from plant investment to Aracruz each year for the next ten years. Note that all of the projections are in real cash flows. Consequently, the price of paper (which grows at the same rate as inflation) is kept constant in real terms, as is any other item having this characteristic.

In Exhibit 5.4 we estimate the cash flows to equity from the plant to Aracruz. To arrive at these cash flows, we do the following:

- Subtract out the portion of the initial capital expenditures that comes from equity; of the initial investment of 250,000 BR, only 150,000 BR comes from equity. In year five, there is an additional investment of 50,000 BR.
- Add back depreciation and amortization, because they are noncash charges.
- Subtract the changes in working capital; because investments in working capital are made at the beginning of each period, the initial investment in working capital of 35.1 million BR is made at time 0 and is 15% of revenues in year one. The changes in working capital in the years that follow are 15% of the changes in revenue in those years. At the end of year ten, the entire investment in working capital is recovered as salvage.

- Subtract the principal payments that are made to the bank in each period, because these are cash outflows to the nonequity claimholders in the firm.
- Add the salvage value of the plant in year ten to the total cash flows, because this is a cash inflow to equity investors.

The cash flows to equity measure the cash flows that equity investors at Aracruz can expect to receive from investing in the plant.



5.5. The Effects of Debt Financing on Cash Flows to Equity

In the analysis, we assumed an additional capital expenditure of 50 million BR in year five, financed entirely with funds from equity; the cash flow to equity in year five (from Exhibit 5.4) is 12.95 million R\$. If, instead, we had assumed the 50 million R\$ had come from new borrowing, the cash flow to equity in year five will

- a. increase by 50 million BR.
- b. decrease by 50 million BR.
- c. remain unchanged.

Explain.



Capbudgeq.xls: This spreadsheet allows you to estimate the cash flows to equity on a project.

Exhibit 5.3 Estimated Net Income from Paper Plant Investment: Aracruz Celulose (in '000s of R\$ – Real terms)

	1	2	3	4	5	6	7	8	9	10
Capacity (in '000s)	650	700	750	750	750	750	750	750	750	750
Utilization Rate	90%	90%	90%	95%	95%	95%	95%	95%	95%	95%
Production Rate (in '000s)	585	630	675	713	713	713	713	713	713	713
Price per ton	400	400	400	400	400	400	400	400	400	400
Revenues (in Real BR 000s)	R\$ 234,000	R\$ 252,000	R\$ 270,000	R\$ 285,000	R\$ 285,000	R\$ 285,000	R\$ 285,000	R\$ 285,000	R\$ 285,000	R\$ 285,000
- Direct Expenses	R\$ 155,300	R\$ 163,400	R\$ 171,500	R\$ 178,250	R\$ 178,250	R\$ 178,250	R\$ 178,250	R\$ 178,250	R\$ 178,250	R\$ 178,250
- Depreciation	R\$ 35,000	R\$ 28,000	R\$ 22,400	R\$ 17,920	R\$ 14,336	R\$ 21,469	R\$ 21,469	R\$ 21,469	R\$ 21,469	R\$ 21,469
Operating Income	R\$ 43,700	R\$ 60,600	R\$ 76,100	R\$ 88,830	R\$ 92,414	R\$ 85,281	R\$ 85,281	R\$ 85,281	R\$ 85,281	R\$ 85,281
- Interest Expenses	R\$ 6,373	R\$ 5,897	R\$ 5,392	R\$ 4,855	R\$ 4,283	R\$ 3,674	R\$ 3,027	R\$ 2,339	R\$ 1,607	R\$ 828
Taxable Income	R\$ 37,327	R\$ 54,703	R\$ 70,708	R\$ 83,975	R\$ 88,131	R\$ 81,607	R\$ 82,254	R\$ 82,942	R\$ 83,674	R\$ 84,453
- Taxes	R\$ 12,691	R\$ 18,599	R\$ 24,041	R\$ 28,552	R\$ 29,965	R\$ 27,746	R\$ 27,966	R\$ 28,200	R\$ 28,449	R\$ 28,714
Net Income	R\$ 24,636	R\$ 36,104	R\$ 46,667	R\$ 55,424	R\$ 58,167	R\$ 53,860	R\$ 54,287	R\$ 54,742	R\$ 55,225	R\$ 55,739
Beginning Book value: fixed assets	R\$ 250,000	R\$ 215,000	R\$ 187,000	R\$ 164,600	R\$ 146,680	R\$ 182,344	R\$ 160,875	R\$ 139,406	R\$ 117,938	R\$ 96,469
- Depreciation	R\$ 35,000	R\$ 28,000	R\$ 22,400	R\$ 17,920	R\$ 14,336	R\$ 21,469	R\$ 21,469	R\$ 21,469	R\$ 21,469	R\$ 21,469
+ Capital Exp.	R\$ 0	R\$ 0	R\$ 0	R\$ 0	R\$ 50,000	R\$ 0	R\$ 0	R\$ 0	R\$ 0	R\$ 0
Ending Book Value: fixed assets	R\$ 215,000	R\$ 187,000	R\$ 164,600	R\$ 146,680	R\$ 182,344	R\$ 160,875	R\$ 139,406	R\$ 117,938	R\$ 96,469	R\$ 75,000

^a Depreciation_t = Higher of (20% (Beginning Book Value_t – Salvage) or (Beginning Book Value – Salvage)/Remaining life). In year 1, for instance, 20% (250,000 – 75,000) = \$35,000, whereas (250,000-75,000)/10 = \$17,500. We use the former. We switch to straight line in year 6, right after the additional investment of 50 million R\$.

Exhibit 5.4 Cash Flows to Equity from Paper Plant: Aracruz Celulose (in '000s of real R\$)

	0	1	2	3	4	5	6	7	8	9	10
Net Income		24,636	36,104	46,667	55,424	58,167	53,860	54,287	54,742	55,225	55,739
+ Depreciation & Amortization		35,000	28,000	22,400	17,920	14,336	21,469	21,469	21,469	21,469	21,469
- Capital Expenditures	150,000	0	0	0	0	50,000	0	0	0	0	0
- Change in Working Capital	35,100	2,700	2,700	2,250	0	0	0	0	0	0	- 42,750
- Principal Repayments		7,455	7,930	8,436	8,973	9,545	10,153	10,800	11,488	12,220	12,999
+ Salvage Value of Plant											75,000
Cashflow to Equity	- 185,100	49,481	53,474	58,382	64,371	12,958	65,176	64,956	64,722	64,473	106,958

Illustration 5.7: Estimating Cash flows from an acquisition: Sensient Technologies

To evaluate how much Tata Chemicals should pay for Sensient Technologies, we estimated the cash flows from the entire firm. As with the Disney analysis, we will estimate pre-debt cash flows, i.e., cash flow to the firm, using the same steps. We will begin with the after-tax operating income, add back depreciation and other non-cash charges and subtract out changes in non-cash working capital. There are two key differences between valuing a firm and valuing a project. The first is that a publicly traded firm, at least in theory, can have a perpetual life. Most projects have finite lives, though we will argue that projects such as theme parks may have lives so long that we could treat them as having infinite lives. The second is that a firm can be considered a portfolio of projects, current and future. As a consequence, to value a firm, we have to make judgments about the quantity and quality of future projects.

For Sensient Technologies, we started with the 2008 financial statements and obtained the following inputs for cash flow in 2008:

- a. Operating Income: The firm reported operating income of \$162 million on revenues of \$1.23 billion for the year. The firm paid 37% of its income as taxes in 2008, and we will use this as both the effective and marginal tax rate.
- b. Capital Expenditures and depreciation: Depreciation in 2008 amounted to \$44 million, whereas capital expenditures for the year was \$54 million. Non-cash working capital increased by approximately \$16 million during the year.

The cash flow to the firm for Sensient Technologies in 2008 can be estimated as follows:

$$\begin{aligned} \text{Cash Flow to the firm} &= \text{After-tax Operating Income} + \text{Depreciation} - \text{Capital} \\ &\text{Expenditures} - \text{Change in Non-cash Working Capital} = 162 (1-.37) + 44 - 54 - \\ &16 = \$76.06 \text{ million} \end{aligned}$$

We will assume that the firm is mature and that all of the inputs to this computation – earnings, capital expenditures, depreciation and working capital – will grow 2% a year in perpetuity.⁷

⁷ For the moment, this assumption seems to be an arbitrary one. Clearly, we need to give more thought to not only what a reasonable growth rate for a firm is but what may cause that growth rate to change. We will return to this issue in much more depth in chapter 12 and use this simplified example for this chapter.

In Practice: Estimating Expected Revenues and Cash Flows

How do we estimate a project's expected revenues and expenses? The key word in this question is *estimate*. No one, no matter what his or her skill at forecasting and degree of preparation, can forecast with certainty how a risky project will do. There are generally three ways in which we can make these forecasts:

- a. *Experience and History*: The process of estimating project revenues and expenses is simplest for firms that consider the same kind of projects repeatedly. These firms can use their experience from similar projects that are already in operation to estimate expected values for new projects. Disney, for instance, can use its experiences with its existing theme parks in making its estimates for Rio Disney.
- b. *Market Testing*: If the project being assessed is different from the firm's existing business, we may need a preliminary assessment of the market before actually investing in the project. In a market survey, potential customers are asked about the product or service being considered to gauge the interest they would have in acquiring it. The results usually are qualitative and indicate whether the interest is strong or weak, allowing the firm to decide whether to use optimistic forecasts for revenues (if the interest is strong) or pessimistic forecasts (if the interest is weak). Companies that need more information will often test market the concept on smaller markets, before introducing it on a larger scale. Test marketing not only allows firms to test out the product or service directly but also yields far more detailed information about the potential size of the market.
- c. *Scenario Analysis*: There are cases in which a firm is considering introducing a product to a market it knows well, but there is considerable uncertainty introduced by external factors that the firm cannot control. In such cases, a firm may decide to consider different scenarios, and the revenues and expenses on the project under each scenario. We will return to this approach later in this chapter.

We have laid out three ways of estimating revenues and expenses for projects, but none of these approaches yields perfect estimates. Although some project risk may come from estimation error, a large portion of risk comes from real uncertainty about the future. Improving estimation techniques, using more market testing, and performing scenario

analysis may reduce estimation error but cannot eliminate real uncertainty. This is why we incorporate a risk premium into the discount rate.

C. Time-Weighted versus Nominal Cash Flows

Very few projects with long lifetimes generate earnings or cash flows evenly over their lives. In sectors with huge investments in infrastructure, such as telecommunications, the earnings and cash flows might be negative for an extended period (say, ten to twenty years) before they turn positive. In other sectors, the cashflows peak early and then gradually decrease over time. Whatever the reason for the unevenness of cash flows, a basic question that has to be addressed when measuring returns is whether they should reflect the timing of the earnings or cash flows. We will argue that they should, with earlier earnings and cash flows being weighted more when computing returns than earnings and cash flows later in a project life.

Why Cash Flows across Time Are Not Comparable

There are three reasons why cash flows across time are not comparable, and a cash flow in the future is worth less than a similar cash flow today:

1. Individuals *prefer present consumption to future consumption*. People would have to be offered more in the future to give up present consumption—this is called the *real rate of return*. The greater the real rate of return, the greater the difference in value between a cash flow today and an equal cash flow in the future.
2. When there is *monetary inflation*, the value of currency decreases over time. The greater the inflation, the greater the difference in value between a cash flow today and an equal cash flow in the future.
3. Any *uncertainty (risk)* associated with the cash flow in the future reduces the value of the cash flow. The greater the uncertainty associated with the cash flow, the greater the difference between receiving the cash flow today and receiving an equal amount in the future.

The process by which future cash flows are adjusted to reflect these factors is called *discounting*, and the magnitude of these factors is reflected in the *discount rate*. Thus the present value of a cash flow (CF_{*t*}) at a point in time *t* in the future, when the discount rate is *r*, can be written as follows:


$$\text{Present Value of Cash Flow} = CF_t \left(\frac{1}{(1+r)^t} \right)$$

Note that the second term in the brackets, $(1/[1+r]^t)$, is called the discount factor and effectively weights the cash flow by when it occurs. The differences in weights across time will depend entirely on the level of the discount rate. Consequently, when discount rates are high, which could be due to high real rates, high inflation, and/or high uncertainty, returns that occur further in the future will be weighted less. Appendix 3 includes a more complete discussion of the mechanics of present value.

The Case for Time-Weighted Returns

If we accept the arguments that cash flows measure returns more accurately than earnings and that the incremental cash flows more precisely estimate returns than total cash flows, we should logically follow up by using discounted cash flows (i.e., time-weighted returns) rather than nominal cash flows for two reasons.

1. Nominal cash flows at different points in time are not comparable and cannot be aggregated to arrive at returns. Discounted cash flows, on the other hand, convert all cash flows on a project to today's terms and allow us to compute returns more consistently.
2. If the objective in investment analysis is to maximize the value of the business taking the investments, we should be weighting cash flows that occur early more than cash flow that occur later, because investors in the business will also do so.

 **5.6. Time Horizons and Time Weighting**

Calculating present values for cash flows leads to a greater weighting for cash flows that occur sooner and a lower weighting for cash flows that occur later. Does it necessarily follow that using present value (as opposed to nominal value) makes managers more likely to take short-term projects over long-term projects?

Yes

No

Why or why not?



Managerial Optimism and Cash Flow Estimation

There is substantial evidence that managers tend to be too optimistic when assessing outcomes from an investment, and systematically overestimate the cash flows on investments. From capital budgeting projects, where expected revenues are higher than expected and costs are lower than expected, to acquisitions, where the projected cash flows on target companies are much higher than actual cash flows, there is an “optimism bias” that leads firms to take many investments that should not be accepted.⁸

The literature on managerial optimism also has two key sub-findings. The first is that people are more optimistic about outcomes that they believe that they can control. Thus, managers often over estimate their capacity to deliver market share and profit margins, in the face of competition. The second is that optimism tends to increase with commitment; the more committed a manager is to an investment, the more he or she is likely to over estimate the cash flows from that investment. These findings suggests two possible solutions to the optimism bias. The first is to take away the project analysis duties away from the project advocates. In other words, managers should not be given the task of generating the expected cash flows from expansion opportunities that they have initiated. In the same vein, investment bankers touting potential target companies for acquisitions should not be generating the expected cash flows for the valuations of these companies. The second is a requirement that all investments, no matter what their pedigree and who advocates them, be put through stress tests, where key assumptions are questioned, changed and analyzed.

To those who believe that hiring more experienced or intelligent managers will solve this problem, there is substantial evidence that the optimism bias becomes worse as managers become more intelligent and with greater experience. In fact, it is to counter this bias that firms often set hurdle rates well above the cost of capital or require net present values to be much greater than zero for a project to pass muster.

⁸ Heaton, J.B., 2002, “Managerial optimism and corporate finance.” *Financial Management* 33-45.

Investment Decision Rules

Having estimated the accounting earnings, cash flows, and time-weighted cash flows on an investment, we are still faced with the crucial decision of whether we should take the investment. In this section, we will consider a series of investment decision rules and put them to the test.

What Is an Investment Decision Rule?

When faced with new investments and projects, firms have to decide whether to invest in them or not. We have been leading up to this decision over the last few chapters, but investment decision rules allow us to formalize the process and specify what conditions need to be met for a project to be acceptable. Although we will be looking at a variety of investment decision rules in this section, it is worth keeping in mind what characteristics we would like a good investment decision rule to have.

- First, a good investment decision rule has to maintain a fair balance between allowing a manager analyzing a project to bring in his or her *subjective assessments* into the decision and ensuring that different projects are judged *consistently*. Thus, an investment decision rule that is too mechanical (by not allowing for subjective inputs) or too malleable (where managers can bend the rule to match their biases) is not a good rule.
- Second, a good investment decision rule will allow the firm to further the stated objective in corporate finance, which is to *maximize the value of the firm*. Projects that are acceptable using the decision rule should increase the value of the firm accepting them, whereas projects that do not meet the requirements would destroy value if the firm invested in them.
- Third, a good investment decision rule should *work across a variety of investments*. Investments can be revenue-generating investments (such as Home Depot opening a new store) or they can be cost-saving investments (as would be the case if Boeing adopted a new system to manage inventory). Some projects have large up-front costs (as is the case with the Boeing Super Jumbo aircraft), whereas other projects may have costs spread out across time. A good investment rule will provide an answer on all of these different kinds of investments.

Does there have to be only one investment decision rule? Although many firms analyze projects using a number of different investment decision rules, one rule has to dominate. In other words, when the investment decision rules lead to different conclusions on whether the project should be accepted or rejected, one decision rule has to be the tie-breaker and can be viewed as the primary rule.

Accounting Income–Based Decision Rules

Many of the oldest and most established investment decision rules have been drawn from the accounting statements and, in particular, from accounting measures of income. Some of these rules are based on income to equity investors (i.e., net income), and others are based on operating income.

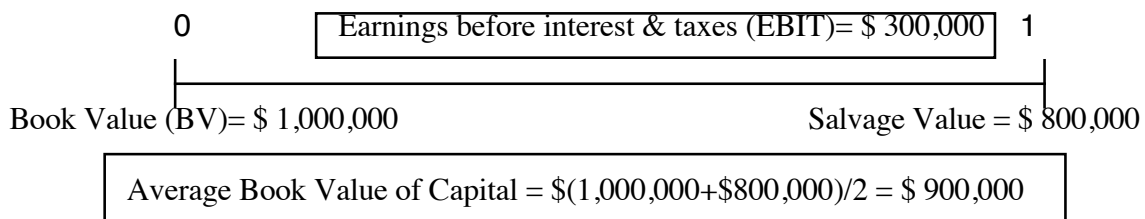
Return on Capital

The return on capital on a project measures the returns earned by the firm on its total investment in the project. Consequently, it is a return to all claimholders in the firm on their collective investment in a project. Defined generally,

$$\text{Return on Capital (Pretax)} = \frac{\text{Earnings before interest and taxes}}{\text{Average Book Value of Capital Invested in Project}}$$

$$\text{Return on Capital (After-tax)} = \frac{\text{Earnings before interest and taxes (1- tax rate)}}{\text{Average Book Value of Capital Invested in Project}}$$

To illustrate, consider a one-year project, with an initial investment of \$1 million, and earnings before interest and taxes (EBIT) of \$300,000. Assume that the project has a salvage value at the end of the year of \$800,000, and that the tax rate is 40%. In terms of a time line, the project has the following parameters:



The pretax and after-tax returns on capital can be estimated as follows:

$$\text{Return on Capital (Pre-tax)} = \frac{\$ 300,000}{\$ 900,000} = 33.33\%$$

$$\text{Return on Capital (After-tax)} = \frac{\$ 300,000 (1 - 0.40)}{\$ 900,000} = 20\%$$

Although this calculation is rather straightforward for a one-year project, it becomes more involved for multiyear projects, where both the operating income and the book value of the investment change over time. In these cases, the return on capital can either be estimated each year and then averaged over time or the average operating income over the life of the project can be used in conjunction with the average investment during the period to estimate the average return on capital.

The after-tax return on capital on a project has to be compared to a hurdle rate that is defined consistently. The return on capital is estimated using the earnings before debt payments and the total capital invested in a project. Consequently, it can be viewed as return to the firm, rather than just to equity investors. Consequently, the cost of capital should be used as the hurdle rate.

If the after-tax return on capital > Cost of Capital → Accept the project

If the after-tax return on capital < Cost of Capital → Reject the project

For instance, if the company considering this project had a cost of capital of 10%, it would view the investment in the new project as a good one.

Illustration 5.8: Estimating and Using Return on Capital in Decision Making: Disney and Bookscape projects

In Illustrations 5.4 and 5.5, we estimated the operating income from two projects—an investment by Bookscape in an online book ordering service and an investment in a theme park in Brazil by Disney. We will estimate the return on capital on each of these investments using our earlier estimates of operating income. Table 5.8 summarizes the estimates of operating income and the book value of capital at Bookscape.

Table 5.8 Return on Capital on Bookscape Online

	1	2	3	4	Average
After-tax Operating Income	\$120,000	\$183,000	\$216,300	\$252,930	\$193,058
BV of Capital: Beginning	\$1,150,000	\$930,000	\$698,000	\$467,800	
BV of Capital: Ending	\$930,000	\$698,000	\$467,800	\$0	
Average BV of Capital	\$1,040,000	\$814,000	\$582,900	\$233,900	\$667,700
Return on Capital	11.54%	22.48%	37.11%	108.14%	28.91%

The book value of capital each year includes the investment in fixed assets and the noncash working capital. If we average the year-specific returns on capital, the average return on capital is 44.82%, but this number is pushed up by the extremely high return in year four. A better estimate of the return on capital is obtained by dividing the average after-tax operating income (\$193,058) over the four years by the average capital invested (\$667,700) over this time, which yields a return on capital of 28.91%. Because this number exceeds the cost of capital of 25.42% that we estimated in Illustration 5.2 for this project, the return on capital approach would suggest that this is a good project.

In Table 5.9, we estimate operating income, book value of capital, and return on capital (ROC) for Rio Disney. The operating income estimates are from Exhibit 5.1.

Table 5.9 Return on Capital for Rio Disney (Income and capital in millions)

Year	After-tax Operating Income	Book value of				Average BV of Capital	ROC (a)	ROC (b)
		Pre-project investment	Fixed assets	Working capital	Total Capital			
0		\$500	\$2,000	\$0	\$2,500		NA	NA
1	-\$31	\$450	\$3,000	\$0	\$3,450	\$2,975	-1.04%	-1.24%
2	-\$93	\$400	\$3,813	\$63	\$4,275	\$3,863	-2.41%	-2.70%
3	-\$52	\$350	\$4,145	\$88	\$4,582	\$4,429	-1.18%	-1.22%
4	\$66	\$300	\$4,027	\$125	\$4,452	\$4,517	1.46%	1.44%
5	\$196	\$250	\$3,962	\$156	\$4,368	\$4,410	4.43%	4.39%
6	\$241	\$200	\$3,931	\$172	\$4,302	\$4,335	5.57%	5.52%
7	\$290	\$150	\$3,931	\$189	\$4,270	\$4,286	6.76%	6.74%
8	\$341	\$100	\$3,946	\$208	\$4,254	\$4,262	8.01%	8.00%
9	\$397	\$50	\$3,978	\$229	\$4,257	\$4,255	9.34%	9.34%
10	\$408	\$0	\$4,010	\$233	\$4,243	\$4,250	9.61%	9.59%
Average							4.05%	3.99%

Average BV of Capital_t = (Capital_{t-1} + Capital_t) / 2

ROC (a) = After-tax Operating Income / Average BV of Capital

ROC (b) = After-tax Operating Income / BV of Capital at end of prior year

The book value of capital includes the investment in fixed assets (capital expenditures), net of depreciation, and the investment in working capital that year. It also includes the capitalized pre-project investment and the return on capital each year is computed based on the average book value of capital invested during the year. The average after-tax return on capital, computed using the average capital invested, over the ten-year period is 4.05%; it is slightly lower if we use capital at the end of the prior year. Here, the return

on capital is lower than the cost of capital that we estimated in Illustration 5.2 to be 8.62%, and this suggests that Disney should not make this investment.

Return on Equity

The return on equity looks at the return to equity investors, using the accounting net income as a measure of this return. Again, defined generally,

$$\text{Return on Equity} = \frac{\text{Net Income}}{\text{Average Book Value of Equity Investment in Project}}$$

To illustrate, consider a four-year project with an initial equity investment of \$800, and the following estimates of net income in each of the four years:

Net Income	\$ 140	\$ 170	\$ 210	\$ 250	
BV of Equity	\$ 800	\$ 700	\$ 600	\$ 500	\$ 400
Return on Equity	18.67%	26.15%	38.18%	55.56%	

Like the return on capital, the return on equity tends to increase over the life of the project, as the book value of equity in the project is depreciated.

Just as the appropriate comparison for the return on capital is the cost of capital, the appropriate comparison for the return on equity is the *cost of equity*, which is the rate of return equity investors demand.

Decision Rule for ROE Measure for Independent Projects

If the Return on Equity > Cost of Equity → Accept the project

If the Return on Equity < Cost of Equity → Reject the project

The cost of equity should reflect the riskiness of the project being considered and the financial leverage taken on by the firm. When choosing between mutually exclusive projects of similar risk, the project with the higher return on equity will be viewed as the better project.

Illustration 5.9: Estimating Return on Equity: Aracruz Celulose

Consider again the analysis of the paper plant for Aracruz Celulose that we started in Illustration 5.6. Table 5.10 summarizes the book value of equity and the estimated net income (from Exhibit 5.3) for each of the next ten years in thousands of real BR.

Table 5.10 Return on Equity: Aracruz Paper Plant

Year	Net Income	Beg. BV: Assets	Depreciation	Capital Exp.	Ending BV: Assets	BV of Working Capital	Debt	BV: Equity	Average BV: Equity	ROE
0		R\$ 0	R\$ 0	R\$ 250,000	R\$ 250,000	R\$ 35,100	R\$ 100,000	R\$ 185,100		
1	R\$ 24,636	R\$ 250,000	R\$ 35,000	R\$ 0	R\$ 215,000	R\$ 37,800	R\$ 92,545	R\$ 160,255	R\$ 172,678	14.27%
2	R\$ 36,104	R\$ 215,000	R\$ 28,000	R\$ 0	R\$ 187,000	R\$ 40,500	R\$ 84,615	R\$ 142,885	R\$ 151,570	23.82%
3	R\$ 46,667	R\$ 187,000	R\$ 22,400	R\$ 0	R\$ 164,600	R\$ 42,750	R\$ 76,179	R\$ 131,171	R\$ 137,028	34.06%
4	R\$ 55,424	R\$ 164,600	R\$ 17,920	R\$ 0	R\$ 146,680	R\$ 42,750	R\$ 67,206	R\$ 122,224	R\$ 126,697	43.75%
5	R\$ 58,167	R\$ 146,680	R\$ 14,336	R\$ 50,000	R\$ 182,344	R\$ 42,750	R\$ 57,661	R\$ 167,433	R\$ 144,828	40.16%
6	R\$ 53,860	R\$ 182,344	R\$ 21,469	R\$ 0	R\$ 160,875	R\$ 42,750	R\$ 47,508	R\$ 156,117	R\$ 161,775	33.29%
7	R\$ 54,287	R\$ 160,875	R\$ 21,469	R\$ 0	R\$ 139,406	R\$ 42,750	R\$ 36,708	R\$ 145,448	R\$ 150,783	36.00%
8	R\$ 54,742	R\$ 139,406	R\$ 21,469	R\$ 0	R\$ 117,938	R\$ 42,750	R\$ 25,220	R\$ 135,468	R\$ 140,458	38.97%
9	R\$ 55,225	R\$ 117,938	R\$ 21,469	R\$ 0	R\$ 96,469	R\$ 42,750	R\$ 12,999	R\$ 126,220	R\$ 130,844	42.21%
10	R\$ 55,739	R\$ 96,469	R\$ 21,469	R\$ 0	R\$ 75,000	R\$ 0	R\$ 0	R\$ 75,000	R\$ 100,610	55.40%
								Average ROE =		36.19%

^aBV = Book Value

^bEnding BV = Beg BV + Capital Expenses - Depreciation

To compute the book value of equity in each year, we first compute the book value of the fixed assets (plant and equipment), add to it the book value of the working capital in that year, and subtract out the outstanding debt. The return on equity (ROE) each year is obtained by dividing the net income in that year by the average book value of equity invested in the plant in that year. The increase in the return on equity over time occurs because the net income rises while the book value of equity decreases. The average real return on equity of 23.24% on the paper plant project is compared to the real cost of equity for this plant, which is 11.46%, suggesting that this is a good investment.

Assessing Accounting Return Approaches

How well do accounting returns measure up to the three criteria we listed for a good investment decision rule? In terms of maintaining balance between allowing managers to bring into the analysis their judgments about the project and ensuring consistency between analysis, the accounting returns approach falls short. It fails because it is significantly affected by accounting choices. For instance, changing from straight-line to accelerated depreciation affects both the earnings and the book value over time, thus altering returns. Unless these decisions are taken out of the hands of individual managers assessing projects, there will be no consistency in the way returns are measured on different projects.

Does investing in projects that earn accounting returns exceeding their hurdle rates lead to an increase in firm value? The value of a firm is the present value of expected cash flows on the firm over its lifetime. Because accounting returns are based on earnings rather than cash flows and ignore the time value of money, investing in projects that earn a return greater than the hurdle rates will not necessarily increase firm value. Conversely, some projects that are rejected because their accounting returns fall short of the hurdle rate may have increased firm value. This problem is compounded by the fact that the returns are based on the book value of investments, rather than the cash invested in the assets.

Finally, the accounting return works better for projects that have a large up-front investments and generate level income over time. For projects that do not require a significant initial investment, the return on capital and equity has less meaning. For instance, a retail firm that leases store space for a new store will not have a significant initial investment and may have a very high return on capital as a consequence.

Note that all of the limitations of the accounting return measures are visible in the last two illustrations. First, the Disney example does not differentiate between money already spent and money still to be spent; rather, the sunk cost of \$0.5 billion is shown in the initial investment of \$3.5 billion. Second, in both the Bookscape and Aracruz analyses, as the book value of the assets decreases over time, largely as a consequence of depreciation, the operating income rises, leading to an increase in the return on capital. With the Disney analysis, there is one final and very important concern. The return on

capital was estimated over ten years, but the project life is likely to be much longer. After all, Disney's existing theme parks in the United States are more than three decades old and generate substantial cash flows for the firm even today. Extending the project life will push up the return on capital and may make this project viable.

Notwithstanding these concerns, accounting measures of return endure in investment analysis. Although this fact can be partly attributed to the unwillingness of financial managers to abandon familiar measures, it also reflects the simplicity and intuitive appeal of these measures. More important, as long as accounting measures of return are used by investors and equity research analysts to assess the overall performance of firms, these same measures of return will be used in project analysis.

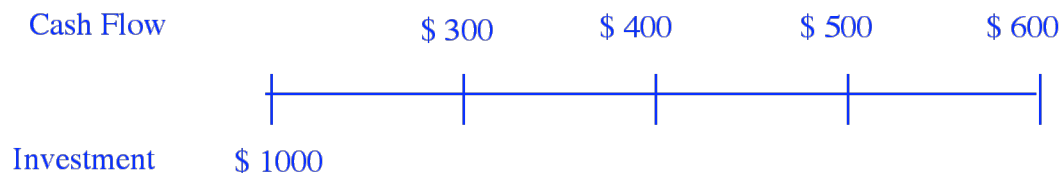


Cash Flow–Based Decision Rules

Measures of accounting return suffer from all of the problems that we noted with accounting profits. The simplest fix is to replace accounting earnings with cash flows. In this section, we will consider two simple variants: payback, where we examine the number of years it will take to get your money back on an investment and cash flows return on capital, where we modify the conventional return on capital by replacing earnings with cash flows.

Payback

The **payback** on a project is a measure of how quickly the cash flows generated by the project cover the initial investment. Consider a project that has the following cash flows:



Payback: The length of time it will take for nominal cash flows from the project to cover the initial investment.

The payback on this project is between two and three years and can be approximated, based on the cash flows to be 2.6 years.

As with the other measures, the payback can be estimated either for all investors in the project or just for the equity investors. To estimate the payback for the entire firm, the free cash flows to the firm are added up until they cover the total initial investment. To estimate payback just for the equity investors, the free cash flows to equity are cumulated until they cover the initial equity investment in the project.

Illustration 5.10: Estimating Payback for the Bookscape Online Service

This example estimates the payback from the viewpoint of the firm, using the Bookscape online service cash flows estimated in Illustration 5.4. Table 5.11 summarizes the annual cash flows and their cumulated value.

Table 5.11 Payback for Bookscape Online

<i>Year</i>	<i>Cash flow in year</i>	<i>Cumulated Cash flow</i>
0	-\$1,150,000	
1	\$340,000	-\$810,000
2	\$415,000	-\$395,000
3	\$446,500	\$51,500
4	\$720,730	\$772,230

The initial investment of \$1.15 million is covered sometime in the third year, leading to a payback of between two and three years. If we assume that cash flows occur uniformly over the course of the year:

$$\text{Payback for Project} = 2 + (\$395,000/\$446,500) = 2.88 \text{ years}$$

Using Payback in Decision Making

Although it is uncommon for firms to make investment decisions based solely on the payback, surveys suggest that some businesses do in fact use payback as their primary decision mechanism. In those situations where payback is used as the primary criterion for accepting or rejecting projects, a maximum acceptable payback period is typically set. Projects that pay back their initial investment sooner than this maximum are accepted, and projects that do not are rejected.

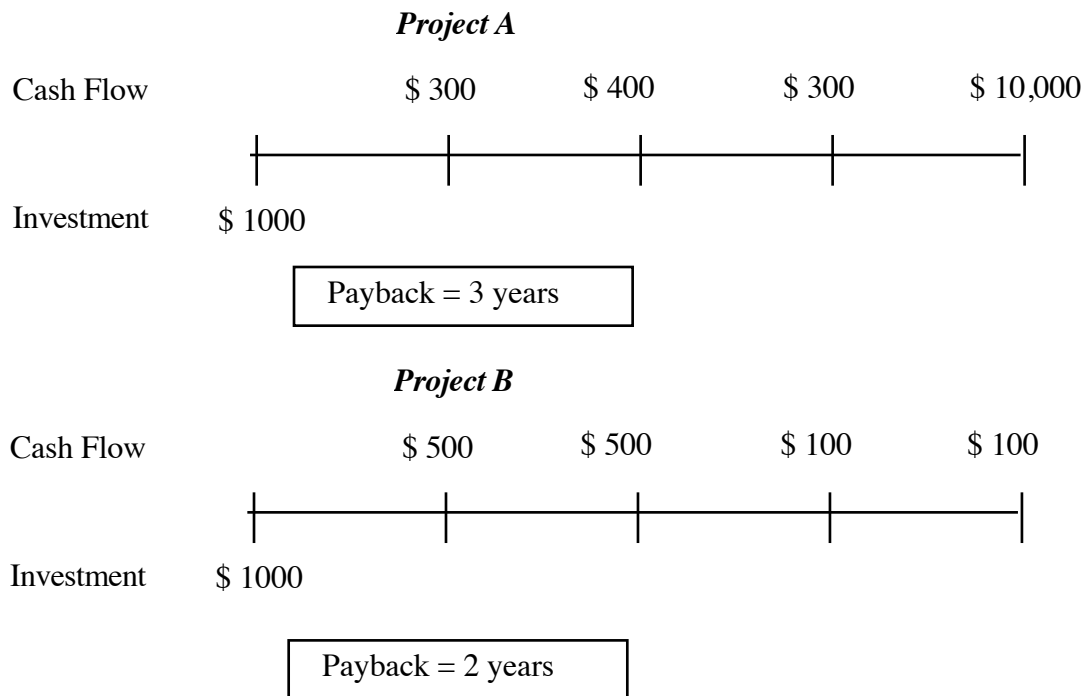
Firms are much more likely to employ payback as a secondary investment decision rule and use it either as a constraint in decision making (e.g., accept projects that earn a return on capital of at least 15%, as long as the payback is less than ten years) or to choose between projects that score equally well on the primary decision rule (e.g., when two mutually exclusive projects have similar returns on equity, choose the one with the lower payback).

Biases, Limitations, and Caveats

The payback rule is a simple and intuitively appealing decision rule, but it does not use a significant proportion of the information that is available on a project.

- By restricting itself to answering the question, “When will this project make its initial investment?” it ignores what happens after the initial investment is recouped. This is a significant shortcoming when deciding between mutually exclusive projects. To provide a sense of the absurdities this can lead to, assume that you are picking between two mutually exclusive projects with the cash flows shown in Figure 5.2:

Figure 5.2: Using Payback for Mutually Exclusive Projects



On the basis of the payback alone, project B is preferable to project A because it has a shorter payback period. Most decision makers would pick project A as the better

project, however, because of the high cash flows that result after the initial investment is paid back.

- The payback rule is designed to cover the conventional project that involves a large up-front investment followed by positive operating cash flows. It breaks down, however, when the investment is spread over time or when there is no initial investment.
- The payback rule uses nominal cash flows and counts cash flows in the early years the same as cash flows in the later years. Because money has time value, however, recouping the nominal initial investment does not make the business whole again, because that amount could have been invested elsewhere and earned a significant return.

Cash Flow Returns

If the problem with the conventional return on capital and return on equity is the dependence on accounting earnings, there seems to be a simple fix in order. If we can replace earnings with cash flows, the return we should estimate should be a cash flow returns. The modification, though, can be tricky and many existing variants fail consistency tests. Table 5.12 summarizes some of the measures of cash flow returns in use and the measurement issues with each:

Table 5.12: Measures of Cash Flow Returns

Measure	Measurement issues/biases
$\frac{\text{EBITDA}}{\text{BV of Capital Invested}}$	Adding back depreciation without netting out capital expenditures and working capital changes will overstate returns, as will ignoring taxes.
$\frac{(\text{EBIT}(1-t) + \text{Depreciation})}{\text{BV of Capital Invested}}$ & $\frac{\text{Net Income} + \text{Depreciation}}{\text{BV of Equity}}$	Same issue with depreciation being added back and capital expenditures not being subtracted out.
$\frac{(\text{EBIT}(1-t) + \text{Depreciation})}{\text{Gross Capital Invested}}$	Gross capital invested is computed by adding back accumulated depreciation over time to the book value. It partially corrects for the failure to add back capital expenditures.

The full estimate of cash flows, described earlier in the chapter, requires subtracting out capital expenditures and changes in non-cash working capital but it is far too volatile on a year-to-year basis to yield reliable measures of returns on equity or capital.

Discounted Cash Flow Measures

Investment decision rules based on discounted cash flows not only replace accounting income with cash flows but explicitly factor in the time value of money. The two most widely used discounted cash flows rules are *net present value* and the *internal rate of return*.

Net Present Value (NPV): The sum of the present values of the expected cash flows on the project, net of the initial investment.

Net Present Value (NPV)

The *net present value* of a project is the sum of the present values of each of the cash flows—positive as well as negative—that occurs over the life of the project. The general formulation of the NPV rule is as follows:

$$\text{NPV of Project} = \sum_{t=1}^{t=N} \frac{\text{CF}_t}{(1+r)^t} - \text{Initial Investment}$$

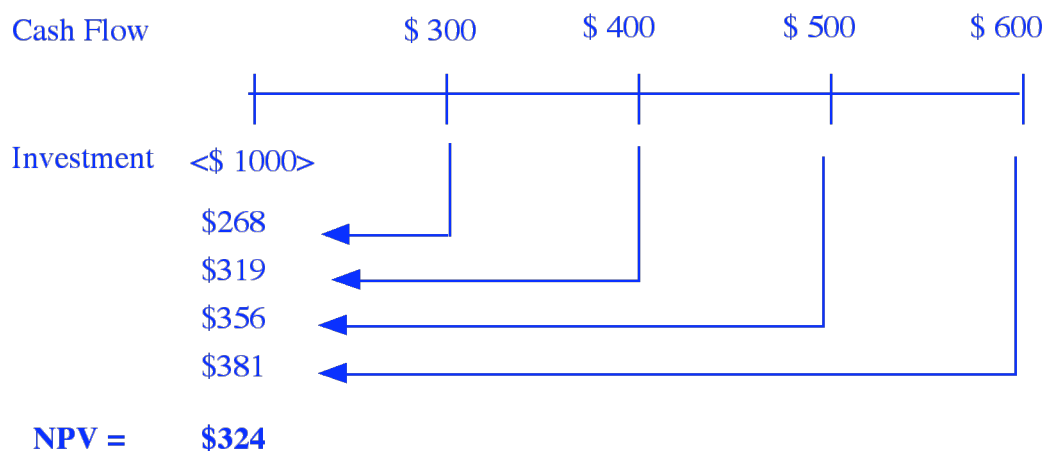
where

CF_t = Cash flow in period t

r = Discount rate

N = Life of the project.

Consider a simple project, with an initial investment of \$ 1 billion and expected cash flows of \$300 million in year 1, \$ 400 million in year 2, \$ 500 million in year 3 and \$ 600 million in year 4. Assuming a discount rate of 12%, the NPV of a project is depicted in figure 5.3:

Figure 5.3: NPV of a Project

Once the NPV is computed, the decision rule is extremely simple because the hurdle rate is already factored in the present value.

Decision Rule for NPV for Independent Projects

If the NPV > 0 → Accept the project

If the NPV < 0 → Reject the project

Note that an NPV that is greater than zero implies that the project makes a return greater than the hurdle rate.

 **5.8. The Significance of a Positive NPV**

Assume that you have analyzed a \$100 million project using a cost of capital of 15% and come up with an NPV of \$1 million. The manager who has to decide on the project argues that this is too small an NPV for a project of this size and that this indicates a poor project. Is this true?

- Yes. The NPV is only 1% of the initial investment.
- No. A positive NPV indicates a good project.

Explain your answer.

Illustration 5.11: NPV from the Firm's Standpoint: Bookscape Online

Table 5.13 calculates the present value of the cash flows to Bookscape as a firm from the proposed online book ordering service using the cost of capital of 25.48% as the

discount rate on the cash flows. (The cash flows are estimated in Illustration 5.4 and the cost of capital is estimated in Illustration 5.2.)

Table 5.13 Cashflow to the Firm on Bookscape Online

Year	Cash Flow	PV of Cash Flows @ 25.48%
0	(\$1,150,000)	\$(1,150,000)
1	\$340,000	\$270,957
2	\$415,000	\$263,568
3	\$446,500	\$225,989
4	\$720,730	\$290,710
NPV		\$(98,775)

This project has a net present value of $-\$98,775$, suggesting that it is a project that should not be accepted based on the projected cash flows and the cost of capital of 25.48%.

Illustration 5.12: NPV from the Firm's Standpoint: Rio Disney

In estimating the cash flows to discount for Disney's theme park in Rio, the first point to note when computing the NPV of the proposed theme park is the fact that it has a life far longer than the ten years shown in Exhibit 5.2. To bring in the cash flows that occur after year ten, when cash flows start growing at 2%, the inflation rate forever, we draw on a present value formula for a growing perpetuity (See Appendix 3):

$$\begin{aligned} \text{Present Value of Cash Flows after Year 10} &= \frac{\text{Cashflow}_{11}}{(\text{Cost of Capital} - \text{Perpetual growth rate})} \\ &= \frac{\$692 (1.02)}{(.0862 - .02)} = \$10,669 \text{ million} \end{aligned}$$

The cost of capital of 8.62% is the cost of capital for Rio Disney that we estimated in Illustration 5.2. This present value is called the *terminal value* and occurs at the end of year ten.

Table 5.14 presents the NPV of the proposed park estimated using the cash flows in millions of U.S. dollars from Exhibit 5.2 and Disney's cost of capital, in dollar terms, of 8.62%.

Table 5.14 NPV of Rio Disney

Year	Annual Cashflow	Terminal Value	Present Value
0	-\$2,000		-\$2,000
1	-\$1,000		-\$921
2	-\$860		-\$729

3	-\$270		-\$211
4	\$332		\$239
5	\$453		\$300
6	\$502		\$305
7	\$538		\$302
8	\$596		\$307
9	\$660		\$313
10	\$692	\$10,669	\$4,970
Net Present Value =			\$2,877

The NPV of this project is positive. This suggests that it is a good project that will earn \$2.877 billion in surplus value for Disney.

NPV and Currency Choices

When analyzing a project, the cash flows and discount rates can often be estimated in one of several currencies. For a project like the Disney theme park, the obvious choices are the project's local currency (Brazilian Reals- R\$) and the company's home currency (U.S. dollars), but we can in fact use any currency to evaluate the project. When switching from one currency to another, we have to go through the following steps:

1. *Estimate the expected exchange rate for each period of the analysis:* For some currencies (Euro, yen, or British pound), we can estimate of expected exchange rates from the financial markets in the form of forward rates. For other currencies, we have to estimate the exchange rate, and the soundest way to do so is to use the expected inflation rates in the two currencies in question. For instance, we can estimate the expected R\$/\\$ exchange rate in n years:

$$\text{Expected Rate (R\$/\$)} = \$R/\$ (\text{Today}) * \left[\frac{(1 + \text{Expected Inflation}_{\text{Brazil}})}{(1 + \text{Expected Inflation}_{\text{US}})} \right]^n$$

We are assuming that purchasing power ultimately drives exchange rates—this is called purchasing power parity.

2. *Convert the expected cash flows from one currency to another in future periods, using these exchange rates:* Multiplying the expected cash flows in one currency to another will accomplish this.
3. *Convert the discount rate from one currency to another:* We cannot discount cash flows in one currency using discount rates estimated in another. To convert a

discount rate from one currency to another, we will again use expected inflation rates in the two currencies. A US dollar cost of capital can be converted into R\$ cost of capital as follows:

$$\text{Cost of Capital(R\$)} = (1 + \text{Cost of Capital (\$)}) * \frac{(1 + \text{Exp Inflation}_{\text{Brazil}})}{(1 + \text{Exp Inflation}_{\text{US}})} - 1$$

- a. Compute the NPV by discounting the converted cash flows (from step 2) at the converted discount rate (from step 3): The NPV should be identical in both currencies but only because the expected inflation rate was used to estimate the exchange rates. If the forecasted exchange rates diverge from purchasing power parity, we can get different NPVs, but our currency views are then contaminating our project analysis.

Illustration 5.13: NPV in R\$: Rio Disney

In Illustration 5.12, we computed the NPV for Rio Disney in dollar terms to be \$2,877 million. The entire analysis could have been done in Brazilian Reals (R\$) terms. To do this, the cash flows would have to be converted from dollars to R\$, and the discount rate would then have been a R\$ discount rate. To estimate the expected exchange rate, we will assume that the expected inflation rate will be 7% in Brazil and 2% in the United States and use the exchange rate is 2.04 R\$ per U.S. dollar in May 2009 as the current exchange rate. The projected exchange rate in one year will be:

$$\text{Expected Exchange Rate in Year 1} = 2.04 \text{ R\$} * (1.07/1.02) = 2.14 \text{ R\$/\$}$$

Similar analyses will yield exchange rates for each of the next ten years.

The dollar cost of capital of 8.62%, estimated in illustration 5.1, is converted to a R\$ cost of capital using the expected inflation rates:

$$\begin{aligned} \text{Cost of Capital (R\$)} &= (1 + \text{Cost of Capital (\$)}) * \frac{(1 + \text{Exp Inflation}_{\text{Brazil}})}{(1 + \text{Exp Inflation}_{\text{US}})} - 1 \\ &= (1.0862) (1.07/1.02) - 1 = 13.94\% \end{aligned}$$

Table 5.15 summarizes exchange rates, cash flows, and the present value for the proposed Disney theme parks, with the analysis done entirely in Brazilian Reals.

Table 5.15 Expected Cash Flows from Disney Theme Park in R\$

Year	Cashflow (\$)	R\$/\\$	Cashflow (R\$)	Present Value
0	-\$ 2,000.00	R\$ 2.04	-R\$ 4,080.00	-R\$ 4,080.00

1	-\$ 1,000.00	R\$ 2.14	-R\$ 2,140.00	-R\$ 1,878.14
2	-\$ 859.50	R\$ 2.24	-R\$ 1,929.49	-R\$ 1,486.19
3	-\$ 270.06	R\$ 2.35	-R\$ 635.98	-R\$ 429.92
4	\$ 332.50	R\$ 2.47	R\$ 821.40	R\$ 487.32
5	\$ 453.46	R\$ 2.59	R\$ 1,175.12	R\$ 611.87
6	\$ 501.55	R\$ 2.72	R\$ 1,363.46	R\$ 623.06
7	\$ 538.06	R\$ 2.85	R\$ 1,534.43	R\$ 615.39
8	\$ 595.64	R\$ 2.99	R\$ 1,781.89	R\$ 627.19
9	\$ 659.64	R\$ 3.14	R\$ 2,070.10	R\$ 639.48
10	\$ 11,360.86	R\$ 3.29	R\$ 37,400.49	R\$ 10,139.72
				R\$ 5,869.78

Note that the NPV of R\$ 5,870 million is exactly equal to the dollar NPV computed in Illustration 5.12, converted at the current exchange rate of 2.04 R\$ per dollar.

$$\text{NPV in dollars} = \text{NPV in R\$} / \text{Current Exchange Rate} = 5,870 / 2.04 = \$2,877 \text{ million}$$

In Practice: Terminal Value, Salvage Value, and Net Present Value

When estimating cash flows for an individual project, practicality constrains us to estimate cash flows for a finite period—three, five, or ten years, for instance. At the end of that finite period, we can make one of three assumptions.

- The most conservative one is that the project ceases to exist and its assets are worthless. In that case, the final year of operation will reflect only the operating cash flows from that year.
- We can assume that the project will end at the end of the analysis period and that the assets will be sold for salvage. Although we can try to estimate salvage value directly, a common assumption that is made is that salvage value is equal to the book value of the assets. For fixed assets, this will be the undepreciated portion of the initial investment, whereas for working capital, it will be the aggregate value of the investments made in working capital over the course of the project life.
- We can also assume that the project will not end at the end of the analysis period and try to estimate the value of the project on an ongoing basis—this is the terminal value. In the Disney theme park analysis, for instance, we assumed that the cash flows will continue forever and grow at the inflation rate each year. If that seems too optimistic, we can assume that the cash flows will continue with no growth for a finite period or even that they will drop by a constant rate each year.

The right approach to use will depend on the project being analyzed. For projects that are not expected to last for long periods, we can use either of the first two approaches; a zero salvage value should be used if the project assets are likely to become obsolete by the end of the project life (e.g., computer hardware), and salvage can be set to book value if the assets are likely to retain significant value (e.g., buildings).

For projects with long lives, the terminal value approach is likely to yield more reasonable results but with one caveat. The investment and maintenance assumptions made in the analysis should reflect its long life. In particular, capital maintenance expenditures will be much higher for projects with terminal value because the assets have to retain their earning power. For the Disney theme park, the capital maintenance expenditures climb over time and become larger than depreciation as we approach the terminal year.



5.9. Currency Choices and NPV

A company in a high-inflation economy has asked for your advice regarding which currency to use for investment analysis. The company believes that using the local currency to estimate the NPV will yield too low a value because domestic interest rates are very high—this, in turn, would push up the discount rate. Is this true?

- a. Yes. A higher discount rate will lead to lower NPV.
- b. No.

Explain your answer.

NPV: Firm versus Equity Analysis

In the previous analysis, the cash flows we discounted were prior to interest and principal payments, and the discount rate we used was the weighted average cost of capital. In NPV parlance, we were discounting cash flows to the entire firm (rather than just its equity investors) at a discount rate that reflected the costs to different claimholders in the firm to arrive at an NPV. There is an alternative. We could have discounted the cash flows left over after debt payments for equity investors at the cost of equity and arrived at an NPV to equity investors.

Will the two approaches yield the same NPV? As a general rule, they will, but only if the following assumptions hold:

- The debt is correctly priced and the market interest rate to compute the cost of capital is the right one, given the default risk of the firm. If not, it is possible that equity investors can gain (if interest rates are set too low) or lose (if interest rates are set too high) to bondholders. This in turn can result in the NPV to equity being different from the NPV to the firm.
- The same assumptions are made about the financing mix used in both calculations. Note that the financing mix assumption affects the discount rate (cost of capital) in the firm approach and the cash flows (through the interest and principal payments) in the equity approach.

Given that the two approaches yield the same NPV, which one should we choose to use? Many practitioners prefer discounting cash flows to the firm at the cost of capital; it is easier to do because the cash flows are before debt payments and therefore we do not have to estimate interest and principal payments explicitly. Cash flows to equity are more intuitive, though, because most of us think of cash flows left over after interest and principal payments as residual cash flows.

Illustration 5.14: NPV from the Equity Investors' Standpoint: Paper Plant for Aracruz

The NPV is computed from the equity investors' standpoint for the proposed linerboard plant for Aracruz using real cash flows to equity, estimated in Exhibit 5.4, and a real cost of equity of 18.45% (estimated earlier in illustration 5.2). Table 5.16 summarizes the cash flows and the present values.

Table 5.16 Cashflow to Equity on Linerboard Plant (in Thousands)

Year	Cash flow to Equity	PV of Cashflow @ 18.45%
0	-R\$ 185,100	-R\$ 185,100
1	R\$ 49,481	R\$ 41,773
2	R\$ 53,474	R\$ 38,110
3	R\$ 58,382	R\$ 35,126
4	R\$ 64,371	R\$ 32,696
5	R\$ 12,958	R\$ 5,556
6	R\$ 65,176	R\$ 23,594
7	R\$ 64,956	R\$ 19,851
8	R\$ 64,722	R\$ 16,698

9	R\$ 64,473	R\$ 14,043
10	R\$ 181,958	R\$ 33,458
Net Present Value =		R\$ 75,806

The net present value of R\$ 75.806 million suggests that this is a good project for Aracruz to invest in.

The analysis was done entirely in real terms, but using nominal cash flows and discount rate would have had no impact on the NPV. The cash flows will be higher because of expected inflation, but the discount rate will increase by exactly the same magnitude, thus resulting in an identical NPV. The choice between nominal and real cash flows therefore boils down to one of convenience. When inflation rates are low, it is better to do the analysis in nominal terms because taxes are based on nominal income. When inflation rates are high and volatile, it is easier to do the analysis in real terms or in a different currency with a lower expected inflation rate.

5.10. Equity, Debt, and NPV

In the project just described, assume that Aracruz had used all equity to finance the project instead of its mix of debt and equity. Which of the following is likely to occur to the NPV?

- The NPV will go up, because the cash flows to equity will be much higher; there will be no interest and principal payments to make each year.
- The NPV will go down, because the initial investment in the project will much higher.
- The NPV will remain unchanged, because the financing mix should not affect the NPV.
- The NPV might go up or down, depending on . . .

Explain your answer.

Illustration 5.15: Valuing a company for an acquisition: Sensient Technologies

Extending the net present value rule to cover an entire company is not complicated. Consider the proposed acquisition of Sensient Technologies by Tata Chemicals:

- In illustration 5.2, we estimated the cost of capital of 6.98% as the right discount rate to apply in valuing Sensient Technologies. This cost is estimated in US dollar terms and reflects the mature market exposure of the company.
- In illustration 5.7, we estimated the cash flow to the firm of \$76.06 million, in 2008, for Sensient Technologies. We also assumed that these cash flows would grow 2% a year in perpetuity.

We can estimate the value of the firm, based on these inputs:

$$\begin{aligned} \text{Value of Operating Assets} &= \frac{\text{Expected Cashflow to the firm next year}}{(\text{Cost of Capital} - \text{Stable growth rate})} \\ &= \frac{\$76.06 (1.02)}{(.0698 - .02)} = \$1,559 \text{ million} \end{aligned}$$

Adding the cash balance of the firm (\$8 million) and subtracting out the existing debt (\$460 million) yields the value of equity in the firm:

$$\begin{aligned} \text{Value of Equity} &= \text{Value of Operating Assets} + \text{Cash} - \text{Debt} \\ &= \$1,559 + \$8 - \$460 \text{ million} = \$1,107 \text{ million} \end{aligned}$$

The market value of equity in Sensient Technologies in May 2009 was \$1,150 million. To the extent that Tata Chemicals pays a premium over this market price, it has to generate other benefits from the merger that will cover the difference.

Properties of the NPV Rule

The NPV has several important properties that make it an attractive decision rule and the preferred rule, at least if corporate finance theorist were doing the picking.

1. NPVs Are Additive

The NPVs of individual projects can be aggregated to arrive at a cumulative NPV for a business or a division. No other investment decision rule has this property. The property itself has a number of implications.

Assets in Place: The assets already owned by a firm or projects that it has already taken.

- The value of a firm can be written in terms of the present values of the cash flows of the projects it has already taken on as well as the expected NPVs of prospective future projects:

$$\text{Value of firm} = \sum \text{Present Value of Projects in Place} + \sum \text{NPV of Future Projects}$$

The first term in this equation captures the value of *assets in place*, whereas the second term measures the value of *expected future growth*. Note that the present value of projects in place is based on anticipated future cash flows on these projects.

- When a firm terminates an existing project that has a negative present value based on anticipated future cash flows, the value of the firm will increase by that amount. Similarly, when a firm invests in a new project, with an expected negative NPV, the value of the firm will decrease by that amount.
- When a firm divests itself of an existing asset, the price received for that asset will affect the value of the firm. If the price received exceeds the present value of the anticipated cash flows on that project to the firm, the value of the firm will increase with the divestiture; otherwise, it will decrease.
- When a firm invests in a new project with a positive NPV, the value of the firm will be affected depending on whether the NPV meets expectations. For example, a firm like Microsoft is expected to take on high positive NPV projects, and this expectation is built into value. Even if the new projects taken on by Microsoft have positive NPV, there may be a drop in value if the NPV does not meet the high expectations of financial markets.
- When a firm makes an acquisition and pays a price that exceeds the present value of the expected cash flows from the firm being acquired, it is the equivalent of taking on a negative NPV project and will lead to a drop in value.

5.11. Firm Value and Overpayment on Acquisitions

Megatech Corporation, a large software firm with a market value for its equity of \$100 million, announces that it will be acquiring FastMail Corporation, a smaller software firm, for \$15 million. On the announcement, Megatech's stock price drops by 3%. Based on these facts, estimate the amount the market thinks Megatech should have paid for FastMail.

- \$15 million
- \$3 million
- \$12 million

How does NPV additivity enter into your answer?

2. Intermediate Cash Flows Are Invested at the Hurdle Rate

Implicit in all present value calculations are assumptions about the rate at which intermediate cash flows get reinvested. The NPV rule assumes that intermediate cash flows on a projects—that is, cash flows that occur between the initiation and the end of the project—get reinvested at the **hurdle rate**, which is the cost of capital if the cash flows are to the firm and the cost of equity if the cash flows are to equity investors. Given that both the cost of equity and capital are based on the returns that can be made on alternative investments of equivalent risk, this assumption should be reasonable.

Hurdle Rate: The minimum acceptable rate of return that a firm will accept for taking a given project.

3. NPV Calculations Allow for Expected Term Structure and Interest Rate Shifts

In all the examples throughout in this chapter, we have assumed that the discount rate remains unchanged over time. This is not always the case, however; the NPV can be computed using time-varying discount rates. The general formulation for the NPV rule is as follows:

$$\text{NPV of Project} = \sum_{t=1}^{t=N} \frac{CF_t}{\prod_{j=1}^{j=t} (1 + r_j)} - \text{Initial Investment}$$

where

CF_t = Cash flow in period t

r_t = One-period discount rate that applies to period t

N = Life of the project.

The discount rates may change for three reasons:

- The level of interest rates may change over time, and the term structure may provide some insight on expected rates in the future.
- The risk characteristics of the project may be expected to change in a predictable way over time, resulting in changes in the discount rate.
- The financing mix on the project may change over time, resulting in changes in both the cost of equity and the cost of capital.

Illustration 5.16: NPV Calculation with Time-Varying Discount Rates

Assume that you are analyzing a four-year project investing in computer software development. Furthermore, assume that the technological uncertainty associated with the software industry leads to higher discount rates in future years.

Cash Flow		\$ 300	\$ 400	\$ 500	\$ 600
Discount Rate	10%	11%	12%	13%	
Investment	<\$ 1000>				

The present value of each of the cash flows can be computed as follows.

$$\text{PV of Cash Flow in year 1} = \$300/1.10 = \$272.72$$

$$\text{PV of Cash Flow in year 2} = \$400/(1.10 * 1.11) = \$327.60$$

$$\text{PV of Cash Flow in year 3} = \$500/(1.10 * 1.11 * 1.12) = \$365.63$$

$$\text{PV of Cash Flow in year 4} = \$600/(1.10 * 1.11 * 1.12 * 1.13) = \$388.27$$

$$\text{NPV of Project} = \$272.72 + \$327.60 + \$365.63 + \$388.27 - \$1000.00 = \$354.23$$

 **5.12. Changing Discount Rates and NPV**

In the analysis just done, assume that you had been asked to use one discount rate for all of the cash flows. Is there a discount rate that would yield the same NPV as the one above?

- Yes
- No

If yes, how would you interpret this discount rate?

Biases, Limitations, and Caveats

In spite of its advantages and its linkage to the objective of value maximization, the NPV rule continues to have its detractors, who point out several limitations.

- The NPV is stated in absolute rather than relative terms and does not therefore factor in the scale of the projects. Thus, project A may have an NPV of \$200, whereas project B has an NPV of \$100, but project A may require an initial investment that is

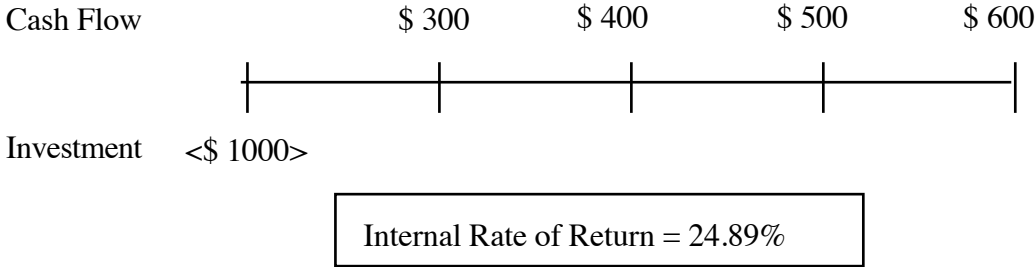
10 or 100 times larger than project B. Proponents of the NPV rule argue that it is surplus value, over and above the hurdle rate, no matter what the investment.

- The NPV rule does not control for the life of the project. Consequently, when comparing mutually exclusive projects with different lifetimes, the NPV rule is biased toward accepting longer-term projects.

Internal Rate of Return

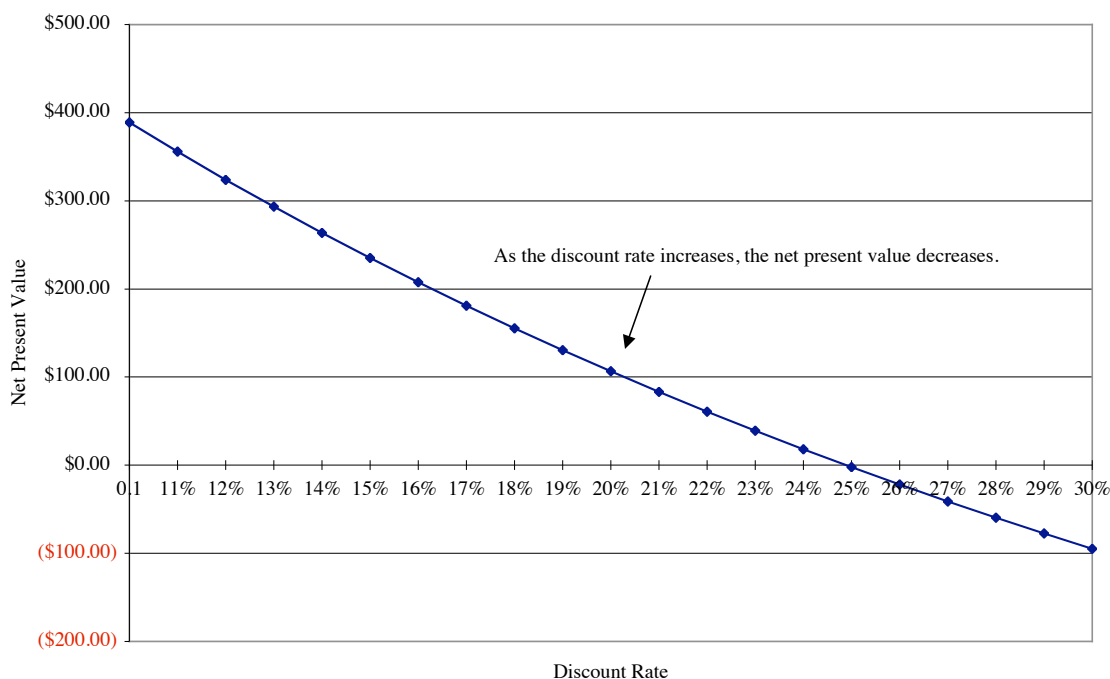
The **internal rate of return (IRR)** is based on discounted cash flows. Unlike the NPV rule, however, it takes into account the project’s scale. It is the discounted cash flow analog to the accounting rates of return. Again, in general terms, the IRR is that discount rate that makes the NPV of a project equal to zero. To illustrate, consider again the project described at the beginning of the NPV discussion.

Internal Rate of Return (IRR): The rate of return earned by the project based on cash flows, allowing for the time value of money.



At the internal rate of return, the NPV of this project is zero. The linkage between the NPV and the IRR is most obvious when the NPV is graphed as a function of the discount rate in a **net present value profile**. An NPV profile for the project described is illustrated in Figure 5.4.

Figure 5.4: NPV Profile



The NPV profile provides several insights on the project's viability. First, the internal rate of return is clear from the graph—it is the point at which the profile crosses the x -axis. Second, it provides a measure of how sensitive the NPV—and, by extension, the project decision—is to changes in the discount rate. The slope of the NPV profile is a measure of the discount rate sensitivity of the project. Third, when mutually exclusive projects are being analyzed, graphing both NPV profiles together provides a measure of the break-even discount rate—the rate at which the decision maker will be indifferent between the two projects.

NPV Profile: This measures the sensitivity of the NPV to changes in the discount rate.



5.13. Discount Rates and NPV

In the project just described, the NPV decreased as the discount rate was increased. Is this always the case?

- Yes.
- No

If no, when might the NPV go up as the discount rate is increased?

Using the IRR

One advantage of the IRR is that it can be used even in cases where the discount rate is unknown. While this is true for the calculation of the IRR, it is *not true* when the decision maker has to use the IRR to decide whether to take a project. At that stage in the process, the IRR has to be compared to the discount rate—if the IRR is greater than the discount rate, the project is a good one; alternatively, the project should be rejected.

Like the NPV, the IRR can be computed in one of two ways:

- The IRR can be calculated based on the free cash flows to the firm and the total investment in the project. In doing so, the IRR has to be compared to the cost of capital.
- The IRR can be calculated based on the free cash flows to equity and the equity investment in the project. If it is estimated with these cash flows, it has to be compared to the cost of equity, which should reflect the riskiness of the project.

Decision Rule for IRR for Independent Projects

A. IRR is computed on cash flows to the firm

If the IRR > Cost of Capital → Accept the project

If the IRR < Cost of Capital → Reject the project

B. IRR is computed on cash flows to equity

If the IRR > Cost of Equity → Accept the project

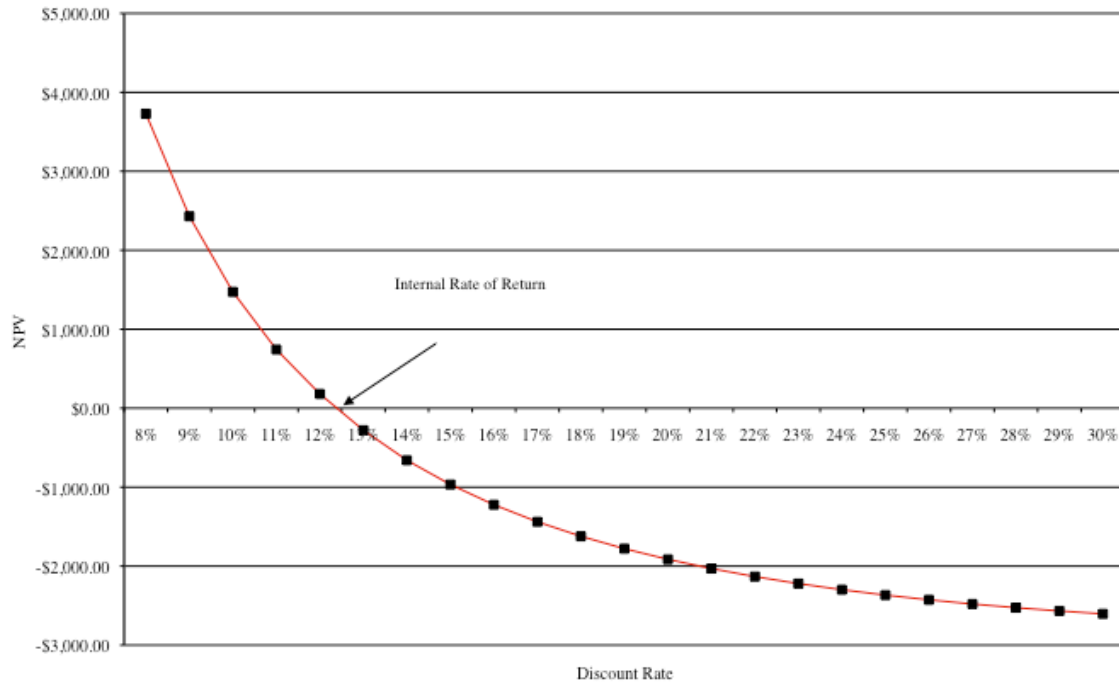
If the IRR < Cost of Equity → Reject the project

When choosing between projects of equivalent risk, the project with the higher IRR is viewed as the better project.

Illustration 5.17: Estimating the IRR Based on FCFF: Rio Disney

The cash flows to the firm from Rio Disney, are used to arrive at a NPV profile for the project in Figure 5.5.

Figure 5.5: NPV Profile for Disney Theme Park



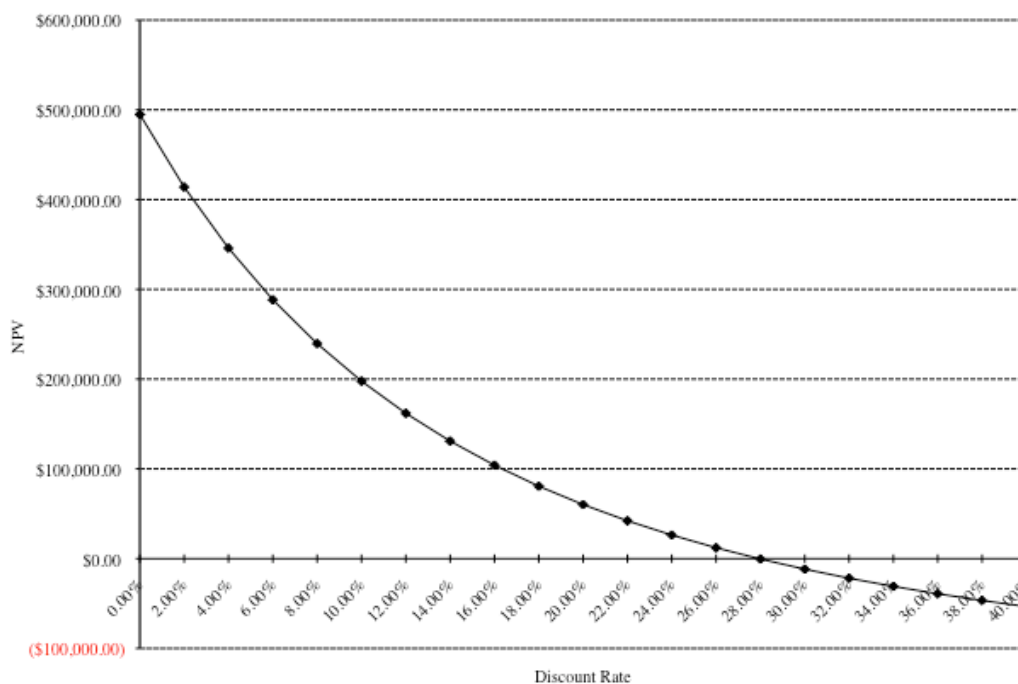
The IRR in dollar terms on this project is 12.35%, which is *higher* than the cost of capital of 8.62%. These results are consistent with the findings from the NPV rule, which also recommended investing in the theme parks.⁹

Illustration 5.18: Estimating IRR Based Upon FCFE - Aracruz Celulose

The net present value profile depicted in Figure 5.6 is based upon the equity investment and the free cash flows to equity estimated for the paper plant for Aracruz.

⁹The terminal value of the project itself is a function of the discount rate used. That is why the IRR function in Excel will not yield the right answer. Instead, the NPV has to be recomputed at every discount rate and the IRR is the point at which the NPV = 0.

Figure 5.6: NPV Profile on Equity Investment in Paper Plant: Aracruz



The IRR (in real terms) on this project is 27.92%, which is *higher* than the real cost of equity of 18.45%. Again, these results are consistent with the findings from the NPV rule, which also recommended accepting this investment.

Biases, Limitations, and Caveats

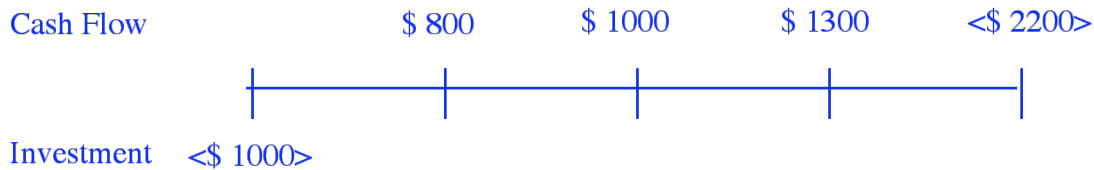
The IRR is the most widely used discounted cash flow rule in investment analysis, but it does have some serious limitations.

- Because the IRR is a scaled measure, it tends to bias decision makers toward smaller projects, which are much more likely to yield high%age returns, and away from larger ones.
- There are a number of scenarios in which the IRR cannot be computed or is not meaningful as a decision tool. The first is when there is no or only a very small initial investment and the investment is spread over time. In such cases, the IRR cannot be computed or, if computed, is likely to be meaningless. The second is when there is more than one internal rate of return for a project, and it is not clear which one the decision maker should use.

Illustration 5.19: Multiple IRR Projects

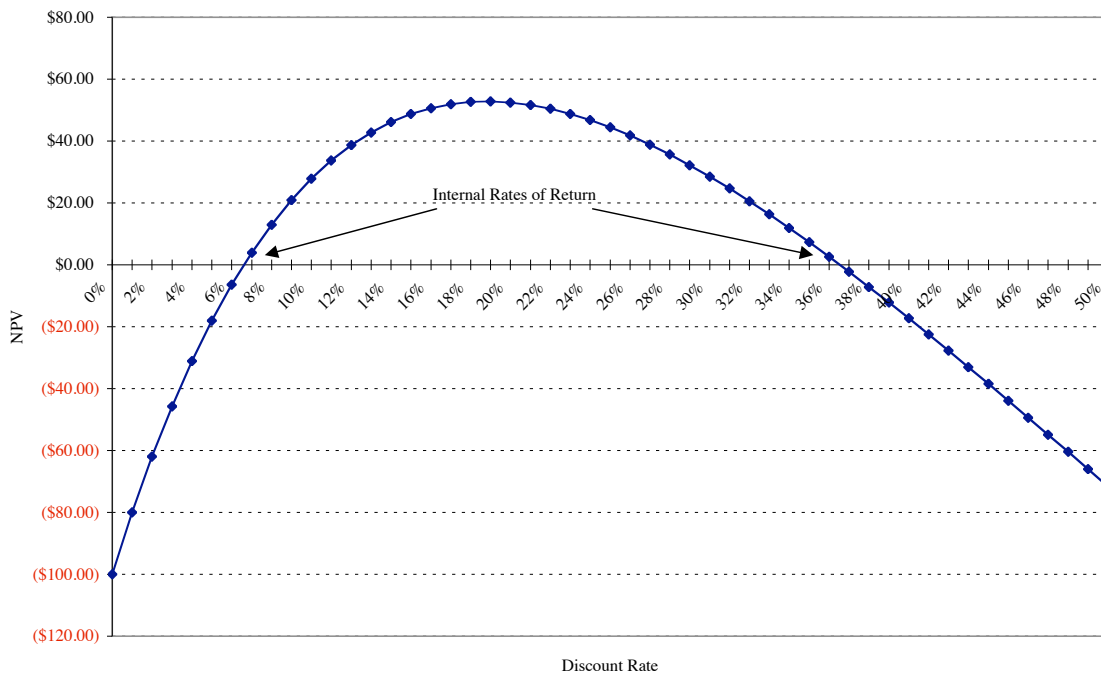
Consider a project to manufacture and sell a consumer product, with a hurdle rate of 12%, that has a four-year life and the following cash flows over those four years. The project, which requires the licensing of a trademark, requires a large payment at the end of the fourth year. Figure 5.7 shows the cash flows.

Figure 5.7 Cash Flows on Investment



The NPV profile for this project, shown in Figure 5.8, reflects the problems that arise with the IRR measure.

Figure 5.8: NPV Profile for Multiple IRR Project



As you can see, this project has two IRRs: 6.60% and 36.55%. Because the hurdle rate falls between these two IRRs, the decision on whether to take the project will change depending on which IRR is used. To make the right decision in this case, the decision maker would have to look at the NPV profile. If, as in this case, the NPV is positive at the

hurdle rate, the project should be accepted. If the NPV is negative at the hurdle rate, the project should be rejected.

In Practice: Multiple IRRs: Why They Exist and What to Do about Them

The IRR can be viewed mathematically as a root to the present value equation for cash flows. In the conventional project, where there is an initial investment and positive cash flows thereafter, there is only one sign change in the cash flows, and one root—that is, there is a unique IRR. When there is more than one sign change in the cash flows, there will be more than one IRR.¹⁰ In Figure 5.7, for example, the cash flow changes sign from negative to positive in year one, and from positive to negative in year four, leading to two IRRs.

Lest this be viewed as some strange artifact that is unlikely to happen in the real world, note that many long-term projects require substantial reinvestment at intermediate points in the project and that these reinvestments may cause the cash flows in those years to become negative. When this happens, the IRR approach may run into trouble.

There are a number of solutions suggested to the multiple IRR problems. One is to use the hurdle rate to bring the negative cash flows from intermediate periods back to the present. Another is to construct an NPV profile. In either case, it is probably much simpler to estimate and use the NPV.

Probabilistic Approaches to Investment Analysis

In all of the approaches that we described in the last section – accounting returns, payback, NPV and IRR – we used earnings or cash flows that were estimated for future years for the projects that we were analyzing. While we use expected values for revenues, margins and other key variables, the future is uncertain and the estimates will therefore reflect that uncertainty. While we cannot make this uncertainty disappear, we can consider ways in which we get a better handle on how a project’s value will change as the inputs change. In this section, we will examine four approaches for dealing with uncertainty. The first and simplest is sensitivity analysis, where we ask what-if questions about key variables and to estimate how much room for error we have on each one. The

¹⁰Although the number of IRRs will be equal to the number of sign changes, some IRRs may be so far out of the realm of the ordinary (e.g. 10,000%) that they may not create the kinds of problems described here.

second is scenario analysis, where we develop a few possible scenarios, ranging from good to bad outcomes and compute the value of the project under each one. The third approach is decision trees, designed for multi-stage investments, where we evaluate the probabilities of success and failure at each stage and the consequences for the final value. The last approach is simulations, where we estimate probability distributions for each input variable rather than expected values. As a consequence, we will generate a distribution of values for a project, rather than a single number.

Sensitivity Analysis

The simplest way to deal with uncertainty is to ask “what if?” questions about key inputs into the analysis, with two objectives in mind. One is to get a sense of how much the value of the project and your decision about investing in the project change as you modify key assumptions. The other is to get a measure of how much margin for error you have on your estimates. Put another way, sensitivity analysis can be used to analyze how much you can afford to be off in your estimates of revenue growth and margins without altering your decision to accept or reject the investment. There are some dangers to sensitivity analysis:

- a. Overdoing what if analyses: There are often dozens of inputs that go into a project analysis, and we could do sensitivity analyses on each and every one of these inputs. In the process, though, we mix the variables that matter with those that do not and risk obscuring the importance of the former.
- b. Losing sight of the objective: The ultimate objective asking “What if?” is not to generate more tables, graphs and numbers but to make better decisions in the face of uncertainty. To help in decision-making, sensitivity analysis should be focused on key variables and the findings should be presented in ways that help decision makers better a grip on how outcomes will change as assumptions change.
- c. Not considering how variables move together: In most sensitivity analysis, we change one input at a time, keeping all other inputs at their base case values. While this makes computation simpler, it may be unrealistic, since input variables are often correlated with each other. Thus, assuming that margins will increase while keeping revenue growth fixed or that interest rates will go down while

inflation stays high may yield higher net present values for the project, but neither is likely to happen.

- d. Double counting risk: In any sensitivity analysis, even good projects (with positive NPV and high IRR) will have negative net present values if key variables move adversely. Decision makers who use this as a rationale for rejecting these projects are potentially double counting risk, since the cash flows were discounted back at a risk-adjusted rate to estimate the base case NPV.

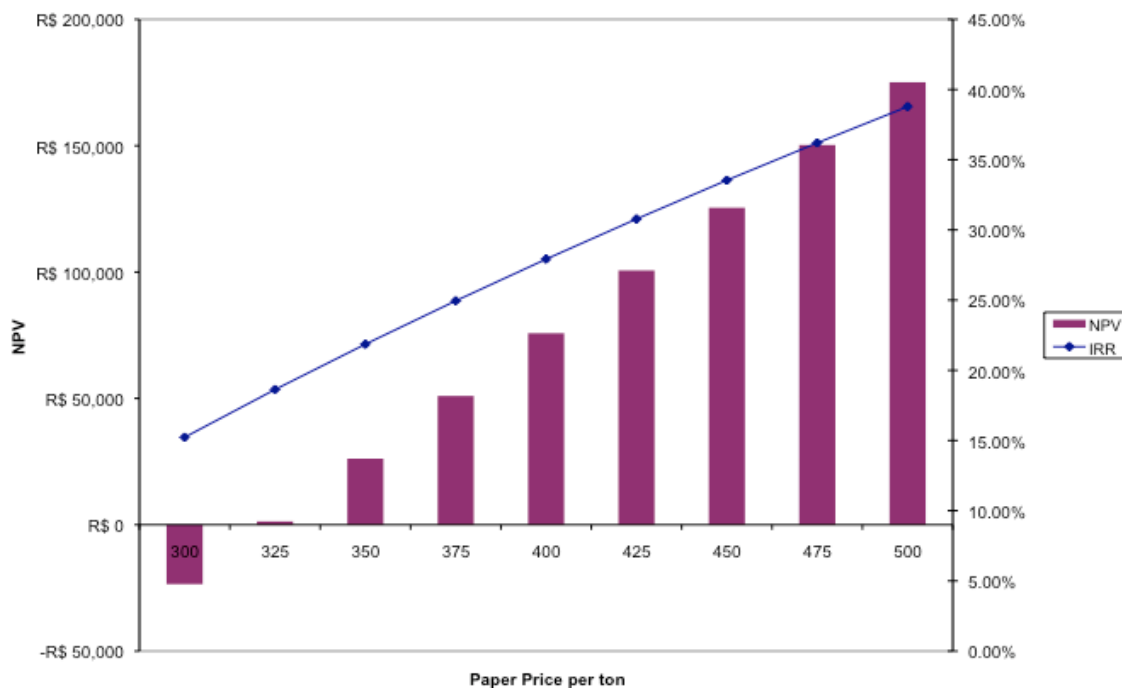
In general, there are two good uses for sensitivity analysis. The first is that it can be used as a tie-breaker when firms have to choose between two projects that are roughly equivalent in terms of base case net present value or IRR; the project that is less sensitive to changes in the key variables should be picked. The second is to use the output from sensitivity analysis to better manage both the operations and the risks of an investment, in the post-acceptance phase. Thus, knowing that the net present value of an investment is sensitive to labor costs may lead to entering into labor contracts that keep these costs under control. Similarly, the finding that a project's value fluctuates as exchange rates move may result in the firm using currency options and futures to hedge risk.

Illustration 5.20: Aracruz Paper Plant: Sensitivity Analysis and Break Even

In illustration 5.14, we estimated a NPV of R\$ 75.8 million for Aracruz's proposed paper plant. While that value suggests that the plant would be a good investment, the conclusion is heavily dependent upon two variables – the price of paper and pulp and the R\$/\\$ exchange rate. The pulp price affects revenues directly and a significant drop in paper prices will make the project an unattractive one; thus changing the assumption that the price per ton will remain at \$ 400 in real terms will affect the value of the project. The exchange rate matters because Aracruz sells a significant portion of its output into dollar-based markets but has most of its costs in Brazil (and in R\$). If the Brazilian Real strengthens relative to the US dollar, Aracruz will find itself squeezed, unable to raise prices but facing higher costs.

In the first part of the sensitivity analysis, we changed the price per ton, in real terms, of pulp from our base case value of \$ 400 and mapped out the effect on the NPV and IRR of the investment. Figure 5.9 presents the findings:

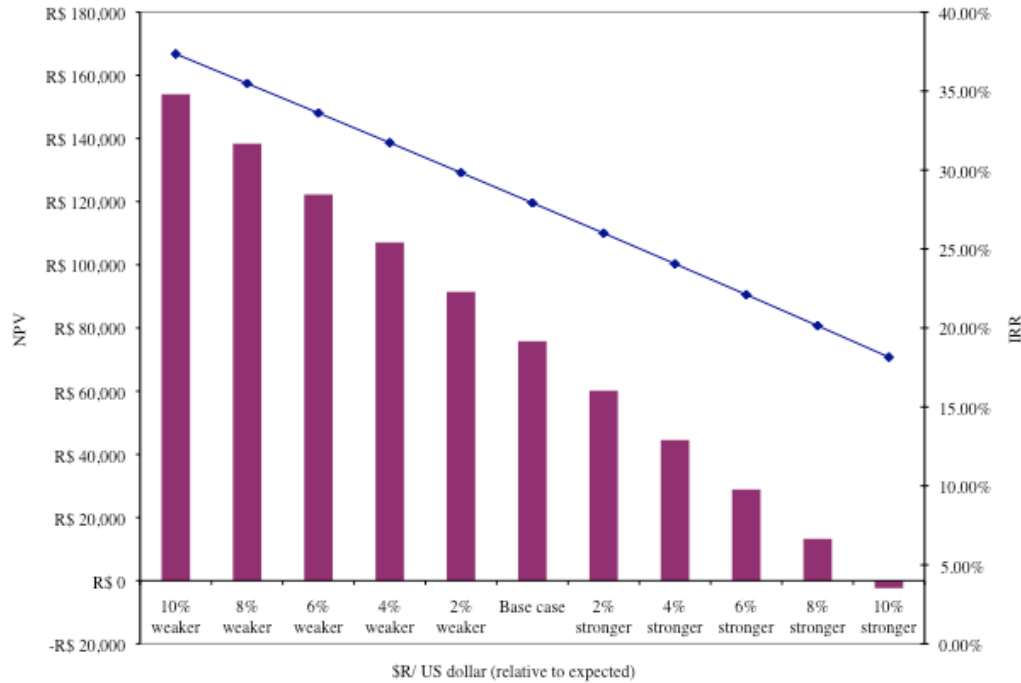
Figure 5.9: Aracruz Paper Plant: Effect of Changing pulp prices



Note that the NPV for the project drops below zero, if paper prices drop below \$325/ton and the IRR drops below the real cost of equity of 18.45%. In making these computations, we held fixed costs constant and kept variable costs at 45% of revenues.

In the second part of the analysis, we assessed the impact of unexpected changes in the exchange rate. While we have built in an expected devaluation into the R\$, based upon the inflation rates of 7% for Brazil and 2% for the US, it is entirely possible that the R\$ could become stronger or weaker, relative to the US dollar. Every 1% increase in the value of the R\$/\$, relative to our assessments, will increase the variable cost (which is entirely R\$ based), as a proportion of revenues, by 1%. Thus, if the R\$ is 5% stronger than expected, the variable costs will be 50% of revenues (instead of our base case estimate of 45%). Figure 5.10 presents the effects of exchange rate changes on NPV and IRR.

Figure 5.10: Aracruz Paper Plant: Effect of Changing Exchange Rates



If the Brazilian Real strengthens 10% of more, relative to our estimates, the associated jump in variable costs alters our assessment of the project, from positive to negative.

In Practice: Should you hedge project risk?

Looking at the sensitivity analysis for the Aracruz paper plant, it is quite clear that the value of the plant will change significantly if paper prices change or if there are unexpected changes in exchange rates. Since there are derivatives markets on both the commodity (paper) and exchange rates, an open question then becomes whether Aracruz should hedge against these risks, using forwards, futures or options.

The answer is not clear-cut. While hedging risk makes the project's cash flows more predictable, there are two costs to consider. The first is that investors in the company may want to be exposed to the risk; investors in an oil, gold mining or paper company may be investing in the company because they believe that these commodities will go up in price and hedging that risk will undercut their rationale. The second is that hedging can be costly and it may be more efficient and cheaper for investors to hedge risk in their portfolios than it is for individual companies to each hedge risks. Thus, an investor who holds a large number of stocks exposed to exchange rate risk in the R\$/

rate may be able to diversify away a large component of that risk in his portfolio and then can choose to hedge or not hedge the remaining risk. These costs have to be weighed against two potential benefits. The first is that hedging against risks that can cause large losses, relative to the size of the firm, may reduce the chance of default, especially if a firm has significant debt obligations. The second is that hedging risk can sometimes yield tax benefits, both in the form of tax-deductible expenses for hedging and from smoothing out earnings.

Applying this trade off to Aracruz, we come to a mixed conclusion. The firm has significant debt obligations and cannot risk large losses. Consequently, we think it makes sense for the firm to hedge exchange rate risk, especially because it is relatively inexpensive to do so, using futures and forward contracts. Given that it is a commodity company, we are reluctant to suggest the same path for paper prices, since investors in the company may want that exposure. One compromise that will allow these investors to retain the upside, while protecting against very adverse moves in pulp prices, would be for Aracruz to buy put options on paper at a price of around \$325 (the breakeven point for NPV). Since the put options will be deep out of the money, the costs should be moderate and investors will still get most of the upside on paper prices.

Scenario Analysis

In sensitivity analysis, we change one input variable at a time and examine the effect on the output variables – NPV, IRR and accounting returns. In scenario analysis, we outline scenarios that are different from the base case, where many or all of the inputs can have different values, and evaluate the project's value under these scenarios. In general, scenario analysis can take one of two forms: a best case/worst case analysis or an analysis of multiple possible scenarios.

Best Case, Worst Case

With risky projects, the actual cash flows can be very different from expectations. At the minimum, we can estimate the cash flows if everything works to perfection – a best case scenario – and if nothing does – a worse case scenario. In practice, there are two ways in which this analysis can be structured. In the first, each input into the project analysis is set to its best (or worst) possible outcome and the cash flows estimated with

those values. Thus, when analyzing a project, you may set the revenue growth rate and operating margin at the highest possible level while setting the discount rate at its lowest level, and compute the value as the best-case scenario. The problem with this approach is that it may not be feasible; after all, to get the high revenue growth, the firm may have to lower prices and accept lower margins. In the second, the best possible scenario is defined in terms of what is feasible while allowing for the relationship between the inputs. Thus, instead of assuming that revenue growth and margins will both be maximized, we will choose that combination of growth and margin that is feasible and yields the maximum value. While this approach is more realistic, it does require more work to put into practice.

There are two ways in which the results from this analysis can help decision makers. First, the difference between the best case and worst case value can be used as a measure of risk on an asset; the range in value (scaled to size) should be higher for riskier investments. Second, firms that are concerned about the potential spill over effects on their operations of an investment going bad may be able to gauge the effects by looking at the worst case outcome. Thus, a firm that has significant debt obligations may use the worst case outcome to make a judgment as to whether an investment has the potential to push them into default. In general, though, best case/worse case analyses are not very informative. After all, there should be no surprise in knowing that an investment is worth a great deal in the best case and does badly in the worst case.

Multiple Scenario Analysis

Scenario analysis does not have to be restricted to the best and worst cases. In its most general form, the value of a risky investment can be computed under a number of different scenarios, varying the assumptions about both macro economic and asset-specific variables. While the concept of sensitivity analysis is a simple one, it has four critical components:

- The first is the determination of which factors the scenarios will be built around. These factors can range from the state of the economy for an automobile firm considering a new plant, to the response of competitors for a consumer product firm introducing a new product, to the behavior of regulatory authorities for a phone company, considering a new phone service.

- The second component is determining the number of scenarios to analyze for each factor. While more scenarios may be more realistic than fewer, it becomes more difficult to collect information and differentiate between the scenarios in terms of asset cash flows.. The question of how many scenarios to consider will depend then upon how different the scenarios are, and how well the analyst can forecast cash flows under each scenario.
- The third component is the estimation of asset cash flows under each scenario. It is to ease the estimation at this step that we focus on only two or three critical factors and build relatively few scenarios for each factor.
- The final component is the assignment of probabilities to each scenario. For some scenarios, involving macro-economic factors such as exchange rates, interest rates and overall economic growth, we can draw on the expertise of services that forecast these variables. For other scenarios, involving either the sector or competitors, we have to draw on our knowledge about the industry.

The output from a scenario analysis can be presented as values under each scenario and as an expected value across scenarios (if the probabilities can be estimated in the fourth step).

In general, scenario analysis is best suited for risks that are either discrete or can be categorized into discrete groups. Thus, it is better suited to deal with the risk that a competitor will introduce a product similar to your product (the competitor either will or will not) than it is to deal with the risk that interest rates may change in future periods.

Decision Trees

In some projects, risk is not only discrete but is sequential. In other words, for an investment to succeed, it has to pass through a series of tests, with failure at any point potentially translating into a complete loss of value. This is the case, for instance, with a pharmaceutical drug that is just being tested on human beings. The three-stage FDA approval process lays out the hurdles that have to be passed for this drug to be commercially sold, and failure at any of the three stages dooms the drug's chances. Decision trees allow us to not only consider the risk in stages but also to devise the right response to outcomes at each stage.

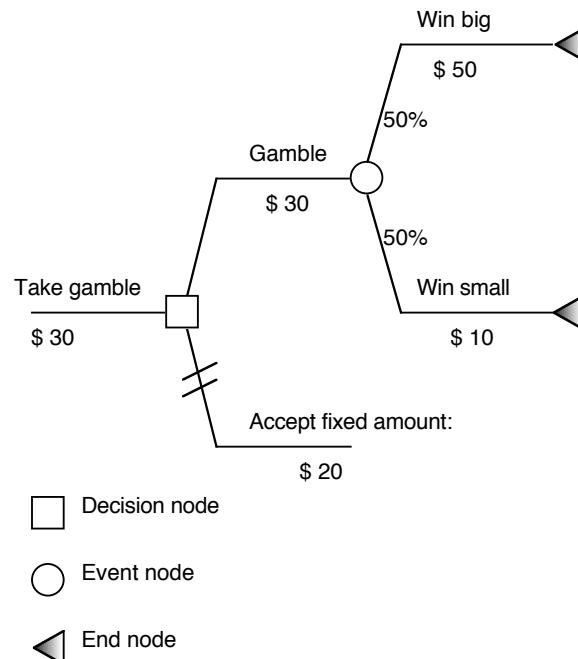
Steps in Decision Tree Analysis

The first step in understanding decision trees is to distinguish between root nodes, decision nodes, event nodes and end nodes.

- The root node represents the start of the decision tree, where a decision maker can be faced with a decision choice or an uncertain outcome. The objective of the exercise is to evaluate what a risky investment is worth at this node.
- Event nodes represent the possible outcomes on a risky gamble; whether a drug passes the first stage of the FDA approval process or not is a good example. We have to figure out the possible outcomes and the probabilities of the outcomes occurring, based upon the information we have available today.
- Decision nodes represent choices that can be made by the decision maker –to expand from a test market to a national market, after a test market’s outcome is known.
- End nodes usually represent the final outcomes of earlier risky outcomes and decisions made in response.

Consider a very simple example. You are offered a choice where you can take a certain amount of \$ 20 or partake in a gamble, where you can win \$ 50 with probability 50% and \$10 with probability 50%. The decision tree for this offered gamble is shown in figure 5.11:

Figure 5.11: Simple Decision Tree



Note the key elements in the decision tree. First, only the event nodes represent uncertain outcomes and have probabilities attached to them. Second, the decision node represents a choice. On a pure expected value basis, the gamble is better (with an expected value of \$ 30) than the guaranteed amount of \$20; the double slash on the latter branch indicates that it would not be selected. While this example may be simplistic, the elements of building a decision tree are in it.

Step 1: Divide analysis into risk phases: The key to developing a decision tree is outlining the phases of risk that you will be exposed to in the future. In some cases, such as the FDA approval process, this will be easy to do since there are only two outcomes – the drug gets approved to move on to the next phase or it does not. In other cases, it will be more difficult. For instance, a test market of a new consumer product can yield hundreds of potential outcomes; here, you will have to create discrete categories for the success of the test market.

Step 2: In each phase, estimate the probabilities of the outcomes: Once the phases of risk have been put down and the outcomes at each phase are defined, the probabilities of the outcomes have to be computed. In addition to the obvious requirement that the probabilities across outcomes has to sum up to one, the analyst will also have to consider whether the probabilities of outcomes in one phase can be affected by outcomes in earlier phases. For example, how does the probability of a successful national product introduction change when the test market outcome is only average?

Step 3: Define decision points: Embedded in the decision tree will be decision points where you will get to determine, based upon observing the outcomes at earlier stages, and expectations of what will occur in the future, what your best course of action will be. With the test market example, for instance, you will get to determine, at the end of the test market, whether you want to conduct a second test market, abandon the product or move directly to a national product introduction.

Step 4: Compute cash flows/value at end nodes: The next step in the decision tree process is estimating what the final cash flow and value outcomes will be at each end node. In some cases, such as abandonment of a test market product, this will be easy to do and will represent the money spent on the test marketing of the product. In other cases, such as a national launch of the same product, this will be more difficult to do since you will

have to estimate expected cash flows over the life of the product and discount these cash flows to arrive at value.

Step 5: Folding back the tree: The last step in a decision tree analysis is termed “folding back’ the tree, where the expected values are computed working backwards through the tree. If the node is a chance node, the expected value is computed as the probability weighted average of all of the possible outcomes. If it is a decision node, the expected value is computed for each branch, and the highest value is chosen (as the optimal decision). The process culminates in an expected value for the asset or investment today.¹¹

There are two key pieces of output that emerge from a decision tree. The first is the expected value today of going through the entire decision tree. This expected value will incorporate the potential upside and downside from risk and the actions that you will take along the way in response to this risk. In effect, this is analogous to the risk adjusted value that we talked about in the last chapter. The second is the range of values at the end nodes, which should encapsulate the potential risk in the investment.

Use in Decision Making

There are several benefits that accrue from using decision trees and it is surprising that they are not used more often in analysis.

1. **Dynamic response to Risk:** By linking actions and choices to outcomes of uncertain events, decision trees encourage firms to consider how they should act under different circumstances. As a consequence, firms will be prepared for whatever outcome may arise rather than be surprised. In the example in the last section, for instance, the firm will be ready with a plan of action, no matter what the outcome of phase 3 happens to be.
2. **Value of Information:** Decision trees provide a useful perspective on the value of information in decision making. While it is not as obvious in the drug development example, it can be seen clearly when a firm considers whether to test market a product before commercially developing it. By test marketing a product, you acquire

¹¹ There is a significant body of literature examining the assumptions that have to hold for this folding back process to yield consistent values. In particular, if a decision tree is used to portray concurrent risks, the

more information on the chances of eventual success. We can measure the expected value of this improved information in a decision tree and compare it to the test marketing cost.

3. Risk Management: Since decision trees provide a picture of how cash flows unfold over time, they are useful in deciding what risks should be protected against and the benefits of doing so. Consider a decision tree on an asset, where the worst-case scenario unfolds if the dollar is weak against the Euro. Since we can hedge against this risk, the cost of hedging the risk can be compared to the loss in cash flows in the worst-case scenario.

In summary, decision trees provide a flexible and powerful approach for dealing with risk that occurs in phases, with decisions in each phase depending upon outcomes in the previous one. In addition to providing us with measures of risk exposure, they also force to think through how we will react to both adverse and positive outcomes that may occur at each phase.

Issues

There are some types of risk that decision trees are capable of handling and others that they are not. In particular, decision trees are best suited for risk that is sequential; the FDA process where approval occurs in phases is a good example. Risks that affect an asset concurrently cannot be easily modeled in a decision tree.¹² As with scenario analysis, decision trees generally look at risk in terms of discrete outcomes. Again, this is not a problem with the FDA approval process where there are only two outcomes – success or failure. There is a much wider range of outcomes with most other risks and we have to create discrete categories for the outcomes to stay within the decision tree framework. For instance, when looking at a market test, we may conclude that selling more than 100,000 units in a test market qualifies as a great success, between 60,000 and 100,000 units as an average outcome and below 60,000 as a failure.

Assuming risk is sequential and can be categorized into discrete boxes, we are faced with estimation questions to which there may be no easy answers. In particular, we

risks should be independent of each other. See Sarin, R. and P.Wakker, 1994, Folding Back in Decision Tree Analysis, *Management Science*, v40, pg 625-628.

have to estimate the cash flows under each outcome and the associated probability. With the drug development example, we had to estimate the cost and the probability of success of each phase. The advantage that we have when it comes to these estimates is that we can draw on empirical data on how frequently drugs that enter each phase make it to the next one and historical costs associated with drug testing. To the extent that there may be wide differences across different phase 1 drugs in terms of success – some may be longer shots than others – there can still be errors that creep into decision trees.

The expected value of a decision tree is heavily dependent upon the assumption that we will stay disciplined at the decision points in the tree. In other words, if the optimal decision is to abandon if a test market fails and the expected value is computed, based on this assumption, the integrity of the process and the expected value will quickly fall apart, if managers decide to overlook the market testing failure and go with a full launch of the product anyway.

Simulations

If scenario analysis and decision trees are techniques that help us to assess the effects of discrete risk, simulations provide a way of examining the consequences of continuous risk. To the extent that most risks that we face in the real world can generate hundreds of possible outcomes, a simulation will give us a fuller picture of the risk in an asset or investment.

Steps in simulation

Unlike scenario analysis, where we look at the values under discrete scenarios, simulations allow for more flexibility in how we deal with uncertainty. In its classic form, distributions of values are estimated for each parameter in the valuation (growth, market share, operating margin, beta etc.). In each simulation, we draw one outcome from each distribution to generate a unique set of cashflows and value. Across a large number of simulations, we can derive a distribution for the value of investment or an asset that will reflect the underlying uncertainty we face in estimating the inputs to the valuation. The steps associated with running a simulation are as follows:

¹² If we choose to model such risks in a decision tree, they have to be independent of each other. In other words, the sequencing should not matter.

1. Determine “probabilistic” variables: In any analysis, there are potentially dozens of inputs, some of which are predictable and some of which are not. Unlike scenario analysis and decision trees, where the number of variables that are changed and the potential outcomes have to be few in number, there is no constraint on how many variables can be allowed to vary in a simulation. At least in theory, we can define probability distributions for each and every input in a valuation. The reality, though, is that this will be time consuming and may not provide much of a payoff, especially for inputs that have only marginal impact on value. Consequently, it makes sense to focus attention on a few variables that have a significant impact on value.

2. Define probability distributions for these variables: This is a key and the most difficult step in the analysis. Generically, there are three ways in which we can go about defining probability distributions. One is to use historical data, especially for variables that have a long history and reliable data over that history. This approach works best for macro economic variables such as interest rates and inflation. The second is to use cross sectional data, from investments similar to the one that is being analyzed. Thus, a retail store like Target can look at the distribution of profit margins across its existing stores, when assessing what the margins will be on a new store. The third is to assume a reasonable statistical distribution for the variable, with parameters for that distribution.¹³ Thus, we may conclude that operating margins will be distributed uniformly, with a minimum of 4% and a maximum of 8% and that revenue growth is normally distributed with an expected value of 8% and a standard deviation of 6%. The probability distributions can be discrete for some inputs and continuous for others, be based upon historical data for some and statistical distributions for others.

3. Check for correlation across variables: While it is tempting to jump to running simulations right after the distributions have been specified, it is important that we check for correlations across variables. Assume, for instance, that you are developing probability distributions for both interest rates and inflation. While both inputs may be critical in determining value, they are likely to be correlated with each other; high

¹³ For more details on the choices we face in terms of statistical distributions and how to pick the right one for a particular variable, see the paper I have on statistical distributions and simulations on <http://www.damodaran.com>, under research/papers.

inflation is usually accompanied by high interest rates. When there is strong correlation, positive or negative, across inputs, you have two choices. One is to pick only one of the two inputs to vary; it makes sense to focus on the input that has the bigger impact on value. The other is to build the correlation explicitly into the simulation; this does require more sophisticated simulation packages and adds more detail to the estimation process.

4. Run the simulation: For the first simulation, you draw one outcome from each distribution and compute the value based upon those outcomes. This process can be repeated as many times as desired, though the marginal contribution of each simulation drops off as the number of simulations increases. The number of simulations you run should be determined by the following:

- a. Number of probabilistic inputs: The larger the number of inputs that have probability distributions attached to them, the greater will be the required number of simulations.
- b. Characteristics of probability distributions: The greater the diversity of distributions in an analysis, the larger will be the number of required simulations. Thus, the number of required simulations will be smaller in a simulation where all of the inputs have normal distributions than in one where some have normal distributions, some are based upon historical data distributions and some are discrete.
- c. Range of outcomes: The greater the potential range of outcomes on each input, the greater will be the number of simulations.

Most simulation packages allow users to run thousands of simulations, with little or no cost attached to increasing that number. Given that reality, it is better to err on the side of too many simulations rather than too few.

There have generally been two impediments to good simulations. The first is informational: estimating distributions of values for each input into a valuation is difficult to do. In other words, it is far easier to estimate an expected growth rate of 8% in revenues for the next 5 years than it is to specify the distribution of expected growth rates – the type of distribution, parameters of that distribution – for revenues. The second is computational; until the advent of personal computers, simulations tended to be too time

and resource intensive for the typical analyst. Both these constraints have eased in recent years and simulations have become more feasible.

Use in decision making

A well-done simulation provides us with more than just an expected value for an asset or investment.

- a. Better input estimation: In an ideal simulation, analysts will examine both the historical and cross sectional data on each input variable before making a judgment on what distribution to use and the parameters of the distribution. In the process, they may be able to avoid the sloppiness that is associated with the use of point estimates; many discounted cash flow valuations are based upon expected growth rates that are obtained from services such as Zack's or IBES, which report analysts' consensus estimates.
- b. It yields a distribution for expected value rather than a point estimate: Consider the valuation example that we completed in the last section. In addition to reporting an expected value of \$11.67 million for the store, we also estimated a standard deviation of \$5.96 million in that value and a break-down of the values, by percentile. The distribution reinforces the obvious but important point that valuation models yield estimates of value for risky assets that are imprecise and explains why different analysts valuing the same asset may arrive at different estimates of value.

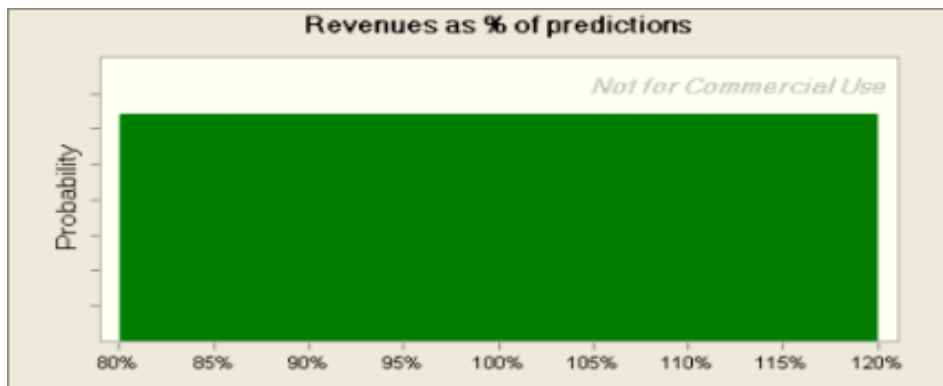
Note that there are two claims about simulations that we are unwilling to make. The first is that simulations yield better estimates of expected value than conventional risk adjusted value models. In fact, the expected values from simulations should be fairly close to the expected value that we would obtain using the expected values for each of the inputs (rather than the entire distribution). The second is that simulations, by providing estimates of the expected value and the distribution in that value, lead to better decisions. This may not always be the case since the benefits that decision-makers get by getting a fuller picture of the uncertainty in value in a risky asset may be more than offset by misuse of that risk measure. As we will argue later in this chapter, it is all too common for risk to be double counted in simulations and for decisions to be based upon the wrong type of risk.

Illustration 5.21: Rio Disney – Simulation

In illustration 5.*, we estimated a net present value of \$2.877 billion for the Rio Disney theme park, suggesting that Disney should make the investment. The analysis, though, rested on a few key assumptions about revenues, expenses and exchange rates that may put the value added to the test. We focused on four variables that we felt had the most uncertainty associated with them:

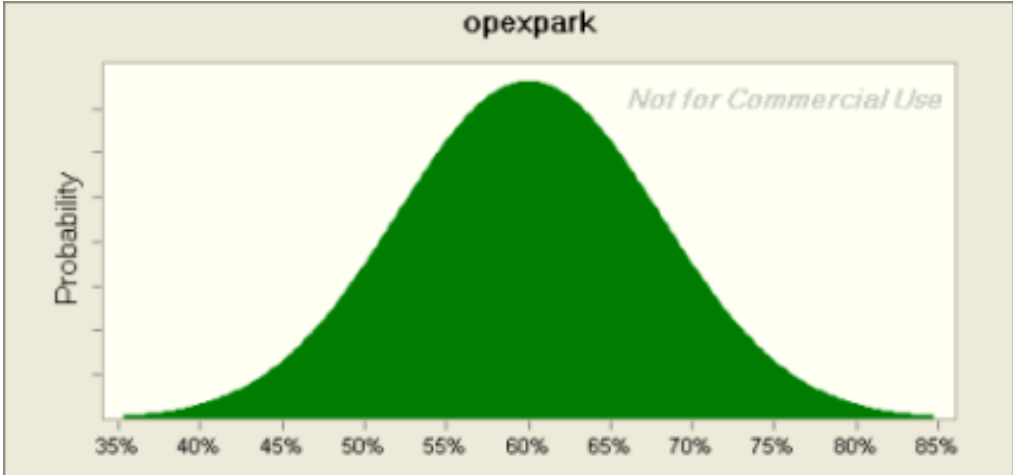
- a. **Revenues:** In our base case, Rio Magic Kingdom starts generating revenues of # 1 billion in year 2 and revenues at that park grow to almost \$ 3 billion in year 10. Rio Epcot is expected to generate revenues of \$ 300 million in year 4 and grow to \$ 750 million in year 10. We assume that the actual revenues will be within 20% of the estimate in either direction, with a uniform distribution (in figure 5.12):

Figure 5.12: Revenues as % of Predictions: Rio Disney



- b. **Direct Expenses:** In the base case analysis, we assumed that the direct expenses would be 60% of revenues, but we based those estimates on Disney's existing theme parks. To the extent that we are entering a new market (Latin America) and may be faced with unexpected surprises, we assume that direct expenses will be normally distributed with an average of 60% and a standard deviation of 6% (in figure 5.13):

Figure 5.13: Operating Expenses as % of Revenues – Rio Disney



c. Country risk premium: In our base case analysis, we used a country risk premium for Brazil of 3.95%, which when added to the mature market premium of 6% yielded a total risk premium of 9.95%. Given Brazil’s volatile history, we examined the impact of changing this risk premium. Again, we assumed that the total equity risk premium would be normally distributed with an expected value of 9.95% but with a standard deviation of 1% (in figure 5.14):

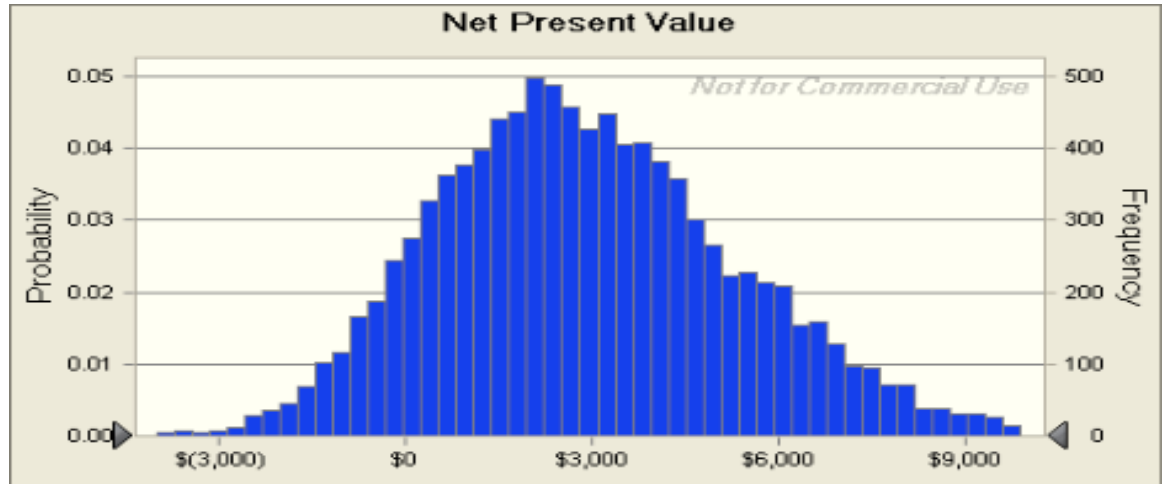
Figure 5.14: Equity Risk Premium: Rio Disney



d. Correlation between assumptions: We also recognize that our estimates of revenues will be tied to our assessments of country risk. In other words, if the risk in Brazil increases, it is likely to scare away potential visitors. To allow for this relationship, we assume that that the outcomes on revenues and total risk

- premium have a correlation of -0.40; revenues are low when the country risk premium is high and revenues are high when the country risk premium is low.
- e. With these assumptions in place, we ran 10,000 simulations and the resulting NPVs are graphed in figure 5.15:

Figure 5.15: NPV of Rio Disney: Results of Simulations



There are three pieces of usable output. The first is that the average NPV across all 10,000 simulations is \$2.95 billion and the median value is \$2.73 billion, both close to our base case estimate of \$2.877 billion. The second is that the NPV is negative in about 12% of all the simulations, indicating again even why even the most lucrative investments come with risk premiums. The third is that net present values range from -\$4 billion as the worst case outcome to \$14.6 billion as the best case outcome.

While this simulation does not change our overall assessment of the project, it does provide the decision makers at Disney with a fuller sense of what the new theme park will generate as value for the firm.

An Overall Assessment of Probabilistic Risk Assessment Approaches

Assuming that we decide to use a probabilistic approach to assess risk and could choose between scenario analysis, decision trees and simulations, which one should we pick? The answer will depend upon how you plan to use the output and what types of risk you are facing:

1. Selective versus Full Risk Analysis: In the best-case/worst-case scenario analysis, we look at only three scenarios (the best case, the most likely case and the worst case) and

ignore all other scenarios. Even when we consider multiple scenarios, we will not have a complete assessment of all possible outcomes from risky investments or assets. With decision trees and simulations, we attempt to consider all possible outcomes. In decision trees, we try to accomplish this by converting continuous risk into a manageable set of possible outcomes. With simulations, we can use distributions to capture all possible outcomes. Put in terms of probability, the sum of the probabilities of the scenarios we examine in scenario analysis can be less than one, whereas the sum of the probabilities of outcomes in decision trees and simulations has to equal one. As a consequence, we can compute expected values across outcomes in the latter, using the probabilities as weights, and these expected values are comparable to the single estimate risk adjusted values that we talked about in the last chapter.

2. Discrete versus Continuous Risk: As noted above, scenario analysis and decision trees are generally built around discrete outcomes in risky events whereas simulations are better suited for continuous risks. Focusing on just scenario analysis and decision trees, the latter are better suited for sequential risks, since risk is considered in phases, whereas the former is easier to use when risks occur concurrently.

3. Correlation across risks: If the various risks that an investment is exposed to are correlated, simulations allow for explicitly modeling these correlations (assuming that you can estimate and forecast them). In scenario analysis, we can deal with correlations subjectively by creating scenarios that allow for them; the high (low) interest rate scenario will also include slower (higher) economic growth. Correlated risks are difficult to model in decision trees.

Table 5.17 summarizes the relationship between risk type and the probabilistic approach used:

Table 5.17: Risk Type and Probabilistic Approaches

<i>Discrete/Continuous</i>	<i>Correlated/Independent</i>	<i>Sequential/Concurrent</i>	<i>Risk Approach</i>
Discrete	Independent	Sequential	Decision Tree
Discrete	Correlated	Concurrent	Scenario Analysis
Continuous	Either	Either	Simulations

Finally, the quality of the information will be a factor in your choice of approach. Since simulations are heavily dependent upon being able to assess probability distributions and parameters, they work best in cases where there is substantial historical and cross sectional data available that can be used to make these assessments. With decision trees, you need estimates of the probabilities of the outcomes at each chance node, making them best suited for risks where these risks can be assessed either using past data or population characteristics. Thus, it should come as no surprise that when confronted with new and unpredictable risks, analysts continue to fall back on scenario analysis, notwithstanding its slapdash and subjective ways of dealing with risk.

Conclusion

Investment analysis is arguably the most important part of corporate financial analysis. In this chapter we defined the scope of investment analysis and examined a range of investment analysis techniques, ranging from accounting rate of return measures, such as return of equity and return on assets, to discounted cash flow techniques, such as NPV and IRR. In general, it can be argued that:

- Any decision that requires the use of resources is an investment decision; thus, investment decisions cover everything from broad strategic decisions at one extreme to narrower operating decisions such as how much inventory to carry at the other.
- There are two basic approaches to investment analysis; in the equity approach, the returns to equity investors from a project are measured against the cost of equity to decide on whether to take a project; in the firm approach, the returns to all investors in the firm are measured against the cost of capital to arrive at the same judgment.
- Accounting rate of return measures, such as return on equity or return on capital, generally work better for projects that have large initial investments, earnings that are roughly equal to the cash flows, and level earnings over time. For most projects, accounting returns will increase over time, as the book value of the assets is depreciated.
- Payback, which looks at how quickly a project returns its initial investment in nominal cash flow terms, is a useful secondary measure of project performance or a

measure of risk, but it is not a very effective primary technique because it does not consider cash flows after the initial investment is recouped.

- Discounted cash flow methods provide the best measures of true returns on projects because they are based on cash flows and consider the time value of money. Among discounted cash flow methods, NPV provides an unscaled measure, whereas IRR provides a scaled measure of project performance. Both methods require the same information, and for the most part they provide the same conclusions when used to analyze independent projects.
- Uncertainty is a given when analyzing risky projects and there are several techniques we can use to evaluate the consequences. In sensitivity analysis, we look at the consequences for value (and the investment decision) of changing one input at a time, holding all else constant. In scenario analysis, we examine the payoff to investing under the best and worst cases, as well as under specified scenarios. In decision trees, risk is assessed sequentially, where outcomes at one stage affect values at the next stage. Finally, in simulations, we use probability distributions for the inputs, rather than expected values, and derive probability distributions for the NPV and IRR (rather than one NPV and IRR).

Live Case Study

Estimating Earnings and Cash Flows only if feasible

Objective: To estimate earnings and cash flows on a typical project for the firm.

Key Questions:

1. Does your firm have a typical investment?
2. If so, can you estimate the earnings and cash flows on a typical investment?

Framework for Analysis:

1. Typical Investment

- 1.1. Does your firm take a few or several investments each year?
- 1.2. Do these investments have much in common?
- 1.3. If so, what do they have in common and what are the differences?

2. Earnings and Cash Flows

- 2.1. What is the typical life of an investment made by your firm?
- 2.2. What is the pattern of earnings on such an investment?
- 2.3. What is the pattern of cash flows on such an investment?
- 2.4. Based upon the company's aggregate numbers, can you estimate the earnings and cash flows on a hypothetical investment?

Getting Information on Projects

Firms do describe their investments, though not in significant detail, in their annual reports. The statement of cash flows will provide some breakdown, as will the footnotes to the financial statements.

Online sources of information:

<http://www.stern.nyu.edu/~adamodar/cfin2E/project/data.htm>

Problems and Questions

1. You have been given the following information on a project:

- It has a five-year lifetime
- The initial investment in the project will be \$25 million, and the investment will be depreciated straight line, down to a salvage value of \$10 million at the end of the fifth year.
- The revenues are expected to be \$20 million next year and to grow 10% a year after that for the remaining four years.
- The cost of goods sold, excluding depreciation, is expected to be 50% of revenues.
- The tax rate is 40%.

a. Estimate the pretax return on capital, by year and on average, for the project.

b. Estimate the after-tax return on capital, by year and on average, for the project.

c. If the firm faced a cost of capital of 12%, should it take this project?

2. Now assume that the facts in Problem 1 remain unchanged except for the depreciation method, which is switched to an accelerated method with the following depreciation schedule:

Year	% of Depreciable Asset
1	40%
2	24%
3	14.4%
4	13.3%
5	13.3%

Depreciable Asset = Initial Investment – Salvage Value

a. Estimate the pretax return on capital, by year and on average, for the project.

b. Estimate the after-tax return on capital, by year and on average, for the project.

c. If the firm faced a cost of capital of 12%, should it take this project?

3. Consider again the project described in Problem 1 (assume that the depreciation reverts to a straight line). Assume that 40% of the initial investment for the project will be financed with debt, with an annual interest rate of 10% and a balloon payment of the principal at the end of the fifth year.

- a. Estimate the return on equity, by year and on average, for this project.
 - b. If the cost of equity is 15%, should the firm take this project?
4. Answer true or false to the following statements:
- a. The return on equity for a project will always be higher than the return on capital on the same project.
 - b. If the return on capital is less than the cost of equity, the project should be rejected.
 - c. Projects with high financial leverage will have higher interest expenses and lower net income than projects with low financial leverage and thus end up with a lower return on equity.
 - d. Increasing the depreciation on an asset will increase the estimated return on capital and equity on the project.
 - e. The average return on equity on a project over its lifetime will increase if we switch from straight line to double declining balance depreciation.
5. Under what conditions will the return on equity on a project be equal to the IRR, estimated from cash flows to equity investors, on the same project?
6. You are provided with the projected income statements for a project:

Year	1	2	3	4
Revenues (\$)	\$10,000	\$11,000	\$12,000	\$13,000
– Cost of goods sold (\$)	\$4,000	\$4,400	\$4,800	\$5,200
– Depreciation	\$4,000	\$3,000	\$2,000	\$1,000
= EBIT	\$2,000	\$3,600	\$5,200	\$6,800

- The tax rate is 40%.
 - The project required an initial investment of \$15,000 and an additional investment of \$2,000 at the end of year two.
 - The working capital is anticipated to be 10% of revenues, and the working capital investment has to be made at the beginning of each period.
- a. Estimate the free cash flow to the firm for each of the four years.
 - b. Estimate the payback period for investors in the firm.
 - c. Estimate the NPV to investors in the firm, if the cost of capital is 12%. Would you accept the project?

- d. Estimate the IRR to investors in the firm. Would you accept the project?
7. Consider the project described in Problem 6. Assume that the firm plans to finance 40% of its net capital expenditure and working capital needs with debt.
- Estimate the free cash flow to equity for each of the four years.
 - Estimate the payback period for equity investors in the firm.
 - Estimate the NPV to equity investors if the cost of equity is 16%. Would you accept the project?
 - Estimate the IRR to equity investors in the firm. Would you accept the project?
8. You are provided with the following cash flows on a project:

<i>Year</i>	<i>Cash Flow to Firm (\$)</i>
0	-10,000,000
1	\$ 4,000,000
2	\$ 5,000,000
3	\$ 6,000,000

Plot the net present value NPV profile for this project. What is the IRR? If this firm had a cost of capital of 10% and a cost of equity of 15%, would you accept this project?

9. You have estimated the following cash flows on a project:

<i>Year</i>	<i>Cash Flow to Equity (\$)</i>
0	-\$ 5,000,000
1	\$4,000,000
2	\$ 4,000,000
3	-\$3,000,000

Plot the NPV profile for this project. What is the IRR? If the cost of equity is 16%, would you accept this project?

10. Estimate the MIRR for the project described in Problem 8. Does it change your decision on accepting this project?

11. You are analyzing two mutually exclusive projects with the following cash flows:

<i>Year</i>	<i>A</i>	<i>B</i>
0	-\$4,000,000	-\$4,000,000

1	\$2,000,000	\$1,000,000
2	\$1,500,000	\$1,500,000
3	\$ 1,250,000	\$1,700,000
4	\$1,000,000	\$2,400,000

- Estimate the NPV of each project, assuming a cost of capital of 10%. Which is the better project?
- Estimate the IRR for each project. Which is the better project?
- What reinvestment rate assumptions are made by each of these rules? Can you show the effect on future cash flows of these assumptions?
- What is the MIRR on each of these projects?

12. You have a project that does not require an initial investment but has its expenses spread over the life of the project. Can the IRR be estimated for this project? Why or why not?

13. Businesses with severe capital rationing constraints should use IRR more than NPV. Do you agree? Explain.

14. You have to pick between three mutually exclusive projects with the following cash flows to the firm:

<i>Year</i>	<i>Project A</i>	<i>Project B</i>	<i>Project C</i>
0	-\$10,000	\$5,000	-\$15,000
1	\$ 8,000	\$ 5,000	\$ 10,000
2	\$ 7,000	-\$8,000	\$10,000

The cost of capital is 12%.

- Which project would you pick using the NPV rule?
- Which project would you pick using the IRR rule?
- How would you explain the differences between the two rules? Which one would you rely on to make your choice?

15. You are analyzing an investment decision, in which you will have to make an initial investment of \$10 million and you will be generating annual cash flows to the firm of \$2 million every year, growing at 5% a year, forever.

- Estimate the NPV of this project, if the cost of capital is 10%.

b. Estimate the IRR of this project.

16. You are analyzing a project with a thirty-year lifetime, with the following characteristics:

- The project will require an initial investment of \$20 million and additional investments of \$5 million in year ten and \$5 million in year twenty.
- The project will generate earnings before interest and taxes of \$3 million each year. (The tax rate is 40%.)
- The depreciation will amount to \$500,000 each year, and the salvage value of the equipment will be equal to the remaining book value at the end of year thirty.
- The cost of capital is 12.5%.

a. Estimate the NPV of this project.

b. Estimate the IRR on this project. What might be some of the problems in estimating the IRR for this project?

17. You are trying to estimate the NPV of a three-year project, where the discount rate is expected to change over time.

Year	Cash Flow to Firm (\$)	Discount Rate (%)
0	\$15,000	9.5%
1	\$5,000	10.5%
2	\$ 5,000	11.5%
3	\$ 10,000	12.5%

a. Estimate the NPV of this project. Would you take this project?

b. Estimate the IRR of this project. How would you use the IRR to decide whether to take this project?

18. Barring the case of multiple IRRs, is it possible for the NPV of a project to be positive while the IRR is less than the discount rate? Explain.

19. You are helping a manufacturing firm decide whether it should invest in a new plant. The initial investment is expected to be \$50 million, and the plant is expected to generate after-tax cash flows of \$5 million a year for the next twenty years. There will be an

additional investment of \$20 million needed to upgrade the plant in ten years. If the discount rate is 10%,

- a. Estimate the NPV of the project.
- b. Prepare an NPV Profile for this project.
- c. Estimate the IRR for this project. Is there any aspect of the cash flows that may prove to be a problem for calculating IRR?

20. You have been asked to analyze a project where the analyst has estimated the return on capital to be 37% over the ten-year lifetime of the project. The cost of capital is only 12%, but you have concerns about using the return on capital as an investment decision rule. Would it make a difference if you knew that the project was employing an accelerated depreciation method to compute depreciation? Why?

21. Accounting rates of return are based on accounting income and book value of investment, whereas internal rates of return are based on cash flows and take into account the time value of money. Under what conditions will the two approaches give you similar estimates?