PROJECT INTERACTIONS, SIDE COSTS, AND SIDE BENEFITS

In much of our discussion so far, we have assessed projects independently of other projects that the firm already has or might have in the future. Disney, for instance, was able to look at Rio Disney standing alone and analyze whether it was a good or bad investment. In reality, projects at most firms have interdependencies with and consequences for other projects. Disney may be able to increase both movie and merchandise revenues because of the new theme park in Brazil and may face higher advertising expenditures because of its Latin American expansion.

In this chapter, we examine a number of scenarios in which the consideration of one project affects other projects. We start with the most extreme case, whereby investing in one project leads to the rejection of one or more other projects; this is the case when firms have to choose between mutually exclusive investments. We then consider a less extreme scenario, in which a firm with constraints on how much capital it can raise considers a new project. Accepting this project reduces the capital available for other projects that the firm considers later in the period and thus can affect their acceptance; this is the case of capital rationing.

Projects can create costs for existing investments by using shared resources or excess capacity, and we consider these side costs next. Projects sometimes generate benefits for other projects, and we analyze how to bring these benefits into the analysis. In the third part of the chapter, we introduce the notion that projects often have options embedded in them, and ignoring these options can result in poor project decisions.

In the final part of the chapter, we turn from looking at new investments to the existing investments of the company. We consider how we can extend the techniques used to analyze new investments can be used to do post-mortems of existing investments as well as analyzing whether to continue or terminate an existing investment. We also look at how best to assess the portfolio of existing investments on a firm's books, using both cash flows and accounting earnings. Finally, we step away from investment and capital budgeting techniques and ask a more fundamental question. Where do good

investments come from? Put another way, what are the qualities that a company or its management possess that allow it to generate value from its investments.

Mutually Exclusive Projects

Projects are mutually exclusive when accepting one investment means rejecting others, even though the latter standing alone may pass muster as good investments, i.e. have a positive NPV and a high IRR. There are two reasons for the loss of project independence. In the first, the firm may face a capital rationing constraint, where not all good projects can be accepted and choices have to be made across good investments. In the second, projects may be mutually exclusive because they serve the same purpose and choosing one makes the other redundant. This is the case when the owner of a commercial building is choosing among a number of different air conditioning or heating systems for the building. This is also the case when investments provide alternative approaches to the future; a firm that has to choose between a "high-margin, low volume" strategy and a "low-margin, high-volume" strategy for a product can choose only one of the two. We will begin this section by looking at why firms may face capital rationing and how to choose between investments, when faced with this constraint. We will then move on to look at projects that are mutually exclusive because they provide alternatives to the same ends.

Project Dependence from Capital Rationing

In chapter 5, in our analysis of independent projects, we assumed that investing capital in a good project has no effect on other concurrent or subsequent projects that the firm may consider. Implicitly, we assume that firms with good investment prospects (with positive NPV) can raise capital from financial markets, at a fair price, and without paying transaction costs. In reality, however, it is possible that the capital required to finance a project can cause managers to reject other good projects because the firm has limited access to capital. *Capital rationing* occurs when a firm is unable to invest in

projects that earn returns greater than the hurdle rates.[1] Firms may face capital rationing constraints because they do not have either the capital on hand or the capacity and willingness to raise the capital needed to finance these projects. This implies that the firm does not have the capital to accept the positive NPV projects available.

Reasons for Capital Rationing Constraints

In theory, there will be no capital rationing constraint as long as a firm can follow this series of steps in locating and financing investments:

1. The firm identifies an attractive investment opportunity.

2. The firm goes to financial markets with a description of the project to seek financing.

3. Financial markets believe the firm's description of the project.

4. The firm issues securities—that is, stocks and bonds—to raise the capital needed to finance the project at fair market prices. Implicit here is the assumption that markets are efficient and that expectations of future earnings and growth are built into these prices.

5. The cost associated with issuing these securities is minimal.

If this were the case for every firm, then every worthwhile project would be financed and no good project would ever be rejected for lack of funds; in other words, there would be no capital rationing constraint.

The sequence described depends on a several assumptions, some of which are clearly unrealistic, at least for some firms. Let's consider each step even more closely.

1. Project Discovery: The implicit assumption that firms know when they have good projects on hand underestimates the uncertainty and the errors associated with project analysis. In very few cases can firms say with complete certainty that a prospective project will be a good one.

2. Credibility: Financial markets tend to be skeptical about announcements made by firms, especially when such announcements contain good news about future projects.

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[1] For discussions of the effect of capital rationing on the investment decision, see Lorie, J.H. and L.J. Savage, 1955, *Three Problems in Rationing Capital*, Journal of Business, v28, 229-239, Weingartner, H.M., 1977, *Capital Rationing: n Authors in Search of a Plot*, Journal of Finance, v32, 1403-1432.

Because it is easy for any firm to announce that its future projects are good, regardless of whether this is true or not, financial markets often require more substantial proof of the viability of projects.

3. Market Efficiency: If the securities issued by a firm are underpriced by markets, firms may be reluctant to issue stocks and bonds at these low prices to finance even good projects. In particular, the gains from investing in a project for existing stockholders may be overwhelmed by the loss from having to sell securities at or below their estimated true value. To illustrate, assume that a firm is considering a project that requires an initial investment of $100 million and has an NPV of $10 million. Also assume that the stock of this company, which management believes should be trading for $100 per share, is actually trading at $80 per share. If the company issues $100 million of new stock to take on the new project, its existing stockholders will gain their share of the NPV of $10 million, but they will lose $20 million ($100 million – $80 million) to new investors in the company. There is an interesting converse to this problem. When securities are overpriced, there may be a temptation to overinvest, because existing stockholders gain from the very process of issuing equities to new investors.

4, Flotation Costs: These are costs associated with raising funds in financial markets, and they can be substantial. If these costs are larger than the NPV of the projects considered, it would not make sense to raise these funds and finance the projects.

Sources of Capital Rationing

What are the sources of capital rationing? Going through the process described in the last section in Table 6.1, we can see the possible reasons for capital rationing at each step.

Table 6.1: Capital Rationing: Theory versus Practice

	In Theory	*In Practice*	*Source of Rationing*
1. Project discovery	A business uncovers a good investment opportunity.	A business believes, given the underlying uncertainty, that it has a good project.	Uncertainty about true value of projects may cause rationing.
2. Information revelation	The business conveys information	The business attempts to convey	Difficulty in conveying

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Lorie and Savage (1955) and Weingartner (1977).

	about the project to financial markets.	information to financial markets.	information to markets may cause rationing.
3. Market response	Financial markets believe the firm; i.e., the information is conveyed credibly.	Financial markets may not believe the announcement.	The greater the credibility gap, the greater the rationing problem.
4. Market efficiency	The securities issued by the business (stocks and bonds) are fairly priced.	The securities issued by the business may not be correctly priced.	With underpriced securities, firms will be unwilling to raise funds for projects.
5. Flotation costs	There are no costs associated with raising funds for projects.	There are significant costs associated with raising funds for projects.	The greater the flotation costs, the larger will be the capital rationing problem.

The three primary sources of capital rationing constraints, therefore, are a firm's lack of credibility with financial markets, market under pricing of securities, and flotation costs.

Researchers have collected data on firms to determine whether they face capital rationing constraints and, if so, to identify the sources of such constraints. One such survey was conducted by Scott and Martin and is summarized in Table 6.2.[2]

Table 6.2: The Causes of Capital Rationing

Cause	*# firms*	*%*
Debt limit imposed by outside agreement	10	10.7
Debt limit placed by management external to firm	3	3.2
Limit placed on borrowing by internal management	65	69.1
Restrictive policy imposed on retained earnings	-	2.1
Maintenance of target EPS or PE ratio	14	14.9

Source: Martin and Scott (1976)

This survey suggests that although some firms face capital rationing constraints as a result of external factors largely beyond their control, such as issuance costs and credibility problems, most firms face self-imposed constraints, such as restrictive policies to avoid overextending themselves by investing too much in any period. In some cases,

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[2] Martin, J.D. and D.F. Scott, 1976, *Debt Capacity and the Capital Budgeting Decision*, Financial Management, v5(2), 7-14.

managers are reluctant to issue additional equity because they fear that doing so will dilute the control they have over the company.

Looking at the sources of capital rationing, it seems clear that smaller firms with more limited access to capital markets are more likely to face capital rationing constraints than larger firms. Using similar reasoning, private businesses and emerging market companies are more likely to have limited capital than publicly traded and developed market companies.

Project Selection with Capital Rationing

Whatever the reason, many firms have capital rationing constraints, limiting the funds available for investment. When there is a capital rationing constraint, the standard advice of investing in projects with positive NPV breaks down, because we can invest in a subset of projects. Put another way, we have to devise ranking systems for good investments that will help us direct the limited capital to where it can generate the biggest payoff. We will begin this section by evaluating how and why the two discounted cash flow techniques that we introduced in chapter 5 – NPV and IRR- yield different rankings and then consider modifying these techniques in the face of capital rationing.

Project Rankings – NPV and IRR

The NPV and the IRR are both time-weighted, cash flow based measures of return for an investment and yield the same conclusion – accept or reject- for an independent, stand-alone investment. When comparing or ranking multiple projects, though, the two approaches can yield different rankings, either because of differences in scale or because of differences in the reinvestment rate assumption.
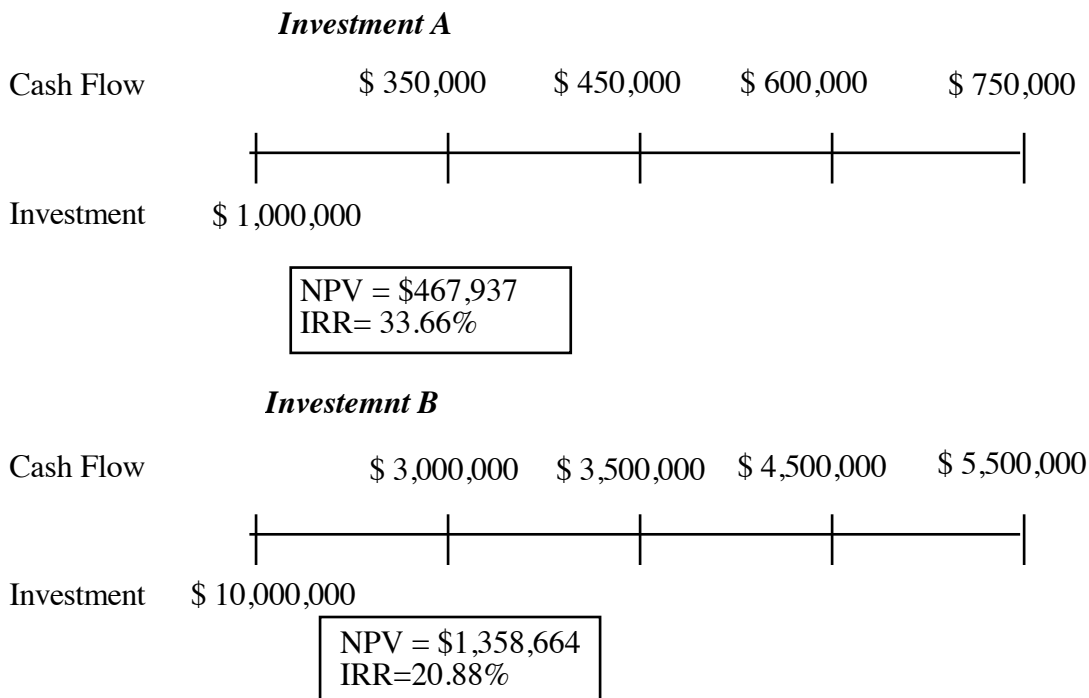
Differences in Scale

The NPV of a project is stated in dollar terms and does not factor in the scale of the project. The IRR, by contrast, is a percentage rate of return, which is standardized for the scale of the project. Not surprisingly, rankings based upon the former will rank the biggest projects (with large cash flows) highest, whereas rankings based upon IRR will tilt towards projects that require smaller investments.

The scale differences can be illustrated using a simple example. Assume that you are a firm and that you are comparing two projects. The first project requires an initial

investment of $1 million and produces the cash flow revenues shown in Figure 6.1. The second project requires an investment of $10 million and is likely to produce the much higher cash flows (shown in Figure 6.1) as well. The cost of capital is 15% for both projects.

Figure 6.1: NPV and IRR - Different Scale Projects

Investment A

Cash Flow $ 350,000 $ 450,000 $ 600,000 $ 750,000

Investment $ 1,000,000

NPV = $467,937
IRR= 33.66%

Investemnt B

Cash Flow $ 3,000,000 $ 3,500,000 $ 4,500,000 $ 5,500,000

Investment $ 10,000,000

NPV = $1,358,664
IRR=20.88%

The two decision rules yield different results. The NPV rule suggests that project B is the better project, whereas the IRR rule leans toward project A. This is not
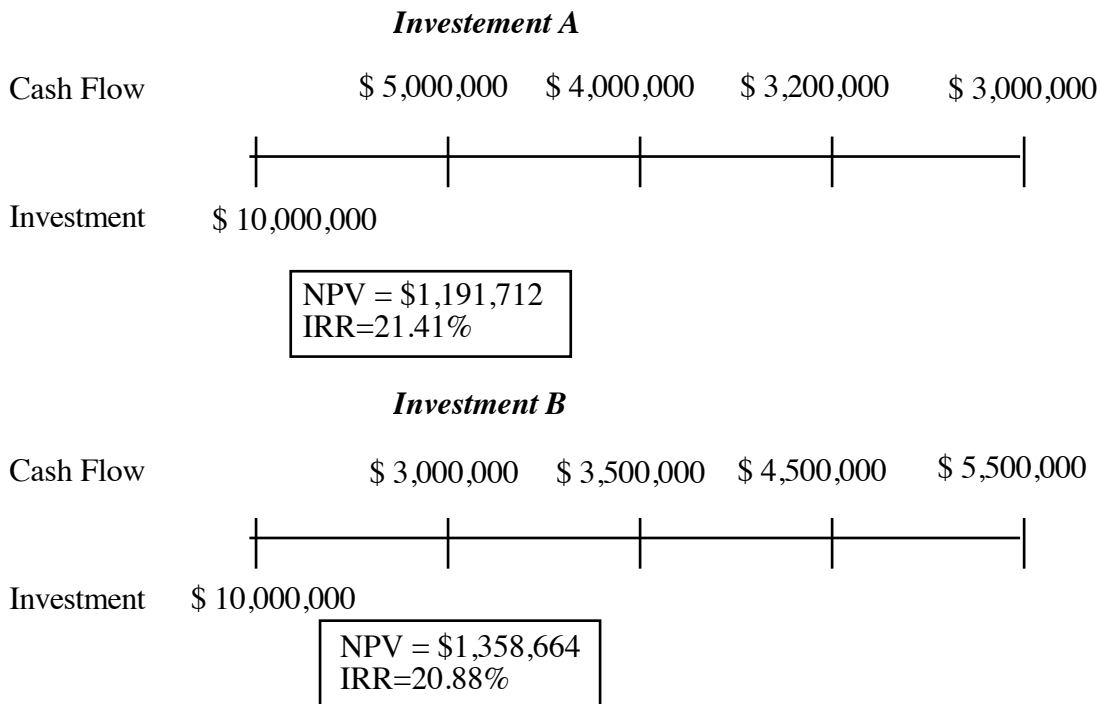
> *Capital Rationing:* The scenario where the firm does not have sufficient funds—either on hand or in terms of access to markets—to take on all of the good projects it might have.

surprising, given the differences in scale. In fact, both projects generate positive net present values and high IRRs.

If a firm has easy access to capital markets, it would invest in both projects. However, if the firm has limited capital and has to apportion it across a number of good projects, however, then taking Project B may lead to the rejection of good projects later on. In those cases, the IRR rule may provide the better solution.

Differences in Reinvestment Rate Assumptions

Although the differences between the NPV rule and the IRR rules due to scale are fairly obvious, there is a subtler and much more significant difference between them relating to the reinvestment of intermediate cash flows. As pointed out earlier, the NPV rule assumes that intermediate cash flows are reinvested at the discount rate, whereas the IRR rule assumes that intermediate cash flows are reinvested at the IRR. As a consequence, the two rules can yield different conclusions, even for projects with the same scale, as illustrated in Figure 6.2.

Figure 6.2 NPV and IRR - Reinvestment Assumption

Investement A

Cash Flow $ 5,000,000 $ 4,000,000 $ 3,200,000 $ 3,000,000

Investment $ 10,000,000

NPV = $1,191,712
IRR=21.41%

Investment B

Cash Flow $ 3,000,000 $ 3,500,000 $ 4,500,000 $ 5,500,000

Investment $ 10,000,000

NPV = $1,358,664
IRR=20.88%

In this case, the NPV rule ranks the second investment higher, whereas the IRR rule ranks the first investment as the better project. The differences arise because the NPV rule assumes that intermediate cash flows get invested at the hurdle rate, which is 15%. The IRR rule assumes that intermediate cash flows get reinvested at the IRR of that project. Although both projects are affected by this assumption, it has a much greater effect for project A, which has higher cash flows earlier on. The reinvestment assumption is made clearer if the expected end balance is estimated under each rule.

End Balance for Investment A with IRR of 21.41% =$10,000,000*$1.2141^4$ = $21,730,887

End Balance for Investment B with IRR of 20.88% = $10,000,000*1.2088^4 = $21,353,673

To arrive at these end balances, however, the cash flows in years one, two, and three will have to be reinvested at the IRR. If they are reinvested at a lower rate, the end balance on these projects will be lower, and the actual return earned will be lower than the IRR even though the cash flows on the project came in as anticipated.

The reinvestment rate assumption made by the IRR rule creates more serious consequences the longer the term of the project and the higher the IRR, because it implicitly assumes that the firm has and will continue to have a fountain of projects yielding returns similar to that earned by the project under consideration.

Project Rankings: Modified Rules

The conventional discounted cash flow rules, NPV or IRR, have limitations when it comes to ranking projects, in the presence of capital rationing. The NPV rule is biased towards larger investments and will not result in the best use of limited capital. The IRR rule is generally better suited for capital rationed firms, but the assumption that intermediate cash flows get reinvested at the IRR can skew investment choices. We consider three modifications to traditional investment rules that yield better choices than the traditional rules: a scaled version of NPV called the profitability index, a modified internal rate of return, with more reasonable reinvestment assumptions and a more complex linear programming approach, that allows capital constraints in multiples periods.

Profitability Index

The profitability index is the simplest method of including capital rationing in investment analysis. It is particularly useful for firms that have a constraint for the current period only and relatively few projects. A scaled version of the NPV, the profitability index is computed by dividing the NPV of the project by the initial investment in the project.[3]

$$\text{Profitability Index} = \frac{\text{Net Present Value of Investment}}{\text{Initial Investment needed for Investment}}$$

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[3]There is another version of the profitability index, whereby the present value of all cash inflows is divided by the present value of cash outflows. The resulting ranking will be the same as with the profitability index as defined in this chapter.

The profitability index provides a rough measure of the NPV the firm gets for each dollar it invests. To use it in investment analysis, we first compute it for each investment the firm is considering, and then pick projects based on the profitability index, starting with the highest values and working down until we reach the capital constraint. When capital is limited and a firm cannot accept every positive NPV project, the profitability index identifies the highest cumulative NPV from the funds available for capital investment.

Although the profitability index is intuitively appealing, it has several limitations. First, it assumes that the capital rationing constraint applies to the current period only and does not include investment requirements in future periods. Thus, a firm may choose projects with a total initial investment that is less than the current period's capital constraint, but it may expose itself to capital rationing problems in future periods if these projects have outlays in those periods. A related problem is the classification of cash flows into an initial investment that occurs now and operating cash inflows that occur in future periods. If projects have investments spread over multiple periods and operating cash outflows, the profitability index may measure the project's contribution to value incorrectly. Finally, the profitability index does not guarantee that the total investment will add up to the capital rationing constraint. If it does not, we have to consider other combinations of projects, which may yield a higher NPV. Although this is feasible for firms with relatively few projects, it becomes increasing unwieldy as the number of projects increases.

Illustration 6.1: Using the Profitability Index to Select Projects

Assume that Bookscape, as a private firm, has limited access to capital, and a capital budget of $100,000 in the current period. The projects available to the firm are listed in Table 6.3.

Table 6.3: Available Projects

Project	Initial Investment (in 1000s)	NPV (000s)
A	$25	$10
B	40	20
C	5	5
D	100	25
E	50	15
F	70	20

G	35	20

Note that all the projects have positive NPVs and would have been accepted by a firm not subject to a capital rationing constraint.

To choose among these projects, we compute the profitability index of each project in Table 6.4.

Table 6.4: Profitability Index for Projects

Project	Initial Investment (1000s)	NPV (1000s)	Profitability Index	Ranking
A	$25	$10	0.40	4
B	60	30	0.50	3
C	5	5	1.00	1
D	100	25	0.25	7
E	50	15	0.30	5
F	70	20	0.29	6
G	35	20	0.57	2

The profitability index of 0.40 for project A means that the project earns an NPV of forty cents for every dollar of initial investment. Based on the profitability index, we should accept projects B, C, and G. This combination of projects would exhaust the capital budget of $100,000 while maximizing the NPV of the projects accepted. This analysis also highlights the cost of the capital rationing constraint for this firm; the NPV of the projects rejected as a consequence of the constraint is $70 million.

6.1. **Mutually Exclusive Projects with Different Risk Levels**

Assume in this illustration that the initial investment required for project B was $40,000. Which of the following would be your best combination of projects given your capital rationing constraint of $100,000?

a. B, C, and G

b. A, B, C, and G

c. A, B, and G

d. Other

Modified Internal Rate of Return (MIRR)

One solution that has been suggested for the reinvestment rate assumption is to assume that intermediate cash flows get reinvested at the hurdle rate—the cost of equity if the cash flows are to equity investors and the cost of

> *__Modified Internal Rate of Return (MIRR):__ The IRR computed on the assumption that intermediate cash flows are reinvested at the hurdle rate.*

capital if they are to the firm—and to calculate the IRR from the initial investment and the terminal value. This approach yields what is called the **modified internal rate of return (MIRR)**.

Consider a four-year 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 nd $ 600 million in year 4. The conventional IRR of this investment is 24.89%, but that is premised on the assumption that the cashflows in years 1,2 and 3 are reinvested at that rate. If we assume a cost of capital of 15%, the modified internal rate of return computation is illustrated in Figure 6.3:

Figure 6.3: IRR versus Modified Internal Rate of Return
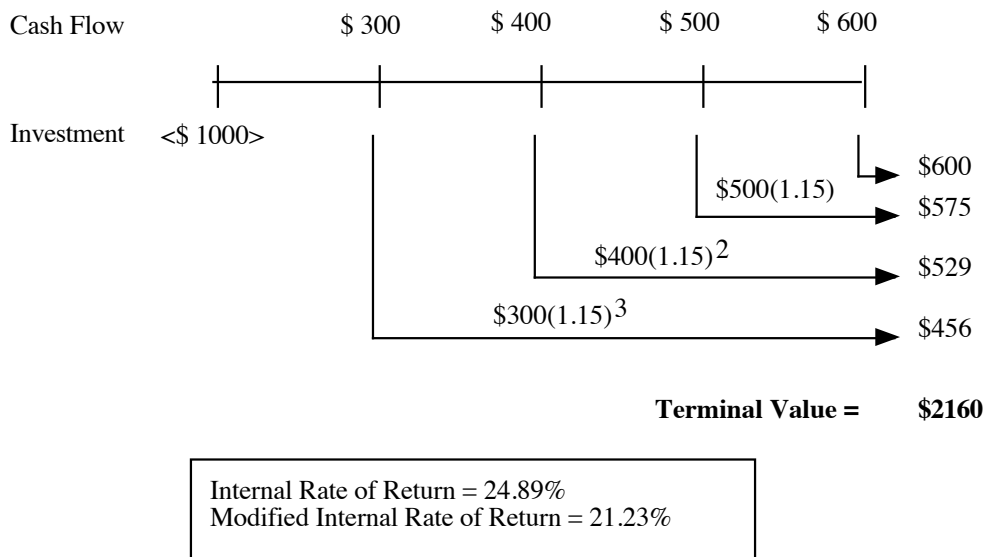
$$MIRR = (\$2160/\$1000)^{1/4} - 1 = 21.23\%$$

The MIRR is lower than the IRR because the intermediate cash flows are invested at the hurdle rate of 15% instead of the IRR of 24.89%.

There are many who believe that the MIRR is neither fish nor fowl, because it is a mix of the NPV rule and the IRR rule. From a practical standpoint, the MIRR becomes a weighted average of the returns on individual projects and the hurdle rates the firm uses, with the weights on each depending on the magnitude and timing of the cash flows—the larger and earlier the cash flows on the project, the greater the weight attached to the hurdle rate. Furthermore, the MIRR approach will yield the same choices as the NPV approach for projects of the same scale and lives.

Multi-period Capital Rationing

All of the approaches that we have described so far are designed to deal with capital rationing in the current period. In some cases, capital rationing constraints apply not only to the current period but to future periods as well, with the amount of capital that is available for investment also varying across periods. If you combine these multi-period constraints with projects that require investments in many periods (and not just in the current one), the capital rationing problem becomes much more complex and project rankings cannot provide an optimal solution.

One solution is to use linear programming techniques, developed in operations research. In a linear program, we begin by specifying an objective, subject to specified constraints. In the context of capital rationing, that objective is to maximize the value added by new investments, subject to the capital constraints in each period. For example, the linear program for a firm. with capital constraints of $ 1 billion for the current period, $1.2 billion for next year and $ 1.5 billion for year and trying to choose between k investments, can be written as follows:

Maximize $\sum_{j=1}^{j=k} X_j NPV_j$ where $X_j = 1$ if investment j is taken; 0 otherwise

Constraints:

$$\sum_{j=1}^{j=k} X_j Inv_{j,1} < \$1,000 \qquad \sum_{j=1}^{j=k} X_j Inv_{j,2} < \$1,200 \qquad \sum_{j=1}^{j=k} X_j Inv_{j,3} < \$1,500$$

where $Inv_{j,t} =$ Investment needed on investment j in period t

The approach can be modified to allow for partial investments in projects and for other constraints (human capital) as well.

In Practice: Using a Higher Hurdle Rate

Many firms choose what seems to be a more convenient way of selecting projects, when they face capital rationing— they raise the hurdle rate to reflect the severity of the constraint. If the definition of capital rationing is that a firm cannot take all the positive NPV projects it faces, raising the hurdle rate sufficiently will ensure that the problem is resolved or at least hidden. For instance, assume that a firm has a true cost of capital of 12 percent,[4] a capital rationing constraint of $100 million, and positive NPV projects requiring an initial investment of $250 million. At a higher cost of capital, fewer projects will have positive NPVs. At some cost of capital, say 18 percent, the positive NPV projects remaining will require an initial investment of $100 million or less.

There are problems that result from building the capital rationing constraint into the hurdle rate. First, once the adjustment has been made, the firm may fail to correct it for shifts in the severity of the constraint. Thus, a small firm may adjust its cost of capital from 12 percent to 18 percent to reflect a severe capital rationing constraint. As the firm gets larger, the constraint will generally become less restrictive, but the firm may not decrease its cost of capital accordingly. Second, increasing the discount rate will yield NPVs that do not convey the same information as those computed using the correct discount rates. The NPV of a project, estimated using the right hurdle rate, is the value added to the firm by investing in that project; the present value estimated using an adjusted discount rate cannot be read the same way. Finally, adjusting the hurdle rate penalizes all projects equally, whether or not they are capital-intensive.

We recommend that firms separate the capital rationing constraint from traditional investment analysis so they can observe how much these constraints cost. In the simplest terms, the cost of a capital rationing constraint is the total NPV of the good projects that could not be taken for lack of funds. There are two reasons why this knowledge is useful. First, if the firm is faced with the opportunity to relax these constraints, knowing how much these constraints cost will be useful. For instance, the firm may be able to enter into a strategic partnership with a larger firm with excess funds and use the cash to take the good projects that would otherwise have been rejected, sharing the NPV of these projects.

Second, if the capital rationing is self-imposed, managers in the firm are forced to confront the cost of the constraint. In some cases, the sheer magnitude of this cost may be sufficient for them to drop or relax the constraint.

Project Dependence for Operating Reasons

Even without capital rationing, choosing one project may require that we reject other projects. This is the case, for instance, when a firm is considering alternative ways, with different costs and cash flows, of delivering a needed service such as distribution or information technology. In choosing among mutually exclusive projects, we continue to use the same rules we developed for analyzing independent projects. The firm should choose the project that adds the most to its value. Although this concept is relatively straightforward when the projects are expected to generate cash flows for the same number of periods (have the same project life), as you will see, it can become more complicated when the projects have different lives.

Projects with Equal Lives

When comparing alternative investments with the same lives, a business can make its decision in one of two ways. It can compute the net present value (NPV) of each project and choose the one with the highest positive NPV (if the projects generate revenue) or the one with the lowest negative NPV (if the projects minimize costs). Alternatively, it can compute the differential cash flow between two projects and base its decision on the NPV or the internal rate of return (IRR) of the differential cash flow.
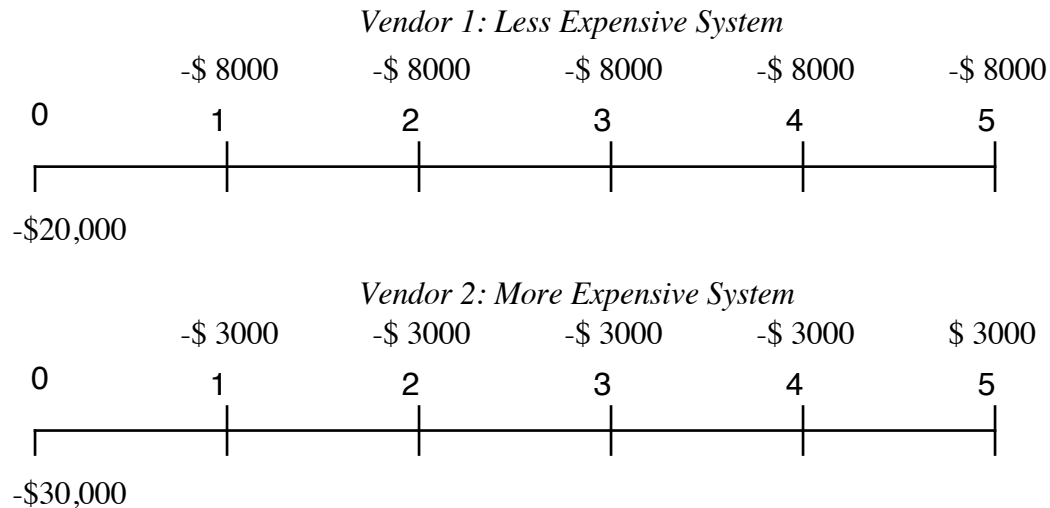
Comparing NPVs

The simplest way of choosing among mutually exclusive projects with equal lives is to compute the NPVs of the projects and choose the one with the highest NPV. This decision rule is consistent with firm value maximization. If the investments all generate costs (and hence only cash outflows), which is often the case when a service is being delivered, we will choose that alternative that has lowest negative NPV.

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[4]By true cost of capital, we mean a cost of capital that reflects the riskiness of the firm and its financing mix.

As an illustration, assume that Bookscape is choosing between alternative vendors who are offering telecommunications systems. Both systems have five-year lives, and the appropriate cost of capital is 10 percent for both projects. However the choice is between a more expensive system, with lower annual costs, with a cheaper system, with higher annual costs. Figure 6.4 summarizes the expected cash outflows on the two investments.

Figure 6.4: Cash Flows on Telecommunication Systems

Vendor 1: Less Expensive System

	-$ 8000	-$ 8000	-$ 8000	-$ 8000	-$ 8000
0	1	2	3	4	5

-$20,000

Vendor 2: More Expensive System

	-$ 3000	-$ 3000	-$ 3000	-$ 3000	$ 3000
0	1	2	3	4	5

-$30,000

The more expensive system is also more efficient, resulting in lower annual costs. The NPVs of these two systems can be estimated as follows:

$$\text{NPV of Less Expensive System} = -\$20{,}000 - \$8{,}000 \; \frac{(1 - (1.10)^{-5})}{0.10}$$

$$= -\$50{,}326$$

$$\text{NPV of More Expensive System} = -\$30{,}000 - \$3{,}000 \; \frac{(1 - (1.10)^{-5})}{0.10}$$

$$= -\$41{,}372$$

The NPV of all costs is much lower with the second system, making it the better choice.

Differential Cash Flows

An alternative approach for choosing between two mutually exclusive projects is to compute the difference in cash flows each period between the two investments. Using the telecommunications system from the last section as our illustrative example, we would compute the differential cash flow between the less expensive and the more expensive system in figure 6.5:

Figure 6.5: Differential Cash Flows on Telecommunication Systems

Vendor 1: Less Expensive System

	- $ 8000	- $ 8000	- $ 8000	- $ 8000	- $ 8000
0	1	2	3	4	5

-$20,000

Vendor 2: More Expensive System

	- $ 3000	- $ 3000	- $ 3000	- $ 3000	- $ 3000
0	1	2	3	4	5

-$30,000

Differential Cash Flows: More Expensive - Less Expensive System

	+ $ 5000	+ $ 5000	+ $ 5000	+ $ 5000	+ $ 5000
0	1	2	3	4	5

-$10,000
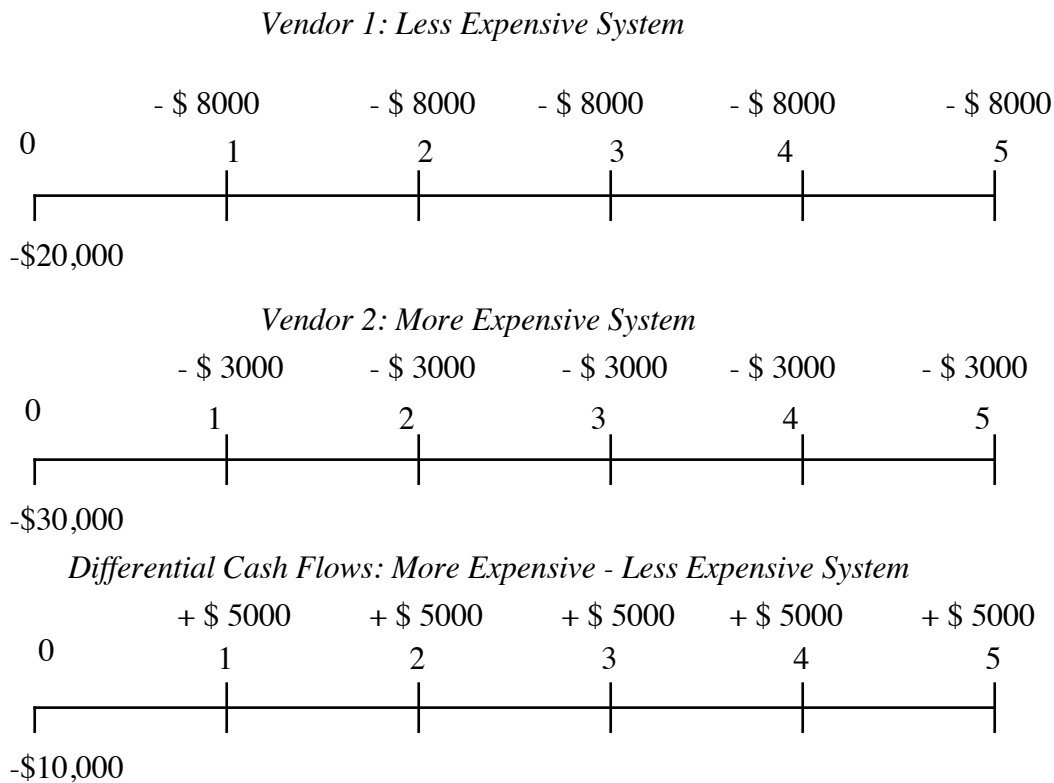
In computing the differential cash flows, the project with the larger initial investment becomes the project against which the comparison is made. In practical terms, the differential cash flow can be read thus: the more expensive system costs $ 10,000 more up front, but saves $ 5000 a year for the next five years.

The differential cash flows can be used to compute the NPV, and the decision rule can be summarized as follows:

If $NPV_{B-A} > 0$: Project B is better than project A

$NPV_{B-A} < 0$: Project A is better than project B

Notice two points about the differential NPV. The first is that it provides the same result as would have been obtained if the business had computed NPVs of the individual projects and then taken the difference between them.

$$NPV_{B-A} = NPV_B - NPV_A$$

The second is that the differential cash flow approach works only when the two projects being compared have the same risk level and discount rates, because only one discount

rate can be used on the differential cash flows. By contrast, computing project-specific NPVs allows for the use of different discount rates on each project. The differential cash flows can also be used to compute an IRR, which can guide us in selecting the better project.

$$\text{If } IRR_{B-A} > \text{Hurdle Rate: Project B is better than project A}$$

$$IRR_{B-A} < \text{Hurdle Rate: Project A is better than project B}$$

Again, this approach works only if the projects are of equivalent risk. Illustrating this process with the telecommunications example in figure 6.5, we estimate the NPV of the differential cash flows as follows:

$$\text{Net Present Value of Differential Cash Flows} = -\$10{,}000 + \$5{,}000 \; \frac{(1-(1.10)^{-5})}{0.10}$$

$$= +\$8{,}954$$

This NPV is equal to the difference between the NPVs of the individual projects that we computed in the last section, and it indicates that the system that costs more up front is also the better system from the viewpoint of NPV. The IRR of the differential cash flows is 41.04 percent, which is higher than the discount rate of 10 percent, once again suggesting that the more expensive system is the better one from a financial standpoint.

✔ 6.2. **Mutually Exclusive Projects with Different Risk Levels**

When comparing mutually exclusive projects with different risk levels and discount rates, what discount rate should we use to discount the differential cash flows?

a. The higher of the two discount rates

b. The lower of the two discount rates

c. An average of the two discount rates

d. None of the above

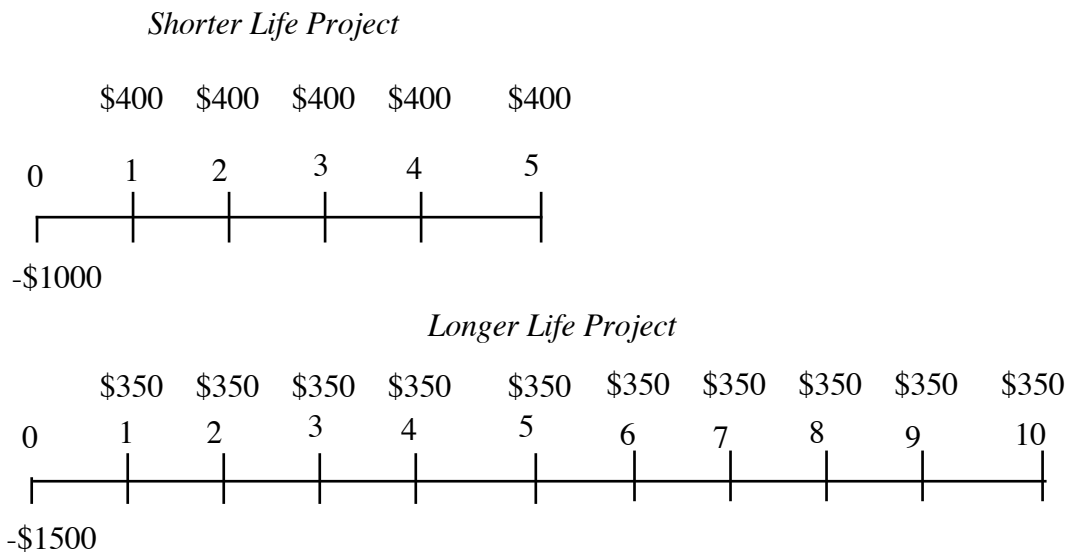Explain your answer.

Projects with Different Lives

In many cases, firms have to choose among projects with different lives.[5] In doing so, they can no longer rely solely on the NPV. This is so because, as a non-scaled figure,

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[5]Emery, G.W., 1982, *Some Guidelines for Evaluating Capital Investment Alternatives with Unequal Lives*, Financial Management, v11, 14-19.

the NPV is likely to be higher for longer-term projects; the NPV of a project with only two years of cash flows is likely to be lower than one with thirty years of cash flows.

Assume that you are choosing between two projects: a five-year project, with an initial investment of $ 1 billion and annual cash flows of $ 400 million, each year for the next 5 years, and a ten-year project, with an initial investment of $1.5 billion and annual cash flows of $ 350 million for ten years. Figure 6.6 summarizes the cash flows and a discount rate of 12 percent applies for each.

Figure 6.6: Cash Flows on Projects with Unequal Lives

Shorter Life Project

| $400 | $400 | $400 | $400 | | $400 |
| | | | | | |

```
0    1    2    3    4    5
├────┼────┼────┼────┼────┤
```

-$1000

Longer Life Project

| $350 | $350 | $350 | $350 | $350 | $350 | $350 | $350 | $350 | $350 |

```
0    1    2    3    4    5    6    7    8    9    10
├────┼────┼────┼────┼────┼────┼────┼────┼────┼────┤
```

-$1500

The NPV of the first project is $442 million, whereas the NPV of the second project is $478 million. On the basis on NPV alone, the second project is better, but this analysis fails to factor in the additional NPV that could be made by the firm from years six to ten in the project with a five-year life.

In comparing a project with a shorter life to one with a longer life, the firm must consider that it will be able to invest again with the shorter-term project. Two conventional approaches—project replication and equivalent annuities—assume that when the current project ends, the firm will be able to invest in the same project or a very similar one.

Project Replication

One way of tackling the problem of different lives is to assume that projects can be replicated until they have the same lives. Thus, instead of comparing a five-year to a

ten-year project, we can compute the NPV of investing in the five-year project twice and comparing it to the NPV of the ten-year project. Figure 6.7 presents the resulting cash flows.

Figure 6.7: Cash Flows on Projects with Unequal Lives: Replicated with poorer project

Five-year Project: Replicated

Longer Life Project

The NPV of investing in the five-year project twice is $693 million, whereas the net present value of the ten-year project remains at $478 million. These NPVs now can be compared because they correspond to two investment choices that have the same life.

This approach has limitations. On a practical level, it can become tedious to use when the number of projects increases and the lives do not fit neatly into multiples of each other. For example, an analyst using this approach to compare a seven-year, a nine-year, and a thirteen-year project would have to replicate these projects to 819 years to arrive at an equivalent life for all three. It is also difficult to argue that a firm's project choice will essentially remain unchanged over time, especially if the projects being compared are very attractive in terms of NPV.

Illustration 6.2: Project Replication to Compare Projects with Different Lives

Suppose you are deciding whether to buy a used car, which is inexpensive but does not give very good mileage, or a new car, which costs more but gets better mileage. The two options are listed in Table 6.5.

Table 6.5: Expected Cash Flows on New versus Used Car

	Used Car	New Car
Initial cost	$3,000	$8,000
Maintenance costs/year	$1,500	$1,000
Fuel costs/mile	$0.20	$0.05
Lifetime	4 years	5 years

Assume that you drive 5,000 miles a year and that your cost of capital is 15 percent. This choice can be analyzed with replication.

Step 1: Replicate the projects until they have the same lifetime; in this case, that would mean buying used cars five consecutive times and new cars four consecutive times.

  a.   Buy a used car every four years for twenty years.

```
        |_____|_____|_____|_____|_____|
Year:   0              4              8              12             16             20
Investment  –$3,000        –$3,000        –$3,000        –$3,000        –$3,000
```

Maintenance costs: $1,500 every year for twenty years

Fuel costs: $1,000 every year for twenty years (5,000 miles at twenty cents a mile).

  b.   Buy a new car every five years for twenty years

```
        |_____|_____|_____|_____|_____|
Year:   0                5                10               15               20
Investment:  --$8,000         –$8,000          –$8,000          –$8,000
```

Maintenance costs: $1000 every year for twenty years

Fuel costs: $250 every year for twenty years (5,000 miles at five cents a mile)

Step 2: Compute the NPV of each stream.

NPV of replicating used cars for 20 years = –22,225.61

NPV of replicating new cars for 20 years = –22,762.21

The NPV of the costs incurred by buying a used car every four years is less negative than the NPV of the costs incurred by buying a new car every five years, given that the cars will be driven 5,000 miles every year. As the mileage driven increases, however, the relative benefits of owning and driving the more efficient new car will also increase.

Equivalent Annuities

We can compare projects with different lives by converting their net present values into *equivalent annuities*. These equivalent annuities can be compared legitimately across projects with different lives. The NPV of any project can be converted into an annuity using the following calculation.

$$\text{Equivalent Annuity} = \text{Net Present Value} * \frac{r}{(1-(1+r)^{-n})}$$

where

r = project discount rate,

n = project lifetime

Note that the NPV of each project is converted into an annuity using that project's life and discount rate and that the second term in the equation is the annuity factor (see appendix 3).[6] Thus, this approach is flexible enough to use on projects with different discount rates and lifetimes. Consider again the example of the five-year and ten-year projects from the previous section. The NPVs of these projects can be converted into annuities as follows:

$$\text{Equivalent Annuity for 5-year project} = \$442 * \frac{0.12}{(1-(1.12)^{-5})} = \$122.62$$

$$\text{Equivalent Annuity for 10-year project} = \$478 * \frac{0.12}{(1-(1.12)^{-10})} = \$84.60$$

The NPV of the five-year project is lower than the NPV of the ten-year project, but using equivalent annuities, the five-year project yields $37.98 more per year than the ten-year project.

Although this approach does not explicitly make an assumption of project replication, it does so implicitly. Consequently, it will always lead to the same decision rules as the replication method. The advantage is that the equivalent annuity method is less tedious and will continue to work even in the presence of projects with infinite lives.

eqann.xls: This spreadsheet allows you to compare projects with different lives, using the equivalent annuity approach.

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[6] This can be obtained just as easilty using the present value functions in a financial calculator or a present value factor table.

Illustration 6.3: Equivalent Annuities to Choose between Projects with Different Lives

Consider again the choice between a new car and a used car described in Illustration 6.3. The equivalent annuities can be estimated for the two options as follows:

Step 1: Compute the NPV of each project individually (without replication)

$$\text{NPV of buying a used car} = -\$3{,}000 - \$2{,}500 * \frac{(1-(1.15)^{-4})}{0.15}$$

$$= -\$10{,}137$$

$$\text{NPV of buying a new car} = -\$8{,}000 - \$1{,}250 * \frac{(1-(1.15)^{-5})}{0.15}$$

$$= -\$12{,}190$$

Step 2: Convert the NPVs into equivalent annuities

$$\text{Equivalent annuity of buying a used car} = -\$10{,}137 * \frac{0.15}{(1-(1.15)^{-4})}$$

$$= -\$3{,}551$$

$$\text{Equivalent annuity of buying a new car} = -12{,}190 * \frac{0.15}{(1-(1.15)^{-5})}$$

$$= -\$3{,}637$$

Based on the equivalent annuities of the two options, buying a used car is more economical than buying a new car.

Calculating Break-Even

When an investment that costs more initially but is more efficient and economical on an annual basis is compared with a less expensive and less efficient investment, the choice between the two will depend on how much the investments get used. For instance, in Illustration 6.4, the less expensive used car is the more economical choice if the mileage is less than 5,000 miles in a year. The more efficient new car will be the better choice if the car is driven more than 5,000 miles. The *break-even* is the number of miles at which the two alternatives provide the same equivalent annual cost, as is illustrated in Figure 6.8.

Figure 6.8: Equivalent Annual Costs as a function of Miles Driven
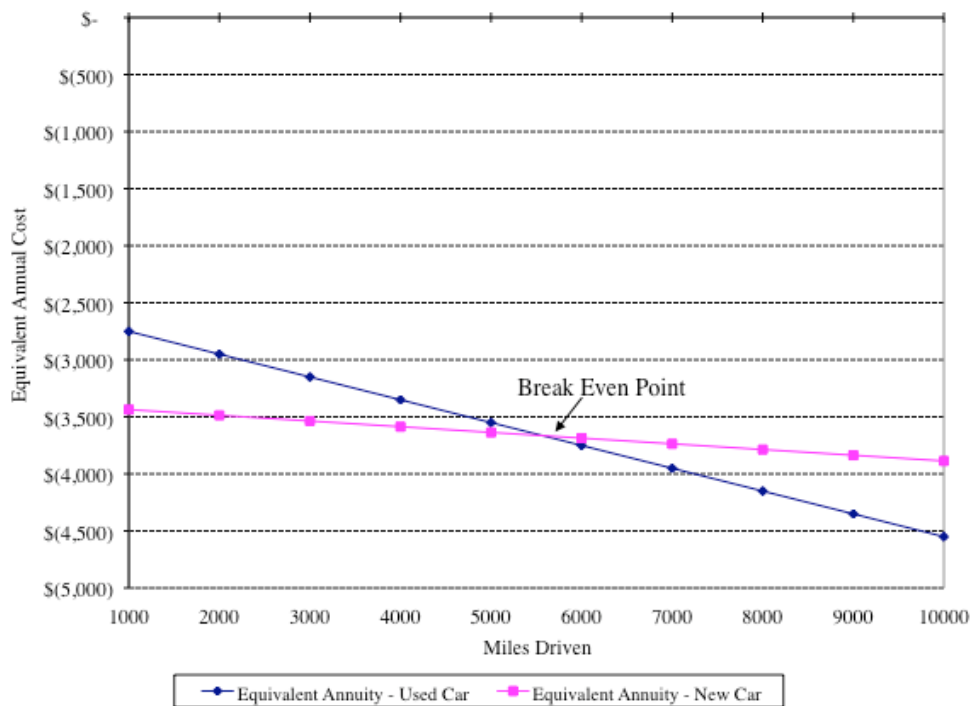
The break-even point occurs at roughly 5,500 miles; if there is a reasonable chance that the mileage driven will exceed this, the new car becomes the better option.

Illustration 6.4: Using Equivalent Annuities as a General Approach for Multiple Projects

The equivalent annuity approach can be used to compare multiple projects with different lifetimes. For instance, assume that Disney is considering three storage alternatives for its consumer products division:

Alternative	Initial Investment	Annual Cost	Project Life
Build own storage system	$10 million	$0.5 million	Infinite
Rent storage system	$2 million	$1.5 million	12 years
Use third-party storage	—	$2.0 million	1 year

These projects have different lives; the equivalent annual costs have to be computed for the comparison. Since the cost of capital computed for the consumer products business in chapter 4 is 9.49%, the equivalent annual costs can be computed as follows:[7]

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[7] The cost of the first system is based upon a perpetuity of $0.5 million a year. The net present value can be calculated as follows:
NPV = 10 + 0.5/.0949 =$ 15.27 million

Alternative	NPV of costs	Equivalent Annual Cost
Build own storage system	$15.62 million	$1.45 million
Rent storage system	$12.80 million	$1.79 million
Use third-party storage	$2.00 million	$2.00 million

Based on the equivalent annual costs, Disney should build its own storage system, even though the initial costs are the highest for this option.

6.3. **Mutually Exclusive Projects with Different Risk Levels**

Assume that the cost of the third-party storage option will increase 2.5 percent a year forever. What would the equivalent annuity for this option be?

a. $2.05 million

b. $2.50 million

c. $2 million

d. None of the above

Explain your answer.

Project Comparison Generalized

To compare projects with different lives, we can make specific assumptions about the types of projects that will be available when the shorter-term projects end. To illustrate this point, we can assume that the firm will have no positive NPV projects when its current projects end; this will lead to a decision rule whereby the NPVs of projects can be compared, even if they have different lives. Alternatively, we can make specific assumptions about the availability and the attractiveness of projects in the future, leading to cash flow estimates and present value computations. Going back to the five-year and ten-year projects, assume that future projects will not be as attractive as current projects. More specifically, assume that the annual cash flows on the second five-year project that will be taken when the first five-year project ends will be $320 instead of $400. The NPVs of these two investment streams can be computed as shown in Figure 6.9.

To convert it back to an annuity, all you need to do is multiply the NPV by the discount rate
Equitvalent Annuity = 15.62 *.0889 = $1.39 million

Figure 6.9: Cash Flows on Projects with Unequal Lives: Replicated with poorer project

Five-year Project: Replicated

$400	$400	$400	$400	$400	$320	$320	$320	$320	$320

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

-$1000   -$1000 (Replication)

Longer Life Project

$350	$350	$350	$350	$350	$350	$350	$350	$350	$350

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

-$1500

The NPV of the first project, replicated to have a life of ten years, is $529. This is still higher than the NPV of $478 of the longer-life project. The firm will still pick the shorter-life project, though the margin in terms of NPV has shrunk.

This problem is not avoided by using IRRs. When the IRR of a short-term project is compared to the IRR of a long-term project, there is an implicit assumption that future projects will continue to have similar IRRs.

The Replacement Decision: A Special Case of Mutually Exclusive Projects

In a *replacement decision*, we evaluate the replacement of an existing investment with a new one, generally because the existing investment has aged and become less efficient. In a typical replacement decision,

- the replacement of old equipment with new equipment will require an initial cash outflow, because the money spent on the new equipment will exceed any proceeds obtained from the sale of the old equipment.
- there will be cash savings (inflows) during the life of the new investment as a consequence of either the lower operating costs arising from the newer equipment or the higher revenues flowing from the investment. These cash inflows will be augmented by the tax benefits accruing from the greater depreciation that will arise from the new investment.
- the salvage value at the end of the life of the new equipment will be the differential salvage value—that is, the excess of the salvage value on the new equipment over the

salvage value that would have been obtained if the old equipment had been kept for the entire period and had not been replaced.

This approach has to be modified if the old equipment has a remaining life that is much shorter than the life of the new equipment replacing it.

> *replace.xls*: This spreadsheet allows you to analyze a replacement decision.

Illustration 6.5: Analyzing a Replacement Decision

Bookscape would like to replace an antiquated packaging system with a new one. The old system has a book value of $50,000 and a remaining life of ten years and could be sold for $15,000, net of capital gains taxes, right now. It would be replaced with a new machine that costs $150,000, has a depreciable life of ten years, and annual operating costs that are $40,000 lower than with the old machine. Assuming straight-line depreciation for both the old and the new systems, a 40 percent tax rate, and no salvage value on either machine in ten years, the replacement decision cash flows can be estimated as follows:

Net Initial Investment in New Machine = –$150,000 + $15,000 = $135,000

Depreciation on the old system = $5,000

Depreciation on the new system = $15,000

Annual Tax Savings from Additional Depreciation on New Machine = (Depreciation on Old Machine – Depreciation on New Machine) (Tax Rate) = ($15,000 – $5,000) * 0.4 = $4,000

Annual After-Tax Savings in Operating Costs = $40,000(1 – 0.4) = $24,000

The cost of capital for the company is 14.90% percent, resulting in an NPV from the replacement decision of

$$\text{NPV of Replacement Decision} = -\$135{,}000 + \$28{,}000 * \frac{(1-(1.149)^{-10})}{0.149} = \$6063$$

This result would suggest that replacing the old packaging machine with a new one will increase the firm's value by $6063 and would be a wise move to make.

Side Costs from Projects

In much of the project analyses that we have presented in this chapter, we have assumed that the resources needed for a project are newly acquired; this includes not only the building and the equipment but also the personnel needed to get the project going. For most businesses considering new projects, this is an unrealistic assumption, however, because many of the resources used on these projects are already part of the business and will just be transferred to the new project. When a business uses such resources, there is the potential for an

> *Opportunity Cost:* The cost assigned to a project resource that is already owned by the firm. It is based on the next best alternative use.

opportunity cost—the cost created for the rest of the business as a consequence of this project. This opportunity cost may be a significant portion of the total investment needed on a project. Ignoring these costs because they are not explicit can lead to bad investments. In addition, a new product or service offered by a firm may hurt the profitability of its other products or services; this is generally termed **product cannibalization** and we will examine and whether and how to deal with the resulting costs.

Opportunity Costs of using Existing Resources

The opportunity cost for a resource is simplest to estimate when there is a current alternative use for the resource, and we can estimate the cash flows lost by using the resource on the project. It becomes more complicated when the resource does not have a current use but does have potential future uses. In that case, we have to estimate the cash flows forgone on those future uses to estimate the opportunity costs.

Resource with a Current Alternative Use

The general framework for analyzing opportunity costs begins by asking whether there is any other use for the resource right now. In other words, if the project that is considering using the resource is not accepted, what are the uses to which the resource will be put to and what cash flows will be generated as a result?

- The resource might be rented out, in which case the rental revenue lost is the opportunity cost of the resource. For example, if the project is considering the use of

a vacant building already owned by the business, the potential revenue from renting out this building will be the opportunity cost.

- The resource could be sold, in which case the sales price, net of any tax liability and lost depreciation tax benefits, would be the opportunity cost for the resource.

- The resource might be used elsewhere in the firm, in which case the cost of replacing it is the opportunity cost. Thus, the transfer of experienced employees from established divisions to a new project creates a cost to these divisions, which has to be factored into the decision making.

Sometimes, decision makers have to decide whether the opportunity cost will be estimated based on the lost rental revenue, the foregone sales price or the cost of replacing the resource. When such a choice has to be made, it is the highest of the costs—that is, the best alternative forgone—that should be considered as an opportunity cost.

6.4. Sunk Costs and Opportunity Costs

A colleague argues that resources that a firm owns already should not be considered in investment analysis because the cost is a sunk cost. Do you agree?

a. Yes

b. No

How would you reconcile the competing arguments of sunk and opportunity costs?

Illustration 6.6: Estimating the Opportunity Cost for a Resource with a Current Alternative Use

Working again with the Bookscape Online example, assume that the following additional information is provided:

- Although Bookscape Online will employ only two full-time employees, it is estimated that the additional business associated with online ordering and the administration of the service itself will add to the workload for the current general manager of the bookstore. As a consequence, the salary of the general manager will be increased from $100,000 to $120,000 next year; it is expected to grow 5 percent a year after that for the remaining three years of the online venture. After the online

venture is ended in the fourth year, the manager's salary will revert back to its old levels.

- It is also estimated that Bookscape Online will utilize an office that is currently used to store financial records. The records will be moved to a bank vault, which will cost $1000 a year to rent.

The opportunity cost of the addition to the general manager's workload lies in the additional salary expenditure that will be incurred as a consequence. Taking the present value of the after-tax costs (using a 40 percent tax rate) over the next four years, using the cost of capital of 25.48% estimated in Illustration 5.2, yields the values in Table 6.6.

Table 6.6: Present Value of Additional Salary Expenses

	1	2	3	4
Increase in Salary	$20,000	$21,000	$22,050	$23,153
After-tax expense	$12,000	$12,600	$13,230	$13,892
Present Value @25.48%	$9,563	$8,002	$6,696	$5,603

The cumulative present value of the costs is $29,865.

Turning to the second resource—a storage space originally used for the financial records—if this project is taken, the opportunity cost is the cost of the bank vault.

$$\text{Additional Storage Expenses per Year} = \$1,000$$

$$\text{After-Tax Additional Storage Expenditure per Year} = \$1,000\,(1 - 0.40) = \$600$$

$$\text{PV of After-Tax Storage Expenditures for 4 Years} = \$600 * \frac{(1 - (1.2548)^{-4})}{0.2548}$$

$$= \$1,404.92$$

The opportunity costs estimated for the general manager's added workload ($29,865) and the storage space ($1,405) are in present value terms and can be added on to -$98,775 that we computed as the NPV of Bookscape Online in Illustration 5.11.The NPV becomes more negative.

$$\text{NPV with Opportunity Costs} = \text{NPV without Opportunity Costs} + \text{PV of Opportunity}$$
$$\text{Costs} = -\$98,775 - \$29,865 - \$1,405 = -\$130,045$$

The cash flows associated with the opportunity costs could alternatively have been reflected in the years in which they occur. Thus, the additional salary and storage expenses could have been added to the operating expenses of the store in each of the four

years. As table 6.7 indicates, this approach would yield the same NPV and would have clearly been the appropriate approach if the IRR were to be calculated.

Table 6.7: NPV with Opportunity Costs: Alternate Approach

Year	Cashflows from Online venture	Opportunity costs	Cashflow with opportunity costs	Present Value @ 25.48%
0	-$1,150,000		-$1,150,000	-$1,150,000
1	$340,000	$12,600	$327,400	$260,916
2	$415,000	$13,200	$401,800	$255,184
3	$446,500	$13,830	$432,670	$218,989
4	$720,730	$14,492	$706,238	$284,865
				-$130,045

Note that this NPV is identical to our earlier computation —this project should not be taken.

Resources with No Current Alternative Use

In some cases, a resource being considered for use in a project will have no current alternative use, but the business will have to forgo alternative uses in the future. One example would be excess capacity on a machine or a computer. Most firms cannot lease or sell excess capacity, but using that capacity now for a new product may cause the businesses to run out of capacity much earlier than they would otherwise, leading to one of two costs:

- They assume that excess capacity is free, because it is not being used currently and cannot be sold off or rented, in most cases.
- They allocate a portion of the book value of the plant or resource to the project. Thus, if the plant has a book value of $100 million and the new project uses 40 percent of it, $40 million will be allocated to the project.

We will argue that neither of these approaches considers the opportunity cost of using excess capacity, because the opportunity cost comes usually comes from costs that the firm will face in the future as a consequence of using up excess capacity today. By using up excess capacity on a new project, the firm will run out of capacity sooner than if it did not take the project. When it does run out of capacity, it has to take one of two paths:

- New capacity will have to be bought or built, in which case the opportunity cost will be the higher cost in present value terms of doing this earlier rather than later.

- Production will have to be cut back on one of the product lines, leading to a loss in cash flows that would have been generated by the lost sales.

Again, this choice is not random, because the logical action to take is the one that leads to the lower cost, in present value terms, for the firm. Thus, if it is cheaper to lose sales rather than build new capacity, the opportunity cost for the project being considered should be based on the lost sales.

A general framework for pricing excess capacity for purposes of investment analysis asks three questions:

1. If the new project is not taken, when will the firm run out of capacity on the equipment or space that is being evaluated?

2. If the new project is taken, when will the firm run out of capacity on the equipment or space that is being evaluated? Presumably, with the new project using up some of the excess capacity, the firm will run out of capacity sooner than it would have otherwise.

3. What will the firm do when it does run out of capacity? The firm has two choices: It can cut back on production of the least profitable product line and make less profits than it would have without a capacity constraint. In this case, the opportunity cost is the present value of the cash flows lost as a consequence. It can buy or build new capacity, in which case the opportunity cost is the difference in present value between investing earlier rather than later.

Product Cannibalization

Product cannibalization refers to the phenomenon whereby a new product introduced by a firm competes with and reduces sales of the

> *Product Cannibalization:* Sales generated by one product that come at the expense of other products manufactured by the same firm.

firm's existing products. On one level, it can be argued that this is a negative incremental effect of the new product, and the lost cash flows or profits from the existing products should be treated as costs in analyzing whether to introduce the product. Doing so introduces the possibility that of the new product will be rejected, however. If this happens, and a competitor then exploits the opening to introduce a product that fills the niche that the new product would have and consequently erodes the sales of the firm's

existing products, the worst of all scenarios is created—the firm loses sales to a competitor rather than to itself.

Thus, the decision on whether to build in the lost sales created by product cannibalization will depend on the potential for a competitor to introduce a close substitute to the new product being considered. Two extreme possibilities exist: The first is that close substitutes will be offered almost instantaneously by competitors; the second is that substitutes cannot be offered.

• If the business in which the firm operates is extremely competitive and there are no barriers to entry, it can be assumed that the product cannibalization will occur anyway, and the costs associated with it have no place in an incremental cash flow analysis. For example, in considering whether to introduce a new brand of cereal, a company like Kellogg's can reasonably ignore the expected product cannibalization that will occur because of the competitive nature of the cereal business and the ease with which Post or General Mills could introduce a close substitute. Similarly, it would not make sense for Compaq to consider the product cannibalization that will occur as a consequence of introducing an updated notebook computer because it can be reasonably assumed that a competitor, say, IBM or Dell, would create the lost sales anyway with their versions of the same product if Compaq does not introduce the product.

• If a competitor cannot introduce a substitute—because of legal restrictions such as patents, for example—the cash flows lost as a consequence of product cannibalization belong in the investment analysis at least for the period of the patent protection. For example, a pharmaceutical company, which has the only patented drug available to treat ulcers, may hold back on introducing a potentially better, new ulcer drug because of fears of product cannibalization.[8]

In most cases, there will be some barriers to entry, ensuring that a competitor will either introduce an imperfect substitute, leading to much smaller erosion in existing product sales, or that a competitor will not introduce a substitute for some period of time, leading

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[8] Even the patent system does not offer complete protection against competition. It is entirely possible that another pharmaceutical company may come into the market with its own ulcer treating drug and cause the lost sales anyway.

to a much later erosion in existing product sales. In this case, an intermediate solution whereby some of the product cannibalization costs are considered may be appropriate. Note that brand name loyalty is one potential barrier to entry. Firms with stronger brand loyalty should therefore factor into their investment analysis more of the cost of lost sales from existing products as a consequence of a new product introduction.

6.5. **Product Cannibalization at Disney**

In coming up with revenues on its proposed theme park in Thailand, Disney estimates that 15 percent of the revenues at these parks will be generated from people who would have gone to Disneyland in California if these parks did not exist. When analyzing the project in Thailand, would you use

a. the total revenues expected at the park?

b. only 85 percent of the revenues, because 15 percent of the revenues would have come to Disney anyway?

c. a compromise estimated that lies between the first two numbers?

Explain.

Side Benefits from Projects

Project Synergy: The increase in cash flows that accrue to other projects, as a consequence of the project under consideration.

A proposed investment may benefit other investments that a firm already has. In assessing this investment, we should therefore consider these side benefits. We will begin this section with a consideration of synergies between individual projects and then follow up by extending the discussion to cover acquisitions, where synergy between two companies is often offered as the reason for large acquisition premiums.

Project Synergies

When a project under consideration creates positive benefits (in the form of cash flows) for other projects that a firm may have, **project synergies** are created. For instance, assume that you are a clothing retailer considering whether to open an upscale clothing store for children in the same shopping center where you already own a store that caters to an adult clientele. In addition to generating revenues and cash flows on its

own, the children's store might increase the traffic to the adult store and increase profits there. That additional profit, and its ensuing cash flow, must be factored into the analysis of the new store.

Sometimes the project synergies are not with existing projects but with other projects being considered contemporaneously. In such cases, the best way to analyze the projects is jointly, because examining each separately will lead to a much lower NPV. Thus, a proposal to open a children's clothing store and an adult clothing store in the same shopping center will have to be treated as a joint investment analysis, and the NPV will have to be calculated for both stores together. A positive NPV would suggest opening both stores, whereas a negative NPV would indicate that neither should be opened.

Illustration 6.7: Cash Flow Synergies with Existing Projects

Assume that Bookscape is considering adding a café to its bookstore. The café, it is hoped, will make the bookstore a more attractive destination for would-be shoppers. The following information relates to the proposed café:

- The initial cost of remodeling a portion of the store to make it a café and of buying equipment is expected to be $150,000. This investment is expected to have a life of five years, during which period it will be depreciated using straight-line depreciation. None of the cost is expected to be recoverable at the end of the five years.

- The revenues in the first year are expected to be $60,000, growing at 10 percent a year for the next four years.

- There will be one employee, and the total cost for this employee in year one is expected to be $30,000 growing at 5 percent a year for the next four years.

- The cost of the material (food, drinks, etc.) needed to run the café is expected to be 40 percent of revenues in each of the five years.

- An inventory amounting to 5 percent of the revenues has to be maintained; investments in the inventory are made at the beginning of each year.

- The tax rate for Bookscape as a business is 40 percent.

Based on this information, the estimated cash flows on the cafe are shown in Table 6.8.

Table 6.8: Estimating Cash Flows from Opening Bookscape Café

	Year 0	1	2	3	4	5
Investment	–$150,000					
Revenues		$60,000	$66,000	$72,600	$79,860	$87,846
Labor		$30,000	$31,500	$33,075	$34,729	$36,465
Materials		$24,000	$26,400	$29,040	$31,944	$35,138
Depreciation		$30,000	$30,000	$30,000	$30,000	$30,000
Operating Income		–$24,000	–$21,900	–$19,515	–$16,813	–$13,758
Taxes		–$9,600	–$8,760	–$7,806	–$6,725	–$5,503
After-tax operating income		–$14,400	–$13,140	–$11,709	–$10,088	–$8,255
+ Depreciation		$30,000	$30,000	$30,000	$30,000	$30,000
– Δ Working capital	$3,000	$300	$330	$363	$399	–$4,392
Cash flow to firm	–$153,000	$15,300	$16,530	$17,928	$19,513	$26,138
PV at 12.14%	–$153,000	$13,644	$13,146	$12,714	$12,341	$14,742
Working capital		$3,000	$3,300	$3,630	$3,993	$4,392

Note that the working capital is fully salvaged at the end of year five, resulting in a cash inflow of $4,392.

To compute the NPV, we will use Bookscape's cost of capital of 14.90 percent (from Chapter 4). In doing so, we recognize that this is the cost of capital for a bookstore and that this is an investment in a café. It is, however, a café whose good fortunes rest with how well the bookstore is doing and whose risk is therefore the risk associated with the bookstore. The present value of the cash inflows is reduced by the initial investment of $150,000, resulting in an NPV of –$89,760. This suggests that this is not a good investment based on the cash flows it would generate.

Note, however, that this analysis is based on looking at the café as a stand-alone entity and that one of the benefits of the café is that is that it might attract more customers to the store and get them to buy more books. For purposes of our analysis, assume that the café will increase revenues at the store by $500,000 in year one, growing at 10 percent a year for the following four years. In addition, assume that the pretax operating margin on these sales is 10 percent. The incremental cash flows from the synergy are shown in Table 6.9.

Table 6.9: Incremental Cash Flows from Synergy

	Year 1	2	3	4	5
Increased revenues	$500,000	$550,000	$605,000	$665,500	$732,050
Operating margin (%)	10.00%	10.00%	10.00%	10.00%	10.00%
Operating income	$50,000	$55,000	$60,500	$66,550	$73,205
Operating income after taxes	$29,000	$31,900	$35,090	$38,599	$42,459
PV of cash flows at 12.14%	$25,861	$25,369	$24,886	$24,412	$23,947

The present value of the incremental cash flows generated for the bookstore as a consequence of the café is $115,882. Incorporating this into the present value analysis yields the following:

$$\text{NPV of Cafe} = -\$89,670 + \$115,882 = \$26,122$$

By incorporating the cash flows from the synergy into the analysis, we can see that the café is a good investment for Bookscape.

✔ 6.6. **Synergy Benefits**

In the analysis, the cost of capital for both the café and the bookstore was identical at 14.90 percent. Assume that the cost of capital for the cafe had been 18 percent, whereas the cost of capital for the bookstore had stayed at 14.90 percent. Which discount rate would you use for estimating the present value of synergy benefits?

a. 18 percent

b. 14.90 percent

c. An average of the two discount rates

d. Could be 14.90 percent or 18 percent depending on . . .

Explain.

In Practice: The Value of Synergy: Disney's Animated Movies

Disney has a well-deserved reputation for finding synergy in its movie operations, especially its animated movies. Consider, for instance, some of the spin-offs from its recent movies:

1. Plastic action figures and stuffed toys are produced and sold at the time the movies are released, producing profits for Disney both from its own stores and from royalties from sales of the merchandise at other stores.

2. Joint promotions of the movies with fast-food chains, such as McDonald's and Burger King, where the chains give away movie merchandise with their kid's meals and reduce Disney's own advertising costs for the movie by promoting it.

3. With its acquisition of Capital Cities, Disney now has a broadcasting outlet for cartoons based on successful movies (*Aladdin*, Lion King, Little Mermaid(, which generate production and advertising revenues for Disney.

4. Disney has also made successful Broadway musicals of its hit movies, *Beauty and the Beast*, *The Little Mermaid* and *The Lion King*, and plans to use the theater that it now owns on Broadway to produce more such shows.

5. Disney's theme parks all over the world benefit indirectly as these movies attract more people to the parks.

6. Disney produces computer software and video games based on its animated movie characters.

7. Finally, Disney has been extremely successful in promoting the video and DVD releases of its movies as must-have items for video collections.

In fact, on its best-known classics, such as *Snow White*, Disney released the movie in theaters dozens of times between the original release in 1937 and the eventual video release in 1985, making substantial profits each time. More recently, the company has released its masterworks on DVD, with special features added and a premium price.

Synergy in Acquisitions

Synergy is often a motive in acquisitions, but it is used as a way of justifying huge premiums and is seldom analyzed objectively. The framework we developed for valuing synergy in projects can be applied to valuing synergy in acquisitions. The key to the existence of synergy is that the target firm controls a specialized resource that becomes more valuable when combined with the bidding firm's resources. The specialized resource will vary depending on the merger. Horizontal mergers occur when two firms in the same line of business merge. In that case, the synergy must come from some form of

economies of scale, which reduce costs, or from increased market power, which increases profit margins and sales. Vertical integration occurs when a firm acquires a supplier of inputs into its production process or a distributor or retailer for the product it produces. The primary source of synergy in this case comes from more complete control of the chain of production. This benefit has to be weighed against the loss of efficiency from having a captive supplier who does not have any incentive to keep costs low and compete with other suppliers.

When a firm with strengths in one functional area acquires another firm with strengths in a different functional area (functional integration), synergy may be gained by exploiting the strengths in these areas. Thus, when a firm with a good distribution network acquires a firm with a promising product line, value is gained by combining these two strengths. The argument is that both firms will be better off after the merger.

Most reasonable observers agree that there is a potential for operating synergy, in one form or the other, in many takeovers. Some disagreement exists, however, over whether synergy can be valued and, if so, how much that value should be. One school of thought argues that synergy is too nebulous to be valued and that any systematic attempt to do so requires so many assumptions that it is pointless. We disagree. It is true that valuing synergy requires assumptions about future cash flows and growth, but the lack of precision in the process does not mean that an unbiased estimate of value cannot be made. Thus we maintain that synergy can be valued by answering two fundamental questions:

1. *What form is the synergy expected to take?* The benefits of synergy have to show up in one of the inputs into value, as higher revenues, a healthier operating margin, more investment opportunities or higher growth in the future. To value synergy, we need to identify which of these inputs will most likely be affected and by how much.

2. *When can the synergy be expected to start affecting cash flows?* Even if there are good reasons for believing that synergy exists in a particular merger, it is unlikely that these benefits will accrue instantaneously after the merger is completed. It often takes time to integrate the operations of two firms, and the difficulty of doing so increases with the sizes of the firms. If we have to wait for the higher cash flows that arise as a result of synergy, the value of synergy decreases, an

Once these questions are answered, the value of synergy can be estimated using an extension of investment analysis techniques. First, the firms involved in the merger are valued independently by discounting expected cash flows to each firm at the weighted average cost of capital for that firm. Second, the value of the combined firm, with no synergy, is obtained by adding the values obtained for each firm in the first step. Third, the effects of synergy are built into expected growth rates and cash flows, and the combined firm is revalued with synergy. The difference between the value of the combined firm with synergy and the value of the combined firm without synergy provides a value for synergy.

Illustration 6.8: Valuing Synergy in Tata-Sensient Merger

In chapter 5, we valued Sensient Technologies for an acquisition by Tata Chemicals and estimated a value of $ 1,559 million for the operating assets and $ 1,107 million for the equity in the firm. In estimating this value, though, we treated Sensient Technologies as a stand-alone firm. Assume that Tata Chemicals foresees potential synergies in the combination of the two firms, primarily from using its distribution and marketing facilities in India to market Sensient's food additive products to India's rapidly growing processed food industry. To value this synergy, let us assume the following:

a. It will take Tata Chemicals approximately 3 years to adapt Sensient's products to match the needs of the Indian processed food sector – more spice, less color.

b. Tata Chemicals will be able to generate Rs 1,500 million in after-tax operating income in year 4 from Sensient's Indian sales, growing at a rate of 4% a year after that in perpetuity from Sensient's products in India.

To value synergy, we first estimate the cost of capital that we should be using in this computation. In this case, there are two aspects to the synergy that focus our estimation. The first is that all the perceived synergies flow from Sensient's products and the risks therefore relate to those products; we will begin with the levered beta of 0.8138, that we estimated for Sensient in chapter 5, in estimating the cost of equity. The second is that the synergies are expected to come from India; consequently, we will add the country risk premium of 4.51% for India, estimated in chapter 4 (for Tata Chemicals). Finally, we will

assume that Sensient will maintain its existing debt to capital ratio of 28.57%, its current

dollar cost of debt of 5.5% and its marginal tax rate of 37%.

Cost of equity in US $ = 3.5% + 0.8138 (6%+4.51%) = 12.05%

Cost of debt in US $ = 5.5% (1-.37) = 3.47%

Cost of capital in US $ = 12.05% (1-.2857) + 5.5% (1-.37)= 9.60%

Since our cashflows are in rupees, we will convert this cost of capital to a rupee rate by

using expected inflation rates of 3% for India and 2% for the United States.

$$\text{Cost of capital in Rs} = (1 + \text{Cost of Capital}_{US\$}) \frac{(1 + \text{Inflation Rate}_{Rs})}{(1 + \text{Inflation Rate}_{US\$})} - 1$$

$$= (1.096) \frac{(1.03)}{(1.02)} - 1 = 10.67\%$$

We can now discount the expected cash flows a this estimated cost of capital to value

synergy, starting in year 4:

$$\text{Value of synergy}_{Year\,3} = \frac{\text{Expected Cash Flow}_{Year\,4}}{(\text{Cost of Capital} - g)} = \frac{1500}{(.1067 - .04)} = \text{Rs 22,476 million}$$

$$\text{Value of synergy today} = \frac{\text{Value of Synergy}_{year\,3}}{(1 + \text{Cost of Capital})^3} = \frac{22,476}{(1.1067)^3} = \text{Rs 16,580 million}$$

In illustration 5.15, we estimated the value of equity in Sensient Technologies, with no

synergy, to be $1,107 million. Converting the synergy value into dollar terms at the

current exchange rate of Rs 47.50/$, we can estimate a total value that Tata Chemicals

can pay for Sensient's equity:

Value of synergy in US $ = Rs 16,580/47.50 = $ 349 million

Value of Sensient Technologies = $1,107 million + $349 million = $1,456 million

Since Sensient's equity trades at $1,150 million, Tata Chemicals can afford to pay a

premium of up to $306 million and still gain in value from the acquisition.

Why do acquirers pay too much? A Behavioral Perspective

There is substantial evidence that acquirers pay too much for target companies

and that the value of synergy is overstated in the process. In addition to academic studies

of mergers that indicate that acquiring firms' stock prices go down in about 40-45% of all

acquisitions, on the announcement of the merger, both KPMG and McKinsey have

studies that follow up acquisitions and indicate that there is little evidence of synergy gains in the years after.

The persistence and the magnitude of the overpayment suggest two problems. The first is that the process of analyzing acquisitions is flawed, with those that are richly compensated by the deal (investment bankers) also being responsible for analyzing whether the deal should be done. However, that does not mitigate the responsibility of the acquiring company's managers, who seem to be cavalier about spending stockholders' money, nor does it explain their behavior. There are three reasons that have been presented for this phenomenon:

a. <u>Hubris:</u> Roll (1986) argues that it is managerial hubris that best explains acquisition over payments. The managers in acquiring firms make mistakes in assessing target company values and their pride prevents them from admitting these mistakes.[9]

b. Over confidence: The same over confidence that leads managers to over estimate cash flows on conventional capital budgeting projects manifests itself in acquisitions, perhaps in a more virulent form.[10] Studies seem to indicate that the managers in acquiring firms are among the most over-confident of the entire group.

c. Anchoring and framing: When negotiating a price for a target firm, both the acquiring firm's managers and the target firm's stockholders compare the price being offered to "reference points", often unrelated to intrinsic value. Wurgler, Pan and Baker (2008) argue that while the current stock price is one reference point, the highest price over the previous 52 weeks seems to be an even stronger one.[11] In fact, they present evidence that the price paid on acquisitions has less to do with fair value and more to do with matching this 52-week high.

How can we reduce the problem of overpayment? First, we need to reform the acquisition process and separate the deal making from the deal analysis. Second, we have to give stockholders a much bigger say in the process. If the board of directors cannot perform their oversight role, the largest investors in the acquiring company should be allowed

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[9] Roll, Richard, 1986, "The hubris hypothesis of corporate takeovers," Journal of Business 59, 197-216.

[10] Graham, J., C. Harvey, and M. Puri, 2008, "Managerial attitudes and corporate actions," Duke University working paper.

[11] Baker, M., X. Pan and J. Wurgler, 2009, The Psychology of Pricing in Mergers and Acquisitions, Working Paper, ssrn.com.

representation during the negotiation, and the representative will be given the responsibility of questioning key assumptions and forecasts. Third, the managers who are most intent on pushing the acquisition through should be given the responsibility of delivering the projected cash flows.

Options Embedded in Projects

In Chapter 5, we examined the process for analyzing a project and deciding whether to accept the project. In particular, we noted

> **Real Option**: An option on a nontraded asset, such as an investment project or a gold mine.

that a project should be accepted only if the returns on the project exceed the hurdle rate; in the context of cash flows and discount rates, this translates into projects with positive NPVs. The limitation with traditional investment analysis, which analyzes projects on the basis of expected cash flows and discount rates, is that it fails to consider fully the myriad options that are usually associated with many projects.

In this section, we will begin by first describing what an option is why they matter, and then analyze three options that are embedded in many capital budgeting projects. The first is the option to delay a project, especially when the firm has exclusive rights to the project. The second is the option to expand a project to cover new products or markets some time in the future. The third is the option to abandon a project if the cash flows do not measure up to expectations. These are generically called real options since the underlying asset is a real asset (a project) rather than a financial asset. With each of these options, we will present both the intuitive implications of valuing them as options as well as the details of using option pricing models to value them. Appendix 4 contains more detail on these models.

Options: Description and Determinants of Value

An option is an asset that derives its value from another asset, called an underlying asset, and has a cash payoff that is contingent on what happens to the value of the underlying asset. There are two types of options. With a call option, you get the right to buy the underlying asset at a fixed price, called a strike price, whereas with put options, you get the right to sell the underlying asset at a fixed price. Since you have the right, as the holder of the option, to buy or sell the underlying asset, and not an

obligation, you will exercise an option only if it makes sense for you to do so. With a call option, that will occur when the value of the underlying asset is greater than your strike price, whereas with a put, it is when the value is lower.

As explained in appendix 4, the value of an option ultimately rests of six variables – the value, volatility and expected dividends of the underlying asset, the strike price and the life of the option and the level of interest rates. Without delving into the minutiae of option pricing models, it is still worth noting the differences between valuing conventional assets or projects on the one hand and options on the other. The first is that conventional assets can be valued by discounting expected cash flows at a risk-adjusted discount rate, whereas options are valued at a premium over their exercise value. The premium can be attributed to the choice that the holder of the option as to when and whether to exercise. The second is that increasing risk and uncertainty reduce the value of conventional assets, but they increase the value of options. This is because the holders of options can never be forced to exercise an option, which protects them against downside risk but preserves upside potential.

It is because of these two differences that this section is necessitated. If an investment has options embedded in it, conventional net present value will miss the option premium and understate the value of the investment. In addition, the option portion of the investment may benefit as the investment becomes more risky, even as the rest of the investment becomes more valuable.

The Option to Delay a Project

Projects are typically analyzed based on their expected cash flows and discount rates at the time of the analysis; the NPV computed on that basis is a measure of its value and acceptability at that time. Expected cash flows and discount rates change over time, however, and so does the NPV. Thus, a project that has a negative NPV now may have a positive NPV in the future. In a competitive environment, in which individual firms have no special advantages over their competitors in taking projects, this may not seem significant. In an environment where a project can be taken by only one firm (because of legal restrictions or other barriers to entry to competitors), however, the changes in the project's value over time give it the characteristics of a call option.

Describing the Option to Delay

In the abstract, assume that a project requires an initial investment of X and that the present value of expected cash inflows computed right now is PV. The NPV of this project is the difference between the two:

$$NPV = PV - X$$

Now assume that the firm has exclusive rights to this project for the next *n* years, and that the present value of the cash inflows may change over that time because of changes in either the cash flows or the discount rate. Thus, the project may have a negative NPV right now, but it may still become a good project if the firm waits. Defining V as the present value of the cash flows, the firm's decision rule on this project can be summarized as follows:

If V > X project has positive NPV

V < X project has negative NPV

This relationship can be presented in a payoff diagram of cash flows on this project, as shown in Figure 6.10, assuming that the firm holds out until the end of the period for which it has exclusive rights to the project.

Figure 6.10: The Option to Delay a Project
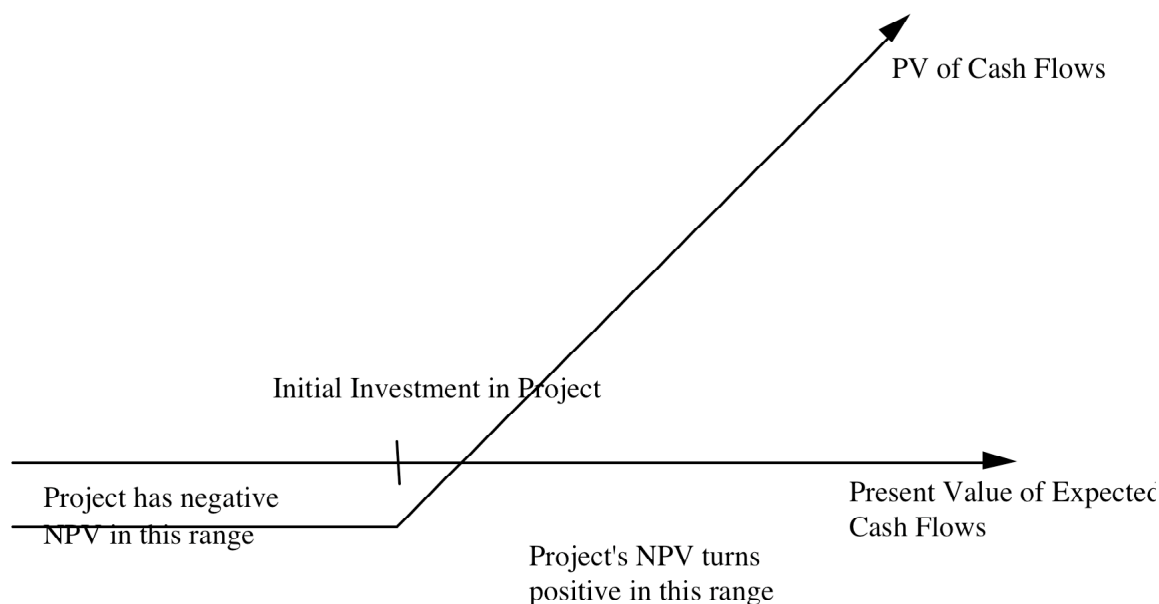
Note that this payoff diagram is that of a call option—the underlying asset is the project; the strike price of the option is the investment needed to take the project; and the life of the option is the period for which the firm has rights to the project. The present value of

the cash flows on this project and the expected variance in this present value represent the value and variance of the underlying asset.

Valuing the Option to Delay

On the surface, the inputs needed to apply option pricing models to valuing the option to delay are the same as those needed for any application: the value of the underlying asset, the variance in the value, the time to expiration on the option, the strike price, the riskless rate, and the equivalent of the dividend yield. Actually estimating these inputs for valuing real options can be difficult, however.

Value of the Underlying Asset

In the case of product options, the underlying asset is the project itself. The current value of this asset is the present value of expected cash flows from initiating the project now, which can be obtained by doing a standard capital budgeting analysis. There is likely to be a substantial amount of estimation error in the cash flow estimates and the present value, however. Rather than being viewed as a problem, this uncertainty should be viewed as the reason why the project delay option has value. If the expected cash flows on the project were known with certainty and were not expected to change, there would be no need to adopt an option pricing framework, because there would be no value to the option.

Variance in the Value of the Asset

As noted in the previous section, there is likely to be considerable uncertainty associated with the cash flow estimates and the present value that measures the value of the asset now, partly because the potential market size for the product may be unknown and partly because technological shifts can change the cost structure and profitability of the product. The variance in the present value of cash flows from the project can be estimated in one of three ways. First, if similar projects have been introduced in the past, the variance in the cash flows from those projects can be used as an estimate. Second, probabilities can be assigned to various market scenarios, cash flows estimated under each scenario, and the variance estimated across present values. Finally, the average variance in firm value of publicly traded companies that are in the business that the

project will be in can be used. Thus, the average variance in firm value of biotechnology companies can be used as the variance for the option to delay a biotechnology project.

The value of the option is largely derived from the variance in cash flows—the higher the variance, the higher the value of the project delay option. Thus, the value of an option to invest in a project in a stable business will be less than the value of one in an environment in which technology, competition, and markets are all changing rapidly.

There is a data set online that summarizes, by sector, the variances in firm value and equity value for companies in each sector in the United States.

Exercise Price on Option

A project delay option is exercised when the firm owning the rights to the project decides to invest in it. The cost of making this investment is equivalent to the exercise price of the option. For simplicity, it is best to assume that this cost remains constant (in present value dollars) and that any uncertainty associated with the product is reflected in the present value of cash flows on the product.

Expiration of the Option and the Riskless Rate

The project delay option expires when the rights to the project lapse; investments made after the project rights expire are assumed to deliver an NPV of zero as competition drives returns down to the required rate. The riskless rate to use in pricing the option should be the rate that corresponds to the expiration of the option.

Dividend Yield

Once the NPV turns positive, there is a cost borne in delaying making an investment. Because the project rights expire after a fixed period, and excess profits (which are the source of positive present value) are assumed to disappear after that time as new competitors emerge, each year of delay translates into one less year of value-creating cash flows.[12] If the cash flows are evenly distributed over time, and the life of the option is n years, the cost of delay can be written as:

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[12]A value-creating cash flow is one that adds to the NPV because it is in excess of the required return for investments of equivalent risk.

$$\text{Annual cost of delay} = \frac{1}{n}$$

Thus, if the project rights are for 20 years, the annual cost of delay works out to 5 percent a year.

✔ 6.7. **Cost of Delay and Early Exercise**

For typical listed options on financial assets, it is argued that early exercise is almost never optimal. Is this true for real options as well? Explain.

a. Yes

b. No

Illustration 6.9: Valuing a Patent

Assume that a pharmaceutical company has been approached by an entrepreneur who has patented a new drug to treat ulcers. The entrepreneur has obtained FDA approval and has the patent rights for the next seventeen years. Although the drug shows promise, it is still very expensive to manufacture and has a relatively small market. Assume that the initial investment to produce the drug is $500 million and the present value of the cash flows from introducing the drug now is only $350 million. The technology and the market is volatile, and the annualized standard deviation in the present value, estimated from a simulation is 25 percent.[13]

Although the NPV of introducing the drug is negative, the rights to this drug may still be valuable because of the variance in the present value of the cash flow. In other words, it is entirely possible that this drug may not only be viable but extremely profitable a year or two from now. To value this right, we first define the inputs to the option pricing model:

Value of the Underlying Asset (S) = PV of Cash Flows from Project if Introduced Now = $350 million

Strike Price (K) = Initial Investment Needed to Introduce the Product = $500 million

Variance in Underlying Asset's Value = $(0.25)^2 = 0.0625$

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[13]This simulation would yield an expected value for the project of $350 million and the standard deviation in that value of 25 percent.

Time to Expiration = Life of the Patent = 17 years

Cost of delay (Dividend yield in option model) = 1/Life of the patent = 1/17 = 5.88%

Assume that the seventeen-year riskless rate is 4 percent. The value of the option can be estimated as follows:

Call Value= 350 exp$^{(-0.0588)(17)}$ (0.5285) – 500 exp$^{(-0.04)(17)}$ (0.1219) = $37.12 million

Thus, this ulcer drug, which has a negative NPV if introduced now, is still valuable to its owner.

6.8. How Much Would You Pay for This Option?

Assume that you are negotiating for a pharmaceutical company that is trying to buy this patent. What would you pay?

a. $37.12 million

b. more than $37.12 million

c. less than $37.12 million

Explain.

Intuitive Implications

Several interesting implications emerge from the analysis of the option to delay a project. First, a project may have a negative NPV based on expected cash flows currently, but the rights to this project can still be valuable because of the option characteristics. Thus, although a negative NPV should encourage a firm to reject an investment or technology, it should not lead it to conclude that the rights to it are worthless. Second, a project may have a positive NPV but still not be accepted right away because the firm may gain by waiting and accepting the project in a future period, for the same reasons that investors do not always exercise an option just because it has the money. This is more likely to happen if the firm has the rights to the project for a long time and the variance in project inflows is high. To illustrate, assume that a firm has the patent rights to produce a new type of disk drive for computer systems and that building a new plant will yield a positive NPV right now. If the technology for manufacturing the disk drive is in flux, however, the firm may delay taking the project in the hopes that the improved technology will increase the expected cash flows and consequently the value of the project.

The Option to Expand a Project

In some cases, firms invest in projects because doing so allows them to either take on other investments or enter other markets in the future. In such cases, it can be argued that the initial projects yield expansion options for a firm, and that the firm should therefore be willing to pay a price for such options. It is easiest to understand this option if you consider the projects in sequence. The initial project is not an option and may very well have a negative net present value. However, investing in the initial investment gives the firm the opportunity to make a second investment – expanding into a new market or introducing a new product – later in time. The firm can choose to exploit this opportunity or ignore it but the choice that it has gives the second investment the characteristics of an option.

Describing the Option to Expand

To examine the option to expand using the same framework developed earlier, assume that the present value of the expected cash flows from expanding into the new market or taking the new project is V, and the total investment needed to enter this market or take this project is X. Furthermore, assume that the firm has a fixed time horizon, at the end of which it has to make the final decision on whether to take advantage of this expansion opportunity. Finally, assume that the firm cannot move forward on this opportunity if it does not take the initial project. This scenario implies the option payoffs shown in Figure 6.11.

Figure 6.11: The Option to Expand a Project
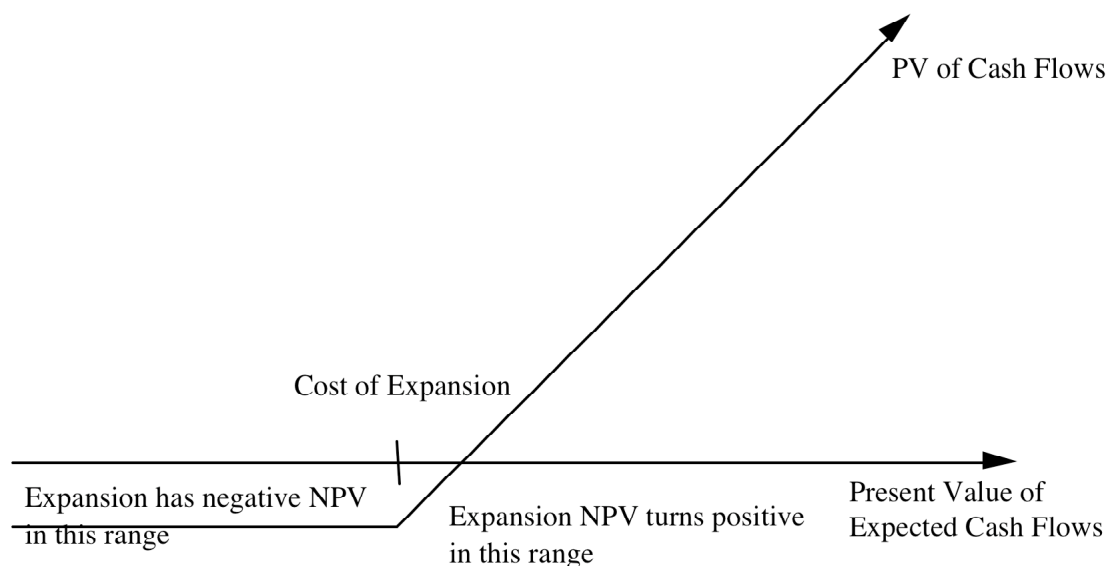
As you can see, at the expiration of the fixed time horizon, the firm will expand into the new market or take the new project if the present value of the expected cash flows at that point in time exceeds the cost of entering the market.

Valuing the Option to Expand

To understand how to estimate the value of the option to expand, let us begin by recognizing that there are two projects usually that drive this option. The first project generally has a negative net present value and is recognized as a poor investment, even by the firm investing in it. The second project is the potential to expand that comes with the first project. It is the second project that represents the underlying asset for the option. The inputs have to be defined accordingly.

- The present value of the cash flows that you would generate if you were to invest in the second project today (the expansion option) is the value of the underlying asset – S in the option pricing model.
- If there is substantial uncertainty about the expansion potential, the present value is likely to be volatile and change over time as circumstances change. It is the variance in this present value that you would want to use to value the expansion option. Since projects are not traded, you have to either estimate this variance from simulations or use the variance in values of publicly traded firms in the business.

- The cost that you would incur up front, if you invest in the expansion today, is the equivalent of the strike price.

- The life of the option is fairly difficult to define, since there is usually no externally imposed exercise period. When valuing the option to expand, the life of the option will be an internal constraint imposed by the firm on itself. For instance, a firm that invests on a small scale in China might impose a constraint that it either will expand within 5 years or pull out of the market. Why might it do so? There may be considerable costs associated with maintaining the small presence or the firm may have scarce resources that have to be committed elsewhere.

As with other real options, there may be a cost to waiting, once the expansion option becomes viable. That cost may take the form of cash flows that will be lost on the expansion project if it is not taken or a cost imposed on the firm until it makes its final decision. For instance, the firm may have to pay a fee every year until it makes its final decision.

Illustration 6.10: Valuing an Option to Expand: Disney Entertainment

Assume that Disney is considering investing $100 million to create a Spanish version of the Disney Channel to serve the growing Mexican market. Assume also that a financial analysis of the cash flows from this investment suggests that the present value of the cash flows from this investment to Disney will be only $80 million. Thus, by itself, the new channel has a negative NPV of $20 million.

One factor that does have to be considered in this analysis is that if the market in Mexico turns out to be more lucrative than currently anticipated, Disney could expand its reach to all of Latin America with an additional investment of $150 million any time over the next ten years. Although the current expectation is that the cash flows from having a Disney channel in Latin America will have a present value of only $100 million, there is considerable uncertainty about both the potential for such an channel and the shape of the market itself, leading to significant variance in this estimate.

The value of the option to expand can now be estimated, by defining the inputs to the option pricing model as follows:

Value of the Underlying Asset (S) = PV of Cash Flows from Expansion to Latin America, if Done Now = $100 million

Strike Price (K) = Cost of Expansion into Latin America = $150 million

We estimate the standard deviation in the estimate of the project value by using the annualized standard deviation in firm value of publicly traded entertainment firms in the Latin American markets, which is approximately 30 percent.

Variance in Underlying Asset's Value = $0.30^2 = 0.09$

Time to Expiration = Period for which Expansion Option Applies = 10 years

Assume that the ten-year riskless rate is 4 percent. The value of the option can be estimated as follows:

Call Value = 100 (0.6803) –150 exp$^{(–0.04)(10)}$ (0.3156)= $36.30 million

In other words, even though this expansion opportunity has a negative net present value today of -$50 million, the option to take it is worth $36.30 million. Since this option is dependent upon making the initial investment in the Spanish channel, this value can be added on to the NPV of -$20 million on the initial investment.

NPV of Disney Channel in Mexico = $80 Million – $100 million = –$20 million

Value of Option to Expand = $36.30 million

NPV of Project with Option to Expand = –$20 million + $36.3 million

= $16.3 million

Considered as a package, Disney should invest in the Mexican project because the option to expand into the Latin American market more than compensates for the negative NPV of the Mexican project.

Tests for Expansion Option to Have Value

Not all investments have options embedded in them, and not all options, even if they do exist, have value. To assess whether an investment creates valuable options that need to be analyzed and valued, we need to understand three key questions.

1. ***Is the first investment a pre-requisite for the later investment/expansion? If not, how necessary is the first investment for the later investment/expansion?*** Consider our earlier analysis of the value of a patent or the value of an undeveloped oil reserve as options. A firm cannot generate patents without investing in research or paying another firm for the patents, and it cannot get rights to an undeveloped oil reserve

without bidding on it at a government auction or buying it from another oil company. Clearly, the initial investment here (spending on R&D, bidding at the auction) is required for the firm to have the second investment. Now consider the Disney investment in a Spanish-language channel, without which presumably it cannot expand into the larger Latin American market. Unlike the patent and undeveloped reserves examples, the initial investment is not a prerequisite for the second, though management might view it as such. The connection gets even weaker, and the option value lower, when we look at one firm acquiring another to have the option to be able to enter a large market. Acquiring an Internet service provider to have a foothold in the online retailing market or buying a Chinese brewery to preserve the option to enter the Chinese beer market would be examples of less valuable options.

2. ***Does the firm have an exclusive right to the later investment/expansion? If not, does the initial investment provide the firm with significant competitive advantages on subsequent investments?*** The value of the option ultimately derives not from the cash flows generated by the second and subsequent investments but from the excess returns generated by these cash flows. The greater the potential for excess returns on the second investment, the greater the value of the expansion option. The potential for excess returns is closely tied to how much of a competitive advantage the first investment provides the firm when it takes subsequent investments. At one extreme, again, consider investing in R&D to acquire a patent. The patent gives the firm that owns it the exclusive rights to produce that product, and if the market potential is large, the right to the excess returns from the project. At the other extreme, the firm might get no competitive advantages on subsequent investments, in which case it is questionable whether there can be any excess returns on these investments. In reality, most investments will fall in the continuum between these two extremes, with greater competitive advantages being associated with higher excess returns and larger option values.

3. ***How sustainable are the competitive advantages?*** In a competitive marketplace, excess returns attract competitors, and competition drives out excess returns. The more sustainable the competitive advantages possessed by a firm, the greater the value of the options embedded in the initial investment. The sustainability of

competitive advantages is a function of two forces. The first is the *nature of the competition*; other things remaining equal, competitive advantages fade much more quickly in sectors where there are aggressive competitors. The second is the *nature of the competitive advantage*. If the resource controlled by the firm is finite and scarce (as is the case with natural resource reserves and vacant land), the competitive advantage is likely to be sustainable for longer periods. Alternatively, if the competitive advantage comes from being the first mover in a market or from having technological expertise, it will come under assault far sooner. The most direct way of reflecting this competitive advantage in the value of the option is its life; the life of the option can be set to the period of competitive advantage and only the excess returns earned over this period counts towards the value of the option.

Practical Considerations

The practical considerations associated with estimating the value of the option to expand are similar to those associated with valuing the option to delay. In most cases, firms with options to expand have no specific time horizon by which they have to make an expansion decision, making these open-ended options or at best options with arbitrary lives. Even in those cases where a life can be estimated for the option, neither the size nor the potential market for the product may be known, and estimating either can be problematic. To illustrate, consider the Disney expansion example. We adopted a period of ten years, at the end of Disney has to decide one way or another on its future expansion in Latin America, but it is entirely possible that this time frame is not specified at the time the store is opened. Furthermore, we have assumed that both the cost and the present value of expansion are known initially. In reality, the firm may not have good estimates for either before starting its Spanish cable channel, because it does not have much information on the underlying market.

Intuitive Implications

The option to expand is implicitly used by firms to rationalize taking projects that may have negative NPV but provide significant opportunities to tap into new markets or sell new products. Although the option pricing approach adds rigor to this argument by estimating the value of this option, it also provides insight into those occasions when it is

most valuable. In general, the option to expand is clearly more valuable for more volatile businesses with higher returns on projects (such as biotechnology or computer software) than in stable businesses with lower returns (such as housing, chemicals or automobiles).

It can also be argued that R&D provides one immediate application for this methodology. Investing in R&D is justified by noting that it provides the basis for new products for the future. In recent years, however, more firms have stopped accepting this explanation at face value as a rationale for spending more money on R&D and have started demanding better returns from their investments.

Firms that spend considerable amounts of money on R&D or test marketing are often stymied when they try to evaluate these expenses, because the payoffs are often in terms of future projects. At the same time, there is the very real possibility that after the money has been spent, the products or projects may turn out not to be viable; consequently, the expenditure is treated as a sunk cost. In fact, it can be argued that what emerges from R&D – patents or technological expertise -- has the characteristics of a call option. If this is true, the amount spent on the R&D is the cost of the call option, and the patents that might emerge from the research provide the options.

Several logical implications emerge from this view of R&D. First, research expenditures should provide much higher value for firms that are in volatile technologies or businesses, because the higher variance in product or project cash flows creates more valuable call options. It follows then that R&D at pharmaceutical firms should be redirected to areas where little is known and there is substantial uncertainty – gene therapy, for example – and away from areas where there is more stability. Second, the value of research and the optimal amount to be spent on research will change over time as businesses mature. The best example example is the pharmaceutical industry—drug companies spent most of the 1980s investing substantial amounts in research and earning high returns on new products, as the health care business expanded. In the 1990s, however, as health care costs started leveling off and the business matured, many of these companies found that they were not getting the same payoffs on research and started cutting back.

6.9. R&D Expenditures and Option Pricing

If we perceive R&D expenses as the price of acquiring options (product patents), R&D expenditures will have most value if directed to

a. areas where the technology is stable and the likelihood of success is high.

b. areas where the technology is volatile, though the likelihood of success is low.

c. Neither

Explain.

In Practice: Are Strategic Considerations Really Options?

Many firms faced with projects that do not meet their financial benchmarks use the argument that these projects should be taken anyway because of strategic considerations. In other words, it is argued that these projects will accomplish other goals for the firm or allow the firm to enter into other markets. Although we are wary of how this argument is used to justify poor projects, there are cases where these strategic considerations are really referring to options embedded in projects—options to produce new products or expand into new markets.

Take the example of the Disney Channel expansion into Mexico and Latin America project. The project, based on conventional capital budgeting, has a negative NPV, but it should be taken nevertheless because it gives Disney the option to enter a potentially lucrative market. Disney might well use the strategic considerations argument to accept the project anyway.

The differences between using option pricing and the strategic considerations argument are the following:

1. Option pricing assigns value to only some of the strategic considerations that firms may have. For instance, the option to enter the Latin American market has value because of the variance in the estimates of the value of entering the market and the fact that Disney has to take the smaller project (the Mexican venture) first to get the option. However, strategic considerations that are not clearly defined and have little exclusivity, such as "corporate image" or "growth potential," may not have any value from an option pricing standpoint.

2. Option pricing attempts to put a dollar value on the strategic consideration. As a consequence, the existence of strategic considerations does not guarantee that the

project will be taken. In the Disney example, the Mexican venture should not be taken if the value of the option to enter the Latin American market is less than $20 million.

The Option to Abandon a Project

The final option to consider here is the option to abandon a project when its cash flows do not measure up to expectations. Generally, the option to abandon a project later will make that project more attractive to investors now.
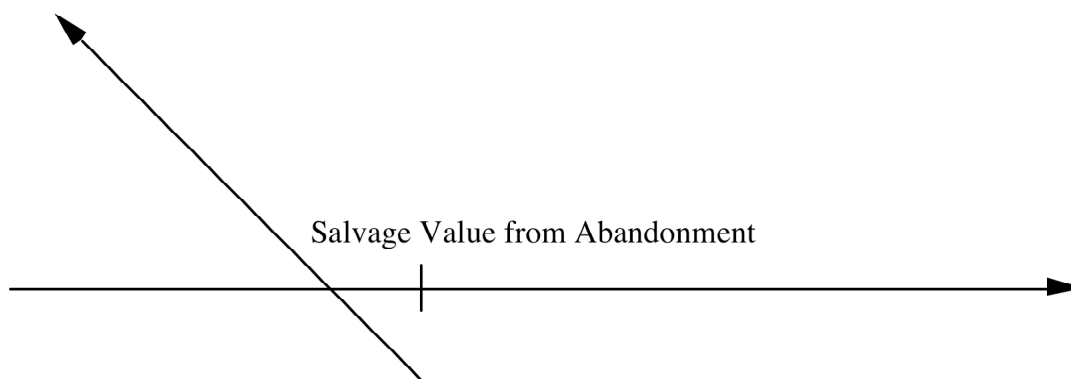
Describing the Option to Abandon

To illustrate the option to abandon, assume that you have invested in a project and that V is the remaining value on a project if your continue it to the end of its life. Now, assume that you can abandon the project today and that L is the liquidation or abandonment value for the same project. If the project has a life of *n* years, the value of continuing the project can be compared to the liquidation (abandonment) value—if it is higher, the project should be continued; if it is lower, the holder of the abandonment option could consider abandoning the project .

$$\text{Payoff from owning an abandonment option} = 0 \text{ if } V > L$$
$$= L \text{ if } V \leq L$$

These payoffs are graphed in Figure 6.12, as a function of the expected stock price.

Figure 6.12: The Option to Abandon a Project

PV of Cash Flows from project

Salvage Value from Abandonment

Unlike the prior two cases, the option to abandon takes on the characteristics of a put option.

Illustration 6.11: Valuing Disney's Option to Abandon: A Real Estate Investment

Assume that Disney is considering taking a twenty-five-year project that requires an initial investment of $250 million in a real estate partnership to develop time-share properties with a south Florida real estate developer and where the present value of expected cash flows is $254 million. Although the NPV of $4 million is small for a project of this size, assume that Disney has the option to abandon this project at any time by selling its share back to the developer in the next five years for $150 million. A simulation of the cash flows on this time-share investment yields a standard deviation in the present value of the cash flows from being in the partnership of 20 percent.

The value of the abandonment option can be estimated by determining the characteristics of the put option:

Value of the Underlying Asset (S) = PV of Cash Flows from Project = $254 million

Strike Price (K) = Salvage Value from Abandonment = $150 million

Variance in Underlying Asset's Value = $0.20^2 = 0.04$

Time to Expiration = Life of the Project = 5 years

Dividend Yield = 1/Life of the Project = 1/25 = 0.04 (We are assuming that the project's present value will drop by roughly $1/n$ each year into the project)

Assume that the five-year riskless rate is 4 percent. The value of the put option can be estimated as follows:

Call Value = 254 exp$^{(0.04)(5)}$ (0.8688) − 150 exp$^{(−0.04)(5)}$ (0.6736) = $97.95 million

Put Value = $97.95 − 254 exp$^{(0.04)(5)}$ +150 exp$^{(−0.04)(5)}$ = $12.80million

The value of this abandonment option has to be added on to the NPV of the project of $4 million, yielding a total NPV with the abandonment option of $16.80 million.

✔ 6.10. **Abandonment Value and Project Life**

Consider the project just described. Assume that three years into the project, the cash flows are coming in 20 percent below expectations. What will happen to the value of the option to abandon?

It will increase.

It will decrease.

It may increase or decrease, depending on . . .

Explain.

Intuitive Implications

The fact that the option to abandon has value provides a rationale for firms to build the flexibility to scale back or terminate projects if they do not measure up to expectations. Firms can do this in a number of ways. The first and most direct way is to build in the option contractually with those parties that are involved in the project. Thus, contracts with suppliers may be written on an annual basis, rather than long-term, and employees may be hired on a temporary basis rather than permanently. The physical plant used for a project may be leased on a short-term basis, rather than bought, and the financial investment may be made in stages rather than as an initial lump sum. Although there is a cost to building in this flexibility, the gains may be much larger, especially in volatile businesses. The option to abandon is particularly valuable for smaller companies investing in large projects, where the investment in the project may represent a significant percentage of the firm's capital.

Measuring the quality of existing investments

A firm is composed of assets in place, i.e., investments already made, and growth assets, i.e., new investments. Much of the last two chapters has been spent talking about the latter, but the techniques we used to examine and analyze new investments can also be used to assess existing investments. In doing so, there is one area where we have to exercise care. Some of the cash flows on existing investments will be in the past and some will be in the future. While we can use past cash flows to learn about these investments, they are sunk costs and should not drive decisions on whether to continue or abandon these investments. In this section, we will begin by looking at cash flow techniques for assessing existing investments and then move on to how accounting returns – return on equity and capital – can also be useful. We will close the section, by linking returns on investments to the competitive advantages and the quality of management in a firm.

Analyzing a past investment

We could analyze a past project's performance by looking at the actual cash flows generated by the investment and measuring the return relative to the original investment in the project. We could measure the returns on the project on an accounting basis, or we could estimate a net present value and internal rate of return for this project.

While the way in which we estimate these measures is similar to what we would do for a new project, the numbers have to be interpreted differently. First, unlike the net present value on a new project, which measures the value that will be added to the firm by investing in the project today, the net present value on an old project is a historic number. It is, in a sense, a post-mortem. If the net present value is negative, the firm cannot reverse its investment in the project, but it might be able to learn from its mistakes. If the net present value is positive, the project's effect on firm value is in the past. Second, unlike the net present value of a project that is based on expected numbers, the net present value on an existing project is based on actual numbers.
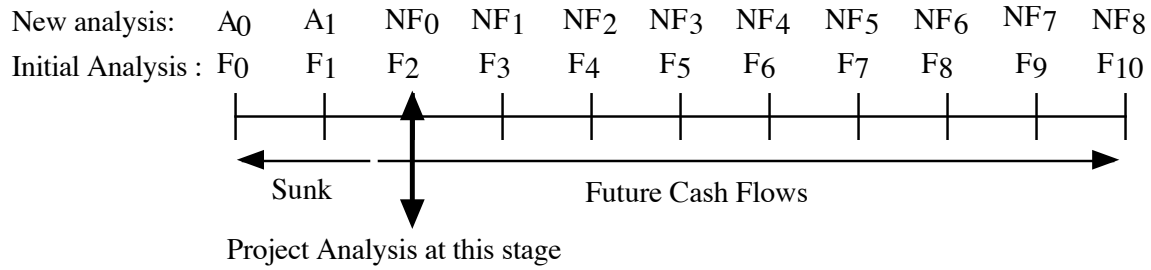
Analyzing an ongoing investment

An ongoing investment is one, where some of the cash flows on the investment have already occurred but some are still to come in the future. Unlike an assessment of a past investment, which is post-mortem, the assessment of an ongoing investment can help us answer the question of whether the investment should be continued or terminated. Tin making this assessment, the cash flows on an existing project have to be evaluated entirely on an incremental basis. Thus, if the firm is considering terminating the project, the incremental cash flow is the difference between the cash flow the firm can expect from continuing the project and the cash flow it could lose if the project is terminated. If the firm has already committed to the expenses on the project, for contractual or legal reasons, it may not save much by terminating the project.

If the incremental cash flows on the existing project are estimated and discounted at an appropriate rate, the firm is in a position to decide whether the project should be continued, liquidated or divested. For example, assume that you are analyzing a 10-year project 2 years into its life and that the cash flows are as shown in Figure 6.13.

Figure 6.13: Analysis of Existing Project

Cashflow estimates from

New analysis:	A_0	A_1	NF_0	NF_1	NF_2	NF_3	NF_4	NF_5	NF_6	NF_7	NF_8
Initial Analysis :	F_0	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}

Sunk   Future Cash Flows

Project Analysis at this stage

F_n = Forecast of cash flows in period n in initial analysis
A_n = Actual Cash Flow in period n
NF_n = New forecast of cash flows in period n at end of period 2

In particular, the following general decision rules should apply:

- If the present value of the expected future cash flows is negative, and there are no offers from third parties to acquire the project, the project should be liquidated.

$$\sum_{t=0}^{t=n} \frac{NF_n}{(1+r)^n} < 0 \qquad \text{........} \quad \text{Liquidated the project}$$

where r is the discount rate that applies to the cash flows, based on perceived risk at the time of the analysis.

- If the present value of the expected future cash flows is positive but it is less than the salvage value that can be obtained by liquidating the project, the project should be liquidated.

$$\sum_{t=0}^{t=n} \frac{NF_n}{(1+r)^n} < \text{Salvage Value} \qquad \text{........} \quad \text{Terminate the project}$$

where r is the discount rate that applies to the cash flows, based on perceived risk at the time of the analysis.

- If the present value of the expected future cash flows is positive but there is an offer from a third party to buy the project for a higher price, the project should be divested .

$$\sum_{t=0}^{t=n} \frac{NF_n}{(1+r)^n} < \text{Divestiture Value} \quad \text{........} \quad \text{Divest the project}$$

- If the present value of the expected future cash flows is positive (even though it may be well below expectations and below the initial investment) and there are no better offers from third parties, the project should be continued.

$$\sum_{t=0}^{t=n} \frac{NF_n}{(1+r)^n} > 0 > \text{Divestiture Value} \qquad .... \quad \text{Continue the project}$$

Firms should not liquidate or divest existing projects simply because the actual returns do not measure up to either the forecasts or the original investment. They should be liquidated or divested if, and only if, the present value of the forecasted incremental cash flows from continuing with the project is less than the salvage value or divestiture value.

Illustration 6.12: Disney's California Adventure: Terminate, continue or expand?

Disney opened the Disney California Adventure (DCA) Park in 2001, just across from Disneyland in Anaheim. The firm spent approximately $1.5 billion in creating the park, with a mix of roller coaster rides, California history and movie nostalgia. Disney initially expected about 60% of its visitors to Disneyland to come across to DCA and generate about $ 100 million in after-cash flows for the firm on an annual basis.

By 2008, it was clear that DCA had not performed up to expectations. Of the 15 million people who came to Disneyland in 2007, only 6 million (about 40%) visited California Adventure, and the incremental after-tax cash flow averaged out to only $ 50 million between 2001 and 2007. In early 2008, Disney faced three choices:

a. Shut down California Adventure and try to recover whatever it can of its initial investment. It is estimated that Disney can, at best, recover about $ 500 million of its it's initial investment (either by selling the park or shutting it down).

b. Continue with the status quo, recognizing that future cash flows will be closer to the actual values ($ 50 million) than the original projections.

c. Expand and modify the park, with the intent of making it more attractive to visitors to Disneyland. Investing about $ 600 million, with the intent of increasing the number of attractions for families with children, is expected to increase the percentage of Disneyland visitors who come to DCA from 40% to 60% and increase the annual after tax cash flow by 60% (from $ 50 million to $ 80 million) at the park.

The first step in assessing this investment is to estimate the cash flows from DCA as a continuing operation. To make this estimate, we assume that the current after-tax cash flow of $ 50 million will continue in perpetuity, growing at the inflation rate of 2%. Discounting back at the theme park cost of capital of 6.62% (from chapter 4), yields a value for continuing with the status quo

$$\text{Value of DCA} = \frac{\text{Expected Cash Flow next year}}{(\text{Cost of capital - g})} = \frac{50(1.02)}{(.0662 - .02)} = \$1.103 \text{ billion}$$

Note that this status quo value is well below the original investment of $ 1.5 billion, suggesting that Disney should never had opened this park, at least in hindsight. Abandoning this investment currently would do little to remedy this mistake since Disney can recover only $ 500 million of its original investment. Since the value of the cash flows, disappointing though they might be, is still higher than the divestiture/salvage value, continuing with the park adds more value than shutting it down.

As a final piece, let us consider whether Disney should make the additional investment in the park. The up-front cost of $ 600 million will lead to more visitors in the park and an increase in the existing cash flows from $ 50 to $ 80 million. Using the same inflation rate and cost of capital, we can assess the present value of the cash flows from expansion:

$$\text{Value of CF from expansion} = \frac{\text{Increase in CF next year}}{(\text{Cost of capital - g})} = \frac{30(1.02)}{(.0662 - .02)} = \$662 \text{ million}$$

Since the present value of the cash flows exceeds the cost of expansion, we would recommend that Disney not only continue with its investment in DCA, but expand it.

Letting go is hard to do: A Behavioral Perspective

The principles of when to continue, expand and terminate projects are fairly simple, with ll decisions based upon incremental cash flows. In practice, though, firms allow poor projects to continue far too long and often invest more to keep these projects going, and this behavior has its roots in the human psyche. Statman and Caldwell provide three behavioral factors that explain why letting go of poor investments is so hard to do:

a. Mental accounting versus economic accounting: In economic accounting, we consider only incremental earnings and cash flows, thus following the conventional rule book

in finance. In mental accounting, we keep track of sunk costs and investments already made in investment, thus making it difficult to let go of investments where substantial time and resources have been committed.

b. Aversion to regret: Individuals distinguish between unrealized paper losses and realized losses and are much more averse to the latter. If terminating a bad project is the realization that a past investment was a mistake, the regret that is associated with this realization may be large enough that managers choose not to terminate. In fact, this resistance seems to increase with the degree of personal responsibility that the manager feels for the investment and with job insecurity.

c. Procrastination: When faced with unpleasant decisions, it is natural to procrastinate, hoping that time and chance will make the problem go away.

If it is human nature to be resistant to accepting mistakes, there are three things we can to at least partially counter this tendency. The first is to require that all investment be reevaluated at regular intervals, say every two years. The second is to have hard and fast rules on termination, where projects that meet pre-specified criteria (for example: actual revenues less than 70% of expectations, three years of losses) are shut down automatically. The third is to separate project assessment from those who initiated the project or currently manage the investment.

Analyzing a Firm's Project Portfolio

Analyzing projects individually becomes impractical when a firm has dozens or even hundreds of projects. Instead, we could consider whether the current portfolio of projects, in which a firm has invested, is earning a sufficient return, relative to its required return. In this section, we will consider two approaches to analyzing a project portfolio – a cash-flow based approach, where we measure returns based upon cash flows, and an earnings-based approach, where we look at accounting returns.

Cash Flow Analysis

We could look at a firm's entire portfolio of existing investments and attempt to compute the amount invested in these investments, as well as the cash flows they generate. The problem with this approach is that different investments were made at different points in time, and given the time value of money, they cannot be easily

aggregated. Instead, we will consider how to compute a cash flow return, taking into consideration both the investments in projects and the timing of the investments.

The cash flow return on investment (CFROI) for a firm measures the internal rate of return earned by the firm's existing projects. It is calculated using four inputs. The first is the gross investment (GI) that the firm has in its assets in place. This is computed by adding depreciation back to the book value of the assets (net asset value) to arrive at an estimate of the original investment in the asset. The gross investment, thus estimated, is converted into a current dollar value to reflect inflation that has occurred since the asset was purchased.

Gross Investment (GI) = Net Asset Value + Cumulated Depreciation on Asset + Current Dollar Adjustment

The second input is the *gross cash flow (GCF)* earned in the current year on that asset. This is usually defined as the sum of the after-tax operating income of a firm and the non-cash charges against earnings, such as depreciation and amortization. The operating income is adjusted for operating leases and any extraordinary or one-time charges.

Gross Cash Flow (GCF) = Adjusted EBIT (1-t) + Current year's Depreciation & Amortization

The third input is the *expected life of the assets (n)* in place, at the time of the original investment, which can vary from business to business but reflects the earning life of the investments in question. The *expected value of the assets (SV)* at the end of this life, in current dollars, is the final input. This is usually assumed to be the portion of the initial investment, such as land and buildings, that is not depreciable, adjusted to current dollar terms.

Based on these inputs, the timeline for cashflows on the asset can be written as follows:
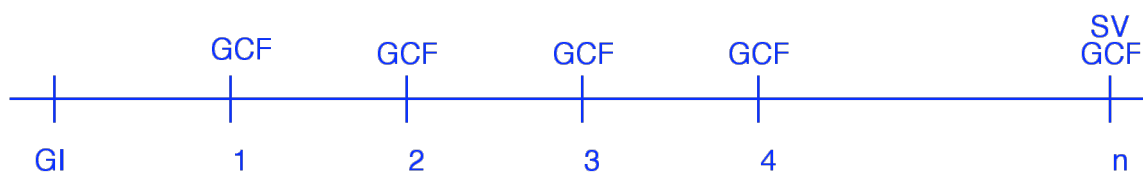
The gross investment in the asset is treated as the initial investment, the gross cash flow as an annuity for the life of the asset and the expected value at the end of the asset's life

as the salvage value. The CFROI is the internal rate of return of these cash flows, i.e, the discount rate that makes the net present value of the gross cash flows and salvage value equal to the gross investment. It can thus be viewed as a composite internal rate of return, in current dollar terms. This is compared to the firm's real cost of capital to pass judgment on whether assets in place are value creating or value destroying.

Illustration 6.13: Estimating CFROI for Tata Chemicals

At the beginning of 2009, the book value of the Tata Chemical's assets was Rs 25,149 million, including Rs 15,126 million in net fixed assets and Rs 10,023 million in non-cash working capital. The accumulated depreciation on the fixed assets amounted to Rs 18,424 million. The firm also earned Rs 5,359 million in operating income[14] during 2007-08, and had a depreciation charge of Rs 1,488 million. The average life of the investments that comprised the Tata Chemical's assets was 8 years, and the inflation rate during that 8-year period was approximately 3%. The operating assets are expected to have a remaining life of 12 years and have a salvage value of 20% of current asset value at the end of the investment period. The firm's marginal tax rate is 33.99%.

To estimate the CFROI, we first estimate the gross investment by adjusting the fixed asset value for inflation; we assume that the non-cash working capital and capitalized leases are already at current value.

Gross Investment = (Rs 15,126+ Rs 18,424) $(1.03)^8$ + Rs 10,023 million

= $Rs 52,523 million

To estimate the gross cash flow, we add the non-cash charges back to the after-tax operating income.

Gross Cash Flow = Rs 5,359 (1-.3399) + Rs 1,488 million = Rs 5,025 million

The expected salvage value is assumed to be 20% of the gross investment:

Expected Salvage Value = Gross Investment (0.2) = Rs 52,523 (.2) = Rs 10,505 million

To estimate the cash flow return on investment, we use the entire life of the asset obtained by adding together their existing age with the remaining life. The internal rate of return based upon these inputs is 7.78%, and it represents the CFROI.

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[14] Consistent with our treatment of operating leases as part of the assets, we adjust the operating income for the imputed interest expense on these leases.

Rs 52,523 = $ 5,025 (PV of Annuity, 20 years, CFROI) + 10,505/(1+CFROI)^{20}

This can then be compared to the real cost of capital to evaluate whether the firm's asset are value creating. Tata Chemicals's nominal cost of capital is currently 11.44%. With an expected inflation rate of 3%, the real cost of capital would be 8.19%.

Real Cost of Capital = (1+ Nominal Cost of Capital in Rs)/(1 + Expected Inflation Rate in Rs)

$$= 1.1144/1.03 - 1 = .0819 \text{ or } 8.19\%$$

Based on this analysis, Tata Chemicals is earning about 0.41% (7.78% - 8.19%) more than its cost of capital on its existing investments.

> *cfroi.xls*: This spreadsheet allows you to estimate the CFROI for a firm.

Accounting Earnings Analysis

In chapter 5, we introduced two measures of accounting return for investments – the return on capital and the return on equity, but our entire discussion revolved around how to analyze individual projects. It is possible, however, to calculate the return on equity or capital for an entire firm, based on its current earnings and book value. The computation parallels the estimation for individual projects but uses the values for the entire firm:

$$\text{Return on Capital} = \frac{\text{EBIT}(1-t)}{(\text{Book Value of Debt} + \text{Book Value of Equity} - \text{Cash})}$$

$$\text{Return on Equity} = \frac{\text{Net Income}}{\text{Book Value of Equity}}$$

We use book value rather than market value because it represents the capital investment in existing investments and net cash out of capital, in computing return on capital, because the income earned on cash balances is not included in operating income.[15] To preserve consistency, the book values used should reflect either the book values at the start of the period (over which the return in earned) or the average capital invested over the period. This return can be used as an approximate measure of the returns that the firm

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[15] Extending the same principle to return on equity, we generally do not net cash out of book value of equity because net income includes the income from cash holdings. However, we can compute a non-cash version of return on equity:

Non-cash return on equity = (Net Income – Interest income from cash (1`-t)))/ (BV of Equity – Cash)

is making on its existing investments or assets, as long as the following assumptions hold:

1. The income used (operating or net) is income derived from existing projects and is not skewed by expenditures designed to provide future growth (such as R&D expenses) or one-time gains or losses.

2. More important, the book value of the assets used measures the actual investment that the firm has in these assets. Here again, stock buybacks, one-time charges and goodwill amortization can create serious distortions in the book value.[16]

3. The depreciation and other noncash charges that usually depress income are used to make capital expenditures that maintain the existing asset's income earning potential.

If these assumptions hold, the return on capital becomes a reasonable proxy for what the firm is making on its existing investments or projects, and the return on equity becomes a proxy for what the equity investors are making on their share of these investments.

With this reasoning, a firm that earns a return on capital that exceeds it cost of capital can be viewed as having, on average, good projects on its books. Conversely, a firm that earns a return on capital that is less than the cost of capital can be viewed as having, on average, bad projects on its books. From the equity standpoint, a firm that earns a return on equity that exceeds its cost of equity can be viewed as earning surplus returns for its stockholders, whereas a firm that does not accomplish this is taking on projects that destroy stockholder value.

Illustration 6.14: Evaluating Current Investments

In Table 6.10, we summarize the current returns on capital and costs of capital for Disney, Aracruz, Tata Chemicals and Bookscape. The book values of debt, equity and cash at the end of the previous financial year (2007) were used together to compute the book value of capital invested at the beginning of 2008, and the operating income for the

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[16]Stock buybacks and large write-offs will push down book capital and result in overstated accounting returns. Acquisitions that create large amounts of goodwill will push up book capital and result in understated returns on capital. Adjusting capital invested for these and other actions can be problematic and are examined in more detail in Damodaran, A., 2008, Return on Capital, Return on Invested Capital and Return on Equity: Measurement and Implications, listed as a research paper on http://www.damodaran.com.

most recent financial year (2008) is used to compute the return on capital.[17] Considering the issues associated with measuring debt and cost of capital for financial services firms, we have not computed the values for Deutsche Bank:

Table 6.10 Return on Capital and Cost of Capital Comparison (Values in millions)

Company	EBIT (1-t)	BV of Debt	BV of Equity	Cash	BV of Capital	Return on Capital	Cost of Capital	ROC - Cost of Capital
Disney	$4,818	$16,636	$30,753	$3,670	$43,719	11.02%	7.51%	3.51%
Aracruz	R$ 379	R$ 3,090	R$ 5,361	R$ 22	R$ 8,430	4.49%	10.63%	-6.14%
Bookscape	$2.15	$9.59	$6.00	$0.40	$15.59	13.76%	14.90%	-1.14%
Tata Chemicals	INR 4,134	INR 12,614	INR 23,928	INR 725	INR 36,542	11.31%	11.44%	-0.12%

The marginal tax rates used in Chapter 4 are used here as well. This analysis suggests that Disney was the only company earning excess returns in 2008, Bookscape and Tata Chemicals were both close to breaking even and Aracruz wass under performing. There are a few caveats that we would offer:

1. The book value of capital is affected fairly dramatically by accounting decisions. The depreciation methods chosen and write offs taken during the year can affect book values and the measured returns.

2. We have used the operating income from the most recent year, notwithstanding the volatility in the income. To smooth out the volatility, we can compute the average operating income over the past three years and use it in computing the return on capital; this approach generates a "normalized" return on capital of 8.39% for Disney and 7.68% for Aracruz.

3. In keeping with our treatment of operating leases as debt, we have included the present value of operating leases from the prior year in the debt for both Disney and Bookscape. In the case of the latter, not including leases would have generated a much higher return on capital.

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[17]Some analysts use average capital invested over the year, obtained by averaging the book value of capital at the beginning and end of the year. By using the capital invested at the beginning of the year, we have assumed that capital invested during the course of year is unlikely to generate operating income during that year.

4. For Aracruz, we assume that because the book values are adjusted for inflation, the return on capital is a real return on capital and can be compared to the real cost of capital.[18]

The analysis can also be done purely in equity terms. To do this, we would first compute the return on equity for each company by dividing the net income for the most recent year by the book value of equity at the beginning of the year and compare it to the cost of equity. Table 6.11 summarizes these results.

Table 6.11 Return on Equity and Cost of Equity Comparisons (Values in millions)

Company	Net Income	BV of Equity	ROE	Cost of Equity	ROE - Cost of Equity
Disney	$4,427	$30,753	14.40%	8.91%	5.49%
Aracruz	-R$ 4,213	R$ 5,361	-78.59%	18.45%	-97.05%
Bookscape	$1.50	$6.00	25.00%	20.94%	4.06%
Deutsche Bank	-€ 3,835.00	€ 38,466.00	-9.97%	10.72%	-20.69%
Tata Chemicals	INR 9,644	INR 23,928	40.30%	13.93%	26.37%
Tata Chemicals(w/o extraordinary loss)	INR 3,700	INR 23,928	15.46%	13.93%	1.53%

Disney's excess equity returns are consistent with what the excess returns we estimated using return on capital and cost of capital. Aracruz and Deutsche reported large losses in 2008, leading to negative returns on equity and negative excess returns. In the case of Aracruz, the net loss stands in contrast to the positive operating income and can be explained by the multi-billion losses incurred on derivatives. Bookscape earns excess returns on an equity basis, whereas it broke even on a capital basis, and we would attribute this to the favorable terms it has on its current operating lease. With Tata Chemicals, the difference is stark, with equity excess returns being dramatically higher (26.37%) than capital excess returns. However, almost all of the excess returns can be attributed to an extraordinary gain of Rs 6,077 million reported in 2008; if we eliminate this extraordinary gain, the return on equity drops to 15.46%, only 1.53% higher than the cost of equity.

This example brings home some of the reasons why excess returns can change when we move from capital to equity measures. First, the net income includes income

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[18]Brazilian accounting standards allow for the adjustment of book value for inflation.

(and losses) from non-operating assets that can yield different results from looking at income from just operating assets. Second, firms that have been able to lock in debt at favorable terms (interest rates lower than what they should be paying, based upon their default risk should have higher equity excess returns than excess returns on capital. In general, we believe that the excess returns computed from capital measures are more dependable and sustainable than the equity excess returns.

There is a data set online that summarizes, by sector, returns on equity and capital as well as costs of equity and capital.

In Practice: Economic Profit or Economic Value Added (EVA)

Economic value added is a value enhancement concept that has caught the attention both of firms interested in increasing their value and portfolio managers looking for good investments. Economic profit or Economic Value Added is a measure of dollar surplus value created by a firm or project and is measured by doing the following:

Economic Value Added (EVA) = (Return on Capital – Cost of Capital) (Capital Invested)

The return on capital is measured using "adjusted" operating income, where the adjustments eliminate items that are unrelated to existing investments,[19] and the capital investment is based on the book value of capital but is designed to measure the capital invested in existing assets. Firms that have positive EVA are firms that are creating surplus value, and firms with negative EVA are destroying value.

Although EVA is usually calculated using total capital, it can be easily modified to be an equity measure:

Equity EVA = (Return on Equity – Cost of Equity) (Equity Invested in Project or Firm)

Again, a firm that earns a positive equity EVA is creating value for its stockholders, and a firm with a negative equity EVA is destroying value for its stockholders.

The measures of excess returns that we computed in the tables in the last section can be easily modified to become measures of EVA:

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[19]Stern Stewart, which is the primary proponent of the EVA approach, claims to make as many as 168 adjustments to operating income to arrive at the true return on capital.

Company	ROC - Cost of Capital	BV of Capital	EVA	ROE - Cost of Equity	BV of Equity	Equity EVA
Disney	3.51%	$43,719	$1,535	5.49%	$30,753	$1,688
Aracruz	-6.14%	R$ 8,430	-R$ 517	-97.05%	R$ 5,361	-5203
Bookscape	-1.14%	$15.59	-$0.18	4.06%	$6.00	$0.24
Deutsche Bank	NMF	NMF	NMF	-20.69%	€ 38,466	-€ 7,959
Tata Chemicals	-0.12%	INR 36,542	-INR 45	1.53%	INR 23,928	INR 367

For Tata Chemicals, we used the net income prior to the extraordinary profits. There are no surprises here, since positive (negative) excess returns translate into positive (negative) economic profits or EVA. Note that while EVA converts the percentage excess returns in these tables to absolute excess returns, it measurement is affected by the same issues of earnings and book value measurement. Ultimately, it is only as good as the operating income and book value of capital numbers that feed into it.

6.11:. **Stock Buybacks, Return on Capital, and EVA**

When companies buy back stock, they are allowed to reduce the book value of their equity by the market value of the stocks bought back. When the market value of equity is well in excess of book value of equity, buying back stock will generally

a. increase the return on capital but not affect the EVA.

b. increase the return on capital and increase the EVA.

c. not affect the return on capital but increase the EVA.

d. none of the above.

Why or why not?

There is a data set online that summarizes, by sector, the economic value added and the equity economic value added in each.

evacalc.xls: This spreadsheet allows you to estimate the economic value added for a firm.

Where Do Good Projects Come From?

In the process of analyzing new investments in the preceding chapters, we have contended that good projects have a positive NPV and earn an IRR greater than the hurdle rate. Although these criteria are certainly valid from a measurement standpoint,

they do not address the deeper questions about good projects, including the economic conditions that make for a good project and why it is that some firms have a more ready supply of good projects than others.

Competitive Advantages

Implicit in the definition of a good project is the existence of **excess returns** to the business considering the project. In a competitive market for real investments, the existence of these excess returns should act as a magnet, attracting competitors to take on similar investments. In the process, the excess returns should dissipate over time; how quickly they dissipate will depend on the ease with which competition can enter the market and provide close substitutes and on the magnitude of any differential advantages that the business with the good projects might possess. Consider an extreme scenario, whereby the business with the good projects has no differential advantage in cost or product quality over its competitors, and new competitors can enter the market easily and at low cost to provide substitutes. In this case the excess returns on these projects should disappear very quickly.

An integral basis for the existence of a good project is the creation and maintenance of barriers to new or existing competitors taking on equivalent or similar projects. These barriers can take different forms, including

a. *Economies of scale*: Some projects might earn high returns only if they are done on a large scale, thus restricting competition from smaller companies. In such cases, large companies in this line of business may be able to continue to earn supernormal returns on their projects because smaller competitors will not be able to replicate them.

b. *Cost Advantages*: A business might work at establishing a cost advantage over its competitors, either by being more efficient or by taking advantage of arrangements that its competitors cannot use. For example, in the late 1980s, Southwest Airlines was able to establish a cost advantage over its larger competitors, such as American Airlines and United, by using nonunion employees, and the company exploited this cost advantage to earn much higher returns.

c. *Capital Requirements*: Entry into some businesses might require such large investments that it discourages competitors from entering, even though projects in those businesses may earn above-market returns. For example, assume that Boeing is faced

with a large number of high-return projects in the aerospace business. Although this scenario would normally attract competitors, the huge initial investment needed to enter this business would enable Boeing to continue to earn these high returns.

d. *Product Differentiation*: Some businesses continue to earn excess returns by differentiating their products from those of their competitors, leading to either higher profit margins or higher sales. This differentiation can be created in a number of ways— through effective advertising and promotion (Coca-Cola), technical expertise (Sony), better service (Nordstrom), and responsiveness to customer needs.

e. *Access to Distribution Channels*: Those firms that have much better access to the distribution channels for their products than their competitors are better able to earn excess returns. In some cases, the restricted access to outsiders is due to tradition or loyalty to existing competitors. In other cases, the firm may actually own the distribution channel, and competitors may not be able to develop their own distribution channels because the costs are prohibitive.

f. *Legal and Government Barriers*: In some cases, a firm may be able to exploit investment opportunities without worrying about competition because of restrictions on competitors from product patents the firm may own to government restrictions on competitive entry. These arise, for instance, when companies are allowed to patent products or services and gain the exclusive right to provide them over the patent life.

Quality of Management and Project Quality

In the preceding section we examined some of the factors that determine the attractiveness of the projects a firm will face. Some factors, such as government restrictions on entry, may largely be out of the control of incumbent management, but there are other factors that can clearly be influenced by management.[20] Considering each of the factors already discussed, for instance, we would argue that a good management team can increase both the number of and the excess returns on available projects by

- *investing in projects that exploit any economies of scale that the firm may possess*; in addition, management can look for ways it can create economies of scale in the firm's existing operations.

- *establishing and nurturing cost advantages over its competitors*; some cost advantages may arise from labor negotiations, and others may result from long-term strategic decisions made by the firm.

- *taking actions that increase the initial cost for new entrants into the business*; one of the primary reasons Microsoft was able to dominate the computer software market in the early 1990s was its ability to increase the investment needed to develop and market new business software programs.

- *nurturing markets in which the company's differential advantage is greatest, in terms of either cost of delivery or brand name value.* In some cases, this will involve expanding into foreign markets, as both Levi Strauss and McDonald's did in the 1980s to exploit their higher brand name recognition in those markets. In other cases, this may require concentrating on segments of an existing market, as The Gap did, when it opened its Old Navy stores to cater to more bargain-conscious consumers.

- *improving the firm's reputation for customer service and product delivery*; this will enable the firm to increase both profits and returns. One of the primary factors behind Chrysler's financial recovery in the 1980s was the company's ability to establish a reputation for producing good-quality cars and minivans.

- *developing distribution channels that are unique and cannot be easily accessed by competitors.* Avon, for instance, employed a large sales force to go door to door to reach consumers who could not be reached by other distribution channels.

- *obtaining patents on products or technologies that keep out the competition and earn high returns*; doing so may require large investments in R&D over time. It can be argued that success of pharmaceutical companies, small and large, can be traced to their capacity to patent blockbuster drugs.

Although the quality of management is typically related to the quality of projects a firm possesses, a good management team does not guarantee the existence of good projects. In fact, there is a rather large element of chance involved in the process; even the best-laid plans of the management team to create project opportunities may come to

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[20]When government policy is influenced by lobbying by firms, it can be argued that even these factors may be affected by the management of a firm.

naught if circumstances conspire against them—a recession may upend a retailer, or an oil price shock may cause an airline to lose money.

Illustration 6.15: Excess Returns and Competitive Advantages: An Assessment

In illustration 6.14, we estimated the excess returns for each of the firms that we are analyzing. Of the four publicly traded firms, only Disney generated returns on capital and equity that exceeded its costs of capital and equity. Aracruz and Deutsche Bank generated negative excess returns and Tata Chemicals roughly broke even on both capital and equity measures.

a. <u>Disney</u>: While most analysts would attribute Disney's excess returns to its brand name built up over decades, it is worth noting that Disney's excess returns have been volatile since Walt Disney's demise in 1966. After a long period of declining returns in the seventies and early eighties, Disney enjoyed a rebirth with its animated movie hits between 1986 and 1995. Those movies, which included the Little Mermaid, Beauty and the Beast and the Lion King created new franchises for Disney to exploit and a new generation of young fans. That gain was put at risk by the Capital Cities acquisition in 1996 and Disney's excess returns dissipated over the next decade. In 2004, for instance, Disney was earning 4% less that its cost of capital. With Bob Iger at its helm, the company has seen a resurrection, and excess returns have become positive again. While some would read the ups and downs of Disney as just luck, we would read it differently. Disney has core advantages that are almost impossible for other firms to replicate and the firm has done best when it has focused on those businesses where it can use these strengths. Using this template, the acquisition of Pixar and even the investment in the cruise line business (which uses Disney characters to appeal to families) make sense. Disney has faltered when it has strayed from this core mission, as was the case with its early investments in the internet business (Go.com), sports (the California Angels) and its expensive entry into broadcasting (Capital Cities/ABC).

b. <u>Aracruz</u>: Aracruz's key advantage is its access to and ownership of the ample timber in the Brazilian rainforests. While the company remains dependent upon

commodity prices for year-to-year profit swings, it should be able to use its cost advantages to generate at least moderate excess returns over time. While this was the template it followed over much of its lifetime, the ease with which money could be made speculating on exchange rates led the firm down that path from 2005 through 2007, generating large earnings for the firm, in the process. Since Aracruz really has no core competence in the area of exchange rate forecasting, the huge losses in 2008 from its exchange rate bets were almost predictable. Looking forward, Aracruz has to refocus on the paper business and recognize that there are no easy pathways to profitability.

c. <u>Tata Chemicals</u>: Tata Chemicals looks like a mature firm in a mature business, with the excess returns (or lack thereof) to match. While managers should search for small competitive advantages in this market, coming perhaps from lower production costs in India and access to a large, vibrant economy, it is important that they show patience and not over reach. In particular, the allure of acquiring growth and entering other markets, especially through acquisition, has to be resisted.

d. <u>Deutsche Bank</u>: The negative excess returns that Deutsche Bank posted in 2008 are not a surprise, given the turmoil in the financial services sector. These negative excess returns did follow an extended period of profitability for commercial and investment banks. Looking forward, we do know that substantial changes are coming to this business, both from a regulatory standpoint (capital ratios, controls on lending) and from the way the business is structured (risk controls, compensation). While these changes may suggest a cap on profitability, there is one factor working in Deutsche Bank's favor. As a relatively healthy survivor in a business with so many casualties, Deutsche Bank will find itself with less competition and can perhaps exploit this factor to generate higher profits.

Conclusions

Projects often create side costs and benefits that are not captured in the initial estimates of cash flows used to estimate returns. In this chapter, we examined some of these indirect costs and benefits:

- Investing in one project may prevent a firm from taking alternative investments if these are mutually exclusive. If projects have equal lives and there are no capital rationing constraints, we can pick the investment with the higher NPV. If this is not the case, we have to find ways of controlling for differences in project lives (by computing an equivalent annuity) and for differences in scale (by computing profitability indices).

- Opportunity costs measure the costs of resources that the company already owns that might be used for a new project. Although the business might not spend new money acquiring these resources, there are consequences in terms of the cash flows that have to be reflected in the returns.

- Projects may also provide synergistic benefits for other projects for a firm. These benefits, which also take the form of cash flows, should be reflected in the returns.

- Projects may also create options that are valuable—options to expand into new markets and produce new products. When such options exist, conventional discounted cash flow models will tend to under state the value of investments.

In summary, the project returns have to reflect all of the side costs and benefits.

In the final part of the chapter, we turned our attention from new investments to the existing investments of a firm. We started by looking at how we can extend the conventional tools of investment analysis (including NPV and IRR) to analyzing a past project and deciding whether to extend or terminate an existing one. We closed the section by evaluating the portfolio of existing projects of a firm, by computing an overall return on capital invested in these projects and comparing that return to the cost of capital.

Live Case Study

Estimating Earnings and Cash Flows only if feasible

Objective: To analyze a firm's existing investments, and to identify differential advantages that explain excess returns on existing investments.

Key Questions:

1. What are the firm's competitive strengths and differential advantages, if any?

2. Does this firm earn excess returns on its existing projects? If yes, can it maintain the competitive strengths that allowed it to earn these excess returns? If not, what can it do to start earning excess returns on its projects?

3. Does the firm have poor investments? If so, what might be the reasons for the poor returns?

Framework for Analysis:

1. *Analyzing Existing Investments*

   1.1. What is the accounting return that the firm earns on its existing investments? How does this compare with the cost of equity and capital?

   1.2. What was the firm's economic value added in the most recent financial year? How does it compare with the previous year?

   1.3. What, if anything, do the accounting returns and economic value added tell you about the quality of the firm's existing investments?

2. *Assessing Competitive Strengths*

   2.1. Who are the primary competitors to this firm and how does the firm compare to them in terms of both quantitative (size, profitability, risk) and qualitative measures (quality of management, service)?

   2.2. Does the firm have any special strength that no other firm in the sector possesses?

   2.3. Does the firm lag other firms in the sector on any of the measures?

3. *Evaluating Sustainability of Competitive Strengths*

   3.1. Are the firm's competitors catching up with the firm on its strengths?

3.2. Are there new competitors either in the market or on the horizon who could compete with the firm on its strengths?

Problems and Questions

1. A small manufacturing firm, which has limited access to capital, has a capital rationing constraint of $150 million and is faced with the following investment projects (numbers in millions):

Project	Initial Investment	NPV
A	$25	$10
B	$30	$25
C	$40	$20
D	$10	$10
E	$15	$10
F	$60	$20
G	$20	$10
H	$25	$20
I	$35	$10
J	$15	$5

a. Which of these projects would you accept? Why?
b. What is the cost of the capital rationing constraint?

2. A closely held, publicly traded firm faces self-imposed capital rationing constraints of $100 million in this period and $75 million in the next period. It has to choose among the following projects (in millions):

Project	Investment Outlay		NPV
	Current Period	Next Period	
A	$20	$10	$20
B	$25	$15	$20
C	$30	$30	$15
D	$15	$15	$20

E	$40	$25	$30
F	$10	$10	$10
G	$20	$15	$20
H	$30	$25	$35
I	$35	$25	$25
J	$25	$15	$10

Set up the linear programming problem, assuming that fractions and multiples of projects cannot be taken.

3. You own a rental building in the city and are interested in replacing the heating system. You are faced with the following alternatives:

> a. A solar heating system, which will cost $12,000 to install and $500 a year to run and will last forever (assume that your building will, too).
>
> b. A gas heating system, which will cost $5,000 to install and $1,000 a year to run and will last twenty years.
>
> c. An oil heating system, which will cost $3,500 to install and $1,200 a year to run and will last fifteen years.

If your opportunity cost is 10 percent, which of these three options is best for you?

4. You are trying to choose a new siding for your house. A salesman offers you two choices:

> a. Wood siding, which will last ten years and cost $5,000 to install and $1,000/year to maintain
>
> b. Aluminum siding, which will last forever, cost $15,000 to install, and will have a lower maintenance cost per year

If your discount rate is 10 percent, how low would your maintenance costs have to be for you to choose the aluminum siding?

5. You have just been approached by a magazine with an offer for renewing your subscription. You can renew for one year at $20, two years for $36, or three years at $45.

Assuming that you have an opportunity cost of 20 percent and the cost of a subscription will not change over time, which of these three options should you choose?

6. You have been hired as a capital budgeting analyst by a sporting goods firm that manufactures athletic shoes and has captured 10 percent of the overall shoe market (the total market is worth $100 million a year). The fixed costs associated with manufacturing these shoes is $2 million a year, and variable costs are 40 percent of revenues. The company's tax rate is 40 percent. The firm believes that it can increase its market share to 20 percent by investing $10 million in a new distribution system (which can be depreciated over the system's life of 10 years to a salvage value of zero) and spending $1 million a year in additional advertising. The company proposes to continue to maintain working capital at 10 percent of annual revenues. The discount rate to be used for this project is 8 percent.

a. What is the initial investment for this project?

b. What is the annual operating cash flow from this project?

c. What is the NPV of this project?

d. How much would the firm's market share have to increase for you to be indifferent to taking or rejecting this project?

7. You are considering the possibility of replacing an existing machine that has a book value of $500,000, a remaining depreciable life of five years, and a salvage value of $300,000. The replacement machine will cost $2 million and have a ten-year life. Assuming that you use straight-line depreciation and that neither machine will have any salvage value at the end of the next ten years, how much would you need to save each year to make the change (the tax rate is 40 percent)?

8. You are helping a bookstore decide whether it should open a coffee shop on the premises. The details of the investment are as follows:

• The coffee shop will cost $50,000 to open; it will have a five-year life and be depreciated straight line over the period to a salvage value of $10,000.

- The sales at the shop are expected to be $15,000 in the first year and grow 5 percent a year for the following four years. <AQ: Should this be the following four years instead of five? Yes....>
- The operating expenses will be 50 percent of revenues.
- The tax rate is 40 percent.
- The coffee shop is expected to generate additional sales of $20,000 next year for the book shop, and the pretax operating margin is 40 percent. These sales will grow 10 percent a year for the following four years.

a. Estimate the net present value of the coffee shop without the additional book sales.

b. Estimate the present value of the cash flows accruing from the additional book sales.

c. Would you open the coffee shop?

9. The lining of a plating tank must be replaced every three years at the cost of approximately $2,000. A new lining material has been developed that is more resistant to the corrosive effects of the plating liquid and will cost approximately $4,000. If the required rate of return is 20 percent and annual property taxes and insurance amount to about 4 percent of the initial investment, how long must the new lining last to be more economical than the present one?

10. You are a small business owner considering two alternatives for your phone system.

	Plan A	Plan B
Initial cost	$50,000	$120,000
Annual maintenance cost	$9,000	$6,000
Salvage value	$10,000	$20,000
Life	20 years	40 years

The discount rate is 8 percent. Which alternative would you pick?

11. You have been asked to compare three alternative investments and make a recommendation.

- Project A has an initial investment of $5 million and after-tax cash flows of $2.5 million a year for the next five years.

- Project B has no initial investment, after-tax cash flows of $1 million a year for the next ten years, and a salvage value of $2 million (from working capital).
- Project C has an initial investment of $10 million, another investment of $5 million in ten years, and after-tax cash flows of $2.5 million a year forever.

The discount rate is 10 percent for all three projects. Which of the three projects would you pick? Why?

12. You are the manager of a pharmaceutical company and are considering what type of laptop computers to buy for your salespeople to take with them on their calls.

- You can buy fairly inexpensive (and less powerful) older machines for about $2,000 each. These machines will be obsolete in three years and are expected to have an annual maintenance cost of $150.
- You can buy newer and more powerful laptops for about $4,000 each. These machines will last five years and are expected to have an annual maintenance cost of $50.

If your cost of capital is 12 percent, which option would you pick and why?

13. You are the supervisor of a town where the roads are in need of repair. You have a limited budget and are considering two options:

- You can patch up the roads for $100,000, but you will have to repeat this expenditure every year to keep the roads in reasonable shape.
- You can spend $400,000 to repave and repair the roads, in which case your annual expenditures on maintenance will drop.

If your discount rate is 10 percent, how much would the annual expenditures have to drop in the second option for you to consider it?

14. You are the manager of a specialty retailing firm that is considering two strategies for getting into the Malaysian retail market. Under the first strategy, the firm will make an initial investment of $10 million and can expect to capture about 5 percent of the overall market share. Under the second strategy, the firm will make a much larger commitment of $40 million for advertising and promotion and can expect to capture about 10 percent of the market share. If the overall size of the market is $200 million, the firm's cost of

capital is 12 percent, and the typical life of a project in the firm is fifteen years, what would the operating margin have to be for the firm to consider the second strategy? (You can assume that the firm leases its stores and has no depreciation or capital expenditures.)

15. You work for a firm that has limited access to capital markets. As a consequence, it has only $20 million available for new investments this year. The firm does have a ready supply of good projects, and you have listed all the projects.

Project	Initial Investment (million)	NPV (million)	IRR (%)
I	$10	$3	21%
II	$5	$2.5	28%
III	$15	$4	19%
IV	$10	$4	24%
V	$5	$2	20%

a. Based on the profitability index, which of these projects would you take?

b. Based on the IRR, which of these projects would you take?

c. Why might the two approaches give you different answers?

16. You are the owner of a small hardware store, and you are considering opening a gardening store in a vacant area in the back of your present store. You estimate that it will cost you $50,000 to set up the new store, and that you will generate $10,000 in after-tax cash flows from the store for the life of the store (which is expected to be ten years). The one concern you have is that you have limited parking; by opening the gardening store you run the risk of not having enough parking for customers who shop at your hardware store. You estimate that the lost sales from such occurrence would amount to $3,000 a year, and that your after-tax operating margin on sales at the hardware store is 40 percent. If your discount rate is 14 percent, would you open the gardening store?

17. You are the manager of a grocery store, and you are considering offering baby-sitting services to your customers. You estimate that the licensing and set up costs will amount to $150,000 initially and that you will be spending about $60,000 annually to provide the service. As a result of the service, you expect sales at the store, which is $5 million

currently, to increase by 20 percent; your after-tax operating margin is 10 percent. If your cost of capital is 12 percent, and you expect the store to remain open for ten years, would you offer the service?

18. You run a financial service firm where you replace your employee's computers every three years. You have 500 employees, and each computer costs $2,500 currently—the old computers can be sold for $500 each. The new computers are generally depreciated straight line over their three-year lives to a salvage value of $500. A computer-service firm offers to lease you the computers and replace them for you at no cost, if you will pay a leasing fee of $5 million a year (which is tax-deductible). If your tax rate is 40 percent, would you accept the offer?

19. You are examining the viability of a capital investment in which your firm is interested. The project will require an initial investment of $500,000 and the projected revenues are $400,000 a year for five years. The projected cost-of-goods-sold is 40 percent of revenues and the tax rate is 40 percent. The initial investment is primarily in plant and equipment and can be depreciated straight line over five years (the salvage value is zero). The project makes use of other resources that your firm already owns:

• Two employees of the firm, each with a salary of $40,000 a year, who are currently employed by another division, will be transferred to this project. The other division has no alternative use for them, but they are covered by a union contract that will prevent them from being fired for three years (during which they would be paid their current salary).

• The project will use excess capacity in the current packaging plant. Although this excess capacity has no alternative use now, it is estimated that the firm will have to invest $250,000 in a new packaging plant in year four as a consequence of this project using up excess capacity (instead of year eight as originally planned).

• The project will use a van currently owned by the firm. Although the van is not currently being used, it can be rented out for $3,000 a year for five years. The book value of the van is $10,000 and it is being depreciated straight line (with five years remaining for depreciation).

• The discount rate to be used for this project is 10 percent.

a. What (if any) is the opportunity cost associated with using the two employees from another division?

b. What (if any) is the opportunity cost associated with the use of excess capacity of the packaging plant?

c. What (if any) is the opportunity cost associated with the use of the van ?

d. What is the after-tax operating cash flow each year on this project?

e. What is the NPV of this project?

20. Your company is considering producing a new product. You have a production facility that is currently used to only 50 percent of capacity, and you plan to use some of the excess capacity for the new product. The production facility cost $50 million five years ago when it was built and is being depreciated straight line over twenty-five years (in real dollars, assume that this cost will stay constant over time).

Product Line	Capacity Used (%)	Growth Rate (%) /Year Currently	Revenues Currently ($ million)	Fixed Cost ($ million) /Year	Variable Cost ($ million)/Year
Old product	50	5	100	25	50
New product	30	10	80	20	44

The new product has a life of ten years, the tax rate is 40 percent, and the appropriate discount rate (real) is 10 percent.

a. If you take on this project, when would you run out of capacity?

b. When you run out of capacity, what would you lose if you chose to cut back production (in present value after-tax dollars)? (You have to decide which product you are going to cut back production on.)

c. What would the opportunity cost to be assigned to this new product be if you chose to build a new facility when you run out of capacity instead of cutting back on production?

21. You are an analyst for a sporting goods corporation that is considering a new project that will take advantage of excess capacity in an existing plant. The plant has a capacity to produce 50,000 tennis racquets, but only 25,000 are being produced currently though

sales of the rackets are increasing 10 percent a year. You want to use some of the remaining capacity to manufacture 20,000 squash rackets each year for the next ten years (which will use up 40 percent of the total capacity), and this market is assumed to be stable (no growth). An average tennis racquet sells for $100 and costs $40 to make. The tax rate for the corporation is 40 percent, and the discount rate is 10 percent. Is there an opportunity cost involved? If so, how much is it?