Chapter 9 Capital Budgeting Process and Decision Criteria

Chapter Overview

The *What Companies Do* opening feature presents the story of the capital investment project by PMI Gold Corporation. It invested in the Obotan Gold Project in Ghana with the net present value of the investment being over USD 650 million. The company estimates the project would yield a pre-tax IRR of 42% – a fantastic return for stockholders!

What Companies Do Discussion Questions

1. How does a project with a high return relate to the concept of maximising shareholder wealth? In other words, what is the direct relationship between returns and wealth generation?
2. While 42% appears to be a very high return on investment, how does a firm make a judgment about how much return is acceptable? Why might such a project not enhance value? Note that this discussion can be brought back to risk/return relationships in previous chapters.

This chapter, after introducing the basic capital budgeting problem, covers:

9-1. Introduction to Capital Budgeting
9-2. Payback Methods
9-3. Accounting-Based Methods
9-4. Net Present Value
9-5. Internal Rate of Return
9-6. Profitability Index
9-7. Capital Budgeting in Practice

Technology

1. **Smart Video**. Daniel Carter, executive vice president of finance, BevMol,, talks about decision metrics that his company uses.

2. **Smart Video.** Chris Muscarella, finance professor, talks about the impact of stock prices on firms' capital budgeting decisions.

3. **Smart Video.** Beth Acton, former vice president and treasurer of Ford, notes that size doesn't matter – both large and small capital budgeting projects are considered using similar procedures.

4. **Smart Concepts** illustrates step-by-step the similarities and differences between the *NPV* and *IRR* methods for valuing capital investments. a step-by-step solution to Problem 9-21, which compares two competing projects using NPV, IRR, and PI techniques.

5. **Smart Solutions** provide step-by-step solutions to Problems 9-8 and 9-22.

After studying this chapter you should be able to:

- understand capital budgeting procedures and the ideal characteristics of a capital budgeting technique
- evaluate the use of the payback period, the discounted payback and the accounting rate of return to evaluate capital expenditures
- discuss the logic, calculation and pros and cons of the net present value (*NPV*) method, as well as a variant of this, the economic value added (*EVA*) method
- describe the logic, calculation, advantages and problems associated with the internal rate of return (*IRR*) technique

- differentiate between the *NPV* and *IRR* techniques by focusing on the scale and timing problems associated with mutually exclusive capital budgeting projects
- discuss the profitability index and recent findings with regard to the actual use of NPV and IRR in business practice.

Lecture Guide

Firm management makes two basic decisions – the financing and the capital budgeting decisions. This chapter provides tools that managers can use to evaluate projects that will add to shareholder wealth.

An Introduction to Capital Budgeting

While few finance classes extensively discuss the choice of capital budgeting projects, clearly this is of utmost importance to a firm. A firm that is unable to find and implement value-increasing projects will not stay in business very long. Similarly, a firm that does not have good evaluative controls in effect will have difficulty continuing its business. After a project has been chosen and implemented, managers must continually monitor that project, ensuring that it is meeting its stated milestones for revenue and cash flow generation. If a project is not performing as expected, then why? Were revenues lower than expected or costs higher than expected? If a project is exceeding expectations, then why is this happening? Is this success something that can be repeated in another project?

The capital budgeting decision should be separate from the financing decision. Project cash flows should be determined without including any financing cash flows, such as interest expense, dividends or principal repayments. The benefit from financing – the company's choices of how much debt to use, the cost of debt, and the tax benefit received from the tax deductibility of interest expense are captured in the discount rate, the weighted average cost of capital used to find the present value of the cash flows.

This chapter covers the primary capital budgeting decision techniques, focusing on the strengths and weaknesses of each technique, including accounting rate of return, payback period, net present value, internal rate of return and profitability index.

9.1a Traits of Ideal Investment Criteria

This section brings information from prior chapters into the capital budgeting process. A sound capital budgeting process must take time value of money – the magnitude and timing of the cash flows into account. It also must appropriately account for relevant risk. The focus should be on cash flow, an important but difficult step in determining the acceptability of a project. In addition, while finance theory says that a company should accept all positive net present value projects, in reality, many companies face capital constraints. They must rank projects and accept only the best projects because they have limited resources. The limited resource might be capital, but it could be any resource. In short, the financial manager should be making decisions that maximise shareholder wealth.

9.1b A Capital Budgeting Problem

This section introduces the fictitious company Global Untethered and walks the students through a capital budgeting investment for the firm. This is a nice problem to walk the students through from beginning to end. Be sure to emphasise the timeline aspect of the investment as depicted in Figure 9.1 Global Untethered .

This chapter follows Global Untethered's fictitious capital budgeting problem. The chapter looks at how this project would be evaluated using various capital budgeting techniques and under what circumstances the project would be acceptable to Global Untethered. This chapter provides the relevant cash flows, focusing on evaluation techniques, not how to generate cash flows for capital budgeting, which is covered later in the textbook.

These slides provide students with the calculation of payback period for Global Untethered and summarise the advantages and disadvantages of the payback method, discussed above.

- Student Interaction: Ask students under what circumstances is discounted payback worse for a company? (When the company uses discounted payback, but doesn't increase the required payback period. In other words, if a company has a three year

payback period, and also a three year discounted payback period, then it is disadvantaging longer term projects even more by using discounted payback than regular payback. It will be even harder for projects with later cash flows to pass a discounted payback hurdle under these circumstances.)

Fig 9.1 Global Untethered Investment Proposals

9.2 Payback Methods

9.2a The Payback Decision Rule

This section begins the study of the most simple of the payback methods. Often used by smaller firms, it is also one of the easiest. However, it does not take into consideration the time value of money.

9.2b Pros and Cons of the Payback Method

This section summarises the pros and cons of this method. Point out the advantages to payback:

- Simple to compute and understand.
- Student Interaction: Ask students if they would rather explain payback or NPV to a manager who has no finance background.
- Can be used as a rudimentary capital rationing tool. If a firm does not have enough money to fund all of its capital budgeting projects, which is the case with a majority of firms, it can use payback to judge which projects will return money faster, so that money can in turn be reinvested in further projects.
- Student Interaction: Ask students if these advantages outweigh the disadvantages of payback:
    - Ignores cash flows after the payback period
    - Does not use time value of money techniques
    - Biases the company against longer-term projects

Show how easily payback can be misused, and lead to incorrect answers:

Consider two projects, A and B

Project A

Year	0	1	2	3
Cash Flow	–100	100	0	0

Project B

Year	0	1	2	3
Cash Flow	–100	10	10	1,000

- Student Interaction: Ask students to take a side and tell us why we should or should not use the Payback Method.
    - Project A has a payback in 1 year, yet without doing any calculations, it is clearly unacceptable. It only pays back the amount invested, without providing any profits. Project B will not payback its initial investment until year 3, yet, again without doing any calculations, clearly has a very high return.

9.2c Discounted Payback

In an effort to correct the problems associated with the payback decision method. The discounted payback method was created. It is a bit cumbersome in its use but does correct for the flaw of no time value of money consideration. Using the Present Value we learned previously – one can use the

payback method with some time value consideration. Although the time value of money is addressed, many of the other flaws of the Payback Method are still present in this method.

9.3 Accounting Based Methods

9.3a Accounting Rate of Return

The accounting rate of return for a project has serious limitations because it does not take time value of money into account and it uses accounting numbers, not cash flows. The concept of a hurdle rate is introduced.

9.3b Pros and Cons of the Accounting Rate of Return

While this method may be popular because managers are accustomed to thinking in terms of returns, and this gives them a per cent return, accounting based methods are very flawed. It is very easy to give an example, without needing to make calculations to see why this method gives wrong answers. Suppose you have two projects with the following cash flows:

Project A				
Year	0	1	2	3
Cash Flow	–100	50	40	30

Project B				
Year	0	1	2	3
Cash Flow	–100	30	40	50

Both projects provide the same accounting rate of return, but clearly project A is superior because it returns its cash flows in a more timely manner. Again, without doing calculations, it is easy to see that accounting rate of return could give you an incorrect accept/reject decision.

9.4 Net Present Value

- Student Interaction: Ask students if they would want a project/investment where someone gives them $100 and they immediately give back $110. Students will say no, because of the time value of money. They, like the company, want time to invest the money and earn returns from it.

Point out that NPV provides correct answers to capital budgeting decisions because it incorporates both market-determined risk and the time value of money. The rule of acceptance of this method is also very simple and intuitive. If the NPV>0, then the company should accept the project and if the NPV<0, then the company should not accept the project. This rule is simply an extension of the techniques introduced in Chapter 3. NPV is the most theoretically correct model.

Note that some common errors when using calculators to solve NPV problems are:

- Failing to enter 0 in years when there is no cash flow
- Failing to correctly enter the signs (negative for outflows and positive for inflows) of cash flows

Note that NPV is the means of seeing if an investment adds economic value to a firm.

9.4a Net Present Value Calculations

Note that this kind of calculation was made in previous chapters. The only addition to previous chapter problems is an initial cost. In previous problems, students computed present value – given a series of future cash flows, they applied a discount rate and calculated present value. This chapter introduces a cost for the project, typically a year zero cost. Now, the project becomes acceptable if its present value is greater than its initial cost. Why does the NPV generally lead to a maximisation of shareholder wealth? The concept is what the r in the equation represents. This r is representative of the rate of return the shareholder can receive on an equally risky project. So a positive NPV should lead to a maximisation of this required return and increase shareholder wealth.

Fig. 9.2 The NPV Rule and Shareholder Wealth

Fig. 9.3a NPV of Global Untethered's Projects at 18% (Western Europe Project)

Fig. 9.3b NPV of Global Untethered's Projects at 18% (South-eastern Australia Project)

9.4b Pros and Cons of NPV

NPV is the most theoretically correct model to use in capital budgeting. Its main drawback – that it doesn't do a very good job of capturing managerial flexibility – is a relatively new concern. Option pricing theory has been increasingly applied to the capital budgeting decision to capture managers' ability to expand on or abandon projects.

9.4c Economic Value Added

Recently a variant of NPV has been used – Economic Value Added. Economic Value Added is based on the economic concept of economic profit. Economic profit is found when a firm earns not only an accounting profit but also eclipses all other opportunity costs. EVA evaluates the economics of a project and then discounts them back to compare what was earned above and beyond accounting profits.

9.5 Internal Rate of Return

Figure 9.4 *NPV* Profile

9.5a Finding a Project's IRR

Possibly the most popular of the alternative methods of capital budgeting decision-making, IRR is intuitive and easy to use with today's technology.

- Student Interaction: Point out to students that they have done IRR calculations in previous chapters – finding the yield to maturity of a bond is finding the IRR of a bond. The methods they can use to calculate IRR include:

- Cash flow menu on a financial calculator
- Time value of money keys on a financial calculator if the cash flows are an annuity or if they are like a bond (annuity payments and one lump sum payment in the final year)
- Excel
- Graphing
- Trial and error

IRR and NPV provide the same answers for a single project with conventional cash flows.

Fig. 9.5a and 9.5b Calculating IRRs for Global Untethered Projects

Using information given in the text, this slide shows IRR for the Western Europe and Southeast US project. If students are unaccustomed to using financial calculators, or Excel, the instructor can demonstrate the use of these tools to find IRR. Note that it would be extremely difficult and time-consuming to solve these problems without a financial calculator.

9.5b Advantages of the IRR Method

IRR has many of the same advantages as NPV. In addition, many managers are used to thinking of their investments as a per cent return. IRR provides this internal measure of profitability. Given the magnitude and timing of the cash flows, the project provides a per cent return. Note that as the name of the method states, this is an internal return. It is determined by the project cash flows, not by market factors. NPV, on the other hand, uses a market-determined discount rate.

- Student Interaction: Ask students about the difference between the r in IRR and in NPV. While they look the same in the formula, they really represent different concepts. IRR is an internal measure of the project's profitability. The r used in NPV is an opportunity cost of capital which

measures what could be earned by investing in projects of similar risk. It is determined by the market and reflects the cost of financing the project.

9.5c Problems with the Internal Rate of Return
Lending vs Borrowing

Timing of the cash flows can cause problems. The book gives the example of timber cutting firms. These firms will cut and sell the timber immediately, but will have to pay to replant and grow in the future. So they will have high income now but possibly have to borrow or pay later to replant. How does IRR deal with this problem? If you examine the scenario given – then both projects appear to have IRRs of 50% but that is misleading and would lead to a bad investment choice if IRR was the only criteria used to examine this prospective investment.

Fig. 9.6 Lending vs Borrowing

Multiple IRRs

- Student Interaction: Ask students for examples of projects with non-conventional cash flows, in particular those with outflows at the beginning and end of the project. Typical examples are nuclear power plants, which have large costs to properly dispose of nuclear material at the end of the project; strip mines, which have large environmental costs at the end of the project, and cases where there is a delay between earning income and paying taxes. Point out to students that some calculators have more difficulty than others in computing IRR when there are multiple sign changes. Some will give students an error message. Others will ask students to input a guess before calculating IRR.

Fig. 9.7 NPV Profile of a Project with Multiple IRRs

No Real Solution

- Student Interaction: Ask students for examples of projects with no IRRs. While mathematically one can devise projects with no IRR (try Cash flow 0 = $100, Cash flow 1 = –$200 and Cash Flow 2 = $150, it would be difficult to think of a real life project which would have these examples. A real world case where no IRR can be computed would be a situation where a firm could increase its cash flows without making new investment, or at least not making an investment greater than its expected cash flows. If you were considering a single project, you would happily accept this project. But suppose you had several choices, for example, a low growth and a high growth strategy, each with differing cash flow patterns, but each not having negative cash flows. Then you could not compute an IRR for each project and compare the IRRs.

9.5d IRR and NPV and Mutually Exclusive Projects
Point out that differences in answers for mutually exclusive projects result from size and timing differences. Projects with lower initial investments that return their cash flows earlier tend to have higher IRRs. This biases managers against longer term projects. This occurs in part because NPV correctly uses an exponentially decreasing present value factor with later cash flows. This makes cash flows received further in the future and discounted at higher rates much smaller.

The Scale Problem
If two projects give positive returns that exceed the hurdle rate – size and scale of the project must be taken into consideration. A large project may give a lower rate but much higher NPV and vice versa. So the actual profit to the project and ultimately – the shareholder – must also be considered before making a choice.

The Timing Problem
This section is a graphical representation (in Figure 9.8) of the conflict between mutually exclusive projects. The instructor can point to the discount rates (below the crossover point) and that the long term project has a higher NPV and is therefore the superior project, even though its IRR is lower. At discount rates greater than the crossover point, the short term project has both the higher NPV and IRR.

- Student Interaction: Have students speculate about why IRR is so popular, even though finance textbooks clearly point out its flaws. There is no definitive answer to this question, but perhaps managers like to think in terms of per cent returns, and IRR does tell them the profitability per dollar of investment.

Fig. 9.8 *NPV* Profiles Demonstrating the Timing Problem

9.6 Profitability Index
Point out that Profitability Index (PI) can be used in capital rationing cases. It automatically adjusts for scale (size of the initial investment) and allows managers to see which projects are giving them the most return, given the initial investment.

9.7 Capital Budgeting in Practice
This last section gives an example using many of the capital budgeting methods introduced in the chapter.

- Student Interaction: Ask students which methods works best in this scenario and why?

Fig. 9.9 Net Present Value of Two Gas Chromatographs

Summary: Capital Budgeting

- Student Interaction: Ask students why popularity of various methods has changed over time. What changes are likely to occur in the future?

Enrichment Exercises

1. Tell students they're in a job where their boss doesn't like all those fancy finance theories. How will you convince him (without being fired) that NPV is the best method to use in capital budgeting projects?
2. Have students give examples of the types of capital budgeting projects they might see in their particular field (e.g., Accounting, Management, Marketing, etc.)

Answers to Concept Review Questions

1. Other things being equal, managers would prefer (1) an easily applied capital budgeting technique that (2) considers cash flow, (3) recognises the time value of money, (4) fully accounts for expected risk and return, and (5) when applied, leads to higher share prices.

2. Payback is popular because it is very easy to compute and to understand and because it gives managers a rough measure of how soon they will receive intermediate cash flows from a project that they could potentially invest in other projects. It would be used primarily in situations that feature quick turnover of projects.

3. A major flaw of the payback method is that it does not take the time value of money into account. It also ignores cash flows beyond the payback period, as does the discounted payback method.

4. Managers focus on the impact that an investment will have on reported earnings because earnings or earnings per share are widely reported in the business press and companies (and management)

are penalised if they earn less than expected. As a result of this emphasis, managers tend to be very focused on earnings, sometimes incorrectly at the expense of cash flow.

5. When determining whether the annual accounting rate of return on a given project will be high or low in the early or in the latter years of an investment's life, the depreciation method used can be a big factor. Accelerated depreciation can mean substantially lower cash flows in the early years of a project.

6. A project having an NPV of $1 million means that $1 million in shareholder value (market capitalisation) is being added to the firm.

7. The discount rates may differ on two different projects because the discount rate reflects the perceived risk of a project.

8 Both *EVA* and *NPV* provide a measure of value added, so it should not be surprising that these methods are quite similar. EVA uses the same basic cash flows as NPV and evaluates the economics of an investment 'one year at a time,' whereas NPV compares the incremental net cash inflows over the investment's life (discounted to the present at the firm's cost of capital) to the net cash outflows required by the investment. Technically, discounting the time series of annual EVAs at the firm's cost of capital should result in the project's NPV. Thus NPV and EVA are fully compatible and yield the same capital budgeting decisions.

9. IRR and NPV are related in that both use the time value of money and take risk into account. NPV accounts for risk by using a risk-adjusted discount rate, while IRR uses a risk-adjusted hurdle rate against which to compare the project and make the accept/reject decision.

10. If a single project with conventional cash flows has an IRR that exceeds the firm's hurdle rate and thus says to accept the project, NPV will also say accept the project. If a project has two IRRs, this says the project has a positive NPV whenever the hurdle rate lies between the two IRRs.

11. You will recall that the 'scale problem' indicates that we should use practical sense along with IRR analysis: we should choose the investment that offers the best ABSOLUTE payoff to maximise shareholder wealth, regardless of its percentage payoff. The 'timing problem' has to do with managers' inability or unwillingness to look at the longer term and simply look for the next best fix – short term payoffs rather than visionary projects that involve R&D and the like. Often, the scale problem or timing problem can cause one project to have a higher IRR than another project that has a higher NPV. This becomes an issue when dealing with two mutually exclusive projects with both projects having positive NPVs because a choice will need to be made between the two projects (i.e. the IRR and NPV disagree as to which project is better). The firm can use IRR with mutually exclusive projects by subtracting one set of cash flows from the other and assessing the IRR of the project that represents these differential cash flows.

12. *NPV*, *IRR*, and *PI* capital budgeting approaches are related because they adjust for the time value of money and risk. Again, for a single project with conventional cash flows, all three methods should provide the same accept/reject decision.

13. Both suffer from a scale problem, which the *IRR* and *PI* don't take into consideration. When choosing between two projects, the one that requires the larger funding but with the substantially greater monetary payoff is generally preferred.

Answers to Self-Test Problems

ST9-1. Nader International is considering investing in two assets – A and B. The initial outlay, annual cash flows, and annual depreciation for each asset is shown in the table below for assets' assumed five-year lives. As can be seen, Nader will use straight-line depreciation over each asset's five-year life. The company requires a 12% return on each of those equally risky assets. Nader's maximum payback period is 2.5 years; its maximum discounted payback period is 3.25 years, and its minimum accounting rate of return is 30%.

	Asset A		**Asset B**	
Year	Cash Flow	Depreciation	Cash Flow	Depreciation
0	–$200,000		–$180,000	
1	$70,000	$40,000	$80,000	$36,000
2	80,000	40,000	90,000	36,000
3	90,000	40,000	30,000	36,000
4	90,000	40,000	40,000	36,000
5	100,000	40,000	40,000	36,000

a. Calculate the payback period for each asset, assess its acceptability, and indicate which asset is best using the payback period.
b. Calculate the discounted payback for each asset, assess its acceptability, and indicate which asset is best using the discounted payback.
c. Assuming that each year's net income equals cash flow minus depreciation, calculate the accounting rate of return from each asset, assess its acceptability, and indicate which asset is best using the accounting rate of return.
d. Compare and contrast your findings in parts a, b, and c. Which asset would you recommend to Nader, assuming that they are mutually exclusive? Why?

	Asset A		**Asset B**
Year	**NPAT**		**NPAT**
1	$70,000 – $40,000 = $30,000		$80,000 – $36,000 = $44,000
2	$80,000 – $40,000 = $40,000		$90,000 – $36,000 = $54,000
3	$90,000 – $40,000 = $50,000		$30,000 – $36,000 = –$6,000
4	$90,000 – $40,000 = $50,000		$40,000 – $36,000 = $4,000
5	$100,000 – $40,000 = $60,000		$40,000 – $36,000 = $4,000
	Average = $46,000		Average = $20,000
Max 2.50	a. Payback	2.56 years / Not acceptable	2.33 years / Acceptable

b.

Discounted payback at 12% (Max 3.25)						
	Asset A			**Asset B**		
Year	**CF**	**12% PV**	**Depr.**	**CF**	**12% PV**	**Depr.**
0	–$200,000			–$180,000		
1	$ 70,000	62,500	$40,000	$80,000	71,429	$36,000
2	80,000	63,776	40,000	90,000	71,747	36,000
3	90,000	64,060	40,000	30,000	21,353	36,000
4	90,000	57,196	40,000	40,000	25,420	36,000

5	100,000		40,000	40,000		36,000
	Discounted payback at 12% : 3.17 years/Acceptable			Discounted payback at 12% : 3.62 years / Not Acceptable		

c. Accounting rate of return		
	$\frac{\$46,000}{100,000} = 46\%$ Acceptable	$\frac{\$20,000}{90,000} = 22.22\%$ Not acceptable

d. They should take asset A because its accounting rate of return is acceptable as is its discounted payback.

ST9-2. JK Products Pty Ltd is considering investing in either of two competing projects that will allow the company to eliminate a production bottleneck and meet the growing demand for its products. The company's engineering department narrowed the alternatives down to two – Status Quo (SQ) and High Tech (HT). Working with the accounting and finance personnel, the company's CFO developed the following estimates of the cash flows for SQ and HT over the relevant 6-year time horizon. The firm has an 11 per cent required return and views these projects as equally risky.

	Project SQ	**Project HT**
Year	**Cash Flows**	
0	–$670,000	–$940,000
1	$250,000	$170,000
2	200,000	180,000
3	170,000	200,000
4	150,000	250,000
5	130,000	300,000
6	130,000	550,000

a. Calculate the net present value (NPV) of each project, assess its acceptability, and indicate which project is best using NPV.
b. Calculate the internal rate of return (IRR) of each project, assess its acceptability, and indicate which project is best using IRR.
c. Calculate the profitability index (PI) of each project, assess its acceptability, and indicate which project is best using PI.
d. Draw the NPV profile for project SQ and HT on the same set of axes and use this diagram to explain why the NPV and IRR show different preferences for these two mutually exclusive projects. Discuss this difference in terms of both the 'scale problem' and the 'timing problem.'
e. Which of the two mutually exclusive projects would you recommend JK Products undertake? Why?

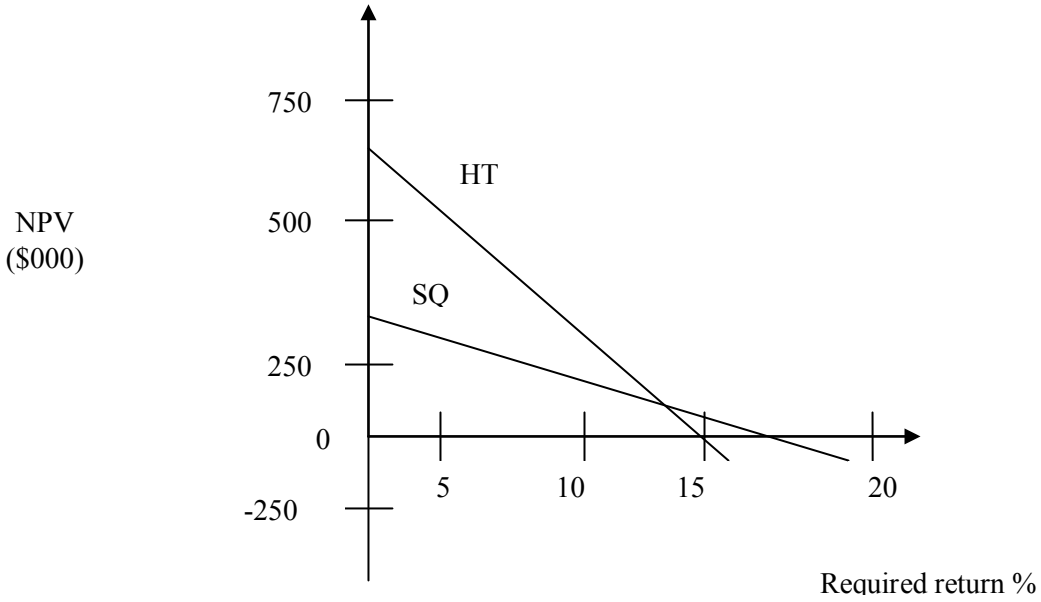
A:

	Project SQ	**Project HT**
a. NPV	$87,313.87	$142,254.07*
b. IRR	16.07%*	15.17%
c. PI	1.13	1.15*

All measures indicate project acceptability:
NPV > 0
IRR >11%
PI > 1.00

*Indicates the preferred project using each measure.

d.



	Project	
Rate	**SQ**	**HT**
0%	$360,000	$710,000
11%	$87,313.87	$142,254.07
15.17%	–	0
16.07%	0	–

At 11% HT is preferred over SQ, but because the profiles cross somewhere beyond 11% and before the functions cross the required return axis the IRR of SQ exceeds the IRR of HT. This behaviour can be explained by the fact that HT's larger scale causes its NPV to exceed that of SQ. The smaller project and the timing of SQ's cash flows – more in the early years – causes its IRR to exceed that of HT, which has more of its cash flows in later years.

e. Project HT is recommended because it has the higher NPV, the better technique. In addition its PI is higher than that of Project SQ.

Answers to End-of-Chapter Questions

Q9-1. Can you name some industries where the payback period is unavoidably long?

A9-1. Payback period is unavoidably long in industries with long-lasting projects, for example, the oil exploration industry, where it might take a long time to find acceptable oil fields and make them produce. Some agricultural products take a long time – for example starting an apple orchard would have a long payback, waiting for the trees to grow, mature and finally produce maximum produce.

Q9-2. In statistics, you learn about Type I and Type II errors. A Type I error occurs when a statistical test rejects a hypothesis when the hypothesis is actually true. A Type II error occurs when a test fails to reject a hypothesis that is actually false. We can apply this type of thinking to capital budgeting. A Type I error occurs when a firm rejects an investment project that would actually

enhance shareholder wealth. A Type II error occurs when a firm accepts a value-decreasing investment, an investment it should have rejected.

a. Describe the features of the payback rule that could lead to Type I errors.
b. Describe the features of the payback rule that could lead to Type II errors.
c. Which error do you think is more likely to occur when firms use payback analysis? Does your answer depend on the length of the cut-off payback period? You can assume a 'typical' project cash flow stream, meaning that most cash outflows occur in the early years of a project.

A9-2. a. Payback could lead to Type I errors when it rejects a good project that has large cash flows after the payback period cut-off.

b. Type II errors occur when payback says to accept a project that doesn't return enough to compensate for the risk taken.

c. A type I error is more likely – good project with higher cash flows in later years may be rejected.

Q9-3. Holding the cut-off period fixed, which method has a more severe bias against long-lived projects, payback or discounted payback?

A9-3. Discounted payback has a more severe bias – discounted cash flows will be smaller, making it even harder for a project to pass the payback hurdle.

Q9-4. For a firm that uses the *NPV* rule to make investment decisions, what consequences result if the firm misestimates shareholders' required returns and consistently applies a discount rate that is 'too high'?

A9-4. If the company consistently uses a 'too high' discount rate, then it will reject good projects that would add to shareholder value.

Q9-5. 'Cash flow projections more than a few years out are not worth the paper they're written on. Therefore, using payback analysis, which ignores long-term cash flows, is more reasonable than making wild guesses as one has to do in the *NPV* approach.' Respond to this comment.

A9-5. NPV automatically adjusts for project time by using an exponentially smaller discount rate applied to later cash flows. It gives these cash flows less importance in the final answer.

Q9-6. 'Smart analysts can massage the numbers in *NPV* analysis to make any project's *NPV* look positive. It is better to use a simpler approach like payback or accounting rate of return that gives analysts fewer degrees of freedom to manipulate the numbers.' Respond to this comment.

A9-6. Any method can be manipulated. It would be hard to argue that accounting numbers can't be manipulated after all the accounting scandals, starting with Enron in late 2001. Managers should have incentives to provide the most accurate information possible.

Q9-7. In what way is the *NPV* consistent with the principle of shareholder wealth maximisation? What happens to the value of a firm if a positive-*NPV* project is accepted? If a negative-*NPV* project is accepted?

A9-7. The NPV approach is consistent with shareholder maximisation because it suggests that firms should only accept projects which earn returns above the opportunity costs of the firm's investors. The NPV in effect measures the dollar contribution that the given project is expected

to make to the firm's overall value. If a firm invests in a project with NPV > $0, then the share price will rise. Conversely, a firm's share price will fall if it invests in projects with NPV < $0.

Q9-8. A particular firm's shareholders demand a 15% return on their investment, given the firm's risk. However, this firm has historically generated returns in excess of shareholder expectations, with an average return on its portfolio of investments of 25%.

a. Looking back, what kind of share price performance would you expect to see for this company?

b. A new investment opportunity arises, and the company's financial analysts estimate that the project's return will be 18%. The CEO wants to reject the project because it would lower the firm's average return and therefore lower the firm's share price. How do you respond?

A9-8. a. A firm that consistently earns returns higher than its opportunity cost of capital is adding value to the firm, and its stock price should increase.

b. For the project returning 18%, as long as it returns enough to compensate for the risk of the project, it is adding value and shareholders will be happy about the decision to accept the project.

Q9-9. What are the potential faults in using the *IRR* as a capital budgeting technique? Given these faults, why is this technique so popular among corporate managers?

A9-9. The IRR suffers from several problems. The IRR is not well suited to ranking projects with very different scales or projects with very different cash flow timing patterns. The IRR method can also yield no solution, or multiple solutions that are hard to interpret. Despite the flaws, the IRR method enjoys widespread use because in most investment situations it generates reliable accept/reject recommendations and it is easy to interpret intuitively.

Q9-10. Why is the *NPV* considered to be theoretically superior to all other capital budgeting techniques? Reconcile this result with the prevalence of the use of *IRR* in practice. How would you respond to your CFO if she instructed you to use the *IRR* technique to make capital budgeting decisions on projects with cash flow streams that alternate between inflows and outflows?

A9-10. The NPV is the most appropriate capital budgeting method because it yields correct accept/reject situations and correct project rankings. Nevertheless, it is somewhat less intuitive than the IRR. In projects with cash flow streams that switch signs, the IRR method can yield multiple solutions. In those cases, it is difficult for a firm to know whether to accept or reject a project based upon its IRR.

Q9-11. Outline the differences between *NPV*, *IRR*, and *PI.* What are the advantages and disadvantages of each technique? Do they agree with regard to simple accept or reject decisions?

A9-11. The NPV is calculated by discounting all of a project's cash flows to the present. The IRR is calculated by finding the discount rate which equates the NPV to zero. The profitability index is the ratio of the present value of a project's cash flows (excluding the initial cash outflow) divided by the initial cash outflow. All three methods lead to the same accept/ reject decision when evaluating a single project, but IRR and PI have problems when ranking projects. NPV generally overcomes these problems.

Q9-12. Under what circumstances will the *NPV*, *IRR*, and *PI* techniques provide different capital budgeting decisions? What are the underlying causes of the differences often found in the ranking of mutually exclusive projects using NPV and IRR?

A9-12. IRR, NPV, and PI can lead to different decisions when they are used to rank projects or to select between mutually exclusive projects. IRR and PI methods are not well suited to evaluating projects which vary in scale. The NPV method yields correct project rankings no matter what the scale of the project.

Solutions to End-of-Chapter Problems

Payback Methods

P9-1. Suppose that a 30-year Treasury bond offers a 4% coupon rate, paid semiannually. The market price of the bond is $1,000, equal to its par value.

a. What is the payback period for this bond?
b. With such a long *payback period*, is the bond a bad investment?
c. What is the *discounted payback period* for the bond assuming its 4% coupon rate is the required return? What general principle does this example illustrate regarding a project's life, its discounted payback period, and its *NPV*?

A9-1. a. Payback on this bond is 25 years. You pay $1,000. You receive $40 a year for 25 years, a total of $1,000.

b. The bond is not necessarily a bad investment. Payback does not take time value of money into account, nor does it account for cash flows received after the payback period. It is more appropriate to calculate the NPV of an investment. Given the risk level of the bond, is 4% a fair return? If the answer is yes, then the bond may be a good investment.

c. The discounted payback, using a 4% discount rate, is 30 years. This shows that unless the acceptable payback period is decreased when discounted payback is used, vs regular payback, then projects which return money late in the life of the investment are even more disadvantaged under discounted payback than under regular payback. NPV is a more appropriate method to use to determine the value of an investment project.

P9-2. The cash flows associated with three different projects are as follows:

Cash Flows	Alpha ($ in millions)	Beta ($ in millions)	Gamma ($ in millions)
Initial Outflow	– 1.5	– 0.4	– 7.5
Year 1	0.3	0.1	2.0
Year 2	0.5	0.2	3.0
Year 3	0.5	0.2	2.0
Year 4	0.4	0.1	1.5
Year 5	0.3	– 0.2	5.5

a. Calculate the payback period of each investment.
b. Which investments does the company accept if the cut-off payback period is three years? Four years?
c. If the company invests by choosing projects with the shortest payback period, which project would it invest in?
d. If the company uses discounted payback with a 15% discount rate and a 4-year cut-off period, which projects will it accept?
e. One of these almost certainly should be rejected, but might be accepted if the company uses payback analysis. Which one?
f. One of these projects almost certainly should be accepted (unless the company's opportunity cost of capital is very high), but might be rejected if the company uses payback analysis. Which one?

A9-2. a. Payback of Alpha = 3.5 years, payback of Beta = 2.5 years, payback of Gamma = 3.3 years

b. If the cut-off is 3 years, then only Beta is acceptable. If the cut-off is 4 years, then all of the projects are acceptable.

c. Project Beta because its payback of 2.5 years is the shortest.

d. If the firm uses discounted payback with a cut-off of 4 years, then Alpha will not pay back at all, Beta will pay back in 3.53 years, and Gamma in 4.48 years. This means only Beta is acceptable.

e. Project Beta should be rejected. You must pay out a total of 0.6 million and take in 0.6 million. When there is a time value to money, in other words, a positive interest rate, this is unacceptable. If cash inflows and outflows are the same, this is a negative net present value project.

f. Project Gamma is rejected under payback, but even without discounting, seems to have a high dollar return for the investment. You pay $7.5 million and receive a total of $14 million in cash inflows. Unless the firm has a very high discount rate, greatly lowering the value of the last $5.5 million cash flow, this is likely to be an attractive investment.

Accounting-Based Methods

P9-3. Kenneth Gould is the general manager at a small-town newspaper that is part of a national media chain. He is seeking approval from corporate headquarters (HQ) to spend $20,000 to buy some Macintosh computers and a laser printer to use in designing the layout of his daily paper. This equipment will be depreciated using the straight line method over four years. These computers will replace outmoded equipment that will be kept on hand for emergency use.

HQ requires Kenneth to estimate the cash flows associated with the purchase of new equipment over a 4-year horizon. The impact of the project on net income is derived by subtracting depreciation from cash flow each year. The project's average accounting rate of return equals the average contribution to net income divided by the average book value of the investment. HQ accepts any project that (1) has an average accounting rate of return that exceeds the cost of capital of 15 per cent, and (2) returns the initial investment within four years (on a cash flow basis). The following are Kenneth's estimates of cash flows:

	Year 1	**Year 2**	**Year 3**	**Year 4**
Cost savings	$7,500	$9,100	$9,100	$9,100

a. What is the average contribution to net income across all four years?
b. What is the average book value of the investment?
c. What is the average accounting rate of return?
d. What is the payback period of this investment?
e. Critique the company's method for evaluating investment proposals.

A9-3. a. If the computers are depreciated on a straight-line basis, depreciation will be $5,000 per year for 4 years. Contribution to net income will be:

Year 1	**Year 2**	**Year 3**	**Year 4**
7,500	9,100	9,100	9,100
–5,000	–5,000	–5,000	–5,000
2,500	4,100	4,100	4,100

The average net income is (2,500 + 4,100 + 4,100 + 4,100)/4 = 3,700

b. The average book value of the investment is (20,000 + 0)/2 = $10,000.

c. The average accounting rate of return = Average net income/Average book investment = 3,700/10,000 = .37 or 37%.

d. The payback period is 2 + 3,400/9,100 = 2.4 years.

e. This is not an appropriate method for evaluating capital budgeting projects. It does not take time value of money into account, nor does it look at cash flows. It also does not consider the risk of the project and what would be an appropriate discount rate for the project's cash flows.

Net Present Value

P9-4. Calculate the net present value (*NPV*) for the following 20-year projects. Comment on the acceptability of each. Assume that the company has an opportunity cost of 14%.
a. Initial cash outlay is $15,000; cash inflows are $13,000 per year.
b. Initial cash outlay is $32,000; cash inflows are $4,000 per year.
c. Initial cash outlay is $50,000; cash inflows are $8,500 per year.

A9-4. a. Project A has CF_0 = −$15,000, and 20 inflows of $13,000. At a 14% discount rate, its NPV is $71,100.70. This is positive NPV and an acceptable project.

b. Project B has CF_0 = −$32,000 and 20 inflows of $4,000. At 14%, its NPV is −$5,507.48. This is negative NPV and is not acceptable.

c. Project C has CF_0 = −$50,000, and 20 inflows of $8,500. At a 14% discount rate, its NPV is $6,296.61. This is positive NPV and an acceptable project.

P9-5. Michael's Bakery is evaluating a new electronic oven. The oven requires an initial cash outlay of $19,000 and will generate after-tax cash inflows of $4,000 per year for eight years. For each of the costs of capital listed, (1) calculate the *NPV*, (2) indicate whether to accept or reject the machine, and (3) explain your decision.
a. The cost of capital is 10%.
b. The cost of capital is 12%.
c. The cost of capital is 14%.

A9-5. CF_0 = –$19,000
Cash flows of $4,000/Year for 8 years.

a. NPV at 10% = $2,339.70, accept
b. NPV at 12% = $870.56, accept
c. NPV at 14% = −$444.54, reject

Only positive NPV projects are acceptable. As the discount rate increases, NPV decreases. At some point, if the discount rate is high enough a previously acceptable project at lower discount rates may become unacceptable.

P9-6. Using a 14% cost of capital, calculate the *NPV* for each of the projects shown in the following table and indicate whether or not each is acceptable.

Year	Project A	Project B	Project C	Project D	Project E
			Cash Flows		
0	–$20,000	–$600,000	–$150,000	–$760,000	–$100,000
1	$3,000	$120,000	$18,000	$185,000	$ 0
2	3,000	145,000	17,000	185,000	0
3	3,000	170,000	16,000	185,000	0
4	3,000	190,000	15,000	185,000	25,000
5	3,000	220,000	15,000	185,000	36,000
6	3,000	240,000	14,000	185,000	0
7	3,000		13,000	185,000	60,000
8	3,000		12,000	185,000	72,000
9	3,000		11,000		84,000
10	3,000		10,000		

A9-6.

Project	NPV	Decision
A	−$4,351.65	Reject
B	$67,678.24	Accept
C	−$71,798.07	Reject
D	$98,189.82	Accept
E	$8,548.44	Accept

P9-7. Scotty Manufacturing is considering the replacement of one of its machine tools. Three alternative replacement tools – A, B, and C – are under consideration. The cash flows associated with each are shown in the following table. The firm's cost of capital is 15%.

Year	A	B	C
		Cash Flows	
0	–$95,000	–$50,000	–$150,000
1	$20,000	$10,000	$58,000
2	20,000	12,000	35,000
3	20,000	13,000	23,000
4	20,000	15,000	23,000
5	20,000	17,000	23,000
6	20,000	21,000	35,000
7	20,000	–	46,000
8	20,000	–	58,000

a. Calculate the *NPV* of each alternative.
b. Using *NPV*, evaluate the acceptability of each tool.
c. Rank the tools from best to worst, using *NPV.*

A9-7.

Project	NPV	Decision
A	−$5,253.57	Reject
B	$2,424.27	Accept
C	$17,992.95	Accept

Project C is the best, followed by Project B. Project A is the worst project, and is unacceptable.

P9-8. Erwin Enterprises has 10 million shares outstanding with a current market price of $10 per share. There is one investment available to Erwin, and its cash flows are provided below. Erwin has a cost of capital of 10%. Given this information, determine the impact on Erwin's share price and company value if capital markets fully reflect the value of undertaking the project.

Year	Cash Flow
0	–$10,000,000
1	$3,000,000
2	$4,000,000
3	$5,000,000
4	$6,000,000
5	$9,800,000

A9-8. NPV of project = $9,972,742
Current company value = $10 × $10,000,000 = $100,000,000
New company value = $100,000,000 + $9,972,742 = $109,972,742
New share price = $109,972,742 ÷ $10,000,000 = $11.00 per share

P9-9. A certain investment requires an initial outlay of $12 million and subsequently produces annual cash inflows of $1.4 million in perpetuity. A company evaluating this investment uses a discount rate of 10%. What is the investment's NPV? What is the EVA each period? What is the present value of the stream of EVAs?

A9-9. Project NPV = –$12 million + ($1.4 million / 0.10) = $2,000,000
Project EVA each period = $1.4 million – (0.10 × $12 million) = $0.2 million
Present value of EVA stream = $0.2 million / 0.10 = $2,000,000

Internal Rate of Return

P9-10. For each of the projects shown in the following table, calculate the internal rate of return (*IRR*).

	Project A	Project B	Project C	Project D
Year	**Cash Flows**			
0	–$72,000	–$440,000	–$18,000	–$215,000
1	$16,000	$135,000	$7,000	$108,000
2	20,000	135,000	7,000	90,000
3	24,000	135,000	7,000	72,000
4	28,000	135,000	7,000	54,000
5	32,000	–	7,000	–

A9-10.

Project	IRR
A	17.4%
B	8.7%
C	27.2%
D	21.4%

P9-11. William Industries is attempting to choose the better of two mutually exclusive projects for expanding the company's production capacity. The relevant cash flows for the projects are shown in the following table. The company's cost of capital is 15%.

Year	Project A Cash Flows	Project B Cash Flows
0	–$550,000	–$358,000
1	$110,000	$154,000
2	132,000	132,000
3	165,000	105,000
4	209,000	77,000
5	275,000	55,000

a. Calculate the *IRR* for each of the projects.
b. Assess the acceptability of each project based on the *IRR*s found in part (a).
c. Which project is preferred, based on the *IRR*s found in part (a)?

A9-11. a.

Project	IRR
A	15.7%
B	17.3%

b. With a cost of capital of 15%, both projects are acceptable.

c. Project B has a higher IRR, and is preferred to Project A, based on the IRR criterion.

P9-12. Contract Manufacturing Ltd is considering two alternative investment proposals. The first proposal calls for a major renovation of the company's manufacturing facility. The second involves replacing just a few obsolete pieces of equipment in the facility. The company will choose one project or the other this year, but it will not do both. The cash flows associated with each project appear below, and the company discounts project cash flows at 15%.

Year	Renovate	Replace
0	−$9,000,000	−$1,000,000
1	3,500,000	600,000
2	3,000,000	500,000
3	3,000,000	400,000
4	2,800,000	300,000
5	2,500,000	200,000

a. Rank these investments based on their *NPV*s.
b. Rank these investments based on their *IRR*s.
c. Why do these rankings yield mixed signals?

A9-12.

Project	NPV	IRR
Renovate	$1,128,309	20.5%
Replace	$ 433,779	36.1%

The Renovate project has a higher NPV but the Replace project has a higher IRR.

The rankings provide mixed signals because of the differing cash flow patterns and initial investments of the two projects. Projects that have lower initial investments and return their cash flows earlier in the life of the project tend to have higher IRRs, as is the case with the Replace project.

P9-13. Consider a project with the following cash flows and a firm with a 15% cost of capital.

Year	Cash Flow
0	−$20,000
1	50,000
2	−10,000

a. What are the two *IRR*s associated with this cash flow stream?
b. If the company's cost of capital falls between the two *IRR* values calculated in part (a), should it accept or reject the project?

A9-13. a. $\$0 = \frac{\$50{,}000}{(1+\text{IRR})^1} - \frac{\$10{,}000}{(1+\text{IRR})^2} - \$20{,}000$

Let $x = \frac{1}{(1+\text{IRR})^1}$

$\$0 = \$50{,}000x - \$10{,}000x^2 - \$20{,}000$

$\$0 = 5x - x^2 - 2$

$x^2 = 5x + 2 = 0$

Using the quadratic formula

$ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x^2 = \frac{5 \pm \sqrt{25-8}}{2} = \frac{5 \pm \sqrt{17}}{2} = \frac{5 \pm 4.1231}{2}$$

$$x = \frac{9.1231}{2} = 4.56155 \text{ and } x = \frac{0.8769}{2} = 0.43845$$

$$4.56155 = \frac{1}{1+IRR} \qquad 0.43845 = \frac{1}{1+IRR}$$

$$4.56155 + 4.56155IRR = 1 \qquad 0.43845 + 0.43845IRR = 1$$

$$4.56155IRR = -3.56155 \qquad 0.43845IRR = 0.56155$$

$$IRR_1 = \frac{-3.56155}{4.56155} = -78.08\% \qquad IRR_2 = \frac{0.56155}{0.43845} = 128.08\%$$

b. Because the undiscounted NPV of the project is positive (i.e; −$20,000 + $50,000 − $10,000 = $20,000) the project will have a positive NPV at all discount rates between – 78.08% and +128.08%. Therefore the company can accept the project as long as its cost of capital falls between the two IRRs.

P9-14. A certain project has the following stream of cash flows:

Year	Cash Flow
0	$ 17,500
1	−80,500
2	138,425
3	−105,455
4	30,030

a. Fill in the following table:

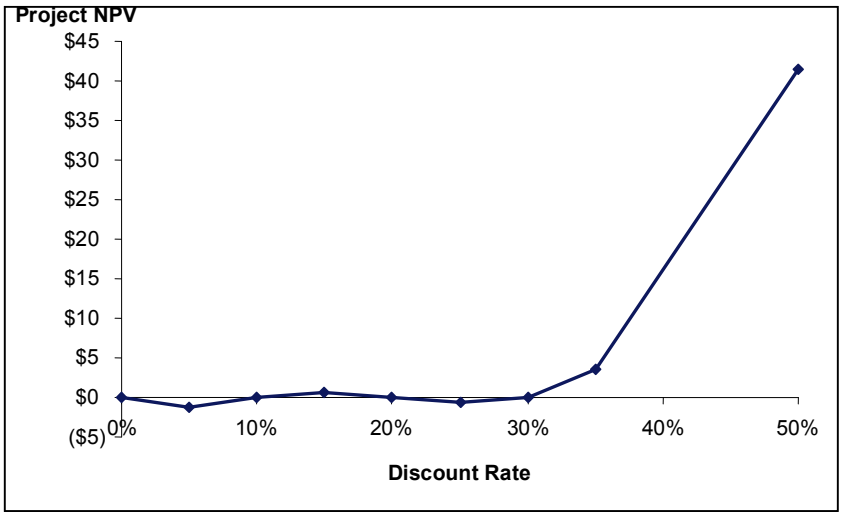
Cost of Capital (%)	Project NPV
0	_____
5	_____
10	_____
15	_____
20	_____
25	_____
30	_____
35	_____
50	_____

b. Use the values developed in part a to draw a NPV profile for the project.
c. What is this project's *IRR*?
d. Describe the conditions under which the company should accept this project.

A9-14. a.

Cost of Capital (%)	Project NPV
0	0
5	−1.35
10	0
15	.56
20	0
25	−.67
30	0
35	3.46
50	41.48

b.



c. The project has an IRR at every point where it crosses the discount rate axis, in this case at 0%, 10%, 20% and 30%.

d. This project is acceptable at discount rates greater than 30%, when the NPV is positive.

Profitability Index

P9-15. Evaluate the following three projects, using the profitability index. Assume a cost of capital of 15%.

	Project		
	Liquidate	**Recondition**	**Replace**
Initial cash outflow	–$100,000	–$500,000	–$1,000,000
Year 1 cash inflow	50,000	100,000	500,000
Year 2 cash inflow	60,000	200,000	500,000
Year 3 cash inflow	75,000	250,000	500,000

a. Rank these projects by their *PI*s.
b. If the projects are independent, which would you accept according to the *PI* criterion?
c. If these projects are mutually exclusive, which would you accept according to the *PI* criterion?
d. Apply the *NPV* criterion to the projects, rank them according to their NPVs, and indicate which project you would accept if they are independent and if they are mutually exclusive.
e. Compare and contrast your answer to part (c) to your answer to part (d) for the mutually exclusive case. Explain this result.

A9-15. a. PI (Liquidate) = $138,161 / $100,000 = 1.38
PI (Recondition) = $402,564 / $500,000 = 0.81
PI (Replace) = $1,141,613 / $1,000,000 = 1.14

b. Accept both Liquidate and Replace because both have a PI > 1.0

c. Liquidate because it has the highest PI

d. NPV (Liquidate) = $38,161
NPV (Recondition) = –$97,436
NPV (Replace) = $141,613
NPV ranking: Replace, Liquidate, Recondition.

Projects Liquidate and Replace have positive NPVs and should be accepted.
Replace has the highest NPV and should be accepted.

e. The answers do not match. Liquidate has the higher PI, but Replace is a larger scale project with a higher NPV. If these mutually exclusive projects are the only ones available and if there is sufficient capital to finance Replace, then it should be accepted because it contributes the most to shareholder value.

P9-16. You have a $10 million capital budget and must make the decision about which investments your company should accept for the coming year. Use the following information on three mutually exclusive projects to determine which investment your company should accept. The company's cost of capital is 12%.

	Project 1	**Project 2**	**Project 3**
Initial cash outflow	–$4,000,000	–$5,000,000	–$10,000,000
Year 1 cash inflow	1,000,000	2,000,000	4,000,000
Year 2 cash inflow	2,000,000	3,000,000	6,000,000
Year 3 cash inflow	3,000,000	3,000,000	5,000,000

a. Which project do you accept on the basis of *NPV*?
b. Which project do you accept on the basis of *PI*?
c. If these are the only investments available, which one do you select?

A9-16. a. $NPV_1 = -\$4{,}000{,}000 + \$1{,}000{,}000 \times (1.12)^{-1} + \$2{,}000{,}000 \times (1.12)^{-2} + \$3{,}000{,}000 \times (1.12)^{-3}$
$= \$622{,}586$
$NPV_2 = -\$5{,}000{,}000 + \$2{,}000{,}000 \times (1.12)^{-1} + \$3{,}000{,}000 \times (1.12)^{-2} + \$3{,}000{,}000 \times (1.12)^{-3}$
$= \$1{,}312{,}637$
$NPV_3 = -\$10{,}000{,}000 + \$4{,}000{,}000 \times (1.12)^{-1} + \$6{,}000{,}000 \times (1.12)^{-2} + \$5{,}000{,}000 \times (1.12)^{-3}$
$= \$1{,}913{,}493$ [highest NPV]

b. $PI_1 = \$4{,}622{,}586 / \$4{,}000{,}000 = 1.16$
$PI_2 = \$6{,}312{,}637 / \$5{,}000{,}000 = 1.26$ [highest PI]
$PI_3 = \$11{,}913{,}493 / \$10{,}000{,}000 = 1.19$

c. Although Project #2 provides 'more bang for the buck' as represented by its higher PI, Project #3 should be accepted since it has the higher NPV and there are no other investments under consideration.

P9-17. Both Old Line Industries and New Tech Ltd, use the *IRR* to make investment decisions. Both companies are considering investing in a more efficient $4.5 million mail-order processor. This machine could generate after-tax savings of $2 million per year over the next three years for both companies. However, due to the risky nature of its business, New Tech has a much higher cost of capital (20%) than does Old Line (10%). Given this information, answer parts (a)–(c).
a. Should Old Line invest in this processor?
b. Should New Tech invest in this processor?
c. Based on your answers in parts (a) and (b), what can you infer about the acceptability of projects across companies with different costs of capital?

A9-17. Project Cash Flows:

Year	0	1	2	3
Cash Flow	−$4.5	2	2	2

a. At Old Line's discount rate of 10%, this project's IRR of 15.9% is acceptable.

b. At New Tech's 20% discount rate, the project's IRR of 15.9% is not acceptable.

c. The cost of capital is very important to the acceptance of a project. A firm that has a lower cost of capital will find more projects acceptable and, all other things equal, will potentially add more value for shareholders.

P9-18. Butler Products has prepared the following estimates for an investment it is considering. The initial cash outflow is $20,000, and the project is expected to yield cash inflows of $4,400 per year for seven years. The company has a 10% cost of capital.

a. Determine the *NPV* for the project.
b. Determine the *IRR* for the project.
c. Would you recommend that the company accept or reject the project? Explain your answer.

A9-18.

Year	0	1	2	3	4	5	6	7
Cash Flow	−$20,000	4,400	4,400	4,400	4,400	4,400	4,400	4,400

b. At 10%, the NPV of the project is $1,421.04.
c. The IRR is 12.13%.
d. This project is acceptable by both NPV and IRR criteria. It has a positive NPV and its IRR is greater than its hurdle rate of 10%.

P9-19. Reynolds Enterprises is attempting to evaluate the feasibility of investing $85,000, in a machine having a 5-year life. The company has estimated the *cash inflows* associated with the proposal as shown below. The company has a 12% cost of capital.

Year	Cash Flows
1	$18,000
2	$22,500
3	$27,000
4	$31,500
5	$36,000

a. Calculate the payback period for the proposed investment.
b. Calculate the *NPV* for the proposed investment.
c. Calculate the *IRR* for the proposed investment.
d. Evaluate the acceptability of the proposed investment using *NPV* and *IRR.* What recommendation would you make relative to implementation of the project? Why?

A9-19. a. The payback period is 3.56 years
b. NPV is $8,672.54
c. IRR is 15.6%
d. This project is acceptable by both NPV and IRR criteria. It has a positive NPV and its IRR is greater than its hurdle rate of 12%.

P9-20. Sharpe Manufacturing is attempting to select the best of three mutually exclusive projects. The initial cash outflow and after-tax cash inflows associated with each project are shown in the following table.

Cash Flows	Project X	Project Y	Project Z
Initial cash outflow	$80,000	$130,000	$145,000
Cash inflows years 1-5	27,000	41,000	43,000

a. Calculate the payback period for each project.
b. Calculate the *NPV* of each project, assuming that the company has a cost of capital equal to 13%.
c. Calculate the *IRR* for each project.
d. Summarise the preferences dictated by each measure, and indicate which project you would recommend. Explain why.

A9-20.

Project	Payback	NPV	IRR
X	2.96 years	$14,965.24	20.4%
Y	3.17 years	$14,206.48	17.4%
Z	3.37 years	$6,240.94	14.75%

Ranking on NPV: X,Y,Z
Ranking on IRR: X,Y,Z
Ranking on Payback: X,Y,Z

All measures agree that X is best, followed by Y and Z. Since they are mutually exclusive projects, accept the project with the highest NPV, Project X.

P9-21. Wilkes Ltd must invest in a pollution-control program in order to meet federal regulations to stay in business. There are two programs available to Wilkes: an all-at-once program that will be immediately funded and implemented, and a gradual program that will be phased in over the next three years. The immediate program costs $5 million, whereas the phase-in program will cost $1 million today and $2 million per year for the following three years. If the cost of capital for Wilkes is 15%, which pollution-control program should Wilkes select?

A9-21.

Year	All at Once	Gradual
0	–$5	–$1
1		–$2
2		–$2
3		–$2

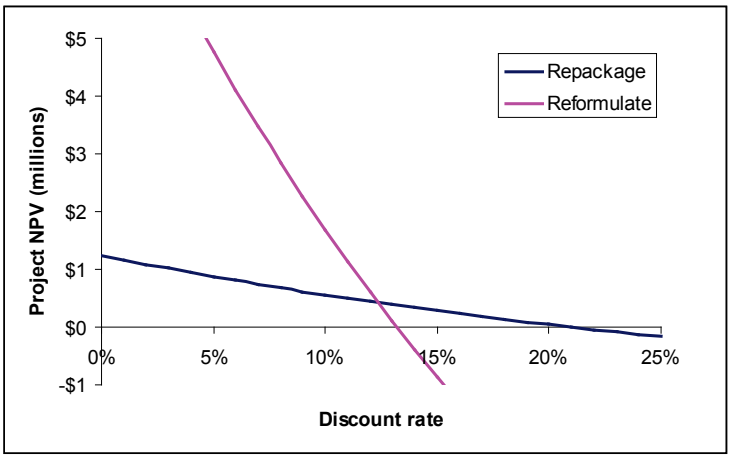
The NPV of the All at Once project is –$5 million. The NPV of the Gradual project, at a discount rate of 15%, is −$5.57 million. It is cheaper to implement the All at Once pollution control project.

P9-22. A consumer product company finds that its brand of laundry detergent is losing market share, so it decides that it needs to 'freshen' the product. One strategy is to maintain the current detergent formula, but to repackage the product. The other strategy involves a complete reformulation of the product in a way that will appeal to environmentally conscious consumers. The company will pursue one strategy or the other, but not both. Cash flows from each proposal appear below, and the firm discounts cash flows at 13%.

Year	Repackage	Reformulate
0	–$3,000,000	–$25,000,000
1	2,000,000	10,000,000
2	1,250,000	9,000,000
3	500,000	7,000,000
4	250,000	4,000,000
5	250,000	3,500,000

a. Rank these investments based on their *NPV*s.
b. Rank these investments based on their *IRR*s.
c. Rank these investments based on their *PI*s.
d. Draw NPV profiles for the two projects on the same set of axes and discuss these profiles.
e. Do these investment rankings yield mixed signals?

A9-22. a. NPV of Repackage is $384,390. NPV of Reformulate is $102,163. Choose the higher NPV, Repackage.
b. IRR of Repackage is 21.04%. IRR of Reformulate is 13.20%. Choose the higher IRR, Repackage.
c. PI of Repackage is PV of inflows divided by PV of outflows: 3,384,390/3,000,000 = 1.128. PI of Reformulate is 25,102,163.50/25,000,000 = 1.004. Choose the higher PI, Repackage.
d.



e. No, the rankings do not yield mixed signals. Repackage is better under all criteria.

P9-23. Lundblad Construction recently acquired ten acres of land and is weighing two options for developing the land. The first proposal is to build ten single-family homes on the site. This project would generate a quick cash payoff as the homes are sold over the next two years. Specifically, Lundblad estimates that it would spend $2.5 million on construction costs immediately, and it would receive $1.6 million as cash inflows in each of the next two years.

The second proposal is to build a strip shopping mall. This project calls for Lundblad to retain ownership of the property and to lease space to retail businesses that would serve the neighbourhood. Construction costs for the strip mall are also about $2.5 million, and the company expects to receive $350,000 annually (for each of 50 years, starting one year from now) in net cash inflows from leasing the property. Lundblad's cost of capital is 10%.

a. Rank these projects based on their *NPV*s.
b. Rank these projects based on their *IRR*s.
c. Rank these projects based on their *PI*s. Do these rankings agree with those based on *NPV* or *IRR*?
d. Draw NPV profiles for these projects on the same set of axes. Use this graph to explain why the *NPV* and *IRR* methods yield mixed signals in this case.
e. Which project should Lundblad choose?
f. Which project should Lundblad choose if its cost of capital is 13.5%? 16%? 20%?

A9-23.

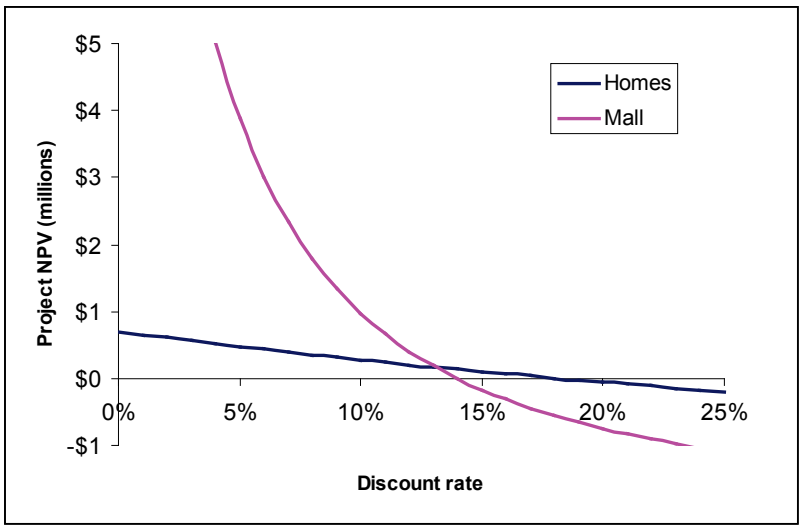
Year	A	B	A-B
0	–$2.5	–$2.5	0
1	1.6	0.35	1.25
2	1.6	0.35	1.25
3		0.35	–0.35
–			
–			
–			
50		0.35	–0.35

a and b.

Project	NPV	IRR	PI
A (Homes)	.277	18.16%	2.777/2.5 = 1.11
B (Mall)	.97	13.98%	3.47/2.5 = 1.39
Rankings:	B,A	A,B	B,A

c. The PI rankings agree with the NPV rankings, but not with the IRR rankings.

d.



IRR and NPV yield mixed signals because of differences in cash flow patterns. Project A (building homes) returns cash sooner than B (building the mall).

e. Lundblad should choose Project B since it has the higher NPV at a 10% discount rate.

f.

Discount rate	NPV of Project A (Homes)	NPV of Project B (Mall)	Choice
13.5%	$151,711	$87,980	A
16.0%	$68,371	–$313,809	A
20.0%	–$55,556	–$750,192	Neither

Answer to MiniCase

Capital Budgeting Process and Techniques

Contact Manufacturing Ltd is considering two alternative investment proposals. The first proposal calls for a major renovation of the company's manufacturing facility. The second involves replacing just a few obsolete pieces of equipment in the facility. The company will choose one project or the

other this year, but it will not do both. The cash flows associated with each project appear below and the firm discounts project cash flows at 15%.

Year	Renovate	Replace
0	–$9,000,000	–$2,400,000
1	3,000,000	2,000,000
2	3,000,000	800,000
3	3,000,000	200,000
4	3,000,000	200,000
5	3,000,000	200,000

Assignment

1. Calculate the *payback period* of each project and based on this criterion, indicate which project you would recommend for acceptance.
2. Calculate the *net present value* (*NPV*) of each project and based on this criterion, indicate which project you would recommend for acceptance.
3. Calculate the *internal rate of return* (*IRR*) of each project and based on this criterion, indicate which project you would recommend for acceptance.
4. Calculate the *profitability index* (*PI*) of each project and based on this criterion, indicate which project you would recommend for acceptance.
5. Overall, you should find conflicting recommendations based on the various criteria. Why is this occurring?
6. Chart the *NPV profiles* of these projects. Label the intersection points on the x- and y-axes and the crossover point.
7. Based on this *NPV profile* analysis and assuming the *WACC* is 15%, which project would you recommended for acceptance? Why?
8. Based on this *NPV profile* analysis and assuming the *WACC* is 25%, which project is recommended? Why?
9. Discuss the important elements to consider when deciding between these two projects.

Answers

1. Renovate project: Payback = 3 years
   Replace project: Payback = 1 + (400,000/800,000) = 1.5 years

Renovation Project	
Input	**Function**
2nd	CLR TVM
	CF
2nd	CLR Work
–9,000,000	Enter ↓
3,000,000	Enter ↓
5	Enter

Replace Project	
Input	**Function**
2nd	CLR TVM
	CF
2nd	CLR Work
–2,400,000	Enter ↓
800,000	Enter ↓↓
200,000	Enter ↓↓
200,000	Enter ↓↓
200,000	Enter ↓↓
200,000	Enter ↓↓

2.

Input	**Function**
	NPV
15	Enter ↓
	CPT

NPV = $1,056,465.29

Input	**Function**
	NPV
15	Enter ↓
	CPT

NPV = $289,334.61

3.

Input	**Function**	**Input**	**Function**
	IRR		IRR
	CPT		CPT
IRR = 19.86%		IRR = 23.69%	

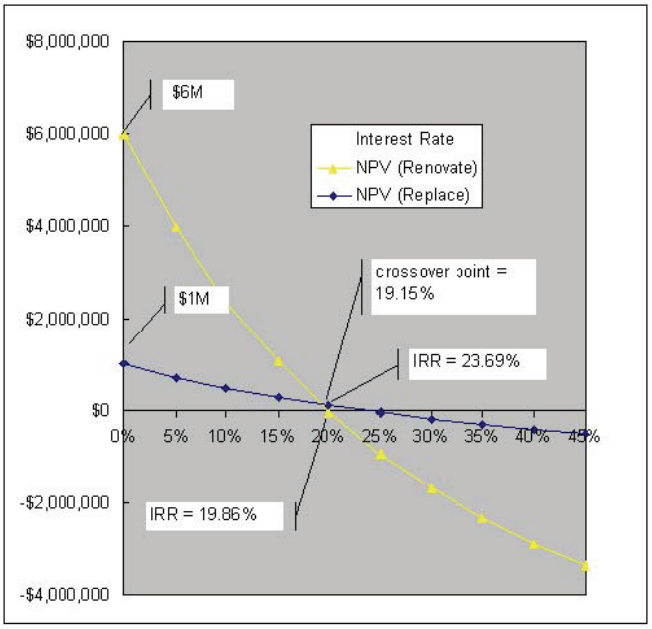
4. PI = PV of Cash Flows / Initial Investment

   = $10,056,465.29 / 9,000,000 = 1.1174

   = 2,689,334.61 / 2,400,000 = 1.1206

5. Conflict occurs primarily because of the difference in the size of the initial investment (scale difference).

6. NPV profiles of these projects



7. Based on the NPV profiles, you would choose to renovate since the NPV is greater at a discount rate of 15%.

8. Based on the NPV profiles, you would choose to replace since the NPV is greater at a discount rate of 25%.

9. The following things should be considered when evaluating projects.
   - What is the appropriate discount rate?
   - Are the alternative projects mutually exclusive?
   - Is there is scale difference?
   - Can the projects be repeated?
   - Is there a significant difference in timing of cash flow?
   - Are the projects of different length?