Chapter 18

Capital Budgeting

Learning Outcomes

Upon completion of this chapter, you will be able to:

1. Identify business situations for capital budgeting decisions.

2. Determine the significance of cash flows and the time value of money in the capital budgeting process.

3. Calculate the net present value and the internal rate of return, and understand the difference between the two.

4. Identify the various components of the cost of capital (such as cost of debt, cost of equity) and demonstrate how it is calculated.

5. Explain the concept of the weighted cost of capital and be able to calculate it in different business situations.

6. Use the different earnings valuation models (Price-Earnings model, Capital Asset Pricing Model).

Preview

In Part 1 through Part 3 of the book we were preoccupied with finding the appropriate techniques whereby a firm is able to maximise its performance (profits or revenues) within the limits of its existing resources, in other words, subject to the constraints it faces (internal constraints and market/competition constraints). In this chapter we will look into the dimensions of how a firm may be able to expand its resources (its productive capacity). Necessarily then we are looking into the long run. We are in the planning horizon of the firm.

Capital budgeting (or long-term investment analysis) is the process of planning for the purchase of productive resources (building, expanding or re-engineering the productive capacity of the firm) so as to yield a desired income stream (cash flows) that extends into the long run. In this chapter we will examine the factors that a firm needs to take into consideration in planning capital expenditures: the present value of the future cash flows, the risk of realisation of these cash flows, the cost of capital and other factors. In addition, we will discuss techniques for adjusting for risk in deriving the net present value, such as the risk-adjusted discount method and the various valuation methods, such as the dividend discount model and the capital asset pricing model.

If these topics sound familiar to finance students it is because capital budgeting draws extensively on concepts taught in finance courses. But, capital budgeting is very relevant for managerial economics and applied microeconomics. Recall that in the previous sections of the book we frequently came across decisions that firms needed to make to enhance their long-run productive capacity. Incremental and marginal analysis was extensively used, and we will be using variants of these concepts here for capital budgeting.
Business Situations for Capital Investments

Any time a firm decides to replace, expand, or modernise its productive assets (its technological base, its plant) in order to increase/enhance its productive capacity it incurs a capital expenditure. A capital expenditure is a cash outlay, which is expected to generate a future stream of benefits (financial and non-financial, direct and indirect, measurable and non-measurable) over the long-term. These capital expenditures may be needed for a firm to cope with a number of different business situations such as:

- Expanding demand for the firm’s products may require new production facilities and/or new sales outlets, or the setting up sales operation in foreign markets, or an entirely new marketing/promotions campaign, etc.

- To introduce modern ICT systems (such as ERP, SCM, or CRM), to improve operational efficiency and make it possible for the firm to reduce its average cost of production.
  - Related to this situation, the firm’s capital expenditure would be different, under different options: Buy (Build) or Lease the necessary capital equipment (or buildings)? Though leasing may be the more expensive long-run option, it is frequently the only option for “cash-poor” firms, or for firms with limited access to long-term funding.

- To facilitate the production and distribution of innovative products requiring new technology (such as the Internet and multimedia technology).
  - Related to this situation, the firm’s capital expenditure would be different under different decision: Make or Outsource (Subcontract)? To make the product the firm may require a substantial cash outflow, whereas if it out sources (subcontracts) the production of the good (or parts thereof), the cash outlay is not made. Recall that we discussed the option of outsourcing in Chapter 9 as a cost minimisation strategy of modern enterprises.

- To conform to new regulations and legal restrictions. This is a very real situation for many Cypriot companies facing the new strict EU regulations pertaining to health and safety at the place of work as well as broader environmental factors and regulations. These legal factors require manufacturing firms to install safety equipment and emission control devices at their manufacturing plants.

Given the many situations where a firm incurs capital expenditures and the frequently large sums of capital outlay required, it is obvious that managing the capital expenditure process is critical not only for the short-run viability of the firm (its ability to absorb the financial burden) but more importantly for its long run profitability and growth potential.

Capital Budgeting

Capital budgeting (or long-term investment analysis) is the process of planning for and evaluating any of the above situations to impact on the productive resources of the firm (building, expanding or re-engineering the productive capacity of the firm) so as to yield a desired income stream (cash flows, or cost savings) that extends into the long run. The expenditure outlay may be a once-off expenditure at the beginning of the project, or may be incurred over a period of 2-3 or more years, depending on the nature of the project and the financing conditions arranged with the provider/vendor (in the case of a machinery), whereas the inflows start at some future date at the completion and full implementation of the project. It should be noted that the benefits (inflows) may be in the form of cost savings. Capital budgeting may be used also in planning non-capital expenditures, such as expenditures in human resources (staff training), research and development expenditures, new product/market launches, mergers and acquisitions, etc.

---

1 Recall from our discussion in Chapter 8 that the long run is not determined by a calendar time period, but is specific to the nature of the activity and is determined by the time required for the firm to vary all inputs in order to change its productive capacity. As such, it could be one month for a photocopy centre, or 5 years for a power plant. In this chapter, however, for simplicity’s sake, we will arbitrarily consider that cash flows extending beyond one year are in the long run.
Capital Budgeting

Capital Budgeting is the process of determining (or ranking) whether investment project(s) should be accepted and whether investment funds should be allocated by the firm.

Case Study 18.1: Aeolos Travel: Capital Budgeting for an ERP System

This Case Study is a real example of capital budgeting: the planning of capital expenditure of €1 million out-of-pocket expenditure by Aeolos Travel for their Oracle Financials ERP system. Let’s first provide some background information.

AEOLOS Travel was founded in 1933, and was one of the pioneers in the Travel and Tourism sectors, a tradition the Company maintains until today. Under the umbrella of AEOLOS there are a number of core activities: incoming and outgoing air and sea travel, airport ground handling, cargo clearing and forwarding, hotel accommodation, hotel investment and management, inland transport, sightseeing excursions & tours, and conference organising and incentive tourism.

Up until 1999, AEOLOS’ computer information system consisted of a number of independent software systems each built around and satisfying the different functional areas of managing the business (Accounting, Sales, Cargo/Logistics, Travel Reservations/Ticketing, Airport Operations/Invoicing, etc.). These systems were not inter-operable. Data was locked within “functional silos” and were unable to support processes that cut across strategic business units (SBUs). In view of these limitations, in 1999 the Company initiated a search for technology solutions that could streamline its internal processes, lower costs of operations, and strategically position the company to take advantage of new value-added processes. The Company was looking for a flexible and expandable Enterprise Resource Planning (ERP) 

The Company decided to go with the Oracle Financials option as the one that more closely matches the needs of the Company. The entire Oracle Financial System, with the interfaced third-party sub-systems, is in operation since 2000. In the words of Director of Finance, George Ioannou, “we have become much more efficient. We deliver all the same services as before, plus a number of new ones, to our clients faster, and we use fewer resources. Operationally, we are able to better integrate our

---


3 ERP is a structured approach to optimising a company’s value chain. Decomposing the words for Enterprise Resource Planning (ERP), one can explain/define ERP as follows:  
- **Enterprise**: single enterprise-wide view of corporate data  
- **Resource**: consolidated, connected access to corporate resources  
- **Planning**: improved, forward-looking view of corporate goals

database, and are able to access that data in a timely manner for making mission-critical business decisions.”

For confidentiality reasons we report in this case that the entire Oracle solution cost AEOLOS 1 million Cyprus pounds. This is out-of-pocket expenditure, without counting the opportunity cost of time of the management and project / steering teams and the many hours devoted to the training of personnel. This is a very considerable investment given the size of operations of AEOLOS. Yet, the Managing Director views this as an investment well worth the expenditure and corporate effort: “We are a forward looking company, with a long-range planning horizon. We have been in this business for a long time and we intend to be pioneers for many decades to come. We view spending on technology as an investment, in much the same way we view investments in new product / services, new distribution systems and branch networks /outlets.”

Case Study Questions
1. What motivated Aeolos Travel to incur a capital expenditure by implementing an ERP system?
2. What elements of capital budgeting did Aeolos Travel manage or did not manage well?
3. Using only information provided in the case (quantitative and qualitative), determine whether at a discount rate of 12% the net present value of the project is positive or negative.

The Capital Budgeting Process

The basic concept in evaluating capital expenditure projects resembles the concept of marginal analysis employed in the chapters of Part 4 to evaluate a firm’s short run output and price decisions. Recall that the basic rule that we accepted was that the firm should go ahead with increasing output (and, by extension, employing more inputs/resources) as long as the additional benefits from the decision exceed the additional costs. We have concluded in Part 4, that irrespective of the market environment (market structure) the firm’s optimum output level (in order to maximise profits) is where marginal revenue (the additional benefits derived from an additional unit of output) is exactly equal to marginal cost (the additional costs incurred from an additional unit of output).

Figure 18.1: A Simplified Capital Budgeting Process for Aeolos ERP Project
The same principle applies in capital budgeting as well. In other words, if we assume a situation where a firm is faced with a number of alternative investment options (each with its respective initial cost outlay and its associated income stream potential over a number of years), then the firm should keep undertaking additional investment projects as long as the benefits (returns) outweigh the fully allocated (full opportunity) costs. The firm should stop only at the point where the marginal returns are exactly equal to the marginal cost. The schedule of returns of alternative projects represents the firm’s demand for capital, whereas the schedule of additional financing costs required for alternative projects represents the firm’s marginal cost of capital. The firm will invest so much capital for investment projects as determined at the intersection of the marginal cost of capital curve and the demand for capital (or investment opportunity) curve.

If we assume that Aeolos or any other company has an infinitely large number of prospective projects under investigation at each point in time (which of course is not realistic), we could draw the MCC curve and the demand for capital curves as continuous smooth curves as in Figure 18.2. The conclusion remains crudely the same. The total sum of money invested is determined at the intersection of the two curves, and all projects up to that point should be undertaken because the marginal benefit exceeds the marginal cost of each project.

**Figure 18.2: A Continuous Capital Budgeting Case for Aeolos ERP Project**

<table>
<thead>
<tr>
<th>Rate of Return (%)</th>
<th>Marginal Cost of Capital (MCC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Demand for Capital

Phase I

Phase II

Phase III

Capital Expenditure (€million)

0.8

1.0

1.5

Case Study 18.2: Capital Budgeting Process of Aeolos

We use the case study of Aeolos Travel to demonstrate the capital budgeting process in Figure 18.1. Aeolos divided the ERP project in three phases and considers each phase as a different project, each requiring separate financial decisions. The financing costs (marginal cost of capital) are represented in Figure 18.2 by the “smooth” Marginal Cost of Capital curve, which is basically a “smoothed” curve of the step-wise “scaled” MC shown in Figure 18.1. From the MCC curve, we see that the average cost for financing Phase I is estimated to be around 8%, that for Phase II at around 9%, while for Phase III it is around 12%.

The expenditure outlays (cost) to Aeolos for Phase I was €800,000. Recall that in Phase I (the basic ERP module of Oracle Financials) the Company was seeking to consolidate and integrate the financial/accounting management side of the operations. Interpreting the claims of the Finance

---

4 Recall that as noted in the case, these figures are reported for the sake of the case study in order to protect the confidentiality of the Company’s data. The figures may or may not represent reality.
Director of Aeolos about significant improvements in efficiency, let’s determine that the cost savings are 15%. Phase II was the installation of an E-Commerce module (at a cost of €200,000) in order to improve sales, customer service and operations planning. This improvement is valued at 10% of the investment cost. Finally, in Phase III, the Company hoped to provide end-to-end supply chain integration. The additional cost was €500,000 and the benefits are forecasted to be 8% of the capital expenditure for this Phase.

Questions:
1. Should Aeolos undertake the ERP project?
2. Up to what phase it should proceed?

Recall that the decision rule is: proceed with a capital expenditure as long as the marginal benefits exceed the marginal cost. Since the estimated return of Phase I, in terms of efficiency improvements, is 15%, the company should go ahead with this first Phase of the project. Additionally, since the estimated return of Phase II is 10% while the additional financing costs are 9%, the Company should go ahead with this Phase as well. But, for Phase II, the company is facing increased financing costs (12%) while the marginal benefits are estimated to be 8%. In this situation the Company should not proceed with the implementation of Phase III.

Projecting Cash Flows

One of the simplifying assumptions we made in the above capital budgeting model (as we frequently did in first introducing new economic concepts and economic models) is that the management of Aeolos knows the return of each Phase of the Project. Life, however, is not that simple. Actually, estimating the net cash flows (revenue inflows or their equivalent of cost savings) from a project is the most difficult aspect of capital budgeting.

Net Cash Flow: We can define net cash flow as the sum of inflow of receipts over the life of the project minus the initial costs (and subsequent costs, if any) of the project. Inflows are measured on an incremental basis, in other words, as the difference of cash flows prior to and after the project.\(^5\)

Case Study 18.3: Cash Flow of ERP system for Aeolos

In the case of Aeolos, we will assume that both outlays occurred in the first year, and the Oracle Financials module has an operational life of five years. At the end of this period the firm’s operations are at an entirely new level requiring a new system or a major update of the existing one, which can be considered as an entirely new project. We assume that the firm may be able to sell the system at the end of the fifth year to another company for €250,000. Taking into consideration these cash outlays, the net cash flows (in terms of cost savings) and the salvage value of the ERP system at the end of the fifth year, we estimate the following cash flow from the project as presented in Table 18.1.

Notice that the cost savings in the first year are negative, considering the significant training costs (and opportunity of time lost) and perhaps the loss of efficiency in navigating from the old system to the new. Subsequently the cost savings are positive and assumed to increase with each successive year as automation allows the firm to get lower and lower on its learning curve. In the fifth year the net cash flow include the cash inflow from selling the system to another company.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>- €50,000 (loss)</td>
</tr>
</tbody>
</table>

\(^5\) Recall that in economic terms, profits are approximated by net income before tax (NIBT). From an accounting perspective, we can define net cash flows as the tax-adjusted economic profits (or net income after tax, NIAT) plus the depreciation allowance.
<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>200,000</td>
</tr>
<tr>
<td>3</td>
<td>350,000</td>
</tr>
<tr>
<td>4</td>
<td>450,000</td>
</tr>
<tr>
<td>5</td>
<td>750,000**</td>
</tr>
</tbody>
</table>

* Data are hypothetical after-tax cost savings. They allow for the equipments’ depreciation.
** The regular cost saving as in the previous year plus €250,000 as the salvage value of the ERP system (equipment plus software).

With this information, should the Finance Director recommend to the Managing Director to go ahead with the project or not, taking into consideration the cost of the project of €1mil. (€800K in the first year and €200K in the 5th year)?

### Time Value of Money

To answer this question, we need a method to adjust the cash flows presented in Table 18.1 for the fact that money received in the future does not have the same value in the present period, the period when the firm paid out the capital expenditure. Since the timing of inflows (returns from an investment) and the capital outlay may not (and usually are not) synchronous, individuals and business managers must recognise that the “true value” of a sum of money received today is not the same as the same nominal sum received at some point in time in the future. This, of course, has to do with the opportunity cost of money. This opportunity cost reflects the time value of money.

Due to the time value of money (examined in Chapter 17), future sums of money are worth less in the present. We need, in other words, a method to calculate the present value of these futures cash flow in order for Aeolos to compare them with the cash outlay represented by the €1 million spent on the project. One such method is the Net Present Value (NPV). The NPV concept relies on the concept of present value analysis. We discussed fairly extensively the present value concept in Chapter 17. We briefly repeat here the key points of the time value of money and present value concepts.

### The Present Value

The present value concept is the inverse of the future value. If we want to find the present value of a sum of money to be received in some future time, then we apply the present value formula, which is:

\[
PV = \frac{FV}{(1+r)^t}
\]

where

- \( PV \) = present value
- \( FV \) = the expected future sum of money
- \( t \) = is the period in the future that the future sum is received
- \( r \) = the discount rate (usually adjusted for a risk factor)

For example, if you expect to receive €1,000 in five years from now, obviously its present value (what it is worth today) is much less. In fact, applying the PV formula this is shown below to be just €620.90.

\[
PV = \frac{1000}{(1+0.10)^5} = \frac{1000}{1.0000} = 620.90
\]

\[\text{The future value formula is:} \]

\[
FV = \sum_{i=1}^{n} PV(1+r)^i
\]

\[\text{6 The future value formula is:} \]
The generalised formula for the present value of all expected future cash flows or returns from an investment (whether an individual’s portfolio investment or a firm’s investment in a business project) is given by:

\[ PV = \sum_{t=1}^{n} \frac{FV_t}{(1 + r)^t} \]

**Example 18.1: Present Value of a Stream of Cash Flows**

Consider the case of an individual being approached by a financial consultant to invest €10,000 in a portfolio of stocks listed on the Cyprus Stock Exchange. He is told that there would be a stream of dividend flows over the next 5 years as shown in the second column of Table 18.2.

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Dividends</th>
<th>PVIF</th>
<th>PV of each Dividends</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>€500</td>
<td>0.9091</td>
<td>€454.55</td>
</tr>
<tr>
<td>2</td>
<td>600</td>
<td>0.8264</td>
<td>495.84</td>
</tr>
<tr>
<td>3</td>
<td>750</td>
<td>0.7513</td>
<td>563.48</td>
</tr>
<tr>
<td>4</td>
<td>1,000</td>
<td>0.6830</td>
<td>683.00</td>
</tr>
<tr>
<td>5</td>
<td>750</td>
<td>0.6209</td>
<td>465.68</td>
</tr>
<tr>
<td>Cash out</td>
<td>11,000</td>
<td>0.6209</td>
<td>6829.90</td>
</tr>
</tbody>
</table>

\[ \text{Present Value of Investment} = \sum PV_i = €9,492.45 \]

A financial consultant tells the investor that he would be able to sell the portfolio at the end of the fifth year for €11,000. Assume that the current interest rate is 10% and it is expected to remain constant for the whole period. Is that a good investment? Should the investor go ahead? At first sight one may hastily decide that since there is some income and at the end the investor recovers his initial investment plus there is a “profit” of €1,000, he may be inclined to go ahead with the investment? Should he?

To answer such questions one would need to find out the present value of the future dividend flows and the cashing-out sum (the «salvage value» of the investment) of €11,000? The calculations of the present value of each dividend stream over the five years and the sum collected from selling the portfolio are presented in the last column of Table 18.2. Notice that the numbers of the third column are the present value interest factors (PVIF), which are found in present value interest tables such as Appendix 1 at the end of the book. So, when all is said and done, the present value of the investment (€9,492.45) is less than the sum of money that the investor would be putting down (€10,000). The investor should not invest in this portfolio, which anyhow carries a lot of risk as far as the realisation of those expected returns. He is better off investing in the risk-free (or at least lower-risk) money market earning 10%.

**The Net Present Value (NPV)**

We extend now the concept of the present value of future cash flows to discuss the concept of net present value (NPV). Essentially, to determine the NPV of a project we compare the discounted present value of the future returns (the benefits from the project in terms of additional revenues or cost savings) with the cost of the project (the capital expenditures) so that we are in a position to decide whether to undertake a project or not. The formula for the net present value is given by:

\[ NPV = \sum_{t=1}^{n} \frac{R_t}{(1 + r)^t} - C_0 = \sum_{t=1}^{n} \frac{1}{(1 + r)^t}R_t - C_0 \]
where \( R_t \) is the estimated net cash flows as presented in Table 18.1, \( C_0 \) is the initial cost outlay\(^7\) for the project (€1 million in the case of Aeolos), and \( r \) is the risk-adjusted discount rate. Notice that the expression \( 1/(1+r)^t \) is the present value interest factor (PVIF) that we find in the statistical tables for the present value. For example the PVIF for one year at 10% interest rate (or discount factor) is 0.9091 (see Appendix 1). This means that the present value of €1.0 received in one year at 10% is 90.91 cents. The reverse should be obvious to you. In other words, 90.91 cents compounded at 10% would be worth €1.0 next year.

Overall, the decision rule is:
- If the NPV is positive the firm should go ahead and undertake the project
- If the NPV is negative the firm should not undertake the project

**Advantages and Disadvantages of NPV:**
We summarise below the advantages and disadvantages of the NPV as a project evaluation method:

<table>
<thead>
<tr>
<th>Advantages of NPV</th>
<th>Disadvantages of NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Considers the time value of money.</td>
<td>• Difficult to compute.</td>
</tr>
<tr>
<td>• Considers all cash flows (before and after the life of the project).</td>
<td>• Cannot give accurate decision for:</td>
</tr>
<tr>
<td>• Considers the profitability and risk of the projects (by using the risk-adjusted cost of capital).</td>
<td></td>
</tr>
</tbody>
</table>
  ➢ mutually exclusive projects with equal investment cost. |
| • Provides information whether the project will increase the value of the firm. |  
  ➢ projects of unequal life. |
| | • Difficult to determine the appropriate discount rate. |
| | • Shows results in values not percentages. |

**Case Study 18.4: NPV of Aeolos ERP System**
Let’s calculate the NPV of the ERP system of Aeolos. We present in Table 18.3 the projected net cash flows and the €1m. capital outlay. We assume that the risk-adjusted discount rate is 10%.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow, ( R_t ) (€)</th>
<th>10% PVIF*</th>
<th>Present Value (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1,000,000 (initial cost)</td>
<td>1.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>1</td>
<td>-50,000 (loss)</td>
<td>0.9091</td>
<td>-45,455</td>
</tr>
<tr>
<td>2</td>
<td>200,000</td>
<td>0.8264</td>
<td>165,280</td>
</tr>
<tr>
<td>3</td>
<td>350,000</td>
<td>0.7513</td>
<td>262,955</td>
</tr>
<tr>
<td>4</td>
<td>450,000</td>
<td>0.6830</td>
<td>307,350</td>
</tr>
<tr>
<td>5</td>
<td>750,000</td>
<td>0.6209</td>
<td>465,675</td>
</tr>
</tbody>
</table>

\[
NPV = \sum_{t=1}^{n} \frac{R_t}{(1+r)^t} - C_0
\]

\(*\text{Present value interest factor (PVIF)} = \frac{1}{(1+r)^t}.*

In other words, the calculations for calculating the NPV are the following:

\[
NPV = \sum_{t=1}^{n} \frac{R_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}
\]

\(^7\) It should be emphasised here that it is only for simplicity’s sake that we are assuming that capital outlays occur once off. In reality, the cash outflows may occur over a number of years, just like the cash inflows. In that case, both the inflows and cost outlays are discounted to the present and the NPV formula is modified to account for this:
NPV = [(0.9091\times -50,000) + (0.8264\times 200,000) + (0.7513\times 350,000) + (0.6830\times 450,000) + (0.6209\times 750,000)] - 1,000,000
= (-45,455 + 165,280 + 262,955 + 307,350 + 465,675) - 1,000,000
= €1,155,805

By undertaking the project, Aeolos would add €155,805 to the value of the firm. If the risk-adjusted discount rate were 8%, the NPV would be larger (around €215 thousand). Can you verify this? Should Aeolos undertake the project if the discount rate is 15%? Should Aeolos undertake the project if there is no salvage value for the ERP system (a likely scenario given the pace of obsolescence of ICT systems)?

### Capital Rationing and the Profitability Index (or Present Value Ratio)

Although the NPV method is a good method for evaluating individual projects, businesses may face a decision problem when they have to choose among a number of mutually exclusive investment opportunities, all of which may have positive, or even equal, NPV. A fact of life is that businesses are faced with a number of constraints, the main one of which may be the availability of, and access to, investment funds, making it impossible for firms to undertake all available projects with positive NPV. So firms need to choose how to allocate (how to ration) these capital funds to maximise total return and the overall value of the firm. The level of required financing of each project is an important consideration. The source of financing also becomes an issue.

For instance, a large project may be promising, but overleveraging a firm with borrowed funds (if long-term equity or debt financing is not possible) to finance it may create problems of repayments in the future. So a firm may have to settle for a smaller project of lower NPV. Although our focus here is on capital budgeting, in reality there may be situations that the binding constraint may not be financing per se, but the lack of technical expertise on the new venture, inappropriate internal managerial and operational set up to cope with fast expansion that may result from investment projects, or perhaps resistance to change.

So, how do firms evaluate alternative investment projects of unequal size in order to ration the available capital funds? One method for capital rationing in complex capital budgeting situations is the profitability index or present value ratio (PI), also known as benefit-cost ratio, which can be expressed as:

\[
PI = \frac{\sum_{t=1}^{n} \frac{R_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}
\]

Notice that if the capital outlay is a lump sum in the current period then the denominator simply becomes \(C_0\). It should be apparent to you that the \(PI\) for projects with positive NPV should be greater than 1. So in terms of the NPV concept, projects with \(PI > 1\) should be accepted. The value of the \(PI\) indicates the proportionate return in cash inflows (in present value terms) of a Euro spent on the project. For example a value of 1.5 indicates that the project returns €1.5 for each €1.0 spent. The \(PI\) method allows firms to rank the alternative projects according to their relative profitability. The decision rule is that the firm should undertake those projects with the highest \(PI\), until the available funds are exhausted. Thus, projects with smaller absolute NPV may be preferred over larger projects.

**Advantages and Disadvantages of Profitability Index:**

We summarise below the advantages and disadvantages of the PI as a project evaluation method:
### Advantages of PI

- Provides information whether the project will increase the value of the firm. It helps in maximising the value of the firm.
- Is useful in cases of capital rationing (by ranking projects).
- Considers the time value of money.
- Considers all cash flows (before and after the life of the project).

### Disadvantages of PI

- Cannot give accurate decision for mutually exclusive projects with unequal investment cost.
- May not be easy to understand.
- Requires the use of a measure of the cost of capital.

---

**Example: Net Present Value vs. Profitability Index**

In Table 18.3 we present hypothetical data for three projects. The NPV of Project A is €1 million, whereas those for Project B and C are €800,000 and €600,000, respectively. Using the NPV method, the firm is more likely to select Project A because it has the highest absolute NPV. But, using the profitability index (PI), the firm gets the best relative profitability from Project C, followed by Project B. Thus, the firm’s would add more to its overall value by using the €4 million on Projects C and B, rather than on Project A.

**Table 18.3: NPV and Profitability Index**

<table>
<thead>
<tr>
<th></th>
<th>Project A</th>
<th>Project B</th>
<th>Project C</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV of Net Cash Flows (€ million)</td>
<td>5.0</td>
<td>3.2</td>
<td>2.2</td>
</tr>
<tr>
<td>PV of Cost of Project (€ million)</td>
<td>4.0</td>
<td>2.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Net Present Value (NPV) (€ million)</td>
<td>1.0</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Profitability Index (PI)</td>
<td>1.25</td>
<td>1.33</td>
<td>1.38</td>
</tr>
</tbody>
</table>

---

**The Internal Rate of Return**

Another method of deciding whether a firm should undertake a certain project is the internal rate of return (IRR) of the project. The IRR expresses the expected rate of return of a project based on its investment cost (its opportunity cost of capital). The IRR is that interest rate which makes the PV of the cash flows of the project equal to the cost of the project. This method determines the risk-adjusted discount rate or cost of capital (r*) that would make the present value of the net cash flows (the first expression in the NPV formula) equal to the cost of the project (C₀), which is the second part of the NPV formula. Specifically, the formula for the IRR is:

$$ IRR = \sum_{t=1}^{n} \frac{R_t}{(1 + r^*)^t} - C_0 = 0 $$

**Decision Rule:** Accept if IRR > r (opportunity cost of capital).  

In other words, the firm should proceed with a project whose IRR is equal to or larger than the marginal cost of capital (or risk-adjusted discount rate used by the firm).

The IRR can be found easily by using a financial/business calculator or a computer spreadsheet function (such as Excel). If these are not available, then one can use a trial and error iterative process, whereby different values for the discount rate are used from Appendix 1 to find the discount factor that makes the NPV equal to zero. Let’s use the hypothetical cash flow data for AEOLOS Travel used in Example 18.2 to demonstrate how we find the IRR. Recall that in Example 18.3 we found that at 10% interest rate (discount factor) the NPV was €155,805 (reproduced in Table 18.4 as one of the interest factors in the trial and error method).
**Table 18.4: Calculation of IRR (using the trial-and-error process)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow, $R_t$ (€)</th>
<th>10% PVIF*</th>
<th>10% Present Value (€)</th>
<th>15% PVIF*</th>
<th>15% Present Value (€)</th>
<th>14% PVIF*</th>
<th>14% Present Value (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1,000,000</td>
<td>1.0000</td>
<td>-1,000,000</td>
<td>1.0000</td>
<td>-1,000,000</td>
<td>1.0000</td>
<td>-1,000,000</td>
</tr>
<tr>
<td>1</td>
<td>-50,000 (loss)</td>
<td>0.9091</td>
<td>-45,455</td>
<td>0.8696</td>
<td>-43,480</td>
<td>0.8772</td>
<td>-43,860</td>
</tr>
<tr>
<td>2</td>
<td>200,000</td>
<td>0.8264</td>
<td>165,280</td>
<td>0.7561</td>
<td>151,220</td>
<td>0.7695</td>
<td>153,900</td>
</tr>
<tr>
<td>3</td>
<td>350,000</td>
<td>0.7513</td>
<td>262,955</td>
<td>0.6575</td>
<td>230,125</td>
<td>0.6750</td>
<td>236,250</td>
</tr>
<tr>
<td>4</td>
<td>450,000</td>
<td>0.6830</td>
<td>307,350</td>
<td>0.5718</td>
<td>257,310</td>
<td>0.5921</td>
<td>266,445</td>
</tr>
<tr>
<td>5</td>
<td>750,000</td>
<td>0.6209</td>
<td>465,675</td>
<td>0.4972</td>
<td>372,900</td>
<td>0.5194</td>
<td>389,550</td>
</tr>
<tr>
<td></td>
<td><strong>NPV = \sum_{t=1}^{n} \frac{R_t}{(1+r)^t} - C_0</strong></td>
<td></td>
<td><strong>155,805</strong></td>
<td></td>
<td><strong>-32,305</strong></td>
<td></td>
<td><strong>2,285</strong></td>
</tr>
</tbody>
</table>

*Present value interest factor (PVIF) = 1/(1+r)^t.*

So, when the interest rate is 10%, the NPV is positive. When we use an interest rate of 15% the NPV becomes negative. Continuing in this trial and error process, the NPV approaches zero when we use an interest rate of 14%. We can conclude, therefore, in this example, that the IRR is slightly above 14% since to get a NPV of zero we need to increase the discount factor slightly higher than 14%. Of course, using a financial calculator (or the IRR worksheet function of Excel) we can determine that the IRR is about 14.1 (14.06% to be exact).

Now that we have demonstrated the concept of IRR and the intuitive “trial-and-error” process for finding it, let’s use a practical formula to find the exact value of IRR:

$$IRR = r_L + \left( \frac{NPV_H}{NPV_H - NPV_L} \right) (r_H - r_L)$$

where:

- $r_L$ = the lower discount rate chosen (10% in Table 18.3)
- $r_H$ = the higher discount rate chosen (15% in Table 18.3)
- $NPV_L$ = the net present value using the lower discount rate (155,805 in Table 18.3)
- $NPV_H$ = the net present value using the higher discount rate (-32,305 in Table 18.3)

Now let’s apply the formula to the hypothetical data in Table 18.3:

$$IRR = 10 + \left( \frac{155,805}{155,805 - (-32,305)} \right) (15 - 10) = 10 + (0.828)(5) = 10 + 4.1 = 14.1$$

We verify, in other words, that the IRR is 14.1% as found by the iterative process followed in Table 18.4. This is also shown graphically in Figure 18.3, where we graph the **NPV profile**.

We identify here two important properties of the NPV profile: The point at which the NPV profile intersects:

- the vertical axis is the sum of undiscounted cash flows (here it is €700, 000).
- the horizontal axis is the IRR (indicating that the NPV=0 or that the IRR = 14.1%).

---

8 In the fx formula function of Excel [IRR(values,guess)] for “values” identify the cells of the array of cash flows for which you want to calculate the IRR. Enter the initial cost as a negative number in year 0. Make sure you put the right values in the right order (year). For “guess” in the formula provide a number which you believe is close to the IRR. However, even if guess is omitted, Excel will calculate the IRR by assuming that guess is 0.1 (10%).
Advantages and Disadvantages of IRR:
We summarise below the advantages and disadvantages of IRR as a project evaluation method:

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Being a return to investment, IRR is intuitively appealing to firms’ managers.</td>
<td>• Difficult to compute.</td>
</tr>
<tr>
<td>• It easily provides to managers the value of a project.</td>
<td>• Requires the use of a measure of the cost of capital.</td>
</tr>
<tr>
<td>• Considers the time value of money.</td>
<td>• Not appropriate for comparing mutually exclusive projects.</td>
</tr>
<tr>
<td>• Considers all cash flows (before and after the life of the project).</td>
<td>• Not appropriate for evaluating projects in case of capital rationing.</td>
</tr>
</tbody>
</table>

Payback Period

The payback period method is another method for evaluating investment projects. It seeks to calculate the time needed for the estimated annual cash flows to cover the capital expenditure for the project. It differs from the other methods / models examined in the previous sections because it does not take into consideration the time value of money. By definition, it does not take into consideration the cash flows that logically are expected to materialise after the project has recovered its capital cost. As such it is considered a naive method.

Yet, it is used quite extensively because of its simplicity, although it must be said that it is being used in addition to the other methods analysed in this chapter. It offers a good picture of the possibility of the project to make cash inflows for a number of years. Although not explicitly taking into consideration the time value of money, it can be said that indirectly and in a sense it does so since it assesses the period during which the capital invested is “at risk”. The shorter the period of capital recovery is the safer the investment. Generally, projects with payback period of more than 7-8 years are considered risky by investors or of poor performance.

The formula for determining the payback period (PBP), when the cash flows are uneven, is:

\[
PBP = \left(\text{Year before full recovery of initial cost}\right) + \frac{(\text{Unrecovered cost at beginning of year})}{\text{Cash flow during year}}
\]

\[
9 \text{ Obviously, if the cash flows are equal in each year the formula is simply: } PBP = \frac{\text{Cost of Investment}}{\text{Annual cash flow}}
\]
Advantages and Disadvantages of Payback Method:
We summarise below the advantages and disadvantages of the Payback method as a project evaluation method:

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Easy to understand.</td>
<td>• Ignores the time value of money.</td>
</tr>
<tr>
<td>• Provides a measure of liquidity.</td>
<td>• Uses an arbitrary cut off point.</td>
</tr>
<tr>
<td>• Provides some information about risk of project.</td>
<td>• Ignores cash flows beyond the payback point.</td>
</tr>
<tr>
<td></td>
<td>• Ignores the risk of cash flows beyond payback date.</td>
</tr>
</tbody>
</table>

Example 18.5: Payback Period for ERP system of Aeolos Travel
Again we use the example of Aeolos Travel and the capital investment in the company's ERP system that we used in the calculations of NPV and the rate of IRR. Since this method ignores the time value of money, we are not interested in the present value of the future cash flows, rather only for the actual cash flow in the nominal value of each period. In Table 18.5 we use the same cash flows in Column 2, while in Column 3 we calculate the cumulative value of the cash flows.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flows $R_i$ (€)</th>
<th>Cumulative Value $\Sigma R_i$ (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1,000,000</td>
<td>-1,000,000</td>
</tr>
<tr>
<td>1</td>
<td>-50,000</td>
<td>-1,050,000</td>
</tr>
<tr>
<td>2</td>
<td>200,000</td>
<td>-850,000</td>
</tr>
<tr>
<td>3</td>
<td>350,000</td>
<td>-500,000</td>
</tr>
<tr>
<td>4</td>
<td>450,000</td>
<td>-50,000</td>
</tr>
<tr>
<td>5</td>
<td>750,000</td>
<td>800,000</td>
</tr>
</tbody>
</table>

**PAYBACK PERIOD** 4 years and 1 month (approx.)

Applying the formula we get: $PBP = 4 + \frac{50,000}{750,000} = 4.067$. We see that Aeolos will need 4 years and 0.067 of one year (or 24 days) to fully recover its initial capital expenditure of €1.0 million. Graphically, the payback period is also shown in Figure 18.4 and the curve of cumulative cash flow $\Sigma R_i$ (in € '000) which crosses the horizontal axis (that is, zero) just right of 4 years.

**Figure 18.4: Cumulative Cash Flows Curve for Aeolos Travel**
Example 18.6: Comparison of Payback Period for two Projects

Let’s suppose that there are two investment projects A and B with the following cash flows as shown in Table 18.6:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flows for Project A (€)</th>
<th>Cumulative Cash Flows for Project A (ΣR_A) (€)</th>
<th>Cash Flows for Project B (€)</th>
<th>Cumulative Cash Flows for Project B (ΣR_B) (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-20,000</td>
<td>-20,000</td>
<td>-50,000</td>
<td>-50,000</td>
</tr>
<tr>
<td>1</td>
<td>5,000</td>
<td>-15,000</td>
<td>-5,000</td>
<td>-55,000</td>
</tr>
<tr>
<td>2</td>
<td>6,000</td>
<td>-9,000</td>
<td>10,000</td>
<td>45,000</td>
</tr>
<tr>
<td>3</td>
<td>4,000</td>
<td>-5,000</td>
<td>15,000</td>
<td>30,000</td>
</tr>
<tr>
<td>4</td>
<td>7,000</td>
<td>2,000</td>
<td>20,000</td>
<td>10,000</td>
</tr>
<tr>
<td>5</td>
<td>8,000</td>
<td>10,000</td>
<td>25,000</td>
<td>15,000</td>
</tr>
<tr>
<td>6</td>
<td>10,000</td>
<td>20,000</td>
<td>30,000</td>
<td>45,000</td>
</tr>
</tbody>
</table>

As we can compute from Columns 3 and 5 in Table 18.6, the payback period for Project A is 3.3 years (i.e., 3 years and approximately 4 months) while that for Project B is 4.6 years (i.e., 4 years and about 7 months). So, the payback period for Project A is less than for Project B.

Yet, a decision in favour of Project A would be myopic and not in the interests of the firm in the long run. As shown in Figure 18.5, the slope of the cumulative cash flow for Project B, from the first year onwards is greater than the corresponding slope of Project A. The slope of the cumulative cash flows shows the profitability (net cash flow) intensity from each project (i.e., sales revenue minus costs). In this sense, the Project B is preferable, especially if the life of the project is more than five years.

Risk-Adjusted Valuation Model

Having discussed the present value model and the risk-adjusted discount rate, we can use the two concepts together to modify our valuation model for evaluating investments. We assume that a portfolio has an initial cost and a series of returns over a number of years. To evaluate the portfolio and decide whether to invest or not we need to calculate the portfolio’s net present value. Recall that the formula for the net present value is given by:
\[ NPV = \sum_{i=0}^{n} \frac{R_i}{(1 + r)^i} - C_0 = \sum_{i=0}^{n} \frac{1}{(1 + r)^i} R_i - C_0 \]

where \( R_i \) is the estimated future cash flows, \( C_0 \) is the initial cost outlay for the portfolio, and \( r \) is the risk-adjusted discount rate (as defined above). Notice that the expression \( 1/(1+r)^t \) is the present value interest factor (PVIF) that we find in the statistical tables for the present value. For example the PVIF for one year at 10% interest rate (or discount factor) is 0.9091. This means that the present value of €1.0 received in one year at 10% is 90.91 cents. If the cash flows are equal over the future time periods, then we can use the PVIF for an annuity, also found in statistical tables for the present value of annuities. For example, the PVIF for an annuity of €1.0 received over the next five years at 10% is 3.7908. This means that the five installments of €1.0 received over the next five years is worth €3.79 at present. So, an investor would decide to undertake an investment that has a positive NPV, otherwise he/she should not.

Example 18.7: Risk Adjusted Net Present Value

Assume that a portfolio is expected to have a stream of returns of €10,000 per year for the next five years. The current risk-free interest rate is 5%, but given the nature of the portfolio with its inherent risk, the investor attaches a risk premium of 10%. Thus, the risk-adjusted discount rate for the project (or required rate of return) is 15%. Looking at the present value tables for annuities, we find that the PVIF for an annuity received over five years at 15% is 3.3522. Using the NPV formula, we get

\[ NPV = \sum_{i=0}^{5} \frac{R_i}{(1 + 0.15)^i} - C_0 = \sum_{i=0}^{5} \frac{1}{(1 + 0.15)^i} R_i - C_0 = (€10,000 \times 3.3522) - €30,000 = €3,522 \]

So, the portfolio has a positive net present value, and if there are no other constraining factors the investor should proceed to invest in this portfolio. If, however the investor perceives the risk premium to be 15%, then the risk-adjusted discount rate (or required rate of return) for the portfolio is 20%. In this case the PVIF of a 5-year annuity is 2.9906. The NPV calculations then become:

\[ NPV = \sum_{i=0}^{5} \frac{R_i}{(1 + 0.15)^i} - C_0 = \sum_{i=0}^{5} \frac{1}{(1 + 0.15)^i} R_i - C_0 = (€10,000 \times 2.9906) - €30,000 = €94 \]

In this case, the individual should not invest in the portfolio since its NPV is negative.

Certainty-Equivalent Valuation Model

The certainty-equivalent valuation model uses elements of the various capital budgeting and investments evaluation methods. In contrast to the risk-adjusted discount rate valuation model, the certainty-equivalent approach adjusts the expected returns for a risk factor (the numerator of the present value formula) instead of adjusting the discount rate (the denominator of the present value formula). So the discount rate in the denominator is the risk-free rate. In other words, the valuation model becomes:

\[ NPV = \sum_{i=1}^{n} \alpha R_i - C_0 \]

where \( R_i \) represents the stream of future flows or returns from an investment project, \( C_0 \) is the initial cost outlay for the project, \( r \) is the risk-free rate, and \( \alpha \) is the certainty-equivalent coefficient. This coefficient ranges from 0 to 1 and reflects the perceived risk of realising a project’s returns. As the
value of $\alpha$ gets smaller, the risk of the project is perceived to be greater. The formula for calculating $\alpha$, is

$$\alpha = \frac{Equivalent\ -\ certain\ Return}{Expected\ Return} = \frac{R^*_t}{R_t}$$

$R^*_t$ is the sum of money that if received with certainty provides the firm or investor the same (or equivalent) benefits or perceived utility as the expected (and risky) return of the project. For example if a firm or an investor is given the option of receiving €8,000 with certainty or the possibility of receiving €10,000 from a risky investment, and the firm or investor is indifferent, then the value of $\alpha = (8000 / 10000) = 0.8$. In other words, in such a case the investor regards the certain sum of €8,000 as equivalent to the risky return of €10,000.

**Example 18.8: Certainty-Equivalent Valuation Method**

Let’s assume that a project with a once-off cost of €30,000 is expected to have a stream of net cash flows (profits or returns) of €10,000 per year for the next five years. The current risk-free interest rate is 5%. Let’s assume that $\alpha=0.8$ as just calculated above. Looking at the present value tables for annuities, we find that the PVIF for an annuity received over five years at 5% is 4.3295. Using the certainty-equivalent method the NPV of the project is

$$NPV = \sum_{t=1}^{5} \frac{\alpha R_t}{(1 + r)^t} - C_0 = \frac{0.8 \times 10,000}{(1 + 0.05)} - 30,000 = (8,000 \times 4.3295) - 30,000 = €4,636$$

The net present value is positive and fairly close to the value obtained using a risk-adjusted discount factor of 15%. If, however the firm perceives the project to be more risky and used a certainty-equivalent coefficient of 0.7, then the NPV would be

$$NPV = \sum_{t=1}^{5} \frac{\alpha R_t}{(1 + r)^t} - C_0 = \frac{0.68 \times 10,000}{(1 + 0.05)} - 30,000 = (6,900 \times 4.3295) - 30,000 = €126$$

The NPV is negative and close to the result obtained when we used a risk-adjusted discount factor of 20%.

**Study Questions**
True-False Questions

Indicate whether each statement below is true (T) or false (F) and give a brief explanation:

1)  Capital budgeting decisions are long term decisions.
2)  A decision to expand the plant size is not considered as a capital budgeting decision.
3)  Capital budgeting decisions do not take into consideration the time value of money.
4)  In situations of mutually exclusive projects, the firm can accept all feasible projects.
5)  Capital rationing is another term we use to define the capital budgeting process.
6)  In capital budgeting for investment projects, we simply compare the sum of the future benefits with the costs of the project.
7)  For capital budgeting purposes, we use future expected profits as the cash inflows of a project.
8)  A project can have a payback period of 2 years and yet have a negative net present value.
9)  The decision rule for the profitability index is different that the decision rule of the NPV method.
10) The certainty-equivalent valuation method uses risk-adjusted cash flows in the denominator.

Multiple Choice Questions

1. Capital budgeting decisions should be primarily consistent with the firm's:
   A) short-term growth of sales
   B) long range strategic plan
   C) availability of retained earnings
   D) the dividend policy

2. To carry out a proper capital budgeting process, one requires information on:
   A) the overhead costs spent for the project
   B) how the firm raises funds to finance a project
   C) the timing of the project’s net cash flows
   D) the money the firm spends on research and development

3. An increase in the interest rate,
   A) will make the present value of future cash flows more valuable
   B) will make present value of future cash flows less valuable
   C) lowers the present costs that the firm will use in capital budgeting
   D) (A) and (C)

4. When we compare the NPV and the IRR as investment evaluation methods:
   A) the IRR method is preferred because it reflects maximisation of shareholder wealth
   B) we may get different answers if the initial costs of the projects differ
   C) leads to the same decision if projects are mutually exclusive
   D) we assume in both cases that the firm can reinvest earnings at the same rate
5. If the IRR for a project is 15%,
A) the NPV is negative if the interest rate is 10%
B) the NPV is positive if the interest rate is 20%
C) the NPV is negative if the interest rate is 20%
D) the NPV is positive if the interest rate is 15%

6. The NPV, IRR and profitability index (PI) methods:
A) take into consideration the time value of money
B) use the accounting profits as a measure of the cash inflows
C) give the same ranking of mutually exclusive projects
D) all of the above

Use the following information to answer Questions 7 and 8:
A project that costs €50 million generates cash flows of €30 million in year 1 and 40 million in year 2. Assume that the interest rate is 8%.

7. The project’s NPV is:
A) €15.05
B) €12.06
C) €10.56
D) €14.25

8. The project’s profitability index is:
A) 1.08
B) 1.14
C) 1.24
D) 0.98

9. You expect to receive €12,000 today and additional 5 equal payments of €12,000 per year. If the discount rate is 5%, what is the value of these cash flows (rounded to the nearest Euro)?
A) €63,945
B) €51,948
C) €53,422
D) €72,000

10. The net present value
A) is calculated by subtracting the discounted cash inflows from the outflows
B) calculates the rate of return which leaves you indifferent in undertaking or not a project
C) leads to the same decisions as the use of the payback period
D) would suggest that we accept projects with a negative net present value

11. The internal rate of return (IRR) of an investment project
A) applies the net present value concept
B) is the interest rate that makes the net present value equal to zero
C) accepts a project if the IRR is higher than the cost of capital of the project
D) all of the above

12. The following are business situations requiring capital budgeting decisions, EXCEPT?
A) replacement of machinery
B) salary adjustments
C) new product development
D) plant expansion
13. Which of the following statements is correct regarding the payback method as a capital budgeting technique?
A) the payback method considers the time value of money
B) an advantage of the payback method is that it indicates if an investment will be profitable
C) the payback method provides the years needed to recoup the investment in a project
D) payback is calculated by dividing the annual cash inflows by the net investment

Consider the following information for Question 14:

A firm is considering choosing between projects A and B, which are mutually exclusive. Project A costs €100,000 while project B costs €200,000. The cash inflows of the two projects are shown in the table below. The cost of capital is 10% for both projects.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Inflows for A (€)</th>
<th>Cash Inflows for B (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50,000</td>
<td>100,000</td>
</tr>
<tr>
<td>2</td>
<td>50,000</td>
<td>100,000</td>
</tr>
<tr>
<td>3</td>
<td>50,000</td>
<td>100,000</td>
</tr>
</tbody>
</table>

14. Which project should the firm choose and on what justification?
A) Project A, because A's NPV > B's NPV
B) Either Project A or B, because it makes no difference which you choose because the IRR for A is identical to the IRR for B and both IRRs are greater than 10 percent, the cost of capital
C) Neither Project A nor B, because the NPV is negative for both projects
D) Project B, because B's NPV > A's NPV

15. Which methods allows firms to rank projects according to their relative value to the firm, in a capital-rationing environment?
A) the payback method
B) the profitability index
C) the internal rate of return
D) the net present value

16. The certainty equivalent rate of an investment/asset is
A) the rate that a risk-free investment/asset would need to offer with certainty to be considered equally attractive as a risky investment/asset.
B) the rate of return that a firm must earn with certainty in order to decide to finance the investment.
C) the minimum rate guaranteed by institutions such as banks.
D) (B) and (C)

Consider the following information for Question 17 and 18

A firm is considering investing in a project costing €104,000. The cash inflows of the project are shown in the table below. The cost of capital for the project is 10%, while the risk-free rate is 6%.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Inflows (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34,444</td>
</tr>
<tr>
<td>2</td>
<td>39,877</td>
</tr>
<tr>
<td>3</td>
<td>25,000</td>
</tr>
<tr>
<td>4</td>
<td>52,800</td>
</tr>
</tbody>
</table>

17. What is the net present value of the project?
A) €15,115
B) €26,798
18. Which of the following is correct concerning the project’s internal rate of return (IRR)?
A) The IRR is less than 10%
B) The IRR is greater than or equal to 10%, but less than 14%
C) The IRR is greater than or equal to 14%, but less than 18%
D) The IRR is greater than or equal to 18%

19. If the profitability index (PI) for a project is 1.15, then this means that
A) The cost of the project is less than the PV of the cash inflows of the project
B) The NPV of the project is smaller than zero
C) The project’s NPV is smaller than 1
D) The project returns €1.15 in present value for each Euro invested (cost)

Consider the following information for Question 20

A project that will cost €800,000 has the following cash inflows over the next four years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Inflows (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>250,000</td>
</tr>
<tr>
<td>2</td>
<td>250,000</td>
</tr>
<tr>
<td>3</td>
<td>200,000</td>
</tr>
<tr>
<td>4</td>
<td>200,000</td>
</tr>
</tbody>
</table>

20. What is the payback period for this investment?
A) 3.2 years
B) 3.5 years
C) 4.0 years
D) Cannot be determined from this information

Consider the following information to answer Question 21.

An investment project has the following expected cash flows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Expected cash flows (€000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>- €250</td>
</tr>
<tr>
<td>1</td>
<td>€20</td>
</tr>
<tr>
<td>2</td>
<td>€40</td>
</tr>
<tr>
<td>3</td>
<td>€60</td>
</tr>
<tr>
<td>4</td>
<td>€80</td>
</tr>
<tr>
<td>5</td>
<td>€100</td>
</tr>
<tr>
<td>6</td>
<td>€120</td>
</tr>
<tr>
<td>7</td>
<td>€140</td>
</tr>
</tbody>
</table>

21. The project’s payback period is:
A) 3.5 years
B) 4 years
C) 4.5 years
D) 5 years

22. The certainty-equivalent rate of return of an investment / asset is:
A) a sum of money equivalent to the expected value of a risky cash flow
B. a value equal to the riskless rate of return plus a risk premium  
C. the expected value of future cash flows weighted by their equivalent probabilities  
D. the risk-free net cash flow divided by its equivalent risky cash flow

23. If a risky cash flow of €50,000 is equivalent to a riskless cash flow of €25,000, then:
A) α = 0.50  
B) α = 1.00  
C) α = 1.50  
D) α = 2.00

Essays, Problems and Applications

1. What is the decision rule for the profitability index? Is this rule consistent with the decision rule of the NPV method?

2. Refer to the information used in the text for the implementation by Aeolos Travel of an ERP system. The estimated cash flows of the firm (in terms of cost savings) are provided in the table below. Data are hypothetical after-tax cost savings, allowing for the equipments’ depreciation. The net cash flow figure for the fifth year includes a €250,000 salvage (a resale) value of the system. The initial capital outlay is €1,000,000, all spent in year 0.

<table>
<thead>
<tr>
<th>Year</th>
<th>Net cash flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>-€50,000 (loss)</td>
</tr>
<tr>
<td>2</td>
<td>€200,000</td>
</tr>
<tr>
<td>3</td>
<td>€350,000</td>
</tr>
<tr>
<td>4</td>
<td>€450,000</td>
</tr>
<tr>
<td>5</td>
<td>€750,000</td>
</tr>
</tbody>
</table>

a) Calculate the firm’s net present value if the risk-adjusted discount rate is 8%.  
b) Should the firm undertake the project if the risk-adjusted discount rate is 15%?  
c) Determine whether the firm should undertake the project if the risk-adjusted discount rate is 12%, but there is no salvage value for the ERP system?

3. Consider an investment project that costs €200,000 in the current period (year 0) which has the following expected cash flows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Expected cash flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>€50,000</td>
</tr>
<tr>
<td>2</td>
<td>€50,000</td>
</tr>
<tr>
<td>3</td>
<td>€100,000</td>
</tr>
<tr>
<td>4</td>
<td>€150,000</td>
</tr>
<tr>
<td>5</td>
<td>€200,000</td>
</tr>
</tbody>
</table>

a) Calculate the NPV of the project if the discount rate is 10%.  
b) What is the NPV if the discount rate is 5%?  
c) Determine the project’s IRR.  
d) What is the project’s payback period?

4. You have the following data about the expected cash flows for an investment project:

<table>
<thead>
<tr>
<th>Year</th>
<th>Outflows (€mil.)</th>
<th>Inflows (€mil.)</th>
</tr>
</thead>
</table>

a)  
b)  
c)  
d)
a) Calculate the internal rate of return (IRR). Should the project be accepted?
b) Calculate the NPV of the Project. Should the project be accepted based on the NPV?
c) Calculate the payback period of the project.

5. A project requires an immediate cost of €5,000, and has the following uncertain returns with the associated probability of each outcome occurring as shown in the table below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Expected Return</th>
<th>Probability of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>€2000</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>€7000</td>
<td>0.5</td>
</tr>
<tr>
<td>Year 2</td>
<td>€2000</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>€4000</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>€7,000</td>
<td>0.2</td>
</tr>
<tr>
<td>Year 3</td>
<td>€2000</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>€3000</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>€4000</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>€6000</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>€7000</td>
<td>0.2</td>
</tr>
</tbody>
</table>

a) What is the expected value of the returns in Year 2?
b) What is the approximate expected net present value (rounded to the nearest Euro) of this project if the discount rate is 8%?

6. A firm is considering two mutually exclusive projects with the following cash flows. Consider that the cost of capital is 10%:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flows Project A (€000s)</th>
<th>Cash flows Project B (€000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-100</td>
<td>-100</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

a) What is the payback period for each project?
b) Calculate the NPV for each project. Which project should the firm choose based on the NPV criterion?
c) Calculate the IRR for each project. Which project should the firm choose based on the IRR criterion?

7. Solea Wines and Spirits (SWS) Ltd is considering building a new winery that is expected to yield annual profits of €420,000 for years 1 through 5, and a profit of €100,000 in year 6. The project will require an initial investment of €1,800,000. SWS's cost of capital is 10%.

a) What is SWS's expected net present value for this project?
b) Should SWS undertake this project?
c) How long would it take for SWS to recover its investment cost?
8. Intersoft Computer Engineering (ICE) is considering expanding its operations in the Middle East, which will require an investment of €750,000. The management of ICE expects that over the next five years it will have annual cash inflows of €250,000.

a) If the cost of capital is 8%, should ICE expand into the Middle East?

b) Due to the recent instability in the region and the increased business risks, the financial controller insists that the firm should require a rate of return of 10%. Should ICE expand in the Middle East?