Project Appraisal

Unit 1 Investment Appraisal Techniques I

Contents

Unit Overview

Units 1 and 2 focus on the *investment appraisal* techniques that are used in the private sector. These methodologies also form the basis of project appraisal as part of social cost–benefit analysis (which you will study in Units 3, 4 and 5), therefore it is useful, as a starting point, to study how the techniques are applied in the original source domain. You will see later on in this module how project appraisal in the public sector differs from the way in which investments are evaluated in the pursue of private (business) interests.

Learning outcomes

After completing your study of this unit, you will be able to:

- explain and use cash flow analysis
- discuss private sector appraisal techniques
- use spreadsheets for investment appraisal
- apply private sector investment appraisal techniques to different situations.

Reading for Unit 1

David Potts (2002) *Project Planning and Analysis for Development*.

Anthony Boardman, David Greenberg, Aidan Vining and David Weimer (2014) *Cost–Benefit Analysis: Concepts and Practice*. Chapters 6 'Discounting benefits and costs in future time periods', and 2 'Conceptual foundations of cost–benefit analysis'.

Clay Carr and Markus Pudelko (2006) 'Convergence of Management Practices in Strategy, Finance and HRM between the USA, Japan and Germany'. *International Journal of Cross Cultural Management*, 6 (1), 75–100.

1.1 Introduction

Investment, in the economic sense of the word, is an increase in the stock of physical capital assets such as plant and machinery, buildings and other assets that will generate a flow of goods or services in the future. This is different to the concept of financial investment, such as buying financial assets like stocks and shares, which merely transfers ownership between seller (or issuer) and buyer, although such activities will generate a flow of income for the purchaser in the future from interest or dividend payments.

Investment appraisal is mainly concerned with the financial and economic viability of projects. This allows project analysts to consider whether the return that might be expected from an investment compares favourably with alternative investment in other projects (the *opportunity cost* of the investment). Thus, if there are a number of alternative investment options, which option produces the best financial return, taking into account other factors such as *risk*? Risk is a complex area in its own right, so it is analysed separately in Unit 6.

This unit is concerned with an examination of investment appraisal in the private sector, often called *financial analysis* or *capital budget*, because companies in this sector will be primarily concerned with the profitability of their investments (although the private sector also includes not-for-profit organisations such as charities and NGOs). Such investment decisions can involve:

- the replacement and/or acquisition of new capital assets
- new products
- cost savings
- acquisitions and mergers.

Investment appraisal techniques are also used in public sector projects and in public–private partnership projects, and similar techniques of appraisal are used; this is why they are covered in this unit. However, investment appraisal in the public sector is normally concerned with broader criteria, including the impact on employment, poverty, and external costs and benefits (*externalities*), rather than just the financial impacts. This involves the use of social cost–benefit analysis (SCBA) and this is considered in Units 3 and 4.

A profit seeking business will be concerned with the evaluation of the prospective costs and revenues (and related cash outflows and inflows) generated by an investment in a capital project over its *expected life*. The expected life of a capital project is the time period that the analyst considers to be relevant for the evaluation of the prospective costs and revenues. It may extend from the date when the investment is made and the capital project starts generating costs and revenues until the date when capital assets are no longer productive and the flow of costs and revenues fades away. Alternatively, it may cover the period between the date when the investment is made and an arbitrary date in the (distant) future when the analyst believes that uncertainty makes evaluation of the prospective costs and revenues no longer workable.

The financial viability of an investment can be appraised by a number of different methods, which include:

- payback period
- accounting rate of return (ARR)
- net present value (NPV)
- internal rate of return (IRR)
- benefit–cost ratio.

These methods are explained, and their strengths and weaknesses discussed, in this unit. Also, this unit provides examples of the use of spreadsheets for investment appraisal (you should download and open the file: 'ProjectAppraisal_Unit-1.xls' available on the VLE).

1.2 Cash Flow Analysis

Investment appraisal in the private sector is called *financial analysis* (or *capital budget*) because the only project impacts considered are those costs and revenues (and related cash outflows and inflows) of the project that affect the financial position of a company (sometimes called *private costs and benefits*). The cash flows that are *relevant* to the decision are those that are affected by the decision. This is most easily calculated by comparing the *status quo* (the *do nothing* or *without option*) with the effects of the project (the *with option*). This produces the *incremental costs and revenues* – that is, the impacts of the project on the cash flows of the business.

These cash flows typically consist of:

- *Capital expenditure or outlay*: this includes the cash outflows due to the purchase cost of such items as buildings, equipment, plant and machinery, design and training expenditure. In financial accounting terms, such investments are exhibited in financial reports as fixed assets (property, plant, and equipment) and are depreciated to take account of their decline in value and to provide for capital replacement. At the end of a project's working life, investments may have a written-down or residual value which will reflect their scrap or disposal value. Some types of projects may have cash outflows at the end of the project due to decommissioning costs, reclamation costs, *etc*.

  Investment costs also include *working capital*. Working capital refers essentially to stocks of goods that the business or project needs to hold in order to operate – such as cloth in the case of a clothing factory. In addition, if sales involve the granting of credit to customers, then these debtors will need financing. Conversely, any credit extended by a company's suppliers will reduce the company's working capital requirements. Typically, capital expenditure will be 'front-loaded' – it will occur at the beginning and/or in the early years of a project's working life.

- *Annual operating costs*: these are the costs incurred in operating the project, such as labour costs, costs of raw materials or other types of stocks, water, electricity, *etc*.
- *Annual revenues*: these will arise from the sale of the output of the project and thus will produce a positive cash inflow into the company. Alternatively, some types of investment produce greater efficiency and thus lower the annual operating costs – these savings can be treated as positive cash gains to the business. These annual revenues less annual operating costs will equal the project's *Annual Net Cash Flows (NCFs)* for each year of the expected life of the project.

Different types of projects will have different cost and revenue profiles; the results of project appraisal techniques will also depend on the project life. Large-scale industrial process projects, such as cement works or dams, may have an assumed project life of around 30–40 years, with occasional investments in updating plant due to the development of new technologies. Investment in an irrigation project for tree crop production will have a shorter investment cycle as trees are replaced and replanted. A hotel project for tourism will require shorter cycle investments to upgrade rooms and facilities if it is to maintain its competitive position in relation to other competing hotels and holiday complexes.

Example 1.1

Let us have a look at a cash flow analysis conducted on a spreadsheet. You should download and open the file named 'ProjectAppraisal_Unit-1.xls' and available on the VLE. The sheet named 'Example 1' provides a simple instance of cash flow analysis. An investment in a piece of machinery is expected to expand current production and sales of manufactured goods of an imaginary firm. After the investment is made, production will increase, as well as costs of direct materials and manufacturing overhead. Labour costs are assumed to remain constant (the piece of machinery is automated and requires no additional specialised workforce). Also, we assume that all the production that originates from the new piece of machinery will be sold.

Cash flow analysis is based on conjectures on prospective costs and revenues. In Example 1, we can set four parameters, that relate to (1) rate of increase of production, (2) rate of increase of direct material costs, (3) rate of increase of manufacturing overhead costs, and (4) expected life of the project (we can also input the capital expenditure, although it does not affect Net Cash Flow). The parameters of the model are:

Rate of increase of production	30 %
Rate of increase of direct material costs	20 %
Rate of increase of manufacturing overhead costs	10 %
Expected life of the capital project (years)	8

As the capital project under consideration consists of the expansion of an existing business venture, we can base our estimation of future cash flow on past performance of existing machinery. Of course, you can try to change the values of the parameters to see how this affects the Net Cash Flow.

Let us have a look at a slightly more complex instance of cash flow analysis. You should now open the sheet named 'Example 2' within the same file. This example relates to an investment in a piece of machinery that is expected to expand current production and sales of manufactured goods of an imaginary firm. Differently from the previous example, production will increase gradually over time (you can input the rate of increase of production). Costs related to materials will increase accordingly, while costs of manufacturing overhead will have a one-time increase after the investment is made. Labour costs are assumed to remain constant. We also assume that all the production that originates from the new piece of machinery will be sold.

In Example 2, we can set three parameters, that relate to (1) expected life of the capital project, (2) year-to-year rate of increase of production and of direct material costs, (3) one-time rate of increase of manufacturing overhead costs (we can also input the capital expenditure, although it does not affect Net Cash Flow). The parameters of the model are:

Expected life of the capital project (years) 7

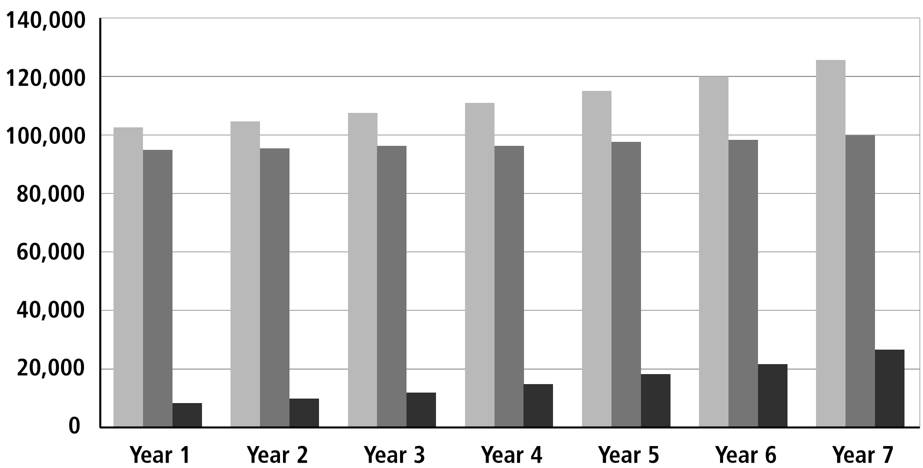
Rate of increase of production and of direct material costs

Year 1	2.00 %
Year 2	2.00 %
Year 3	3.00 %
Year 4	3.00 %
Year 5	4.00 %
Year 6	4.00 %
Year 7	5.00 %

Rate of increase of manufacturing overhead costs 10 %

As in the previous example, because the capital project under consideration consists of the expansion of an existing business venture, we can base our estimation of cash flow on past performance of existing machinery. The result is a forecast of revenues, costs, and Net Cash Flow streams (graphically, this is illustrated in Figure 1.1).

Figure 1.1 Revenues, costs, and Net Cash Flow of the model in Example 2



This model provides some additional insights, with respect to the previous one. We notice that, after the investment is made, Net Cash Flow is relatively disappointing for a few years – in Year 1 and 2, Net Cash Flow is actually lower than the one that we got before the investment is made! This is not so surprising, provided that (as it may happen in capital projects) the investment entails a sharp increase in fixed costs (manufacturing overhead) while production and sales (hence, income on sold products) increase only gradually over time. Only from Year 3 onwards is Net Cash Flow higher than the one before the investment is made.

✍ Try and change the values of the parameters and see how this affects Net Cash Flow. For example, let us say that we cautiously expect lower year-to-year rate of increase of production and sales in all of the 7 years while leaving all other parameters constant. If we halve year-to-year rates of increase of production and sale, how long should we wait until Net Cash Flow is higher than the one we got before the investment is made?

1.3 Private Sector Appraisal Techniques

Private sector appraisal techniques concentrate on financial analysis and commercial profitability. The main components of financial analysis are cash flow analysis (revenue and costs), the profit and loss account and balance sheet, working capital, source and application of funds and working capital statements.

Reading 1.1

Potts (2002) Chapter 5 'Financial analysis for commercial projects' in *Project Planning and Analysis for Development*. pp. 89–107.

Please now read Potts's extract, 'Financial analysis for commercial projects', which goes into more detail on financial analysis of investment projects. The reading also discusses financial ratios and how these may be interpreted. However, Potts notes that these financial ratios are not often used in project appraisal. Financial ratios are more likely to be used to assess the financial viability of a company or organisation, and therefore be of interest to institutions, which provide funding.

The main aim of private sector appraisal is to establish the financial viability of the project and to assess its impacts on the financial statements of the commercial organisation. In the case of publicly floated companies, investors will be concerned with the returns to shareholders. A number of investment appraisal techniques are discussed below. It should be noted that all these techniques provide financial guidelines for whether a project seems financially viable. There are other factors that can determine whether a private sector project is viable or not. These factors may include market conditions for the project's products and or services, the financier's assessment of risk, and the legal and regulatory environment (this may be particularly important for privatised companies that are subject to regulation, such as water, telecommunications, energy and other utility companies).

✍ Make sure your notes cover the points cited.

1.3.1 Payback method

The payback method, based on cash flows, is a traditional method of investment appraisal. It assesses how quickly the incremental Net Cash Flows, which accrue to an investment project, pay back the initial capital invested. Where there are several projects, the project that pays back the investment in the shorter period would normally be chosen. Typically, companies that use the payback method use a pre-determined minimum acceptable payback period in order to accept or reject projects.

Example 1.2

Have a look at the sheet named 'Example 3' within the same file as the previous example. Here we see how the payback method helps in choosing between two different projects. Let us assume that we have the option to invest in one of two alternative capital projects, named A and B. An analyst has estimated the expected Net Cash Flow that originates from both projects, as is shown below.

Table 1.1 Net Cash Flow of two alternative capital projects

Year	Project A Cash flows ($)	Project B Cash flows ($)
0	–150,000	–150,000
1	10,000	20,000
2	20,000	50,000
3	50,000	80,000
4	70,000	100,000
5	50,000	150,000

Our task is to select which of the two investments is more advantageous. The payback method simply suggests choosing the capital project that provides quicker repossession of the capital expenditure. Hence, we need to calculate the cumulative Net Cash Flow that is obtained after each year in the future and see when the cumulative Net Cash Flow is at least equal to the capital expenditure. You can see from the calculation made in the example that Project A repays its capital expenditure of $ 150,000 in Year 4, while Project B does so in Year 3. Other things being equal, Project B would be selected.

Try to change the values of the Net Cash Flows and see how this affects payback periods and, therefore, the selection of the project.

The advantages of payback as an appraisal technique are:

- it is simple to calculate
- the emphasis on speed of return of the investment, which may be important if liquidity or risk[1] are significant issues
- it avoids having to forecast cash flows beyond the payback point; forecasting is subject to uncertainty, especially the further into the future the forecast is made, so this is an advantage.

But the technique also has disadvantages:

- it ignores cash flows beyond the payback point; projects that are worthwhile when cash flows are considered over the life of the project are rejected because these cash flows are not received quickly enough

1 This assumes risk is a function of time, so that a project that pays back more quickly is less risky because the present value of any future sum is always lower; see Unit 6.

(notice in the above example that Project A more than recovers its capital outlay by the end of the project's life)

- it ignores the cost of capital employed to finance the project
- it ignores the' time value of money'; the positive cash flows received in later years are treated the same as those received earlier in the project's life[2].

1.3.2 Accounting rate of return (ARR)

The accounting rate of return (ARR) is the second major method for investment appraisal. There are slight variations in its calculation. The basic form is the ratio of accounting profit generated by an investment project to the required capital expenditure, expressed as a percentage. Two main methods of calculation are used:

- the ratio of the average annual profit over the life of a project to the average capital employed; this measure reflects the fact that as the value of the asset is written down over its life through depreciation charges – see below, Box 1.1 – then the firm recovers the costs of the investment during the project's working life
- the ratio of the average annual profit over the life of the project to the total investment (capital outlay).

The accounting rate of return may be expressed as:

$$ROCE = \frac{Average\ Profits}{Initial\ or\ Average\ Capital\ Employed}$$

Granted some approximation for the sake of simplicity, accounting profits can be conceived here as cash flows less depreciation[3]. You should read Box 1.1 for further information concerning depreciation if you are unfamiliar with the concept.

Box 1.1 Depreciation

Depreciation is an accounting concept. In order to match the cost of an investment with the revenues the investment produces, a fraction of the initial investment cost is considered an expense in each accounting period. Depreciation is not included in cash flow analysis. With cash flow analysis, all investment expenditures are included in the cash flow *only* in the year in which the investment cost was actually incurred. If depreciation was included in the cost streams of the cash flow, there would be *double counting* of the project's investment costs and therefore the project's net benefits would be *undervalued*.

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2 This objection can be overcome by calculating the discounted payback period. Discounting is explained in Section 1.3.3. Discounting will extend the time period before a project pays back its capital outlay, because the present value of any future sum is always lower than the current value.

3 In practice, there may be other differences arising from non-cash transactions as well; for example, if sales are on credit, then sales cash flows will be lower than the sales revenues as recorded in the profit and loss/income statement (the difference being recorded as an increase in debtors on the balance sheet). To simplify the analysis these are ignored.

This may be important where one receives financial data for inclusion in the investment appraisal cash flow analysis. If you receive data on costs net of depreciation, depreciation should be added back into the cost stream.

Straight-line depreciation

This is the most common form of depreciation. The original or historic cost of a capital asset (less any expected residual or scrap value at the end of the asset's working life) is divided by the years of its estimated working life to produce an annual depreciation charge or expense to set against revenues. The expression for straight-line depreciation is given as:

$$D_t = \frac{K - S}{N}$$

where:

D^t = annual depreciation
K = the cost of the asset
S = scrap or residual value of the asset at the end of its life
N = working life of the asset.

Example 1.3

A vehicle purchased for $30,000 has an estimated working life of 5 years and an estimated residual value of $5,000.

$$D_t = \frac{30,000 - 5,000}{5} = 5,000$$

This annual amount is charged against revenues each year for five years. Each year, the value of the asset on the balance sheet is reduced (written down) by the $5,000. Thus at the end of the five years, total depreciation charges will amount to $25,000, and the balance sheet value of the assets will show as $5,000. This final $5,000 (its residual value) is recovered by the sale of the asset for $5,000 (and this, plus the depreciation charges, equals the initial outlay of $30,000). In practice, forecasting this residual value more than five years ahead is likely to be subject to error and may require a further adjustment, depending on the actual sales value realised.

The decision rule for the ARR is that the return generated by the project should be compared with the cost of the capital employed in the project. For example, if a project were financed by a loan, the cost of capital would be the interest rate on the loan. If the interest on the loan were 10%, then a project must earn more than, or at least equal to, this rate to be acceptable. If the project were financed by shareholders, the cost would be the return (in the form of dividends) that shareholders expect on their shares.

If there is a combination of the two sources of finance (shares and loans), the costs of finance are weighted according to the proportions of each type involved in the financing of the project. The resulting cost of capital is called 'weighted average cost of capital' or WACC. Calculating the WACC is important because it sets the benchmark against which the return generated by the project is compared, when the project is financed by a combination of different financial sources. Sometimes, the calculation of WACC gets complicated because of the variety of sources of finance within contemporary economies, *eg*, common stocks, preferred stocks, bonds, *etc*, each bearing different costs.

Example 1.4

Have a look at the sheet named 'Example 4' within the same file. In this example, we see the calculation of ARR of an investment in a capital project. A company is trying to decide whether to invest in a project that involves an initial capital expenditure of $100,000. The project will have an estimated life of four years and it is assumed there will be no residual value of the asset at the end of this period.

The project's Net Cash Flows (NCFs) are estimated as follows:

Table 1.2

Year	NCFs ($)
0	–100,000
1	40,000
2	60,000
3	35,000
4	15,000

Profits are defined as cash flows minus depreciation. It is assumed that the company uses straight line depreciation. Thus the annual depreciation charge would be:

$$\frac{\$100,000}{4} = \$25,000$$

Annual profits are thus:

Table 1.3

Year	NCFs ($s)	Less Annual Depreciation Charge ($)	Annual Profits ($)
1	40,000	25,000	15,000
2	60,000	25,000	35,000
3	35,000	25,000	10,000
4	15,000	25,000	–10,000
		Total Profits	**50,000**

Average Annual Profits = $\frac{\$50,000}{4} = \$12,500$

ARR on initial capital employed = $\frac{12,500}{100,000} = 0.125 \;\; or \;\; 12.5\%$

ARR on average capital employed = $\frac{12,500}{50,000} = 0.25 \;\; or \;\; 25\%$

Obviously, the definition of capital employed makes a lot of difference to the ARR.

✍ Try to change the values of the Net Cash Flows and see how this affects ARR and, therefore, the selection of the project.

The advantages of the ARR method are:

- the concept of a percentage return is familiar to financial institutions and managers
- it is linked to profitability, a central objective of private sector projects
- it is commonly understood as a concept in the private sector.

The disadvantages of the ARR method may be summarised as follows:

- differing interpretations of how capital involved should be calculated
- it does not take account of the financial scale of the project
- accounting profit rather than cash flow is used as the criterion; accounting profit is based on a number of conventions, rules and standards such as historic cost, whereas it is cash that gives the power to command resources
- the time-value of money is not taken into account.

1.3.3 Discounted cash flow methods

Broadly speaking, most of the costs of the capital expenditure or outlay of an investment project are incurred now (in the present), or in the early years of a project. Most of the benefits occur further into the future. To make the two comparable, we need to *discount* those future benefits so as to express everything in *present value* terms. Using present values then reflects the preference of most people for present consumption over future consumption; we place less value on something expected in the future as compared with something we receive today. *Discounting* reflects not only people's preferences for current consumption over future consumption, which is known as *time preference,* but also the opportunity cost of foregone interest when we spend today rather than investing for the future. This is called the *time value of money* because equal sums of money do not have the same value if they relate to different time periods.

Reading 1.2

If you are unfamiliar with discounting, you should now read from Chapter 6 of your key text by Boardman *et al* pages 137–43, 'The basics of discounting', and the first part of 'Compounding and discounting over multiple years' up to the paragraph heading 'Net present value of a project' on page 143.

Boardman *et al* (2014) Extract from Chapter 6 'Discounting benefits and costs in future time periods' in *Cost–Benefit Analysis: Concepts and Practice*. pp. 137–43.

In your notes on this reading, be sure to cover the relationship between the discount rate and the discount factor.

Example 1.5

Turn now to work sheet named 'Example 5' in the 'ProjectAppraisal_Unit-1.xls' file. The model shows the calculation that is made to 'convert' future values into present values according to a given discount rate. For example, future values of $2,000 at time 2 and $10,000 at time 4 discounted at the rate of 3% per time period results in total present value of $10,770.

✍ Try to change the values of the parameters and see how this affects the present value. What happens if you increase the discount rate? What happens if you decrease it? How does total present value change if you postpone (or anticipate) future values in time?

Net present value (NPV)

The *net present value* (NPV) of the project is the total of the discounted net cash flows over the lifetime of the project. The mathematical expression for the NPV is:

$$\sum_{t=0}^{n} \frac{A_t}{(1+r)^t}$$

where A_t is the project's cash flows (either positive or negative) in time *t*; *t* takes on values from 0 to year *n*, where *n* represents the point in time when the project comes to the end of its life; and *r* is the annual rate of discount or the time value of money (which is assumed to remain a constant over the life of the project), which should reflect the organisation's cost of capital. The assumption is that the 'free' cash flows generated by the project can be re-invested at that cost of capital, which – as the opportunity cost – represents the next best alternative return available.

Example 1.6

Have a look at the sheet named 'Example 6', which shows the calculation of Net Present Value of an investment in a capital project. A company is deciding whether to invest in a project that requires an initial capital expenditure of $180,000. The project is expected to generate annual Net Cash Flows (NCFs) of $60,000 during its estimated five-year working life, and the asset is expected to have no residual value at the end of this period. The company's cost of capital is 10%.

The table below assumes that investment takes place in period 0 so that discounting applies from the first year after the investment has occurred. It also assumes that the cash flows accrue at the beginning of each year so that the discounting applies for the whole year. These are common assumptions used to simplify the analysis.

Table 1.4 Discounted cash flows

Year	NCFs ($)	Discount Factor (r = 10%)	Present Value (PV) ($)
0	–180,000	1.000	–180,000
1	60,000	0.909	54,545
2	60,000	0.826	49,587
3	60,000	0.751	45,079
4	60,000	0.683	40,981
5	60,000	0.621	37,255
			Net Present Value (NPV) = +47,447

Please be clear about the difference between the discount rate and the discount factor. The discount rate is *r*. The discount factor is given by

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

In this example, $r = 0.10$, so in Year 1 the discount factor is $1/(1 + 0.10)$ or 0.909. In Year 2 the discount factor is $1/(1 + 0.10)^2$ or 0.826. The net cash flow in each year is multiplied by the discount factor for that year. Discount factors can be obtained from discount tables often included in accountancy and finance texts, and can be used for manual calculations. Of course, we can conveniently use the spreadsheet to make the required calculations. In the example, the discount rate is 10% as this represents the company's cost of capital.

The NPV of the project is the sum of the PV of the future net cash flows less the capital expenditure. That is, \$227,447 less \$180,000 = \$47,447.

✍ Try to change the values of the parameters and see how this affects the Net Present Value. What happens if you increase the discount rate? What happens if you decrease it? How does NV change if the expected life of the project is longer (or shorter)?

Notice that NPV measures the absolute addition to the cash of the business, in present value terms. A project that has a positive NPV should be selected. If there are several project options, one would normally choose the project which has the higher NPV over the lifetime of the project. This is because we are assuming that firms are seeking to maximise shareholder value. A project with a positive NPV is generating a return that is greater than the (opportunity) cost of capital and is thus increasing the wealth of the company. A project with a negative NPV implies that the company would be better off investing in alternatives (as indicated by the cost of capital) than investing in this particular project.

Thus NPV is an appropriate measure for assessing the impact of investment projects on shareholder value or wealth. It also takes into account the time value of money, the full life of the project although there may be some bias in terms of scale.

📖 Reading 1.3

Boardman and his colleagues provide additional information on NPV analysis on pages 143–47 of Chapter 6. Please read these pages now.

Boardman *et al* (2014) Extract from Chapter 6 'Discounting benefits and costs in future time periods' in *Cost–Benefit Analysis: Concepts and Practice*. pp. 143–47.

✍ If you feel that you are still unfamiliar with NPV, check that you can calculate the NPV in the example in the reading.

Spreadsheets typically contain inbuilt computing functions that facilitate the calculation of NPV. We can bypass the effort to calculate the sum of present values of each net cash flow by using appropriate formulas.

Example 1.7

Net Present Value Function

Have a look at the sheet named 'Example 7'. Let us consider an investment in a capital project that entails a capital expense of $250,000 and the following Net Cash Flow:

Table 1.5

Year	Net Cash Flow
1	$ 8,500
2	$ 23,700
3	$ 37,700
4	$ 44,850
5	$ 48,425
6	$ 51,925
7	$ 52,000
8	$ 52,000

Let also assume a given discount rate of 3%. The Present Value of the Net Cash Flow can be calculated with the "NPV" function. You can either type the function in any empty cell, or recall the appropriate command from the menu of the spreadsheet (you can find it in the menu Insert / Function). The function requires an argument, whose general syntax is in the form (rate; values), where "rate" is the discount rate and "values" is the vector or matrix of the Net Cash Flow. You can either type the actual figures as the function's argument (*ie* 3%; 8,500; 23,700; 37,000…) or you can more conveniently point at the co-ordinates of the cells that contain the data.

By using the NPV function, you can easily calculate that the Present Value of the capital project is $273,530.

In order to calculate the Net Present Value of the capital project, we need to subtract the capital expense from the Present Value. You will find that the Net Present Value of the capital project is $273,530 – $250.000 = $23,530.

Try to type the functions in the spreadsheet and see if you get these results.

You should notice that the NPV function assumes the cells contain the future net cash flows for the project. In our example, the initial investment occurs in period 0, and Net Cash Flows begin at the end of period 1. Therefore, to calculate the Net Present Value of the project, you need to subtract the initial investment (in period 0) from the NPV of the Net Cash Flows in next periods.

Internal rate of return (IRR)

The *internal rate of return* of the project is defined as that rate of discount which, when applied to the project's cash flows, produces a zero NPV. The mathematical expression for the IRR is therefore linked to the expression for the NPV:

$$\sum_{t=0}^{n} \frac{A_t}{(1+r)^t} = 0$$

Example 1.8

Now we will demonstrate the calculation of IRR. Have a look at the sheet named 'Example 8'. Let us assume that we wish to calculate the IRR of an investment in a capital project equal to the one that we used in the previous exercise. We can proceed in two ways. In the first approach, we try to find IRR through a sequence of approximations. We know that at a discount rate of 10%, the NPV was positive, so to find the IRR, the DR needs to be raised (in order to lower the PV). This is a trial and error process if done manually. A discount rate of 21% produces a negative NPV. So we know that the Internal rate of return (IRR) is below this rate. It may take you a while, but after some further trials you may find that the IRR is about 19.85–19.86%.

Table 1.6 Calculation of IRR

Year	NCFs ($)	Discount Factor (r = 10%)	Present Value (PV) ($s)	Discount Factor (r = 21%)	PV ($s)
0	–180,000	1.000	–180,000	1.000	–180,000
1	60,000	0.909	54,545	0.826	49,587
2	60,000	0.826	49,587	0.683	40,981
3	60,000	0.751	45,079	0.564	33,868
4	60,000	0.683	40,981	0.467	27,990
5	60,000	0.621	37,255	0.386	23,133
			NPV = +47,447		NPV = –4,441

In the second approach, we make use of powerful tools of the spreadsheet. Rather than manually searching for IRR, we can have the software do the effort for us. We can use the command "Goal Seek" of the spreadsheet, which you should find – depending on the software that you use and its version – within the "What-if Analysis" menu or the "Tools" menu. You can fill in details about the "Formula cell" that you wish to get equal to the "Target value" by changing the "Variable cell". In our model, we wish the cell that contains the NPV to be set equal to zero by changing the value of the cell that contains the discount rate. The command allows to find IRR remarkably faster and more precisely than we can most probably get by manually changing the discount rate: we should get that IRR is equal to 19.8577097873201%.

✍ Try both approaches by working on the sheet "Example 7". First, try to find IRR by manually changing the discount rate (cell D14). Then, try to calculate IRR by using the "Goal Seek" command so that it will be the software to search for you the value of the discount rate (D40) that makes NPV = 0.

The decision rule is to accept any projects whose IRR exceeds the organisation's cost of capital since this will add to shareholder wealth, and consequently, reject any project that does not meet this criterion. If we continue to assume that this company's cost of capital is 10%, then the project generates a higher return than this and should be accepted. Typically, companies, especially large diversified ones with many different business units or product divisions, will set 'hurdle rates' for IRR; that is, the minimum acceptable rate of return that projects must generate to be acceptable (this is sometimes called 'soft capital rationing'). Occasionally in financial analysis (as opposed to social cost–benefit analysis which is considered in Unit 3), these discounting methods are referred to as the financial net present value and the financial internal rate of return.

Reading 1.4

The IRR is explained on pages 160–62 in Chapter 6 of your key text by Boardman *et al*, which you should read now.

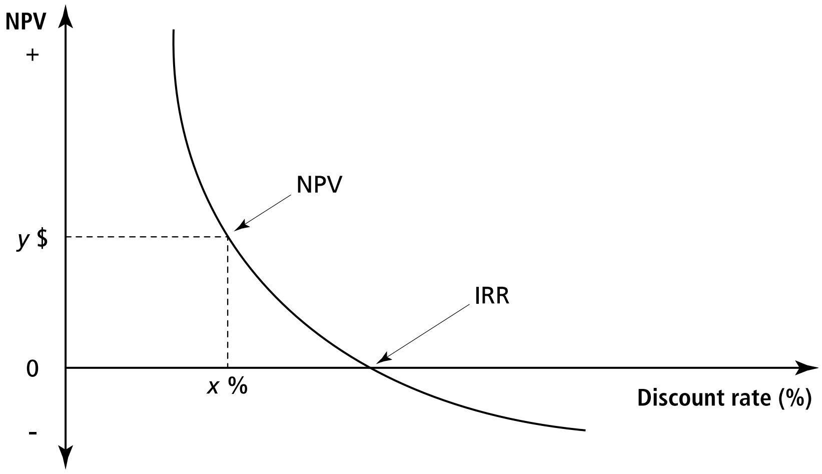
Make sure your notes cover the defects of IRR, which are discussed in the last section on p. 162.

Boardman *et al* (2014) Extract from Chapter 6 'Discounting benefits and costs in future time periods' in *Cost–Benefit Analysis: Concepts and Practice*. pp. 160–62.

In the case of independent projects there is no conflict between NPV and IRR. A project that yields a positive NPV will generate an IRR that exceeds the cost of capital. But if you have to choose between alternative projects, a conflict between the two methods can arise (this is looked at in detail in next unit).

An investment project whose cash flows are discounted at x% generates an NPV of $$y$. The IRR, the rate of discount that just makes the NPV equal to zero, is shown where the NPV curve intersects the horizontal axis. That is, the higher the rate of discount, the lower the NPV, until that NPV is zero. Any further increase in the DR produces a negative NPV. The relationship between NPV and IRR is shown in Figure 1.2 below:

Figure 1.2 Relationship between NPV & IRR



As before, we can make use of the inbuilt computing functions of spreadsheets for calculating IRR while avoiding the search for the discount rate that makes NPV equal to nil.

Example 1.9

Internal rate of return function

A similar procedure can be carried out to conveniently calculate the Internal Rate of Return of the project. Have a look at the sheet named 'Example 9' within the same file. Here we will calculate the Internal Rate of Return of the same model that we used before.

The internal rate of return can be calculated with the "IRR" function of the spreadsheet (again, you may find it in the menu Insert / Function). The argument of this function is in the form (values; guess), where "value" is a vector or matrix of the Net Cash Flow and "guess" is just a number from where calculation will start to approximate the value of IRR in an iterative fashion. You can either type the actual figures as the function's argument (*ie* 8,500; 23,700; 37,000 … ; and for example 5% as "guess") or you can more conveniently point at the co-ordinates of the cells that contain the data of the Net Cash Flow.

By using the IRR function, you should find that the Internal Rate of Return of the capital project is about 4.83%.

✍ Try to type the function in the spreadsheet and see if you get that result.

Benefit–cost ratio

Another measure that is used in net present value analysis is the *benefit–cost ratio* of different project options. This is also called the *profitability index*. The benefit–cost ratio compares the present value of project benefits with the present value of project costs over the project life. In effect, this displays the PV of returns per $ invested. Thus, with two project options, one would normally choose a project with a benefit–cost ratio of, for example, 3.0 over a project with a benefit–cost ratio of 2.5. The mathematical expression for the benefit–cost ratio is:

$$BCR = \frac{\sum_t (B(t))/(1+d)^t}{\sum_t (C(t))/(1+d)^t}$$

where:

BCR	is the benefit–cost ratio
d	is the rate of discount
t	is the number of years from the base year, for each year of the project period
B(*t*) and *C*(*t*)	are total benefits and total costs in year *t*.

At any discount rate *d*:

- if BCR > 1.0, accept the project proposal
- if BCR < 1.0, reject the project proposal
- if BCR = 1.0, there will be no net effect whether the project proposal is accepted or not.

Example 1.10

If we continue to use the same example that we used to illustrate NPV and IRR, then, at a rate of discount of 10%, the project yields the following benefit–cost ratio:

Net cash flows in present value terms	= $227,447
Capital expenditure	= $180,000
Benefit–cost ratio	= 1.26

In the case of independent projects, both benefit–cost ratio and NPV give the same result. A project that yields a positive NPV must have a benefit–cost ratio greater than one.

Reading 1.5

Please now read the section in your key text, 'Applications of the decision rule in practice' beginning on pages 32–34 in Chapter 2, which explain the benefit–cost ratio. Notice particularly the problem of using the benefit–cost ratio when comparing projects of different scale.

Boardman *et al* (2014) Section 'Applications of the decision rule in practice' from Chapter 2 'Conceptual foundations of cost– benefit analysis' in *Cost–Benefit Analysis: Concepts and Practice*. pp. 32–34.

How widely used are these methods of financial decision-making, and are they applied in the same way in different systems of market economy? This is the subject of the next reading. You will see that there are significant differences between the three economies covered in the study, concerning which investment appraisal methods are used, and also differences in the criteria used (*eg* length of pay-back period, required return on investment).

Reading 1.6

Please now read the article by Carr and Pudelko, on their international comparison of management practices. The section on finance, pages 79–81, and the first part of the discussion on pages 89–90 highlight the differences in the use of investment appraisal techniques such as discounted cash flows (DCF) payback and return on capital as between the different countries.

Carr & Pudelko (2006) 'Convergence of management practices in strategy, finance and HRM between the USA, Japan and Germany'. *International Journal of Cross Cultural Management*, 6 (1), 75–100.

✍ Your notes should cover the main issues raised in this unit.

1.4 Conclusion

This unit has introduced you to some of the basic methods used in investment appraisal, and their respective strengths and weaknesses. The main methods considered are those commonly used in private sector investment appraisal; they include:

- the payback period
- accounting rate of return (ARR)
- net present value (NPV)
- internal rate of return (IRR)
- benefit–cost ratio.

The two principal methodologies, however, are NPV and IRR. While this unit has been mainly concerned with investments in the private sector, the methodologies also form the basis for project appraisal as part of a social cost–benefit analysis of the wider costs and benefits to society, which you will study in Unit 3. Investment appraisal techniques, by definition, concentrate on the financial viability of the project or proposed investment.

A summary of the strengths and weaknesses of investment appraisal techniques is contained in Table 1.7.

Table 1.7 Summary of the strengths and weaknesses of investment appraisal techniques

METHOD	STRENGTHS	WEAKNESSES
Payback	Simplicity Emphasis on speed of return of the investment Avoids having to deal with cash flows in future periods	Ignores total cash flows beyond the payback period Ignores the time value of money
Accounting Rate of Return (ARR)	Based on profitability Focuses on corporate financial performance Relatively easy calculation Commonly understood as a concept in the private sector	Possible different definitions of what to include in the cost streams Ignores the scale of investment Ignores time value of money
Discounted cash flow – Net Present Value (NPV)	Takes account of the time value of money Focuses on project worth and thus impact on shareholder value Takes account of scale of investment solution is determinate The NPV decision rule performs better than the IRR of the incremental cash flow in choosing between mutually exclusive projects	No indication of the safety margin of the investment Concept of NPV less familiar than rate of return
Discounted cash flow – Internal Rate of Return (IRR)	Takes account of the time value of money Gives an idea on the safety margin of the investment More familiar concept than NPV – rate of return	No account taken of investment scale Assumes interim reinvestment of revenue at the project's own rate of return Problems with mutually exclusive projects

References

Boardman A, D Greenberg, A Vining and D Weimer (2014) *Cost–Benefit Analysis: Concepts and Practice.* Harlow UK: Pearson Education Ltd.

Carr C and M Pudelko (2006) 'Convergence of management practices in strategy, finance and HRM between the USA, Japan and Germany'. *International Journal of Cross Cultural Management*, 6 (1), 75–100.

Potts D (2002) *Project Planning and Analysis for Development*. London UK: Lynne Rienner.