CHAPTER 12

Capital investment appraisal

CONTENTS

LEARNING OUTCOMES

After reading and understanding the contents of this chapter and working through all the worked examples and practice questions, you should be able to:

- Understand the criteria used for making capital investment decisions.
- Calculate the accounting rate of return.
- Calculate the payback period.
- Discount cash flows and calculate the net present value of a project.
- Use annuities in discounted cash flow calculations.
- Calculate net terminal values.
- Interpret NPV profiles and use them to make comparisons between projects.
- Calculate internal rate of return.
- Calculate modified internal rate of return.
- Calculate profitability ratios and use them to set investment priorities.
- Compare different methods of capital investment appraisal.
- Take account of taxation in capital investment appraisals.

Introduction

This chapter explains the financial basis for evaluating capital investment opportunities, which are often referred to as capital investment projects.

Most of these techniques are based on some measure of profit. Profit may be measured by the effect of an investment project on the accounting profit as shown in the profit and loss account. But there are reasons for using cash flow rather than accounting profit as a measure of profitability. This chapter explains how project cash flows can be calculated and evaluated, allowing for such things as taxation and specific project funding.

If the cash flows generated by a project are identified, it is possible to investigate other aspects of the project than its profitability. One such further aspect is the payback period, which gives an indication of the effect of a project on the company's liquidity.

Another aspect of investment appraisal based on cash flows is the idea of discounting: other things being equal, a project that generates cash flows earlier is preferable to one that generates cash flows later (because earlier cash flows reduce the cost of borrowing or make it possible to reinvest funds to earn a return elsewhere). This concept gives rise to the idea of discounting future cash flows, to reflect the fact that cash received, or paid out, earlier is worth more than the same amount of cash received, or paid out, later. The discount factor applied to a future cash flow also reflects the degree of risk associated with the cash flow – the chance that a cash inflow may be smaller than envisaged, or may not occur at all.

Many companies use more than one technique to evaluate the financial return from a capital investment project. The main techniques used are explained and compared in this chapter.

1 Capital expenditure decisions

Capital investment decisions will largely shape the future of the business and its ability to manage its future operations. They are generally difficult and expensive to reverse. So they need to be right first time.

In making capital investment decisions, managers aim to maximise shareholder wealth by maximising long-term returns, taking account of risk and liquidity.

In this chapter we will look at the following measures of investment performance that can be used in capital investment appraisal:

- Return on Investment (ROI) or Accounting Rate of Return (ARR), which uses conventional 'accounting profit and asset figures'.
- Payback period, which is based on cash flows.
- Net Present Value (NPV), which is based on cash flows discounted to reflect their timing and the cost of capital.
- Internal Rate of Return (IRR), as NPV.
- Profitability index or cost/benefit ratio, which can be used to rank projects for priority if investment funds are limited

These techniques complement one another and many companies use more than one technique to evaluate capital investment projects.

As you work through the following sections, try to assess the validity of each of these techniques in relation to the primary objective of corporate finance of maximising shareholders' wealth.

2 Return on investment (accounting rate of return)

accounting rate of return (ARR) A traditional method of evaluating capital investment projects which expresses the profit from an investment as a percentage of the investment. The profit is the accounting profit, calculated as in the profit and loss account, and may be calculated before or after tax. It is usually the average profit over the life of the project. The investment includes fixed assets and working capital specific to the project, valued in the same way as in the balance sheet, and is usually also averaged over the life of the project. The ARR for the project is usually compared with a company, group or divisional target.

Return on investment (ROI) or **accounting rate of return (ARR)** is a traditional method of evaluating capital investment projects. It expresses the profit from an investment as a percentage of the total investment (or, alternatively, the average investment over the life of the project). The profit is the accounting profit, calculated as in the profit and loss account. The investment includes fixed assets and working capital specific to the project, valued in the same way as in the balance sheet. The profit may be calculated before or after tax. If the project lasts more than one year, the profit figure used is the average annual profit over the life of the project. The ARR figure calculated in this way is compared with a predetermined company (or group, or division) target, an investment being accepted if the result meets or exceeds the target.

When using ARR to compare projects which are mutually exclusive (i.e. the acceptance of one prevents the adoption of the other) the project which gives the highest ARR is the one that should be accepted (provided it meets or exceeds the target ARR).

WORKED EXAMPLE 12.1

An investment in a new machine costing £1,000 will generate the earnings shown below over the five years of its projected useful life. After five years the machine will have no residual value. Depreciation will be on a straight line basis, reflecting how the value of the machine is expected to fall over the five years.

Year	1	2	3	4	5
Budgeted cash surplus	600	550	500	450	400
Less: Depreciation	(200)	(200)	(200)	(200)	(200)
	400	350	300	250	200
Tax	(105.0)	(108.7)	(107.8)	(103.4)	(25.1)
Net profit	215	241.3	192.2	146.6	174.9

$$\text{Average profit} = \frac{295.0 + 241.3 + 192.2 + 146.6 + 174.9}{5} = £210$$

$$\text{Average profit / original investment} = \frac{210}{1{,}000} \times \frac{100}{1} = 21\%, \text{ or}$$

$$\text{Average profit / average investment} = \frac{210}{500} \times \frac{100}{1} = 42\%.$$

In this example, the average value of the investment is take as the average of the initial and final values of the machine (as the value of the asset falls at a uniform rate from £1000 at the start to nil after 5 years): (£1,000 + 0)/2= £500.

The ARR figures above are calculated over the five-year life of the project. Note that the annual ARR (which can be calculated for each year separately) changes over the life of the project. Using the initial capital values at the start of each year (which, as we have assumed, fall by £200 each year) the annual returns are shown below:

Year 1 $\frac{295.0}{1{,}000} = 29.5\%$

Year 2 $\frac{241.3}{800} = 30.2\%$

Year 3 $\frac{192.2}{600} = 32\%$

Year 4 $\frac{146.6}{400} = 36.7\%$

Year 5 $\frac{174.9}{200} = 87.45\%$

An important drawback of the ARR calculation is that it does not reflect the fact that a net profit of £174.90 in five years' time is worth less than the same profit received in the first year of the profit. In other words, the method fails to recognise the time value of money. This is dealt with by discounted cash flow methods of project evaluation, as we shall see below.

Another problem is that the profit and capital values used to calculate ARR depend on the methods a company chooses, for example, to value stocks and calculate depreciation. Different methods are possible and acceptable, leading to the possibility of ARR figures being calculated in different ways for similar – and apparently comparable – projects. Within one company or group of companies, accounting methods can be standardised, though different approaches to stock valuation and depreciation may be appropriate for different businesses within the same group. If ARR is being used to make comparisons between different companies, problems will arise in interpreting and comparing the figures.

ARR is a relative measure: the accounting profit is divided by the investment. This makes it possible to compare the profitability of projects of different sizes, but means that if ARR is used to choose between two projects, a small project may have a higher ARR than a large project while giving a smaller absolute profit.

Despite these drawbacks, ARR is still widely used. This is partly because it is simple to calculate and also because the profit figures and asset valuations are arrived at in the same way as the figures in the profit and loss account and balance sheet. They are, therefore, readily recognised and understood by managers who are not trained accountants, but who are used to using accounting statements. ARR is similar to Return on Capital Employed (ROCE) or Return on Investment (ROI), which are frequently used to measure the performance of businesses or their managers.

3 Payback period

The payback period is the time it takes for the cash flows generated by a project to pay back the initial cash outflows (for capital investment, working capital and initial costs) at the start of the project. Like NPV and IRR, the payback period is based on cash flows rather than profits and ignores non-cash items such as depreciation. An important advantage of cash flows is that they avoid the problems of accounting definitions (described above) that affect ARR. Projected future cash flows are of course subject to uncertainty, but the problems of possible ambiguity that arise in interpreting accounting profits and balance sheet valuations are largely avoided.

A project is accepted if its payback period is less than a predetermined company (or group, or division) target. When comparing different projects, the project with the quickest payback would be chosen.

		Project A	Project B	Project C
		£	£	£
Investment outflow	Year 0	(600)	(600)	(600)
Cash inflows	Year 1	400	700	200
	Year 2	200	400	400
	Year 3	800	100	800
	Total inflows	1,400	1,200	1,400

The payback period for Project A is two years. The payback period for Project B is less than one year. If we assume that the cash inflows occur evenly during the year, the payback period for B is:

£600/£700 = 0.84 years or £600/£700 × 12 months = 10.3 months.

Payback focuses on risk in considering the period during which the initial investment remains outstanding. The sooner the investment is returned, the safer the project should be.

You will note that the payback calculation takes no account of cash inflows after payback and therefore does not reflect the total return from the project. Nor does it take account of the timing of cash flows within the payback period: Project C, with the same initial cash outflow of £600 and the same total cash inflows up to the end of Year 2 as Project A, has a payback period of two years, the same as Project A, but cash comes in later over Years 1 and 2 than with Project A. Project C means that the company has to wait longer for its money. If the company has profitable ways of using money that it receives earlier, Project A is preferable to Project C, but the payback period does not reflect this. Although payback calculations reflect one aspect of the timing of cash flows, they do not fully reflect the time value of money.

Payback should be viewed more as a risk appraisal tool than as a measure of profitability.

4 Discounted cash flow methods

4.1 Present values of cash flows

We have seen above why cash flows have advantages over accounting profit as a basis for capital investment appraisal calculations. We have also seen what is intuitively obvious: that, other things being equal, companies as well as individuals prefer to receive cash earlier rather than later and to pay out cash later rather than earlier. By discounting cash flows, this can be represented in a way that helps in evaluating capital projects.

Let us suppose that you can invest £1,000 for a year to earn a return of 10 per cent. At the end of a year, the investment would consist of the original £1,000 plus 10 per cent of £1,000, or £100 of profit: a total of £1,100. If you left the total investment of £1,100 to earn a return at the same rate for a further year, then at the end of the second year the investment would consist of the £1,100 that you left invested plus 10 per cent of £1,100, or £110 of profit: a total of £1,210. You can easily calculate what the total investment would be if you left the investment of £1,210 to earn a return, still at 10 per cent, for a third year.

THEORY INTO PRACTICE 12.1

What would the investment be three years from the start?

Answer

£1,210 + 10% of £1,210 = £1,331

We can set out these figures in a slightly different way:

Investment now	=	£1,000		
Investment 1 year from now	=	£1,100	=	£1,000 × 1.10
Investment 2 years from now	=	£1,210	=	£1,100 × 1.10
Investment 3 years from now	=	£1,331	=	£1,210 × 1.10

We can say that, in some sense, the figures of £1,000 now, £1,100 one year from now, £1,210 two years from now, etc. are equivalent to each other. Provided we think the rate of return is realistic, we would be as happy to have £1,000 now as £1,100 in one year's time, or £1,210 in two years' time, and so on.

So we could also say that, if:

£1,100 in one year is equivalent to £1,000 now, so
£1,000 in one year is equivalent to £1,000/1.10 = £909.09 now

£1,210 in two years is equivalent to £1,000 now, so
£1,000 in two years is equivalent to £1,000/1.21 = £826.45 now

£1,331 in three years is equivalent to £1,000 now, so
£1,000 in three years is equivalent to £1,000/1.33 = £751.31 now

We say that:

£909.09 is the present value of £1,000 one year from now, using an annual rate of return of 10 per cent
£826.45 is the present value of £1,000 two years from now, using an annual rate of return of 10 per cent
£751.31 is the present value of £1,000 three years from now, using an annual rate of return of 10 per cent

The present value of a future cash flow is the cash flow now that would be considered equivalent to it.

In general, the present value of £1,000 n years from now, using an annual rate of return of i, is:

$$\frac{£1{,}000}{(1 + i)^n}$$

where:
n = number of periods
i = the cost of capital/rate of return/interest rate per period.

The expression

$$\frac{1}{(1 + i)^n}$$

is the discount factor by which we multiply the future cash flow (here £1,000) to find its present value.

The reasons for the time value of money could include:

- the scope for earning a return if money received now can be reinvested;
- the risk associated with the delay in receiving cash;
- the expectation that the value of money will fall due to inflation.

Various names are given to the rate of return (10 per cent in the examples above):

- interest rate;
- discount rate;
- required rate of return;
- target rate of return;
- borrowing rate;
- yield rate;
- opportunity cost of capital;
- cost of capital;
- weighted average cost of capital.

4.2 Discounted cash flow analysis

d

discounted cash flow (DCF) analysis Technique for evaluating investment projects by identifying the future cash flows attributable to the project and calculating their present values so that they can be compared on a like-for-like basis. The present value of a future cash flow is the amount of money at today's date that has an equivalent value. The present value is calculated by discounting the future cash flow to allow for its timing and the cost of capital. The sum of the present values of all the project's cash flows is the net present value (NPV) of the project. The discount rate that makes the NPV of a project zero is the project's Internal Rate of Return.

Discounted cash flow (DCF) analysis determines the net value of a project in terms of today's money. It identifies all the cash flows associated with a project and calculates their present values so that they can be assessed on a like-for-like basis. The sum of the present values of all the project cash flows is the **net present value** (NPV) of the project.

DCF methods take account of all the cash inflows and outflows associated with a project over its full life and reflect the time value of money (as they take account of the timing of cash flows and the cost of capital) and so give a better picture of the profitability of a project than the other methods discussed so far.

The discount rate or cost of capital used in evaluating capital investment projects is generally the required rate of return of those investing in the firm, which we have seen to be its weighted average cost of capital (WACC). To calculate the cost of equity you may need to use the dividend growth model or CAPM, depending on the information provided

As we have seen, present values can be calculated by multiplying future cash flows by discount factors. (Examples of discount factor tables are provided as an Appendix to this book.) Find the column with the percentage discount rate and the row with the number of years from now for the cash flow you want to discount. For example, with a cash flow arising ten years in the future, for a company with a 5 per cent cost of capital, the discount factor is 0.614. Multiply the cash flow by 0.614 to find its present value.

5 Net present value

d

net present value The sum of the present values of all the cash flows associated with an investment project (see discounted cash flow analysis).

The concept of NPV is of vital importance in the field of corporate finance and we have already referred to it in previous chapters.

To determine the NPV of a project, we need to list all the cash flows related to the project. The net cash flows are then discounted at the cost of capital using the formula shown above. The decision rule in using the NPV technique is that if the NPV is positive, the project should be accepted, and if the NPV is negative, then the project should be rejected. The reasoning behind this is that when there is a positive NPV the project offers you a return in excess of your cost of capital and acceptance of such a project will increase the wealth of the company. For a negative NPV project the cost of capital is not covered and acceptance of such a project will reduce the value of the firm. The primary objective of the firm is, of course, to maximise shareholder wealth by maximising the value of the firm. The value of a company will increase by the NPV of a project provided that its WACC remains unchanged. The increase in wealth will be reflected in the share price because of the efficient market hypothesis (EMH), discussed in chapter 7.

The use of the NPV technique is best seen by considering an example.

The NPV of a project represents the absolute increase in shareholder wealth generated by a project. The NPV method assumes that all cash flows generated by an investment will be reinvested at the company's cost of capital. This is realistic, as the company's cost of capital corresponds to the rates available in the market, or the returns that can be achieved by investing in other projects.

5.1 Conventions used in NPV calculations

(a) *Presentation* – the best method of answering such questions is to set out all your cash flows and discount factors in a table, putting each year's cash flows in the same column or row. Examples of correct presentation are provided throughout this text.

WORKED EXAMPLE 12.2

A project has an initial cost of investment of £10,000 in a machine and the following expected cash inflows:

Year 1 = £6,000
Year 2 = £6,000
Year 3 = £6,000
Year 4 = £5,000
Year 5 = £5,000

No scrap value is expected from the machine. The cost of capital is expected to be 10 per cent throughout the five years of the project.

Required

Should the project be accepted?

The way to make this decision is to turn these future cash flows into present values either by the use of discount factor tables (see appendix), or the formula noted above. (Note that we shall use both of these methods in this chapter.)

Answer

Present value of machine revenues:

Year	*Net cash flows*	*Formula*	*Disc factor*	*Present value*
	£		£	
0	−10,000	–	1	−10,000
1	+6,000	$\frac{1}{(1 + 0.1)^1}$	0.909	5,454
2	+6,000	$\frac{1}{(1 + 0.1)^2}$	0.826	4,956
3	+6,000	$\frac{1}{(1 + 0.1)^3}$	0.751	4,506
4	+5,000	$\frac{1}{(1 + 0.1)^4}$	0.683	3,415
5	+5,000	$\frac{1}{(1 + 0.1)^5}$	0.621	3,105
	+18,000			NPV +11,436

If the cash flows are not discounted, the cash generated by the investment is as follows:

	£
Cash inflows	28,000
Less cash cost of machine	10,000
Cash gain	18,000

This cash gain is received over a period of five years. When the future cash flows are discounted , the net surplus is equivalent to £11,436 received now.

(*b*) *Signs* – the normal method is to regard cash inflows as positive and cash outflows as negative.

(*c*) *Years* – a simplifying assumption is made that all cash flows occur in discrete steps at the end of the year, but all initial outlays are regarded as occurring at the end of Year 0 and thus are not discounted (and so are given a discount factor of 1).

(d) Time periods always commence at the present, which is Year 0.

(e) The only relevant figures to put into an evaluation are those cash flows arising as a result of accepting the project. Thus, the concept of relevant cost, which you will have met elsewhere in your studies, should be applied in investment appraisal. For example, sunk costs and apportioned overheads are ignored in DCF calculations.

(f) Items such as depreciation, which are accounting concepts and not cash flows, are ignored (the value of fixed assets is already taken into account in the initial outlay required for the project and in any scrap value from the assets at the end of or during the project).

(g) Interest and repayment of loan principal are not included in the cash flows because this would be double-counting, as the sums have already been included in the cost of capital used. An exception is when finance is made available on special terms specifically for a particular project, so that the capital receipts and capital servicing costs are cash flows that are specifically part of the project. It may be that the cost of loan capital supplied in this way does not correspond to the cost of capital that would be used for other projects with similar combinations of risk and return. In this case, the funding cash flows should be treated as project cash flows and the cost of capital determined in the same way that it would be for other, comparable, projects.

5.2 Net terminal values

Instead of calculating the present values of a project's cash flows, expressing them all in equivalent amounts of cash paid or received today, the terminal values may be calculated. The cash flows are compounded (allowed to grow at the company's rate of return) up to the end-date of the project. The sum of the terminal values of all the project cash flows is the net terminal value (NTV). Any surplus or shortfall represented by a positive or negative NTV is expressed in terms of money at the project end-date.

WORKED EXAMPLE 12.3

An investment in Project R of £20,000 is expected to generate cash receipts of £6,000 at the end of Year 1, £8,000 at the end of Year 2 and £10,000 at the end of Year 3. The business can invest money at an annual rate of 10 per cent (the opportunity cost).

End of:	*Cash flow £*	*Compound factor**	*Terminal value £*
Year 0	(20,000)	1.331	(26,620)
Year 1	(6,000	1.210	7,260)
Year 2	(8,000	1.100	8,800)
Year 3	(10,000	1.000	10,000)
		Net Terminal Value =	(560)

The negative NTV shows that the project is not worthwhile.

*The compound factors reflect the fact that cash received at, for example, the end of Year 1 is available for investment for two years up to the end of Year 3. The compound factor, up to the end of Year 3, for cash received at the end of Year n is:

$(1 + i)^{3-n}$

where i = the annual interest rate.

Therefore for cash received at the end of Year 1 the compound factor is:

$(1 + 0.1)^2 = 1.210$

NTV may look less useful than NPV: the year at which the NTV is evaluated depends on the life of the project. The NTVs of two different projects with different project lives would therefore not be directly comparable. However, the concept of NTVs proves useful in calculating the modified internal rate of return, which we shall consider in section 6.1.

5.3 **Annuities**

If the level of cash flow is uniform from year to year, there is an easier method of calculating the NPV than using the discount factor tables. The easier method is to use annuity or cumulative discount factor tables (provided in the Appendix to this book and in your examination), which are the sums of discount factors over a number of years. Annuity tables show the present value of £1 received every year, starting one year from now and going on for n years. Find the column for the correct cost of capital and the row for the number of years. Worked example 12.4 shows how annuity tables can be used.

WORKED EXAMPLE 12.4

A company is considering investing in a project which will cost £5,000 and will yield cash inflows of £2,000 in Year 1 and £3,000 in each of the following three years. There is no scrap value at the end of the project.

Required

Should the investment be accepted if the company's cost of capital is 10 per cent?

Answer

First we need to set out the cash flows as before:

Year	*Cash outflow £*	*Cash inflow £*	*Discount factor*	*Present value £*
0	–5,000		1	–5,000
1	2,000	0.909	1,818	
2	3,000			
3	3,000	2.4868 × 0.9091	6,782	
4	3,000			
			3,600	

We can find the present values of the cash flows in Years 2, 3 and 4 in either of two ways. Both give the same result:

(a) The cash flows in Years 2, 3 and 4 are equivalent to (cash flows of £3,000 in Years 1, 2, 3 and 4) minus (a single cash flow of £3,000 in Year 1). This is the same as a four-year annuity minus a one-year annuity. Using a discount rate of 10 per cent, the values of these annuities are: 3.1699 – 0.9091 = 2.2608. To find the present value of the three cash flows in Years 2, 3 and 4 we multiply £3,000 by 2.2608

(b) The cash flows in Years 2, 3 and 4 are equivalent to (cash flows in Years 1, 2 and 3) all deferred by one year. This is the same as a three-year annuity with all the payments deferred by one year. The value of a three-year annuity, with a discount rate of 10 per cent, is 2.4868. If each payment is deferred by one year, the effect is to reduce the present value of each payment by multiplying it by the present value factor for one year: 0.9091. So we multiply the present value for the whole three-year annuity by 0.9091: 0.9091 × 2.4868 = 2.2607. The difference from the figure in (a) is due to rounding of the annuity values.

As the project gives a positive net present value it should be accepted.

Check the annuity-based calculations above by finding the present value of each cash flow separately, using your calculator or present value tables (also in the Appendix at the end of this book).

5.4 Annuities using time periods different from one year

If uniform cash flows occur on a basis other than once a year, standard annuity tables can still be used as follows: divide i, the annual interest rate, by the number of payments in a year. Instead of n, the number of years, multiply n by the number of payments in the year.

Example

Find the PV of a uniform series of receipts of £500 made half-yearly for two years, with an annual interest rate of 8 per cent.

i is replaced by $i/2 = 8\%/2 = 4\%$
n is replaced by $n \times 2 = 4$

The annuity for four years with an interest rate of 4 per cent is 3.6299

PV of cash flows is $3.6299 \times £500 = £1,815$

5.5 Perpetuities

When a project yields a sum of £1 every year for ever (starting one year from now), its present value can be calculated as:

$$PV = \frac{\text{cash flow}}{i}$$

where i is the interest rate.
For example, if the rate of return is 30 per cent, $i = 0.3$ and the present value of a perpetuity of £1 is:

$$PV = \frac{£1}{0.3} = 3.3333$$

A perpetuity is an annuity where the number of years has no limit. If you look at the annuity values in the Appendix to this chapter for an interest rate of 30 per cent, you will find that the value of a 15-year annuity is 3.2682. With an interest rate as high as 30 per cent, the present values of the cash flows after 15 years are very small, so the value of a 15-year annuity is close to the value of a perpetuity. The formula above corresponds to the dividend valuation model in chapter 4 if dividends remain constant.

5.6 NPV profile

For any project, the NPV can be calculated for a range of different values for the discount rate and drawn as a graph. This graph is often called an NPV Profile Curve. Figure 12.1 shows NPV profiles for two projects, X and Y.

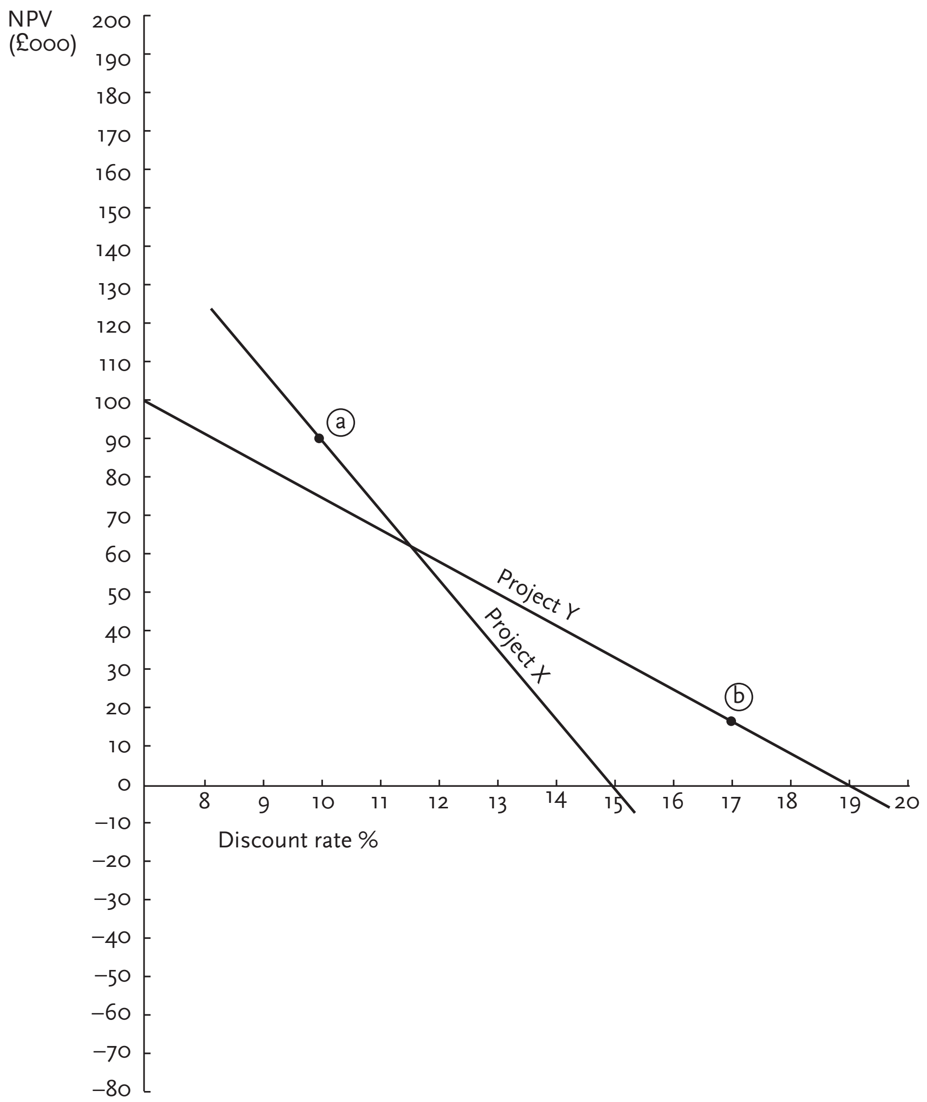
The net present value of a project at any selected discount rate can be read directly from the graph. For example:

(a) If the discount rate is 10 per cent, Project X has an NPV of £90,000 (point a) on the curve).
(b) If the discount rate is 17 per cent, Project Y has an NPV of just below £20,000 (point b on the curve).

The point of intersection of the two NPV profile graphs shows the discount rate below which one project is more profitable and above which the other project is more profitable. The NPV profile graphs for X and Y intersect at 11.5 per cent. Above this discount rate Y is more profitable (i.e. has a higher NPV); below it X is more profitable.

Where a NPV profile line cuts the horizontal axis, the NPV of the project is nil. The discount rate at this point is known as a project's internal rate of return (see later). X has an internal rate of return (IRR) of 15 per cent and Y has an IRR of 19 per cent.

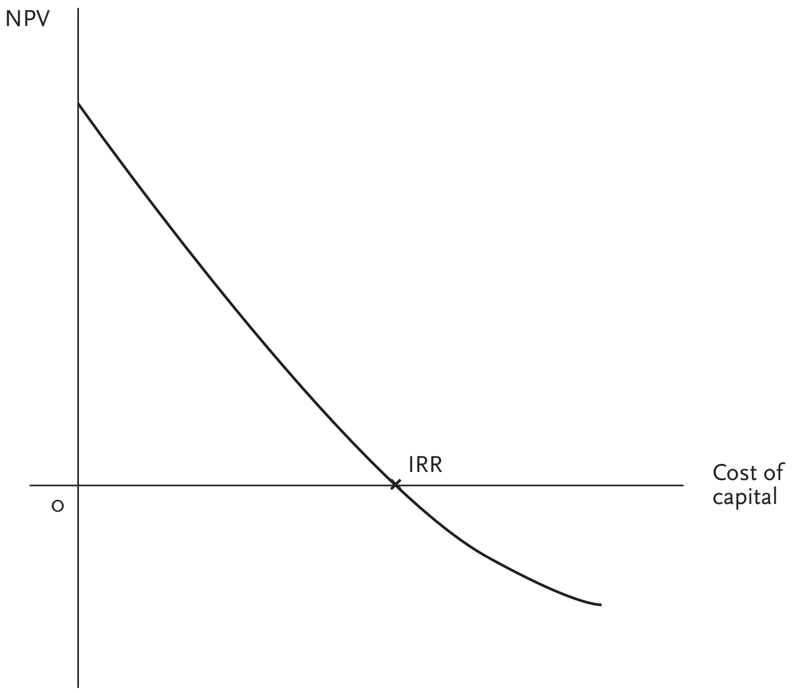
FIGURE 12.1 **NPV profiles of Project X and Project Y**



6 Internal rate of return

We stated above that the IRR of a project is the cost of capital or discount rate that makes the NPV of the project zero. The graph of NPV against cost of capital in Figure 12.2 shows the point where the graph of NPV cuts the horizontal axis. The value of the cost of capital at this point is the IRR.

FIGURE 12.2 **NPV against cost of capital**



THEORY INTO PRACTICE 12.2

The graph of NPV slopes downwards because a higher cost of capital means a lower NPV.

Why?

Answer

(a) A higher cost of capital or discount rate means that the discount factors are smaller (look at the discount tables in the Appendix, or the formula in section 4). This makes the present values of future cash flows smaller. But the present value of the initial cash outflow does not change as it is at the present time and the discount factor is 1 for any discount rate. So the sum of the present values of all the cash flows is reduced.

(b) Alternatively, the NPV represents the surplus when cash flows have been discounted to reflect the time value of money. We can consider the future cash inflows from a project as needing to pay back the initial cash outflows plus interest at a rate equal to the cost of capital. If the interest rate increases, the larger interest charges will reduce any surplus.

Since the graph of NPV slopes downwards, if the cost of capital is greater than the internal rate of return the NPV is negative, so the project should be rejected. If the cost of capital is less than the internal rate of return, the project should be accepted.

The internal rate of return can be found by trial and error: simply calculate the NPV at different discount rates until a discount rate is found that makes the NPV zero, or sufficiently close to zero. A discount rate equal to two thirds of the project's ARR is often found to be a good starting point.

Example

An investment of £20,000 is expected to generate cash receipts of £6,000 at the end of Year 1, £8,000 at the end of Year 2 and £10,000 at the end of Year 3. The business can invest money at an annual rate of 10 per cent (its opportunity cost).

Our aim is to find the discount rate that makes the NPV of the project zero.

To find two-thirds of the ARR as a first estimate of the IRR:

The ARR is the average profit/average investment. The total project profit is the total of the cash flows over the three years (which include any residual value for capital equipment) minus the total capital investment: £24,000 − £20,000 = £4,000. The average profit is £4,000/3 = £1,333. The average investment (assuming that the assets have no residual value) is £20,000/2 = £10,000.

ARR = £1,333/£10,000 = 13.33%

Two-thirds of ARR = 2/3 × 13.33 per cent = 8.9%

In fact we find that a discount rate of 9 per cent gives a NPV close to zero. Table 12.1 below shows the calculations at a discount rate of 9 per cent.
In fact, we find that a discount rate of 9 per cent gives a NPV close to 0. Table 12.1 shows the calculations at a discount rate of 9 per cent.

TABLE 12.1 Calculations at a discount rate of 9 per cent

End of year	Cash flows	Discount factor (discount rate 9%)	Present value
0	20,000	1.000	(20,000)
1	6,000	0.917	(5,502)
2	8,000	0.842	(6,736)
3	10,000	0.772	(7,720)
			NPV = (42)

An alternative to finding the IRR by trial and error is to calculate the NPV for two discount rates and use these two values to calculate the discount rate that gives a NPV of zero (assuming that the graph of NPV is a straight line). This method is known as interpolation. As an illustration of this method, worked example 12.5 shows how the company's IRR can be calculated for the example of Pierrot's redeemable debentures in section 4.2 of chapter 6. The IRR for an investment in redeemable loan stock at the current market price is calculated to find the cost of debenture capital. The cost of purchasing the debenture in the market is treated as an investment by Pierrot and the savings in payments of interest and redemption of capital (less tax savings on interest) are taken as the return to the company on its investment. The steps in calculating the IRR on this investment, which is the company's cost of capital, are:

- calculate NPV of cash flows for a low discount rate;
- calculate NPV of cash flows for a high discount rate;
- substitute the NPV and discount rate figures in the formula given below.

WORKED EXAMPLE 12.5

Pierrot plc has redeemable 10 per cent loan stock, redeemable on 31 December 2005, with a current market price on 31 December 2002 of £95.60 per £100 nominal. Interest is payable on 31 December each year. Tax relief at the assumed corporation tax rate of 30 per cent is given on interest one year after interest is paid.

Required

Find the cost of the loan stock capital.

Answer

Pierrot's cash flows for £100 nominal of 10 per cent loan stock 2005 are shown below, together with the present values of the cash flows using two different discount rates. The discount rates used here are 6 per cent and 12 per cent:

WORKED EXAMPLE 12.4 CONTINUED

	Year	*Cash flow £000*	*Discount factor (6%)*	*Present value (6%) £000*	*Discount factor (12%)*	*Present value (12%) £000*
Current market price	2002	(95.60)	1.0	(95.60)	1.0	(95.60)
Interest (31 Dec 03)	2003	10	0.94	9.40	0.89	8.90
Tax relief (31 Dec 04)	2004	(3)	0.89	(2.67)	0.80	(2.40)
Interest (31 Dec 04)	2004	10	0.89	8.90	0.80	8.00
Tax relief (31 Dec 05)	2005	(3)	0.84	(2.52)	0.71	(2.13)
Interest (31 Dec 05)	2005	10	0.84	8.40	0.71	7.10
Redemption (31 Dec 05)	2005	100	0.84	84.00	0.71	71.00
Tax relief (31 Dec 06)	2006	(3)	0.79	(2.37)	0.64	(1.92)
				7.54		(7.05)

The IRR can be calculated using the following formula:

$$\text{IRR} = \text{lowrate} + \left[\frac{\text{NPVlowrate}}{(\text{NPVlowrate} - \text{NPVhighrate})} \times (\text{highrate} - \text{lowrate})\right]$$

$$= 6\% + \left[\frac{7.54}{(7.54 + 7.05)} \times (12\% - 6\%)\right]$$

$$= 9.1\%$$

This is the cost of debenture capital.

Note that a project with a higher IRR may not necessarily be better than a project with a lower IRR as IRR is a relative measure. A 30 per cent return may sound excellent, but if the investment is small the surplus return in excess of the cost of capital, when calculated in £, may not be large. A larger project with a lower IRR – still above the cost of capital – may generate a larger surplus.

It is also important to note that IRR calculations assume that surplus cash flows are invested to earn a return at the project's own 'internal' rate. However, suitable investment opportunities to do this may not be available at the times when the cash flows are generated by the project.

6.1 Solutions: a possible further drawback of IRR

Most capital investment projects involve an initial investment – with cash outflows – followed by a series of cash inflows in later years. This is called a conventional cash flow pattern. Sometimes the cash flows change direction in later years. Typically, this happens when there are closure costs that cause cash outflows at the end of the project. An example of this is a nuclear power station, where decommissioning costs at the end of the station's life are very high. Another example is a chemical production facility, where decontamination has to be undertaken when the facility is closed down, at a cash cost greater than any operating cash inflow in the final year. If the cash flows change direction more than once (in the two examples quoted here, they would change direction twice) the cash flows are said to be 'non-conventional'. With non-conventional cash flows, the internal rate of return can take more than one value. Table 12.2 shows what can happen:

TABLE 12.2 **Present values of cash flows £m**

Year	Cash flow £m	Discount rate 7%	8%	9%	10%	11%	12%	13%	14%
0	(101)	(101)	(101)	(101)	(101)	(101)	(101)	(101)	(101)
1–15	22 pa	200.4	188.3	177.3	167.3	(158.2	149.8	142.2	(135.1
16	(300)	(101.6)	(87.6)	(75.6)	(65.3)	(56.5)	(48.9)	(42.4)	(36.9)
Net Present Value		(2.2)	(0.3)	0.7	1.0	0.7	(0.1)	(1.2)	(2.8)

(The present value of the series of cash flows between Year 1 and Year 15 can be calculated using annuity tables.)

The NPV is zero with a discount rate of about 8 per cent and also with a discount rate of 12 per cent. Between 8 per cent and 12 per cent, the NPV is positive. Below 8 per cent, or above 12 per cent, the NPV is negative. What does this mean? Not much to practical people - a slightly different approach is required. The modified internal rate of return, or adjusted internal rate of return, is calculated as follows.

Modified IRR

Instead of assuming, as the basic IRR calculation does, that every surplus £ earns a positive return at the same rate as has to be paid for every £ invested (i.e. the same internal rate of return for positive and negative cash flows), we determine the rate of return that can be obtained on all the company's surplus funds. This might be a company-wide figure for the return obtainable on capital invested in projects, or alternatively the interest rate on bank deposits or other short-term investments. The choice may depend on the number of projects in which surplus funds may be invested. If there are many such projects, it may be realistic to compound surplus cash flows at the rate of return available from projects. If not, it may be more appropriate to assume a bank deposit rate. Let us assume that the return on surplus funds is 4 per cent p.a.

Compound all the positive cash flows to the terminal date (here 16 years from the present). This means that the cash flow of £22 million received in Year 1 grows with interest at 4 per cent p.a. for 15 years up to Year 16, giving a terminal value of £39.6 million. The cash flow of £22 million received in Year 2 grows at 4 per cent p.a. for 14 years up to the terminal date, giving a terminal value of £40.7 million. The total of the terminal values of the positive cash flows in Years 1–15 is £458.1 million.

Subtract the negative cash flow at Year 16 to give a total terminal value of all cash flows after the initial investment of £458.1 million – £300 million = £158.1 million.

Find the annual compound growth rate needed for the initial cash flow of £101 million at Year 0 to grow to £158.1 million by Year 16. This is given by:

$$\pounds 101\text{m} \times (1 - \text{r})^{16} = \pounds 158.1\text{m}$$

which gives r = 0.028 = 2.84 per cent. This is the modified internal rate of return or adjusted rate of return.

The rather meagre return on this project reflects the assumption that surplus funds generated in Years 1–15 will earn a return of only 4 per cent and not some possibly higher rate of return that they might get if they were reinvested in other projects.

d

profitability index Ratio for a capital investment project used to put capital investment projects in order of priority for allocation of funds, since it shows how much surplus a project offers over the cost of capital for every £ invested.

7 Profitability index (PI)

The **profitability index**, sometimes referred to as the cost/benefit ratio, is calculated by the formula:

$$\frac{\text{PV of future inflows}}{\text{PCV of future investment outflows}} \text{ (discounted at the cost of capital)}$$

A project with a PI greater than 1.0 should be accepted. In the case of competing projects, the highest over 1.0 will generally be preferred.

Thus, where capital rationing is important, the PI can be used to help to rank projects in order of relative profitability. Use of the profitability index in capital rationing is described in more detail in chapter 13.

8 Comparison of methods

As with other areas of financial modelling, each method of investment appraisal has its drawbacks and many firms use more than one method.

The ARR ignores both the timing of cash flows and the opportunity cost of capital, but it is used in practice in approximately half of all companies.

The payback method ignores the time value of money and total cash flows over a project's life once the payback period has been reached. However, it is often used in practice as a screening device, being considered to provide a fair approximation to NPV if cash flows follow a pattern. It is useful when firms have liquidity problems or are perhaps producing novelty products which require a quick repayment of investment.

8.1 Comparison of NPV and IRR

We noted above that it is generally preferable to use a method of investment appraisal that discounts cash flows, the two main methods being IRR and NPV. Both techniques are acceptable in capital investment appraisal if an organisation can accept all projects which are beneficial to it. However, when there is capital rationing NPV is the better method, as IRR can wrongly rank the projects. This superiority can be proven using the incremental approach.

Example

Zak plc has only the space to implement either Project X or Project Y; both projects last one year and have the following details:

	Cash flow Yr 0	*Cash flow Yr 1*	*IRR*	*NPV @ Cost of Capital 10%*
Project X	(£10,000)	£20,000	100%	£8,182
Project Y	(£20,000)	£35,000	75%	£11,818

NPV and IRR give different rankings. To find which is the better we need to use the incremental cash flow approach.

Firstly, let us accept Project X which is the preferred project using the IRR technique. If this is the correct choice, then the incremental cash flows of Y − X will not produce an IRR which is acceptable (i.e. it will be lower than the cost of capital).

Consider the differences to cash flows if we move from Project Y to Project X:

	Cash flow Yr 0	*Cash flow Yr 1*	*IRR*	*NPV @ 10%*
change =	(£10,000)	£15,000	50%	£3,636

IRR of 50 per cent is acceptable, therefore using IRR as an appraisal tool we should accept X and (Y − X), but X + (Y − X) = Y. Thus, Y should be chosen (as per NPV) and we have used IRR to prove that NPV is the superior method.

NPV is also useful for evaluating interrelated projects and demonstrates the size of the surplus generated by a project. IRR has the problem that it can give multiple IRRs (though we have seen how this can be dealt with by calculating the modified IRR).

Despite the advantages of NPV over IRR, IRR is widely used, because:

- It is better at highlighting the rate of return against the cost of capital.
- It can be calculated on the basis of project cash flows alone. NPV needs a discount rate and not all companies know their cost of capital. Even if they do not, managers may be able to decide that an IRR calculated to be (say) 5 per cent is too low, or an IRR of 25 per cent is acceptable.
- It may be intuitively more appealing to non-specialists. It may be easier for a non-accountant to make sense of the information that 'Project A gives a return on capital of 25 per cent' than 'the NPV of Project A is £8,500'.

9 Impact of taxation on capital investment appraisal

Taxation must be taken into account in DCF analysis, as tax payments can have an important impact on project cash flows and you should include additional columns or rows in your DCF analysis to allow for taxation.

Capital investment appraisal is affected by taxation in four main ways:

1. Annual profits are taxed, under current rules for large companies, half in the year when they are made and half in the following year. You must read the question carefully to see what assumptions the examiner has made. You may, for example, be told that tax is to be paid in the year following that in which the taxable income arises (which would mean that a four-year project would need a five-year table).
2. Interest on debt is allowable against corporation tax and this will affect the discount rate used.
3. Tax losses must be included and will normally give rise to tax relief one year later.
4. The tax bill may be reduced by grants and capital allowances, increasing the chance of a project being acceptable. Read examination questions carefully for details of any such allowances. The most common allowances in examinations (and in practice) are writing-down allowances calculated on a reducing balance basis.

Capital allowances on plant and machinery are provided by means of writing-down allowances (WDAs) at the rate of 25 per cent of the written down value (WDV) of the asset. WDV is the original cost less capital allowances previously given. The rate of allowance on industrial buildings is 4 per cent, also on a reducing balance basis.

When appraising a capital investment scheme you should also be aware of the possibility of changes in the tax regime (for example the removal of government grants or the availability of new government or EU funding) as risk factors affecting an investment project.

CHAPTER SUMMARY

- In this chapter we have discussed the various methods used in firms when undertaking capital investment appraisal.
- While no one method is perfect, we have seen that the best single method is probably NPV and you should use this unless told otherwise in an exam question.
- However we have seen that many companies use more than one method, as different techniques for evaluating investment projects deal with different aspects and give different insights.
- We have also considered the impact that a country's taxation regime can have on investment appraisal.

PRACTICE QUESTIONS

Section A (4 marks each)

12.1 Why are capital investment decisions important?

12.2 What are the main drawbacks of the ROI and payback methods of capital investment appraisal?

12.3 Outline the principles of the DCF approach to capital investment appraisal.

12.4 Explain the term Net Present Value and explain the significance of a NPV profile.

12.5 What advantages do Discounted Cash Flow methods of capital investment appraisal have over Accounting Rate of Return and Payback Period in the evaluation of capital investment projects?

12.6 A company is considering three projects, in the same business area and with similar risk. The cash flows of the three projects are as follows:

	Project A	Project B	Project C
	£ million	£ million	£ million
Year 0	–9.0	–0.9	–4.5
Year 1	3.0	0.3	1.5
Year 2	5.0	0.5	2.5
Year 3	4.0	0.4	2.0

The NPV of Project A is £1.0 million and its IRR is 15%. Calculate:

the NPV of Project B;
the IRR of Project C?

You do not need to show any working, but should state briefly why you have given the answer you show.

12.7 Explain why, despite its drawbacks (which you should identify), Accounting Rate of Return is still widely used in the evaluation of capital investment projects.

12.8 Explain why many companies use their weighted average cost of capital (WACC) to evaluate capital investments, and what particular assumptions they make in using WACC for this purpose.

12.9 Explain why, although it does not reflect the time value of money, and therefore does not give a good measure of profitability, payback period is widely used by companies in evaluating capital investment projects.

12.10 Company A has evaluated an investment project and has found that it has a negative NPV when cash flows are discounted at 10% p.a. Is the IRR on the investment project more or less than 10%? State the reason for your answer.

12.11 Company B is considering two investment projects: Project Q and Project R, which are mutually exclusive. Their initial investments and NPVs are as follows:

	Project Q	Project R
Initial investment	£10.0 million	£2.0 million
NPV	£6.0 million	£2.0 million

Company B has only a limited amount of money available for investment, and expects to have to ration capital investment funds.

Suggest, giving your reasons, which project should be chosen by Company B on the basis of the information provided.

12.12 Identify four situations in which a corporate financial manager might do calculations or use formulae, Based on NPV, IRR or other discounted cash flow methods.

12.13 A company is carrying out the initial screening of several possible capital investment projects. One of these projects has the following forecast cash flows:

	£000
Year 0	–125
Year 1	30
Year 2	45
Year 3	70
Year 4	45

In any given year from Year 1 to Year 4, the cash inflow is expected to occur at a uniform rate over the whole year. Calculate the payback period in years, correct to one decimal place, and comment on the value of payback period as a measure to evaluate capital investment projects.

12.14 A company has issued 8 per cent redeemable preference shares of £1. Dividends are paid annually, and the first dividend is due to be paid one year from now. The shares are due to be redeemed at par eleven years from today. Calculate the ex-dividend price that an investor would be willing to pay for the preference shares if he required a return of 9 per cent p.a.

12.15 The corporate financial department of a group of companies is considering the commitment of capital investment funds for the coming year. It has received bids for funds for projects of a similar kind from two of its divisions. The information provided by the divisions is as follows:

	Division A's project	**Division B's project**
Initial investment	£4 million	£7 million
Duration of project	4 years	5 years
Accounting rate of return	23%	21%

Suggest why it might be unwise to rely on a comparison of the accounting rates of return to choose between the projects.

12.16 A company has evaluated a possible investment project. As part of its evaluation, it has calculated the NPV, IRR and ARR attributable to the project. The NPV (using the company's cost of capital as the discount rate) is negative. The IRR is less than the cost of capital, and the ARR is greater than the company's target figure. The directors are planning to go ahead with the project. Suggest possible reasons why they may have decided to do so.

12.17 A company is evaluating a capital investment project with the following cash flows:

	Cash flow (£ million)
Year 0	–20.0
Year 1	6.0
Year 2	12.0
Year 3	8.0
Year 4	4.0

Using the company's cost of capital of 18% to discount the cash flows, the NPV of the project has been found to be £0.635 million. Calculate the NPV of the project with a discount rate of 20%, and also calculate the IRR.

Section B (20 marks each)

12.18 (a) Identify and outline briefly the main methods of capital investment appraisal, including discounted payback period and modified IRR.

(b) Explain in what way NPV and IRR are complementary.

12.19 (a) Compare and contrast the NPV and IRR methods of capital investment appraisal.

(b) A project has an initial cost of investment of £25,000. It is expected to produce the following cash inflows:

Year 1 £3,000

Year 2 £4,500

Year 3 £9,000

Year 4 £11,500

No scrap value is expected. The cost of capital is expected to be 9 per cent over the four years.

The company requires all capital investment projects to achieve payback within four years or less.

Comment on whether the project should be accepted.

12.20 (a) Epsilon plc is considering marketing a new product with a four-year life. Epsilon will need to install new equipment to manufacture the product. Epsilon has to choose between two machines both of which would be suitable. Machine 1 costs £460,000 to purchase and install, and will have a residual value of £20,000 at the end of four years. Machine 2 costs £630,000 to purchase and install, and has a residual value of £30,000 at the end of four years. Machine 2 takes slightly longer to install and commission, but once in operation it has slightly lower operating costs per unit, and will eventually produce more output. The following projections have been prepared of the cash flows from product sales and operating costs for the two machines:

	Machine 1		Machine 2	
	Sales income	Operating costs	Sales income	Operating costs
	£000	£000	£000	£000
Year 1	1340	1160	700	610
Year 2	1460	1260	1400	1100
Year 3	1300	1140	1600	1240
Year 4	820	760	900	750

The company's cost of capital is 12% p.a.

All capital investments have to achieve a payback period of three years or less.

Required

Do calculations to show which project should be accepted, and advise the management.

(b) Epsilon is considering new investment to replace its existing fire detection and inert gas extinguishing system. The investment has to be made for safety, legal and contractual reasons, and there are two possible systems under consideration. It is not practical to assess the income or cash flows arising from the investment, but neither of the possible systems is expected to give rise to any difference in the income of the business. Reliable estimates have been made of the initial investment costs of the two systems and of the annual cash operating costs. The two systems are both expected to have a useful life of ten years. One of the systems has higher costs for purchase and installation, and the other is expected to have higher cash operating costs. How can Epsilon determine which system is financially preferable?