8 INVESTMENT APPRAISAL

After studying this chapter, you should:

- *understand what is meant by the time value of money;*
- *be able to carry out a discounted cash flow analysis to assess the viability of a proposed investment proposal;*
- *be able to interpret a discounted cash flow analysis in commercial terms.*

8.1 INVESTMENT PROPOSALS

Successful companies are always looking at ways in which they can change and develop. The senior management will be faced with a number of different proposals, ranging perhaps from the development of a new product to establishing a company presence in a new part of the world. The company will only have a limited amount of money of its own available and lenders and investors will only be prepared to offer limited amounts. The management is therefore faced with the need to decide which of the proposals to support.

There is no single way of assessing and comparing the different proposals; factors that must be taken into consideration include, for example:

- the extent to which the proposals are consistent with the company's long-term plans;
- the risk attached to the proposals;
- the availability of the necessary resources even if the money is available.

One important criterion, however, is the financial one: which of the proposals will give the best return on the investment? The usual way of determining this is to use the method known as **discounted cash flow** (DCF) and this is what we shall describe in this chapter.

It is important to realise that DCF is a tool that is used for many different purposes, for example:

- by investors on the stock market to assess whether the share price of a company reflects accurately its financial prospects;
- to assess whether it is better to purchase capital equipment or to lease it;
- to decide which of several possible projects is the most financially appealing;
- to decide whether a proposed capital project will be worthwhile.

In this book, however, we are concerned almost exclusively with the third and fourth of these.

8.2 THE TIME VALUE OF MONEY

Advertisements for cars often make offers like the following:

New Wolseley Hornet
£8,995 or
only £500 down and £400 per month for 24 months

Suppose that you have £8,995 available so that you could pay cash if you decided to. Would you be better off at the end of two years paying cash at the beginning or taking the easy payment terms? We shall show how to answer this question a little later. For the moment, we consider a simpler situation.

Suppose that you have £100. You can choose to deposit it with a bank or some other savings organisation. If the rate of interest is 3 per cent, then in a year's time you will have £103. In other words, the promise of £103 in a year's time is worth the same as £100 now. This simple example illustrates what is known as the **time value of money**. It forms the basis of discounted cash flow analysis.

In general, if the interest rate is r (expressed as a fraction such as 0.03, not a percentage), then the present value of a sum of money X due in t years' time is

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

The quantity $1/(1 + r)^t$ is known as the **discount factor**. Table 8.1 shows the discount factors for periods up to five years for a range of interest rates:

To use this table, we look for the cell in the row corresponding to the discount (interest) rate and the column corresponding to the time period. The value in this cell gives the discount factor. Thus the discount factor for a discount rate of 8 per cent over a period of four years is 0.7350. This means that, if the discount rate is 8 per cent, the present value of a sum of £1,000 payable in four years' time is £1,000 × 0.7350 = £735.

We are now in a position to tackle the question of buying the car. The easy terms on offer mean we pay £500 now, £400 at the end of the first month, another £400 at the end of the second month, and so on until the end of the 24th month. Using the idea of discount factors, we can calculate the present value of each of those monthly payments. If we add the present value of all those payments to the £500 that we have to pay immediately, we shall obtain the present value of the total of the payments we have to make. If this is more than £8,995, we shall be better off buying the car outright immediately.

Table 8.1 Discount factors for periods up to five years

Interest rate	1	2	3	4	5
3%	0.9709	0.9426	0.9151	0.8885	0.8626
4%	0.9615	0.9246	0.8890	0.8548	0.8219
5%	0.9524	0.9070	0.8638	0.8227	0.7835
6%	0.9434	0.8900	0.8396	0.7921	0.7473
7%	0.9346	0.8734	0.8163	0.7629	0.7130
8%	0.9259	0.8573	0.7938	0.7350	0.6806
9%	0.9174	0.8417	0.7722	0.7084	0.6499
10%	0.9091	0.8264	0.7513	0.6830	0.6209
15%	0.8696	0.7561	0.6575	0.5718	0.4972
20%	0.8333	0.6944	0.5787	0.4823	0.4019

The discount rate that we need to use in doing our calculations is the rate of interest that we would receive on our £8,995 if we left it in our savings account. Let us assume that this is around 3 per cent per year. We, however, need the equivalent monthly rate and this is 0.2466 per cent per month. (The equivalent monthly rate is not simply 1/12th of the annual rate because the interest is compounded. The monthly equivalent of a rate of r (as a fraction) is ($(1+r)^{\frac{1}{12}}-1$.) With this discount rate, the discount factors at the end of the months 1 to 3 are 0.9975, 0.9951 and 0.9926. The present values of the first three £400 payments are thus £400 × 0.9975 = £399.02, £400 × 0.9951 = £398.03 and £400 × 0.9926 = £397.05. The necessary calculations are tedious but, fortunately, spread sheets such as Excel have a built-in function for calculating the net present value of a series of payments at a given discount rate. The result of applying this function (NPV) to a sequence of 24 payments of £400 with a discount rate of 0.2466 per cent is a net present value of £9,310.30. To this we must add the £500 down payment. This shows that the net present value of the payments on easy terms is £9,810.30. Clearly we shall be much better off by buying the car outright for £8,995 if we have the money available.

8.3 APPLYING DCF TO A SIMPLE INVESTMENT PROJECT

The essence of investment is that money is spent now so as to produce benefits in the future; assuming those benefits can be quantified in monetary terms, we need to ask what their present value is. To do this, we calculate the net cash flows that the project will generate over each year of its life and convert these to a present day value. Then we add these up to get the net present value (NPV) of the project as a whole.

As an example of simple DCF analysis, consider a small computer maintenance company. The company has one van that it uses for transporting computers that cannot be repaired on site to and from its workshop. When things are busy, the one van is not enough and the company often has to rent a second van. It is considering whether it is worthwhile to buy a second van.

A new van will cost £10,000. There will be annual costs of £500 for insurance and £150 for road tax. The cost of maintenance is estimated to be £200 in each of the first two years, £300 in year 3, £400 in year 4 and £500 in year 5. At the end of the fifth year, it is expected that the van will be sold for around £2,000. The interest rate that the company pays on its borrowings is 10 per cent. Van hire costs £30 per day and it hires a van for about 100 days a year. All the costs are subject to inflation, which is judged to be around 5 per cent over the period but the resale value of the van is the cash figure expected at the time.

Table 8.2 shows the cash flows in the two cases. Most of the figures are in brackets, indicating negative cash flows, because the flows of cash are out of the company.

Table 8.2 DCF analysis of van purchase v. leasing

	Year 0	Year 1	Year 2	Year 3	Year 4
Buying a van					
Van purchase/sale	(10,000)				2000
Tax and insurance	(650)	(683)	(717)	(752)	(790)
Maintenance	(200)	(210)	(331)	(463)	(608)
Annual cash flow	(10,850)	(893)	(1,048)	(1,215)	602
NPV of annual flow	(10,850)	(812)	(866)	(914)	412
	(13,030)				
Continuing to rent					
Annual costs	(3,500)	(3,675)	(3,859)	(4,052)	(4,254)
NPV of annual costs	(3,500)	(3,341)	(3,189)	(3,044)	(2,906)
Total NPV	(15,980)				

The NPV of the cost of continuing to rent is £15,980, while the NPV of the cost of buying a van is £13,030. We conclude that the company will be better off by buying a van. This conclusion depends, of course, on the validity of the assumptions. The main uncertainty is in the number of days for which a van would have to be rented. If the company's business expands, so that it would have to rent a van more often, the cost of the rental option would increase so that buying would have more of an advantage. If, however, business declined or the company were able to use the existing van more efficiently, the cost of the rental option would decrease and the advantage of buying would be reduced or even disappear.

8.3.1 Timing of the cash flows

The analysis assumes that the cash flows take place at the start of each period, so that the discount factor for year 0 is 1. In other words, the first payments are at the start of project so that their net present value is their actual monetary value. This is realistic for the costs involved in buying the van; the cost of the van itself is due when it is bought, which is effectively the start of the project, while the insurance and the road tax are both due at that point and on the same date in succeeding years. Only the comparatively small maintenance costs occur at different points during the year.

This assumption about the timing of the cash flows is not, however, valid for the rental option. The maintenance company is likely to have an account with the rental company so that it receives monthly invoices for the rentals in the previous month, so that the cash flows are distributed throughout the year. If we assume that 'on average' the rental costs are paid half way through the year, we can correct for the result of assuming that the cash flows take place at the beginning of the period by applying a further six month discount factor to the NPV. This factor is the square root of the annual discount factor, 0.9091, that is, 0.9535. The resulting NPV is £15,237. The advantage of buying the van is thus slightly less than in the original calculation but is still significant.

8.3.2 Cost of capital

We said that the company pays 10 per cent interest on its borrowings and we assumed that it would have to borrow the money to buy the van. This is an over-simplification.

Even if the company has the cash available to buy the van outright, there is still a cost because the company will lose the income it could have received by investing the money somewhere else, in a suitable interest bearing account for example. Such a cost is known as an **opportunity cost**. If the company is able to pay cash for the van, this is the interest rate it would be appropriate to use in the DCF analysis.

As we have seen in Chapters 4–6, large companies raise money by taking loans, the rate of interest on which may be fixed or variable, by the issue of shares, on which dividends may be paid, or by retaining profits. When a large company invests in new projects, the money required is likely to come from a combination of these. The company's financial director is expected to carry out arcane calculations to balance the cost of money from these different sources and come out with a single figure for the cost of capital, which the company will use in appraising all investment proposals.

8.3.3 Handling inflation

Inflation in a financial context means the fall in the value of money over time. It is usually expressed as an annual percentage. Thus, for example, an inflation rate of 5 per cent means that in a year's time goods that today cost £100 will cost £105. In two years' time, they will cost £100 × 1.05 × 1.05 = £110.25. The inflation rate can vary very much from time to time and from country to country. Typically, in countries with a stable economy it will be under five per cent while in countries where the economy is disintegrating and out of control it can rise to several thousand per cent.

The presence of inflation means that the 'monetary' rate of interest, that is, the rate that is normally quoted is something of a delusion. £100 invested at a quoted interest rate of 10 per cent, will be worth £110 in money in a years' time. However, if the rate of inflation is 5 per cent, this £110 will only buy as much as £110/1.05 = £104.76 would buy today. Thus the real rate of interest is only 4.76 per cent.

In the example, we initially estimated all costs in today's pounds. We then assumed an inflation rate of five per cent and adjusted the cash flows for future years to take this into account. We used the 'monetary' rate of interest rather than the 'real' rate. In normal economic conditions this is the simplest way to carry out a DCF analysis. It is perfectly possible, however, to carry out a DCF analysis ignoring inflation and using the 'real' rate of interest as the discount factor.

8.3.4 Financial cash flows

It is not necessary to include the cash flows associated with borrowing the money to buy the van, that is, the cash inflow when the bank loan is received and the interest payments made to the bank. The DCF analysis automatically takes these into account so that the same result is obtained whether or not they are included.

8.4 ASSESSMENT OF A SOFTWARE PRODUCT PROPOSAL

As a more sophisticated example, we consider a company that is assessing a proposal for the development of a software product. It is estimated that three people will be required for development in the first year and a further person and a half in the second year; suitable staff cost £35,000 per year, including the employer's pension and National Insurance costs. The product will be released in the second year. After the second year, maintenance is expected to require one person, full-time. Sales and marketing costs are estimated to be £20,000 in the first year, rising to £30,000 for each of the next four years. The product itself is a fairly high value but specialised product. It is expected that about 100 copies will be sold over this period, at around £5,000 a copy. Table 8.3 shows the DCF analysis of the project over a five year period, using 10 per cent as the (monetary) cost of capital.

In Table 8.3, we have shown additional entries for the **cumulative present value**. This is the NPV at the end of the first year, the NPV at the end of the second year (that is, the present value of the cash flows for the first two years), and so on. The NPV of the project over its five year life is the cumulative present value at the end of year 4, shown in the bottom right hand entry, £52,993, but there are other measures of a project's attractiveness which can be deduced from this table. One is the **pay-back period;** this is the time required for the project to achieve a positive net cash flow. For the project in the table, this is a little over four years, since the cumulative cash flow at the end of year 3 (£3796) is close to zero, and the cumulative cash flow is firmly positive by the end of the year 4. (The term **simple pay-back period** is sometimes used to refer to the pay-back period calculated without taking into account the time value of money.)

Table 8.3 DCF analysis of a proposed software package development

	Year 0	Year 1	Year 2	Year 3	Year 4
Development cost	105,000	55,125			
Maintenance			38,588	40,517	42,543
Sales and marketing	10,000	21,000	22,050	23,153	24,310
Number of sales		10	20	40	30
Revenue		50,000	100,000	200,000	150,000
Net cash flow	(115,000)	(26,125)	39,363	136,331	83,147
Discount factor	1	0.9091	0.8264	0.7513	0.6830
Present value	(115,000)	(23,750)	32,529	102,425	56,789
Cumulative present value	(115,000)	(138,750)	(106,221)	(3,796)	52,993

The pay-back period is important in a project like this one because predicting the sales of a software product three or four years ahead is a very uncertain activity. A project that promises a pay-back within two years will therefore usually be preferred to one whose pay-back period is four or five years. The same thing would not necessarily be true of a project in a more stable industry such as electricity generation, where it is quite normal to look 20 years ahead and to accept projects whose pay back periods are 10 years.

It is also possible to calculate the **internal rate of return** (IRR) on the project. This is the cost of capital which would lead to the NPV being precisely zero. The calculation involves some difficult mathematics but, fortunately, most spread sheets provide a function to calculate it. The IRR is the maximum cost of capital at which the project would be viable. For the figures in the table, it is 23 per cent. The term **accounting rate of return or simple return on investment** is used to denote the average annual benefit as a percentage of the average investment.

There are times when interest rates can fluctuate quite violently, even in basically stable economies. This happened, for example, in the UK in the mid-1970s and again in the late 1980s. The IRR is a useful guide to the viability of a project in such an environment. An IRR of 23 per cent at a time when the company's cost of capital is 10 per cent means that the viability of the project will not be affected by any likely increase in interest rates.

A proposal will normally be rejected out of hand if its NPV is not positive, if its pay-back period is greater than some pre-set threshold or if its IRR is less than the current cost of capital. If there still remain projects between which a choice must be made, the organisation should probably choose those which have the highest positive NPV. This, however, usually reflects a long-term view and other pressures may cause companies to accept the projects with the highest IRRs or the shortest pay-back periods.

8.5 PITFALLS OF DCF

Because of its apparently precise nature, there is a tendency to put too much trust in DCF analysis. However precise the calculations, the cash flow predictions are inherently uncertain. An example of the case where uncertainty is comparatively low, is the replacement of plant or equipment in the manufacturing or process industries. If the new plant is installed and functioning correctly by the scheduled date and if market conditions do not change dramatically, the cash flow predictions should be reasonably accurate and the major source of uncertainty is the cost of capital; there are, of course, plenty of occasions when the assumptions about installation of the plant and market conditions will prove false but this is likely to be the exception rather than the rule.

If we use DCF analysis to assess a proposal for developing a software product, as we have done above, then the sources of uncertainty are very much greater. Although a net present value of £52,993 and an IRR of 23 per cent look attractive, we must take into account that:

- most software projects take more effort than expected;
- most software doesn't work very well when it's first released;

- we may not manage to sell as many copies as we expected;
- there is a considerable risk that a competitor will launch a similar product before ours is ready.

We need to assess how sensitive the project is to such risks. The way to do this is to carry out a series of DCF analyses with different estimates of the cash flows and the discount rate and see how the results change. If the project remains attractive under the different sets of assumptions, it is comparatively low risk; if it becomes unattractive under small changes, then it is high risk and should probably be rethought. In the given example, if the sales in year 3 drop from 40 to 20, the cash flow never becomes positive. Predicting sales this far ahead is very uncertain, so the project should be regarded as high risk. On the other hand, if the price is increased to £6,000, the NPV rises to £117,420 and the pay-back period falls to two years. This sensitivity to changes in sales volumes and selling price is characteristic of software product developments.

FURTHER READING

The following book is highly recommended. It contains a lot of more detailed material specifically concerned with the assessment of IT investment proposals, as well as some material covering other aspects of finance and accounting:

Blackstaff, M. (2012) *Finance for IT decision makers: a practical handbook*. 3rd ed. British Informatics Society, London.

The book by Atrill and McLaney recommended at the end of Chapter 5 also covers the material in this chapter.

Much of the other literature on discounted cash flow is aimed at investors on the stock market or in other financial markets. It is not therefore directly relevant to the appraisal of alternative investment proposals within a company.