FINANCIAL MANAGEMENT
FOR DECISION MAKERS

NINTH EDITION

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Real World 5.1

Getting into deep water

The following is an extract from an article in which it is argued that oil and gas businesses have pursued a strategy of 'volumes over value'. This has led them to invest in deep water projects with large reservoirs of oil and gas that do not provide the best use of capital invested.

> **Operators chased opportunities in deep water in the hopes of finding large accumulations that could be significantly accretive to their production and cash flow. Many operators, in fact, found these large accumulations. But the more important question for the long-term is whether bigger is always better? As [Figure 5.1] suggests – maybe not!**

The figure shows that, beyond a certain point, the profitability index starts for fall as the reservoir volume increases.

Figure 5.1 Is bigger always better?

> **The figure illustrates the relationship between the estimated reservoir size (P50 hydrocarbons in place) and the profitability index (How much value does each dollar of capital generate?). The data represents real projects, contained in IPA's proprietary Oil and Gas Databases, which are currently in various stages of planning or execution and focused only on deep water projects globally. Most companies use the profitability index as a hurdle to decide which projects move forward and which don't. The figure shows that bigger reservoirs aren't always the most profitable.**
>
> **The profitability index increases with larger reservoirs – more reserves, more production, more revenue etc. – up to a point when the capital expenditure required outstrips the gain in higher production. Beyond this 'inflexion point', larger reservoirs make a company's portfolio increasingly capital intensive. In fact, something interesting happens as the reservoirs get larger. Very large reservoirs in deep water require higher capital investment. Companies who use net present value (NPV) as a value metric are then driven towards building facilities for the highest peak production possible – higher production, higher revenue in early years, better NPV. Once the peak is past, the facilities often remain underused. The empirical data suggests that companies are either better off developing things just below the inflexion point or developing reservoirs to the right of the inflexion point in a phased manner.**

Source: Nandurdikar, N. (2015) *Is Bigger Always Better? An Examination of the Relationship Between Reservoir Size and Profitability Index in Deepwater*, Independent Project Analysis, www.ipaglobal.com, 20 August.

Activity 5.2

Davos plc is considering four possible investment projects for the current year but has only a limited amount to invest. As a result, it will not be able to undertake in full all of the projects available. All of the projects are divisible (that is, it is possible to undertake part of a project and to receive a pro rata return). Details of each project are as follows:

Project	*Investment outlay*	*Present value of net cash inflows*
	£m	*£m*
Alpha	40	48
Beta	45	64
Gamma	60	66
Delta	70	92

In what order should they be ranked if the business wishes to maximise the wealth of its shareholders?

Your answer should be as follows:

Project	*Investment outlay*	*Present value of net cash inflows*	*Profitability index*	*Rank order*
	£m	*£m*		
Alpha	40	48	1.2 (48/40)	3
Beta	45	64	1.4 (64/45)	1
Gamma	60	66	1.1 (66/60)	4
Delta	70	92	1.3 (92/70)	2

There may be a need for projects to be funded over more than one year and limits may be placed on the availability of funds in each year. In such circumstances, there will be more than one constraint to consider. A mathematical technique known as **linear programming** can be used to maximise the NPV, given that not all projects with a positive NPV can be undertaken. This technique adopts the same approach (that is, it maximises the NPV per £ of scarce finance) as that illustrated above. Computer software is available to undertake the analysis required for this kind of multi-period rationing problem. A detailed consideration of linear programming is beyond the scope of this book. If, however, you are interested in this technique, take a look at the suggested further reading at the end of the chapter.

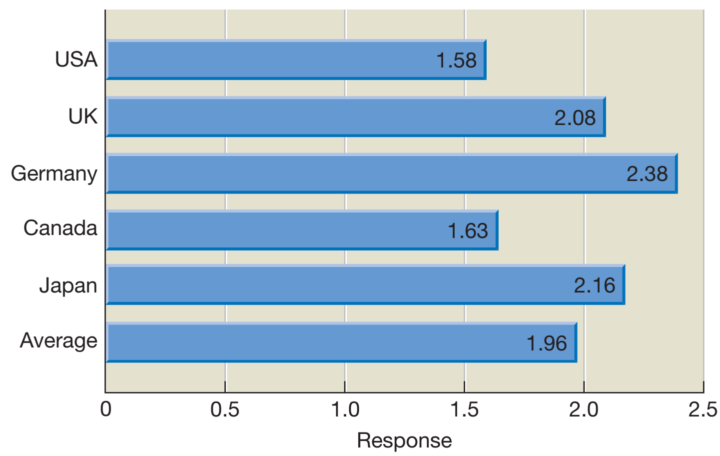
Real World 5.2 reveals the popularity of the profitability index among large businesses in five major industrialised countries.

Real World 5.2

A popularity index

The multinational study of financial policies by Cohen and Yagil (see Real World 4.7) revealed the frequency with which the profitability index is used by large businesses, as shown in Figure 5.2.

→



Response scale: 1 = never, 5 = always.

The figure shows that managers of large German businesses use the profitability index the most, although, generally, this method does not appear to be very popular.

Figure 5.2 Frequency of use of profitability index by large businesses

Source: Cohen, G. and Yagil, J. (2007) 'A multinational survey of corporate financial policies', *Journal of Applied Finance*, vol. 17, no. 1.

Non-divisible investment projects

The profitability index approach is suitable only where projects are divisible. Where this is not the case, the problem must be looked at in a different way. The particular investment project, or combination of whole projects, that will produce the highest NPV for the limited finance available should be selected.

Activity 5.3

Recommend a solution for Unicorn Engineering Ltd in Example 5.1 above if the investment projects were not divisible (that is, it was not possible to undertake part of a project). Assume the finance available was:

(a) £12 million
(b) £18 million
(c) £20 million.

If the capital available was £12 million, only Project Z should be recommended as this would provide the highest NPV (£3.6 million) for the funds available for investment. If the capital available was £18 million, Projects X and Y should be recommended as this would provide the highest NPV (£6 million). If the capital available was £20 million, Projects Y and Z should be recommended as this would provide the highest NPV (£6.8 million).

In the following section, we look at another situation where modification to the simple NPV decision rules is needed to make optimal investment decisions.

COMPARING PROJECTS WITH UNEQUAL LIVES

On occasions, a business may find itself in a position where it has to decide between two (or more) competing investment projects, aimed at meeting a continuous need, which have different life spans. When this situation arises, accepting the project with the shorter life may offer the business the opportunity to reinvest sooner in another project with a positive NPV. The opportunity for earlier reinvestment should be taken into account so that proper comparisons between competing projects can be made. This is not taken into account in the simple form of NPV analysis, however.

To illustrate how direct comparisons between two (or more) competing projects with unequal lives can be made, let us consider Example 5.2.

Example 5.2

Khan Engineering Ltd has the opportunity to invest in two competing machines. Details of each machine are as follows:

	Machine A	*Machine B*
	£000	*£000*
Initial outlay	(100)	(140)
Cash flows		
1 year's time	50	60
2 years' time	70	80
3 years' time	–	32

The business has a cost of capital of 10 per cent.

State which of the two machines, if either, should be acquired.

Solution

One way to tackle this problem is to assume that the machines form part of a repeat chain of replacement and to compare the machines using the **shortest-common-period-of-time approach**. If we assume that investment in Machine A can be repeated every two years and that investment in Machine B can be repeated every three years, the *shortest common period of time* over which the machines can be compared is six years (that is, 2 × 3).

The first step in this process of comparison is to calculate the NPV for each project over their expected lives. Thus, the NPV for each project will be as follows:

	Cash flows	*Discount rate*	*Present value*
	£000	*10%*	*£000*
Machine A			
Initial outlay	(100)	1.00	(100.0)
1 year's time	50	0.91	45.5
2 years' time	70	0.83	58.1
		NPV	3.6
Machine B			
Initial outlay	(140)	1.00	(140.0)
1 year's time	60	0.91	54.6
2 years' time	80	0.83	66.4
3 years' time	32	0.75	24.0
		NPV	5.0

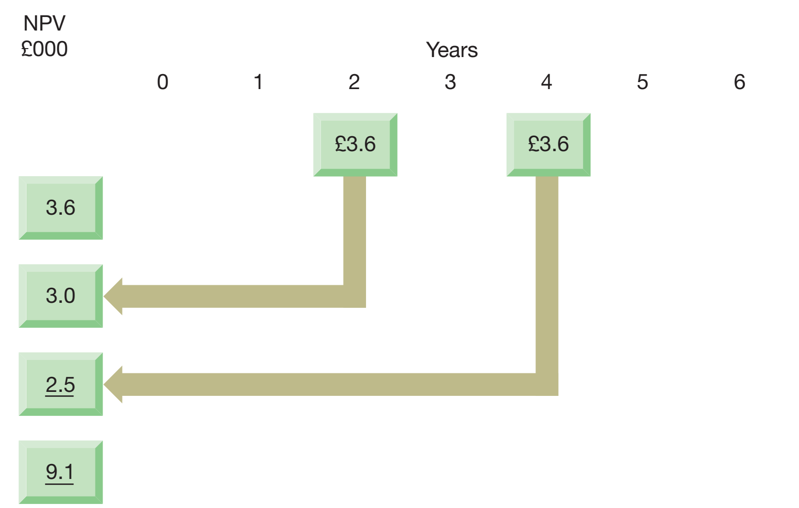
→

The next step is to calculate the NPV arising for each machine, over a six-year period, using the reinvestment assumption discussed above. That is, investment in Machine A will be repeated three times and investment in Machine B will be repeated twice during the six-year period.

This means that, for Machine A, the NPV over the six-year period will be equal to the NPV above (that is, £3,600) plus equivalent amounts two years and four years later. The calculation (in £000s) will be:

$$\begin{aligned} \text{NPV} &= £3.6 + \frac{£3.6}{(1+0.1)^2} + \frac{£3.6}{(1+0.1)^4} \\ &= £3.6 + £3.0 + £2.5 \\ &= £9.1 \end{aligned}$$

The calculations above can be shown in the form of a diagram as in Figure 5.3.



The figure shows the NPVs for Machine A arising in Years 2 and 4 translated into present value terms.

Figure 5.3 NPV for Machine a using a common period of time

Activity 5.4

What is the NPV for Machine B over the six-year period? Which machine is the better buy?

In the case of Machine B, the NPV over the six-year period will be equal to the NPV above plus the equivalent amount three years later. The calculation (in £000s) will be:

$$\text{NPV} = £5.0 + \frac{£5.0}{(1+0.1)^3} = £8.8$$

The calculations set out above suggest that Machine A is the better buy as it will have the higher NPV over the six-year period.

An alternative approach

When investment projects have a longer life span than those in Example 5.2, the calculations required using this method can be time-consuming. Fortunately, there is another method that can be used which avoids the need for laborious calculations. This approach uses the annuity concept to solve the problem. An **annuity** is simply an investment that pays a constant sum each year over a period of time. Thus, fixed payments made in respect of a loan or mortgage or a fixed amount of income received from an investment bond would be examples of annuities.

To illustrate the annuity principle, let us assume that we are given a choice of purchasing a new car by paying either £6,000 immediately or by paying three annual instalments of £2,410, commencing at the end of Year 1. Assuming interest rates of 10 per cent, the present value of the annuity payments would be:

	Cash outflows £	*Discount rate* *10%*		*Present value* £
1 year's time	2,410	0.91		2,193
2 years' time	2,410	0.83		2,000
3 years' time	2,410	0.75		1,807
			NPV	6,000

As the immediate payment required is £6,000, we should be indifferent as to the form of payment. They are equal in present value terms.

In the example provided, a cash sum paid today is the equivalent of making three annuity payments over a three-year period. The second approach to solving the problem of competing projects that have unequal lives is based on this annuity principle. Put simply, the **equivalent-annual-annuity approach**, as it is referred to, converts the NPV of a project into an annual annuity stream over its expected life. This conversion is carried out for each competing project and the one that provides the highest annual annuity is the most profitable project.

To establish the equivalent annual annuity of the NPV of a project, we apply the formula:

$$\textbf{Annual annuity} = \frac{i}{1 - (1 + i)^{-n}}$$

where i is the interest rate and n is the number of years.

Thus, using the information from the car loan example above, the annual value of an annuity that lasts for three years, which has a present value of £6,000 and where the discount rate is 10 per cent, is:

$$\begin{aligned}\text{Annual annuity} &= £6{,}000 \times \frac{0.1}{1 - (1 + 0.1)^{-3}} \\ &= £6{,}000 \times 0.402 \\ &= £2{,}412\end{aligned}$$

(*Note*: The small difference between this final figure and the one used in the example earlier is due to rounding.)

There are tables that make life easier by providing the annual equivalent factors for a range of possible discount rates. An example of such an annuity table is given as Appendix B at the end of this book.