managing the various components of working capital efficiently: stocks, debtors and creditors. These techniques are described by Professor Clarkson. In addition, he shows how the cash flows associated with working capital can be analysed to control profitability in this area. He also provides a useful discussion of conventional ratio analysis as applied to working capital, with the emphasis on the interpretation and use of the ratios, rather than just the mechanics of their computation.

The final chapter of this section (Chapter 5) deals with the important area of international money management. Andreas Prindl demonstrates the basis for effective cash management in a domestic context. He then generalises this approach to international management of the corporate cash resources. Special instruments of international financing are discussed, as well as the effective use of the institutional framework available for effective international money management.

2

Capital project planning

Tessa Ryder Runton, Jack Broyles and Ian Cooper

Capital project planning is the process by which companies allocate funds to various investment projects designed to ensure profitability and growth. Evaluation of such projects involves estimating their future benefits to the company and comparing these with their costs. Such analysis is appropriate not only to the purchase of long lived physical assets, but to any decision which has impacts extending into the future. Thus capital project planning can encompass, for example, long term contracts for goods and services, marketing expenditures, disinvestment by sale, mergers and plant closures.

While capital project planning is a process that takes place in an organisational context over extended periods of time, certain elements of this process are essential to good project planning. These are:

1. Access to the appropriate information.
2. Knowledge of the company’s required financial return.
3. Realistic evaluation of the prospective cash flow and profit impacts of projects.
4. Analysis of the costs and benefits of projects with attention to the timing of their occurrence.
5. Evaluation by senior management of the strategic implications of large projects.
6. A well defined approval process.
7. Consistency with strategic planning and budgeting procedures.
8. A review procedure.
THE GOALS OF PROJECT PLANNING

Businesses have responsibilities to various interested groups including employees, customers, suppliers, bankers and shareholders. This goal is met by maximising the total market value of the company's shares. The capital market values shares at the present value of current and future cash flows attributable to shareholders. If the company maximises the net present value of all the operations that make up its business, the sum will be the maximisation of the value of the company. This value net of debt belongs to shareholders. Companies pursuing other objectives, whether social or technological, must primarily be profitable. Should shareholders, corporate members or financiers become dissatisfied with the company's operations, they may withdraw their support, causing such awkward problems as loss of morale and personnel, shortage of funds, a fall in the company's share price if it is publicly quoted, or stormy annual general meetings. Any of these can lead to undesirable vulnerability and result in a takeover, close-down, or governmental interference.

REQUIRED RATE OF RETURN STANDARDS AND COST OF CAPITAL

Cost of capital is a major standard of comparison used in financial analysis and is a vital company statistic needing careful calculation. The return on capital resources must equal or exceed the cost of that capital. Although zero or negative returns are acceptable in special cases, the necessary subsidies may lead to costs in another form.

The realities of commercial life have caused the cost of capital to be a very complex subject. Any comparisons must be made between like numbers. A percentage profit before tax made on a hotel in Bermuda bears no relationship to the same figure made after tax on a farm in Scotland. A profit expressed as a percentage of capital employed should not be compared with a discounted cash flow internal rate of return. Many measures of company performance can be devised but these are valuable only to those who are completely familiar with the definitions involved. The appraisal of projected cash flow discounted at a rate equal to a carefully estimated required rate of return leads to fewer pitfalls. In particular, the time-value of money is taken into account, all the financial effects are assessed and tax and inflation are taken into account in the calculation of the cash flow and the estimation of the cost of capital.

Capital investment analysis aims to discover the financial truth about the plan under investigation. If it does not meet the survival standard of the organisation, that fact should be stated clearly before the discussion as to its desirability begins. In practice, many apparently unprofitable processes go on in any business because they enhance the profitable activities which, of course, should outnumber them. Obvious examples are the provision of catering and other services for the work force, advertising, research and so on. It used to be thought that discounted cash flow analysis led to categorical 'yes' or 'no' judgements on any plan; in fact, all it does is marshal the financial facts for the guidance of the decision takers. In addition, it can point to the least unprofitable way of tackling a loss-making but necessary job.

The cost of capital to the firm

Most companies raise funds from many sources - retained earnings, new equity, grants and many forms of loans. The overall cost of capital to the firm is the return it must earn on its assets to meet the requirements of all those providing it with financing. Lenders require interest payments and shareholders expect to receive dividends and see capital growth.

In the past, UK shareholders have expected to earn a real net return of about 8 per cent after tax on average risk shares. To obtain this required net return in money terms, the expected inflation rate must be added. If this expected inflation rate is 10 per cent, the required return on the company's present equity and retained earnings is 18 per cent. The cost of new equity raised by means of 'rights' is a little more than this to allow for the costs of the issue. Other forms of new equity issues incur further costs of about 2 per cent.

Although the average real expected return on shares is about 8 per cent, companies in risky industries or with high gearing (borrowing relative to equity funds) will have more vulnerable shares than average. The real return required by their shareholders will be commensurately higher. This means, as explained in the overview of Part Four, that borrowing is not necessarily a cheap way of raising funds. Although the interest rate on borrowing may be lower than the return expected by shareholders, increased gearing will raise the risk of shares and not
change the overall cost of funds to the company. This is discussed later in this chapter (for a more detailed analysis see Franks and Broyles, 1979).

If a company maintains a proportion of debt capital agreed with its lenders, it can compute a weighted average cost of capital. For example, if the interest rate on debt is 10 per cent, and the company has 25 per cent debt and 75 per cent equity, the weighted average cost of capital in money terms including 10 per cent average inflation is \((0.25 \times 10 \text{ per cent}) + (0.75 \times 18 \text{ per cent}) = 16 \text{ per cent.}\) This cost does not allow for the tax savings from interest payments. This benefit is added separately.

In deciding the appropriate standards for an organisation, the marginal cost of capital is a vital guide. In a growing company, new capital will be needed and, therefore, the return on a project of normal risk should be judged against a standard of the weighted average cost of new capital. Companies making investment decisions continuously should use this marginal cost of capital as the standard for all projects with risks normal to the company’s business. If a project cannot pass this test, it will diminish the company’s value.

**Required rates of return on projects**

Obviously projects involve differing risks. Some, such as cost saving investments and lease or buy decisions, are of low risk; others, such as research projects, involve greater than average levels of risk. A company should classify its risk categories for projects and set required returns for each. A large project of risk significantly different from normal can alter the overall character of a company, its cost of capital, its accepted gearing and the returns expected by financiers.

The required rate of return for a project can be significantly different from the weighted average cost of capital for the company. High risk projects are characterised by high fixed operating expenditure and high revenue variability. These should be expected to earn high rates of return. The exact return required will depend upon a judgement about the level of risk in the project compared with the average risk of the company. In the case above, where the weighted average cost of capital in real terms is 6 per cent, the real required return on a project twice as risky as the market should be 12 per cent. With 10 per cent expected inflation the money required return should be 22 per cent.

The use of a separate required rate of return for each individual project is most important when the projects are large relative to the company and/or when the projects being considered have long lives. A typical classification scheme, in increasing order of risk is: cost reduction, replacement, scale expansion, new products. The risks of these different types of investment differ, and so should their required returns.

By evaluating different projects at different required rates of return, the company seeks to protect its shareholders. Shareholders require higher rates of return for higher levels of risk, and receive compensation for high risk in the capital markets. Companies undertaking high risk asset investment decisions must seek to achieve higher returns than their shareholders can earn for that level of risk in the capital markets.

**Effect of debt on required returns**

Unless there are non-financial incentives, a project is acceptable only if it stands on its own feet; that is, its cash flow should at least meet the company’s return criterion for the risks involved. With the possibility of debt financing is the position changed? A typical case arises when new assets simply increase the total assets on a proportion of which debt is available. Some people argue that, even apart from tax advantages, debt is cheap since the interest rate is lower than the cost of equity funds. This argument ignores the hidden cost of debt: the increased vulnerability of the equity as more borrowing is undertaken. The total operating risk of the company remains constant as more debt financing is used, so it is unrealistic to believe that the overall cost of funds can be reduced in this way.

One advantage that borrowing does confer is the reduction in taxes caused by the deductibility of interest payments. The impact on cash flows of this tax saving is simply the future stream of tax payments that are saved by the interest payments on the debt. The value of these tax savings can be added to the value of the operating cash flows from the project to get an overall value including the benefits of debt financing. This is preferable to using a weighted average cost of capital including the cost of debt at an after-tax rate. Use of the latter assumes that the debt available for a project will be very long term and will be the same proportion of the project financing as it is for the company. Both these assumptions can be very erroneous when projects have short maturity debt or very high or low gearing.
Care needs to be taken when a project merits special loans. Usually these are projects of significant size for which government incentives are available, or for which special working capital loans can be raised, or involving mortgageable property. If the result is a new company finance structure, then cost of capital and risk classifications must be reassessed. Some large capital investments, such as in mining, involve parent companies in special financial guarantees and these need special attention. Other capital investments such as in research, do not result in increased total assets which can be partly debt financed.

TRADITIONAL TECHNIQUES FOR TESTING VIABILITY

The natural question, ‘When do I get my money back?’ has often been answered by the traditional technique of adding up the forecast net cash inflow (sometimes the sum of the profit before depreciation from the forecast profit and loss account) year by year until the amount of the original investment is reached, thereby giving the years to payback. Such a calculation is inconclusive because standard variances vary, definitions of the original capital vary, tax is not always deducted and most of the benefits of tax allowances are obscure. The method ignores the time-value of money, cannot cope with inflation and takes no account of the later profits, if any. Whether, in fact, any profit is made on the investment is not measured at all. Payback calculations give some guidance in matters of liquidity in which case the cash inflow should be carefully defined and be free of any ‘accounting numbers’ such as ‘tax provision’ instead of ‘tax payable’. A better payback calculation is the discounted payback, which is computed using the present values of the future cash inflows.

Another traditional technique involves the use of balance sheet ratios for current and proposed operations. These include the ratios of profit to capital employed, of profit to sales, and many others concerning stock, current assets and liabilities, and working capital. These ratios are useful for regulating smooth operations but are unhelpful for judging profitability, owing to definition problems and the choice of standards, but mostly because the time-value of money is not included.

One ratio used is the return on capital, known as ‘the accountant’s return’ or the ‘book rate of return’. An average profit, before or after tax, is calculated for a number of years of the proposed project and this is expressed as a percentage of the capital employed. The latter is often defined as the initial investment or the average capital employed over the years, thereby allowing for further investment and depreciation. This procedure suffers from the same snags as the techniques mentioned above and, in addition, smooths out the effect of irregular annual profits. Clearly, quick profits are preferable to a slow build up, but advantages or disadvantages are obscured.

MODERN TECHNIQUES FOR TESTING VIABILITY

The traditional techniques take no account of the time value of money. But money received today is much more valuable than the same money received later. Present inflationary conditions magnify the difference. This is the principal fact which modern analysis techniques have incorporated to improve on past procedures. Analysis concentrates on the incremental cash flow of a project. The cash flow is discounted at the project’s discount rate to the present time, giving a present value. The work involved has increased, but once an analysis discipline has been set up, decision takers can expect that the realities of the given data for some plan will be clearly identified. They can then concentrate on the non-financial problems involved, judge whether the data is sufficient to work with and act accordingly.

The concept of moving money in time using the relevant discount rate is new. Today’s quoted price for benefits to be received in the future can be judged by netting the price, or capital cost, from the present value of the future cash flow. A positive resultant Net Present Value (NPV), if properly calculated (see page 30), shows that the transaction is financially worthwhile. The value of the transaction can also be assessed by judging its Internal Rate of Return (IRR) (see pages 31-3).

CASH FLOW DISCIPLINE IN PROJECT ANALYSIS

The discounted cash flow techniques use as their raw material the incremental cash flow resulting from some plan. Profit flow study is necessary for proper annual accounting as required by shareholders, but it is the cash flow that should be studied to identify the return forecast and the finance that is required. Provisions for depreciation
Capital project planning

are excluded, but expenditures on working capital and capital expenditures are included. The cash flow of a project is a forecast of the total monetary effects computed periodically (usually annually or monthly) over the whole life of the project, including scrap values. Such items as tax savings achieved on other profits of the organisation because of allowances due to the new project or any other cash effects which would not occur without the new project, for example, the cost of head office extensions or replacing an executive who would be transferred, should be included. Interest payments are often wrongly deducted from the cash flow, but they are not operating flows, being part of the cost of funds included in the cost of capital. A project can be defined as any procedure which alters the organisation's cash flow. Projects, therefore, include opportunities for cost savings and productivity improvements, where capital cost is not necessarily involved. What, therefore, is analysed is the total cash flow effect of an opportunity, that is, the net incremental cash flow, which is the difference between the cash flow in the company if the project is undertaken and the cash flow if it is not.

This analysis must be in real terms or in money terms with respect to inflation and, if necessary, alterations must be made so that real terms cash flows are judged by a real terms required return standard and money cash flows are judged by a money terms required return standard. Tax allowances and loan servicing schedules are always in money terms but sales and cost figures are usually forecast in real terms. It is usual for the marketing and production departments to project schedules showing changes in sales percentages or production costs without allowing for external price changes. However, the estimation of taxable profits and taxes requires that these data be converted to money terms. In cases of high inflation forecasts, or different effects on prices and costs, and for lengthy projects, some estimate must be made of the inflation pattern over the life of the project. This estimate could differ for use on prices, on costs and on the overall situation including the cost of capital. All figures must then be converted to money terms so that expected tax payments can be calculated.

It should go without saying that cash flows are forecast after the effects of company taxes when paid. Because tax allowances are normally in money terms, consistent cash flows almost certainly have to be forecast in money terms, unless real terms tax allowances can be calculated. Sometimes it is necessary to consider any likely future changes in tax structure. In this, as in treating inflation and in all problems of data uncertainties, it is important not to be over meticulous, particularly at the outset. Analysis of the most roughly prepared cash flow will show whether it is worth spending any further time attending to the details. The first question to answer is: 'What is the profitability of the given set of data, warts included?' If the answer looks promising it is then sensible to take the time to examine the given data, prepare a detailed net incremental cash flow in money terms and look at possible outcomes of the project as opposed to one set of data. The analysis should then examine sensitivities, risks and probabilities and the effect of the project on the organisation as a whole. Decision takers prefer consistent analysis disciplines so that they can use consistent standards of judgement and comparison.

For a fuller discussion of inflation and its effects on required rates of return and cash flows, see Chapter 3.

NPV AND IRR IN MORE DETAIL

The use of the concept of present value (NPV)

The net present value, NPV, of a project is the net incremental cash flow discounted at the project's required rate of return. A zero NPV shows that the project repays the capital invested plus the minimum acceptable return on the invested capital throughout the project's life. The minimum acceptable return is equal to the opportunity cost of that capital including a return required for the risk taken by investing in that operation for that period. NPVs show that the minimum return is achieved plus extra value. Given a discount rate of 11 per cent for a project, the NPV is found as shown in Table 2.1.

Other things being equal, this project looks financially acceptable. One could pay up to £199 more for the opportunity and still not lose. NPV represents the analyst's estimate of the net increase in the value of the company which would accrue from the project. If the discount rate used is the capital market's capitalisation rate for the risk of the project, the NPV represents an estimate of the incremental market value of the firm due to the project. The NPV technique thus gives a simple assessment tool, but is inaccurate if there is doubt or dispute as to the correct discount rate.
### Table 2.1
Calculating the NPV

<table>
<thead>
<tr>
<th>Time in years from today</th>
<th>Cash flow (£)</th>
<th>11% Discount factor</th>
<th>Present value (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(1500)</td>
<td>1.000</td>
<td>(1500)</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>0.901</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
<td>0.812</td>
<td>812</td>
</tr>
<tr>
<td>3</td>
<td>1000</td>
<td>0.731</td>
<td>731</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>0.659</td>
<td>66</td>
</tr>
</tbody>
</table>

The NPV, the sum of the present values of the cash flow = +£199

---

**The use of the concept of internal rate of return (IRR)**

The internal rates of return, IRR, is also known as the discounted cash flow yield, DCF, the DCF return or the actuarial return. IRR is defined as the break-even financing rate for the project. This is not to say that the capital released by the project earns such a return. Reinvestments, whether wise or not, should be kept separate from the analysis of a project on its own merits. The IRR of a project is judged against the cost of capital standard or the minimum required return.

The mathematical definition of the IRR is that it is the discount rate which, when used to discount the net incremental cash flow, gives a zero net present value for the project. The NPV (which is calculated at the project’s required rate of return discount rate) should not be confused with the many net present values which can be calculated using other rates.

The calculation of the NPV consists in setting out the cash flow, discounting it to the present time and adding up the net total. DCF or IRR calculations necessitate trial and error. If, however, the graph shown in Figure 2.1 is borne in mind, the process need not be lengthy.

Most practitioners find it convenient to calculate the NPV first. If this shows, for example by being positive, that it is worth doing more sums, a guess must be made of the next trial rate. A positive NPV indicates that the DCF/IRR will be greater than the cost of capital rate; how much greater can sometimes be guessed by the size of the

NPV. Trial rate A per cent is used and will give a net present value VA. Consideration of this result might lead to trial rate B per cent and VB. Having thus both over and underestimated the answer, the true IRR can be found by mathematical interpolation, or by drawing a similar graph (always provided the trial rates are not more than one or two percentage points apart – if they are, the curve that represents the relationship will give too inaccurate a result, which should be checked by the another trial and interpolation or extrapolation).

The following example shows how this procedure applies. Suppose the cost of capital is 11 per cent and an investment is being considered which costs £1500, lasts four years and has no terminal value:

---

**Fig. 2.1** The use of trial rates to calculate the Internal rate of return
Table 2.2  
Finding the true IRR

<table>
<thead>
<tr>
<th>Time in years</th>
<th>Cash flow from today (£)</th>
<th>Discount factor</th>
<th>Cash flow discounted at:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>11 per cent</td>
<td>20 per cent</td>
</tr>
<tr>
<td>0</td>
<td>1500</td>
<td>1.000</td>
<td>(1500)</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>0.901</td>
<td>0.833</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
<td>0.812</td>
<td>0.694</td>
</tr>
<tr>
<td>3</td>
<td>1000</td>
<td>0.731</td>
<td>0.579</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>0.659</td>
<td>0.482</td>
</tr>
</tbody>
</table>

Net present values: 199 (96) (6) 25

By interpolation between the net present value calculated at 16 per cent and 17 per cent the IRR is calculated to be:

\[ 16 + \frac{25}{31} = 16.8 \text{ per cent} \]

The same result is obtained extrapolating from the 17 per cent and 20 per cent figures:

\[ \text{IRR} = 17 - \frac{3 \times 6}{90} = 16.8 \text{ per cent} \]

Interpolation between the 11 per cent and 20 per cent figures, however, gives the answer:

\[ 11 + \frac{9 \times 199}{295} = 17.1 \text{ per cent} \]

which may be too inaccurate, although in this case the return would probably be quoted at 17 per cent. These figures could also be found graphically.

The use of present value: mid-year discounting

Discount tables are available for all periods—weeks, quarters, years—and to various numbers of places of decimals. It is not normally helpful to calculate the cash flow in too small periods or to discount it using more than four-figure tables. It is more important to notice that the tables usually refer to points of time and the cash flows represent a total for a period. A fitting assumption is needed. It is easy if the majority of receipts and payments occur at the beginning or at the end of the periods. For flows which are continuous and irregular over the periods, the total cash flow is often assumed to arise mid-year. The calculation should therefore be refined. If only annual discount tables are available, the half-year discount factor at \( r \) per cent can be calculated from the equation:

\[ \text{Discount factor} = \sqrt{\frac{1}{1+r}} \]

Examples

(A) In the example suppose the investment is bought today and the operation is immediate and continuous. The NPV calculation becomes:

Table 2.3  
The NPV calculation

<table>
<thead>
<tr>
<th>Time from today</th>
<th>Cash flow (£)</th>
<th>Present value at 11 per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Discount factor</td>
</tr>
<tr>
<td>0</td>
<td>1500</td>
<td>1.000</td>
</tr>
<tr>
<td>( \frac{1}{2} )</td>
<td>100</td>
<td>0.949</td>
</tr>
<tr>
<td>1</td>
<td>1000</td>
<td>0.901 \times 0.949</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
<td>0.812 \times 0.949</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>0.731 \times 0.949</td>
</tr>
</tbody>
</table>

NPV = 289

The IRR now needs to be recalculated to take account of the refined timing. The IRR is now 21\( \frac{1}{2} \) per cent because of the earlier cash flow.

(B) Suppose again that the operation were to be built up and paid for over one construction year. In this case the £1 500 cash flow is similarly assumed to be mid-year and the other cash flows occur six
Capital project planning

months later than before. The NPV can then be obtained from the first calculation, which has so far given a present value six months from today, by discounting the result by six months. NPV today = 199 \times 0.949 = £189.

The IRR is 17 per cent in this case, as at first, because it is mathematically true that the same yield is given wherever period zero is assumed to occur if the succeeding time periods bear the same relationship to period zero.

In some cases, such as natural resource projects, which involve large negative cash flows at the end of the project, a special problem arises in using IRR. Projects of this sort can have more than one IRR, some of which may be above the required return and some below. Complex techniques have been developed to salvage the IRR method in these circumstances. These adjustments usually involve procedures similar to the present value approach, and fewer problems will be encountered by the use of the NPV rule in these circumstances.

The use of present value – optimisation of mutually exclusive alternatives

Financial analysts are constantly being asked to advise as to which of two viable alternatives is financially preferable. Such choices include large long life machinery versus cheaper short life machinery, labour versus automation, the choice of site, speed of construction, shaft versus open pit mining, air versus sea transport, and so on; in each case choice of one excludes the possibility of choosing the other alternative. Use of the net present value calculation is the easiest approach. Suppose that in a company with a cost of capital of eleven per cent the choice is between:

- Method A (which is capital intensive) showing a NPV of +£1 500
- Method B (with a lower capital cost) showing a NPV of +£1 300

If the analyst calculates the NPVs using the minimum acceptable return discount rate for the risk of the project, different discount rates might be appropriate to A and B. For example, one method might involve installing a possibly risky unproved technological improvement, whereas the other method would re-equip as before.

The actual question to be answered, since both methods are financially desirable, is whether the expenditure of the extra capital involved on Method A is worth while. The incremental investment, which is represented by the difference between the cash flows of the two alternatives (cash flow A and cash flow B, for each period), shows an NPV of +£200 (NPV A – NPV B). It is therefore worth spending the extra money. Where the patterns of the alternative cash flows are very different, the incremental approach avoids problems in comparing projects with different levels of capital expenditure. Indeed, different cash flows can arise from the same total capital invested but the incremental cash flow analysis still gives the financially preferable operational plan.

Use of the DCF/IRR approach is also straightforward but contains a snare for the unwary. The question of whether the incremental investment would be desirable is answered by finding the DCF/IRR on the incremental cash flow (cash flow A minus cash flow B, for each period). If the incremental IRR is greater than the company’s minimum acceptable return, then alternative A is financially preferable. When setting out the results, however, an apparent problem frequently arises.

<table>
<thead>
<tr>
<th>Method</th>
<th>Incremental investment</th>
<th>11 per cent NPV</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Expensive</td>
<td>+£1 500</td>
<td>14 per cent</td>
</tr>
<tr>
<td>B</td>
<td>Cheaper</td>
<td>+£1 300</td>
<td>16 per cent</td>
</tr>
<tr>
<td>A–B</td>
<td>Incremental investment</td>
<td>+£200</td>
<td>13 per cent</td>
</tr>
</tbody>
</table>

It looks as though one should choose method B because the IRR is better than that in A. This is an illusion because the capital on which the yield is earned is different in each case. The analysis of the incremental investment points to the same answer whichever method is used. It is often argued that, perhaps, the incremental capital should be spent on some other investment which might show a better return than the 13 per cent here. This could be the case in conditions of severe capital rationing when investments yielding 13 per cent cannot be financed. In other conditions there is no conflict and both investments are desirable. Of course, more than two projects might be available, in
which case, several incremental investment choices would be necessary. It is easier simply to compare the NPVs; the most preferable choice has the highest NPV.

Some practitioners approve the calculation of the NPV but find the answer, which is of necessity expressed in currency, difficult to use. The profitability index is therefore sometimes used, particularly when projects need to be ranked because budgets are limited. The index is calculated by dividing the present value of the net cash returns by the present value of the net cash investments. In the example on page 32 the profitability index is $1,699/1,500 = 1.13$ which means that every unit of investment earns 1.13 units of present value in the project. Care must be taken not to confuse this with the IRR, which is 17 per cent. In practice analysts report the profitability of a project both in terms of NPV in currency and of IRR as a percentage, to assist understanding.

When mutually exclusive opportunities are being analysed, equal project lives should be compared. This is often difficult, but a three-year life machine can be compared with a five-year machine by assuming that the longer life machine will be sold at the end of the third year. Alternatively a fifteen-year period can be taken with five three-year machines compared with three five-year machines. The most sensible assumption will be obvious.

**Present value and expected value: decision trees**

Much of capital investment planning involves arranging a continuous series of actions which may be altered in the light of future events or future actual patterns of marketing. It is possible to set out likely outcomes in a map known as a decision tree - it grows as it is extended further into the future. NPVs of each likely chain of events can be prepared and this could help the decision that must be taken later. Very often decision tree calculations are of the expected value of the outcome. To calculate expected values, the probabilities of likely intermediate events of outcomes are incorporated. Decision trees have been described extensively. A decision tree is shown in Figure 2.2.

Faced with the need to decide whether to install a computer, the possibilities or likely events might appear as shown. The decision taken would depend, financially, on the relative NPVs or expected values of the three good possibilities. Expected values are weighted by the relevant probability; for example, if there is a 60 per cent chance of an NPV of £100 and a 40 per cent chance of an NPV of zero, the expected value is £60.

![Example of a decision tree](image)

**Fig. 2.2 Example of a decision tree**

**Computational Resources**

Although computers, big and small, are invaluable as calculating aids for complex problems they should not be used indiscriminately because the cost, and the time taken to eliminate errors, can become disproportionate to the problem being analysed. Time sharing on computer terminals using borrowed working programs can be invaluable. Modern analytical methods can generally be employed for simple problems, using everyday hand calculators.

Calculation shortcuts and standard procedures for all problems are often sought in this field. If, however, they are used without understanding or without necessary adaption to the different circumstances of each case, much more time can easily be wasted than if the problem were initially approached from first principles.
DATA

The collection and sifting of project data normally leads to far more problems than the analysis. This is no reason for allowing less than rigorous analytical techniques. If a quick look at the first set of data indicates a promising idea, it is sensible to re-examine the data before extending the analysis. Data is given, begged, borrowed or stolen, but in spite of, or because of, the uncertainties involved, the best way to obtain good understanding leading to better decisions is to establish good communications with the project initiators as a top priority.

Discussions should be held 'on site' as early as possible so that there is no suggestion of ivory tower thinking. Diplomatic approaches to the hard-worked estimators who have to grapple with difficult forecasting problems can lead to a good understanding, not only of the best realistic guess at some figure, but also of the possible range in which it may lie and of the probabilities involved. Conversation with outsiders often helps clarification. Much the best hunches are those agreed by two or more experts. Special and outside experts can be called in to advise on variables found by sensitivity analysis to be critical enough to merit the cost of the advice.

A special problem to be tackled is that of inflation, particularly when costs are subject to special pressures leading to price rises greater than the general rate. The analyst will have to take a view as to when it is safe to assume that, on balance, costs and revenue will be similarly inflated. (See also Chapter 3.)

Missing data – reverse economics

Very often, data is simply not available for such vital factors as the achievable price for a new product, the size of the reserves in a new oil field, the time required to obtain safety clearance or planning permission or the market or technological life period. Reverse economics is the formal technique whereby it is possible to define the achievable or viable range for the missing data. If a graph is drawn of the profitability (NPV or IRR/DCF) of the project against invented values of the missing data, it is possible to find the value that gives the minimum acceptable result. If that value is very unrealistic, it may be possible to conclude that the new product will not be profitable, or that the oilfield cannot be exploited economically under present circumstances. A decision might then be taken to stop any further expenditure on the promotion of the idea. If a project must be killed off or frozen it is far better halted early, before reputations become involved.

This technique is also useful when considering the merger, takeover or sale of a company, or its flotation on the public market. An attempt is made to forecast the foreseeable cash flow of the company, possibly including benefits caused by savings in the new managerial context. The difference between the present value of the forecast cash flow and the debt divided by the number of issued shares will give a measure of the acceptability of a quoted or offered price, or will indicate what price to set at the beginning of negotiations. In a takeover situation the buyer should use the incremental required return for the project, that is the required rate of return for the risk of the company being taken over. If the company is quoted, the value of its equity share capital is given in the market place, unless there are undisclosed facts such as technological advance, or unless the market has anticipated a possible merger. The premium paid should be less than the NPV of the merger benefits (see also Chapter 16).

Uncertain and erroneous data

A good approach to uncertain data is to attempt to identify the range in which the answer may lie. This is sometimes done by adding to the best guess two more guesses, one of which is the most pessimistic and the other the most optimistic. In this way it may be possible to exclude too much subjectivity on the part of the estimator, who might previously have thought that his future depended on the success of his estimates and who therefore, understandably, introduced too much conservatism. In large organisations a chain of conservatism may be introduced. In such cases the analyst must try to assess the realities, and it is helpful if the motivations of the personnel are adjusted so as not to interfere. Overestimating can be as wrong as underestimating and can easily lead to raising too much finance, or to premature expansion.

Often, data is manipulated, either innocently or deliberately, to achieve the desired result – perhaps acceptance of a scheme by head office or of a contract in a tendering competition. The results can lead to public embarrassment, if not disaster. A good review discipline can help to avoid or to sort out such problems.
Once the range in which critical data lies is found, sensitivity analysis can be carried out. Alternatively, a calculation of the likely profit or loss, should everything turn out for the worst, can help in a discussion. If the organisation simply cannot survive such a loss and the chances of it are significant, then the project may well have to be forgone.

**SENSITIVITY ANALYSIS**

This technique can highlight the facts and problems caused by the risks and uncertainties of the plan under discussion. It has limitations but can be carried out with a minimum of calculating aids if necessary. The aim of this analysis is to discover the value of an uncertain variable at which the project is just profitable. Two or three calculations will give the necessary sensitivity curve.

![Graph of the sensitivity of the project's viability to profit variation](image)

**Example**

A project is showing a negative net present value at the company's cost of capital rate. What would need to be done to make it profitable? The sensitivity graph is drawn (Figure 2.3) and shows that the operating profit would need to be raised by ten per cent to give a zero NPV of the net incremental cash flow for the project. All other things are assumed at first to remain constant (capital cost, speed of coming into operation, life of the project, tax, inflation, etc.). Table 2.5 shows data which give the desired result.

**Table 2.5 Variables in the profit estimates**

<table>
<thead>
<tr>
<th></th>
<th>Original estimate</th>
<th>Acceptable estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price per unit £</td>
<td>20 21</td>
<td>20 20 20 20 20 20.3</td>
</tr>
<tr>
<td>Volume/Number sold</td>
<td>10 10</td>
<td>10.5 10 10 10 10 10.15</td>
</tr>
<tr>
<td>Labour cost £</td>
<td>40 40</td>
<td>40 40 40 40 40 38</td>
</tr>
<tr>
<td>Materials cost £</td>
<td>50 50</td>
<td>50 50 40 50 50 47.5</td>
</tr>
<tr>
<td>Overhead cost £</td>
<td>10 10</td>
<td>10 10 10 10 0 9.5</td>
</tr>
<tr>
<td>Operating profit</td>
<td>100 110</td>
<td>110 110 110 110 110 111.045</td>
</tr>
</tbody>
</table>

It is thus possible to say that the project would be acceptable if either the price could be raised by 5 per cent, or the volume sold is increased by 5 per cent, or if the labour cost could be lowered by 25 per cent, or the material cost by 20 per cent or the overhead cost by 100 per cent. Another possibility to explore would be if (as shown in the final column) both the price and volume sold could be raised by 1½ per cent at the same time as all costs are reduced by 5 per cent. However, one should try to ensure that joint changes in variables are not contradictory and fit a plausible and consistent scenario.

The graph could have been plotted using IRR and the company's required rate of return as the cut-off line but this involves more sums. One more uncertainty can be explored to extend the analysis. Suppose, for example, that the market for the product is thought to last ten years but could be hit by competition in eight to twelve years' time; further calculations give the graph shown in Figure 2.4. Annual operating profit is thought likely to lie between 95 and 120. Assuming the variables examined to be the most critical, the profitability 'envelope' is shown by the two outer curves and the dotted connecting lines. This envelope is divided into two parts by the cut-off line of zero net present value. By inspection of the two areas it is possible to conclude that the project has roughly only a forty per cent chance of being viable. The worst likely outcome is also shown. The decision may then be taken more easily.
Subjectivity is not avoided by this, but the further discussion can sometimes help clarify the situation. The results could be shown for each variable in a histogram, which is a practical approach to the underlying mathematical curve. An example is shown in Figure 2.5.

Fig. 2.5 Examples of probability distributions

Mathematical sampling using such data for each significant variable results in the type of profitability/probability graph shown in Figure 2.6.

Fig. 2.6 Example of a profitability/probability graph

The peak of the curve shows the most likely outcome, but there is a significant chance that the yield might be negative or that the original investment would not be recovered. The area under the curve being
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taken as unity, the area to the left of the cost of capital or required rate of return cut-off line, if measured, gives the probability of unprofitability. The use of sensitivity and probability analyses does not remove uncertainty and subjectivity of data; it helps decision takers to judge the likelihood of profit or loss in projects.

RISK

Uncertainty of data is not the only unknown bedevilling projects. Many possible events could have a highly significant effect. Such events include acts of God (earthquake, flood) of governments (tariffs, nationalisation), of competitors, of technological improvement. Some risks can be insured against. In every case it is helpful to define the risk and assess its possible effect (what happens if...?), and in particular when such an effect might occur. If the likely loss caused by the risky circumstances were to be disastrous to the company, then perhaps the venture is too risky. There are several ways in which organisations of different kinds can proceed to minimise the effect of risk. Obvious examples are diversification, both geographically and in the nature of the business, the tying of customers or suppliers to long term contracts, and the cautious introduction of new or different scale business. Other risks can be eliminated through markets in which risk is traded. A surprising variety of risks can be insured against and others, such as commodity price variation and exchange rate variations, can be hedged in futures markets.

THE DISCUSSION FORUM FOR CAPITAL INVESTMENT PROBLEMS

Good decision taking depends more than anything else on good communication. The decision takers (at the level appropriate to the size of the proposal) do well to arrange a free debate between the project sponsors, the experts, the analysts and themselves. Documentation of the proposal, the analysis, the decision and any argument or discussion are of great value to all concerned in future planning, as well as the relevance to interrelated projects in the context of the organisation's future as a whole. The techniques described in this chapter contribute only by assembling such facts as can be established and highlighting the likely probabilities. This, however, is of great value in releasing management effort for the interpretation of the problems.

Most private organisations are to some extent limited as to the amount of capital available, particularly for unspectacular investments. It would be convenient if all projects turned up simultaneously and could be ranked in order of profitability and then accepted in turn until available funds were used up. (Such a procedure is to a certain extent available to the public sector at budget time). In most companies, however, capital investment or operational optimisation opportunities turn up irregularly. It is therefore highly desirable to establish and monitor a clearly understood set of criteria and discount rates, reflecting the company's required rates of return for different risks, against which each scheme can be measured as it arises and progresses. With the aid of the right criteria there is some chance that a good source of investments will have been chosen so that, at the minimum, returns can exceed costs and the company's value can be increased, leading to a healthy financial context for future development.

Tactics

When analysis precedes or accompanies negotiations with governments, financiers, associates or opponents, it is usually helpful to make calculations in order that one can understand the opposite point of view, which might be based on different methods or criteria.

Few organisations can avoid differences of opinion which lead to apparent or very real conflicts. The experienced decision taker and his advisers can normally recognise the behavioural signs. Discussion is not always avoided for good reasons, such as a real emergency. Emergencies can be contrived by skilful delays and, perhaps, decisions can be precipitated by prompted outside pressures. Decisions taken in real emergencies should be appraised and documented as soon as possible. If a decision taker is known to be susceptible to private discussions, then project sponsors will be quick to arrange suitable lobbying. Such a situation has obvious dangers.

A very real problem can arise in planning investments which can or should be phased. The purchase of options or expenditure on pilot plants, which lead either to subsequent large investment or to
embarrassment if the second stage is deemed unacceptable, should not be appraised in isolation. Appraisal of the first stage should be accompanied by a best guess of the likely subsequent history, and the project should be discussed at the level relevant to the whole operation, in which case the decision will be taken after consideration of the future commitments. The decision tree technique examined earlier can help.

When a superficially attractive proposal is financially marginal, special care must be taken. At this time criticism may be made of the company's criteria which were otherwise accepted when the proposals were better than marginal. Such criticism at this time may not always be valid. In this situation excessive subjectivity may be introduced into uncertain data; in fact, some estimators claim to be able to produce estimates which pass company tests. Wide discussions of parameters, perhaps calling in outside advice, as well as the discipline contained in carrying out sensitivity and probability analysis, go some way to reduce the risk. Afterwards, a well established routine of project monitoring reappraisal, review or ex-post evaluation, or whatever the subsequent comparison of forecast with actual results is called, may be especially appropriate.

RE-APPRAISAL: EX-POST EVALUATION AND CAPITAL EXPENDITURE REVIEWS

It has been said that, without subsequent re-examination, formal planning appraisal techniques are largely counter-productive. Ex ante evaluation - the prior preparation of forecast results - is very necessary when raising finance for a project, either internally or externally, and obtaining the desired go-ahead. There is, however, no certainty that the combined estimates and skills which resulted in the forecasts have been optimised unless a subsequent view is taken.

There are well established commercial routines whereby periodic (weekly, monthly, quarterly, annual) accounts are compiled of both financial and physical resources used and benefits achieved, and reports are made to relevant technical and financial monitors. Usually the results are compared with annual and three or five-year plans for the project or the organisation as a whole. Variations are studied and adjustments are made.

Projects which were initially appraised using cash flow disciplines should be reviewed using the same disciplines. If the conclusions drawn differ, speedy action may be desirable or, if it is not, it would be nice to know that it is not.

Unfortunately, it is necessary to take a cynical look at projects built for less than the forecast cost, sales that noticeably exceed budget, and other successes. If the planners’ faults were not in their stars but in themselves they should remain as underlings. People have gone as far as saying that it is useless to plan at all unless one also reviews the results. But, as always, too much is as bad as too little.

It is not always clear who should conduct re-appraisal reviews. Conflicts may be avoided if the project operators undertake the review in the normal course of their duties. It is highly desirable also to include some sort of outside view to ensure a balanced opinion as to why the resulting return differs from the first forecast. The review should, of course, cover all the unquantifiable as well as the measurable aspects.

If the organisation sets up a separate reviewing team, its members may need great powers of diplomacy as well as of detection and endurance.

Reviews are discussed preferably at the same forum as are capital expenditure proposals, or, at least, the decision takers should check that re-evaluation has taken place. Very often the lessons do not need to be driven home but have been learnt in the course of the operation.

The introduction of this routine is often problematical. As usual, opposition may be a cover. Other avoidance tactics can include radical changes of scope of a project leading, among other things, to a delay in the review date. Significant change of scope should be appraised as rigorously as new projects.

FURTHER READING

Howard Thomas, Decision Theory and the Manager, Pitman, 1972.