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Challenges in advanced management accounting

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Introduction

This free course focuses on selected challenges for organisations that management accounting concepts and techniques may be useful to address. The aim is to develop an understanding of some strategic approaches that contribute to the successful navigation of mid- to long-term challenges to create sustainable organisations. This is an advanced free course that requires a prior understanding of basic management accounting approaches.

This OpenLearn course is an adapted extract from the Open University course B392 *Advanced management accounting*

Learning Outcomes

After studying this course, you should be able to:

- understand and describe strategic management accounting
- make decisions based on customer profitability using activity costing
- incorporate risk and uncertainty in project appraisal.

1 Strategic management accounting

The purpose of this first section is to focus on how management accounting has adapted to the demand for it to play a role in strategic management. This is part of the broader organisational and environmental pressure on management accounting to change to remain relevant.

1.1 Defining strategic management accounting

Strategic management accounting (SMA) was first discussed in the literature of the late 1980s as a response to concerns about management accounting losing its relevance for business practice (Roslender and Hart, 2003). SMA is still not clearly defined, so writers emphasise different perspectives and techniques or avoid defining it altogether. Examples of different definitions are provided below.

Box 1 Definitions of strategic management accounting

> SMA refers to a variable portfolio of mainly financial information geared towards aiding strategic decision making ...
>
> Bhimani and Bromwich (2010, p. 48)

> Strategic management accounting (SMA) is usually described in ways which place emphasis on factors external to an organization (Bromwich and Bhimani, 1994). Simmonds (1981) defines the concept as the provision and analysis of management accounting data for use in developing and monitoring business strategy. Consistent with the notion of achieving competitive advantage, he advocates that attention be paid to competitors' relative levels and trends in such factors as costs, prices, market share, cash flow and financial structure.
>
> Coad (1996, p. 387)

> SMA is identified as a generic approach to accounting for strategic positioning, defined by an attempt to integrate insights from management accounting and marketing management within a strategic management framework.
>
> Roslender and Hart (2003, p. 255)

> Strategic management accounting is the process of identifying, gathering, choosing and analysing accounting data for helping the management team to make strategic decisions and to assess organisational effectiveness.
>
> Hoque (2003, p. 2)

> Strategic management accounting is the form of management accounting in which emphasis is placed on information that relates to factors external to the entity, as well as non-financial information and internally generated information.
>
> CIMA (2005, p. 54)

The definitions emphasise different aspects of SMA. Roslender and Hart (2003) use a marketing perspective which is appropriate for their customer focus. Coad (1996) gives prominence to the external and competitor view, while the other definitions simply combine definitions of accounting with the term strategy. The definition from CIMA (2005) focuses on the type of information that is most likely to be useful. One reason for the variation in definitions is that the form of SMA that evolves in an organisation, like accounting in general, depends on the organisational context. There is not a one-size-fits-all definition. So while the diversity reduces the clarity on the topic of SMA it may also reflect the possibility of appropriately tailoring it to different settings.

Activity 1 Strategy and the overlap between functions in organisations

Spend about 10 minutes on this activity.

A strategic focus for management accounting results in it overlapping with other functional perspectives within the organisation, not just marketing as highlighted by Roslender and Hart (2003). Think about the situation of new product development to identify the overlaps that may occur with other functional areas.

Discussion

A strategic focus on delivering value to the customer requires integrated ways of organising around the value chain. The specialist areas of production and product development, corporate management, human resources, procurement, finance, and law need to work together and with accountants to achieve a coherent view of the organisation's strategy. For example, the development of a new product may be based on marketing's projections about demand for features, but its design should also be influenced by cost efficiency which will involve consulting with people responsible for procuring raw materials from suppliers and the production team responsible for factory floor operations. Human resources may be involved where the availability of additional skilled workers is an issue or where the working conditions of current employees may be changed. Lawyers will be involved in determining the likelihood that the development can be patented. Corporate management and finance will be involved if the new product represents a change in strategy for the organisation and significant, new capital investment is required. Once again the accountant should have a role in the process of evaluating the capital project. In cooperating it is important that all specialists are able to contribute their perspectives, and are also able to accept and integrate the importance of other views to achieve a coherent view. It is perhaps easier to see the connections needed for a specific project like this. It is more difficult to ensure that cooperation among specialist areas in an organisation is achieved in an ongoing way. It is reflected in the move away from functional specialisation in organisations to a more organic structure around teams.

Another way to refine our understanding of strategic management accounting is to contrast it with the role and techniques that were traditionally associated with the management accounting function – or so-called traditional management accounting.

1.2 Comparison of strategic and traditional management accounting

It is not surprising that the focus of SMA mirrors the features identified as important in strategic management; that is, a longer term focus, the environment external to the organisation and a future rather than historical perspective. This emphasis contrasts with the traditional focus of management accounting (see Table 1).

Table 1 The focus of traditional vs strategic management accounting

Traditional management accounting	Strategic management accounting
Historical	Prospective
Single entity	Relative position
Single period	Multiple periods
Single decision	Sequences, patterns
Introspective	Outward looking
Manufacturing focus	Competitive focus
Existing activities	Possibilities
Reactive	Proactive
Overlooks linkages	Embraces linkages

Extract from Wilson and Chua (1993, p. 530) as quoted by Wickramasinghe and Alawattage (2007, p. 245)

Activity 2 Information sources for strategic management accounting

Spend about 10 minutes on this activity.

Consider what information sources may be useful to evaluate the organisation's position relative to its competitors in an industry. To begin the exercise it is important to define what is meant by position. It could be market share or it could be in terms of cost structure, size, financial stability, product differentiation, etc. Assume for this activity that the concern is around market share and financial stability because two competitors are rumoured to be considering a merger.

Discussion

The marketing department may have access to industry associations that produce and disseminate market data. Usually this works on the basis that each member organisation that contributes to the survey is entitled to receive the results. Alternatively it may be necessary to commission market research or undertake it in-house if the organisation has the necessary resources and skills. It is then possible to

compare the internal information about product sales with the external data about the market to get a sense of relative position (either in unit sales or sales revenue).

Financial stability may be a concern if the potential combined competitor is likely to use its increased size to gain access to the share market (if it is going to become publicly listed) or to raise debt. In considering its relative financial position, the organisation needs to consider its position, including its cash flows and working capital to support increased price competition or to sell on better terms to distribution networks. It may also need to consider its leverage in absolute and relative terms. If the new competitor reduces cash inflows from sales for a period of time, could it survive and service its debt and other commitments longer than others in the industry? This information may not be very timely, but it should be available through annual and interim reports for competitors. Having connections in the capital markets and financial services sectors may help with early warning of any significant competitor raising capital.

Overall, it is important to understand the focus of the information required and be prepared to cooperate and communicate with others in the organisation who may be in a better position to provide it. Just looking at the information generated internally will not be sufficient.

Research has found that in practice the approach to strategic management accounting is at best partial (Scapens and Jazayeri, 2003). Certainly providing information and analysis in some of the categories listed in Table 1 presents particular challenges. In general terms, the type of information that will be useful in strategy formulation is more broad-based and informal than internal, narrowly defined and historical data. Enterprise resource planning systems facilitate the integration of internal information in an organisation, allowing easier generation of data about customers and suppliers. However, identifying future opportunities requires stepping outside the regular systems of information recording and processing in such systems. Management accountants need to identify what isn't being done, not just what has happened.

Broadening the basis of the management accounting system also requires abandoning the belief that everything of value can be measured in monetary terms. While Bhimani and Bromwich's (2010) definition of SMA above emphasises financial information, other authors stress the value of non-financial information such as the industry's predicted unit sales, market share, etc. (Hoque, 2003). Beyond these concerns, environmental impacts that have no direct cost to the organisation but impose costs on the public or future generations (**externalities**) are increasingly important to organisations when they are considering strategy. A challenge facing strategic management accounting, and accounting more broadly, is how to represent these almost unquantifiable issues in reports and decisions.

A strategic approach to management accounting also requires collection of data from the external environment. This may in part be a regular process of monitoring competitors' share prices, accounting reports, newspaper reports and social media on the internet. However, it also requires an element of informal collection of information by individuals in the organisation who are part of larger networks of contacts. Making connections between events in the wider environment to trigger the identification of opportunities cannot be programmed into a system.

The management accounting information and tools that will be most appropriate will depend on the organisational context and purpose. For example, even though broad based, outward looking data may be important in choosing a cost leadership strategy, its implementation requires accurate and timely cost information as part of tight controls and

formal systems. This approach fits well with the traditional management accounting techniques of budgeting and variance analysis.

The paradox of strategic management accounting is that, while the need for it is clear, exactly what it is, is not! It is not uncommon, however, for service functions like management accounting to evolve with the changes in organisations, just as the organisations are changing in response to the pressures they face. Not defining SMA too closely allows the flexibility that is needed to apply appropriate tools and change them as needed. The comparison with a strictly traditional approach to management accounting highlights some stark differences in the focus and types of information useful for SMA. However, it is important to distinguish between the role of SMA in supporting the formulation of strategy and its implementation. It may be that many of the traditional management accounting approaches to planning, performance evaluation and control at the operational level will play an important part in turning deliberate and emergent strategy into realised strategy. The research evidence that adoption of SMA is limited is challenging for accountants since strategy formulation is a contested area in which management accountants must contribute effectively alongside other professionals (Activity 1). The next section takes a perspective that may be controversial, that is, that some customers may not be worth having!

2 Strategic customer analysis

By the end of this section you should be able to:

- explain the need to choose which customers to deal with and on what basis
- critically evaluate the widely used traditional approaches to customer profitability analysis
- calculate customer profitability using activity costing
- undertake a Pareto analysis of customers or groups of customers.

2.1 The customer selection decision

An important strategic decision, in addition to which products or services to produce/provide, is which customers to deal with and on what basis.

In any organisation, not all customers can be considered equal in terms of the size of their actual or potential purchases (and profitability) and the demands they place on the organisation's resources.

Market segmentation provides a means to identify which existing and potential customers the organisation should focus on. However, even within market segments, some customers will be considered more important than others and it is necessary for an organisation to decide which it should focus its attention on. This is an aspect of relationship marketing.

Customer relationship marketing (CRM) describes the need to 'establish, maintain and enhance relationships with customers and other partners at a profit, so that objectives of both parties involved are met' (Grönroos, 1994, p. 348). Even in the simplest way of looking at exchanges in the for-profit sector, there is a range of possibilities. At one

extreme, there are what are referred to as transaction-based exchanges: here, buyer and seller simply exchange products and services for money and at the end of the exchange there is very little likelihood that they will do business with each other again. A one-off purchase from a mobile snack bar at the annual fun fair could be an example. The two parties do not need to trust each other as they immediately see what each side is getting in the exchange, and after all if they have never met before and are not likely to do so again, what basis for trust could there be?

At the other end of the continuum are very long-term exchanges that will perhaps span many years. These may well involve people making promises to each other and they will probably require substantial levels of trust, in addition to a contract and monitoring of performance. Such long-term exchanges are often referred to as being 'relationship based'. Building long-term relationships with customers is considered to be particularly important in many professional service organisations, such as law or accountancy firms. But long-term external buyer–seller relationships can also exist in the non-profit sector – for example, people who give regular donations to their favourite charity.

It is, therefore, important for an organisation to decide what kind of relationship, if any, it wishes to have with its customers. It is possible to categorise customers on the basis of the costs and subsequent profit that a relationship would generate. This is shown in Figure 1.

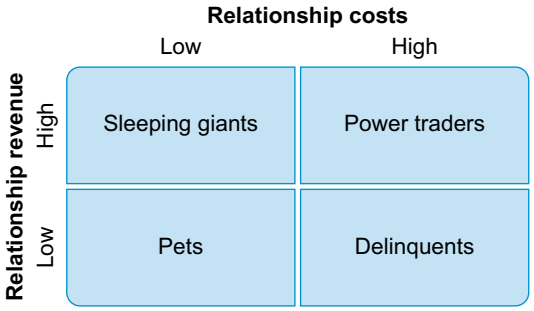


Figure 1 Categorisation of customers by cost and profitability

(Source: Kotler et al., 2005, p. 30)

For a commercial organisation, the extent to which it should enter into a relationship is likely to be determined (in large part) by the potential profitability of the customer. Customers can be categorised into four groups:

Sleeping giants: these customers generate a lot of profit, and are undemanding and do not necessarily want much from the relationship.

Power traders: these customers provide a large amount of profit but are demanding in their needs.

Pets: these customers produce a small amount of revenue and have no real need for a relationship with the organisation.

Delinquents: these customers provide little profit but are the most demanding in their needs for a relationship. The most difficult group to deal with is the 'delinquents'. In some instances it will not be possible to remove these customers and they will have to be dealt with. In these instances, opportunities should be provided to allow them to access products/services that are less likely to upset them. If this is not possible then the organisation will simply have to accept that they exist and find ways of coping with their behaviour.

One important aspect of customer relationship marketing is **key account management (KAM)**. But as Millman and Lucas observe, one of the most problematic aspects of KAM is devising and making operational, meaningful criteria for key account definition and monitoring of performance.

> Ten customers represented about fifty per cent of our sales last year. Five years ago it was about thirty customers. We can't afford to lose any of them. Yet I often wonder whether our tender loving care is misdirected and costing us an arm and a leg.
>
> (Financial Controller of a US software company).
>
> (1998, p. 11)

They cite this (p. 12) and numerous similar comments extracted from their research, as reinforcing the assertion that effective KAM needs to be underpinned by sound financial data and the use of appropriate decision-support tools. These comments raise the following questions:

- Does the KAM activity add value to the operations?
- Are the returns from individual accounts commensurate with the costs incurred in serving them?
- What measures should be used to assess key account relationships?
- How can the joint efforts of marketing/sales and accounting/finance managers be brought to bear on KAM to enhance best practice?

Millman and Lucas report the following insights gained from their research into KAM practice which tend to be overlooked by marketing/sales managers who rely largely on intuition rather than systematic financial analysis of customers.

- Blanket measures of performance (e.g. target return on sales/investment) may grossly distort the value of individual key accounts to the selling company. Key accounts at different stages of relational development may require different approaches to performance measurement. The best way to monitor performance at the early stages of building a key account relationship might well be customer share growth and cash flow rather than a punitive financial ratio that will demotivate those people tasked with account development and penetration.
- Attribution of customer-related costs has been noted as one of the main stumbling blocks in key account profitability analysis.
- Service and support costs vary with customer order size, type and mix. Some customers are more demanding than others and they often attempt to shift responsibility for support on to the selling company beyond reasonable limits. There is much work to be done in analysing the cost trade-offs associated with varying levels of service/support, escalation procedures, and charging for special treatment previously regarded as free.

Section 2.1 has discussed the customer selection decision which is necessary because some customers will be more attractive than others. This has implications for the basis on which the organisation wishes to deal with any particular customer – if at all. An important factor in for-profit organisations is the actual or potential profitability of the customer. Management accountants have an important potential role to play in determining customer profitability as discussed in the Section 2.2.

2.2 Determining customer profitability

For commercial enterprises, customer profitability (actual or potential) will be a major factor in deciding which customers to deal with and what type of relationship to cultivate. The traditional management accounting approach was to assume that selling product X to one customer was pretty much the same (in terms of profitability) as selling it to another. This assumption was reflected in common management accounting practice, which was to calculate product costs and measure product profitability, but not calculate the cost of serving particular customers in order to measure customer profitability. However, the profitability of a particular product can vary enormously across customers. The 80:20 rule (the so-called **Pareto rule**, named after the Italian economist Vilfredo Pareto) often applies to customer profitability: 80% of profit comes from 20% of customers. Consequently, the decision as to which customers to deal with and on what basis, is a very important one.

Yet many organisations' management accounting systems do not provide adequate information on customer profitability. Even where customer profitability is measured, the approach taken is often inadequate. The problem and a possible solution are described in Box 2.

Box 2 Measuring customer profitability

Two common approaches are:

1 only measuring customer profitability at the level of gross margin (i.e. sales value minus product cost)
2 assigning average cost by function (e.g. sales order processing cost is typically 2% of sales value).

The first approach is inadequate because gross margin is not a good guide to true profitability. Evidence suggests that selling and distribution, service and support costs may constitute up to 60% of sales value. Christopher (1992) gives a typical checklist of attributable (i.e. to particular customers) costs:

- cost of sales
- commissions
- sales calls
- key account management time
- order processing costs
- promotional costs
- non-standard packaging and unitisation
- dedicated inventory holding costs
- dedicated warehousing costs
- material handling costs
- transport costs
- documentation/communication
- returns/refusals
- credit taken.

Yet only the first of these will normally be reflected at the gross margin level.

The second approach is inadequate due to the enormous variability of cost among different customers. Bellis-Jones (1989) cites evidence of cost variability by function as follows:

Table 2

Function	Cost as percentage of sales value
Selling and order taking	2–20
Storage and distribution	2–35
Production and purchasing	20–70
Marketing and advertising	1–20
General administration	10–30

Activity-based costing (ABC) techniques may provide a basis for ascertaining the costs attributable to a particular customer. ABC works by assigning costs to products or customers according to their consumption of the activities that give rise to costs. This may be contrasted with the traditional approach which apportions functional/departmental costs on some, more or less arbitrary, volume basis (e.g. percentage of sales value).

ABC views the organisation as a range of activities which often cross traditional functional boundaries. (These however are activities at a much more disaggregated level than the value chain activities – e.g. machine set-ups and production scheduling are activities which would be the concern of ABC, yet would be subsumed under 'operations' in the value chain framework. Similarly, raising purchase orders and inspection of incoming goods are examples of activities which would be subsumed under 'inbound logistics' in the value chain, but would be the concern of ABC.) The range of activities necessitated by serving different customers can vary enormously and so consequently can the real costs. ABC implementation consists of two stages:

1 *An activity analysis*: this is a detailed exercise to identify the activities performed at a fairly disaggregated level, based typically on interviews with employees. The resources consumed by each activity are then determined and hence its cost.
2 *Costing customers*: this involves determining how much of each activity serving a particular customer will require.

The activities which form the basis for allocating overheads are called cost drivers. Examples of cost drivers are: number of sales invoices raised – as a basis for allocating sales invoicing costs; number of customer complaints – as a basis for charging the costs of handling customer complaints.

(Adapted from Millman and Lucas, 1998, pp. 16–17)

Activity 3 The inadequacy of traditional management accounting systems for customer relationship marketing (CRM)

Spend about 10 minutes on this activity

Write some notes explaining why traditional cost and management accounting systems may not provide adequate support for customer relationship marketing and what the likely adverse consequences of this failure might be.

Discussion

Customer relationship marketing (CRM) requires knowledge/understanding of customer profitability, rather than just turnover/revenue, since the cost of serving different customers differs greatly and is not necessarily proportional to the revenue generated by them.

In the early days of industrial capitalism, the emphasis was on standardisation and economies of scale; selling a product to one customer was pretty much the same, in terms of profitability, as selling it to another. This situation was exemplified by Henry Ford's famous statement concerning the product offered to his customers: 'They can have any colour, as long as it's black!' In today's much more competitive business environment, this is not often the case, with the modern emphasis on customer service and catering for the differing demands of different customers.

Measuring customer profitability is therefore as important as measuring product profitability as it is likely to be a major factor influencing the sort of relationship that is developed with a particular customer. Customer costing is of vital importance, yet many organisations do not undertake this in any systematic way. Traditional costing systems focus on product costs rather than customer-related costs; this is likely to result in dealing with, and perhaps even giving preferential treatment to, unprofitable customers and/or, conversely, failing to court highly profitable ones.

2.2.1 Tracing of costs to customers

In order to apply the activity-based costing approach it is necessary to identify the cost driver for a particular indirect cost and then establish a cost driver rate for charging the cost to a particular 'cost object', be it a product or customer. For example, the cost driver for sales order processing cost might be the number of orders taken. If the total sales order processing cost for a period is £150,000 and the number of orders taken is 1,000, then the cost driver rate will be:

$$\frac{\text{Order processing cost for period}}{\text{number of orders taken for period}} = \frac{£150,000}{1,000} = £150 \text{ per sales order}$$

Equation 1

Order processing costs should then be allocated to customers at a rate of £150 for every sales order received from the customer.

Activity 4 Calculate customer profitability using activity based costing

Spend about 25 minutes on this activity.

(This activity is adapted from Glad and Becker, 1995, pp. 57–58.)

Alpha Ltd has three customers: Beta, Gamma and Delta. The management accountant has collected the following data concerning sales, transactions and costs relating to the three customers, as follows:

Table 3

	Beta	Gamma	Delta
Sales revenue	£120,000	£150,000	£90,000

Number of orders placed	13	66	39
Number of units sold	300	500	450
Warehouse floor space occupied (square metres)	30	40	25

Table 4

Alpha's indirect costs and cost drivers

	£
Order taking (number of orders taken)	1,534.00
Packing (number of units packed)	5,250.00
Dispatch (number of units dispatched)	4,312.50
Warehousing (cost of floor space occupied by goods)	1,007.00
Account administration (number of orders taken)	2,242.00

The gross profit on sales (based on the standard profit margin) is 30%. The directly traceable service and support costs (consisting of selling, delivery, financing and settlement discounts) for each customer are as follows.

Table 5

Beta:	£13,120
Gamma:	£18,476
Delta:	£13,620

Using activity based costing, calculate the net profit for each of the three customers.

Note: You can assume that the number of units packed is the same as the number of units dispatched/sold.

Answer

Table 6 Calculation of cost driver rates

Order taking = £1,534/118	= £13.00 per order
Packing = £5,250/1,250	= £4.20 per unit
Dispatch = £4,312.50/1,250	= £3.45 per unit
Warehousing = £1,007/95	= £10.60 per square metre of floor space
Account administration = £2,242/118	= £19.00 per order

Table 7 Customer activity costs

Activity	**Beta**		**Gamma**		**Delta**	
		£		£		£
Ord. taking	13 × £13 =	169	66 × £13 =	858	39 × £13 =	507
Packing	300 × £4.20 =	1,260	500 × £4.20 =	2,100	450 × £4.20 =	1,890

Dispatch	300 × £3.45 =	1,035	500 × £3.45 =	1,725	450 × £3.45 =	1,553
W'housing	30 × £10.60 =	318	40 × £10.60 =	424	25 × £10.60 =	265
Acc. admin	13 × £19.00 =	247	66 × £19.00 =	1,254	39 × £19.00 =	741
Total act'y traced costs		3,029		6,361		4,956

Table 8 Customer profitability analysis

	Beta	Gamma	Delta
	£	£	£
Sales revenue	120,000	150,000	90,000
Gross profit (30% of sales)	36,000	45,000	27,000
Directly traceable service/support costs	13,120	18,476	13,620
Total activity costs (as per above analysis)	3,029	6,361	4,956
Net profit	19,851	20,163	8,424

Discussion

The calculations show that the ranking of customers in terms of total profit is the same as in terms of sales revenue:

Table 9

	Beta	Gamma	Delta
Revenue	120,000	150,000	90,000
Ranking	2	1	3
Net profit	19,851	20,163	8,424
Ranking	2	1	3

However, if profitability in terms of profit as a percentage of sales revenue is considered, a different picture emerges:

Table 10

	Beta	Gamma	Delta
Revenue	120,000	150,000	90,000
Ranking	2	1	3
Net profit as % of revenue	16.5%	13.4%	9.4%
Ranking	1	2	3

This is because both indirect costs and directly traceable service and support costs are (proportionately) highest for Delta and lowest for Beta (with Gamma in between):

Table 11

	Beta	Gamma	Delta
Indirect costs as % of revenue	2.5%	4.2%	5.5%
Direct support as % of revenue	10.9%	12.3%	15.1%

This analysis indicates that Delta consumes a proportionately (relative to sales revenue) higher amount of indirect and support resources than the other two customers. Gamma consumes significantly more resources than Beta, so that, although sales for Gamma are 25% higher than for Beta, the difference in profit is almost negligible.

It is appropriate at this point to add a cautionary note. Activity based costing has considerable potential for providing more accurate product and customer costing, but it is based on a number of assumptions which may not always hold true in practice. It effectively assumes a linear relationship between activities and costs which may not be realistic due to the existence of fixed costs and joint costs. It also assumes that the costs of individual activities are independent of each other and therefore separable (Noreen, 1991) which may also not always be the case. These assumptions limit the possible application of activity based costing in practice (Bhimani and Bromwich, 2010).

2.2.2 Applying Pareto analysis to customer profitability

It is often useful to distinguish between the most important few and the less important many in order to determine where management attention should be directed in keeping customers happy and/or cultivating relationships. The Pareto rule, that 80% of something is accounted for, or caused by, 20% of something else, often applies to customer profitability. These may not be the exact proportions but the general principle, that a high proportion of something is accounted for by a small proportion of something else, nevertheless often applies. Based on the assumed existence of this relationship, it can be helpful for management to undertake a Pareto analysis. For example, customers may be grouped by profitability to help management decide where their efforts should be directed, for example in KAM or CRM.

It is quite common to find that the top 20% of customers generate about 80% of total profit, the next 30% generate about 10% of total profit and the remaining 50% of customers

generate about 10% or less of the total profit, as illustrated by the following example of DJM Ltd.

Example 1 Customer profitability analysis

DJM Ltd has 20 customers and has undertaken a Pareto analysis of customer profitability as shown below.

Table 12

Customer	Profit (£000s/ year)	Total profit (%)	Cumulative profit (%)
A	2,800	26.31	26.31
B	2,476	23.26	49.57
C	1,800	16.91	66.48
D	1,600	15.03	81.51
E	400	3.76	85.27
F	200	1.88	87.15
G	176	1.65	88.80
H	170	1.60	90.40
I	130	1.22	91.62
J	115	1.08	92.70
K	110	1.03	93.73
L	100	0.94	94.67
M	96	0.90	95.57
N	96	0.90	96.47
O	90	0.85	97.32
P	88	0.83	98.15
Q	80	0.75	98.90
R	64	0.60	99.50
S	32	0.30	99.80
T	20	0.19	100.00
Total (rounded)	10,643		100.00

It is useful to classify the top four customers as Class A customers and treat these as key accounts. The next six customers are treated as Class B customers, with less effort devoted to keeping them happy. All other customers receive relatively little attention.

It is sometimes helpful to illustrate the results of a Pareto analysis in a Pareto diagram, which shows the impact of each customer group on total profit, see Figure 2.

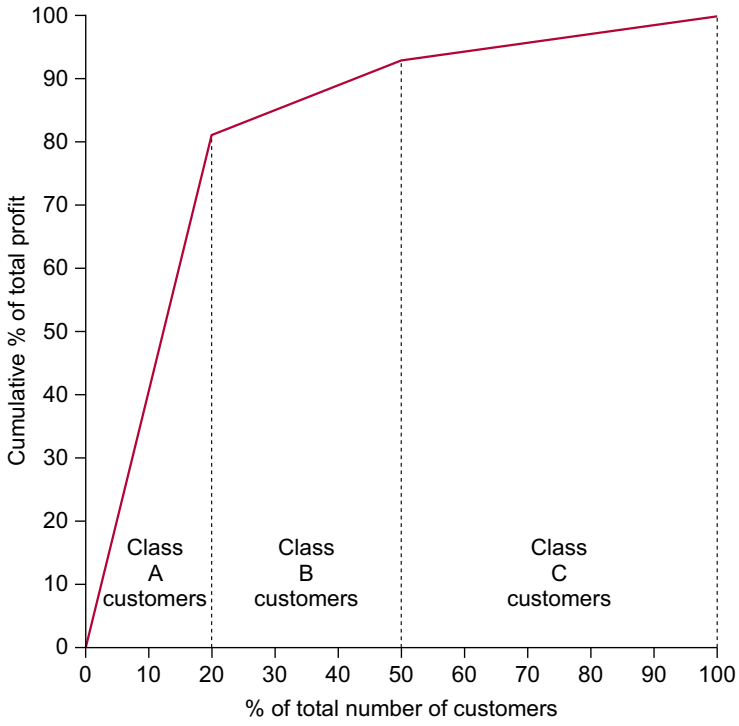


Figure 2 Pareto diagram for customer profitability

Stop and reflect

Internet retail outlets such as Amazon have thousands of customers in many countries. How could such companies use customer profitability analysis? They can no doubt trace the purchase history and related costs of each individual, but it may be useful to have categories of customer. Geographic region is one obvious category, gender or age might be others. Can you think of more possibilities?

This section has discussed how, in addition to knowing the costs (and hence the profitability) of providing particular products or services, an organisation should know the cost of serving different customers to determine their respective profitability. Many organisations' cost and management accounting systems have focused only on product (rather than customer) costing. Increasingly, however, the impact of competitive pressures on profits is making it necessary for organisations to know the profitability of different customers. Activity based costing, although originally developed for product costing, can be adapted for this purpose. The next section lays the foundation for an important technique for addressing a different strategic challenge – making decisions about investments in projects.

3 Principles of project appraisal

At the end of this section you should:

- be able to distinguish between relevant and non-relevant cash flows
- be able to explain the time value of money, and why discounting is carried out

- know how to use a company's WACC as a discount rate and discuss its drawbacks
- be able to calculate an appropriate discount rate by using the CAPM and discuss its drawbacks
- be able to use a spreadsheet to model a discounted cash flow analysis.

Before we examine specific appraisal techniques, we shall review and expand on some of the principles underlying them. At this more advanced level it is important that you not only know how to perform techniques, but also *why* they are carried out in the way they are, and how this affects which technique is most appropriate for a task. This will help you to explain them to other people if necessary, and deepen your understanding of the techniques themselves, allowing you to recognise their strengths and limitations too.

We review the type of costs that are included in an appraisal; how to decide if costs are relevant or not; why we should ignore sunk costs; and also whether there are opportunity costs incurred which would not normally be identified on an accounting budget of a project's financial costs. People have a tendency to take sunk costs into account; however, doing so means that irrelevant information may be influencing a decision, so the optimal decision may not be made.

We look in depth at the related concepts of discounting, the time value of money, and present value (of future cash flows). These are the foundation of discounted cash flow (DCF) techniques, which is based around the idea that £1 received or paid today does not have the same economic value as £1 received or paid at some point in the future. We will discuss the causes of the time value of money.

Discounted cash flow techniques such as net present value and internal rate of return require us not only to take account of the time value of money, but to estimate what it is by using a discount rate. We show how the weighted average cost of capital, discussed in the previous course, can be used as a discount rate to take account of the time value of money, and also review the potential problems with this technique. If we decide that the WACC is not an appropriate discount rate, the capital asset pricing model (CAPM) is another method to calculate a discount rate. We review how this can be used, and look at the potential problems with this method too.

3.1 Relevant cash flows and sunk costs

When carrying out a quantitative investment appraisal, you need to work out which costs and revenues should be included in the analysis. Costs and revenues that should be included are called **relevant cash flows**.

Activity 5 Relevant costs and revenues

Spend about 5 minutes on this activity.

Name three characteristics that a relevant cost or revenue has.

Discussion

1 *It must be a cash flow.* This excludes accounting charges such as depreciation, which aim to reflect how an asset is used over its economic life and do not affect actual cash flows, whereas we are only interested in the timing of cash being paid or received.

2 *It must be incremental* This means that a cash flow will change, as a result of making a decision. Costs or revenues which will take place regardless of the decision made are *not* incremental.

3 *It must arise in the future.* Costs or revenues which have already occurred cannot be affected by a decision taken now, so they are irrelevant to decisions about the future.

The main principle to remember is that you want to know what will happen to cash flows if one decision is taken compared with an alternative decision. (This alternative could be the status quo or it may be an alternative project under consideration). In order to decide if a cash flow is relevant, ask yourself: 'How will a cash flow change as a result of this decision being made?' If the answer is that it won't change, then it is not a relevant cash flow for that particular decision.

A cost which has already been incurred (so is a past not a future cash flow), is called a **sunk cost** and is not relevant. In addition a cost which has not occurred yet, but cannot be avoided in the future regardless of the decision, is also a sunk cost. Even though it is a future cash flow, it will be incurred irrespective of the decision made, so is not relevant to the decision.

Also note that the relevant cash flow is the only part of a cash flow that will change depending on the decision. This may not be the entire cash flow. For example if a new machine will reduce the raw materials used in production from £20,000 to £15,000, the relevant cash flow is a saving of £5,000: the incremental difference between the figures. Similarly, overheads such as salaries, heating, etc. are only included if they will increase or decrease if the project goes ahead. Even then, only the change in cash flow is relevant to the calculations used in investment appraisal.

Relevant costs (cash outflows) of a project could include:

- the initial investment in purchasing new equipment
- extra staff costs for manning new equipment or providing new services
- additional infrastructure or marketing to support the new goods or services provided
- additional tax payable on any expected profits from a project
- an increase in **working capital** required as a result of a project (a factor that is often ignored!)
- revenue which would have been earned if the project did not go ahead, which is no longer earned due to a project going ahead. This revenue is called an **opportunity cost** of the project.

Relevant revenue (cash inflows) includes:

- increases in revenue
- reductions in cash outflows due to cost savings, e.g.:
  - less raw material to be purchased in the future
  - reductions in staff labour time which result in lower staff cost
  - reduction in overheads which can be directly attributed to the project – for example, reduction in energy cost or fuel cost due to greater efficiency
- cash flow from the disposal of old equipment
- working capital released at the end of a project (note this may be lower than the working capital required at the beginning of the project).

Box 3 The fallacy of sunk costs

The logic of ignoring sunk costs is clear; and taking them into account is called a fallacy – a faulty argument. However, it is a fallacy humans are very prone to making and can be difficult to overcome. It often results from reluctance to waste money that has been previously spent (Arkes and Blumer, 1985) or being viewed by others as wasting it. In reality, money that has already been spent is gone, and wasting more money to attempt to recoup some does not make sense. Making further investment, on the basis that money has been spent in the past (i.e. on sunk costs), is sometimes known in English by the phrase 'throwing good money after bad money'. In fact most languages have some equivalent phrase, which probably shows how tempting and widespread this fallacy is! Note that those responsible for previous spending may have a personal incentive to push for further spending to achieve something from a project in order to avoid criticism of their previous decisions.

Such thinking is not confined to management accounting situations or even financial situations. In politics, a common strategy to achieve a desired goal is to spend or commit as much money as possible at the beginning of a project. Then when people object, it is argued that the money already spent should not be wasted (hint: it has already been wasted – the money can't be recovered!). A particularly bad example of the sunk cost fallacy in practice is the 'Concorde effect': the doomed joint project of the British and French governments with the supersonic commercial jet. While it was clear for over 30 years that continuing with the project would involve losing even more money, it was always continued because it was felt undesirable to waste the money already spent.

So, you can see failing to ignore sunk costs can have very serious consequences! Even though the consequences in management accounting are not usually as severe, be wary of letting them affect your decisions.

Stop and reflect

Think about the type of project which your organisation (or an organisation you are familiar with) might invest in. What would be the relevant costs and revenues that should be taken into consideration when deciding if the project should proceed?

3.2 The time value of money, discounting and present value

Many projects involve cash flows that occur over several years and, in order to accurately assess the benefit that will be received from projects, it is necessary to take into account the time value of money. The **time value of money** reflects the fact that cash flows in the future are less valuable than those that take place immediately. The further into the future they occur, the larger the discount needs to be to reflect the greater reduction in value. **Discounting** each future cash flow in proportion to how far it occurs in the future allows us to compare all the future cash flows which result from taking on a project on an equal basis.

This equal basis is called the **present value** of the future cash flows, and which is the equivalent value of each future cash flow if it were paid or received today. By converting

each future cash flow into its present value, you can compare future cash flows that occur at different points of time in the future on a like-for-like basis. Converting a cash flow to its present value is achieved by discounting using the **discount rate**, which is the annual discount that must be applied to future cash flows. This technique can be applied to two types of decisions in project appraisal, which are discussed below.

Determining whether or not a project should proceed

The NPV (**net present value** – the total sum of all the positive and negative relevant future cash flows) of a project is calculated. A project will add value to an organisation when its net present value is positive. Note that net present value is not simply totalling all cash flows from a project to see if they are positive: because of the time value of money, cash that is received a long time in the future has significantly less value than cash paid out now. So a project that produces a lot of cash inflows sometime in the future may have positive *net cash flows*; however, when the time value of money is taken into account the *net present value* may actually be negative.

A very simple example of this would be if a company offered to pay you £110 in 10 years' time, if you invest £100 with them now. Despite the net cash flow being £10, this is clearly not a good investment. Inflation over 10 years will mean that £110 in 10 years has significantly less present value than £100 now. (And this is without taking into account the additional risk that you do not receive the money back, for example if the company goes bankrupt over the 10 years and you lose your initial £100.)

Choosing between projects

Sometimes, there is more than one project available and only one can be chosen (perhaps the projects are mutually exclusive, or they both achieve the same objective in different ways).

When appraising several projects, not only do you have the problem that the actual cash flows cannot simply be added together, but also that different projects will last for different lengths of time and have different patterns of cash outflows and inflows over the lifetime of the project. Using net present value makes it easy to compare the relative value that each project will provide to the organisation. Once you have discounted the cash flows into present values the rest is simple: simply find the net present value for each project and the highest net present value is the best option, at least economically, as it produces the most value for the organisation.

3.3 Why does the value of money depend on time?

Money has time value for several reasons:

- the risk that cash flows do not take place in the future
- the loss of the flexibility to use money for more profitable projects, if such opportunities arise while the money is invested in an ongoing project
- the loss of value of money due to inflation

- the opportunity cost of alternative investments (such as in gilts, bonds, or other shares).

These can be divided into two types of reasons: underlying ones about risk and flexibility, and ones involving comparisons with the potential rates of return from alternative investments.

3.3.1 Underlying factors

The risk that cash flows do not take place in the future

The future is uncertain and relying on predictions of the future carries risk. You can invest money now in the expectation of getting future cash inflows, but the expected inflows may not happen! For example, a counterparty that owes you money may go bankrupt, market conditions may change and sales may not meet the forecast levels, efficiencies from a new machine may not be achieved due to manufacturing problems or incorrect assumptions made. There are many things that may go wrong resulting in you not receiving some, or even any, of the money you were expecting, and the further into the future you have to wait to receive it, the more that can go wrong.

So the value of a future cash flow must be less than the same sized cash flow that takes place now or sooner in the future. This is summed up, loosely, in the phrase ‘a bird in the hand is worth two in the bush’, meaning it can be preferable to have something of lesser value now, rather than the risky prospect of gaining something of greater value in the future. The risk of a project is usually the major factor in choosing a discount rate for a project, because the risk involved with a project leads to a much higher discount rate than a discount rate based solely on inflation or the rate from investments such as bonds.

The loss of flexibility

During the time that the funds are invested and committed, an organisation loses the ability to use those funds for other opportunities that may arise. Sometimes other opportunities will present a higher return than that available from the project undertaken, but it is too late to change the organisation’s plan. The time value of money can reflect what opportunities an organisation might miss by committing funds to a project. In economic terms, having more options can only make you better off. At worst, you do not use the options and have the same wealth as before.

Committing funds to a project removes options, and there is a potential opportunity cost associated with this. In a way, this is the reverse effect of future cash flows having less value due to their risk. Money in the present has greater value compared to money in the future, because money now could be used to invest in other opportunities if they arise, so money now has some extra value compared with money in the future. Since cash flows in the future have less value, they should be discounted to reflect this.

3.3.2 Comparisons with other rates of return

Inflation

In all but seriously distressed economies, inflation always occurs. £1 now is worth less than £1 in the year 2000. Similarly £1 is worth more now than £1 will be in 2025. Inflation puts a minimum figure on what the discount rate can be, because at the very worst, we want to earn a financial return from a project that is greater than the rate of inflation. A

financial return lower than the rate of inflation is effectively a negative return in terms of value – the money you get back has lost value compared with the value of money invested.

It might help you to think of the discount rate as a kind of 'inflation-plus'. As discussed above, inflation decreases the value of money over time: £1 in the future will buy you less than £1 now. However, other reasons for the time value of money also decrease the value of money over time – cash flows in the future that are more risky, for example, are worth less than cash flows that are certain or known with greater confidence. So the discount rate needs to be raised above the rate of inflation to account for the loss of value over time from inflation, and also from other factors.

The opportunity cost of alternative investments (such as gilts, bonds, and shares)

This follows on from the loss of flexibility. Imagine that the flexibility to invest the cash in another project somewhere else is not just an abstract benefit: you know about other investments and what the return from them would be. For example, cash can be used in less risky investments such as gilts, bonds and deposit accounts (i.e. savings accounts for organisations). If investing in gilts (which are normally considered risk free) would earn 5% per year, it would be foolish to invest in any project which had a return of less than 5% per year, as this return could be achieved without any of the risk that the project involves simply by investing in gilts.

The risk from a project is usually higher than investments such as gilts or bonds, so clearly, it doesn't make sense to invest money in a project which provides a lower return despite having a higher risk. So in the example above, the minimum value for the time value of money would be 5% per year, as that is a risk-free alternative use of the cash compared to investing it in a project. When we set a discount rate to appraise a particular project, what we are implicitly saying is that by investing in a typical project of the same risk, we could earn a return equal to the discount rate. Therefore, if the project under consideration does not produce a return of at least this discount rate, then the project is not providing a sufficient return to compensate for the risk taken, and is not worth investing in.

How the discount factor is calculated, and how it relates to other rates of return

Though discount factors are provided to you in the Appendix, you can calculate the discount factor applicable to cash flows in any year with a simple formula. Understanding this formula may also help you to understand how discounting works. The formula for the discount factor is:

$$(1 + r)^{-n}$$

Equation 2

Where r equals the discount rate as a percentage figure, e.g. 5%, and n equals the number of years into the future when the cash flow takes place. This formula is equal to:

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

Equation 3

Using some numbers for an example now, let's say the discount rate is 5%; 5% expressed as a decimal is 0.05. The discount factor for a cash flow in year 1 would be:

$$\frac{1}{(1+0.05)^{1}} = \frac{1}{1.05} = 0.952$$

Equation 4

The discount factor for a cash flow in year 3 would be:

$$\frac{1}{(1+0.05)^{3}} = \frac{1}{1.05^{3}} = 0.864$$

Equation 5

Now, what is the logic behind this? Imagine that a gilt returns 5% per year, and we base the time value of money entirely on this alternative investment. After one year, £100 invested in the gilt will be worth 5% more, so will be £105. A project which returns more than £105 for £100 invested at the present time will be a better use of that money than investing it in the gilt (if the risk was the same), whereas a project which returns less than £105 is not a better use, and the money is better invested in the gilt.

Think about trying to do the reverse now, valuing an expected cash flow in year 1, compared to what is invested at the present time (also known as year 0). We already know that £105 in year 1 has the same value as £100 in year 0. Applying the discount factor for year 1 to a cash flow in year 1 transforms it into year 0 pounds. Therefore:

$$\text{£105 cash in year 1} \times \text{discount rate year 1} = \text{£100 cash in year 0}$$

Equation 6

With some simple algebra:

$$\text{discount rate year 1} = \frac{\text{£100}}{\text{£105}} = \frac{100}{105} = \frac{1.00}{1.05} = \frac{1}{1+0.05} = \frac{1}{(1+0.05)^{1}}$$

Equation 7

This result is now the same as the formula for the discount factor, given above, when n equals 1 and r equals 5%. The discount factor compares a cash flow in a future year with the amount that would have been needed to be invested in year 0 at the minimum return, represented by the discount rate (in this example 5%) which would have resulted in a future cash flow of the same size as the one being discounted. Future cash flows are

being discounted at the rate of the minimum return to give their equivalent amount invested in year 0.

The additional factor that makes discounting a difficult concept is that the discount rate represents more than just the minimum return of an alternative investment (5% in the example above). The discount rate also represents the risk that a project involves, and for this reason is higher than a risk-free alternative investment. However, it is possible to think of this component as the minimum return necessary to compensate an investor for the additional risk the project carries. If a hypothetical alternative investment was not risk-free, but had the same risk as the project being considered, the return which would be necessary to interest investors in that investment is equal to the discount rate that is used for the project appraisal.

3.4 Using the WACC as the discount rate for a project

Comparisons with other investments are based on the time value of money being linked to the risk of future cash flows. The more risk a project under consideration carries, the higher the time value of money for that project will be. This is because cash flows in the future will have less value when more risk is attached to them, and management will require a higher return to undertake the project. It follows that, if an investment with less risk returns 5%, a more risky use of the same cash (such as a project under consideration) must return more than 5%, in order for the project to be worthwhile and to add value to the organisation. How much higher does this return have to be? An obvious answer is that it will depend on how much more risky the project is; however, in order to appraise the project we need to estimate a precise discount rate.

One solution for companies is to use their **weighted average cost of capital** (WACC). The WACC reflects the risk to the future cash flows received by an organisation from its operations. If two companies are expected to produce the same future cash flows but one has a lower WACC, then it will be more valuable. This is because the company with lower WACC is seen as having less risk attached to the cash it will generate in the future. If the business environment changes, in a way that increases the company's WACC such as the likelihood that government regulation will impact on its ability to generate cash, then the value of the company (and its shares) will decrease.

The theory behind using the weighted cost of capital to appraise projects is that the WACC is the cost that the business pays for the capital it uses to invest in its operations. Given the risks of the company's position, investors want the company to give them at least this return, or the risk of investing in the company is not worth bearing. So in order for a project to be worthwhile, it must return at least the WACC.

If a company has cash to invest and does not think it can deliver the WACC rate, it would be better returning this surplus cash to shareholders in the form of dividends, or repaying its debt, rather than investing it in a project which will not produce an adequate return. The company will have to pay out a rate equal to the WACC as the cost of having the capital available to commit to the project; however, if it actually receives a return from the project lower than the WACC it has to pay out, the organisation will lose value overall by taking on the project.

3.5 Problems with using the WACC as the discount rate for a project

Unfortunately, there are requirements about when the WACC will be exactly the same as the appropriate discount rate.

Business risk

For the WACC to be appropriate, the new project must have the same business risk as the company overall, and this will often not be the case. For example, expanding into new markets will usually not bear the same business risk as the company's current operations (it will usually be higher). If the company has a lower business risk than the project has, risky projects could be accepted when they should not be. While if the company has a higher business risk than the project, relatively safe projects may be rejected incorrectly.

Financial risk

For the WACC to be appropriate, the financial risk of the project must be the same as the financial risk of the whole company. At the very least, this means that the capital structure of the company should not change significantly as a result of undertaking the project. So either the project is small enough compared with the overall size of the company for it to fund the project from existing capital, or new funds for the project will be raised in the same proportions as the existing capital of the business. Other elements of financial risk of a project such as foreign exchange risk may also be different from the company as a whole.

Floating finance

Floating finance is any finance where the interest rate payable changes as the market interest rate changes (i.e. the finance has a floating rate). Therefore when the market rate changes, the WACC of an organisation that uses floating finance will also change. In a later section you will see how a discount rate that varies over time can be used for project appraisal – however, this does make the calculations more cumbersome. There is also the problem that changes in the floating rate in the future are unknown, so how the WACC will actually change in the future can also only be estimated.

These requirements mean that the WACC may be misleading if used as a discount rate. Where the above factors are not significantly different from the company overall, WACC could be used without changing the result of project appraisal. However, if you feel that the project is quite different from the company on these requirements, you may want to use another way to calculate a discount rate; the Section 3.6 looks at this.

3.6 Using the CAPM to find a project-specific cost of equity

In order to adjust for a difference in business risk between the company and a new project, it is possible to use the **capital asset pricing model** (CAPM) to calculate the return on equity that would be required for the new project. Then this figure can be used to calculate an effective WACC for the project. Doing this means the project is being treated as if it were an independent business, and the price of equity would be worked out as if it were a company whose only operation was the project under consideration.

Using the CAPM allows you to appraise a project on the basis of the risk of that project specifically, rather than the risks that apply to the company as a whole. This allows decisions about whether to proceed with a project to be more accurately focused. Another benefit is that projects with different risk profiles can be compared with each other. Using the same discount rate to appraise different projects is misleading, as it implies that all projects have the same risk profile, whereas riskier projects should have their cash flows discounted to a greater extent to reflect this.

To calculate the cost of equity for a project, it is necessary to find a group of companies which operate in the industry the new project will be in. Beta values are published and available publicly, so the average beta value for companies in the industry can be calculated and used to work out the equity cost of capital.

Remember, the formula for calculating the cost of equity is:

$$E(R_i) = R_f + \beta_i \times (E(R_m) - R_f)$$

Equation 8

where:

$E(R_i)$ = the expected return on shares of company i = cost of equity

R_f = the risk-free rate of return

$E(R_m)$ = the expected return on the market

$E(R_m) - R_f$ = the expected equity risk premium

β_i = the beta for the company

Activity 6 Using NPV to choose between projects

Spend about 15 minutes on this activity.

A company wants to choose between two projects. Find the net present value of each project, based on the company's cost of capital which is 10%. Assume that the company is entirely financed by equity. Make a recommendation about which project should be accepted.

Table 13

Cash flow (£)	Year 0	Year 1	Year 2	Year 3
Project A	(70,000)	30,000	30,000	30,000
Project B	(25,000)	10,000	10,000	10,000

Answer

Table 14 Project A

Year of cash flow	0	1	2	3	Total
Cash flow (£)	(70,000)	30,000	30,000	30,000	
Discount factor of 10%	1.0000	0.9091	0.8264	0.7513	
Discounted cash flow	(70,000)	27,273	24,792	22,539	4,604

Table 15 Project B

Year of cash flow	0	1	2	3	Total
Cash flow (£)	(25,000)	10,000	10,000	10,000	
Discount factor of 10%	1.0000	0.9091	0.8264	0.7513	
Discounted cash flow	(25,000)	9,091	8,264	7,513	(132)

The discounted cash flow of Project A is £4,604, compared with (£132) for Project B. Therefore Project A should be accepted.

Activity 7 Using the CAPM to calculate a discount rate

Spend about 25 minutes on this activity.

The company in Activity 6 is still choosing between Projects A and B. However, there is now some additional information.

The beta value of the company is 0.875. Assume a risk-free rate of 3% and expected equity risk premium of 8%. The average beta value of equity capital for companies in the industry relevant to Project A is 1.5 and the average beta value of equity capital for companies in the industry relevant to Project B is 0.375.

Question 1

1 Calculate the expected return (cost of equity) using CAPM for Projects A and B.

Answer

Project A

The average expected return for this industry is 3.0% + (1.5 × 8%) = 15% p. a.

Project B

The average expected return for this industry is 3.0% + (0.375 × 8%) = 6% p. a.

Note that the expected return, or cost of capital, for the company's current industry is 3.0% + (0.875 × 8%) = 10% p.a. However, since the business risk in the company's current industry is different from the industries relevant to Projects A and B, knowing the expected return for the company's current industry is not relevant. Indeed, you should be able to see that using 10% as the expected return to assess the new projects is not appropriate, given they both differ from this expected return.

Question 2

2 Find the net present value of each project, based on the cost of equity for each project implied by CAPM. Again assume that the company is entirely financed by equity. Make a recommendation about which project should be accepted.

Answer

Table 16 Project A

Year of cash flow	0	1	2	3	Total
Cash flow	(70,000)	30,000	30,000	30,000	
Discount factor of 15%	1.0000	0.8696	0.7561	0.6575	
Discounted cash flow	(70,000)	26,088	22,683	19,725	(1,504)

Table 17 Project B

Year of cash flow	0	1	2	3	Total
Cash flow	(25,000)	10,000	10,000	10,000	
Discount factor of 6%	1.0000	0.9434	0.8900	0.8396	
Discounted cash flow	(25,000)	9,434	8,900	8,396	1,730

So after adjustment for the specific risk that each project will face, Project A now has a negative net present value of (£1,504), while Project B has a positive net present value of £1,730.

3.7 Problems with using the CAPM to find a project-specific cost of equity

Unfortunately, using the CAPM is not without problems, like the WACC. We shall briefly look at these areas now.

3.7.1 Problems with using industry comparisons to estimate business risk and beta value

It can be difficult to estimate the beta that a project should have as it is difficult to find other companies which are a close match in business risk to the project under appraisal on account of differences in their operations, finances and strategic positions. Or to put it another way, the risk attributed to a company is not solely determined by what industry it is in. Many other factors come into play and all of these will affect its beta.

For example, companies used for the industry comparison may:

- sell different products

- vary in size
- vary in the balance of fixed and variable costs (operating gearing)
- vary in the capability and reputation of management
- operate in different industries as well as the one for the project being considered
- vary in potential for future growth or decline
- more generally, vary in their strategic position, as identified through techniques such as **PESTEL** and **SWOT** analysis.

One pragmatic (if not optimal) solution when using the CAPM is to assume that on average, things balance out, and that the average beta of companies operating in the relevant industry is a good estimate for the correct beta the company should use when appraising its own project in that industry. (However, note that if the company doing the project appraisal does systematically differ from other companies on the above factors, it is possible that the beta it should apply when appraising the project should be different from the industry average. This is a complicated issue which is beyond the scope of this course.)

Arguably, the expected returns from a company entering a new market should also be higher than those the market expects from a company which is already established in a market. This is because entering a new market is intrinsically more risky than continuing to operate in one.

3.7.2 Problems with financial risk

Using the average beta from the relevant industry for a project does not eliminate the problem of financial risk mentioned earlier. What this means in practice, is that the equity risk of the company that has the project and the comparison industry will vary depending on how much debt they also carry (i.e. if there is a difference in their capital structures).

As discussed earlier, when comparing the company's project with the company as a whole, there will be a difference in financial risk if the company's project is funded with a different capital structure from the company as a whole. (In the activities above, it has been assumed that the company and its project are entirely funded by equity capital.) However, even if the same capital structure is used, there can also be differences between the company considering a project and the comparison industry whose beta is used to evaluate the project. If that industry has a different capital structure on average from the company considering the project, then the comparison industry will vary in financial risk from the project being considered, and this will systematically affect the beta used by the comparison industry.

3.7.3 Other problems with the CAPM calculation

The risk-free rate can also be difficult to estimate. Government securities have traditionally been taken as the risk-free rate. However, the financial difficulties in Europe from 2008 onwards and subsequent losses for bond investors have shown that many government equities certainly do come with some risk. Even the UK and the US have suffered credit rating downgrades as a result of continuing sovereign debt problems (BBC News, 2011). Though their ratings are still high, the downgrades reflect the fact that they are not considered absolutely risk free anymore.

CAPM only produces an expected return for one year at a time so, in theory, when using the expected return as a discount factor, it needs to be estimated separately for every

year of the analysis. However, note that this is a problem that all types of discounted cash flow methods share and not just using discounted cash flows with a discount rate derived from the CAPM.

3.8 Using a spreadsheet to model project evaluation

In practice the factors to be included in a project evaluation decision are likely to be more detailed and complex than in the examples above. It is useful to model them in a spreadsheet that can be used for different projects and to allow different scenarios to be analysed quickly and easily. In this section we will work through an example of a spreadsheet designed for this purpose.

You will watch four videos which show you how to build a spreadsheet discounted cash flow model. The four videos show a range of techniques and complement each other so watch them in the order they are presented. In your first viewing, watch the four videos one after the other. They are:

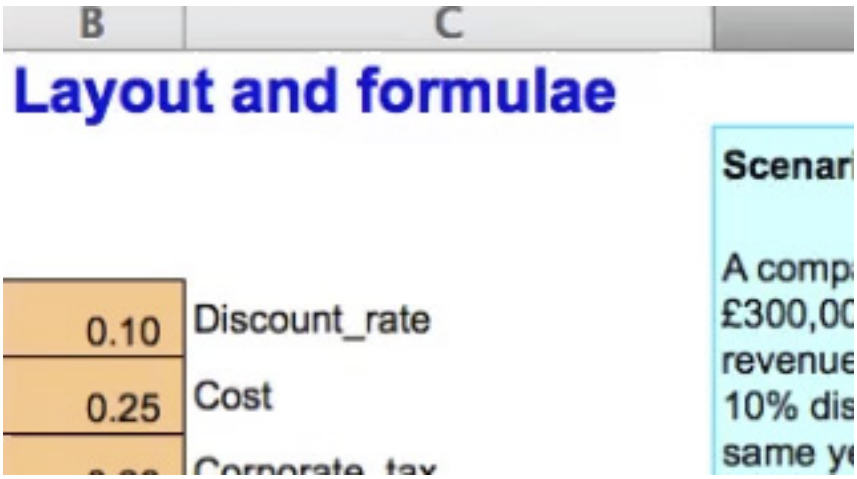
- Layout and formulae
- Using input ranges
- Calculate the internal rate of return
- Calculate payback

All the videos use the following investment scenario:

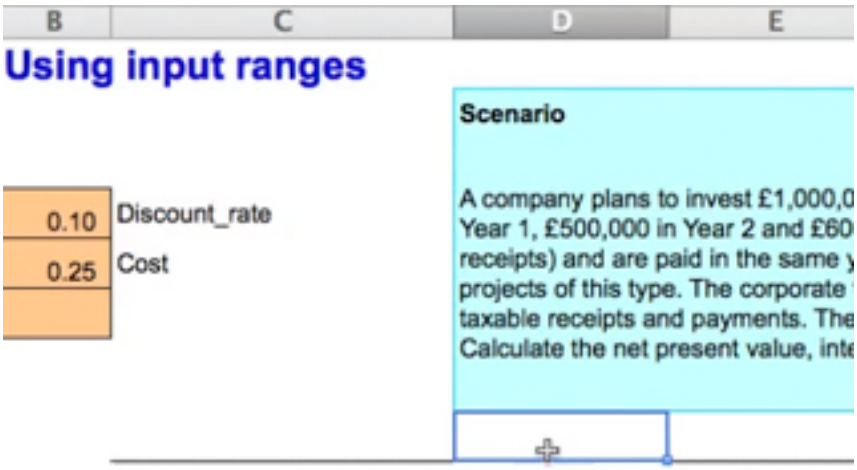
> A company plans to invest £1,000,000 in a new product that will generate revenues (cash receipts) of £300,000 in Year 1, £500,000 in Year 2 and £600,000 in Years 3 to 5. Costs (cash payments) will be 25% of revenues (cash receipts) and are paid in the same year as the relevant cash receipts.
>
> This company uses a 10% discount rate for projects of this type.
>
> The corporate tax rate is 28%. Taxation cash flows occur in the same year as the relevant taxable receipts and payments. There are no taxation cash flows arising from the investment of £1,000,000.
>
> Calculate the NPV, the IRR and the payback period of this investment.

Now watch the videos:

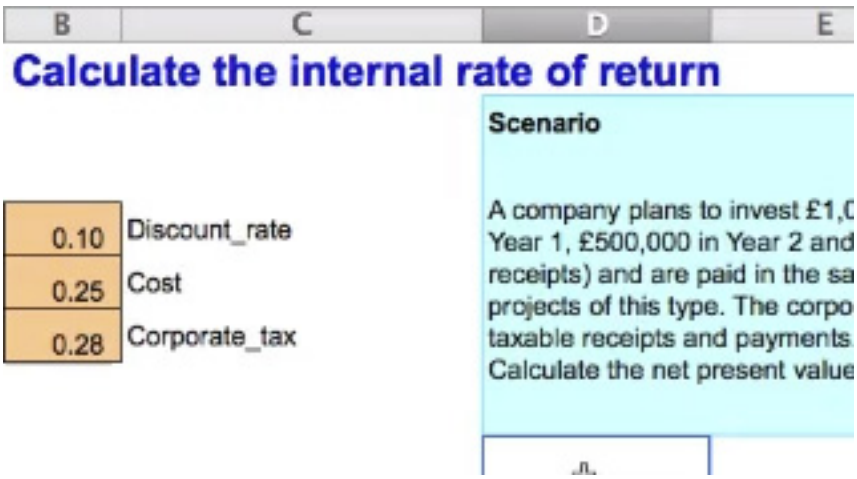
Video content is not available in this format.
Video 1 Layout and formulae



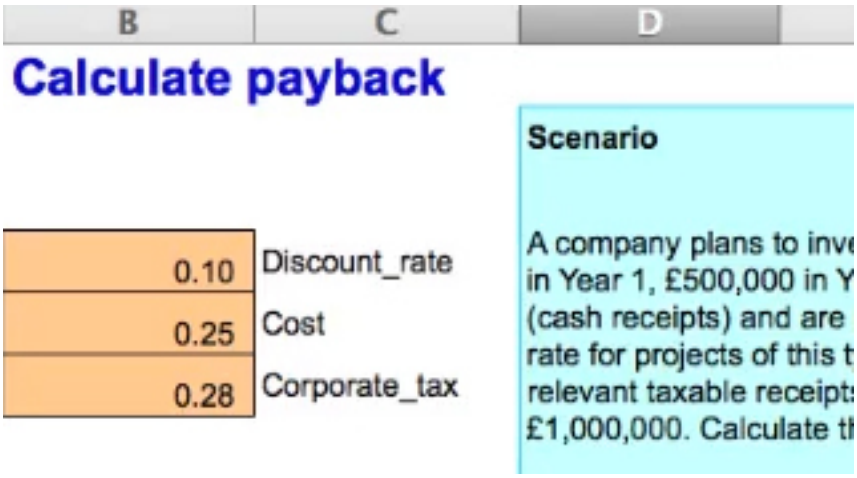
Video content is not available in this format.
Video 2 Using input ranges



Video content is not available in this format.
Video 3 Calculate the internal rate of return



Video content is not available in this format.
Video 4 Calculate payback



You can see the DCF spreadsheet (solution) here.

Spreadsheets can be useful tools for decision making, but it is very important that they are constructed and tested carefully. Research suggests that poorly designed and controlled spreadsheets are reasonably common in business and can cause sizable losses (Powell et al, 2009).

This section has looked at the principles which are the foundation of the project evaluation. These include what information to include in an appraisal, using concepts such as relevant cash flows, sunk costs and opportunity costs. The time value of money and how project appraisals account for it by using a discount rate were discussed. Some approaches to estimating the discount rate, and their advantages and disadvantages, were discussed and the use of a spreadsheet to model discounted cash flow decisions introduced.

When performing project appraisal for decisions in practice, you would need to decide what the appropriate discount rate to use is, and the information in this section should help you do that. The guidance about designing a spreadsheet should also assist in applying this understanding to practical situations, but note the warning from research

studies that it is important to be very careful using any tool - but spreadsheets in particular!

4 Dealing with risk and uncertainty in project appraisal

During this course, we have dealt with information as if the cash flows from decisions are known with certainty. The cash flows used to calculate NPV have been supplied to you without any reference to how accurate they are or whether they are only estimates from a range of values. Information about this is needed, because in real life the future is never known for certain and we are interested in the range of outcomes which could occur, not just the best estimate of what might happen. Investment decisions are particularly susceptible to risk and uncertainty, because the cash inflows from an investment can take place over many years or even decades. The number of years these cash flows will last; how large these cash flows will be; and whether they will even take place at all are all uncertainties.

This section looks at risk and uncertainty in more detail, and how it can be taken into account during project appraisal. This section begins with a discussion on the difference between risk and uncertainty, and typical attitudes which people have towards risk and uncertainty. We discuss some simple ways to adjust the discount rate and payback period to take risk into account. We explain how combining cash flows with their probabilities of occurring can be used to provide information about the expected values for the outcomes of projects. Finally the value of further information when making decisions is defined.

At the end of this section you should:

- be able to discuss the technical definitions of risk and uncertainty, and the range of attitudes which can be taken towards them
- be able to demonstrate some simple adjustments to NPV analysis to deal with risk
- know how to calculate probability-weighted cash flows, and explain why this approach is effective when risk is present in NPV analysis
- be able to apply probabilities to future outcomes, and explain why this is an alternative to an increased discount rate
- be able to explain the meaning of value of information.

4.1 Risk and uncertainty

The terms '**risk**' and '**uncertainty**' tend be used interchangeably in normal language; however, they have different technical meanings, set out by Knight (2012). Take a situation where there are several possible future outcomes. We cannot say which will occur, but if we can assign probabilities to the likelihood of each possible outcome occurring, we have a situation of risk. (These probabilities can be determined by reference to the relative frequency of outcomes that happened in the past. Alternatively they may be estimated from market research or using the expertise and experience of the staff

involved in a project.) If we cannot assign probabilities to the likelihood of each possible outcome occurring, we have a situation of uncertainty.

Note that, technically, risk and uncertainty do not necessarily have negative connotations. They simply mean that future outcomes are not known with certainty. Where they are present, it means that cash flows could be better or worse than their estimated values. However in everyday use, risk and uncertainty are typically used to mean outcomes which are worse than a level previously predicted, so be aware of this difference.

You may notice that despite the definitions above, there is still a grey area between risk and uncertainty. While we may always be able to estimate probabilities of certain outcomes occurring, the degree to which these probabilities are accurately known is also subject to uncertainty. For example, if I am rolling a die or tossing a coin, I know exactly the probabilities that the possible outcomes have. However, a situation where you know the probabilities for certain is unlikely in business situations.

A manager trying to forecast demand for a new product may be able to estimate the probability of achieving sales of £500,000, £1,000,000 and £1,500,000 as 20%, 50% and 30%, respectively, based on past sales for similar products. However the probabilities themselves are not known with certainty. The amount of uncertainty will vary depending on the situation, so there will be varying amounts of uncertainty about the risks faced! In practice, you would have to use your judgement to decide whether probabilities can be estimated accurately enough for risk analysis to be worthwhile, or whether the project should be treated as having uncertain outcomes without probabilities attached to them.

4.1.1 Attitudes towards risk

In this course, we have taken the attitude that decision-makers are risk neutral. This means that they select the option which produces the greatest NPV, regardless of how risky the option is. If the same decision was taken many times, selecting the option with the greatest expected value each time would produce the highest value in the long run. However, many decisions taken in business are one-off decisions, not decisions which are repeated many times.

In this context, other attitudes towards risk are often taken. People can be risk averse, meaning that they avoid risk. The technical definition of a risk-averse decision-maker is someone who will sacrifice higher expected value in order to avoid risk. Note that this definition is different from the common definition of simply avoiding risk where it is present. Here is an example to demonstrate what this means.

Imagine you are offered a bet: you win £9,000 if you roll a six on a die, but you pay £1,500 if you roll any other number. Would you take the bet? The expected value of the bet is in your favour:

$$\frac{5}{6} \times (£1{,}500) = (£1{,}250)$$

$$\frac{1}{6} \times £9{,}000 = £1{,}500$$

So the expected value = (£1,250) + £1,500 = £250

A risk-neutral person would accept the bet, since it has a positive expected payoff: the average gain on the bet is £250 per time. However many people would refuse such a bet, and demonstrate that they are risk averse in this case. A risk-averse attitude is common in many people, and in business decision-makers to some extent. People often prefer to stick with what they have – for example, a profitable and low risk business, rather than risk losing this for the (better than average) chance of making more money or expanding the business successfully.

It is also possible to be risk seeking, meaning unsurprisingly that people seek out risk in order to get better returns. The technical definition of a risk-seeking decision-maker is someone who will sacrifice higher expected value in order to take on risk. Note that this is different from the common definition of someone who is simply willing to take risks: a risk-neutral decision-maker will also do this when the expected value is in their favour.

Suppose the bet above is changed slightly so the payoff for a six is only £6,000. The expected value of the bet is now:

$$\frac{5}{6} \times (£1{,}500) = (£1{,}250)$$

Equation 9

$$\frac{1}{6} \times £6{,}000 = £1{,}000$$

Equation 10

So the expected value is (£1,250) + £1,000 = (£250).

Someone who was risk neutral would now reject the bet, because the expected value is negative and the bet will lose money on average. However a risk-seeking individual would still take the bet despite the expected value being negative, because taking the bet increases the risk they are exposed to.

Obviously, risk-seeking individuals in this definition are unusual. Most people will accept some risk in return for a greater average return, and people vary in how much reward they require for additional risk. However, few people will take on more risk at the same time as making the expected value worse on average – being ‘risk-taking’ is usually meant as a relative term. Almost everyone is risk-averse to some extent, and how ‘risk-taking’ someone is, is a measure of how close to being risk-neutral they are.

The layman definitions fit in better with how most people use these terms (and also how they are used throughout this course). Risk-seeking people are simply people more likely to take on risk than risk-averse people. For example, risk-seeking investors would be more likely to invest in stocks, attracted by the higher potential returns on offer, while risk-averse investors may invest in bonds and gilts, which have little risk attached to them but have lower expected returns.

By investing in riskier investments such as stocks, risk-seeking investors are actually increasing their expected return not decreasing it, because the long-term average return of stocks is historically higher than bonds. So these risk-seeking investors are really just risk-neutral investors (in the technical sense of the term) who are taking the option with the highest expected value and are not deterred by the higher overall risk.

Note that the technical and common definitions of risk-averse investors tend to be more similar. For example, in declining to invest in stocks, investors are both avoiding risk (the common definition), and also reducing their expected return in order to do so (the technical definition).

4.1.2 Attitudes towards uncertainty

Uncertainty exists when we know that several different outcomes could occur, but we do not have estimates of the probability of each of these outcomes happening. In this scenario, there are several rules we can use to guide our decision making called: maximax, maximin, and minimax regret. Minimax is loosely equivalent to being risk averse, since it seeks to minimise the worst outcome that could occur. Maximax is roughly similar to being risk seeking, since it seeks to maximise the best outcomes that occur.

4.2 Simple adjustments to deal with increased risk

Dealing with risk can be relatively simple: the techniques below are quick ways to incorporate some understanding of the risk of a project into the project appraisal. While they are not the most sophisticated methods available, they benefit from being easy to understand and implement, and are certainly better than making no adjustment for risk. The following subsections discuss how the discount rate and payback period can be adjusted, and clarify that the discount rate does *not* need to be adjusted for cash flows which occur further in the future, if the discount rate is used appropriately to calculate a discount factor for each year.

4.2.1 Risk and the discount rate

Remember that in Section 3, you saw that the reasoning behind the discount rate is that it represents the return that would be demanded by investors in order to invest in a project. The higher the risk of a project, the higher the return that would be demanded to invest in that project. A higher rate compensates an investor for the possibility that the future cash flows are not actually received. A higher risk means that future cash flows are less certain, so where the risk of a project is higher, a higher discount rate should be used.

So, the most basic way to adjust the discount rate for increased risk is to discount future cash flows by an appropriate amount. Throughout most of this course, the discount rate has been supplied to you as the cost of capital or the required return. Using the cost of capital is acceptable if a project has the same risk as the on-going operations in an organisation. However, if the project has a risk different from the normal operations in an organisation, a different discount rate should be used to reflect this. Section 3 discussed how the CAPM can be used to estimate the risk of a project by using the beta of companies which undertake similar projects or operate in the same industry as a comparison.

4.2.2 Risk and the payback period

A similar way to adjust for risk is to shorten the length of the payback period, a technique known as adjusted payback period. A shortened payback period means that a project must pay back the initial investment more quickly in order to be acceptable. However it is still not recommended, as it still has all the issues of the payback period that make it only somewhat useful as a heuristic. NPV is the superior method of dealing with risk: if the discount rate is calculated correctly then cash flows further into the future will be given less weight due to higher discounting, but they will still be given some weight, rather than being ignored if they are after the payback period.

The same method of decreasing the acceptable payback period can also be used with the discounted payback period. This is an improvement on the payback period but still has most of the same problems. Also note that, whether you use the standard payback period or an adjusted one, and standard or discounted payback, the decision rule about whether to accept a project is still arbitrary. How many years is an acceptable payback time? There is no right answer since the payback rule does not consistently produce the best decision. Increasing the discount rate to deal with higher risk is a blunt instrument, but if risk is accounted for properly in setting a discount rate, then the decision rule is still clear: accept any project where NPV is greater than zero.

4.2.3 Risk and time delay

People sometimes think that if cash flows occur further into the future, they are riskier so should be discounted at a higher rate. This is incorrect: the discount rate is already applied and compounded each year, so cash flows further into the future are discounted at a higher rate in proportion to the amount of time you have to wait until they occur. If risk is constant over time (e.g. the same discount rate is applied for each additional year), then the discount rate already takes into account the increased risk with greater time into the future.

4.3 Using probability and future cash flows to deal with risk

One way to deal with risk is by using estimated cash flows in NPV analysis that take into account the range of outcomes that could occur in the future. In fact, this has already been done implicitly when talking about cash flows in earlier sections: it is rare that the values of future cash flows that will occur are known precisely.

Estimated cash flows using the probability of different values of the cash flows allows NPV analysis to take into account the possibility that actual cash flows are better or worse than expected. This also allows adjustment for when there is a chance that cash flows may not occur at all (i.e. they may have zero value). An extension of this technique is to assign probabilities to different possible future scenarios and calculate the expected NPV for each scenario. The probability of each scenario can then be used to calculate an overall probability-weighted NPV. This probability-weighted NPV is used to decide whether the project should go ahead.

4.3.1 Estimating future cash flows

In this course, future cash flows have been presented to you as if they are concrete predictions of what will occur. However, this is not strictly what they are. The cash flows used when calculating NPV are the best estimates of future cash flows. The cash flows do not represent the best case scenario and the purpose of the discount rate is not to reflect the risk that the best case scenario may not occur.

The best estimate of a cash flow should be an unbiased estimate. This means that the actual outcome may be higher or lower than the estimate, however on average the errors in estimates should balance each other out. Another name for an unbiased estimate is the expected value, which was mentioned earlier in this section.

The discount rates reflect the risk that the best estimate of a cash flow could be wrong, and a higher risk means that the actual value could be further from the estimate than a cash flow with lower risk will be different from its estimate. At the extreme, an estimate which will definitely occur has no risk attached to it, since there will be no difference between the estimated cash flow and the actual cash flow (and it would be discounted at the risk-free rate).

It follows that you should avoid estimating best-case cash flows and then using a higher discount rate to try to adjust for the fact that the best-case estimate may not occur. The cash flows used should be a fair estimate of what is expected to happen, which is neither optimistic nor pessimistic.

Activity 8 Calculating unbiased estimates of cash flows

Spend about 10 minutes on this activity.

A company is considering a project and needs to estimate the sales the project will generate in year 1. The table below gives different levels of sales that might occur, with their respective probabilities. Calculate the unbiased estimate of the revenue from sales which should be used when calculating the NPV of the project.

Table 18

Sales revenue	Probability
£	
400,000	0.2
500,000	0.5
700,000	0.3

Answer

Table 19

Sales revenue	Probability	Probability weighted cash flow
£		£
400,000	0.2	80,000
500,000	0.5	250,000
700,000	0.3	210,000
Total		**540,000**

So in the discounted cash flow calculation to calculate NPV, £540,000 would be used as the year 1 sales figure.

4.3.2 Calculating probability-weighted cash flows instead of increasing the discount rate

As mentioned above, it is tempting to try to estimate the increase of the discount rate rather than try to estimate the probability of certain outcomes occurring. However this practice should be avoided if possible (it is sometimes known as adding a fudge factor, obviously not a term of approval!). Ideally, major sources of risk that stem from one unknown outcome should be dealt with separately and then the remaining cash flows discounted at a lower discount rate.

For example, imagine that the project in Activity 8 also carries a risk that the project will not be approved by regulators, and consequently no sales will be made. If the project was originally going to be discounted at 10%, the company may now feel the project's extra risk means it should be discounted at 15%. However a better approach is to estimate the probability of the undesirable outcome occurring. Table 20 shows the situation where there is a 20% probability of the project not being approved, and if it does go ahead, the likely revenue figures are in the same proportion as before.

Table 20 Calculating a probability-weighted cash flow for sales revenue

Sales revenue	Probability	Probability weighted cash flow
£		£
0	0.20	0
400,000	0.16	64,000
500,000	0.40	200,000
700,000	0.24	168,000
Total		**432,000**

So the cash flow used in an NPV calculation would be estimated as an expected value of £432,000 to take account of the possibility of a zero sale revenue.

4.3.3 Estimating probabilities for scenarios instead of increasing the discount rate

Here is a similar scenario. Say a project requires an £800,000 investment to develop a new product. If the market demand for the product is good, an expected income of £125,000 per year in perpetuity will be generated. However, if demand is poor the income in perpetuity will only be £75,000. The company estimate good demand at only 50% likelihood, so uses a discount rate of 25% rather than their cost of capital of 10% (which is the standard return for selling established products in their industry). Discounted cash flow calculations show that the project is not worthwhile:

$$\text{Initial investment} = (£800,000)$$

Equation 11

$$\begin{aligned}\text{Expected value of cashflows} &= 50\% \times £125{,}000 + 50\% \times £75{,}000 \\ &= £62{,}500 + £37{,}500 \\ &= £100{,}000\end{aligned}$$

Equation 12

$$\text{NPV of perpetuity} = \frac{£100{,}000}{0.25} = £400{,}000$$

Equation 13

So the NPV of the project equals (£400,000), and the project is clearly not worth pursuing.

However, this is using the discount rate to account for the uncertainty in the success of the project, not the uncertainty of the project once it is established. To look at it another way, the company justified using a large discount in the first year because the demand is unknown. However, after the outcome of the first year is known, will the level of additional risk be as high for the second and subsequent years?

The answer is probably no: after the first year, whether the product is successful or unsuccessful, cash flows in the second year and onwards will continue to be high or low, depending on the outcome of the first year. So a further discount of 25% for income in the second year, third year, etc. is not warranted. (Obviously this is a simplification, since cash flows from a new product are unlikely to be constant each year.)

If we could resolve the uncertainty about the success of the product, we could avoid using this fudge factor in the discount rate. The company thinks that if it carried out some market research before investing in the project, it would be able to determine whether demand for the product would be good or poor. This market research would cost £25,000 and take place just before paying out the £800,000 investment.

The two scenarios can now be looked at separately. Since the market research removes the risk of how well the product is received, the discount rate for the normal selling of products in this industry can be used, rather than for launching products.

Good demand

$$\text{Initial investment} = (£800,000)$$

Equation 14

$$\text{NPV of perpetuity} = \frac{£125{,}000}{0.1} = £1{,}250{,}000$$

Equation 15

$$\text{NPV} = £450,000$$

Equation 16

Poor demand

$$\text{Initial investment} = (£800,000)$$

Equation 17

$$\text{NPV of perpetuity} = \frac{£75{,}000}{0.1} = £750{,}000$$

$$\text{NPV} = £50,000$$

Equation 19

So the project is actually worth undertaking if there is good demand, but not if there is poor demand. If the company knew in advance there was poor demand, it would not actually invest in the project, whereas with good demand the project has an NPV of £450,000 and would be invested in.

However, a company may be reluctant to invest in the project while there is risk about the levels of demand, in case there was poor demand and the project generated negative NPV. So it would want to carry out the market research to remove this risk.

In this scenario, the company can find out whether there would be good demand by spending an additional £25,000 on market research, before having to decide whether to go ahead with the £800,000 investment. So, the decision to make now is whether to go ahead with the market research! To do this, we calculate the expected NPVs of the project with and without paying for market research first.

Once the market research is completed, the company will know whether demand will be good or poor, and will invest or not depending on this knowledge. The probability-weighted NPV of the project can be calculated, taking into account that the company will have to pay for the market research to make its decision about investment.

The probability-weighted NPV of the project is found by multiplying the NPV in each case by its estimated probability, and deducting the cost of the market research. The

probabilities of good demand and poor demand have already been estimated as 50% for each by the company.

Good demand

Project goes ahead.

$$\text{NPV} = £450,000$$

Equation 20

$$\text{Probability of this demand} = 50\,\%$$

Equation 21

$$\text{Probability-weighted NPV} = 0.5 \times £450,000 = \mathbf{£225,000}$$

Equation 22

Poor demand

The project does not go ahead.

$$\text{NPV} = £0$$

Equation 23

$$\text{Probability of this demand} = 50\,\%$$

Equation 24

$$\text{Probability-weighted NPV} = 0.5 \times £0 = \mathbf{£0}$$

Equation 25

Market research

This is undertaken in both scenarios.

$$\text{Cost of market research} = \mathbf{(£25,000)}$$

Equation 26

$$\text{Probability of this demand} = 100\,\%$$

Equation 27

$$\text{Probability-weighted NPV} = 1 \times (£25,000) = \mathbf{(£25,000)}$$

Equation 28

$$\mathbf{\text{Total Probability-weighted NPV} = £200,000}$$

Equation 29

There will be a positive NPV of £200,000 with the benefit of the market research, even after paying for the market research itself, so the project will go ahead. This demonstrates the benefits of trying to determine the probabilities of future outcomes, rather than simply adjusting the discount rate higher to account for increased uncertainty.

4.4 Modelling sensitivity analysis

Spreadsheets allow us to see the impact of different possible outcomes on the net present value of the project. This form of sensitivity analysis can be very helpful as it allows us to see the effect of a single or a combination of possible outcomes as 'what if' scenarios. The following material shows the use of spreadsheets in this context.

First watch the video ‘Sensitivity analysis’ which shows you how to carry out break-even sensitivity analysis in investment appraisal.

Break-even sensitivity analysis finds the percentage change from the original value, in each of the project’s inputs in turn, that is required to achieve a zero NPV. The input or variable that shows the smallest change is the most sensitive.

The most sensitive variables are the variables where small changes or deviations from the project’s plan will have a greater impact on the outcome, or NPV, than changes in other variables.

Knowing which variables are the most sensitive helps you focus on the high risk areas of a project. It allows further testing of assumptions regarding the forecasts and projections associated with the sensitive variables.

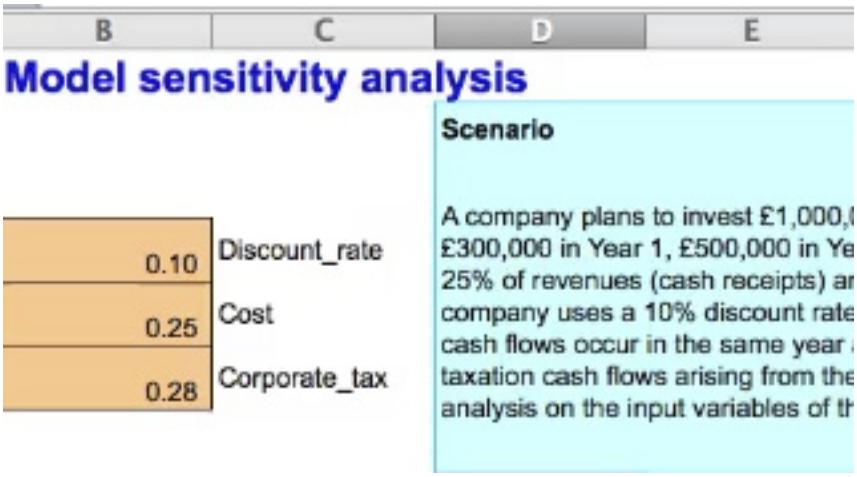
The sensitive variables will be monitored closely by managers if the project goes ahead.

> A company plans to invest £1,000,000 in a new product that will generate revenues (cash receipts) of £300,000 in Year 1, £500,000 in Year 2 and £600,000 in Years 3 to 5.
>
> Costs (cash payments) will be 25% of revenues (cash receipts) and are paid in the same year as the relevant cash receipts.
>
> This company uses a 10% discount rate for projects of this type.
>
> The corporate tax rate is 28%. Taxation cash flows occur in the same year as the relevant taxable receipts and payments. There are no taxation cash flows arising from the investment of £1,000,000. Calculate the NPV of this investment.

This time, carry out break-even sensitivity analysis on the inputs of this investment.

Watch the video:

Video content is not available in this format.
Video 5 Sensitivity analysis



Make your own notes.

You can see the Sensitivity analysis (solution) here.

4.5 The value of information

You saw in the example in Subsection 4.3.3 that by determining whether or not the product will be a success in advance, the company can increase the expected NPV from the project by £225,000. Without this information the project would not go ahead at all so the NPV would be zero. With this information the company has a 50% chance of gaining an NPV of £450,000, so the expected value is 50% of £450,000. The increase of £225,000 in NPV, attributable to holding information that is used in decisions about whether to proceed with projects, is sometimes called the value of information.

More formally, the value of information is the weighted average of the increase in value which having that information will generate. The NPV that would be achieved with the information is compared with the NPV that would be achieved without the information for each possible scenario. Table 21 shows this for the example above:

Table 21 Demonstrating the probability-weighted increase in NPV from having information about demand

	Good demand NPV	**Poor demand NPV**
	£	£
With information about demand	450,000	0*
Without information about demand	0*	0*
Difference in NPV from information	450,000	0
Probability of scenario	0.5	0.5
Difference from information weighted by probability of that scenario	225,000	0
Total of differences in NPV weighted by probability of each scenario	**225,000**	

* project not undertaken

The value of information of £225,000 is the *maximum* amount that it is worth paying for the market research to determine the demand for the product. Since in this case the market information costs only £25,000, there is an overall increase in NPV of £200,000 after paying for the market research.

Calculating the value of knowing information about a project can highlight areas where a company can benefit from putting more resources into resolving uncertainty. Obtaining certain information can change what decisions are made and increase the expected NPV and, if so, it is worthwhile spending some money to obtain that extra information.

This section has reviewed how risk and uncertainty arise in project appraisal, and described some techniques to deal with them. The difference between risk and uncertainty and the attitudes towards them that people can take were discussed. You saw some simple adjustments which can be made to account for risk; how to combine probabilities and cash flows to account for risk; and how to model different scenarios in a spreadsheet. You also learned how to work out the value of gaining additional information when making decisions.

5 End-of-course exercises

This section contains two end-of-course exercises. They are designed to allow you to practise what you have learned in the course and help you to strengthen your understanding of the practical application of the concepts. Since accounting is an applied discipline this is an important step in your learning. The best approach is to attempt the questions by referring to the material in the course if you need to, but without looking at the answers until you have finished.

Exercise 1 Customer profitability

Spend about 25 minutes on this question

(This question is adapted from Bhimani et al., 2008, pp. 399–400)

Maltloaf produces a soft drink which it distributes to a range of retailers. In addition to the costs of producing the product, Maltloaf has identified a number of customer-related costs, as shown below.

Table 22

Activity	Cost driver and rate
Order taking	£200 per purchase order
Sales visits	£160 per visit
Delivery	£4 per delivery mile travelled
Product handling	£0.004 per bottle sold

Maltloaf has collected the following data to facilitate a customer profitability analysis for its four largest customers.

Table 23

	Smith	Jones	Greene	Browne

Bottles sold	2,000,000	1,600,000	140,000	120,000
List price	£1.20	£1.20	£1.20	£1.20
Actual price paid	£1.12	£1.18	£1.10	£1.20
Number of purchase orders	60	50	30	20
Number of sales visits	12	10	8	6
Number of deliveries	120	60	40	30
Miles travelled per delivery	10	24	40	12
Production cost of sales (@ £1 per bottle)	£2,000,000	£1,600,000	£140,000	£120,000

Required:

Calculate the operating profit for each customer. Comment on your results, and say which customer(s) Maltloaf would find most attractive.

Discussion

Table 24

	Smith	**Jones**	**Greene**	**Browne**
Sales revenue (£)	2,240,000	1,888,000	154,000	144,000
Production cost of sales	2,000,000	1,600,000	140,000	120,000
Gross profit	240,000	288,000	14,000	24,000
Gross profit (% of sales value)	10.71%	15.25%	9.09%	16.67%
Order taking	12,000	10,000	6,000	4,000
Sales visits	1,920	1,600	1,280	960
Delivery	4,800	5,760	6,400	1,440
Product handling	8,000	6,400	560	480
Total customer costs	26,720	23,760	14,240	6,880
Customer costs (% of sales value)	1.19%	1.26%	9.25%	4.78%
Net profit	213,280	264,240	(240)	17,120
Net profit (% of sales value)	9.52%	14.00%	(0.16)%	11.89%

The most notable issues highlighted by this analysis are as follows. (Percentages have been calculated in the analysis, as it often provides greater insights to look at something in terms of its relationship to something else rather than in absolute terms alone).

1 There is considerable variation in the gross profit as a percentage of sales and this is due to the discounts from the list price the customers are receiving. Smith receives a large discount, but this is understandable as it is the biggest customer. More surprising is that the biggest discount is received by Greene whose sales volume is extremely low in relation to the two biggest customers, Smith and Jones. Clearly, this is something that Maltloaf's management should look at.

2 Another significant issue revealed is the difference in customer costs in relation to sales revenue, which together with the discounts offered, have a major impact on

the operating profit. Most noticeable is Greene, whose customer costs (as a percentage of sales) vastly exceed those of the other customers. The primary cause of this seems to be the disproportionate costs of order taking and delivery. Greene appears to place a relatively large number of purchase orders (i.e. it orders lots of small quantities) and also receives lots of deliveries of relatively small amounts. Compared with the most profitable customer, Jones, Greene's average order is for 4,667 bottles as against Jones's 32,000. A similar picture emerges with deliveries: the average number of bottles per delivery for Greene is 3,500 whereas for Jones it is 26,667 (made worse by the fact that Greene also has the longest delivery distance!)

The analysis reveals (in particular) that Maltloaf should renegotiate its terms of trading with Greene, with particular reference to the generous discount offered and the order/delivery batch size. In order to be profitable, and assuming sales volume cannot be increased, Greene would need to buy the same number of bottles in larger orders and with fewer deliveries. It would also need to pay the full list price, as the other small customer, Browne, does.

Exercise 2 Risk, uncertainty and sensitivity analysis

Spend about 45 minutes on this question.

Adapted from: The Association of Chartered Certified Accountants, Paper F9 Financial Management Practice & Revision Kit for exams in 2012. December 2004, Question 27.

Umunat Co (FMC, 12/04)

Umunat Co is considering investing $50,000 in a new machine with an expected life of five years. The machine will have no scrap value at the end of five years. It is expected that 20,000 units will be sold each year at the selling price of $3.00 per unit. Variable production costs are expected to be $1.65 per unit, while incremental fixed costs, mainly the wages of a maintenance engineer, are expected to be $10,000 per year. Umunat Co uses a discount rate of 12% for investment appraisal purposes and expects investment projects to recover their initial investment within two years.

Required:

(a) Explain why risk and uncertainty should be considered in the investment appraisal process.

(b) Calculate and comment on the payback period of the project.

(c) Evaluate the sensitivity of the project's net present value to a change in the following project variables, then discuss the use of sensitivity analysis as a way of evaluating project risk:

  (i) Sale volume

  (ii) Sales price

  (iii) Variable cost.

(d) Upon further investigation it is found that there is a significant chance that the expected sales volume of 20,000 units per year will not be achieved. The sales manager of Umunat Co suggests that sales volumes could depend on expected economic states that could be assigned the following probabilities:

Table 25

Economic state	Poor	Normal	Good
Probability	0.3	0.6	0.1
Annual sales volume (units)	17,500	20,000	22,500

Calculate and comment on the expected net present value of the project.

Discussion

(a) A risky situation is one where we can say that there is a 60% probability that returns from a project will be in excess of $100,000 but a 40% probability that returns will be less than $100,000. If, however, no information can be provided on the returns from the project, we are faced with an uncertain situation. Managers need to exercise caution when assessing future cash flows to ensure that they make appropriate decisions. If a project is too risky, it might need to be rejected, depending upon the prevailing attitude risk.

In general, risky projects are those whose future cash flows, and hence the project returns, are likely to be variable. The greater the variability is, the greater the risk. As the cash flows in capital investment decisions might be for several years ahead, therefore there is bound to be risk involved in such decisions. Therefore, it is highly likely that the actual costs and revenues may either be below or above budget as the work progresses.

(b) Assuming that cash flows occur evenly throughout the year:

$$\text{Contribution per unit} = \$3.00 - \$1.65 = \$1.35$$

Equation 30

$$\text{Total contribution} = 20,000 \text{ units} \times \$1.35 = \$27,000 \text{ per year}$$

Equation 31

$$\text{Annual cash flow} = \$27,000 - \$10,000 = \$17,000$$

Equation 32

$$\frac{\$50,000}{\$17,000} = 2.9 \text{ years}$$

Payback shows how long it will take to recover the initial investment. In this case, the payback period exceeds the company's hurdle payback period of two years. Therefore, Umunat might be tempted to reject this project. However, a project should not be evaluated on the basis of payback alone. If a project gets through the payback test, it should then be evaluated with a more sophisticated investment appraisal technique, such as NPV. Payback ignores the timing of cash flows within the payback period, the cash flows after the end of payback period and therefore the total project return. It also ignores the time value of money.

Table 26

Year	Investment	Contribution	Fixed costs	Net	Discount factor	Total

	$	$	$	$	12%	
0	(50,000)			(50,000)	1.000	(50,000)
1–5		27,000	(10,000)	17,000	3.605	61,285
						11,285

$$\text{NPV of sales revenue} = 20,000 \times \$3.00 \times 3.605 = \$216,300$$

Equation 34

$$\text{NPV of variable costs} = 20,000 \times \$1.65 \times 3.605 = \$118.965$$

Equation 35

$$\text{NPV of contribution} = \$97,335$$

Equation 36

(c)

(iii) *Sensitivity to sales volume* For an NPV of zero, contribution has to decrease by $11,285.

This represents a reduction in sales of $\frac{11,285}{97,335} = 11.6\%$

(iv) *Sensitivity to sales price* As before, for an NPV of zero, contribution has to decrease by $11,285.

This represents a reduction in selling price of $\frac{11,285}{216,300} = 5.2\%$

(v) *Sensitivity to variable cost* As before, for an NPV of zero, contribution has to decrease by $11,285.

This represents an increase in variable costs of $\frac{11,285}{118,965} = 9.5\%$

The basic approach of sensitivity analysis is to calculate the project's NPV under alternative assumptions to determine how sensitive it is to changing conditions. Therefore, sensitivity analysis provides an indication of why a project might fail. Management should review critical variables to assess whether or not there is a strong possibility of events occurring which will lead to a negative NPV. Management should also pay particular attention to controlling those variables to which the NPV is particularly sensitive, once the decision has been taken to accept the investment.

(d)

$$\text{Expected sales} = (17,500 \times 0.3) + (20,000 \times 0.6) + (22,500 \times 0.1) = 19,500 \text{ units}$$

Equation 40

$$\text{Expected contribution} = 19,500 \text{ units} \times \$1.35 = \$26.325$$

Equation 41

Table 27

Year	Investment	Contribution	Fixed costs	Net	Discount factor	Total
	$	$	$	$	12%	$
0	(50,000)			(50,000)	1.000	(50,000)
1-5		26,325	(10,000)	16,325	3.605	58,852
						8,852

The expected net present value is positive, but it represents a value that would never actually be achieved, as it is an amalgamation of various probabilities. Examining each possibility:

Table 28 Worst case (sales of 17,500 units, 30% probability)

Year	Investment	Contribution	Fixed costs	Net	Discount factor	Total
	$	$	$	$	12%	$
0	(50,000)			(50,000)	1.000	(50,000)
1-5		23,625	(10,000)	13,625	3.605	49,118
						(882)

We already know the NPV of sales of 20,000 units to be $11,285

Table 29 Best case (sales of 22,500, 10% probability)

Year	Investment	Contribution	Fixed costs	Net	Discount factor	Total
	$	$	$	$	12%	$
0	(50,000)			(50,000)	1.000	(50,000)
1-5		30,375	(10,000)	20,375	3.605	73,452
						23,452

The managers of Umunat will need to satisfy themselves as to the accuracy of this latest information, but the fact that there is a 30% chance that the project will produce a negative NPV could be considered too high a risk. It can be argued that assigning probabilities to expected economic states or sales volumes gives the managers information to make better investment decisions. The difficulty with this approach is that probability estimates of project variables can carry a high degree of uncertainty and subjectivity.

Conclusion

There are many challenges facing businesses in dynamic economic environments. In this course we have briefly considered the use of a strategic perspective in management accounting and the application of this approach to pricing and project evaluation.

Customer profitability analysis encourages a focus on strategically evaluating customers and the costs and effort the business puts into engaging with them. It draws on an activity based approach to trace the cost of the activities to specific customers. As with all financial analysis – it should be considered in the light of other factors, for example whether or not the less profitable customer will help to open up a new market.

Project evaluation is fundamental in a strategic perspective as organisations make decisions about where to invest for competitive advantage in the mid to long-term future. A complaint about using discounted cash flow analysis is that it is too difficult to forecast cash flows over five (or even less) years into the future. In this course we provide the technical understanding for the application of discounting and techniques that support the explicit consideration of uncertainty and risks to improve the basis for decision making.

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Glossary

Capital asset pricing model

The capital asset pricing model (CAPM) is a model for determining the expected return on an individual share.

Discounting

Finding a present value from a future value is known as discounting. Discounting is the practice of adjusting future cash flows to take into account the time value of money. The result of discounting is the present value of a future cash flow, and allows cashflows at different points of time in the future to be compared on a like for like basis.

Discount rate

The discount rate is the rate applied to future cash flows to derive the present value of those cash flows. It is often determined by the organisation's weighed average cost of capital. In banking, the interest rate at which member banks of a national clearing system may borrow short term funds directly from the central bank.

Externalities

The costs or benefits that fall on the public not just on the private persons involved in the transaction or activity.

Net present value

A net present value (NPV) is the current (today's) value of a stream of future cash flows. The NPV is derived by discounted cash flow (DCF) analysis. If the calculation gives a positive result, then the project is suitable since, by definition, it will increase the net present value of the business.

Opportunity cost

A key concept in economics, an opportunity cost is the cost related to the second best choice available to someone who has chosen from several mutually exclusive options. Thus it is a measure of what has been foregone by a particular course of action and expresses the basic relationship between scarcity and choice. Opportunity costs are not restricted to monetary or financial costs: the real cost of output foregone, lost time, pleasure or any other benefit that provides utility should also be considered opportunity costs. An opportunity cost is cash inflow which would have been received, but which will not be received if a project under consideration goes ahead. For example the opportunity cost of discontinuing manufacturing product B to focus solely on product A is the sales of product B which would have been made if both were manufactured. Like sunk costs, people also have a tendency to ignore opportunity costs. The concept is now widely applied beyond financial contexts, for example one opportunity cost of studying this course is the alternative use of the time that is spent studying.

PESTEL

PESTEL is an extension of PEST analysis. The letters stand for the following factors; Political/legal, (macro)Economic; Social, Technological, Environmental and Legal. It is a way of grouping the major environmental factors impacting on a organisation in order to anaylse their effects.

Present value

The present value of a sum is the amount that would have to be received now to be worth the same as an amount received in the future. Future flows are converted to their present value by discounting using a discount factor. The present value of a project is calculated by discounting each relevant future cash flow in order to arrive at its present day value. Then the total of all positive and negative discounted future cashflows is calculated to get a net positive or negative discounted cash flow.

Relevant cash flows

A relevant cash flow is a cost or revenue which can be changed depending on the outcome of a decision. A cash flow which will not be changed by a decision is not a relevant cash flow to that decision.

Risk

A measure of uncertainty. Risk occurs when there is more than one possible outcome and it is possible to assign probabilities to these possible outcomes.

Sunk cost

Sunk costs are costs which have already been incurred, or committed to be incurred, and cannot be recovered and which now have no relevance to financial decision making. An example is capital expenditure on plant and equipment.

SWOT

SWOT stands for **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats. A technique for developing business strategy by identifying opportunities to be exploited and threats to be safeguarded against, having regard to the organisation's strengths and weakness (i.e. capabilities).

Time value of money

The time value of money is the concept that if cash flows are paid or received in the future they are less valuable than if paid or received immediately. This is reflected in the discount rate used in financial analysis of present value. Taking account of the time value of money converts future cash flows into their present value by discounting them.

Uncertainty

There is uncertainty when a number of different outcomes are possible, but it is not possible to assign probabilities to these outcomes. Three quantitative approaches to

uncertainty: the Maximax, Maximin and Minimax Regret decision-making rules are discussed.

Weighted average cost of capital

The weighted average of the cost of capital (WACC) is the weighted average of the cost of debt and the cost of equity for an organisation, where the weights are the market proportions of debt and equity in the organisation's capital structure

Working capital

The working capital of a business is its current assets and current liabilities. Current assets less current liabilities is called net working capital. Working capital comprises the resources organisations have at their disposal as a result of the day-to-day running of their business. It comprises cash held at the bank, the value of the holdings of stock (also known as 'inventory') plus the cash due to be received from customers ('trade receivables' or, simply, 'receivables') less the cash due to be paid to suppliers ('trade payables' or, simply, 'payables'); often referred to as net current assets.

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