technical

dealing with risk in financial decisions

relevant to all Diploma in Financial Management exams

risk

In this article, we consider the problem of risk, which can be defined as the likelihood that what we predict will happen, will not actually happen. We shall examine some of the simpler techniques of dealing with risk in relation to financial decisions. We shall see that each of the techniques examined has its strengths and weaknesses and that none provide a perfect solution for the decision maker. There is plenty of evidence to show, however, that these techniques are used by managers when making financial decisions.

The problem of risk

When making a financial decision, we must normally make some prediction about the future. That is, we must try to form some view about the likely future outcome resulting from our decision. Whilst we may try our best to produce an accurate prediction, the future is uncertain and so misjudgements will often occur. In recent years, the business environment has become more turbulent as a result of such factors as increasing global competitiveness, stock market volatility, and changes in technology. This has increased the degree of uncertainty faced by businesses which, in turn, has made financial decision making more difficult and complex. Techniques for dealing with the problem of risk are, therefore, becoming increasingly important to a business.

Risk analysis and evaluation is of particular relevance when making capital expenditure decisions. The amounts invested in long-term assets are often substantial and the decision, once made, may be irreversible. Capital expenditure decisions will often require predictions to be made over many years and so the likelihood of prediction error can be very high. However, the problem of risk is not confined to this type of decision. Risk analysis techniques may also be used, for example, when making short-term working capital decisions, such as those involving the extension of credit. Below we consider four techniques for dealing with risk and uncertainty. These are:

- sensitivity analysis
- scenario analysis
- risk-adjusted discount rate
- probability analysis.

Each technique will be considered in turn and its relevance to managers will be discussed.

Sensitivity analysis

Sensitivity analysis is a simple technique which begins by identifying the key factors influencing a financial decision. Once identified, a calculation of the change to each of the individual key factors necessary before the proposal ceases to become profitable is carried out. The amount of change required for an individual key factor will represent the 'margin of safety' for that factor. The calculations will, therefore, provide managers with some insight into the riskiness of the proposal: the smaller the 'margin of safety', the more risky the proposal. To illustrate this approach, let us consider a problem that requires the application of sensitivity analysis to a capital expenditure proposal.

Example 1

Plato Pharmaceuticals has developed a new type of insect repellent. The repellent is now ready for production and sale, and the marketing director estimates that the product will sell 150,000 bottles per year over the next five years. The selling price of the insect repellent will be $5 per bottle and variable costs are estimated to be $3 per bottle. Additional cash fixed costs of $160,000 per year relate to the product.

In order to produce the repellent, machinery and equipment costing $520,000 will have to be purchased immediately. The estimated residual value of this machinery and equipment in five-years' time is $100,000.

The business has a cost of capital of 12%.

Required

Calculate the net present value (NPV) of the product. Undertake sensitivity analysis to show by how much the following factors (taken separately) would have to change before the product ceased to be worthwhile:

- the discount rate
- the initial outlay on machinery and equipment
- the net operating cash flows
- the residual value of the machinery and equipment.

Solution

To calculate the NPV, we must first calculate the annual net cash flows as follows:

Calculation of annual net cash flows

	$000	$000
Sales revenue (150,000 x $5)		750
Less Variable costs (150,000 x $3)	450	
Fixed costs		
	160	610
Annual net cash flows		140

Now the annual net cash flows have been deduced, we can calculate the NPV of the project.

NPV of project

	$000
Annual cash flows (140,000 x 3.60*)	504
Residual value of machinery and equipment	
(100,000 x 0.57)	57
Present value	561
Less initial outlay	520
Net present value	41

* The sum of the annual discount factors over a five-year period, based on a 12% discount rate.

The sensitivity of the project to changes in the discount rate can be determined through a process of trial and error. As a 12% discount rate gives a positive NPV, we must raise the discount rate in order to find the point at which the project ceases to be worthwhile (ie NPV = 0). If we raise the discount rate to 18%, the NPV of the project will be:

	$000
Annual cash flows (140,000 x 3.13*)	438.2
Residual value of machinery and equipment	
(100,000 x 0.44)	44.0
Present value	482.2
Less initial outlay	520.0
Net present value	(37.8)

*The sum of the annual discount factors over a five-year period, based on a discount rate of 18%.

As the NPV is now negative, the required discount rate must be lower than 18%. Using linear interpolation, we can derive the discount rate at which the project ceases to be worthwhile as follows:

12% + [41/(41 + 37.8 x 6%) = 3.1%] = 15.1% (approximately)

This means that the discount rate could increase by more than three percentage points before the project ceased to be worthwhile for that reason alone. The figure of 15.1% which has been calculated above is, of course, the internal rate of return (IRR) of the project.

We saw earlier that the NPV of the project is expected to be $41,000. The change required in the initial outlay to make the project no longer viable will be equal to the NPV of the project (ie $41,000). This is because the initial outlay is already expressed in present value terms.

To deduce the change in the annual net cash flows from operations necessary to make the project no longer worthwhile, we must calculate the reduction in the annual net cash flows over the five-year period necessary to eliminate the positive net present value of the investment project, which was calculated earlier as $41,000. This problem is similar to the problem of valuing annuities as the cash flows, in this example, are constant over the five-year period. (An annuity is an investment which provides a fixed amount each year over a set period.)

Let R = the reduction in the annual operating cash flows of the project necessary to make the project no longer profitable.

(R x annuity factor for a five-year period)	=NPV
(R x 3.60*)	=$41,000
R	=$41,000/3.60
R	=$11,389

*Based on a rate of 12% (ie the cost of capital) per year.

The change in the residual value necessary to make the project no longer worthwhile requires some basic algebraic manipulation:

Let V = the required value	
(V x discount factor at end of five years) – NPV of project	=0
Which can be re-arranged as:	
(V x discount factor at end of five years)	=NPV of project
V x 0.57	=$41,000
V	=$41,000/0.57
V	=$71,930

We can set out the absolute and percentage change in each of the factors required to produce a zero NPV as follows:

Key factor	Size of increase/reduction	% change required to produce zero NPV
Cost of capital	3.1%	25.8
Initial outlay	$41,000	7.9
Net cash flows	$11,389	8.1
Residual value	$71,930	71.9

We can see from the above that the project will be most sensitive to changes in the initial outlay and to net cash flows. There would have to be much more significant changes, in percentage terms, to the cost of capital and the residual value of the project before the project ceased to be profitable. Such insights may help managers to focus any further investigations on the two most sensitive factors identified.

Another approach to sensitivity analysis

In addition to the 'break-even' type of analysis carried out above, sensitivity analysis can also be used to answer 'what if?' questions. This type of question may be useful in helping managers to gain a feel for the likely future outcomes. Thus, managers may wish to know:

- What if the sales volume were 10% lower than anticipated?
- What if the sales price was 5% higher than expected?
- What if the material costs were 20% higher than expected?
- What if the labour costs were 15% lower than expected?

This type of analysis is, of course, ideally suited to the computer. Spreadsheet models can be used to carry out the analysis quickly and accurately.

Weaknesses of sensitivity analysis

Survey evidence suggests that sensitivity analysis is one of the most popular methods of dealing with risk uncertainty among UK businesses. However, it is not without its problems. The technique requires that we consider only one factor at a time although, in practice, it is likely that more than one factor will change. (Indeed, there may be strong inter-relationships between key factors.) An inability to cope with simultaneous changes in the key factors undoubtedly weakens its usefulness.

Furthermore, sensitivity analysis does not provide an indication of the likelihood of any change in the key factors. In the example above, the initial outlay had the lowest 'margin of safety'. However, this amount may be certain and so the fact that a small change in this amount will cease to make the project worthwhile, may not be a real cause for concern. Finally, this technique does not provide managers with any clear guidance concerning the investment decision. Faced with the sensitivity calculations for Plato Pharmaceuticals, which were provided above, should we accept or reject the project? To answer this question, we must rely on the exercise of judgment. However different individuals may come to different judgements according to their particular attitude to risk.

Scenario analysis

Scenario analysis is similar to sensitivity analysis in so far that it calculates different possible outcomes based on different values for each of the key factors relating to an investment decision. However, unlike sensitivity analysis, it does not examine the effect of a change in one factor at a time. Instead, several, if not all, of the key factors may be changed to fit a particular scenario. This form of analysis considers different possible 'states of the world' or scenarios and then assigns values to the key factors according to the particular scenario chosen. For example, managers may wish to consider three possible scenarios:

- a best-case scenario
- a worst-case scenario, and
- a most-likely scenario.

Values for each key factor will then be assigned to each key factor to fit the particular scenario. Preparing a worst-case and best-case scenario may be useful in giving managers a feel for the range of possible outcomes associated with a particular investment decision.

Scenario analysis, however, suffers from similar problems to those mentioned in relation to sensitivity analysis which we discussed above. Calculating the results of different possible scenarios does not provide managers with clear guidance concerning whether to accept or reject the project and so, once again, managers must rely on judgment.

Furthermore, scenario analysis does not provide an indication of the likelihood of each scenario occurring. This information is vitally important when deciding whether or not to invest. (Consider, for example, the best-case scenario for entering a national lottery competition and then consider the likelihood of winning.)

Risk-adjusted discount rate

This method recognises that investors will, generally speaking, only be prepared to take on additional risk if there is the prospect of additional returns. When considering a long-term investment decision, therefore, the cost of capital (which is used as the discount rate for projects and which represents the required returns for investors) can be increased according to the riskiness of the particular project. The greater the risk, the greater the required returns from the investor and so the higher the cost of capital figure used to discount the future cash flows of the project.

The relationship between risk and return in investment decisions is shown in **Figure 1** on page 15. We can see that the required return from investors is made up of two elements: a risk-free element which will be common to all investment decisions and which represents the return from government securities, and a 'risk premium' which represents the additional return required from investors to compensate for the particular level of risk relating to the project.

To operationalise this concept, a business may divide project proposals into categories, eg low risk, medium risk and high risk. A risk premium will then be assigned to each category of risk for discounting purposes.

The risk-adjusted discount rate is likely to have appeal for many managers who may have an intuitive understanding of the relationship between risk and return. Furthermore, the risk-adjusted discount rate, unlike the previous techniques discussed, provides clear guidance concerning acceptance or rejection of a particular project. If the NPV (using the risk-adjusted discount rate) of the project is positive, it will enhance shareholder wealth and should, therefore, be accepted. If the NPV is negative, the project will reduce shareholder wealth and should, therefore, be rejected. The main problems with this technique are that the allocation of projects to particular risk categories can be arbitrary and the risk premium to be applied to each category may be difficult to determine.

A more sophisticated approach would be to use the capital asset pricing model (CAPM) as a basis for calculating the required return from an investment proposal. This technique is based on the proposition that a business will require a rate of return from a project that is in excess of the risk-free rate of return to compensate for the systematic risk (ie the risk that cannot be diversified away) from the project. (Any unsystematic risk, which relates specifically to the project, can be diversified away and so should not therefore require a risk premium.) The greater the systematic risk associated with a project, the greater will be the required returns. A detailed description of the way in which CAPM, helps to calculate a required return, is beyond the scope of this article but will be considered in a future article.

Probability analysis

The final approach we will consider to dealing with risk involves the use of statistical probabilities. This approach requires us to identify the possible outcomes associated with a particular decision, or event, and then to assign a probability of occurrence to each outcome. It is then possible to derive an expected value which is, in essence, the weighted average of the different possible outcomes, where the assigned probabilities are used as weights.

To illustrate this approach, let us consider the following simple example:

Example 2

Assume that the Plato Pharmaceuticals (**Example 1**) have made the following estimates of the number of products to be sold per year:

Number of products to be sold	Probability of occurrence
100,000	0.3
150,000	0.5
180,000	0.2
	1.0*

Assume no other changes to the information in **Example 1**.

*Note the sum of the probabilities equals 1.0 (ie the three options identified are the only possible outcomes).

Required

Calculate the expected value of the number of products to be sold each year.

The expected value will be a weighted average of the possible outcomes and will be calculated as follows:

(100,000 x 0.3) + (150,000 x 0.5) + (180,000 x 0.2) =
141,000 units

Expected net present value
An expected net present value (ENPV) can be calculated for the project. To do this, expected values are used in the calculation process, as shown in **Example 3**.

Example 3
The ENPV of the project currently being considered by Plato Pharmaceuticals is calculated as follows:

Calculation of expected annual net cash flows

		$000	$000
Expected sales revenue (141,000 x $5)			705
Less	Variable costs (141,000 x $3)	423	
	Fixed costs	160	583
Expected annual net cash flows			122

The ENPV of the project is calculated as follows:

Expected net present value of project

	$000
Expected annual net cash flows (122,000 x 3.60)	439
Residual value of machinery and equipment (100,000 x 0.57)	57
Expected present value	496
Less initial outlay	520
Expected net present value	(24)

The ENPV approach provides a clear decision rule for managers. A single figure outcome is derived that can be used to decide whether to accept or to reject a proposal. The ENPV of a project, if positive, will indicate that it should be accepted and, if negative, will indicate that it should be rejected. In the above example, the calculations indicate that the project should be rejected as it is likely to reduce shareholder wealth.

Weaknesses of ENPV
There are drawbacks associated with the ENPV approach. First, the expected value which is calculated represents a long-run average figure based on the decision being repeated many times. It may not actually occur. In the example above, we can see that the expected values of the sales demand do not correspond with any of the possible outcomes. Where a business has a large number of similar projects, this may not be an issue as, overall, the business will expect to achieve the sum of the expected values of the individual projects. However, where this is not the case (eg where a business is considering a unique project which is significantly bigger in scale than other projects) this will be an issue.

The second drawback of this approach is that it may obscure the underlying risks associated with a particular project. Consider the following example:

Example 4
Marcuse Co is considering two competing projects. The following information is available concerning each project:

PROJECT 1		PROJECT 2	
Net present value $m	**Probability of occurrence**	**Net present value $m**	**Probability of occurrence**
20	0.6	(40) loss	0.8
40	0.4	300	0.2

Required
State which project the managers of the business should select.

We can calculate the ENPV of each project as follows:

Project 1
($20m x 0.6) + ($40m x 0.4) = $28m

Project 2
[($40m) x 0.8] + ($300m x 0.2) = $28m

The calculations suggest that the managers should be indifferent between the choice of projects as both provide the same expected net present value. However, we can see that Project 2 has a high probability of a loss. Generally speaking, investors prefer less risk rather than more risk for a particular return. As a result, Project 1 is more likely to be preferred because it is less risky. This failure to take account of the investors' attitude towards risk when evaluating investment proposals limits the usefulness of this technique.

Decision trees
In **Example 2** above, we considered the level of sales demand as the factor that created uncertainty about the future outcome of a project. However, there may well be more than one factor that creates uncertainty about the outcome of a particular project. Furthermore, one outcome may be dependent on another outcome. To obtain a clear picture of the possible courses of action concerning a project and their possible outcomes, it is often useful to produce a decision tree. To illustrate this technique, a simple example may be used.

Example 4
Russell and Co leases office machinery. The business has recently offered to lease to a major client, office machinery for $30,000 per annum for Office A of the client and to lease office machinery to Office B of the client for a further $20,000 per annum. The client may decide to lease the office machinery for either one or two years. Russell and Co

believes that there is a 0.8 chance that only Office A will lease the office machinery and a 0.2 chance that both offices will lease the machinery in any one year.

We can identify four possible outcomes for Russell and Co given the information provided above. These outcomes and their probability of occurrence are as follows:

Outcome	Probability of occurrence
$30,000 received in years 1 and 2	0.8 x 0.8 = 0.64
$30,000 received in year 1 and $50,000 received in year 2	0.8 x 0.2 = 0.16
$50,000 received in years 1 and 2	0.2 x 0.2 = 0.04
$50,000 received in year 1 and $30,000 received in year 2	0.2 x 0.8 = 0.16
	1.00

We can see that the probability of each outcome is a multiplicative function of the probabilities of the individual events. Thus, the probability of $30,000 being received in both years will be the probability of $30,000 being received in year 1 multiplied by the probability of $30,000 being received in year 2, and so on.

A decision tree as in **Figure 2** opposite sets out the various possible outcomes in the form of a diagram.

The problem with using probabilities is that it is often difficult to identify all the possible outcomes arising from a particular decision and it may be even more difficult to assign probabilities to them. In some cases, probabilities may be determined objectively from past data or may even be calculated mathematically. However, for the majority of decisions faced by a business, it is likely that subjective judgement will have to be used. Nevertheless, the identification and measurement problems associated with probability analysis should not cause us to dismiss this technique as being of no value. Probabilities can be very helpful in making explicit some of the risks relating to a financial decision and the judgements used to assess these risks.

SUMMARY

In this article we have examined some simple techniques for dealing with risk and uncertainty in financial decisions. We have seen that none of the techniques examined provide a perfect solution to dealing with risk and so we must be careful when using any of them as an input to a financial decision. There is survey evidence to show, however, that these techniques are used by businesses and so, presumably, managers find them useful.

It is worth mentioning that risk management techniques are not confined solely to the Risk Management syllabus. Thus, sensitivity analysis appears in the Financial Strategy syllabus, as well as the Risk Management syllabus, as it is important in the context of investment appraisal. The techniques described cannot be neatly compartmentalised as risk is an inherent feature of financial decision making.

Peter Atrill is examiner for Module B

FIGURE 1: THE RELATIONSHIP BETWEEN RISK AND RETURN

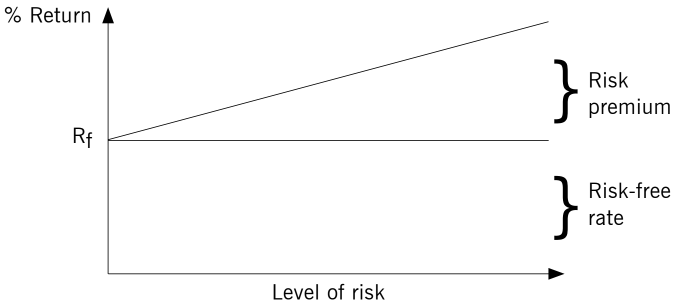
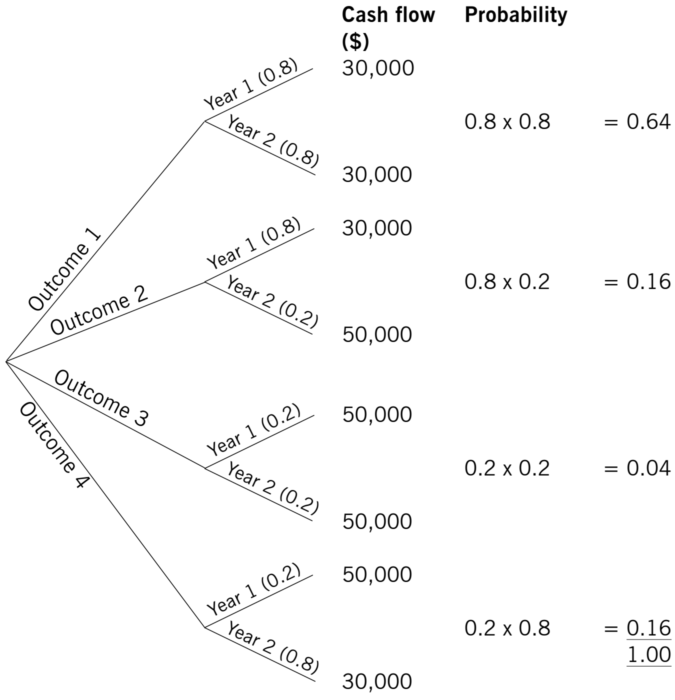


FIGURE 2: A DECISION TREE



It is worth mentioning that risk management techniques are not confined to the Risk Management syllabus. The techniques described cannot be neatly compartmentalised as risk is an inherent feature of financial decision making.