

CHAPTER 8 - Strategic evaluation and choice

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8.5 Financial Evaluation

Active reading. Note the different methods of financial evaluation that can be used and why the net present value calculation might be the preferred method. Remember that decisions should not be taken based on the numbers only. Think about the reasons why financial analysis does not provide the answer.

The accountant has a pivotal role to play in the evaluation of capital investment and strategic decisions that required significant amounts of investment over a period. The term capital investment appraisal is also often referred to as capital budgeting, as the organization may not be able to undertake every investment opportunity due to the limited availability of capital resources at its disposal. The investment appraisal process, therefore, provides a basis for evaluating those investments that will enable the organization to close any gap that arises from the GAP analysis discussed in Chapter 5, section 5.4.

It is important to note that strategic decisions should not be based solely on the numerical evaluation but also take account of strategic factors of a nonfinancial nature. There may be circumstances in which it makes sense strategically to undertake a decision that provides benefits other than financial, for example, developing a presence in a geographic market that eventually opens access to other markets. Considering strategic and financial factors has implications for being sure of the long-run benefits of the strategic decision being made and the time frame in which those benefits might be realized. For example, establishing a business in Bangladesh can open markets in countries such as Northeast India, Nepal, and Bhutan, due to the strategic importance of their seaports. It may be more appropriate to evaluate the cost of setting up in Bangladesh as a separate exercise. The future cash flows emanating from access to other markets may be too far in the future to be able to estimate with any meaningful accuracy, even though this may be the real intention behind the strategy.

The long-run impact of strategic decisions raises another critical issue in that some strategies, such as the instance of Bangladesh, can be broken down into phases, and at specific points in the future, different decisions can be made. The decision to operate in Bangladesh can be part of the cost of a much broader strategy. The example also serves to indicate that an investment appraisal of a strategic option is not just undertaken once, but should be repeated at significant milestones to see if it is still worth continuing given the changes in the environment. There are, therefore, exit points or decision points at which the initial decision can be reassessed considering new and more up-to-date information.

8.5.1 Methods of Investment Appraisal

Payback Period

A typical investment appraisal technique is known as the payback period. In its purest form, this is answering the question, how long does it take to recoup the initial investment? Everyone quickly understands the technique, and the basic principle states that the investment with the shortest payback period is the preferred option. However, there are some drawbacks to this method, as illustrated in Table 8.1.

Table 8.1 Simple payback period calculation

Years	Project A \$	Project B \$
0	(1,000)	(1,000)
1	900	100
2	100	900

The immediate difficulty is that both project A and project B payback in 2 years. However, the instinct suggests that project A would be preferred over project B, as more of the investment is recouped in year 1. This conclusion is instinctively considering two factors. Firstly, the time value of money, that is, given a choice people would prefer to receive the money earlier rather than later as they perceive that the buying power of cash now is more than in the future, owing to inflation and the chance of earning interest. And secondly, the risk involved in that early cash flows represent less risk than future cash flows. In its crudest form, the payback method ignores future cash flows received after the payback period.

Net Present Value (NPV) Calculation

The net present value (NPV) technique takes account of the time value of money by applying a discount factor to all future cash flows (capital costs and all revenues and expenses) that convert the nominal cash flows into present-day values. It is worth noting that discounted cash flows can be used within the payback method described above to account for the time value of money. It would then be called a discounted payback period.

NPV raises the issue of what to use as the discount factor. The organization's weighted average cost of capital (WACC) is typically used as the discount factor, and this can be adjusted to take account of risk and the effect of future financing requirements. Using a discount factor to convert cash flows to present-day values enables a comparison of different investment options that have different timings of cash flow as all cash flows are represented in equivalent values.

The standard rule is that a project providing a positive NPV would be acceptable in financial terms, and one with a negative NPV would not be acceptable. In the case where there

are alternatives, the one with the highest positive NPV would be preferred. It is important to reiterate that strategic decisions should not be made purely based on the financial evaluation. The example in Table 8.2 illustrates this for three projects, each of which would require an initial investment of \$50,000. Each project provides a different profile of net cash flows over the life of the project.

Table 8.2 NPV for three alternative projects

Year	Project A	Project B	Project C	Discount factor (10%)	Project A	Project B	Project C
	Nominal cash flows \$,000				Discounted cash flows \$,000		
0	(50)	(50)	(50)	1.0	(50)	(50)	(50)
1	28	0	40	0.91	25	0	36
2	22	30	8	0.83	18	25	7
3	8	30	12	0.75	6	22	9
4	4	0	14	0.68	3	0	9
5	0	21	1	0.62	0	13	1
	12	31	25		2	10	12

When looking at the nominal cash flow on the left, project B may be preferred as it provides a higher net benefit over the life of the project. However, when the timing of the cash flow is considered by applying the discount factor, which converts all cash flows into present-day values, project C produces a higher NPV. It is quite close to project B, so a final decision will also need to consider the nonfinancial factors.

The NPV analysis can be enhanced and made more sophisticated, for example, by applying probability values to future cash flows creating an expected value. Another variation might be inflating costs by an expected rate of inflation, but increasing sales by the predicted growth in sales value based on volumes and pricing strategy.

The discount factor can be adjusted for various situations. For example, it could be increased over the cost of capital to include a risk factor, and within this, different discount rates can be applied to revenues and costs. It may be that costs can be estimated with a higher degree of certainty than revenue cash flows. This degree of uncertainty can be accommodated by using different discount factors for different items. For example, future rental costs may be known with some degree of certainty, but raw material costs could be extremely volatile. Sensitivity analysis can also be applied to model different scenarios.

The process of the net present value calculation is to establish the cash inflows and outflows for a project and then to determine the discount factor to use, which, as already mentioned, is usually the weighted average cost of capital of the organization. The weighted average cost of capital is outside the scope of this learning resource, but as a simple example, suppose an organization has the capital structure shown in Table 8.3.

Table 8.3 Simple capital structure consisting of equity and debt

	\$	
Equity: Share capital / common stock	60,000	60%
Loan stock at 5% interest per annum	40,000	40%
Total capital	100,000	100%

If shareholders expect a return of 8%, the weighted average cost of capital would be as shown in Table 8.4.

Table 8.4 Calculation of WACC

Equity – share capital	60% x 8%	4.8%
Loan capital	40% x 5%	2.0%
Weighted average cost of capital		6.8%

Many organizations will have a more sophisticated capital structure than illustrated here, but the principle of the calculation still applies.

It should be noted that there are alternative methods to estimate the cost of equity capital. A detailed explanation of these is more suited to learning resources related to corporate finance. In practice, an estimated cost of capital is often used. In situations where funding is limited, a higher cost of capital may be set as a hurdle rate that investments must reach before they are considered further. The hurdle rate is a technique commonly used in capital rationing, where there are many potential projects, but limited finance is available.

Example NPV calculation.

Chuck Sandecker left College wondering what to do with his life. He had been on a football scholarship and had enjoyed a successful college football career but had missed out on playing professionally in the NFL. However, having majored in sports science, he did know how to keep fit, and his girlfriend, Maria Esparido, had majored in business and economics. Pooling their expertise, they had decided to set up their own gym in their hometown of Gulf Shores in Alabama. The town has a population of just over 10,000 people and is famous for music festivals. It also borders the Gulf State Park, which is said to be the best in Alabama. The fitness center, which they named My-Kind-of-Gym, and branded **MKGym**, was extraordinarily successful, and on the back of their success, Chuck and Maria were investigating opening an outdoor activity center with accommodation near the Gulf State Park.

Chuck and Maria have prepared a forecast of the cost and potential cash flows of building and operating the accommodation at the **MKGym** outdoor center.

They estimate that it will cost \$300,000 to create a timber-framed building that could include 15 large double rooms with en suite bathrooms and ten family rooms (also with en suite

bathrooms) capable of sleeping four people. The building could be established very quickly and would be built by a local company that specializes in this type of construction.

The cost of furnishing a total of 25 rooms and bathroom suites would cost an additional \$125,000.

The initial target for customers is to achieve an average occupancy rate of 50% in the first year, rising by 20% each year until a 100% occupancy rate is reached. The center would be open 365 days in the year, so 50% represents (25 rooms x 365 days x 50% = 4,562 rooms days in the first year). For planning purposes, it is assumed that all rooms will be charged at the same rate of \$50 per day. At the moment, it is anticipated that this will be competitive, and Chuck suggests that they keep the same price for the foreseeable future.

The operating costs, such as energy and maintenance of the building, are expected to be \$200,000 per annum. This cost will rise each year by the rate of inflation, which is currently 3% per annum.

A manager will be recruited to manage the building and make sure that accommodation and general site is maintained to a high standard. A salary of \$35,000 per annum will be paid. For planning purposes, assume that this remains the same each year. One of the staff currently employed at the town gym is interested in the position. They are currently paid \$25,000 per annum. Chuck is keen to promote from within the company, so it is highly likely that the employee will be transferred to the outdoor gym and paid at the higher salary. Chuck will not recruit a replacement at the town gym. [Note that in investment appraisal calculations, only the additional relevant cash flows are considered. In this case, as the employee is already employed, the only extra cost is the increase in salary of \$10,000].

Cleaning will be done by a contract cleaning company that specializes in hotel cleaning and charge based on the number of rooms cleaned. For planning purposes, the cost can be calculated as 2% of the revenue earned from renting out the rooms.

Chuck is also anticipating that they can make extra money by renting out mountain bikes. He plans to invest \$20,000 immediately to buy a range of mountain bikes of varying sizes. Chuck is then planning to increase the number of bikes each year by spending a further \$4,000 in each of years 2, 3, 4, and 5. He estimates that the revenue generated in each year from hiring out these bikes will amount to 1.5 times the total accumulated cost of the investment in each year.

Assume the cost of capital is 10%, which includes a risk element. **MKGym** usually uses five years over which to evaluate capital investment projects.

Ignore taxation.

Calculation of anticipated room occupancy.

Total capacity is 25 rooms on 365 days in the year = 9,125. [Note that it could be deemed unrealistic to assume 100% all year round, but as a target, it enables a model to be established on which sensitivity analysis can be conducted.]

The number of rooms occupied each year each shown in Table 8.5.

Table 8.5 Calculation of room occupancy

Year	1	2	3	4	5
Number of rooms	4,562	5,474	6,569	7,883	9,125
Price \$	50	50	50	50	50
Revenue \$	228,100	273,720	328,464	394,156	456,250

The net present value calculation is shown in Table 8.6. Note that we use the year zero to account for costs that are incurred immediately. The normal convention in NPV calculations is to assume that all revenues and costs occur at the end of the year.

Table 8.6 NPV calculation for the expansion project

Year	0	1	2	3	4	5
Description	\$000	\$000	\$000	\$000	\$000	\$000
Cost of building	(300)					
Furnishing	(125)					
Revenue from rooms		228	274	328	394	456
Operating costs		(200)	(206)	(212)	(218)	(225)
Manager - increase		(10)	(10)	(10)	(10)	(10)
Cleaning		(5)	(5)	(7)	(8)	(9)
Purchase of mountain bikes	(20)		(4)	(4)	(4)	(4)
Revenue from the initial investment in bike hire		30	30	30	30	30
Revenue from additional bikes			6	12	18	24
Net cash flow	(445)	43	85	137	202	262
Discount factor 10%	1.00	0.91	0.83	0.75	0.68	0.62
Discounted cash flow	(445)	39	70	103	138	163
NPV						68

Note: The discount factors can be calculated using the formula $PV = 1/(1+r)^n$ where r = interest rate (cost of capital), n = number of periods. There are also present value calculators freely available on the Internet or present value tables (see Appendix D) where the discount factors can be easily obtained.

Internal Rate of Return (IRR)

An internal rate of return can also be calculated as a means of making comparisons. It is the equivalent of the discount factor that is required to achieve an NPV of zero. It can be calculated

by trial and error using an NPV calculation with different discount factors until the NPV is zero. The following formula shows what you are looking for.

$$NPV = \sum_{n=0}^n \frac{C_n}{(1+r)^n} = 0$$

Where: C = cash flows; n = number of years; r = cost of capital (in decimals)

There is an NPV function and IRR function in Excel that can be used to calculate the IRR.

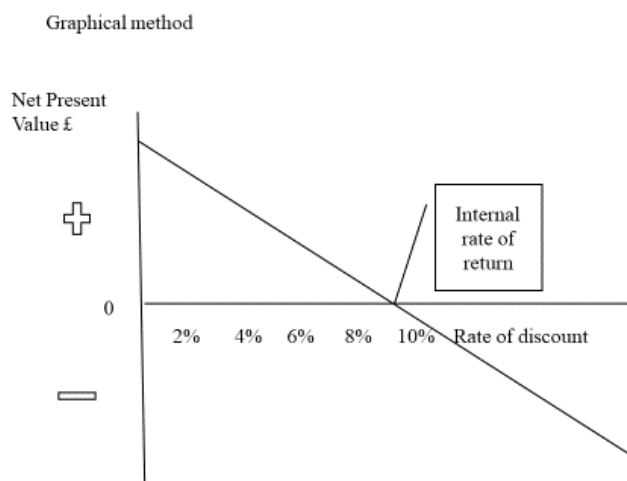
Alternatively, it can be calculated via interpolation, or ascertained using a graphical method shown in Figure 8.4. The method of interpolation uses a low discount rate to calculate a positive NPV and a high discount rate to calculate a negative NPV.

The result can be read from a graph, shown in Figure 8.4 where the IRR is approximately 9.5%. Or the following formula can be used.

$$IRR \approx a + \left\{ \left(\frac{NPV_a}{NPV_a - NPV_b} \right) (b - a) \right\} \%$$

Where

- a: is the lower of the two rates of return used in the calculation that produces a positive net present value.
- b: is the higher of the two rates of return used in the calculation that produces a negative net present value.
- NPV_a : is the positive net present value as the result of using lower rate of return a.
- NPV_b: is the negative net present value as the result of using higher rate of return b.



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Figure 8.4 Internal Rate of Return

The IRR can be useful as organizations may set a high hurdle rate of return, which projects must achieve before they are accepted. Managers, therefore, readily understand that if a hurdle rate of 15 percent is set, the IRR must be above the target.

Accounting Rate of Return and Profitability Index

Other methods that could be used include the accounting rate of return in which the profit that can be earned is compared to the initial investment, or an average investment, to create a measure based on profitability.

$$\frac{\textit{Profit on investment}}{\textit{Average investment}} \times 100 = \% \textit{ return}$$

A profitability index can be created, which compares different projects based on a calculation of the value per unit of investment.

$$\frac{\textit{Present value of future cash flows}}{\textit{Initial investment}} = \textit{profitability index}$$

Learning activity.

Yelena Petrov and Vladimir Boshirov had moved from Russia to Salisbury in the U.K. in 2010. Yelena and Vladimir were both passionate about healthy eating. They had picked up on a growing trend for freshly made fruit drinks, particularly among the millennial generation, who were becoming more concerned with how they look and the benefits of a healthy lifestyle. Having settled into the local community and noting the tourist trade and the growing younger population of Salisbury, they began their first business venture in 2011, which was a small bar selling freshly made fruit juices from organic produce. The venture was called the Fruit Bat Bar. The business was hard work in the first year, but they managed to make a small profit. Within a few years, they had opened another four outlets in the region.

An interesting opportunity

Nisa stores, which are independently owned local convenience stores trading throughout the U.K., have recently expressed an interest in stocking a range of Fruit Bat juices.

The plan would be for them to stock the Fruit Bat products in their stores in the local area around Wiltshire, which is where Salisbury is located, and if successful, to broaden the sales to more regions. Vladimir thinks that if they agree to work with Nisa stores, they will need to set up a dedicated unit to service the demand from the stores. It would entail finding suitable premises and staffing them accordingly.

Vladimir is considering the opportunity from Nisa to provide their stores with Fruit Bat Bar products.

Nisa has proposed that they will sell them under the Fruit Bat Bar Limited brand. They are considering launching the products in the local region currently served by the Fruit Bat Bar outlets as this is where the brand is known, but eventually, assuming that it is successful, they will make it available to all of their stores. The Nisa stores are typically convenience stores located within the local community.

To satisfy the requirement, Vladimir estimates they will need to secure separate premises to produce the products required. Vladimir has found premises in Salisbury that would be suitable. There is a current space available that could be rented at an annual cost of £100,000. The unit also has additional space that could be rented in one year's time. Vladimir thinks that this would allow for expansion if Nisa decided to offer the product more widely after the first year. The extra space would be at an additional cost of £50,000 per annum commencing in year 2.

Vladimir will need to buy immediately the equipment necessary for juicing and packaging the product costing £25,000. In year 2, he would need to purchase additional equipment totaling £50,000. Assume that these have no value at the end of 5 years.

He would require 2 unskilled workers at the cost of £8 per hour for a 35 hour week, in the first year. He would manage the operations himself during the first year. Assuming the expansion goes ahead in year 2, he would need an additional 2 workers on the same pay as the initial workers but would recruit a manager on an annual salary of £25,000.

Administration and general operating costs in the first year associated with the new operation would be £75,000, rising to £90,000 per annum in the second year of operations.

Nisa wishes to trial the product initially in 5 stores local to Salisbury. They believe that they will be able to sell 2,000 units per week in each of their 5 stores for £3.60 each. They will take a margin of 60%, i.e., they pay Fruit Bat Bar 40% of the sales price.

Nisa will then roll out the product into the other 15 stores in the region in year 2. They believe that they will be able to sell 2,000 units per week in each of these stores as well.

The material cost for each unit produced is £1.20.

Vladimir usually undertakes investment evaluation over 5 years using an estimated cost of capital of 10% as the discount rate.

Ignore taxation.

Required:

Using NPV as a method of investment appraisal, recommend whether Vladimir and Yelena should go ahead with the opportunity to supply Nisa with juice products. Assume that the project extends for five years.

A solution to the learning activity

Investment appraisal						
Description	0	1	2	3	4	5
Rental		(100,000)	(100,000)	(100,000)	(100,000)	(100,000)
Additional space rental			(50,000)	(50,000)	(50,000)	(50,000)
Equipment	(25,000)		(50,000)			
Workers		(29,120)	(29,120)	(29,120)	(29,120)	(29,120)
Additional workers			(29,120)	(29,120)	(29,120)	(29,120)
Manager			(25,000)	(25,000)	(25,000)	(25,000)
Operational costs		(75,000)	(90,000)	(90,000)	(90,000)	(90,000)
Sales by Nisa stores		1,872,000	1,872,000	1,872,000	1,872,000	1,872,000
Additional sales			5,616,000	5,616,000	5,616,000	5,616,000
Margin taken by Nisa		(1,123,200)	(4,492,800)	(4,492,800)	(4,492,800)	(4,492,800)
Cost of materials		(624,000)	(2,496,000)	(2,496,000)	(2,496,000)	(2,496,000)
Net cash flows	(25,000)	(79,320)	125,960	175,960	175,960	175,960
discount factor 10%	1	0.909	0.826	0.751	0.683	0.621
Discounted cash flow	(25,000)	(72,102)	104,043	132,146	120,181	109,271
NPV						368,539

8.6 Real Options

Active reading. Note how the real options approach uses the net present value concept. As with other methods, the numbers only provide part of the information required to decide the best course of action. Also, remember that many factors come into play when estimating future cash flows, and therefore the use of sensitivity analysis is recommended.

An approach that is becoming more popular is known as real options analysis. This method recognizes that organizations often have multiple options available related to a strategic decision. For example, concerning the case of the Bangladesh project discussed in Chapter 7 and HW Inc. activity 13, there are several options. The management team could decide to delay the project or adopt a graduated phased approach. For example, they could begin by exporting, then later establishing a local sales office, followed by creating local production facilities, and

finally setting up a local subsidiary company, or; abandon at any stage, or entirely. Using this approach entails evaluating the various options. It makes management aware of the financial implications of implementing the different options that can be considered in the decision-making process. The real options are treated similarly to financial market options in that they create a right, rather than an obligation, to act.

8.6.1 The concept of options and real options in investment appraisal

A net present value (NPV) calculation within an investment appraisal evaluation assumes typically that a project commences immediately and proceeds until it finishes. It is treating the investment as a one-off decision. Many investment decisions, however, are flexible, and managers are faced with several possible actions that could be taken. NPV calculations also largely ignore the strategic value of the projects, such as the opportunity to expand into a new market, or develop natural resources such as shale gas, oil, gold, and other minerals, or exploit new technology, or agree to acquire or merge with another company.

Risks and uncertainties can be dealt with in NPV evaluations by adjusting the cost of capital, attaching probabilities to outcomes, or conducting sensitivity analysis (which is always recommended). This section reviews the basic concept of evaluating options within investment decisions. Firstly, by introducing the concept of options via a simple example. Then moving on to look at how an option is valued to aid decision making, and finally, it looks at the use of the Black-Scholes option pricing model to attach a fair value to an option within an investment decision.

8.6.2 Different types of options

Option to delay/defer

In business decisions, there are frequently options to delay/defer without losing the opportunity. For example, should the organization begin mining silver now or wait until the price goes up. Or wait until market conditions are more favorable before opening a new store. Or wait until the political environment is known with more certainty, for example, it may make sense to delay when an election is on the horizon, or new legislation is being debated, and the outcome is uncertain.

Options to switch/redeploy assets

If market conditions change, there may be options to switch/redeploy assets. For example, investing in a flexible manufacturing system that is capable of producing more than one product without any additional switching cost. Or changing the use of a building, such as an option for a college to turn office space into extra teaching space should the capacity be required.

Options to expand/contract operations

When market conditions are good, there may be options to expand, or when bad, options to contract. For example, designing projects in an easily scalable way may cost more upfront but saves money later. Similarly, construction projects such as a sports stadium could be designed to incorporate a single-tier stand with much stronger foundations than initially required. If the team (or venue) was successful and needed additional space to accommodate increased attendance in the future, a second-tier could easily be added without having to alter the foundations. These are sometimes described as follow-on projects where additional investment is made if phase one is successful. As in the example of the sports stadium, projects such as this often require more expenditure in phase 1 than would be necessary if there was no follow-on option. Thus, there is a cost to building flexibility into a project. This extra cost is akin to a premium paid for a financial option, as will be explained in section 8.6.4.

Options to abandon/exit

The nature of the project may be such that there are options to abandon/exit the project at various stages during its lifetime. For example, a phased project to expand the market into overseas locations by first establishing an export facility, then later establishing overseas sales offices in key locations, then adding production facilities in key markets, provides opportunities to abandon part or all of the project at various stages within its lifetime. Similarly, projects that involve equipment or facilities that would have a resale value at various points within a project lend themselves to reviewing an abandonment option.

Situations where the concept of options is useful

Viewing options within investment decisions are generally useful in situations where there is:

- *Flexibility*: the ability to change the business route over time.
- *Uncertainty*: the value of a project cannot be fully predicted.
- *Irreversibility*: most decisions have no turning back, and as a result, imply sunk costs.

8.6.3 Viewing options as real options

An option definition when referring to financial options gives the holder the right, but not the obligation, to buy or sell an underlying asset, such as a stock or share. The option helps to place a value on the flexibility in the decision. For example, a call option (the right to buy in the future) on a share or stock allows an investor to wait and see what happens to the price of a share before deciding whether to exercise the option. It is possible for the price of the option, known as the premium, to benefit from favorable movements without being affected by adverse movements in the price of the underlying asset (the share). Real options, however, refer to the choices or opportunities that a business may or may not take advantage of, or realize. Real

options involve decisions that managers make that involve tangible assets. As with financial options, real options can involve spending some money upfront (like the premium paid for a financial option) which provides the flexibility later.

The concept of real options provides a means of placing a value on the flexibility that is present in many real investment decisions. As with any numerical technique, it does not give the definitive answer to an investment decision but provides managers with some additional information that facilitates a more informed decision.

The following examples provide some simple illustrations of how the concept of real options can be used in different types of investment decisions. We begin by using NPV calculations.

Option to wait (example 1)

Suppose a company has the opportunity to launch a new product. The initial investment in machinery to produce the product will cost \$27,500. There is, however, some uncertainty over the demand conditions for this year due to the impact of a virus that is potentially spreading around the globe and could reduce demand.

If demand for the product proves to be unaffected, the net cash inflow could be \$10,000 per annum, but if the outbreak adversely affects demand, the net cash inflow may only reach \$5,000 per annum. The marketing department suggests that there is a 50% chance of the demand being affected.

The concept of probabilities can be used to calculate the likely cash inflow.

$$(\$10,000 \times 50\%) + (\$5,000 \times 50\%) = \$7,500$$

The resultant net present value calculation is shown in Table 8.7, assuming a cost of capital of 10% and a time horizon of 5 years.

Table 8.7 – Net present value calculation

Year	0	1	2	3	4	5
	\$	\$	\$	\$	\$	\$
Initial investment	(27,500)					
Cash flow		7,500	7,500	7,500	7,500	7,500
Net cash flow	(27,500)	7,500	7,500	7,500	7,500	7,500
Discount factor (10%)	1.000	0.909	0.826	0.751	0.683	0.621
Discounted Cash Flow	(27,500)	6,818	6,195	5,633	5,123	4,658
Net Present Value						925

This option provides a positive present value, but it is relatively low.

However, the product development team does not believe that any of the competitors are in a position to launch a similar product and steal the market. They suggest that it would be a possible to wait and launch the product next year once the potential demand is more certain.

Another NPV calculation can be undertaken to illustrate what might happen if the company waited and launched the product next year. As with the normal convention, it is assumed that all cash flows occur at the end of the year. The best-case scenario is shown in Table 8.8, and the worst-case scenario is shown in Table 8.9.

Table 8.8 – Best-case scenario delaying by one year

Year	0	1	2	3	4	5	6
	\$	\$	\$	\$	\$	\$	\$
Investment		(27,500)					
Cash flow			10,000	10,000	10,000	10,000	10,000
Net cash flow	0	(27,500)	10,000	10,000	10,000	10,000	10,000
Discount factor (10%)	1.000	0.909	0.826	0.751	0.683	0.621	0.564
Discounted Cash Flow	0	(24,998)	8,260	7,510	6,830	6,210	5,640
Net Present Value							9,453
Expected value 50% probability							4,726

The calculation provides a more significant positive NPV than going ahead immediately and facing a higher degree of uncertainty.

Table 8.9 – Worst-case scenario delaying by one year

NPV calculation	0	1	2	3	4	5	6
	\$	\$	\$	\$	\$	\$	\$
Initial investment		(27,500)					
Cash flow			5,000	5,000	5,000	5,000	5,000
Net cash flow	0	(27,500)	5,000	5,000	5,000	5,000	5,000
Discount factor (10%)	1.000	0.909	0.826	0.751	0.683	0.621	0.564
Discounted Cash Flow	0	(24,998)	4,130	3,755	3,415	3,105	2,820
Net Present Value							(7,773)
Expected value 50% probability							(3,886)

The calculation returns a negative NPV.

It can be seen from this basic analysis that there is a benefit with the option to wait and see what the demand conditions are like in one year. If demand is high, the company will launch the product, but if demand is low, the decision not to begin would be more appropriate. The

example illustrates that waiting until there is more certainty about the likely market would benefit the organization, either potentially making a higher gain, or avoiding a potential loss. The analysis of the option to delay gives management more information on which to base a decision.

Option to abandon (example 1)

The same basic approach can be used to evaluate an option to abandon.

Assume that the company launched the product but, at the end of the first year, has the option to abandon the project and sell the plant and equipment for \$22,500. This option to abandon can be treated as a separate decision, as the initial cost and the first year of trading are effectively sunk costs. The concept of the opportunity cost can be used to determine that the lost future cash inflows constitute the cost of abandoning the product. The best-case scenario is shown in Table 8.10, and the worst-case scenario is shown in Table 8.11.

Table 8.10 – Best-case scenario – good trading conditions

Year	0	1	2	3	4	5
	\$	\$	\$	\$	\$	\$
Cash flow (Lost income)			(10,000)	(10,000)	(10,000)	(10,000)
Sale of plant and machinery		22,500				
Net cash flow	0	22,500	(10,000)	(10,000)	(10,000)	(10,000)
Discount factor (10%)	1.000	0.909	0.826	0.751	0.683	0.621
Discounted Cash Flow	0	20,453	(8,260)	(7,510)	(6,830)	(6,210)
Net Present Value						(8,358)
Expected value 50% probability						(4,179)

Table 8.11 – Worst-case scenario – adverse trading conditions

Year	0	1	2	3	4	5
	\$	\$	\$	\$	\$	\$
Cash flow (Lost income)			(5,000)	(5,000)	(5,000)	(5,000)
Sale of plant and machinery		22,500				
Net cash flow	0	22,500	(5,000)	(5,000)	(5,000)	(5,000)
Discount factor (10%)	1.000	0.909	0.826	0.751	0.683	0.621
Discounted Cash Flow	0	20,453	(4,130)	(3,755)	(3,415)	(3,105)
Net Present Value						6,048
Expected value 50% probability						3,024

It may not seem that surprising, but this example illustrates that if demand turns out to be good, then it is better to continue with the project. Abandoning the project produces a negative net present value, and therefore would not be accepted. If demand proves to be poor, then it is better to abandon the project as the net present value of the option is positive.

These examples only use the net present value concept to evaluate each option or decision. The following examples are slightly more complicated but use the same principle as they look at how the concept of financial options and, later the Black-Scholes option pricing model can be used to place a 'fair value' on an option.

Option to wait (example 2)

Assume that a company has a choice of investing in a new facility this year, wait until next year, or not at all. The plant and equipment can only be used for this investment, and once the decision is made, it cannot be reversed.

The cost of the plant and equipment is \$50m, and the net cash flows arising from the investment are estimated with some degree of certainty at \$75M. The cash flows for the next year, however, are less certain, and if trading conditions are favorable net cash flow generated could be \$100m, but if conditions are bad net cash flow could be \$50M. The marketing department predicts that there is a 66.66% chance of good conditions and a 33.34% chance of poor conditions.

In this example, we are ignoring the on-going situation in future years, and focusing on the initial decision of when to invest.

The case of investing this year is shown in Table 8.12.

Table 8.12 Invest this year

Year	0	1
	\$m	\$m
Investment now cash flow	(50)	75
Discount factor (10%)	1	0.909
Discounted Cash Flow (DCF)	(50)	68.175
Net Present Value (NPV)		18.175

If the investment is made next year, it provides the following net present values shown in Tables 8.13 and 8.14.

Table 8.13 - Good conditions

Year	0	1	2
	\$m	\$m	\$m
Investment next year – Good year cash flow		(50)	100
Discount factor (10%)	1	0.909	0.826
DCF		(45.45)	82.6
NPV			37.15

Table 8.14 - Bad conditions

Year	0	1	2
	\$m	\$m	\$m
Investment next year - Bad year cash flow		(50)	50
Discount factor (10%)	1	0.909	0.826
DCF		(45.45)	41.3
NPV			(4.15)

These calculations show that investing next year if conditions are favorable provides a higher NPV than investing this year, and if conditions are adverse, the company will not invest.

Taking the expected value of the good scenario 66.66% of \$37.15m = \$24.76m and deducting the NPV from investing this year of \$18.157m, the option to wait has a value of \$6.603m.

This result is by no means precise, but it provides the management team with more information on which to base a decision. If the decision is made to invest without this knowledge, there is a 33% chance that management finds themselves in a situation with reduced net cash flows and regretting having made the decision to invest. With this knowledge, management has a better idea of the value of waiting and having the benefit of additional information on the likely trading conditions.

Option to wait/abandon phase 2 (example 3)

Supermarkets often have a similar dilemma when entering a new market. Assume that a supermarket is planning to enter a new market, and the operations team and marketing team have combined to identify the following information.

Open 1 store, 2 stores, or not invest

Table 8.15 Expected cash flow under demand conditions

	\$m		\$m
Cash flow if high demand	14	50%	7
Cash flow if low demand	8	50%	4
Expected value of cash inflow			11
Investment per store	(10)		

An analysis of the situation might be as follows:

Invest in opening one store now and operating for 1 year. The expected value of the cash flows generated can be used.

Table 8.16 Invest in one store now

Year	0	1
	\$m	\$m
Investment per store	(10)	
Cash flow		11
Net cash flow	(10)	11
Discount factor (10%)	1	0.909
Discounted Cash Flow	(10)	9.999
Net Present Value		(0.001)

This calculation produces an extremely low NPV, and therefore the company may be uncertain as to whether to proceed. However, suppose that management has made the strategic decision that there are significant benefits to entering the new market. They decide to proceed with the risk that if demand is low, the store may lose money.

The cautious approach is to open one store now and then see how demand develops before deciding to invest in second and potential future stores.

If demand conditions are good or bad, it generates the following NPV's under each scenario for the investment in the second store.

Table 8.17 – Best-case scenario

Year	0	1	2
	\$m	\$m	\$m
Investment per store		(10)	
Cash flow good conditions			14
Net cash flow		(10)	14
Discount factor (10%)		0.909	0.826
DCF		(9.09)	11.564
NPV			2.473
Expected value 50%			1.2365

Table 8. 18 – Worst-case scenario

Year	0	1	2
	\$m	\$m	\$m
Investment per store		(10)	
Cash flow bad conditions			8
Net cash flow			8
Discount factor (10%)		0.909	0.826
DCF		(9.09)	6.608
NPV			(2.482)
Expected value 50%			(1.241)

If demand conditions are bad, then the decision would be not to open the second store. A decision must then be made as to whether to close the first store and cut its losses.

However, taking the expected value of the good outcome of \$1.2365, and adding it to the NPV of opening one store in year 1, which was \$(0.001)m, indicates that the value of the option to wait is \$1.2355m.

This is a relatively crude way of putting a value on the option to wait, and various authors suggest that the options are treated in the same way as financial options, and use the Black-Scholes option pricing model that was developed to place a ‘fair value’ on the options.

8.6.4 Black-Scholes Option Pricing model

The benefit of the Black-Scholes model is that it takes account of the volatility in the future cash flows.

The Black-Scholes formula is given as follows:

$$c = S_0 N(d_1) - K e^{-rT} N(d_2)$$

$$p = K e^{-rT} N(-d_2) - S_0 N(-d_1)$$

$$\text{where } d_1 = \frac{\ln(S_0 / K) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$$

$$d_2 = \frac{\ln(S_0 / K) + (r - \sigma^2 / 2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

c = a call option – this is the right, but not the obligation, to buy a share by, or at, a specified date and price, in the future

p = a put option – this is the right, but not the obligation, to sell a share by, or at, a specified date and price, in the future.

There are five variables that we need before we can calculate the value of a real option. Table 8.19 illustrates how these relate to the financial option calculation.

Table 8.19 Variables for the Black-Scholes model

Symbol	Financial Option	Real Option
S	Stock price	The underlying asset value, which is the present value of future cash flows arising from the project.
K	Strike price	The exercise price, which is the amount paid when the call option is exercised or amount received if the put option is exercised.
T	Time to maturity	Time before the opportunity expires
σ	Volatility	Riskiness of asset/project. This is measured by the standard deviation and can be derived from past projects or estimated using statistical techniques.
r	Risk-free rate	The risk-free rate which is normally taken as the return offered by a short-dated government bill.

[For the mathematicians among the readers, the e in the formula indicates an exponential term, and \ln signifies the natural logarithm. N is the cumulative probability distribution function for a standardized normal variable]

The formula can look quite daunting, but it is relatively easy to undertake using Excel, and there are excellent free resources that can be downloaded to help. In this learning resource, a free resource is used from the Corporate Finance Institute web site that can be found at:

<https://corporatefinanceinstitute.com/resources/templates/excel-modeling/black-scholes-calculator/>

This calculator is free to use for educational purposes, but other sites provide access to a calculator.

Option to wait (example 4)

An organization has the opportunity to bid for a contract that will give it exclusive rights to manufacture and market a new product in its home country. The initial set up costs would be \$50m, and the cash flows generated over four years are estimated as follows:

Table 8.20 Expected cash flows generated

			1	2	3	4
Cash flow \$m			20	25	15	10

However, there is considerable volatility attached to the cash flows. The rights are such that the organization does not have to commence manufacturing straight away but could wait 2 years to see how the market conditions develop before deciding to go ahead and manufacture.

If the organization manufactures immediately, the NPV, assuming a cost of capital of 11% is as follows:

Table 8.21 NPV of manufacturing now

Year	0	1	2	3	4
	\$m	\$m	\$m	\$m	\$m
Initial investment	(50)				
Cash flow		20	25	15	10
Net cash flow	(50)	20	25	15	10
Discount factor 11%	1	0.901	0.812	0.731	0.659
DCF	(50)	18.02	20.3	10.965	6.59
NPV					5.875

The difficulty is the high degree of volatility over the cash flows, which means that the future, if a decision to wait, is taken, could be quite different. The difficulty is how much to bid for the contract. Logic might suggest that the company could offer up to \$5.875m, as this is the estimated NPV of the project. However, what is the value of the option to wait? This is like a call option where the organization pays a cost (the premium) to provide the opportunity to buy a share in the future. The Black-Scholes option pricing formula can be used to calculate a value for this option.

S – the asset value would be the NPV of the cash flows generated if the organization waited. Assuming a cost of capital of 11%, this provides the following net cash flows.

Table 8.22 NPV of waiting to manufacture as input to the Black-Scholes model

Year	0	1	2	3	4	5	6
	\$m	\$m	\$m	\$m	\$m	\$m	\$m
Cash flow				20	25	15	10
Net cash flow	0	0	0	20	25	15	10
Discount factor 11%	1	0.901	0.812	0.731	0.659	0.593	0.535
DCF	0	0	0	14.62	16.475	8.895	5.35
NPV							45.34

$S = \$45.34\text{m}$
 $K = \$50\text{m}$
 $T = 2 \text{ years}$
 $r = 4.5\% \text{ (assumed)}$
 $\sigma = 50\%$

If these values are input to the Black-Scholes formula, it provides the following value of the option.

Table 8.23 Value of call option

Type of Option	Call Option
Stock Price (S_0)	\$ 45.34
Exercise (Strike) Price (K)	\$ 50.00
Time to Maturity (in years) (t)	2.00
Annual Risk Free Rate (r)	4.50%
Annualized Volatility (σ)	50.00%
Option Price	\$ 12.40

Additional Calculation Parameters	
$\ln(S_0/K)$	(0.098)
$(r+\sigma^2/2)t$	0.340
$\sigma\sqrt{t}$	0.707
d_1	0.342
d_2	(0.365)
$N(d_1)$	0.634
$N(d_2)$	0.358
$N(-d_1)$	0.366
$N(-d_2)$	0.642
e^{-rt}	0.91393

The call option has a value of \$12.4m. The organization could, therefore, bid up to \$12.4m for exclusive rights rather than the \$5.875m. The increase in value reflects the fact that there is a period before the decision needs to be made and the volatility of the cash flows. The benefit of the model is that it can take some account of the degree of volatility in the outcomes (future cash flows) without having to undertake numerous NPV calculations. However, as highlighted later, in section 8.6.5, under the limitations of Black-Scholes, the model makes some assumptions about the behavior of the stock market. Therefore, it is always advisable to undertake some sensitivity analysis by adjusting the input values to take account of differing

cash flows and different degrees of volatility. As with any model, it is an aid to decision making, not the decision-maker itself.

Follow-on option (example 1)

This example illustrates the situation where a company has the option to undertake a follow-on project at some point in the future.

Assume the following data has been provided.

Table 8.24 Basic information

Cost of capital	10%
	\$000
Initial investment	(750)
Additional investment in year 2	(600)

Table 8.25 Estimated cash flows of the project

Year	1	2	3	4	5	6	7	8	9	10
	\$000	\$000	\$000	\$000	\$000	\$000	\$000	\$000	\$000	\$000
Net cash flow from first project	150	150	150	150	150	150	150	150	150	150
Net cash flow from additional investment			75	75	75	75	75	75	75	75
	150	150	225	225	225	225	225	225	225	225

If the NPV for the overall project is calculated, it provides the following NPV.

Table 8.26 NPV of total project

Year	0	1	2	3
	\$000	\$000	\$000	\$000
Initial investment	(750)			
Additional investment			(600)	
Cash flow		150	150	225
Net cash flow	(750)	150	(450)	225
Discount factor (10%)	1	0.909	0.826	4.409*
Discounted Cash Flow	(750)	136.35	(371.7)	992.025
Net Present Value				6.675

* using the annuity value for years 3 – 10

The management team is worried that this is quite low.

However, the project could be viewed as consisting of two separate phases.

Table 8.27 – NPV of Phase 1

Year	0	1	2	3
	\$000	\$000	\$000	\$000
Initial investment	(750)			
Cash flow		150	150	150
Net cash flow	(750)	150	150	150
Discount factor (10%)	1	0.909	0.826	4.409
DCF	(750)	136.35	123.9	661.35
NPV				171.6

Table 8.28 NPV of Phase 2

Year	0	1	2	3
	\$000	\$000	\$000	\$000
Initial investment	0		(600)	
Cash flow				75
Net cash flow	0	0	(600)	75
Discount factor (10%)	1	0.909	0.826	4.409
DCF	0	0	(495.6)	330.675
NPV				(164.925)

Phase 1 is positive, but phase 2 is negative, which gives us the low overall NPV for the project. But what if phase 2 is optional? Inputting the values into the Black-Scholes formula, a value for the follow-on option can be calculated.

Note the \$600m is used as the investment required in year 2 for phase 2, but the NPV of the future cash flows of \$330.675m

Table 8.29 Value of call option

Type of Option	Call Option
Stock Price (S_0)	\$ 330.67
Exercise (Strike) Price (K)	\$ 600.00
Time to Maturity (in years) (t)	2.00
Annual Risk Free Rate (r)	5.00%
Annualized Volatility (σ)	50.00%
Option Price	\$ 41.24

Additional Calculation Parameters	
$\ln(S_0/K)$	(0.596)
$(r+\sigma^2/2)t$	0.350
$\sigma\sqrt{t}$	0.707
d_1	(0.348)
d_2	(1.055)
$N(d_1)$	0.364
$N(d_2)$	0.146
$N(-d_1)$	0.636
$N(-d_2)$	0.854
e^{-rt}	0.90484

This gives an option value of \$41.24m. The total NPV could be given as Phase 1 plus the option value. $\$171.6m + \$41.24m = \$212.84$.

Phase 1 is clearly beneficial, and the company then has the option to undertake phase 2 if it finally becomes worthwhile. Note, again, that the benefit of the Black-Scholes model is that it takes account of the volatility of future cash flows.

Option to abandon (example 2)

The two examples using the Black-Scholes model are call options; however, the option to abandon can be viewed like a put option (the right to sell).

XYZ is part of a group of companies that operates worldwide. XYZ is known for its innovative approach to developing new technology projects but often lacks the marketing expertise to exploit its potential fully. To date, XYZ has developed new products that it has effectively sold to the parent company, which then organizes one of the operating subsidiaries to manufacture and distribute the product.

XYZ has developed a new product that is ready for launch, but the senior management team is uncertain about future demand. The marketing department, however, is confident that once consumers use the product and word of the benefits gain momentum, the product will do well. The marketing department is so bullish about the product that they want XYZ to manufacture and distribute the product. The NPV for the product was calculated by the finance department as follows:

Table 8.30 NPV of the project

Year	0	1	2	3	4	5
	\$000	\$000	\$000	\$000	\$000	\$000
Initial investment	(40,000)					
Cash flow		1,750	5,500	12,500	15,000	20,000
Net cash flow	(40,000)	1,750	5,500	12,500	15,000	20,000
Discount rate 10%	1.000	0.909	0.826	0.751	0.683	0.621
DCF	(40,000)	1,591	4,543	9,388	10,245	12,420
NPV						(1,814)

Despite the negative NPV, the marketing department is still extremely keen to launch the product. The chief executive was not entirely convinced and sought advice from their parent company.

The proposal was sent to the parent company for review, and the result was that they liked the idea. However, their operations team was unsure about the reliability of the new technology, so they have agreed that if XYZ wants to take the risk and launch the product, they can do so. Once any teething problems have been sorted out, after 2 years, the parent company would buy the project for \$30,000,000 and manage the project after that.

The marketing department of XYZ insisted that there was a strong possibility that cash flows could improve in the future. The finance department suggested using the Black-Scholes option pricing model to calculate the value of the abandonment option at the end of year 2.

The benefit foregone in this case would be the NPV of the cash flows in years 3 – 5 of (\$9,388 + \$10,245 + \$12,420) \$32,053. The finance department suggested using a volatility of 50% and a risk-free rate of 5%.

Table 8.32 Value of put option

Type of Option	Put Option
Stock Price (S_0)	\$ 32,052.00
Exercise (Strike) Price (K)	\$ 30,000.00
Time to Maturity (in years) (t)	2.00
Annual Risk Free Rate (r)	5.00%
Annualized Volatility (σ)	50.00%
Option Price	\$ 5,940.38

Additional Calculation Parameters	
$\ln(S_0/K)$	0.066
$(r+\sigma^2/2)t$	0.350
$\sigma\sqrt{t}$	0.707
d_1	0.589
d_2	(0.119)
$N(d_1)$	0.722
$N(d_2)$	0.453
$N(-d_1)$	0.278
$N(-d_2)$	0.547
e^{-rt}	0.90484

The put option value – the right to sell the project to the parent company, has a value of \$5,940.

The NPV with the put option is therefore $\$5,940 - \$1,814 = \$4,126$.

It suggests that it would be worth XYZ undertaking the project with the put option in place; that is the right to sell to the parent company.

8.6.5 Limitations of the Black-Scholes options pricing model

There are some limitations to using the Black-Scholes model of option pricing.

It is useful for valuing European style options where the option has a specific time that it can be exercised. However, many real business decisions are akin to American style options that can be exercised at any time up to the exercise date. The use of the Black-Scholes model, therefore, indicates the likely value. The model also makes some general assumptions about the performance of the stock market, which may not apply directly to real business decisions.

It is also not able to take account of the behavioral aspects of many decisions. As with any business decision, the strategic aspects should always be considered, and a decision should never be made based purely on the numbers. The numbers are only part of the information that is used to make strategic decisions.

Whatever method is used, the accountant can undertake sensitivity analysis to understand the potential impact of inaccurate estimates; that is, what degree of error could be accommodated before the project becomes nonviable in financial terms. Long-term projects inevitably entail making estimates, which could prove to be incorrect due to environmental events beyond the control of the organization. Therefore, testing the estimates can be a valuable exercise.

Investment appraisals are useful in a variety of strategic decisions, such as product development, market development, mergers and acquisitions, customer lifetime profitability, investment in assets such as new technologies, and when making any business case.