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ESSENTIALS OF CORPORATE FINANCIAL MANAGEMENT

Second Edition

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Essentials of
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project halfway through if new information is received indicating that the worst-case scenario is now likely to happen (say, building costs double).

However, with most projects the managers are not making all-or-nothing decisions at the outset. They are able to respond to changing circumstances as they unfold over the life of the project. For example, if events turn out badly they can react by abandoning the project. So, a company that goes ahead with wind power electricity machinery production on the basis of a positive NPV given the government's current support for subsidising renewable energy may abandon the project if government policy changes two years later. The option to abandon rather than be forced to persist has value. This value is usually ignored in traditional NPV analysis.

Sometimes it is the option to expand if events turn out well that is extremely valuable. On other occasions the decision to go ahead or not to go ahead is not now-or-never but to consider a range of dates for going ahead; this year, next year or the year after. That is, the company has the option to defer the project, e.g. developing a copper mine only when the world market price of copper rises sufficiently. Going ahead now would destroy value at current low copper prices (a negative NPV) but the option to develop has value. The ability to abandon, expand or defer a project can add considerable value compared with a project without one of these flexibilities.

The real options perspective takes account of future managerial flexibility whereas the traditional NPV framework tends to assume away such flexibility.

Real options give the right, but not the obligation, to take an action in the future. They give value by presenting managers with the opportunity to exploit an uncertain future in which conditions change unpredictably, making one decision choice better than the other(s). By holding a real option we have the right to select whatever decision suits us best at the time. They differ from financial options traded in the market in that their value does not depend on the movement of a financial security or instrument, such as a share, or currency rate, but on the cash flows of real investment projects within the firm.

Some examples of valuable real options

Firms sometimes undertake projects which apparently have negative NPVs. They do so because an option is thereby created to expand, should this be seen to be desirable. The value of the option outweighs the loss of value on the project. For example, many Western firms have set up offices, marketing and production operations in China which run up losses. This has not led to a pull-out because of the long-term attraction to expand within the world's largest market. If they withdrew they would find it very difficult to re-enter, and would therefore sacrifice the option to expand. This option is considered to be so valuable that some firms are prepared to pay the price of many years of losses.

Another example would be where a firm has to decide whether to enter a new technological area. If it does it may make losses but at least it has opened up the choices available to the firm. To have refused to enter at all on the basis of a crude NPV calculation could close off important future avenues for expansion. Microsoft is thought to have lost $4 billion on the original X-box. However, three assets were created (options to expand): a prominent market position, some strong franchises (e.g. 'Halo' series of games) and the online-gaming service. The introduction of subsequent X-boxes exercises these options to grow. The pharmaceutical giants run dozens of research programmes showing apparent negative NPVs: they do so for what are often described as 'strategic reasons'. We might alternatively call this intuitive option analysis. Perhaps the drugs a company is currently developing in a field of medicine, say, for the treatment of Alzheimer's disease, show negative NPVs when taken in isolation. However, by undertaking this activity the firm builds capabilities within this specialism, allowing the firm to stay in the game and participate in future generations of drugs which may have very high payoffs.

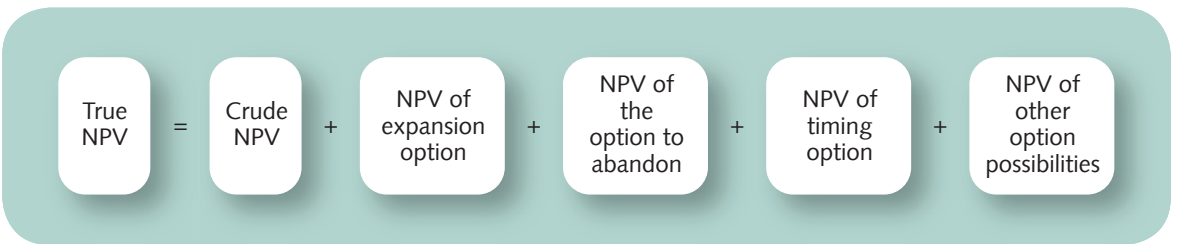
If a property developer purchases a prime site near a town centre there is, in the time it takes to draw up plans and gain planning permission, the alternative option of selling the land (abandonment option). Flexibility could also be incorporated in the construction process itself – for example, perhaps alternative materials can be used if the price of the first choice increases. Also, the buildings could be designed in such a way that they could be quickly and cheaply switched from one use to another (switching option), for example from offices to flats, or from hotel to shops. At each stage there is an option to abandon plan A and switch to plan B.

Having plan B available has value. To have plan A only leaves the firm vulnerable to changing circumstances.

Perhaps in the example of the property developer it may be possible to create more options by creating conditions that do not compel the firm to undertake investment at particular points in time. If there was an option to wait a year, or two years, then the prospects for rapid rental growth for office space *vis-à-vis* hotels, flats and shops could be more accurately assessed (deferral option or timing option). Thus a more informed, and in the long run more value-creating, decision can be made.

True NPV

Thus we need to raise the sophistication of NPV analysis by allowing for the value of flexibility during the life of the project. A project in which there is the ability to take further action after uncertainty has been resolved or reduced significantly is more valuable than one that is rigid.



An example of option use – the option to abandon

Imagine you are the chief executive of a company that designs, creates and sells computer games. A film studio is about to start shooting a major action thriller film. It will reach the box office in one year from now. The film company have contacted you offering you the right to develop and market a game based on the film (with film clips and voice-overs from the principal actors). You would have to pay £10m now for this. From previous experience you estimate that there is a 50 : 50 chance of the film being a success or a box office flop. If it is a success the present value of all the future cash flows for the game will amount to £50m. If, however, it is a flop, the high costs of development and promotion will mean a present value of all the future cash flows associated with the game will be negative £50m.

Should you pay £10m now for the game rights?

Conventional NPV analysis is likely to mislead you in this decision. You would set out the cash flows and their probabilities and calculate an expected NPV from them, which will be –£10m (*see* **Exhibit 4.22**). Hence you would reject the project.

The fact that you would be purchasing merely an option to develop the game, without the obligation to do so, is very significant in the valuation of this project. You can abandon the whole plan in one year's time when you have some vital information: how the film performs at the box office after release. If it is a success then continue. If it is a failure then do not invest any more than the original £10m and save yourself £50m.

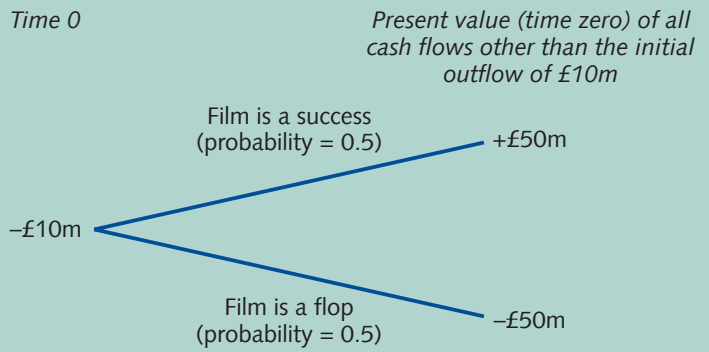
With this flexibility built in, your cash flows in the future are +£50m if the film is well received, and zero if it is hammered by the critics and audiences stay away. Each of these has a 50 per cent chance of occurring (*see* **Exhibit 4.23**).

The important point is that we don't view the project as a take-it-now-in-its-entirety-or-forget-it deal, but rather consider the possibility of future managerial choices. In other words managers are not passive, but active over the life of the project. There are contingent future decisions which can boost NPV. We need to allow for these possibilities now, when deciding whether to buy the game rights.

The payoff when the real option to abandon is considered is +£15m and it is correct to pay £10m for the game rights now.

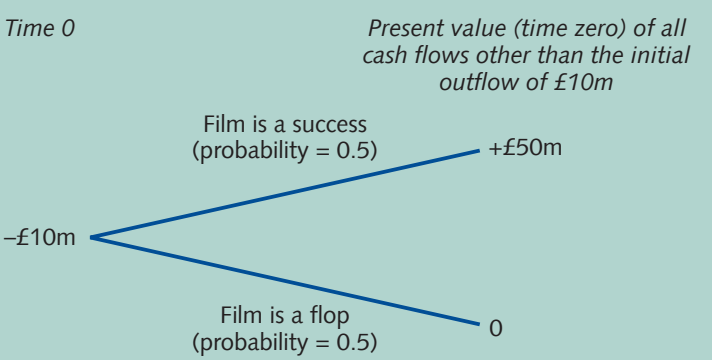
The value of the option to abandon is calculated as the difference between the NPV if obligated to go ahead with the entire project and the NPV with the option to abandon.

Exhibit 4.22 Conventional NPV calculation



Film is a success (–10m + £50m)0.5	= +£20m
Film is a failure (–£10m – £50m)0.5	= –£30m
Expected NPV	= –£10m

Exhibit 4.23 Options approach



Film is a success (–10m + £50m)0.5	= +£20m
Film is a failure (–£10m + 0)0.5	= –£5m
Expected NPV	= +£15m

NPV with option – NPV if there is no option

+£15 – (–£10m) = £25m

Welcoming risk

In traditional NPV analysis the greater the degree of uncertainty about the future cash flows the lower the value of the project. The higher standard deviation is offputting to a risk-averse shareholder, and their agents, the managers.

Real option analysis takes a different perspective. Uncertainty provides value because the opportunity to exercise the option to take action later becomes all the more precious. To illustrate, let us double the range of the present value of the cash flows after the initial payment. So there is now a 50 per cent chance of +£100m and a 50 per cent chance of –£100m. The

expected NPV under traditional analysis of this remains at –£10m but the range of outcomes has increased, i.e. risk has risen.

Film is a success	(–£10m + £100m)0.5	=	+£45m
Film is a failure	(–£10m – £100m)0.5	=	–£55m
Crude NPV		=	–£10m

This project is even more unattractive under traditional NPV analysis than the original situation because of the higher risk for the same return.

The options perspective shows the more volatile cash flow project to be more valuable than the less volatile one because managers can avoid the downside risk by simply abandoning the project if the news turns out to be bad in one year's time. Risk is no longer symmetrical, that is, with equal probabilities of negative outcomes and positive outcomes around the expected return. It is asymmetrical: you benefit if things go well and do not lose if things go badly (at least you lose no more than you put down as a 'premium' to purchase the option in the first place).

Film is a success	(–£10m + £100m)0.5	=	£45m
Film is a failure	(–£10m + 0)0.5	=	–£5m
Option perspective NPV		=	£40m

Uncertainty can therefore be a good thing, if you hold an option to exploit the change in circumstances as time goes on. If you do not have flexibility to respond then uncertainty is a bad thing and reduces value. Traditional NPV analysis assumes away the possibility of response to contingencies, resulting in a symmetric risk profile. Thus traditional NPV can seriously underestimate the true NPV of many capital investments.

Difficulties with real option analysis

- ***Complexity of the valuation process*** This book has explained real options using very simple mathematical examples. Analysts in this field often make use of complex option pricing models. This complexity means that most managers are unable to participate in the valuation process in an informed manner without extensive training. The danger is that untrained managers treat the exercise as black box decision making: supplying some inputs, e.g. standard deviation of key cost or revenue components, then handing the numbers over to the financial wizards who put them into the model and out pops the answer. The managers are totally unable critically to assess the machinations within the black box. It may be necessary to question the assumptions behind the calculations but the key managers are not empowered to do so. This could lead to poor decision making because the quality of inputs is often poor (see next point) and to cynicism about the real options approach throughout the organisation.
- ***Measuring uncertainty*** There is a practical constraint of not being able to measure the degree of uncertainty, and therefore the value of an option. Historic data are usually used (where available), e.g. historic volatility of oil prices for an oil exploration and development project. A leap of faith is then made in assuming that future standard deviations will be like those in the past. In many cases the option valuer clutches at straws to provide inputs to the calculations – giving the impression of scientific rigour, when the foundations are in fact very weak. Standard deviation numbers are often derived from a source only tangentially related to the project, e.g. average standard deviation of technology company share price movements may be used as a proxy for the standard deviation of outcomes for a new project initiated by a new company in a new technological field.
- ***Over-optimism*** In circumstances of very high uncertainty, e.g. when there is brand new technology such as the internet in the 1990s, there is a tendency to be over-optimistic about the value of expanding. In 1999 new 'dotcom' companies joined the stock market proclaiming that once their model was established the potential for scaling up was almost limitless. The market was so huge, they said, that even if the company had an 80 per cent chance of complete failure it was still worth backing as it might be the one left standing with options to expand to control the industry standard (the one most visited by travellers, pet owners, book

buyers, etc.). Similar arguments were made about social networking sites in 2012. These companies presented 'analysis' from 'independent' experts on the growth of internet connections (usually exponential) and the revenues in this field (again exponentially rising). Sadly too many people believed the hype. Similar hype can be exhibited by junior and middle managers about a growth area they are particularly enthusiastic about. Senior managers need to view the high ranges of likely outcomes presented to them with scepticism. In particular they should ask whether the firm's competitors are really going to do nothing while they take all this market for themselves.

- ***What is the life of an option?*** It may not be clear how long the option value will be available to the firm. For example, a pharmaceutical company may have invested considerably in cardiovascular drug R&D, providing it with potential competitive advantages for many years to come through its options to expand to new generations of drugs. But it is impossible to be precise on how many years the option to develop more drugs in this field will be valuable: is it three years, five or twenty years? The life of the option depends on so many variables, e.g. developments in surgery or competitors' actions.

Concluding comments

This chapter, and the previous one, have dealt with some of the more sophisticated aspects of project analysis. They have, it is hoped, encouraged the reader to consider a wider range of factors when embarking on investment appraisal. Taking into account more real-world influences such as inflation, rationing, tax and risk will enable the appraiser and the decision maker to obtain a clearer picture of the nature of the proposal being discussed. Greater realism and more information clear away some of the fog which envelops many capital investment decision-making processes.

However, this chapter has focused primarily on the technical/mathematical aspects of the appraisal stage of the investment process sequence. While these aspects should not be belittled, as we ought to improve the analysis wherever we can, it should be noted that a successful programme of investment usually rests far more on quality management of other stages in the process. Issues of human communication, enthusiasm and commitment are as vital to investment returns as, for example, assessing risk correctly.

Key points and concepts

- **Risk** – more than one possible outcome. **Objective probability** – likelihood of outcomes established mathematically or from historical data. **Subjective probability** – personal judgement of the likely range of outcomes along with the likelihood of their occurrence.
- Risk can be allowed for by **raising or lowering the discount rate**: Advantages: (i) easy to adopt and understand; (ii) some theoretical support. Drawbacks: susceptible to subjectivity in risk premium and risk class allocation.
- **Sensitivity analysis** views a project's NPV under alternative assumed values of variables, changed one at a time. It permits a broader picture to be presented, enables search resources to be more efficiently directed and allows contingency plans to be made. Drawbacks of sensitivity analysis: (i) does not assign probabilities and these may need to be added for a fuller picture; (ii) each variable is changed in isolation.
- **Scenario analysis** permits a number of factors to be changed simultaneously. Allows best- and worst-case scenarios.
- **Probability analysis** allows for more precision in judging project viability.
- **Expected return** – the mean or average outcome is calculated by weighting each of the possible outcomes by the probability of occurrence and then summing the result:

$$\bar{x} = \sum_{i=1}^{i=n} (x_i p_i)$$

Key points and concepts continued

- **Standard deviation** – a measure of dispersion around the expected value:

$$\sigma_x = \sqrt{\sigma_x^2} \quad \text{or} \quad \sqrt{\sum_{i=1}^{i=n} \{(x_i - \bar{x})^2 p_i\}}$$

- It is assumed that most people are **risk averters** who demonstrate **diminishing marginal utility**, preferring less risk to more risk.
- **Mean–variance rule:** Project X will be preferred to Project Y if at least one of the following conditions applies: the expected return of X is at least equal to the expected return of Y, and the variance is less than that of Y, or the expected return of X exceeds that of Y and the variance is equal to or less than that of Y.
- If a normal, bell-shaped distribution of possible outcomes can be assumed, the probabilities of various events, for example insolvency, can be calculated using the ***Z* statistic**.

$$Z = \frac{X - \mu}{\sigma}$$

- **Problems with probability analysis**: (i) undue faith can be placed in quantified results; (ii) can be too complicated for general understanding and communication; (iii) projects may be viewed in isolation rather than as part of the firm's mixture of projects.
- Sensitivity analysis and scenario analysis are the most popular methods of allowing for project risk.
- The **real options** perspective takes account of future managerial flexibility whereas the traditional NPV framework tends to assume away such flexibility. Real options give the right, but not the obligation, to take an action in the future.

Further reading

Real options are discussed in the following: Amran, M. and Kulatilaka, N. (1999), Brennan, M.J. and Schwartz, E.S. (1985), Brennan, M.J. and Trigeorgis, L. (eds) (2000), Childs, P.D., Ott, S.M. and Triantis, A.J. (1998), Copeland, T. and Antikarov, V. (2001), Copeland, T. and Tufano, P. (2004), Dixit, A. and Pindyck, R. (1994), Dixit, A.K. and Pindyck, R.S. (1995), Hertz, D.B. (1964), Hertz, D.B and Thomas, H. (1984), Howell, S., Stark, A., Newton, D., Paxson, D., Cavus, M. and Pereira, J. (2001), Luehrman, T.A. (1998a), Luehrman, T.A. (1998b), Merton, R.C. (1998), Moel, A. and Tufano, P. (2002), Pike, R.H. (1988), Pike, R.H. (1996), Quigg, L. (1993), Schwartz, E.S. and Trigeorgis, L. (eds) (2001), Triantis, A.J. and Hodder, J.E. (1990), Trigeorgis (1996), Van Putten, A.B. and MacMillan, I.C. (2004), Bulan, L. *et al.* (2009) and Harchaoui, T.M. and Lasserre, P. (2001).

The following show surveys of practical use of the techniques discussed in the chapter: Arnold, G.C. and Hatzopoulos, P.D. (2000), Graham, J.R. and Harvey, C.R. (2001), Hertz, D.B and Thomas, H. (1984), Ho, S. and Pike, R.H. (1991), Pike, R.H. (1988), Pike, R.H. (1996).

Case study recommendations

See www.myfinancelab.com for case study synopses.

Also see Harvard University: http://hbsp.harvard.edu/product/cases

- The Value of Flexibility at Global Airlines: Real Options for EDW and CRM (2006) Authors: M. Jeffery, C. Rzymski, S. Shah and R. J. Sweeney. Kellogg School of Management. Available on the Harvard Case Studies website.
- Mountain Man Brewing Co.: Bringing the brand to light (2007) Author: Heide Abelli. Harvard Business School.