Understanding the options in strategic decisions and investments

If a company wants to move forward, it is usually faced with a number of real options to choose from. **RICHARD STEWART**, **JOHN STUDLEY**, **DONALD STOKES**, **PETER VASSALLO** and **PETER WELLS** examine the methodology of choosing.

RICHARD STEWART
Pricewaterhouse Coopers, Sydney

DONALD STOKES
University of Technology, Sydney

JOHN STUDLEY
Pricewaterhouse Coopers, Sydney

PETER VASSALLO
University of Technology, Sydney

PETER WELLS
University of Technology, Sydney

Should the plant be upgraded now, or should a competitor's strategy be replicated? How much should be spent on research and development (R&D) this year and next? These are difficult strategic questions for management, requiring careful analysis. This paper examines some of the developments in real options analysis and argues that, applied pragmatically, this approach can capture benefits that traditional valuation techniques cannot.

There is much debate about real options analysis. Usually this debate centres on the complexity of real options and their modelling. There is a popular misconception that real options analysis is purely an academic concept and too analytical to be applied to management decision making, and beyond the comprehension of most boardrooms.

This is incorrect in our view. Real options are embedded in investment decisions managers make every day. This paper argues that using a degree of simple real options thinking in addition to net present value (NPV)/discounted cashflow (DCF) can yield a much better answer than that of NPV/DCF alone. Real options analysis is the tool of choice for those seeking better answers to tough strategic investment questions.

The challenge of strategic investment decisions

Strategic investments such as those in R&D create a number of important challenges for firms. There is the challenge of investment valuation – the uncertainty of activities and associated costs; the uncertainty of R&D output and measurement; and the uncertainty over exogenous events intervening to unsettle assumptions (the surprise management didn't see coming).

More than Black-Scholes theory

Real options are quite different from financial options, and should not be confused as a mere extension of Black-Scholes options pricing. Unlike financial options, real options do not have any fixed variables such as strike price and expiry periods. In addition, several fundamentals that allow financial options to be systematically traded on exchanges, like liquid markets for underlying assets, do not hold true for real options.

Real options are rights, without obligations, embedded in investment projects (especially strategic ones like R&D or market entry), to make decisions. These may be contingent on certain states of nature occurring that enable management to reduce the risks of the investments and add value (Brealey and Myers 1996, McAneney and Berkman 2000). The states of nature that give real options value are competitor responses or lessons from success or failure. Essentially, the value of real options lies in the flexibility they provide.

The value of flexibility

Real options thinking provides a set of tools to help management understand that flexibility is economically valuable. Why? Because investments are characterised by a degree of uncertainty. While uncertainty can only be resolved with time, flexibility provides management with the right but not the obligation to choose from a pre-established set of actions so as to limit downside risk and take advantage of upside risk. For example, if a development project meets with early success, management can decide to invest further or faster.

Embedded options, whether through design or otherwise, allow management to be actively involved in the process depending on the information feedback that arises within the investment period. One of the key strengths of real options thinking is the descriptive framework it provides to support the strategic management of investments.

It values the strategy, but more importantly, provides a map to navigate future strategic decisions which could impact value.

Previous research has tended to consider this framework on three levels – conceptual, analytical and empirical. Conceptually, real options thinking describes four generic options:

(a) Option to defer (wait for more information before making a decision). Management may decide to lease a property or asset rather than buy it, or decide to develop an asset in stages without losing the opportunity to undertake the full investment. This enables the owner of the option either to wait for more information, or to shift the timing of the decision to an optimal point in time.

(b) Option to switch (right to change tack). The option to switch applies to investments already held by the firm. This is a right, but not an obligation, to repurpose assets to alternative uses. This increases the value of the investment as it provides an insurance against a total loss of value if the original purpose of the investment becomes uneconomic. The inherent flexibility of an employee in the labour market is an example of such an option.

(c) Option to expand (invest further in a project or acquire). The option to expand is a call option where an investment permits present capacity to be increased, if market conditions improve. Examples are R&D joint ventures or strategic acquisitions. Typically, there exists an opportunity to stage an R&D project after the results from a pilot become known at a future date. Hence the pilot project itself may have a negative NPV, however, the positive NPV implications for subsequent projects can only be discovered when the pilot project is completed.

(d) Option to abandon (shut down or scale back activity). The option to abandon or scale back is similar to a put option. The ability to put capacity is important where output prices may vary. These options have been highlighted by recent activity in the airline industry where planes have been mothballed or returned under lease agreements.

At the analytical level there have been attempts since the mid-1980s to model investment projects as complex options to take account of different kinds of uncertainty that arise in investment projects such as mines, oil leases and; pharmaceutical product development. Trigeorgis (1996, p 225) makes the point that analytical models are somewhat limited in practice where complex investment problems have many real options operating that interact simultaneously or when competitive entry occurs leading to compounding within or between projects. Nevertheless work continues in modelling these challenges (see Trigeorgis 1996, chapter 7).

Empirical applications of real options thinking are disproportionately low. A recent survey by Brabazon (1999) investigated the use of real options thinking by US firms to evaluate investments. He found that 9.8% of firms interviewed were actively using real options methodology to evaluate investments. Moreover he found that 24.6% of the firms were expecting to be using real options techniques within 3 years time. Australian companies however, are more than 50% less likely to use real options thinking than their advanced American counterparts. In a recent Australian survey, Matolcsy et al. (2001) show that the incidence of use of real options thinking in strategic investment evaluations is less than 5%.

An extension of DCF – is it?

The capacity of real options thinking to explain the value of flexibility has broadened the set of assumptions that is otherwise required under a simple DCF framework. It amounts to a more sophisticated version of a DCF analysis.

Not so far from DCF

Under a DCF analysis, the estimation of the future income from projects is subject to a discount rate that is measured by the level of estimated risk. NPV is based on the premise that discounted projected outlays and income within the time period of the investment provide the summary measure to determine whether management should proceed with the development or not. A positive net present value supports a decision to proceed while a negative one does not.

While much of the literature on real options is motivated by the limitations of present value analysis (Trigeorgis 1996), it fails to point out that DCF is still a core element of real option analysis. For this reason boardrooms familiar with DCF should not fear real options analysis, and those who have used it once are often surprised by how intuitive the process is.

Real options thinking examines the contingency aspect of an investment as separate from the valuation of the main investment. It also entertains situations where the decision to invest can be made at any point within a predetermined future period as opposed to a present irreversible decision.

Most importantly, however, it provides management with a decision framework by which they can consider the optimal time to invest rather than rely on a range of present values.

The fact that management has a right, but not the obligation, to make a decision (ie: exercise their option to choose different paths) is an important value driver that is easily overlooked in terms of competitive advantage.

Most experts agree that real options have a part to play

In 1998, Copeland and Keenan provided an overview of real options and their value in capital investment decisions. They argued that the passive management assumptions implicit in NPV modelling could generate counter intuitive implications that could be rectified by the application of real options thinking. In particular they argued that real options are powerful where the investment contains a higher level of flexibility without significant opportunity loss due to the presence of competition. For example, flexibility to enter and exit a market, particularly where the barriers to either are high, is very valuable. Real options thinking is highly applicable to more uncertain investments where the investment provides some competitive advantage.

In 2000, Anderson provided a more explicit link between strategy and real options. He noted an increase of emphasis in strategy theory that combined a top-down with a bottom-up strategy.

Bottom-up strategy refers to inter-firm opportunities that management needs to nurture to exploit internal opportunities while keeping a top down strategic direction. Anderson also cites Lippman and Rumelt (1982) who propose that whereas risk is traditionally seen as negative, the presence of risk for investment, and the possibility that a firm may create a risk advantage over competitors by employing real options thinking, turns risk into an opportunity. If this sounds strangely familiar, it is.

It is widely accepted that DCF using the capital asset pricing model (CAPM) has limitations in capturing risk. In 1999, Chatterjee et al. used real options thinking within a wider framework to present an alternative interpretation of management interaction with cost of capital.

CAPM has been consistently challenged with the most notable evidence provided by Fama and French in their controversial 1992 study. They observe the limited explanatory power of beta to explain risk by itself and add other firm characteristics that increase the prediction accuracy of beta, such as tactical risk and its management.

Tactical real options are procured either through investments, or are nurtured within the company through knowledge management and innovation.

The study of entrepreneurs provides some interesting parallels. In 1999, McGrath used real options to show that failure can become a productive feedback event rather than a negative incentive for investment. She noted that successful entrepreneurs employed a portfolio approach with an emphasis on overall return rather than individual successes. Their skill was in limiting downside risk through greater use of expansion and abandonment options.

The benefits from this approach are not only that a broader opportunity set becomes available but entrepreneurs actually gain from investments with higher variance. This is an interesting look at real options theory at work.

Real options analysis – how is it done?

The selected examples above demonstrate the applicability of real options thinking to strategic issues such as risk minimisation, leverage and optimal timing. Choice forms a substantial part of the investment decision. This all seems good in theory, however converting this conceptual thinking into measurable parameters for investment evaluation and performance evaluation depends upon building analytical models that capture these concepts. This is the current challenge.

Start with traditional DCF as a building block

A good place to start is valuation of the current business plan. Traditional DCF analysis for investment evaluation uses both an estimate of the cash inflows and outflows within the investment period and a discount rate to factor in the uncertainties associated with time.

The riskier the cashflows the higher is the discount rate. The methodology for determining the discount rate is provided by the CAPM, which disaggregates overall risk into market or diversifiable risk and firm or non-diversifiable risk. It is based on portfolio theory that proposes that investors can diversify away market wide risks by constructing portfolios to suite their risk profile while leaving firm-specific risk to management.

But DCF alone based on a single financial forecast has obvious limitations, and can miss important strategic considerations.

Add some sensitivities and simulations

For this reason a number of extensions to DCF valuation are employed to address the complexities introduced by the assumption of active management within the investment period. These consist of sensitivity analysis, Monte Carlo simulations and the use of decision trees to map the contingencies within the investment period.

In sensitivity analysis, a base NPV case is set and key variables are identified. A suitable range for each variable is estimated and discrete values from within the range are then fed into the main NPV model to generate a table of values.

The drawbacks of this approach are that interdependencies are missed and the estimated range is subjective, covering typically only best case, worst case and expected case scenarios.

The procedure for a Monte Carlo simulation is to set up mathematical relationships that describe the operation of the variables for the particular investment being modelled. Distributions for individual variables are allocated and sample random values are collected for each variable.

Outputs are then repeatedly obtained using the random value set inputted into the mathematical relationship used for the model.

After a sufficiently large number of iterations, a mean and variance are obtained from the output set to obtain a valuation.

The process is evidently more sophisticated and inclusive than that

for sensitivity analysis, is a significant step forward from linear DCF, and in addition provides valuable insights into a range of possible value outcomes.

Now build in flexibility to make decisions

Both scenario modelling and sensitivity analysis suffer from some major drawbacks. Important decisions contingent on important events are missed simply because the simulation keeps on running, whereas in a real scenario, management may elect to stop the process or make major alterations to the investment. This condition is known as a free boundary. Examples are a rare catastrophic event or a major discovery in Research and Development (R&D). Consequently the role of important exogenous events could be missed and not factored into the investment's discount rate.

Contingencies can be imported into NPV through the use of decision trees as proposed by Hertz (1964). This allows the availability of choices to be mapped along the time series within the investment period. The result is that probabilities can be explicated and used to weight respective outcomes to provide a weighted distribution of outcomes at the end of the tree. These are then subsequently discounted back to the present to provide a summary valuation. In this way decision trees continue to constitute a variant of NPV.

There are other sophisticated procedures which can be used to model real options such as dynamic programming, contingent claims analysis and compound options, however for simplicity they are not discussed here.

CONCLUSION – IT'S WORTH THE EFFORT

Leveraging off corporate strategy, real options analysis provides a set of tools which explicitly recognises that flexibility is economically valuable, largely because investments are characterised by a degree of uncertainty. While uncertainty can only be resolved with time, flexibility provides management with the right but not the obligation to choose from a pre-established set of actions so as to limit downside risk and take advantage of opportunities. This includes the management options to defer, switch, expand or abandon an investment or business activity.

Embedded real options, whether through design or through circumstance, allow management to be actively involved in the process of capitalising on information feedback that arises within any investment period. The strength of this thinking is its capacity to support the strategic management of investments with a descriptive framework, which for the first time provides a quantified roadmap for changes in strategy.

Analytical models are somewhat limited in practice, particularly where complex investment problems have many real options operating that interact simultaneously or when competitive entry occurs, leading to crossover between projects. Work continues on ways to model these challenges. In the meantime, the developments to date extend the traditional DCF analysis and are already providing management teams with a better understanding of value, and a clear advantage over their competitors.

Should the plant be upgraded now, or should a competitor's strategy be replicated? How much should be spent on R&D this year, and next? Management and the board could be surprised by the answers.

REFERENCES

Anderson, T. J. (2000). "Real Options Analysis in Strategic Decision Making; an applied approach in a dual options framework." *Journal of Applied Management Studies* 235

Brabazon, T. (1999). "Real Options: Valuing flexibility in capital investment decisions." *Accountancy Ireland* 31(6): 16-18.

Brealey, R. A. and S. C. Myers (1996). Principles of Corporate Finance. New York, McGraw-Hill Companies.

Chatterjee, S., M. H. Lubatkin, and B. Schulze. (1999). "Toward a strategic theory of risk premium: Moving beyond CAPM." *Academy of Management Review*.

Copeland, T. E. and P. T. Keenan (1998). "How much is flexibility worth?" *McKinsey Quarterly* (Number 2): 38-49.

Dixit, A.K and R.S Pindyck, (1994), Investment under Uncertainty, Princeton University Press, New Jersey.

Fama, E. and K. French (1992). "The Cross-Section of Expected Stock Returns." *Journal of Finance* 47: 427-465.

Hertz, D. (1964). "Risk Analysis in Capital Investment." *Harvard Business Review* (Jan-Feb 1964): 95-106.

Lippman, S. A. and R. P. Rumelt (1982). "Uncertain Imitability: An Analysis of Interfirm Differences in Efficiency Under Competition." *Bell Journal of Economics* 13: 418-438.

McAneney, J. and H. Berkman (2001). "Valuing New Product Development and Analysing License Agreements for Intellectual Property." WP - University of Auckland, Arthur Andersen.

Matolcsy, Z., D. Stokes and P. Wells (2002), *JASSA, Autumn 2002*. "Evaluating intangible assets: The new financial management, reporting and analysis challenge."

McGrath, R. G. (1999). "Falling forward: Real options reasoning and entrepreneurial failure." *Academy of Management Review* 13.

Trigeorgis, L., (1996), Real Options Managerial Flexibility and Strategy in Resource Allocation, The MIT Press, Cambridge Massachusetts.

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