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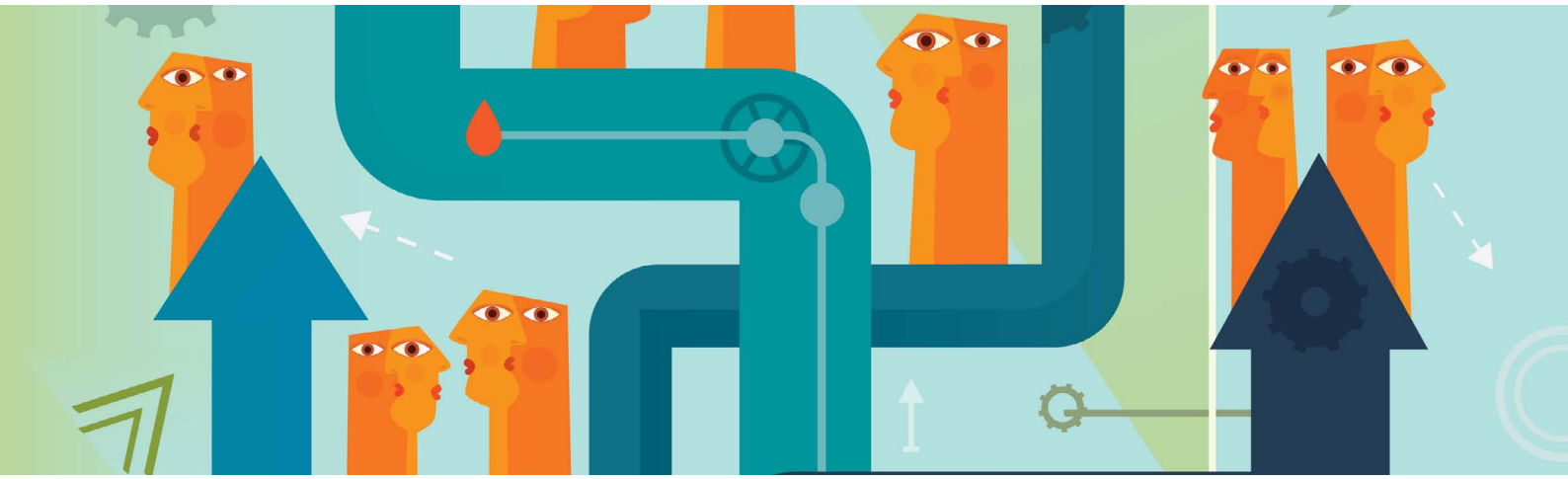

Real Options
The State of the Art

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Preface

At a recent corporate retreat, a senior-level executive of a large industrial company was asked to name his most difficult problem. Instead of citing the competition from China or rising labour costs, the executive stated simply, "trying to convince top management to approve an investment to pursue an innovative idea."

Many managers will agree that getting a project through the investment approval committee can be one of the most frustrating and unrewarding experiences of corporate life. Battles wage. Typically, two sides develop. Business developers and strategists, who look at a project for what it might accomplish, are pitted against the corporate financiers and analysts, who look at the project for what and when it will pay back. Often the only result is a stalemate.

This paper [1] explains how some companies are bridging the gap between the two sides. Using "real options" they apply a harder analytic edge to the intangible side of the innovation investment.

Grounded in the basic intuition that decision makers seek to "keep options open" in situations that involve an uncertain future, real options is supported by a solid financial economics foundations.

Let me describe my experience with real options. Since the 1990s I have introduced the practice of real options to companies in Asia and Australia: airlines, beverage companies, energy producers and electricity generators, infrastructure operators, miners and telcos. Projects realised a wide range of strategic benefits: better decisions on production capacity expansions, more accurate pricing of assets in competitive auctions, all-inclusive cost-benefit analysis of vertical de-integration, and full value recognition on market entry decisions.

Drawing on this experience and the work of real option pioneers such as Triantis and Borison (2001), this paper explains the practice of real options. Triantis and Borison noted three ways that real options are being used within organisations:

- **A different way of thinking**: recognising that multiple scenarios and pathways to the future are a better way to manage risks and opportunities than a single view of the future;
- **New analytics for valuation**: taking into account both flexibility and forward market prices – and integrating the processes of formulating strategy and valuing assets;
- **A dynamic decision making process** that involves a strategic conversation between the decision makers, project experts and the financial analysts – and integrates subjective judgment in project evaluation, not just hard data and the facts.

[1] The author would like to acknowledge the comments of Dr Adam Borison and Michael Collins in the preparation of this White Paper.

Introduction: The Return of the Real Option

Some thirty years have passed since Myers (1977) coined the term "real options." Myers' key insight was that since the future is uncertain, it pays to invest in a range of options that allow management to capitalize on favorable opportunities – and mitigate the downside by responding to events over time in a flexible fashion.

Through the 1990s corporate finance and business strategy people together started viewing investment opportunities through a real options lens.

The bursting of the 1990s tech bubble and a general lack of expertise in corporations to make effective use of real options, dampened some of the initial enthusiasm. Nevertheless, in the 21st century, real options are more relevant as ever to decision making.

The time for real options has come again. How companies respond to the big uncertain ties of our time – global economic shifts, the rise of China, volatile commodity prices, new technologies, climate change – can benefit from real option thinking.

With increased uncertainty, real options actually become more valuable, so managers should be willing to pay for flexibility in times like today.

In this next era, investments will succeed or fail depending on well they are designed to cope with uncertainty. Value will be driven by product, program and service innovation, and the ability to respond to shifting markets, new technologies, and new regulatory imperatives. When markets, technologies and regulation are changing, real options are more valuable. Investors therefore should be willing to pay for flexibility in times like today.

Real Options as a Way of Thinking

Real option thinking recognises that multiple scenarios and pathways to the future are a better way to manage risks and opportunities than a single view of the future.

Real options logic has an intuitive sense. It advises to move forward in stages when steering investments through uncharted waters: Consider a variety of future scenarios and potential strategies; favour actions that are robust to uncertainties; favour actions that yield useful information; probe, experiment and learn through doing; monitor results and adapt to changing conditions.

Steering big, complex, multi-stage assets in dynamic markets

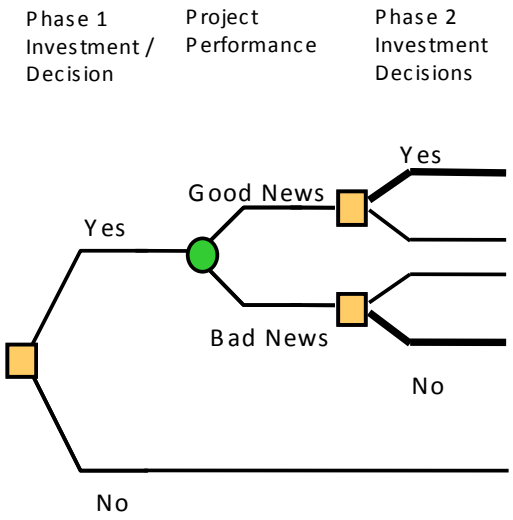
The real options framework explicitly recognises that management always has the power to change track in response to changing conditions. They use levers such as: accelerate or defer, "make or buy", switch markets or production, expand or contract, and so on.

By breaking decisions into stages, executives can build flexibility into their plans. When building a new plant, for example, it may be tempting to realize the full economies of scale by building the biggest facility the company can manage. But it may be wiser to first build a smaller plant that can be easily expanded later on. That way, if the market for the products the plant produces does not emerge as expected, a smaller investment has been put at risk. At that point, managers have the option to scale down or abandon operations. On the other hand, if things turn out well, they have the option to expand the plant.

Exhibit 1 illustrates a decision tree for a two-stage investment decision, the simplest form of real option.

Value is created through identifying, creating, owning, managing, and exercising options.

Exhibit 1 – Decision tree for a two-stage investment decision: by deconstructing projects into stages, flexibility is added



Value is created through identifying, creating, owning, managing, and exercising options such as:

Planting seeds: Experiment strategically by making a series of small investments, before making the big ones;

Learning actively: Decisions on a program do not always have to be made up front; conduct tests and capitalise on learnings;

Building ramps: Embed options to defer or accelerate, to switch direction at a future stage;

"Failing fast:" Build-in flexibility to abandon if conditions weaken.

Where are companies applying real options?

A new farmland investment, a power plant, a marketing trial, a mining or energy project, an R&D investment, a technology platform, a new product development, a multi-sourcing strategy are some of the ways firms use real option thinking.

Triantis and Borison (2001) surveyed and interviewed corporate executives from more than thirty companies in seven different industries: **C**onsumer and industrial products, financial services, high tech and info-com, life sciences, energy and power, real estate / homebuilding and transportation. Their overwhelming conclusion was that real options help managers make better investment decisions — decisions that end up creating more wealth for the firm's shareholders.

Table 1 below shows applications of real options across most industries.

Table 1 – Real options in industry

Type of Decision	***Examples of Real Options***
Asset development	Options such as plant sizing decisions provide flexibility to change the asset development strategy in response to changing conditions.
Product development	Building options into the development process to modify new designs well into the product development cycle can add significant value to the development program.
Asset leases	Options over asset and property leases provide transaction timing flexibility if and when the market turns while locking in a price today.
Platform investments	Platforms are technological and organizational investments that permit a firm to address a wider menu of future markets. They provide flexibility in the delivering the end result, i.e., what the system might provide for different markets and future uses.
Marketing strategy	Market trials for new products can provide valuable learning prior to full-scale launch.
Equipment acquisition	Options in procurement contracts (e.g., adding or reducing the order quantity) are a common feature of contracts for aircraft and other major equipment purchases.
Sourcing strategy	Multi-sourcing in I.T. services may be more expensive but it reduces the risk exposure of being locked into one vendor only.
R&D and innovation capabilities	Acquiring new capabilities is one way companies can build resilience in the face of market and technological change. A "capability" real option creates a match between current competencies and the emerging business situation.
Joint ventures	Joint ventures in emerging markets or new technologies allow learning about the true value of an investment to occur prior to committing.
Global production and sourcing	Manufacturers set up plants around the world, to enable switching of production from site to site to take advantage of fluctuations in exchange rates or operating costs. The capital cost of the multi-plant system is higher than operating one plant only, but the value of flexibility may be higher still.

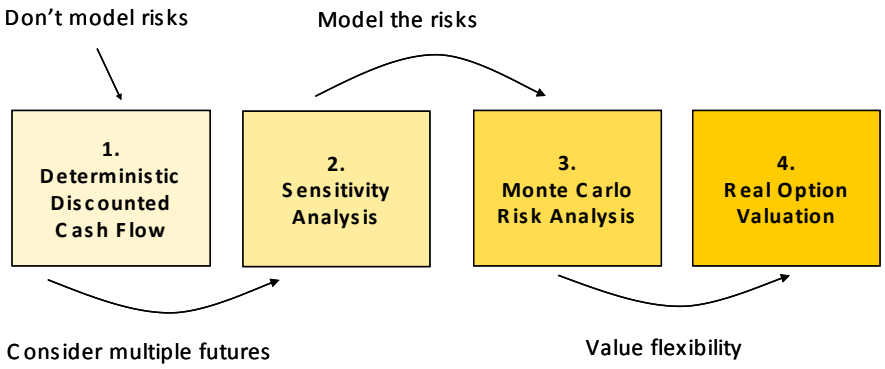
Real Options as Analytics for Valuation

Valuation lies at the heart of investment decision making. "What is it worth?" "How can the full value potential be realized?" Real option analysis takes into account both flexibility and forward market prices when valuing assets – and integrates the processes of formulating strategy and valuing assets.

Valuation as an evolving paradigm

Exhibit 2 shows how project investment valuation techniques have evolved over the last two to three decades. The next section examines each of these techniques in turn.

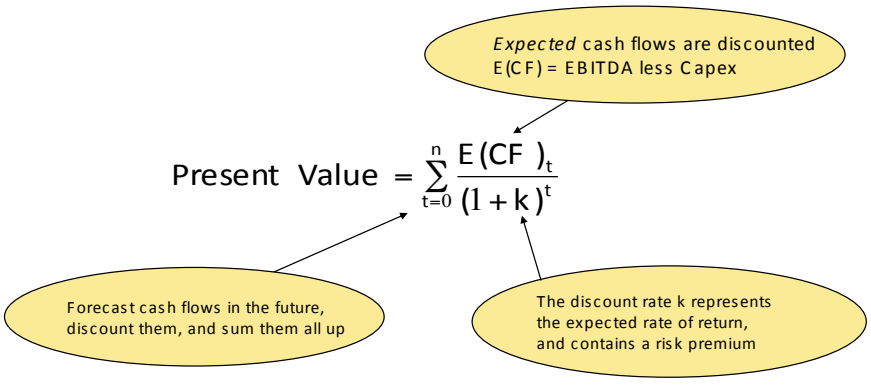
Exhibit 2 – Evolution of valuation techniques



1. Deterministic discounted cash flow valuation

The first approach adopted by many corporations in the 1960s and 1970s, deterministic discounted cash flow valuation, relates the value of an asset to the present value of expected future cash flows on that asset, as depicted in Exhibit 3 below.

Exhibit 3 – The formula for discounted cash flow valuation



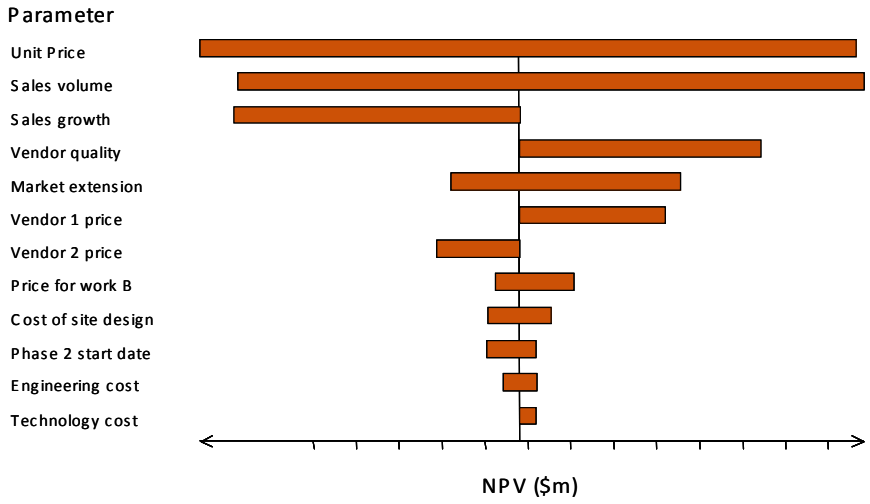
Using traditional DCF, the approach is to make a "best guess" as to how the future will pan out, lock-in the strategy, and value the project in this "expected" state of the world. So DCF asks "what are your 20 year forecasts?" trapping managers into the mug's game of prediction, when the real question should be:

"given that we cannot predict the future outcomes with accuracy, what are our best positioning options?"

2. Sensitivity analysis

The second approach involves applying sensitivity analysis to the deterministic DCF model. Exhibit 4 shows a "Tornado Diagram" which quantifies the sensitivity of the net present value by switching each of the DCF model's input parameters from its "high" value to its "low" value. The Tornado Diagram presents the parameters in order of importance revealing the major drivers of value.

Exhibit 4 – Tornado diagram shows sensitivity of NPV to inputs



3. Monte Carlo risk analysis

The third approach to valuation, Monte Carlo risk analysis came into vogue in the 1980s when computing power made it possible to run very quickly many thousands of valuation scenarios. Instead of single values for each input parameter, the Monte Carlo algorithm repeatedly samples values from the probability distributions of each of the input parameters – the drivers of project value and risk – to produce a probability distribution of the net present value as shown in Exhibit 5.

Exhibit 5 – Drivers of project value and risk

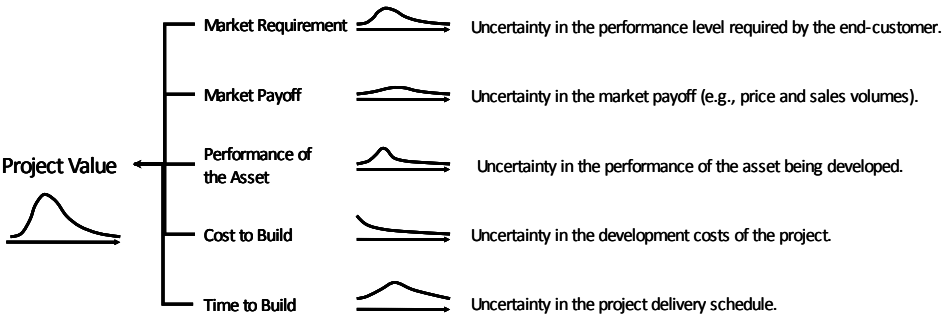


Exhibit 5 shows the probability distribution of project value which is computed from the probability distribution of the five cost and risk drivers: market requirement, marker payoff, asset performance, cost to build, and time to build.

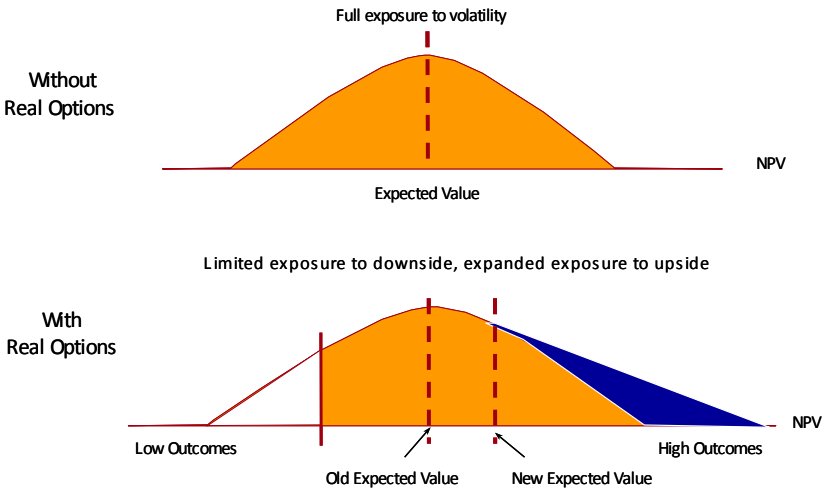
A limitation of the Monte Carlo technique is that it does not take into account the fact that management can alter the strategy in response to changing conditions.

A limitation of the Monte Carlo technique, however, is that it does not take into account the fact that management can alter the strategy in response to changing conditions. In other words, the Monte Carlo valuation assumes that the strategy is set in advance, and cannot be adjusted down the track.

4. Real option valuation

The fourth approach to valuation, Real option valuation (ROV) was pioneered in the 1980's and 1990s in the oil and gas and pharmaceutical industries. ROV recognises not only that the future is uncertain but also that an essential element of value in assets is their inherent flexibility. Active management of real options creates more value by limiting the downside and capturing more on the upside, as shown in Exhibit 6.

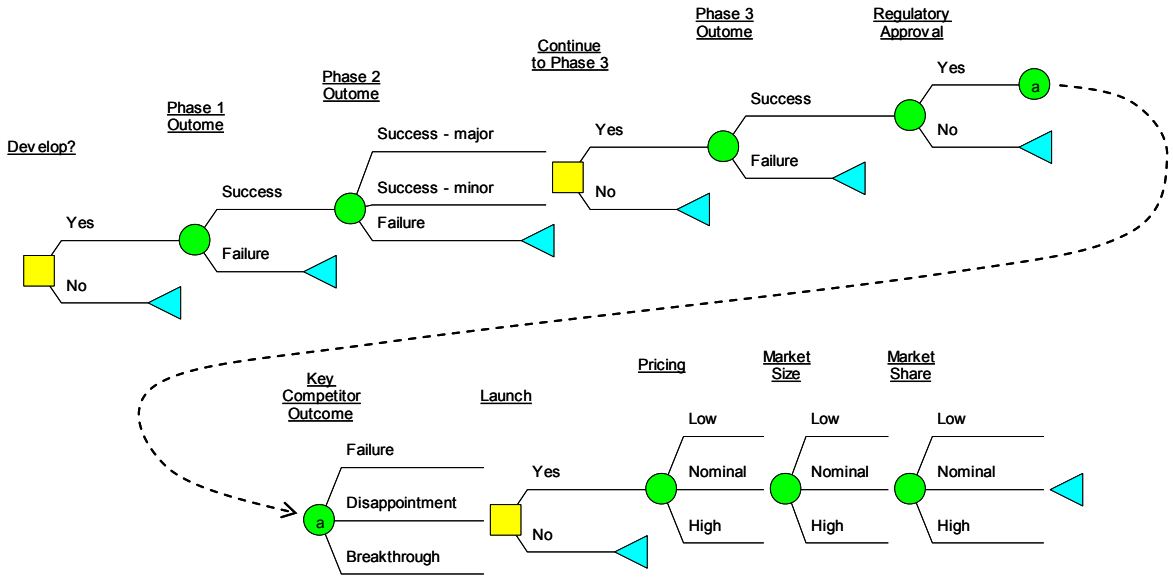
Exhibit 6 – Real Options limit the downside and capture the upside



Modelling real options using decision trees

Decision tree software tools are used to build multi-stage real option valuation models with wide scope and complexity. Exhibit 7 on the following page shows an example of a new product strategy involving three real option decisions (the yellow squares) and eight uncertainties (the green circles).

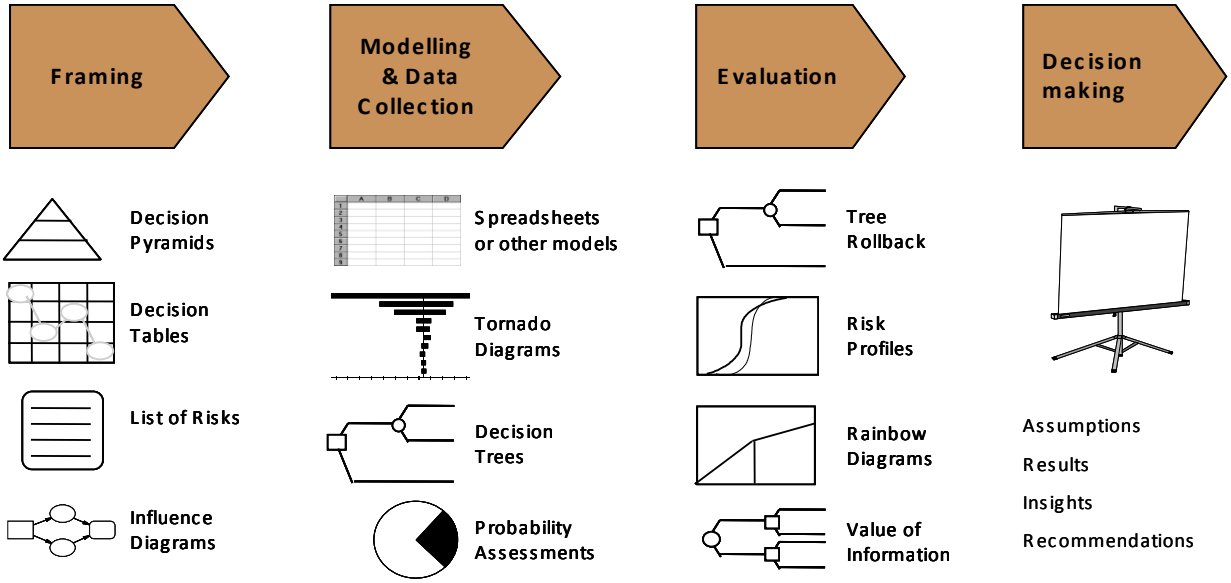
Exhibit 7 – Example of a real options tree for a product development



The toolset of real options

The toolset for identifying, structuring and valuing real options is shown in Exhibit 8 below.

Exhibit 8 – The real options analysis toolset



Framing means determining the objectives, identifying alternatives, agreeing on what must be decided, and establishing the logic for choice.

Framing: Framing means determining the objectives, identifying alternatives, agreeing on what must be decided, and establishing the logic for choice. Developing a well structured decision frame leads to better and more defensible choices. Framing tools such as a decision pyramid, decision table, risk identification list, and an influence diagram are used to structure the real options problem. [2]

Structuring the real option valuation of the project includes the following:

- **Defining value**: How should we measure value and success?
- **Risks and opportunities; decisions and options**: What alternatives do we have now and how can we adjust to minimize risks and maximize opportunities in the future?
- **Timing**: When do we have to make these decisions?

Modelling and data: Modelling involves the development of a spreadsheet financial model for the Project, gathering baseline information for the inputs (including estimation of the probabilities), and conducting a baseline analysis. Tools such as spreadsheet valuation models, tornado diagrams, decision trees, and probability assessments are used for the real options modelling and data analysis.

With real options, data estimation is not so much about predicting future outcomes, but about calibrating our level of uncertainty about what might happen through the use of probabilities.

Evaluation: Evaluation uses the financial model together with the decision tree to value the project including flexibility options. Evaluation tools such as rainbow diagrams, risk profiles, and value of information are used for the real options modelling and data analysis.

Decision Making: Decision making includes communicating and documenting the analysis, assumptions, and the results and key insights for management.

Results of a real options analysis

ROV provides more than just a "go/no go" recommendation and a dollar value for the project. Rather, it provides a true management roadmap with milestones, decision points, on-ramps and off-ramps. This helps ensure that the project's "optimal" strategy identified through the analysis is actually realised through management action.

Risk profile

The aggregate probability distribution for Net Present Value for the optimal strategy is produced. The decision then is made based on comparing probability distributions of NPV, rather than point estimates that essentially ignore the uncertain quantities and factors involved in the decision.

Exhibit 9 following shows an example of a project valued with and without its real options taken into account.

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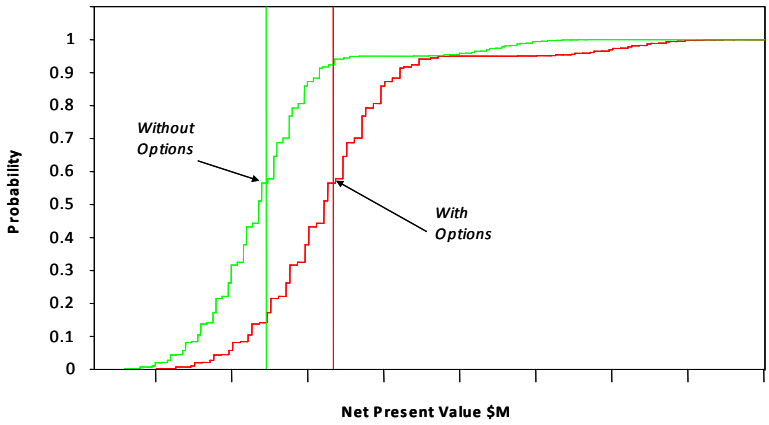
[2] A decision pyramid ranks the decisions in a hierarchy of importance. A decision table is a way to aggregate decisions into strategies. An influence diagram is a way of describing the dependencies among the probabilistic variables and decisions.

Exhibit 9 – Cumulative probability distribution of net present value

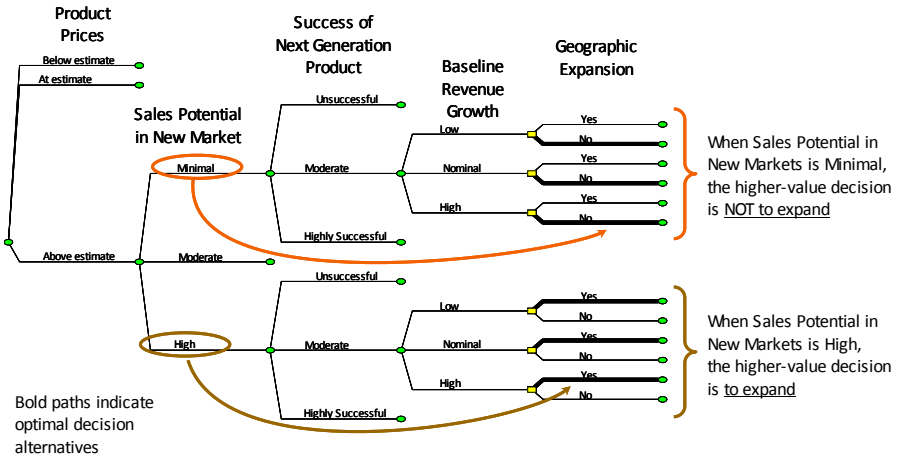


The graph shows the expected NPV of a project with real options (the vertical red line) is higher than the expected NPV of the same project with real options ignored (the vertical green line).

Optimal decisions – the value creation strategy through time

The real options analysis reveals the optimal strategy: the set of decisions both now and in the future to maximise the expected pay-off. The decision tree in Exhibit 10 shows that a different decision on "geographic expansion" is taken, depending on the "sales potential in the new market."

Exhibit 10 – Results of the real options analysis show the optimal strategy through time



Using the real options analytic model, sensitivity analysis can examine under what circumstances a different decision set would have been recommended; in other words, by how much would the input assumptions have to change before a different decision strategy becomes optimal.

Conclusion

In a world of change and uncertainty, risk based methods are more important than ever for investment decision making. Business environments are not getting more stable or any easier to compete in. But in fact, a bigger menu of uncertainties in today's dynamic business world provides innovators with new opportunities to create new kinds of value.

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