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Option pricing for investment and benefits management

The global financial crisis is well into its second year, but the sense of déjà vu with past market collapses remains. As with the 'Dotcom Bubble' bust of 2001, there is once again an extraordinary amount of corporate collapses and high share market volatility. Also, evidence of greed, fraud and negligence by the finance and business communities and outright incompetence by regulators abounds.

Of course, the more things change the more things stay the same. Case in point is the voluminous commentary focusing on the lack of independence within corporate governance frameworks, excessive executive remuneration, the level of negligence and direct fraud committed by boards and senior executives, and the poor performance of auditors, particularly credit rating agencies, in carrying out their duties. However, to limit the debate to these things is to miss 'the real picture' on why companies, good and bad, produce poor results. Poor results are created through poor investment decisions and/or poor implementation of those investment decisions.

In considering their organisations' direction and which new initiatives to advance, there are three options senior management face every day of their working lives. They are:

1. Hold and maintain
2. Invest
3. Abandon

Project managers are faced with these three options every week, however, the benefit models and decision-making frameworks do not exist to assist them with the decisions. However, real option pricing is a method available to track project benefits and ensure that the investment fundamentals that got the project approved in the first place are still relevant. This model includes the use of the following:

- Binomial method of option pricing
- Decision tree analysis
- Monte Carlo simulation
- Base case net present value fundamentals

Option Pricing – A model for Investment Management and Benefits Management

<u>Managing by Design Philosophy</u>

The aim of this paper is to provide a framework in which investment decisions can be made with as much confidence and validity as is possible. It is important to understand the philosophy and principles that need to be present if the framework presented is to be at its most effective. The philosophy that best represents the right environment for agile and adaptable investment decision making is known as Managing by Design. This philosophy can be broken down into four core principles. They are outlined in the diagram below:

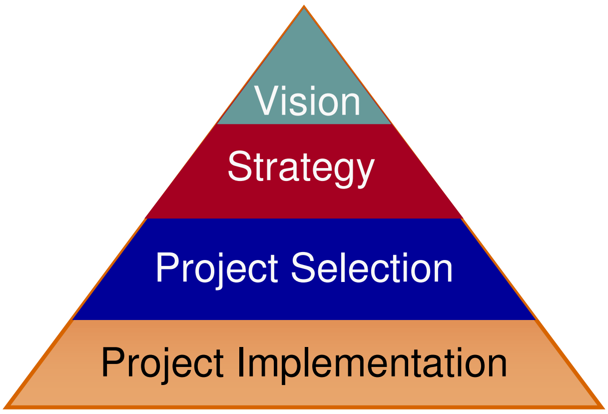

Diagram 1

Vision is the inspirational goal that guides and motivates the stakeholders of an organisation to achieve the strategic objectives that are outlined underneath it.

Strategy is the approach and measurement objectives that will assist the organisation in understanding what work needs to take place and what measurement processes will be required to track progress.

Project selection is the method and measurement criteria to which investments in achieving the strategic objective will be made and hence movement towards the vision achieved.

Project Implementation is the planning, execution and change management practices for the projects that have been selected.

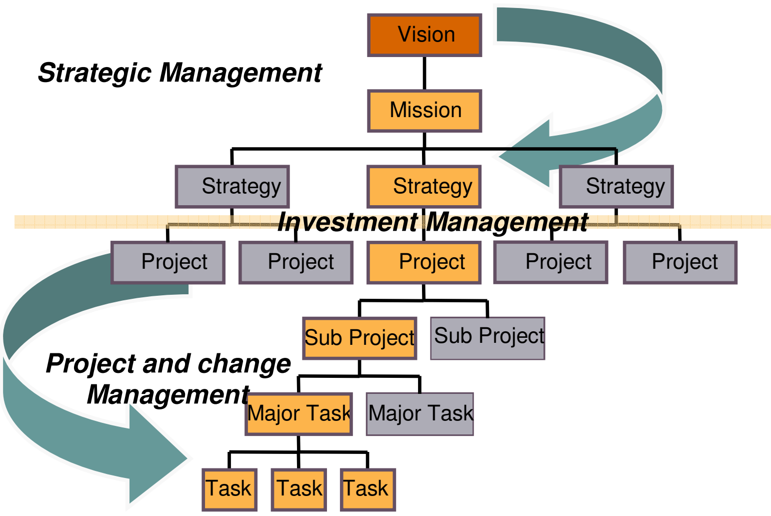

Diagram 2

The four principles above require the following four management skills:

1. Strategic Management
2. Investment Management
3. Change Management and
4. Project Management

Like the principles themselves, these four areas of management must work in harmony. Each management skill is interdependent on the success of the other and must be all at the peak for the creation of value for the stakeholders of the organisation. **Diagram 2** illustrates how these management skills and principles inter-relate.

Organisation Value

The model that will be outlined in this paper is described in terms of a commercial organisation that is looking to maximise its shareholder wealth. Although this is the environment described in the paper, it does not necessarily preclude other types of organisations from using the principles and method described; it just requires that organisation develop a different measurement system than a financial one.

For commercial organisations, an organisation's value is made up of the discounted future cash flows of the benefits that are accruing from past projects plus the discounted future cash flows of the benefits that will accrue from future investments. Most of these future investments will be due to the options and opportunities past projects have created. It is rare and often risky for organisations to invest in completely new businesses that have no link or "synergy" with their existing business models. Most of the companies that tried this diversified investment approach failed in the late 80's and early 90's. The ones that still exist (GE and Wesfarmers for example) have succeeded in great part due to their ability to implement a stringent and rigorous investment management framework.

There are two important facts to take out of the above statement on organisational value. The first is that benefits realisation on past projects is crucial to the success of a business and therefore should take a considerable amount of senior managers' time and thought space. The second is that future investments have to be valued not only on the benefits they create directly, but also on the opportunities or options they create in the future. It is this second fact that has led to the reduction in the use of Net Present Value (NPV) and other return on investment (ROI) techniques and the replacement of the need for ROI to a more gut feel approach.

It is also clear from the amount of value written down on the profit and loss statements by large-listed organisations every year that neither the old ROI approaches nor the gut feel method works. The former doesn't work because it ignores the value of options created by an investment and the latter does not work because it provides no means to track and measure how your gut feel guess is performing to its original gut feel estimate. Thankfully, with the addition of option pricing on real assets, management can return to using proper quantitative methods to value their own "gut feel" decisions and tell them whether it is worth the time investing, or whether they are wasting their shareholder's money.

Managers gut feel, strategic value, NPV and option pricing

Basic microeconomics arises from the principle that, over time, an industry will settle into equilibrium. In this case, all assets are expected to return their respective opportunity cost of capital. The premise behind this is that if an industry is earning more than its opportunity cost of capital, more businesses will enter that industry or individual businesses in that industry will expand. Companies that create value greater than the opportunity cost of capital employed are seen to be companies that have some sort of strategic or competitive advantage. This may be temporary (i.e. industry equilibrium has not been reached) or long term (i.e. a continuing monopolistic environment exists).

Advantages of this nature can arise in several ways. Examples of such transitory competitive advantages include being first to market with a new product, registering patents, developing intellectual property, or creating a production cost advantage over competitors. Cartels (such as OPEC) or government-regulated monopolies are examples of long-term competitive advantage. As can be seen from the examples described above, most businesses can only hope to create temporary competitive advantages. This highlights the need for companies to continually improve themselves. As business cycles shorten and competitive advantages become more fleeting, the need for innovation becomes critical.

Developing a strategy that outlines the high level approach to achieving an organisation's vision is key to ensuring that the innovation taking place within an organisation is of the kind that is creating value. Essential to the development of a sound strategy is the development of strategic objectives (or organisational key performance indicators, or KPIs) that allow senior management to track progress towards the vision. Once these strategic objectives have been developed (and defining the right KPIs is easier said than done), an organisation has the framework to implement sound investment management practices.

The first of such practices is the adoption of a Net Present Value (NPV) valuation process for a considered investment. To calculate NPV, the following steps are required:

1. The **benefit drivers** (which should be the same as some of the strategic objectives identified in the strategic management piece) are identified and quantified
2. The **costs of the project** are estimated
3. The **ongoing costs** created by the project are estimated
4. The risk of the investment is compared to the current risk profile of the organisation. If the beta (risk rating) of the project is the same as the companies then the **Weighted Average Cost of Capital** (WACC) is used as the discount rate. If it differs then the discount rate is adjusted appropriately.
5. The cash flows calculated in steps one to three are discounted by the discount rate assessed at step four to produce the project's **Net Present Value**.

As mentioned earlier, currently when NPV and other more theoretically flawed return on investment methods are used, the results are viewed sceptically by those who are against the project and sometimes even more so by those who are for the project. There are three main reasons for this.

The first reason is that management does not link the NPV result to the qualitative "gut feel" beliefs in the project. The only way that a project can have a positive NPV is for it to have some sort of strategic or competitive value (these two terms are synonymous in this sense). Therefore, this competitive advantage should be easily articulated and linked to the number calculated through the benefit drivers that have been used to calculate it. For example, an organisation that has a huge weakness in the performance of its call centres invests in upgrading the old legacy systems and software to a more efficient modern system and business process. The benefit drivers are productivity savings and these savings have been valued and can be tracked. It is therefore possible for the investment manager to articulate the positive NPV in qualitative terms by linking the NPV number to the competitive advantage the new system creates.

Even if the new system brings the organisation in line with its competitors, it reduces the drag the current system is having on other areas of the business that may be strengths and therefore have real competitive advantages (e.g. brand awareness). This example demonstrates that an investment does not have to be in leading edge technology or be superior to your competitors to have a competitive advantage or add strategic value to the business. It just has to align to the direction the organisation wants to head in and generate greater benefits than the cost for implementation.

The second slightly more genuine reason that NPV is not used is due to forecast error. Not only is it difficult to forecast future cash flows, but it is extremely difficult to estimate a project's discount rate. It is the debate over what is the correct discount rate (even among finance theorists) that creates the scepticism. Once again, this issue can be resolved if the "black box" of the NPV number is removed, and the benefits are articulated in terms of their alignment to strategy and the level to which they take the business down that strategic path. You must be able to qualitatively identify the strategic value an investment will create and then quantify the benefits in terms of the KPIs that the business currently is using to measure performance.

The third reason, and the only really genuine reason, is that NPV will be negative on investments that will add value and in some cases more value than any other investment the organisation could make. The reason for this is that NPV is based in a passive buy and hold assumption. It ignores the options management have every day. It is the value of these options (or the value of management) that NPV is missing.

One can understand management's dislike of NPV as it ignores the value they can create by coming to work every day and making decisions. However, all is not lost. Option pricing on real assets gives the investment manager the capability to value the options created and thereby give greater certainty to the risky strategic investments an organisation makes. Risk equals volatility and it is volatile investments that have the highest option value.

A model for valuing options on real assets

Every day management have the following three options when reviewing what to do with the existing assets in the business:

- Do nothing
- Invest in more assets
- Sell assets

Each asset in the business can represent a different option to management. In the 'do nothing' scenario an asset can be valued as an:

- In the money call option – this is where further investment in that asset would result in a positive NPV project, but the NPV will be even greater if the investment is delayed
- Out of the money call option – this is the value of holding an asset where further investment results in a negative NPV project but due to the assets volatility in forecasting future cash flows, it still has value.

The option to invest in more assets represents an in the money call option. When a call option is "in the money" (i.e. the present value of the future cash flows of the investment are of greater value than its exercise price), then it may be worthwhile exercising the option to invest and therefore select and implement the project. Remember the emphasis on 'maybe'. There still may be value in not investing if waiting will result in even greater value in the future. In this case, you are holding onto the call option and waiting to exercise it.

The option to sell assets represents a put option. This is where a business will receive more money by selling the asset than if they continued to use the asset to generate cash flow. This option can limit the downside risk of an investment. For example, a project that will cost $300k but has an abandonment value of $300k no matter what happens will have a significant put option value, which should be added to the total value of the project while it is being considered for selection and during implementation.

By creating the parallel universe between financial options and real options we enable the investment manager to utilise the option pricing methods that have been developed to value financial options. The first important point to note here is that the method that needs to be used to value real options is not the Black-Scholes model but the binomial model. The reason for this is that the Black-Scholes model does not work where dividend payments on the underlying asset are possible prior to the options expiry date. Obviously, delaying an in the money call option means delaying the receipt of positive cash flows. Only the binomial method will price the option accurately in this scenario.

<u>The Binomial Method</u>

The following are the steps to valuing a follow-on investment option created if investing in an initial negative NPV project.

1. Value project 1 using the NPV method (see above)
2. Value project 2 using the NPV method. The NPV provides two inputs. The present value of the future cash flows generated gives an estimate of the underlying value of the asset for the option to derive its value from (hence the term derivatives when describing options and other financial constructs). The cost of implementing the second project, plus the ongoing incremental cost, discounted back to present value gives the exercise price of the option.
3. Estimate the standard deviation or risk of project 2 by carrying out Monte Carlo simulation. To do this, estimate a best, base and worse case scenario for each of the benefit and cost drivers of project 2. Assign probabilities of the event occurring and then simulate at least 1000 iterations of the NPV. This will give a statistical sample with a normal distribution. From this a standard deviation (level of risk) can be calculated.
4. Determine what the time horizon is before a decision on whether to invest or not needs to be made. Factors may include first to market, changes in technology, changes in the environment etc.
5. Decide which government bond rate you will use as the risk free rate of return. Select the bond rate that is closest to the time horizon selected at point 4. (e.g. for an option that expires in 2 years, use a 2 year bond rate).
6. Decide how many periods per year you will use when generating the decision trees for the binomial model. Use a minimum of 4 periods per year (i.e. quarterly) to create the model. The binomial model is more accurate the more periods that you use as it gets closer to a continuum of project possibilities rather than a 2 period model that represents either boom or bust.
7. Calculate the percentage change in the Asset Value (i.e. the present value of the future cash flows of project 2) of an upside and downside event. The formula for the upside event is:

   $u = e^{\square\sqrt{h}} - 1.$

   Where:

   u = upside change

   e = base for natural logarithms = 2.718

σ = Standard deviation of annual return on assets

h = Time periods as a fraction of a year

The formula for the downside event is the reciprocal of the upside event. Ie: d = 1/u – 1

8. Calculate the probability of an upside and downside event. The formula for this is: (risk free rate – downside change)/ (upside change – downside change)
9. Starting at present day, develop a decision tree diagram (see diagram 3 below) using the base case Present Value for project 2 as the starting value. Calculate the possible values for the period 1, period 2 etc using the percentage up and percentage down values calculated at 7. This will give you a range of possible outcomes for the value of the project at the end of the project.
10. Now start at the end of the project and calculate what the call option is worth at the end of the project (See diagram 4). Do this by subtracting the exercise price from the asset value calculated at 9 above for each of the possible outcomes. Remember that an option cannot be negative, it is either worthless (i.e. of zero value) or positive, and therefore if the exercise price is greater than the asset price then the option's value is zero.
11. Discount the option values calculated by dividing the option value by the risk free rate divided by the number of periods in a year. Multiply the result of the option by the upside event probability calculated at 8 if it is an upside option or the downside event probability if it's a downside option and add the two together.(See diagram 5)
12. Continue until you have discounted the options value back to present day.

The following is an example to work through using the steps above. An organisation has decided to invest in new IT infrastructure. This new infrastructure has little direct benefit but allows the business the option in the future to invest in more sophisticated BI and CRM systems. The IT infrastructure project is expected to take 12 months to implement and have a present day cost of $5M.

There have been no measurable benefits assigned to the infrastructure project. The follow on investments will begin immediately after the infrastructure project and are expected to have a present value cost of $20M and take 18 months to implement. They have been assigned measurable benefits worth a present day value of $19M. (Note that both projects have an expected negative NPV). Monte Carlo simulation on the BI and CRM project has shown a standard deviation of 60 per cent. We now have all the data we need to complete a binomial method option pricing valuation on the second project. The current 1 year government bond rate is 6 per cent.

Step 1: Project 1 has a negative NPV of $5M. This is effectively the cost of buying the call option. The call options value needs to be greater than this for the investment in the infrastructure project to be viable.

Step 2: Project 2 has an Asset Value of $19M. It has an exercise price of $20M

Step 3: The standard deviation is 60 per cent as calculated by our Monte Carlo simulation

Step 4: A decision on investing in the CRM and BI projects is to be made in 12 months time

Step 5: The risk free rate of return is 6 per cent

Step 6: We will use quarterly periods to calculate our option value

Step 7: percentage change of an upside event = $2.718^{0.6 \times \sqrt{1/4}} - 1 = 0.419$

percentage change of a downside event = 1/0.419 – 1 = 0.295

Step 8: Probability of upside event = (.06/4-0.295)/(0.419-.159) = 45%

Therefore, probability of downside event = 1- 0.45 = 0.55

Step 9:

Asset Value Now					19,000,000				
Option Value Now					?				
Asset Values Period 1				26,961,305		13,389,560			
Option Values Period 1				?		?			
Asset Values Period 2			38,258,525		19,000,000		9,435,806		
Option Values Period 2			?		?		?		
Asset Values Period 3		54,289,461		26,961,305		13,389,560		6,649,541	
Option Values Period 3		?		?		?		?	
Asset Values Period 4	77,037,616		38,258,525		19,000,000		9,435,806		4,686,022
Option Values Period 4	?		?		?		?		?

Diagram 3

The two asset values in period one are calculated as follows:

- 19M x 1.419 for the upside event
- 19M x 1.295 for the downside event

This is continued until an array of possible values is calculated in period 4.

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Step 10:

Asset Value Now					19,000,000				
Option Value Now					?				
Asset Values Period 1				26,961,305		13,389,560			
Option Values Period 1				?		?			
Asset Values Period 2			38,258,525		19,000,000		9,435,806		
Option Values Period 2			?		?		?		
Asset Values Period 3		54,289,461		26,961,305		13,389,560		6,649,541	
Option Values Period 3		?		?		?		?	
Asset Values Period 4	77,037,616		38,258,525		19,000,000		9,435,806		4,686,022
Option Values Period 4	57,037,616		18,258,525		0		0		0

Diagram 4

In step 10, we calculated the option values in period 4 by subtracting the exercise price (cost of the second project) from the resulting asset value calculated in step 9 above. If the exercise price is greater than the asset value then the option is worthless and the second project would not proceed.

Step 11 and 12:

Asset Value Now					19,000,000				
Option Value Now					5,379,038				
Asset Values Period 1				26,961,305		13,389,560			
Option Values Period 1				10,415,886		1,528,491			
Asset Values Period 2			38,258,525		19,000,000		9,435,806		
Option Values Period 2			19,511,848		3,494,062		0		
Asset Values Period 3		54,289,461		26,961,305		13,389,560		6,649,541	
Option Values Period 3		34,777,265		7,987,266		0		0	
Asset Values Period 4	77,037,616		38,258,525		19,000,000		9,435,806		4,686,022
Option Values Period 4	57,037,616		18,258,525		0		0		0

Diagram 5

Once the period 4 options value is obtained, this is discounted to period 3 by multiplying the two events (up and down) by their respective probabilities of occurring and then discounting the combined figure by the risk free rate of return.

For the upside value of option period 3 this is calculated as follows:
(57M x 0.45 + 18.2M*.55)/(1+.06/4) = $34.77M

We continue this method until we discount the option value back to a present day value. In this example, the value of our call option is $5.3M. When added to the original negative $5M of project 1, we get a positive value of $0.379M. The $5.3M option represents the value of the possible upside created by investing in infrastructure that provides for more sophisticated technologies in the future. If in a year's time, the benefits for the CRM and BI are not good, then the call option is abandoned. The same method can be used to value put options except instead of subtracting the exercise price from the asset value, the asset value is subtracted from the exercise price. Remember, just as in call options, you cannot have a negative value for a put option. It is either worthless or has some value.

Project Selection and Investment Management

Option pricing provides for the valuation and assessment of negative NPV projects. This is significant as most of the investments that are going to add value in 5 to 10 years will initially have negative NPV's. By using option pricing, management now have a framework for assessing whether something is truly worthwhile or whether its 'strategic fit' is actually a waste of time.

However, the option pricing model needs to be continuously updated and tracked over the time. If our infrastructure project goes over budget, or the market research carried out for the CRM benefits proves to be in error, remedial action should be taken and this could mean abandoning both projects. The put option valuation gives the project manager implementing the infrastructure project the means by which to make the decision whether to abandon or not.

Option pricing, however, requires an understanding of the underlying causes for value before any quantitative assessment is made. If a project has very little positive cash flow in its first 2-5 years of implementation, then the timing option value will be very high. It is important to recognise this and perhaps delay investing in the project until positive cash flows accrues at an earlier stage in the project life cycle.

Option pricing allows organisations to: (1) utilise a stage gate financing approach to project approval; (2) implement a program rather than a project; and (3) manage a portfolio of projects rather treat each project in isolation. Investments in IT infrastructure and business process change should always be run as programs. With option pricing, the program can be tracked on a monthly basis and decisions can be made in terms of future direction and current tactical changes. This process also leads to eliminating the need for the 'big bang' rollout.

Lastly, it is important to never buy a call option for more than what it will cost to exercise it. Option pricing is all about reducing risk. There is no point using option pricing if the organisation is going to invest so much initially that it removes the options the business has and locks them into the chosen investment. Invest a bit at a time, test out the waters and as more information becomes known, exercise the call options that have a high certainty of generating massive value and exercise the put options on those projects that are never going to generate more cash flow than their current abandonment value.