"Options"

Critical Equation #6 for Business Leaders

$$C_t = S_t N(d_1) - Xe^{(-rT)} N(d_2)$$

Overview

There is not a business leader in the world who would not argue the importance of being flexible in making decisions, being alert to the arrival of new information, and being certain their teams always think through their available options. These business leaders also would recognize that having options is essential to managing risk in a globally complex and ambiguous environment. They would acknowledge that the product and service differentiations that produce superior shareholder returns can come directly from a culture that understands and uses options in making decisions. Yet, while many talk about and recognize the relevance of flexibility in decisions, we know of no particular company that has fully endorsed an options perspective and has embedded it within their culture.

Understanding how to value an option is quite complex. Given the ambiguous nature of business today, organizations must engrain the concept of options or flexibility into their cultures to remain competitive. Everyone in an organization must continually be thinking in terms of creating options. This may require a change in the organizational processes and tools used to identify investment opportunities, but understanding, applying and having a culture around flexibility will improve the potential for profitable growth.

Options in capital markets are the right (not a commitment or an obligation) to buy/sell an asset at a given price within a time period, whereas a futures contract is a commitment. Rights vs. Obligations are very different concepts. The right to buy is often referred to as a call, the right to sell a put. Operating managers rarely deal directly with options in capital markets, but do continually make decisions regarding their product/service offerings as information changes. The ability to be flexible to change is an option. Moving from the capital to product/service markets will take us into the domain of ***"Real Options,"*** a term often used by academics and some practitioners. Real Options allow us to expand, contract or defer (to name a few possible decisions) and are considered a contingent claim because the ultimate value depends on the arrival of new information. In a capital market option, the contingency exists because the value is contingent upon the underlying equity.

Judy Lewent, former CFO of Merck, sums up the practical application of Real Options as applied to R&D: *"Finance theory properly applied is critical to managing in an increasingly complex and risky business climate. Option analysis provides a more flexible approach to valuing our investments. To me, all kinds of business decisions are options."*

Options in a capital markets context have existed and been traded for decades (even before exchange traded call options warrants were commonplace). Since the 1980s, academics have written about the aforementioned Real Options, but acceptance and application has been slow. Many of our clients are only beginning to consider their use in investment decisions.

The related issue of embedded options in derivatives and contracts, and their associated accounting treatment, is an essential area for risk managers but beyond the scope of this article.

In Critical Equation #6 for Business Leaders, we introduce and review one of the most famous formulas of modern financial theory, taught in every MBA program and numerous undergraduate finance courses. This article examines the:

- basic mathematics of options
- drivers of option value in capital and project markets
- potential applications in business from valuing flexibility
- pros and cons in practice, and
- corporate culture necessary to make Real Options a real option.

This article introduces our business equation 6, the option pricing model then explores the drivers of option value and Real Options for business leaders with an example of applied Real Options. We also discuss the culture that drives options thinking, the relevance of options to technical sales and long-cycle businesses, and the value of revealed information illustrated by the Monty Hall problem.

TRI's Critical Equation # 6 – Option Pricing

Our equation # 6, known as the basic Black-Scholes Option Pricing Model (BS), is represented by

$$C_t = S_t N(d_1) - Xe^{(-rT)}N(d_2)$$

where, in a typical capital market application, C is the value of the call option today (t), S is the value of equity, X is the exercise level (also referred to as the strike price), T is the time to maturity, and r is the risk-free rate of interest (on government bond of appropriate maturity).

In addition to S, X, T, and r, there is a fifth driver of option value (C). The fifth driver is volatility, as measured by the standard deviation of the equity returns. e is defined as the base of the natural logarithm (approximately 2.71828), and $e^{(-rT)}$ is a present value operator. $N(d)$s represent the cumulative normal density functions that can be linked to the probability of the event. The impact of the volatility is embedded within the definitions of d_1 and d_2. Details are available upon request as well as nonstandard variations of the model often seen in capital market applications. Specifically, our equation 6 is for a call option (that is, the right to buy). The BS model has been at the heart of financial theory since the 1970s and has engendered more debate (positive and negative) than any paradigm we are aware of in theoretical and/or practical finance.

Drivers of Option Value

The comparative statics (derivatives of C_t with respect to the driver of option value) can provide some interesting insight and are summarized in Exhibit 1.

Exhibit 1

Drivers of Option Value

Factor *	Impact from Increase in Factor **
Stock Price	*Positive*
Exercise Price	*Negative*
Time to Maturity	*Positive*
Volatility of Stock	*Positive*
Risk Free Interest Rate	*Positive*

* Dividend Yield another potential factor
** Specifically on Call Option Value

All things being equal, the implication of the drivers of option value are that:

- an increase in stock price will increase call option value
- an increase in the exercise price (or strike price) will decrease call option value
- an increase in time to maturity will increase call option value (because of the increased probability the stock will exceed the exercise level given an increase in maturity)
- an increase in volatility will increase call option value (This is one of the counter-intuitive results of options but is critical to both capital market and Real Options. It results from the fact that with greater volatility there is an increased probability the stock price will exceed the exercise level prior to and/or at maturity.)
- an increase in the risk-free rate increases option value (again possibly counter-intuitive but logical because, with an option, an increase in the interest rate decreases the present value of the exercise level or the amount needed to be put aside today for potential exercise).

All of these drivers have a nonlinear impact on option value and have special names in capital market applications (e.g., the derivative of call option value with respect to stock price is routinely referred to as Delta).

Exhibit 2 depicts the call option value as a function of the underlying stock price for a given exercise level $50, time to maturity, volatility and risk-free interest rate (government rate of maturity equal to the time to maturity). The blue line represents the value at maturity. (Note: This value must be at a 45 degree angle. For example the exercise price is $50, and the stock price is $65, and the call option has a value of $15. Arbitrage guarantees very little room for excess returns.) A stock value below the exercise level makes the option worthless (i.e., no one will exercise at $50 when they can buy in the market at less than $50). Any time prior to maturity the option will have a positive value given by the red line. Increases in time to maturity, volatility and the risk-free rate will all increase the option value for any given stock price. This is the speculative value on the Exhibit. The maximum value reflects the fact that the option value can not exceed the stock price, again due to arbitrage.

Exhibit 2

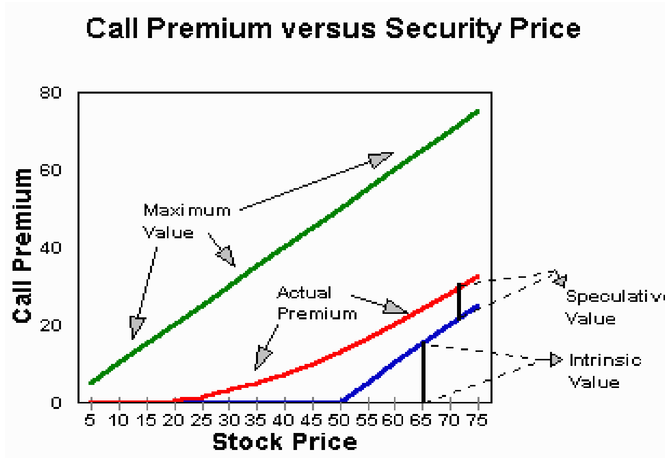
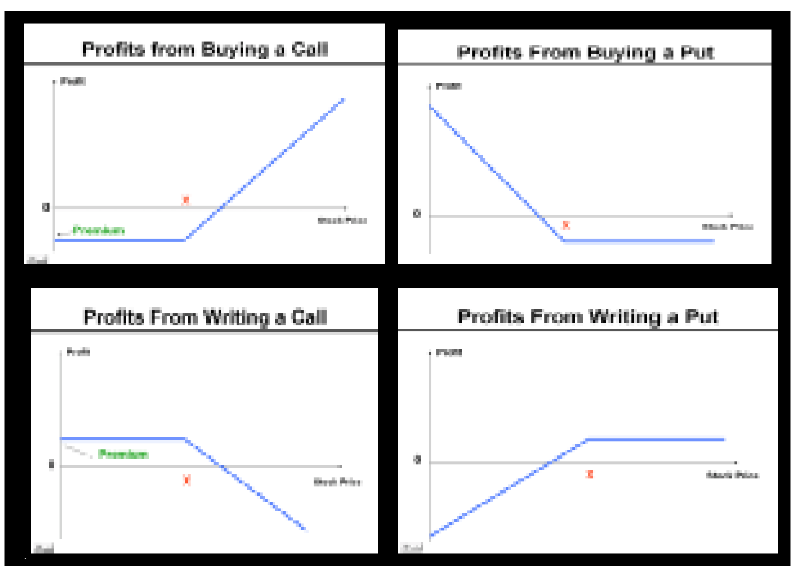


Exhibit 3 contains the graphs of profit and loss potential at maturity of puts and calls from the perspective of buying and selling (or writing) the option. The graphs represent the intrinsic value at maturity as seen in Exhibit 2. The option always has two sides, the buyer and seller (or writer). As you can see, the loss potential for writers of uncovered calls (without the underlying asset) is unlimited. The loss potential from writing a put is the value of the exercise level. This is one reason we emphasize, from a risk management perspective, to never get on the wrong side of an option. It can and will be used against you at just the wrong time. One of the often debated examples of potentially getting on the wrong side of an option is when GM gave a put (right to sell) option to Fiat a decade ago. Of course, the option would have the most value when Fiat's financials suffered and probably at a time when GM would least want to own Fiat. Even though the exercise price was to be quantified by experts named by both sides, there remained considerable risk to GM and ultimately a few billion dollars were required to make the problem go away.

Exhibit 3



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To demonstrate an application of our equation 6 and to see the implicit complexity, consider a stock with a stock price today (S_t) of $92, an exercise (strike) price of $95 ($X$), time to maturity of 50 (T) days (or .137th of a year), an annual risk free rate of 7% (r), and a standard deviation of annual returns of 35%. The values for $N(d_1)$ and $N(d_2)$, which are very complex functions and include the standard deviation, are .4566 and .4058 respectively. We gladly will supply any reader with the details of the calculation. Substituting into equation 6:

$$C_t = S_t N(d_1) - Xe^{(-rT)} N(d_2)$$

$$C_t = (\$92 * .4566) - (\$95 * e^{(-.07*.137)} * .4058)$$

$$C_t = \$3.83$$

The call option value, based on the realism of the assumptions, is $3.83. Note that because the stock price is below the exercise level the intrinsic value is $0 with the entire $3.83 being associated with speculative value. The positive value is a reflection that at maturity the stock price may be above the exercise level based on the underlying volatility of the equity.

Financial instruments with options have existed for years. Warrants are long-lived options. Convertible bonds have an option feature to convert to equity. Since the global financial crisis, CoCo Bonds (contingent convertible) have come into vogue as a way to shore up the equity capital of a financial service business by having the option feature contingent upon some element of inferior performance. This feature ideally would reduce the financial leverage as losses hit the balance sheet. Catastrophe bonds issued by the insurance industry are another interesting financial instrument with an embedded option that allows the issuer to not pay back interest and principal subsequent to a natural disaster.

Option pricing also has played its way into what is known as risk indicators in capital markets. As an indicator of risk in capital markets, the VIX financial index is the volatilty measure in our equation 6. The VIX represents the implied volalility in options prices (i.e., the standard deviation that solves for the observable call option price with assumptions about the other drivers of option value). Another risk index is the so-called CBOE Skew index, or as some say the "Black Swan Index."

Using data inferred from out-of-the-money options (current market value below the exercise level), the Skew index attempts to identify tail risk. Think of this as an index to track the probability of the improbable. No doubt you may be rightfully skeptical. In fairness, academics and practitioners debate the inferential value of these indexes.

The reality is that many authors also would argue that equity itself is a call option on a levered firm. The option is the ability to have the right to all assets by paying off any debt. In this framework, the beta coefficient we introduced in critical equation 4 continually declines as the maturity of debt approaches (which is the time to maturity).

Real Options for Business Leaders

The basic premise of Real Options is the nature of a contingent decision. The decision or opportunity to invest occurs after you see how events have unfolded. The contingency exists because you may make alternative decisions from the new knowledge. Exhibit 4 includes basic managerial options that often follow revealed information.

Exhibit 4

Basic Managerial Options

Option to	*Description*
Abandon	Exit or Discontinue an unprofitable project (possible liquidate)
Defer	Wait for additional Information and/or when timing is favorable
Expand/Contract	Increase or Decrease scale/capacity as market conditions vary
Grow	Short-term product/services with potential for follow ups
Stage/Learning	Incremental and conditional phased investments sized to the probability of success
Switch	Alter mix of inputs and/or outputs

Each of these managerial options gives decision-makers the flexibility to respond to new information and can be modeled as a decision tree. There also is a direct link between managerial options and the basics of puts and calls. For example, the option to contract or abandon a project is a put option. The option to expand or grow a project is a classic call option. An option to defer is classic example of waiting to learn

Real Options analysis has found a fair degree of application in extractive industries, pharmaceuticals, high tech, and long-cycle businessess . Pilot programs and/or beta tests are examples of applied options. The reality is Real Options analysis may have an application any time a business has a contingent investment decision. Whether you recognize it or not, every business has a series of Real Options inherent in its product/service portfolio .

Historically, the most common application of options is in the use of Terms and Conditions to manage risk (i.e., a better alignment between contract risks and value). With regard to risk management, to the degree we can use options to manage uncertainty, the dial between controllable and uncontrollable risk can be moved toward the former. The valuation of movie sequels, upgrade options (multi-generational product/service plans), warranties, multiple suppliers, information technology, mineral rights and patents are all options. Even in cases of short-term failure in terms of market acceptance of a seed R&D project, there will be a technology on-the-shelf option for later deployment. Patents are a classic example because of the issue of expiration. Any global company that has invested in an emerging market has in effect taken out a call option on that country's growth

Conceptually, a Real Options perspective works best when a contingency exists in the investment path over time and when the level of uncertainty is significant enough to wait for additional information. The key for applications of Real Options analysis is that it allows your business to consider seed (potentially high-return and smaller) projects while becoming more agile. This should not only improve the value of your business but also make you responsive to your customers and suppliers because of your enhanced use of information. In responding to RFPs or RFQs, proper use of changing information can improve the probability of being selected. A Real Options perspective also is appropriate when your future growth is not in current and known outcomes such as cash flows. Finally, options are critical anytime one uses gated decisions and/or project updates that could result in strategic or tactical change. Exhibit 5 shows the Real Option analogy to the drivers of capital market options such as puts and calls.

Exhibit 5

Capital Market Options Vs Real Options

Capital Market *	Real **
Stock Price	***PV of Project Cash Flows***
Exercise Price	***Investment Cost***
Time to Maturity	***Time Opportunity Lasts***
Volatility of Stock	***Variance in Cash Flows***
Risk Free Interest Rate	***Time Value of Money***

*** Normally Exchange Traded** **** Not Usually Traded**

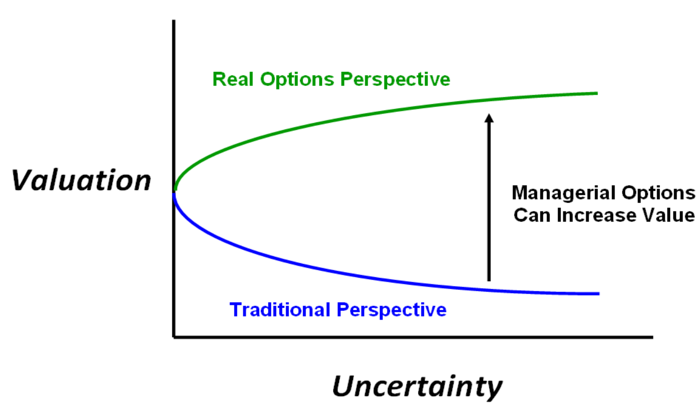
The exercise price is often a sunk cost in a Real Option application. Management would exercise the option if the present value (PV) of expected project cash flows exceeds the exercise level. This is one of the complexities in application because, unlike equity options that trade, the PV of project cash flows or the market value of underlying assets can be subject to significant uncertainty.

As Exhibit 5 notes, Real Options typically are not tradable (e.g., the owner of a factory may not be able to readily sell it). The option itself is probably not easily saleable or assignable (e.g., an airline has an option on the production skyline of an airframe manufacturer), and even if a secondary market did exist there is no guarantee of liquidity. Many of the drivers of Real Options are, in practice, very difficult to properly estimate and can lead to a wide range of estimates.

Exhibit 6 illustrates the primary difference between standard or traditional perspectives to project valuation and the Real Options perspective. With net present value (NPV) and internal rate of return (IRR) methods, as typically applied, is an assumption that one would never have any option or flexibility over time and that uncertainty as measured by volatility will decrease valuation. The Real Options perspective has valuation increasing as a function of volatility for the aforementioned reason of why variance increases option value.

Exhibit 6

Valuation and Uncertainty



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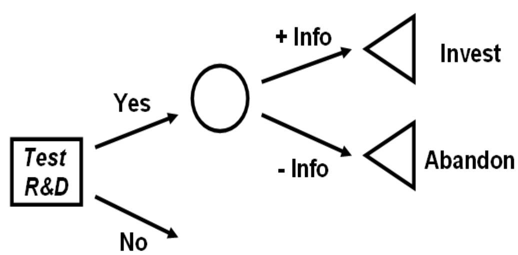
Decision trees are excellent tools for visualizing options and potentially reducing risk of failure late in a process. These visualizations depict the sequential choices that confront business leaders (assuming an open-minded dialogue has occurred on outcomes). Exhibit 7 is a simplified decision tree with an abandonment option. Squares represent decisions to be made, circles represent the arrival of new information (often called chance nodes in decision analysis), lines from squares are alternatives, and triangles are end nodes (which can include additional investment as well as an estimate of cash flows, thus the NPV that will exist from various options). In our example, the critical thinking perspective that is then forced is 1) to test or not test and 2) to invest or not invest.

Exhibit 7

Decision Tree and Real Options



Decision trees allow for the identification of points of new information with associated probabilities (in the overly simplified Exhibit 7, please keep in mind that testing does not ensure successful results and success in developing a technology does not imply the market is guaranteed). Admittedly, nothing is harder than estimating probabilities. (There is substantial evidence in many areas of study, including the experimental psychology area, that both individuals and teams will routinely overestimate the likelihood of an event.)

We suggest using historical data when available, with the caveat that the distribution may not reflect current reality. As examples, historical data can provide a range of probabilities of wining RFPs and the success of R&D investments. Decision trees also can be formulated in the format of tools such as Net Present Value (NPV). The reliance on the Real Option applications of modified variations of our equation 6 and its complexity goes away, without sacrificing the spirit of flexibility in decision making. There is a fundamental difference in option applications of decision trees vs. standard decision trees analysis, in that we assume one does act optimally with regard to the decision (see the section on the corporate culture necessary for effective implementation). To properly value a project with options in a decision tree format requires thinking from the future to the present, commonly referred to as backward induction.

Example of Applied Real Options

Let's look at abandonment as a Real Option. Knowing when to exit is never easy because commitments have been made for all types of resources. Marketing and R&D managers also have an inherent emotional bias to remain committed and not to pull the plug. This bias potentially can destroy shareholder value. Of course, abandoning in the short-term can give you an on-the-shelf option for the longer term.

Exhibit 8 gives the assumptions for a basic appropriation request (capital budget). Note that one year from today new information will arrive, whether the market will be higher or lower than originally planned.

Regardless of the new information the expected case is 10,000 units of volume per year forever. A standard NPV reveals a valuation of -$10,000 ([$10,000/.1] minus $100,000). The decision would be to reject the project because the NPV is less than zero and, in the strictest sense, would destroy shareholder value.

Exhibit 8

Real Options in Valuation

-Assumptions –

- Expected Unit Sales of 10,000 per year forever
- Expected Net Cash Flow is $1 per Unit Sold
- One Year from today, expected unit sales will either be revised up to 14,000 or revised down to 6,000 per year forever (this is concurrent to receiving the 10,000 at end of year 1)
- The cost today is $110,000 and the cost of capital is 10%
- The project can be abandoned for $90,000 at end of year 1

Implicit in our basic analysis is the assumption that we would never respond with any flexibility should it be logical to do so. For example, our original analysis assumes we will stay in the project forever. With the option to abandon, we need to value if this choice ever makes economic sense. When the new information arrives, one year from today, there are two equally likely outcomes. The present values of the cash flows will be revised upwards to $140,000 or downwards to $60,000. If the new information is such that the market is not as big as originally anticipated, the value to abandon of $90,000 exceeds the present value of remaining in the game of $60,000. The decision would be to abandon.

Herein lays a major difference with standard decision tree analysis, which is often incorporated into decision making under uncertainty. We will never go down the path of the non-economic solution. This is the result of application of the aforementioned backward induction process. The expected cash flow is $115,000 (not the $100,000 that would include the suboptimal path of $60,000). In addition, we expect to receive the $10,000 at the end of year 1 so the total cash flow is $125,000. The present value of the $125,000 is $113,636. The NPV with the option to abandon is thus $3,636.

The implication is, when allowing for the flexibility of the abandonment option, we have a positive NPV, and the project should be accepted, not rejected. The difference in the standard and option NPVs is $13,636, the value of the option to abandon. An alternative explanation of the embedded option value is that we are $30,000 better off by abandoning, and the probability of this outcome is 50% for an expected value of $15,000. This is the value at the end of year 1 -- its present value $15,000/(1.10) = $13,636. The abandonment value of $90,000 is itself a function of the alternative uses of whatever is sold off.

As seen in the hypothetical example, the NPV of the standard Discounted Cash Flow (DCF) is less than the NPV with the option to abandon. This will always be the case. Option value can only add to the base case standard NPV. The implication is standard NPV will always undervalue a project that has potential contingencies. Standard decision analysis does not properly eliminate inappropriate branches (e.g., assumes you stay in project when you should have exited).

A Culture that Drives Option Thinking – Making Real Options a Real Option

Getting appropriate and accurate information in a timely manner with time to act is crucial to a successful options culture. Businesses that are market leaders and enjoy economies of scale typically have been successful in having an options culture. As stated before, management must not only understand options but must be able to properly identify and/or create them. Knowing when to exercise (hold or fold) is crucial to making tough decisions. Access to capital also is critical to quickly absorb losses and/or invest for growth as new information arrives.

The culture should encourage a climate where experimentation is the order of the day or, as some say, celebrated. Cultures that create dream budgets and/or allow employees a percentage of their time for just thinking understand the value of options. Also critical to an options culture is never succumbing to complacency from success. Complacency when allowed in the door will reduce the probability of using options and identifying and solving new issues. Bureaucracy and hierarchy are prime impediments to a successful options culture. Nothing will stifle open communication and sharing of ideas more than bureaucracy and hierarchy. Growth will stall.

There are well-known obstacles to Real Options in practice. It can be very complex, difficult and time consuming. Numerous methodologies can be applied, and one may get very divergent results. It also is not unusual for applications to require the assumption of types of distributional reality (e.g., the distribution of cost, capacity, volume, etc). Distributional reality requires a very diverse and cross-functional team to model and/or mimic reality. Make sure the right people are in the room when using Real Options analysis, and it is not only the Quants.

No one can fully comprehend the impact of employees' having multiple jobs in their lifetimes, but it is fair to argue that a short-term mentality may be creeping into the behavior of many employees. The changing nature of the employer – employee contract, the speed at which resources are reassigned, and the growing portability of defined contribution pensions -- may be creating a scenario that is not optimal for people to share information, and where individualism trumps the team. These trends may not be good for a company trying to embed and develop an options culture.

Real Options analysis assumes that management is active in decision-making as new information arrives. A passive management will miss critical options and destroy shareholder value. Real Options analysis forces management to identify, as reasonably as possible, all potential outcomes and their likely response to each of the contingent scenarios. Responding means exercising the option to cutoff or mitigate negative outcomes and to promote or enhance for upside outcomes. A cross-functional team will reduce individual bias as well as maximize the probability the response to a future outcome will be the correct decision. Managers using an options perspective will not wait for 100% confirmation of information and are willing to make tough calls as needed.

Knowing when to hold and/or fold is crucial. Too much focus on the status quo and the short run vs. the long run will make you an effective leader within an options culture.

Options, Technical Sales and Long-Cycle Businesses

An area where the concept of contingency and options can be of significant value is in the bid-to-award phase of long-cycle sales. This is particularly true in transactions where the bid currency is different from the supplier's functional currency. For example, a U.S.-based domestic export business with a cost structure in dollars bids in the currency of its customer (we are assuming that a dollar bid would only shift the exchange risk from us to our customer). The award is contingent upon winning, which is not a certainty, and there is an exchange rate risk from bid to award because we have entered the bid in our customer's currency. A devaluation of bid currency during that time period, if left alone, could steeply reduce expected profitability.

Management has access to numerous hedging tools, and we need to identify the appropriate tools when cash flows are not certain but contingent upon winning. A standard forward contract, if implemented during a bid-to-award phase that we lost, could leave the business in a speculative position. Not a good day.

The most appropriate tool, given the contingent nature of the result, is a currency option that is the right, not the obligation, to hedge your currency. Exhibit 9 gives examples of four feasible outcomes. XYZ is assumed to be a U.S.-based business with a cost structure in dollars. If the bid-to-award phase was not hedged by an appropriate instrument and if the dollar strengthened during the 90 days (i.e., the pound weakened), the dollar value of the award would be reduced. Because the cost structure is in dollars, the anticipated profit margin eroded. This scenario is the equivalent of losing price, the worst possible profit lever.

Exhibit 9

Bid to Award Risk Matrix

- **XYZ Corp. places 10 million Pound Sterling Bid to Potential British Customer**
- **Contract will be awarded in 90 days**
- **XYZ Buys a 3-month Put Option on Pound Sterling paying a 2% Premium**

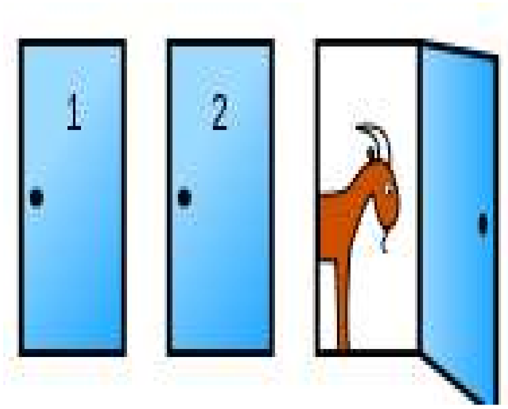
Scenarios for Protecting Bid Margin and Creating Upside
Size, Probability, Volatility vs. Margin, & # of Competitors (Location)

	XYZ Wins Bid	XYZ Loses Bid
£ Appreciates 10%	*Enhanced Margin Do Not Exercise +8%*	*Do Not Exercise -2%*
£ Depreciates 10%	*Margin Protected Exercise -2%*	*Exercise +8%*

The Value of Revealed Information and the Monty Hall Problem

One of the most captivating, puzzling and controversial applications of an option to switch, in the context of revealed information, is in the infamous Monty Hall problem. The Monty Hall problem has intrigued us for decades and even was at the heart of the movie "21". The basic version of the problem is illustrated in the three doors in Exhibit 10. Behind two of the doors are goats. Behind a third is a car. The assumption is the contestant wants to win the car not the goat. The contestant chooses one of the doors (e.g., 1), and then Monty reveals a goat (see door 3 below). The contestant then has the option to stay with door 1 or switch to door 2.

Exhibit 10



Then the debate begins. In a typical executive education program, at least 90% of participants will suggest staying or that it does not matter (i.e., the probability of winning is only 50%). The reality is that by exercising the option to switch you will win 66.6% of the time. The crux of the discussion is in the issue of revealed information. Did Monty reveal any valuable information when the goat behind door 3 was revealed? The answer is yes. This is no different than being in on the ground floor of an R&D investment and finding out the market will be better than anticipated or worse and we should abandon.

Assuming we could continually replay the game, if one had a plan of picking a door and always sticking with that plan (in Real Options, never exercising managerial flexibility as new information came in) one would win 33.3% of the time. The only other viable option would be to always switch. The sums of the probabilities of both mutually exclusive strategies must be 1.Therefore the probability of the switching strategy has to be 66.6%.

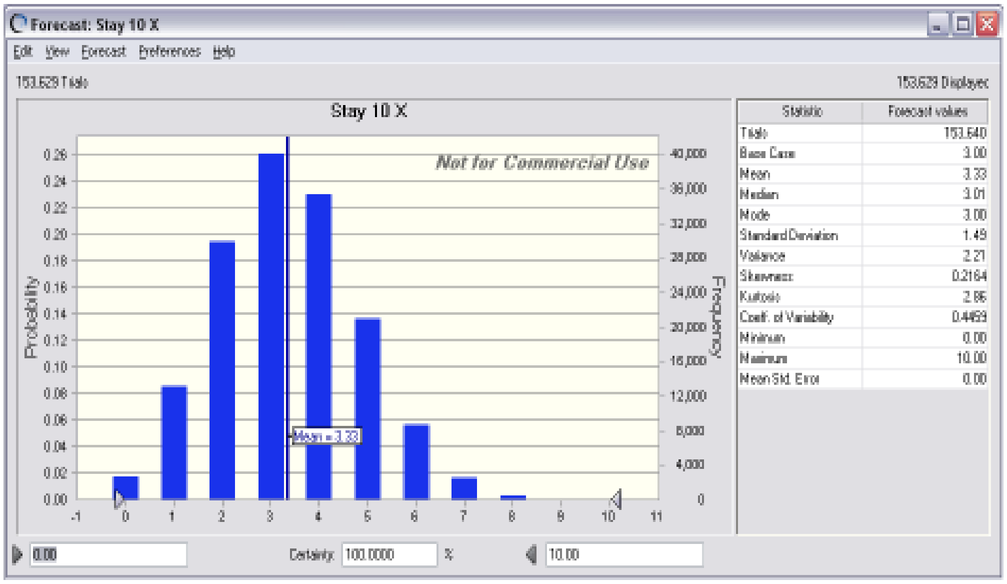
From our executive education programs over many years, our best estimate is that half of any class is believers. For the nonbelievers and/or skeptics, we look at the one-million-door example. A participant chooses one door of the million, and Monty then reveals 999,998 goats (two doors are left closed, the original choice and one more). Would you switch under those circumstances? Have I revealed any information? In reality, I took you to the solution because if you did not switch you are betting that you can pick the car with a one-in-a-million probability, and most of us are not taking that bet. It's all about the arrival of new information and understanding how to assess it properly.

When you ask the participant if they would sell their option at a premium once the goat is revealed, naturally they say of yes and should realize that the real value was in being in on the ground floor or at the seed level of the investment. Buying in after the fact can be very expensive.

If you are still a nonbeliever or skeptical of the solution we posit, we totally understand and can only suggest that you play the game with a friend 25 to 30 times and keep a record. Exhibit 11 depicts the results of a Monte Carlo simulation that has played the game more than 150 million times. The results depict the stay strategy. Specifically, the game is played ten times at once (note in the Exhibit the 153,629 trials). Within a trial, if the stay strategy wins four times it is embedded within column 4.

Note the mean value is the aforementioned 3.33 and that 5 or greater is much less than 50% for those who feel 50% is the correct solution. In almost 4000 trials, playing 10X at once, always switching won every time. While the stay strategy hit 10 out of 10 at least one time.

Exhibit 11



A Monte Carlo simulation also is an appropriate tool for your team to be familiar with in applications of Real Options. This tool is best used in a diverse and cross-functional team to properly model distributional reality critical to accurate option value.

For those who still are nonbelievers, run the simulation yourselves but think hard about the value of new information. Our Critical Equation 7 for Business Leaders on Bayesian probability will re-examine the Monty Hall problem.

Summary

In a globally complex and ambiguous environment, the winners will be companies that recognize the criticality of flexibility in making decisions, being alert to the arrival of new information, and inculcating options thinking. We explored the basics of options, in particular calls, the right to buy at a specific price within a given time period. These are the familiar capital market options with incredible leverage. For the operational business leader, the equivalent of capital market options is known as ***"Real Options."*** These are options to expand, contract, or defer -- all thought of as a contingent claim. While many business leaders would claim to have flexibility built into their internal processes, such as appropriate requests and/or capital budgets, this is not the reality we often observe.

A fascinating book *"Little Bets"* by Peter Sims (Free Press, 2011) has excellent examples of Real Options. The book's theme is that little bets primarily are for learning while subsequent big bets bring the value home in the market.

How are you instilling considerations of options in your business? How many times have you really pulled the plug or let things continue that ultimately destroyed shareholder value?

If you are not charging for options you extend, you are leaving money on the table. Never give away a free option and do not get on the wrong side from selling one. Identify every option you give to anyone in your value chain and ask *“Why is this being given away? Can we charge for it and if not why?”*

The power of understanding, applying and having “Options” around flexibility improves the potential for profitable growth.

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