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Διπλωματική Εργασία

REAL OPTIONS APPROACH AS A MODEL TO COMPANY VALUATION

της

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ABSTRACT

This study aims to contribute a better understanding of real options. My extensive elaboration distinguishes types of real options, classification for corporate real growth options, real options with market and private risks, real options as a complement, functions of real options, real options on project-level and management-level. Moreover, it addresses and elaborates on several noteworthy valuation approaches and it combines real options analysis with DCF method. In addition, a practitioner's guide for company valuation and a four step process for valuing real options are elaborated in depth.

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CHAPTER 1
INTRODUCTION

According to John Seely Brown,

"Fundamental changes are under way in the world of business….The accelerating pace of change is real…With this shift, we are finding many of our background assumptions and time-honored business models inadequate to help us understand what is going on, let alone how to compete."

Business development requires making investment decisions filled with uncertainty. Managers by instinct know that they must undertake and manage investments by changing subsequent plans according to market conditions. There is also a gap between what managers know and current tools. Managers know that standard financial tools don't work for strategic investments, transaction valuations, and strategic vision. Strategically significant projects often fail internal financial tests. In other words, internal strategic investment opportunities don't be linked by current tools.

"As a practical matter, many managers seem to understand already that there is something wrong with the simple NPV rule, as it is taught that there is value to waiting for more information, and that this value is not reflected in the standard calculation. In fact, managers often require that an NPV be more than merely positive…..It may be that managers understand a company's options are valuable, and that it is desirable to keep these options open."

The real options approach is the extension of financial option theory to options on real assets. Real options embedded in strategic investments must be identified and specified. In contrast, financial options are detailed in the contract. Moving from financial options to real options requires a way of thinking, which brings the discipline of the financial markets to internal strategic investment decisions. Stewart Myers coined the term "real options" to bridge the gap between strategic planning and finance. [1]

This study focuses on obtaining a theory on the application of real options to company valuation model. This theory should answer the question when real options theory should be applied and how it could be applied. In addition, this study focuses on obtaining a model, which operationalises this theory.

[1] *Amram, M. & Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.*

The study consists of seven chapters. The reader would be familiar with real options approach after reading the study and he could use it as a practitioner's guide. In the first chapter, there is the abstract and we have introduced the importance of real options method, our research goal. In the second chapter, we will cite definitions and value drivers of real options. Furthermore, we will analyze real options as a way of thinking. In the third chapter, we will quote types of real options, market and private risks, functions and quantifications method of real options. We will include a section about how to use real options as a complement. This chapter will give answers about when and how real options theory could be applied to improve the valuation of companies.

In the fourth chapter, we will analyze DCF valuation methods which can be used in combination with real options theory. For example, the enterprise Discounted Cash Flows model, Static NPV and Future Assets in Place. In the fifth chapter, we will analyze which functions of real options approach to improve the valuation of companies should be operationalised. In the sixth chapter, we will cite real options value in a company valuation model. In addition, we will analyze whole process to company valuation via the real options approach as a practitioner's guide. In the final chapter, we will discuss the conclusions and the limitations.

CHAPTER 2
BIBLIOGRAPHY OVERVIEW

Myers (1977) first stated the original definition of real options. According to first definition, real options are opportunities to purchase real assets on possibly favourable terms. Black and Scholes (1973) presented their famous option-pricing formula for European financial options. Black and Scholes financial option theory could be the basis for valuation of other assets.

Finance theory has had scant impact on strategic planning. Strategic planning needs finance and should learn to apply finance theory correctly. Myers (1984) explained the gap between finance theory and strategic planning. Even if discounted cash flow analysis is properly applied, it may not be accepted and it may fail in strategic applications. In the DCF approach, managers are usually nurture relatively low-valued NPV projects for strategic reasons. This creates a gap between strategic and financial analyses. Smart managers don't accept positive or negative NPVs unless they can explain it.

A first step closing the gap between traditional corporate finance and strategic planning is given by Smit & Trigeorgis (2004). According to them, strategic decisions must be made and adjusted throughout the process of creating business value. The capability of management to identify and flexibly exploit available options maps the embedded growth option value. Executives must be flexible in decision making for successfully responding to technological and competitive challenges.

According to Trigeorgis (1993), academics and practitioners have recognised that standard DCF approach often undervalues investments with real operating options and other strategic interactions. As a result, many corporate managers overrule passive NPV approach and use intuition and executive judgement to value future managerial flexibility.

Copeland and Antikarov (2003) suggested to review NPV carefully becayse it is the base for real options analysis. In addition, they summarized the empirical evidence that compares traditional method with real options and they concluded that real options approach is a superior approach to traditional DCF approaches. Especially they mention that real options would replace traditional approach as the central paradigm for investment decisions in ten years. However, DCF analysis is still the most popular capital budgeting method.

Dixit and Pindyck (1994) emphasized that DCF analysis do not recognise the factors in a project's capital budgeting decision. These factors are irreversibility, uncertainty of future

rewards and timing or staging among investment decisions. Koller, Goedhart, and Wessels (2010) refer that option pricing methods are preferable than traditional DCF analysis.

According to Amram and Kulatilaka (1999), DCF analysis doesn't link internal strategic investment criteria and transaction opportunities in product and financial markets. Real options can be used to value simple capital budgeting decisions that are closely related to the financial markets. These decisions can be valued by real options using standard option-pricing formulas. However, as complexity and distance from the financial markets increase, customised real option approach, as a model to company valuation, is necessary (Amram & Kulatilaka, 1999). However, there are some problems associated with using real options.

Borison and Triantis (2001) categorize real option's functions into the three classes. Real options are a way of thinking, an analytical tool for decision making and an organisational change process. Real options are used primarily as a language that applies a border and communicates decision problems qualitatively. Most companies that have shown broad interest in real options theory are engaged in either the energy sector or life sciences, sectors where large investments with uncertain returns are commonplace. Before real options could breakthrough, managers seem to demand a need for more information, as seen in both the energy sector and the life sciences industry. Furthermore, if executives are not familiar with analytical tools, they seem to demand a more friendly application as capital budgeting technique.

However, there is still some major critique on the use of real options. Real options analysis is the next step forward in the capital budgeting decision and that large scale application among executives is just a question of time. The critique is mainly twofold. It is both focused on the wrong application of real options approach and on the use of real options in the wrong situations.

Therefore, as a lot of authors prefer real options analysis than standard NPV it is not clear that real options approach will replace DCF techniques within the field of capital budgeting. In some situations such as complex capital budgeting challenges it is extremely difficult real options analysis to replace DCF method. It may be that the bundles of assets and opportunities that companies own cannot be practically valued as options. However with better insights, analysts could apply real options approach in the right way to the right situations.

CHAPTER 3
REAL OPTIONS

Life can be understood backward, but.....it must be lived forward" - Soren Kierkegaard (1813-1855).

3.1 Real Options

In this section we will give you a broad review of the real options literature and definition.

3.1.1 Literature

In 1977 Myers first coined the term "Real Options". Then literature within the field of real options theory expanded very quickly. In 2005 it is estimated that there were approximately 1000 research papers about this theory. The most important contributors to the real options theory are Stewart C. Myers, Avinash K. Dixit and Robert S. Pindyck, Thomas E. Copeland, Alexander J. Triantis, Lenos Trigeorgis, Timothy A. Luehrman, Martha Amram.

Stewart Myers is the creator of this field of interest and has done several follow-up studies. Avinash Dixit and Robert Pindyck have done a lot of research together into investment under uncertainty. Thomas Copeland is an expert in financial decision making, with a lot of work-related experience. Alexander Triantis has published articles as of 1990 to date, of which several are published in the Journal of Applied Corporate Finance. Lenos Trigeorgis is also a great contributor to the real options theory, with research on real options and strategy, using game-theory, and research on the simplification of real options valuation methods. Timothy A. Luehrman conceived the idea of treating a business strategy as a series of options and published two widely quoted articles in the Harvard Business Review. Finally, Martha Amram has written some important articles published in the Harvard Business Review and the Journal of Applied Corporate Finance and as well publishing a highly recommended book.

3.1.2 Definition

Myers first stated that a real option is a decision opportunity for a corporation or an individual. A real option is the right to take an action in the future, rather than an obligation. Right's value is contingent on the uncertain price of some underlying asset. He coined the term real options to address the gap between strategic planning and finance. He believes that *"Strategic planning needs finance. Present value calculations are needed as a check on strategic analysis and vice versa. Standard discounted cashflow techniques will tend to understate the option value attached to growing profitable lines of business. Corporate finance theory requires extension to deal with the real options".* [2]

Dixit and Pindyck define real options as an opportunity to obtain real assets. Real option investments are characterised by sequential, irreversible investments made under uncertainty conditions. They explain that real options are based on an important analogy with financial options. A company with an opportunity to invest is holding something much like a financial call option: it has the right to buy an asset at a future time of its choosing. The company has the right but not the obligation.[3]

Panayi and Trigeorgis explain that real options involve discretionary decisions or rights, with no obligation, to acquire or exchange the value of one asset for a specified value or price. Trigeorgis explicitly states that managerial flexibility is a set of real options. He suggests the use of option-based techniques to value the managerial flexibility implicit in investment opportunities. [4]

According to Triantis, real options are opportunities to delay and adjust investment and operating decisions over time in response to the resolution of uncertainty. [5] Another study performed by Borison and Triantis gives us the valuable insight that under practitioners there are different interpretations of the term real options. They deviced three categories of interpretations, real options as a way of thinking, real options as an analytical tool and as an organisational process. In each category corporate decision-making is improved by a better understanding of the role of uncertainty on investments.[6]

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[2] Myers, S. C. (1977), "Determinants of corporate borrowing", Journal of Financial Economics, 5, 147-175.

[3] Dixit, A. K. and Pindyck, R. S. (1994), "Investment under Uncertainty", New Jersey: Princeton University Press. Dixit, A. K. and Pindyck, R. S. (1995), "The Options Approach to Capital Investment", Harvard Business Review, May-June, 105-115.

[4] Panayi, S. and Trigeorgis, L. (1998), "Multi-stage real options: The cases of information technology infrastructure and international bank expansion", The Quarterly Review of Economics and Finance, 38, 675-692.

[5] Triantis, A. J. (2000), "Real Options and Corporate Risk Management", Journal of Applied Corporate Finance, 64-73.

[6] Borison, A. and Triantis, A. J. (2001), "Real Options: State of the practice", Journal of Applied Corporate Finance.

Amram and Kulatilaka use two definitions: in a restricted way, the real options approach is the extension of financial option-pricing models to the valuation of options on real (that is, non-financial) assets. More broadly, the real options approach is a way of thinking that helps managers formulate their strategic options, the future opportunities that are created by today's investments".[7]

Copeland and Antikarov define real options as the right, but not the obligation, to take an action (e.g. deferring, expanding, contracting, or abandoning) at a predetermined cost called the exercise price, for a predetermined period of time, which is the life of the option. [8]

According to Timothy A. Luehrman, real options theory could be used for valuing strategic decision-making. He describes that real options capture the value of managerial flexibility to adapt strategic decisions in response to unexpected market developments. Companies create shareholder value by identifying, managing and exercising Real Options associated with their investment portfolio. The real options method applies financial options theory to quantify the value of management flexibility and leverage uncertainty in a changing world". [9]

The definition of Martha Amram and Nalin Kulatilaka explain the development of the term real options. Real options are based on an important analogy with financial options, real options are rights and not obligations related to a company's assets. Real options are also a way of thinking that helps managers formulate their strategic options, the future opportunities that are created by today's investments. Real Options and Derivatives thinking will change the structure of many industries. [10]

3.1.3 The Real Options Approach is a Way of Thinking

According to Amram and Kulatilaka, introductions of the real options approach have too much focused on the technical aspects of modelling and as a result, it has been neglected that real options approach is a way of thinking. The real options approach provides an important perspective on value creation in an uncertain world. This way of thinking has three components that are of great use to managers.

[7] Amram, M. and Kulatilaka, N. (2000), "Strategy and shareholder value creation: The real Options Frontier", Journal of Applied Corporate Finance, 13.2 (Summer), 15-27.
[8] Copeland, T. E. and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", U.K. Thomson Texere.
[9] Luehrmam, T. A. (1998), "Strategy as a portfolio of real options", Harvard Business Review, September-October 1998, 89-99.
[10] Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.

Options are contingent decisions

The payoff to an option is nonlinear because it changes a decision which is taken depending on whether the events have turned out well or bad. Fixed decisions have linear payoffs because they are implemented no matter what happens.

Options valuations are aligned with financial market valuations

In the real options approach, financial market inputs and concepts are used to value complex payoffs across all types of real assets. The outcome of this method is a comparison of managerial options, market alternatives and internal investment opportunities and transaction opportunities. In other words, the result is a probability of joint ventures, acquisitions and technology licenses.

Options thinking can be used to design and manage strategic investments proactively

The nonlinear profits can also be a design tool, which could give the ways payoff to be increased or the exposure to uncertainty to be reduced. Firstly, we must identify and value the options in a strategic investment and then redesign the investment to better use the options. Finally, the last step is to manage the investment proactively through the options created. [11]

3.1.4 Value Drivers

Firstly it is necessary to explain what is the structure of an option. "*Call Option*" and "*Put Option*" are the basic types of options.

A *Call Option* is an option to buy a certain asset by a certain date for a certain price, the strike price. At the time of exercise, the profit is the difference between the underlying asset's value and the exercise price. When the price of the underlying value is above the exercise price, we have an immediate profit by exercising the option. This option is "in the money". When the price of underlying value is below the exercise price, the option is "out of the money".

[11] *Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.*

A *Put Option* is an option to sell a certain asset by a certain date for a certain price, the strike price.

Options could be distinguished as either European or American. European options can be exercised only on their maturity date. American options can be exercised at any time during their life. Two options have the same underlying asset, strike price and time to expiration. There are times when the right to early exercise is worthless, so American and European options have the same value.

C_{Amer} (S, K, T) $\geq C_{Eur}$ (S, K, T)

P_{Amer} (S, K, T) $\geq P_{Eur}$ (S, K, T)

S= Value of the underlying asset

K= Exercise price

T= Time to expiration

There are a number of variables relating to the underlying asset and financial markets that drives the real options analysis value.

The value of the underlying risky asset

In the case of real options, this is a project, investment, acquisition or any real asset that is under consideration. This value is influenced by the financial markets. Changes in the value of the underlying asset affect the value of the options on that asset. If the value of the underlying asset increases, the value of a call option will go up too. The owner of a financial option cannot affect the value of the underlying. That's the important difference between financial and real options. The management which operates a real asset can increase its value. The rise in the value of real options depends on this asset.

The exercise price

The amount of money someone needs to invest, starting an investment, in case someone else wants to execute a real option, finalizing an acquisition. In case of call option, it is the amount of money to exercise the option if someone is buying the asset. In case of put option, it is the

amount of money received if someone is selling it. An increase in the exercise price will increase the value of the puts. Calls, in contrast, become less valuable as the exercise price increases. In financial option pricing, we are familiar with the exercise price, as it can be found in the option contract. In real options, the exercise price can also easily be found if the investment amount or salvage value are fixed or determined in a contract. In contrast, in the event that an investment is still being considered, we can suppose that the exercise price amounts to the present value of future investments. Also, by raising the number of decision points, we create a "compound Real Option". However, the uncertainty of future investments renders exercise prices for Real Options stochastic.

Time to Expiration

Wikipedia defines it as the expiration date of an option contract is the last date on which the holder of the option may exercise it according to contract's terms. Both put and call options become more valuable as the time to expiration increases. The longer time to expiration time furnishes more time for the value of the underlying asset to move, going up the value of both types of options. In case of call options, the buyer must pay a fixed price at expiration and the present value of this fixed price decreases as the life of the option increases, so the value of the call increases. [12]

Triantis (1999) mentions that it is reasonable to assume that exercise price for many investment projects will go up with the risk free rate of interest, and this will neutralise the benefit of a longer time to expiration. In addition, if there is an expected "leakage" in the present value of the underlying asset or opportunity, (which can be modelled with a dividend payout), then the longer the time to expiration, the larger the decrease in the present value of the underlying asset.[13]

According to McDonald, if the options are American, the price of the option can never decline with an increase in time to expiration. If the options are European, the option price can go either up or down as the time to expiration increases. [14]

The standard deviation of the value of the underlying risky asset

In case of a real option, the riskiness of the underlying asset, which will increase its volatility, leads to an increase in real option's value. It happens because the payoffs of a call option

[12] *http://en.wikipedia.org/wiki/Expiration_%28options%29/*
[13] *Triantis, A. J. (1999), "Creating and Managing Shareholder Value: A View Through a Real Option Lens".*
[14] *McDonald, L. Robert (2003), "Derivatives Market", USA, Addison Welsey.*

depend on the value of the underlying exceeding its price and the probability of this increases with the volatility of the underlying. The volatility is often the variable which has the biggest impact on option value.

Volatility is measured as the standard deviation of the rate of return of the underlying asset. It is common to express the volatility as an annual figure. When the volatility is 25%, it is usually meant that the volatility is 25% per year.

In case of a real option, the underlying asset is usually not traded in the market. It is not easy to find historical data about the real asset's market value. According to Luehrman (1998), we can estimate the volatility through an educated guess or through a twin security or historical data, or through a simulation model. Furthermore, Hevent (2001) accepted that a general method for an estimated guess begins with isolating the primary source of uncertainty. The volatility could be derived from the following set of equations through an estimation of the asset's value up (u) and down movements (d). An underlying normal distribution is assumed,

$u=e^{\sigma}$ $\quad$ $d=1/u$

Davis (1998) believes that we can estimate the volatility from a historical series of unlevered company values using companies with identical projects. Copeland and Antikarov (2001) analyse a method where the projected cash flows for the project are used to make a Monte Carlo simulation of the project's returns. This could be used to estimate the project's volatility. On the other hand, Pindyck and Majd (1987) note that it may be impossible to estimate the volatility correctly. Dixit and Pindyck (1994) take into account that the volatility is the average percentage standard deviation of stock market equity. It means about 20% to 30%.

The risk free rate of interest over the life of the option

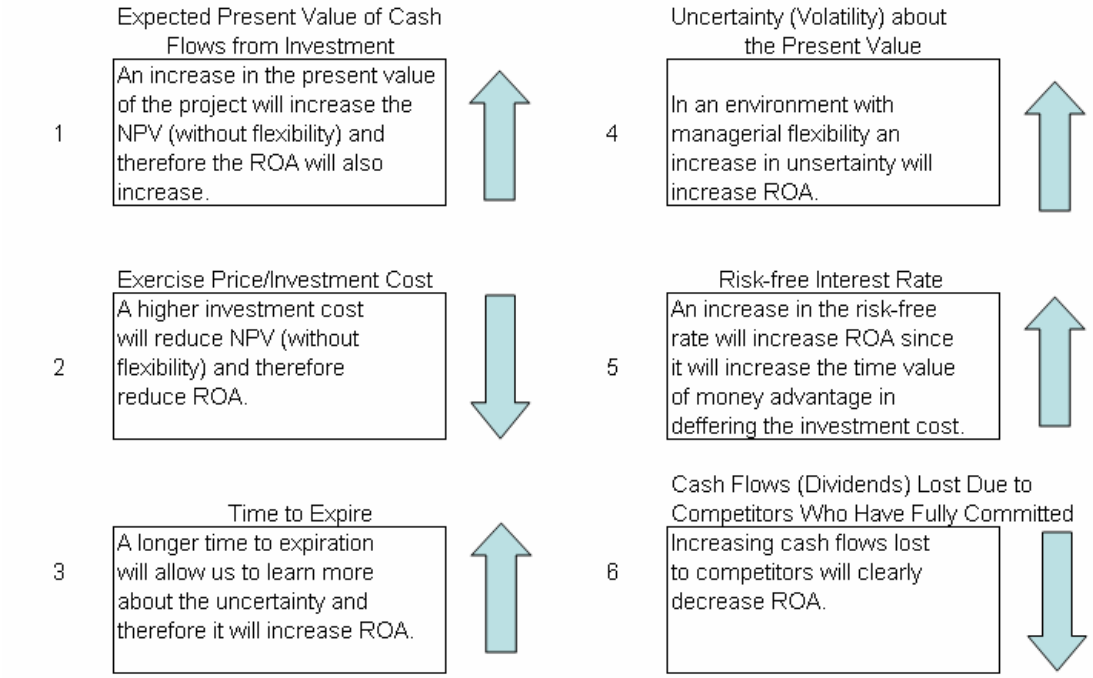
The risk free rate of interest is the theoretical rate of return of an investment without risk. The value of the option has the same direction with the risk free rate. If the risk free rate increases, the option's value will go up too.

Dividend

Dividend is a payment to the shareholders usually as a distribution of profits. Not all companies pay dividend, and that's why this variable is not always relevant in financial option

pricing. Although real assets do not pay dividends, this variable is very important. In real options, a dividend is a cash outflow from the real asset. Therefore, it decreases the value of the asset.

All variables are illustrated in table below:



Source: Copeland, T. E., Koller, T. and Murrin, J (2000), "Valuation, Measuring and Managing the Valuation of Companies", 3rd edition, New York, Wiley & Sons, 2000.

Triantis (1999) shows in a table the directions in which these drivers affect call and put option values, for example an increase in exercise price decreases the value of a call option and increases the value of a put option. With a financial option, it is reasonably assumed that the holder of the option cannot influence the value of the option, other than to ensure that it is exercised optimally. Finally, the exercise price and time to maturity are specified in the option contract, and the holder can (legally) do nothing to affect the price path of the underlying asset. Contrary to that, there are many ways to affect real option, and thus shareholder, value. The six value factors listed will be examined in greater detail to determine how each may be used as a lever to control option value. [15]

[15] *Triantis, A. J. (1999), "Creating and Managing Shareholder Value: A View Through a Real Option Lens", Real Options and Business Strategy: Applications to Decision-Making, p.39-58.*

Effect of an increase in six key value drivers on call and put option values		
Option value driver	**Call Option**	**Put Option**
Underlying asset value	Increase	Decrease
Exercise price	Decrease	Increase
Time to maturity	Increase	Increase
Volatility	Increase	Increase
Risk-free interest rate	Increase	Decrease
Payout rate	Decrease	Increase

Source: Triantis, A. J. (1999), "Creating and Managing Shareholder Value: A View Through a Real Option Lens", Real Options and Business Strategy: Applications to Decision-Making, p.39-58.

3.1.5 Identifying a simple option

Someone has the opportunity to buy a toy bank with one euro today and there is guarantee that he will take euro 1,05 one year later with absolute certainty. In the same period interest rates at the real bank are 10%. I wonder how much the toy bank is worth.

Wrong Answer NPV-No Flexibility	The toy bank is worthless because you can earn 10% by putting your money in the bank instead of earnings 5% with the toy bank (problem:this assumes that the interest rate never changes)
Right Answer Total Value with Flexibility (ROA)	The toy bank is valuable because it is an option (you have the right, but not the obligation, to use it) and because interest rates are uncertain. There is a chance that the rate will fall below 5%. When it does, the option is valuable and will be exercised (the uncertainty in the interest rate is the key to understanding the problem.

NPV is misleading because it does not consider the option/flexibility value this toy bank offers.

Source: Steve Ross, Sterling Professor of Economics and Finance at Yale University.

CHAPTER 4
REAL OPTIONS, FUNCTIONS AND QUANTIFICATION

In this section we will give you a broad review of the types of the real options and the methods of quantifying these will be cited.

4.1 Types of Real Options

Copeland and Antikarov (2003) mention that real options are classified mainly by the type of flexibility that they offer. An option is the right and not the obligation to invest in a project in the future. The indicate five types of real options:

Option to defer

A *deferral option* is an American call option which we can find in most projects in which someone has the right to delay the start of a project. The exercise price of deferral option is the amount of money invested in getting the project started.

Option to abandon

The *option to abandon* a project for a fixed price is formally an American put where one has the right to exit a project. The exercise price in this case is the amount payable for abandoning the project.

Option to contract (scale back)

Option to contract is an American put where someone has the right to sell a fraction of it for a fixed price, that is the exercise price, which is thus the amount of potential cost savings.

Option to expand

The option to expand investments and increase the output if conditions are favorable is the *Option to expand,* an American call in which someone has the right to scale up the project's

activities for a fixed price. This price is the exercise price, the amount of the money payable for expanding a project.

Option to extend

The option to make longer the life of a project is the *option to extend.* This kind of option could be constructed as an American call, in which someone has the right to extend the life of an asset. The direct cost involved with extending the life of the project is the exercise price.

Copeland and Antikarov (2003) add more kinds of real options which are classified by type of combination of options. This classification is primarily concerned with the modelling structure.

Switching options

These options are portfolios of American call and put options that allow their owner to switch at a fixed cost between two modems of operation.

Compound options

There are options on options which are called *compound options*. This category consists in phased investments. When one sets out an investment, he can choose to do so in phases. He has the option to stop or defer the project at the end of each phase. Each phase is an option which is contingent on the earlier exercise of another option. In other words, options on options.

Rainbow options

Options driven by multiple sources of uncertainty are called *rainbow options*. The option value is dependent on two or more underlying variables, price of a unit of output and the quantity that might be sold and on uncertain interest rates that affect the present value of the project. Many real world applications demand modelling as *compound rainbow options.*

Lenos Trigeorgis mentions one more type of options, corporate growth options.

Corporate growth options

Another version of the option to expand of considerable strategic importance is *corporate growth options.* They set the path of future opportunities. Many early investments can be seen as prerequisites or links in a chain of interrelated projects. The value of these projects may derive not so much from their expected directly measurable cash flows, but rather from unlocking future growth opportunities such as a new generation product or process, access to

a new market or strengthening of the firm's core capabilities and its strategic positioning. For example, an opportunity to invest in a first generation high tech product is analogous to options on options.

Although Net Present Value (NPV) may look negative, the already established infrastructure, experience acquired as well as the potential of first generation products may allow the business to bounce back by offering lower cost, by making quality improvements on first generation products or by diversifying. However, all subsequent generations are contingent on the firm making that initial investment. Factors which can give a firm a competitive edge are infrastructure and acquired experience, which can be proprietary, as well as learning cost curve effects. There are growth options in all industries, especially high tech, R & D, or those with multiple product generations or applications (e.g., semiconductors, computers, pharmaceuticals), in multinational operations, and in strategic acquisitions.

Common Real Options

Category	Description	Important in	References
Option to defer	Management holds a lease on (or an option to buy) valuable land or resources. It can wait x years to see if output prices justify constructing a building or a plant or developing o field.	All natural-resource-extraction industries, real estate development, farming, paper products.	McDonald and Siegel 1986 Paddock et al 1988 Tourinho 1979 Titman 1985, Ingersoll and Ross 1992
Time to build option (staged investment)	Staging investment as a series of outlays creates the option to abandon the enterprise in midstream if new information is unfavorable. Each stage can be viewed as an option on the value of subsequent stages and valued as a compound option.	All R&D intensive industries, especially pharmaceuticals, long development capital intensive projects (large-scale construction or energy-generating plants) startup ventures.	Majd and Pindyck 1987 Carr 1988 Trigeorgis 1993
Option to alter operating scale (to expand, to contract, to shut down and restart)	If market conditions are more favorable than expected, the firm can expand the scale of production or accelerate resource utilization. Conversely, if conditions are less favorable than expected, it can reduce the scale of operations. In extreme cases, production may be halted and restarted.	Natural-resource industries (e.g. mining) facilities planning and construction in cyclical industries, fashion apparel, consumer goods, commercial real estate.	Trigeorgis and Mason 1987 Pindyck 1988 McDonald and Siegel 1985 Brennan and Schwartz 1985
Option to abandon	If market conditions decline severely, management can abandon current operations permanently and realize the resale value of capital equipment and other assets on secondhand markets.	Capital-intensive industries (e.g airlines, railroads) financial services, new product introductions in uncertain markets.	Mayers and Majd 1990
Option to switch (outputs or inputs)	If prices or demand change, management can change the output mix of the facility (product flexibility) Alternatively, the same outputs can be produced using different types of inputs (process flexibility)	Output shifts: Any good sought in small batches or subject to volatile demand (e.g. consumer electronics) toys,specialty paper,machine parts autos Inputs shifts: All feedstock depedent facilities,electric power,chemicals,crop switching, sourcing.	Margrabe 1978 Kensinger 1987 Kulatilika 1988 Kulatilika and Trigeorgis 1994
Growth options	An early investment (e.g. R&D,lease on undeveloped land or oil reserves, strategic acquisition, information network) is a prerequisite or a lonik in a chain of interrelated projects, opening up future growth opporunities (e.g. new product or process, oil reserves, access to new market, strengthening of core capabilities). Like interproject compound options.	All infastructure based or strategic industries, esp. high tech, R&D,and industrieswith multiple product generations or applications (e.g. computers, pharmaceuticals) multinational operations, strategic acqusitions.	Myers 1977 Brealey and Mayers1991 Kester 1984,1993 Trigeorgis 1988 Pindyck 1988 Chung and Charoenwong 1991
Multiple interacting options	Real life projects often involve a collection of various options. Upward potential enhancing and downward protection options are present in combination. Their combined value may differ from thw sum of their separate values, i.e they interact. They may also interact with financial flexibility options.	Real-life projects in most industries listed above.	Trigeorgis 1993 Brennan and Schwartz 1985 Kulatilika 1994

Source: James, Alleman and Eli, Noam (2002), "The New Investment Theory of Real Options and its Implications Economics".

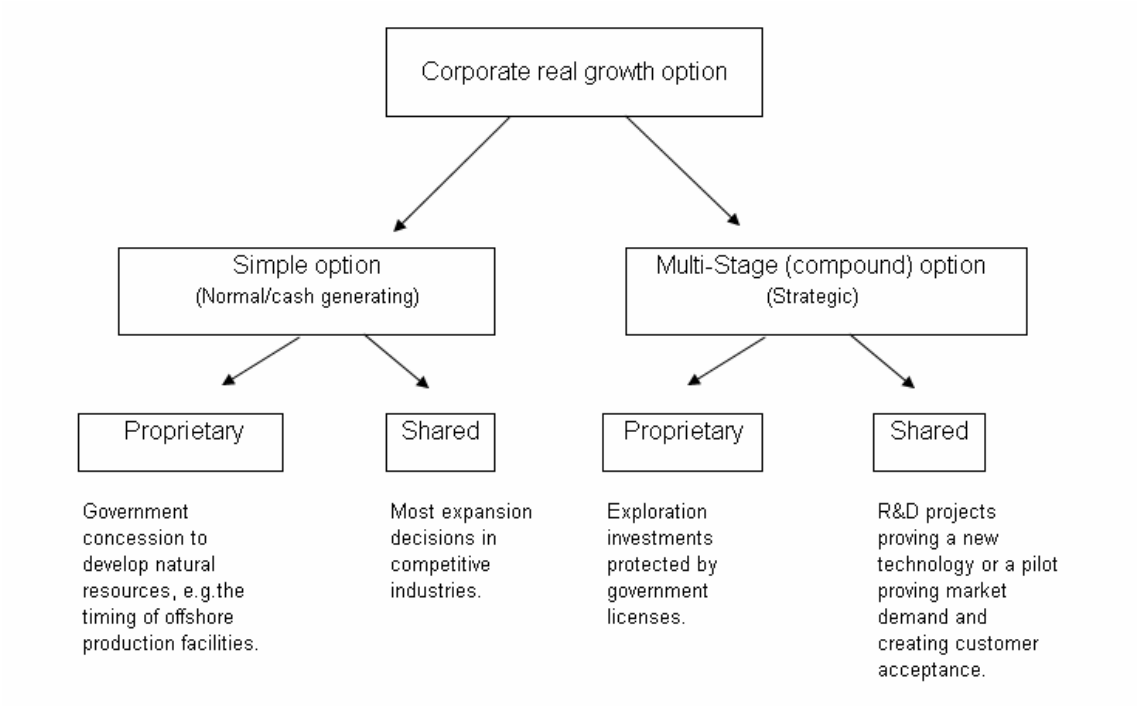
4.2 Classification for Corporate Real Growth Options

Smith and Trigeorgis (2004) state that the internal resources and capabilities of a firm are explicitly linked to environmental opportunities. Companies that use their internal strengths in exploiting environmental opportunities while motivating in a prudent, staged fashion, are more likely to gain competitive advantage. Tangible assets may have a lot of option to expand, but intangible assets such as knowledge and experience depend on the generation of future growth options for the firm. The management knows which are its internal strengths and how it can link them with external opportunities to enhance the company's strategic competitive advantage.

The intangible value of investments, which make up a part of a company's resources, derives from the set of options to invest in future growth. If the management measured projects only by cash flows, the net present value would be negative and the project unattractive. But the project may create a strategic position to invest in valuable follow on opportunities. In practice, firms use strategic investments to enhance their strategic position and earn market share, and appreciate the value of flexibility to react to a dynamic environment.

The real options perspective suggests that management has valuable flexibility to decide whether to proceed to the next stage terminate or alter its future investment plans. Like a call option, the value of the growth options of a firm is influenced by uncertainty, time to maturity and interest rates. If we think investment opportunities such as real option, we will have the following classification scheme.[16]

[16] *Smit, T. J. H. and Trigeorgis, L. (2004), "Strategic Investment: Real Options and Games", Princeton University Press.*



Source: Trigeorgis, L. and Smit, T. J. H. (2004), Based on Trigeorgis 1988. (page 434-437).

This classification uses the similarities between real options and financial options, so we have four different categories:

A ***simple proprietary option*** is a production license which allows for a specified period to invest in production facilities in order to produce proven reserves.

A ***proprietary compound option*** is an exploration license that gives the right to an oil company to invest in exploration wells.

Many expansion decisions in competitive environment can be viewed as ***simple shared options***. For example, options which include the opportunity to launch a new product impacted by substitutes or to penetrate a new target market without limits to competitive entry.

Shared compound option consists of investment in R&D for the production of a new product with close substitutes. [17]

According to Triantis (1999) real options analysis can help a firm better plan its financing, portfolio optimisation, risk management, and compensation strategies shareholder value creation with a view to creating shareholder value. He believes that a firm can position itself to potentially exercise profitable "growth options" in the future by investing in research and development, IT expertise, brand name recognition and other sources of competitive advantage. Furthermore firms typically have the ability to revise their investment and

[17] *Smit, T. J. H. and Trigeorgis, L. (2004), "Strategic Investment: Real Options and Games", Princeton University Press.*

operating decisions over time as uncertainty is resolved. These "flexibility options" may include the ability to expand or contract a manufacturing operation or to shut down or abandon operations. The degree of flexibility available to the firm will be determined by the costs associated with making and implementing these managerial decisions. He gives a list with examples of growth and flexibility options from a variety of different industries.[18]

Industry	Growth option	Flexibility option
Pharmaceuticals	Research and development	Outsource production or sales
Oil & gas	Lease blocks	Delay production
Power	Global expansion	Peak generating plants
Computer hardware	New model under brand name	Assembly configuration
Financial services	IT infrastructure	Abandon service or divest
Airline	Aircraft delivery options	Contingency rights
Real estate	Undeveloped land	Redevelop with adjusted mix
Telecommunications	Mergers and acquisitions	Re-deploy assets
Internet	Marketing investments	Outsource services

Source: Triantis, A. J. (1999), "Creating and Managing Shareholder Value: A View Through a Real Option Lens", Real Options and Business Strategy: Applications to Decision-Making, p.39-58.

Growth options

Companies may have different opportunities to expand. Capacity expansion takes place by introducing new products, by trying to gain bigger market share or by entering new global markets. To position themselves for growth, significant investments are typically required in R&D, marketing, IT infrastructure, or foreign production capacity. Growth options come into being in the form of investments, acquired from other firms, or can be created naturally due to a firm's competitive position in the industry. However, contracts, directly analogous to financial options, offer another choice for purchasing growth options. Therefore, the value of growth options cannot be denied, seeing as they provide the firm with the opportunity to capitalize on / exploit profitable opportunities and curtail future investments. [18]

Flexibility options

Investments in flexibility can affect a firm's risk profile. They prevent the firm from having negative outcomes by altering its direction. On the other hand, they allow firms to exploit favourable situations by increasing production or market share.

[18] *Triantis, A. J. (1999), "Creating and Managing Shareholder Value: A View Through a Real Option Lens", Real Options and Business Strategy: Applications to Decision-Making, p.39-58.*

For example, an automobile manufacturer recognizes that a product line is lagging in sales while it is still profitable. The management decides that the firm's production capacity and labour force be deployed by producing a more popular line of vehicles. Whether this redeployment is feasible and profitable depends on the firm's ability to reconfigure its existing manufacturing plants, to train its employees to assemble a different style of vehicle. The key value is the ability to alter the business strategy. Such flexibility can be immensely worthy when there is considerable uncertainty regarding the future demand for a company's product.

The ability to adjust the scale of a business in general in response to demand and/or price uncertainty is a special case that combines both input and output flexibility. The ability to scale production volume down is probably largely driven by the relative size of fixed versus variable costs. If a company has little flexibility to downsize its labour force, fixed costs, it may be forced to sustain losses for extended periods of time. Some times downsizing may require an all or nothing decision, such as the mothballing of a plant or the abandonment of a product line. [19]

4.3 Real Options with Market and Private Risks

Managerial choice is valuable under uncertain situations and when investment decisions are irreversible. Traditional net present value rule does not consider the value of reacting to uncertain outcomes and change a course of action. On the other hand, real options are supported by financial analysts who are dissatisfied with techniques that cannot validate valuations of companies in new sectors of the economy with low EBITDAs and few physical assets, but with growth potential. Option pricing techniques (OPT) are used to value real, as opposed to financial, investment decisions, and face risks of different nature. The analogy with financial options is immediate: a bet, where the initial investment is the option premium, then a choice, where the second investment matches the exercise price of the right and finally, acquiring an uncertain cash flow stream with an estimated value, the underlying asset.

Real options face risks of different nature. The value of real options can be influenced either by market risks or by private risks or by a combination of both. The "market risks" are

[19] *Triantis, A. J. (1999), "Creating and Managing Shareholder Value: A View Through a Real Option Lens", Real Options and Business Strategy: Applications to Decision-Making, p.39-58.*

market priced risks, whereas "private risks" are non-market priced risks. Market risks are risks captured in the price fluctuations of traded securities, and private risks are risks not captured in the price fluctuations of traded securities. Assets are influenced by a market-priced risk and are associated with a wider set of opportunities because one can always acquire, reduce, or reshape the risk through a position in traded securities. The type of risk underlying a real option has important implications for the applicability of real options theory.

Market risk is the risk of the price and cost of the new product, or the demand can be low or high and everybody in the industry faces this risk. A gold mining company, for example, faces volatile gold prices depending on supply and demand conditions. A portfolio of gold mining stocks and risk-free bonds can monitor the progress of the risk and return characteristics of the investment opportunity in a gold mine. The tracking may not be exact because the portfolio may not be perfectly connected to the particular gold mining investment, but the approximation is usually good. When there are no_transaction costs, arbitrage aligns the price of the tracking portfolio with the value of the gold mine. The advantage of the replicating strategy is the availability of traded securities that mimic the payoffs of operating the mine.

On the other hand, some risky projects cannot be replicated by the set of securities which are available in the capital market. For example, before the results of an exploratory become known, an oil company faces risks related to the size of the oil reserves on the ground. Because of the fact that these risks really differ from the risk of oil prices, the oil company cannot hedge the risk with oil price indexed securities, such as oil futures and oil stocks. Similarly, a drug company must go through a number of R&D stages, from discovery and clinical trials, before the drug reaches the patient. Each and every one of these stages poses unique technical risks that are difficult to replicate with existing securities in the capital markets.

According to financial analysts, there are usually two ways to deal with private risks. Firstly, they ignore such risks on the assumption that they can easily control them because unique risks are small. A company can try to face uncertain situations with a specific product development by taking actions that influence the outcomes. Another alternative is to include in our calculations of private risk the assumption that it can be reduced if a firm diversifies and bets on several different projects at the same time. In this case, private risk is estimated by taking into account only market risk, while we multiply the expected value of the project by the probability related to private risk. This probability can be estimated from the corporate database, government data, technical publications or comparison with industry standards.

The impact of private risk is simple and this fact eases the computational requirements in option valuation. This is extremely important when the sequence of decisions is large, requiring numerous steps in the binomial-lattice. In such cases, consideration of all sources of uncertainty may not be practicable, as the decision tree expands rapidly out of control. However, in other instances, private risk is as important as market risk, and companies may abandon projects if there are bad results about either or both. Careful specification of both market and private risks is then essential in obtaining more precise estimates and avoiding errors in judgment.

Private risk cannot be properly evaluated using option-pricing techniques (OPT), that is the problem of valuing a real option in the presence of private risk. OPT can only provide bounds on value. The reason is that the component of private risk in the overall value of the project cannot be inferred from the information reflected in traded security prices. Accurate estimates must be obtained from an equilibrium approach, instead of by arbitrage. In the case that information which is available in market prices does not facilitate evaluation of investments, OPT is not more helpful than the equilibrium approach. This theory always applies when there is private risk involved.

There is often confusion about the real option's sensitivity to the component of private risk in the investment opportunity. Some claim that private risk diminishes the value of the real option while others defend that private risk adds to the overall volatility of the investment and volatility enhances option value. According to Antonio Mello and Unyong Pyo, private risk may increase as well as decrease the value of the real option. What plays a decisive role is whether the expected payoffs are affected by private risk and how much more risk is added by including private risk. But on the contrary, more volatility is not necessarily beneficial.[20]

Real options include all the company's future opportunities which are caused by today's investment without considering these future opportunities to be valued by option pricing theory. According to Dixit and Pindyck, decision analysis should be used to calculate real options influenced by private risks. On the other hand, decision analysis can be very complex and time-consuming, as every decision may be influenced by different variables and could have possible multiple outcomes. [21]

Copeland and Antikarov recommend using the present value of the project itself without flexibility as the underlying risky asset. They make the assumption that the present value of

[20] *Mello, S. A. and Pyo, Un. (2003), "Real Options with Market Risks and Private Risks", Journal of Applied Corporate Finance, Vol. 15, No. 2.*

[21] *Dixit, A. K. and Pindyck, R. S. (1994), "Investment under Uncertaint", New Jersey: Princeton University Press.*

the cash flows of the project without flexibility is the best unbiased estimate of the market value of the project were it a traded asset. They call this assumption the Market Asset Disclaimer (MAD). This assumption is often followed by the assumption that the value of the underlying asset behaves as a Geometric Brownian motion through time (other underlying distributions are also possible). The combination of these two assumptions will be referred to as the MADD assumption (MAD inclusive Distribution).

The MADD approach makes it possible to calculate the value of real options influenced by all risk types, in a way that is fairly easy to understand. Subjective estimates are necessary to derive the underlying distribution. The assumed distribution should reflect reality, otherwise the option price could be subject to serious flaws. In addition, applying option-pricing theory, which is based on no-arbitrage arguments, to illiquid assets that are not traded in the financial markets, violate the fundamental assumptions of option-pricing theory.

Decision analysis also makes use of subjective estimates about the development of the value of the underlying asset through time similarly to the MADD approach. However, the behavior of the asset's value is not to follow some distribution for convenience. Decision analysis is therefore theoretically a better method than the MADD approach to value real options influenced solely by private risks. However, the behavior of the asset's value does not have to follow some distribution for convenience. As a consequence, decision analysis is theoretically a better method than the MADD approach to value real options influenced solely by private risks. Scenario analysis is a form of decision analysis. If the decision tree becomes too large and complex, the MADD approach will probably be a better method to use, considering the ease of use.[22]

According to Amram & Kulatilaka, the value of strategic real options is always driven by private risks. In consequence, there is no consensus about whether strategic real options actually could be valued with option-pricing methods. Sometimes market risks can be separated from private risks. Real options theory could then be used to evaluate market risks whereas decision analysis could then be used to evaluate private risks. The MADD approach can also be used to evaluate all risk types at once.[23]

Alexander Triantis describes real options analysis as a way of evaluating or justifying specific strategic investments in the firm. ROA provides a financially disciplined approach to making strategic investment decisions. Valuation benefits of this analysis technique can be

[22] *Copeland, T. E. and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", New York: Texere Publishing.*

[23] *Amram, M. and Kulatilaka, N. (2000), "Strategy and shareholder value creation: the real options frontier", Journal of Applied Corporate Finance.*

applied to other corporate decisions, including financial strategy, enterprise risk management, project portfolio optimization, compensation policies. [24]

4.4 Quantifications Methods of Real Options

4.4.1 Binomial (or trinomial) lattices

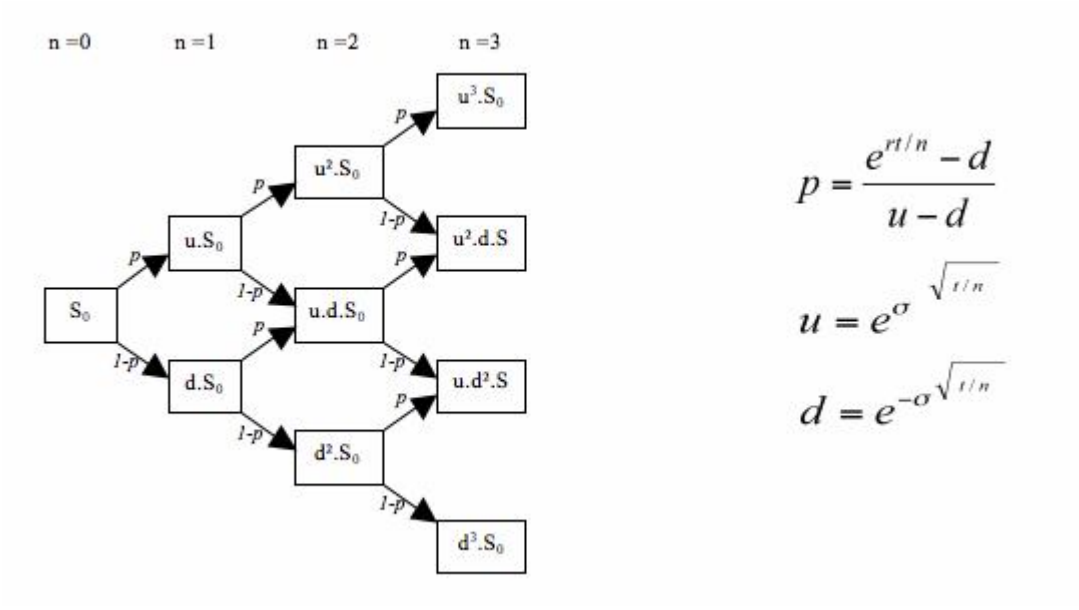
A binomial lattice can be used to value real options on underlying assets which follow either a multiplicative or additive stochastic process. If the binomial lattice is multiplicative, real options are valued by using it approach the Black Scholes formula as the number of subintervals per year becomes large. This approach can be used to value either European or American puts, and compound options.

The binomial tree is a diagram depicting different possible paths that might be followed by the asset price over the life of the option. In each time step, it has a certain probability of moving up with probability *p* by a certain factor *u* and it has a certain probability of moving down with probability *1-p* by a certain factor *d* (where, by definition, $u \geq 1$ and $0 < d \leq 1$). If S is the current price, then in the next period the price will either be $S_{up} = S \cdot u$ or $S_{down} = S \cdot d$. The term binomial refers to the fact that the value of the underlying asset can take on two possible values during each short time interval in the model.

The binomial lattice model allows for great flexibility, as allowing for optimal timing of the exercise decision as well as allowing for more general specifications of the distribution of the underlying asset's value at different points in time. This model has a significant advantage. The actual probabilities of an up or a down movement of the underlying asset are not relevant, the model makes use of "risk-neutral probabilities". The binomial model was first suggested by Cox, Ross and Rubinstein in 1979.

It is easy for a practitioner to build an excel spreadsheet to model compound options. The procedure starts with a binomial lattice for the value of the underlying risky asset. Next a third lattice for the second option (with payoffs contingent on the first option) is built.

[24] *Triantis, A. J. (1999), "Creating and Managing Shareholder Value: A View Through a Real Option Lens", Real Options and Business Strategy: Applications to Decision-Making, p.39-58.*



Source: http://en.w ikipedia.org/wiki/Binomial_options_pricing_model

S_0 is the current price of the underlying asset. This could be derived from market data or the MAD assumption.

p is the "risk-neutral probability"

u and *d* are the factors for reaching the up or down state.

r is the corresponding risk free rate of interest.

The up and down factors are calculated using the underlying volatility, σ, and the time duration of a step, t, measured in years. From the condition that the variance of the log of the price is $\sigma^2 t$, we have:

$$u = e^{\sigma\sqrt{t}}$$
$$d = e^{-\sigma\sqrt{t}} = \frac{1}{u}.$$

Binomial Value = [p × Option up + (1-p) × Option down] × exp (- r × Δt)

or $C_{t-\Delta t,i} = e^{-r\Delta t}(pC_{t,i+1} + (1-p)C_{t,i-1})$

$C_{t,i}$ is the option's value for the ith node at time t.

$$p = \frac{e^{(r-q)\Delta t} - d}{u - d}$$

p is in the interval $(0,1)$ the following condition on Δt has to be satisfied $\Delta t < \frac{\sigma^2}{(r-q)^2}$ [25]

It is necessary that a risk-neutral portfolio be set up for solving the binomial lattice model for the value of the real option at different states. For a risk-neutral portfolio, someone supposes a risk-neutral world, where all investors are indifferent to risk and where the expected return equals the risk free rate of interest. Together with the supposition that arbitrage opportunities do not exist, such a risk-neutral portfolio could be set up. The option values are calculated by starting at the end of the three and working back to the current time. In case the real option has multiple exercise moments, it must be checked if early exercise is preferable to holding the real option instead. When the value of the real option is denoted as f and in state u and d its value is denoted as respectively fu or fd, the following equation must hold,

$$S_{0u}\Delta - f_u = S_{0d}\Delta - f_d$$

The binomial lattice model can deal with market risks. In combination with the MADD assumption, it can also deal with private risks. The model is not suited to dealing with private risks without further assumptions. The binomial lattice model supposes that the asset price follows a random walk. On the other hand, Dixit and Pindyck argue that it is more realistic to model an economic variable as a process that makes infrequent but discrete jumps, a jump process. The binomial lattice model is suited to coping with other underlying distributions as well.[26]

4.4.2 Decision - Tree Analysis

Another approach to account for uncertainty and the possibility of later management decisions is decision-tree analysis (DTA). Amram and Kulatilaka define decision analysis as an

[25] *http://en.wikipedia.org/wiki/Binomial_options_pricing_model. Copeland, T. E. and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", New York: Texere Publishing. Borison, A. and Triantis, A. J. (2001), "Real Options: State of the practice", Journal of Applied Corporate Finance.*

[26] *Dixit, A. K. and Pindyck, R. S. (1994), "Investment under Uncertainty", New Jersey: Princeton University Press.*

unambiguous way to lay out future decisions and sources of uncertainty. This analysis relies on subjective assessments of probabilities, subjective discount rates and preferences about the goal.[27] According to Trigeorgis, decision-tree analysis helps managers to structure the decision problem by mapping out all feasible alternative managerial actions contingent on the possible states of nature in a hierarchical manner. It is particularly useful for analyzing complex sequential investment decisions when uncertainty is resolved at distinct, separate points in time. In the practice of this approach, management is compelled to clarify and define its operating strategy and understand that initial decisions are independent of subsequent decisions.[28]

The decision setting is structured as follows:

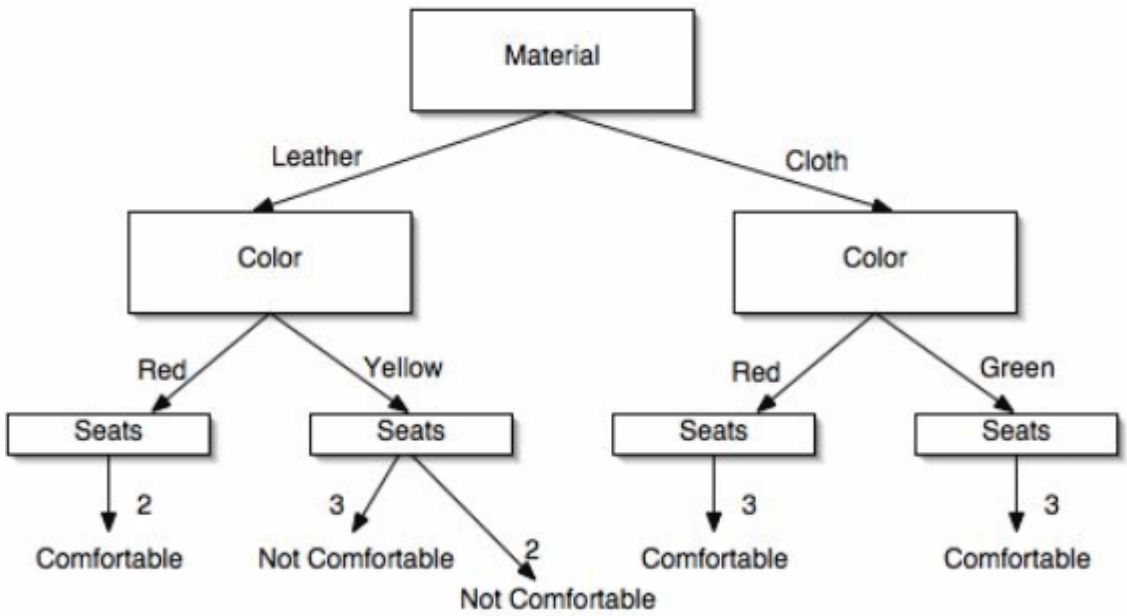
1. Management must decide which alternative course of action to follow.
2. The chosen alternative action produces an outcome which is based on uncertain future eventualities. Management can use past information to describe a probable development.
3. Finally, the selection of strategy by management is assumed to be in agreement with its preferences for uncertain consequences, and is based on prior judgements related to the probable ocurrence of chance events.

Example

One possible decision tree is to decide what type of sofa we want to buy. The first decision refers to the sofa's material, leather or cloth. The second decision is about the colour and the last is about how many seats it has. If the leather sofa is red, it will have two seats. If the leather sofa is yellow, it will have three seats but it won't be comfortable. If the sofa is made of cloth and the colour is red, it will have three seats and it will be comfortable. If the sofa is made of cloth and the colour is green, it will have three seats but it won't be comfortable.

[27] *Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard Business school press, United States Of America.*

[28] *Trigeorgis, L. (1996), "Real Options, Managerial Flexibility and Strategy in Resource Allocation", The MIT Press, Cambridge, Massachusetts, London, England.*



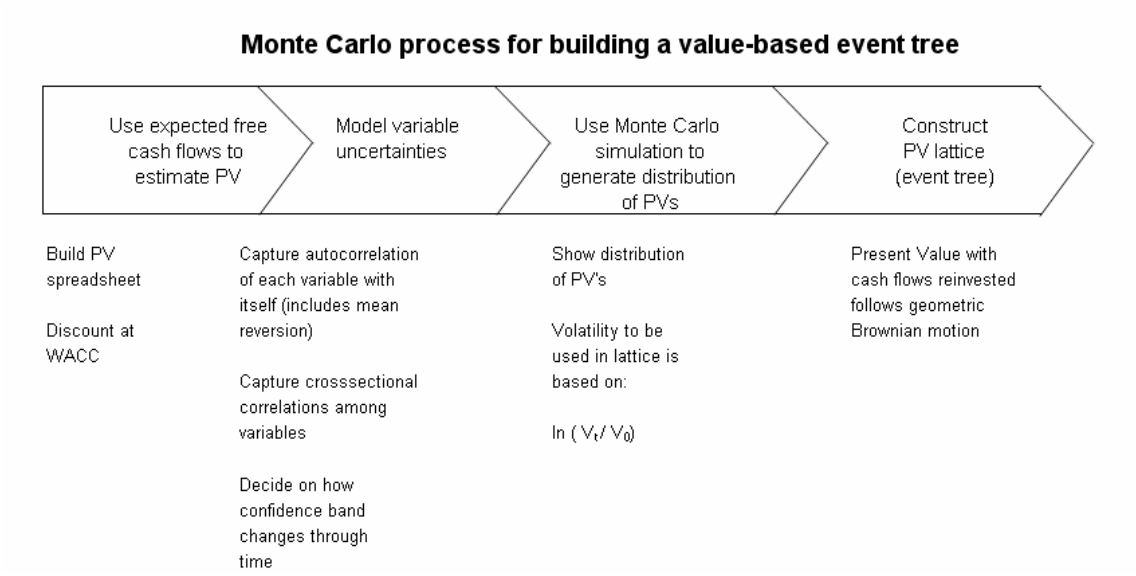
Source:http://dkv.columbia.edu/demo/medical_errors_reporting/site/module3/0303b-decision-tree.html

4.4.3 Monte Carlo Simulation

Borison and Triantis explain the basic idea behind Monte Carlo simulation with respect to real options well:

"Monte Carlo simulation is a powerful technique that allows for considerable flexibility in the number and specification of the uncertainties in the decision problem. Based on assumed probability distributions for each uncertainty, a large number of possible scenarios are generated for the underlying project cash flows or value. The real option value is then calculated for each of these scenarios, and the average of these values is discounted back to the present. The Monte Carlo valuation approach is useful when the cash flows from a project are path dependent, that is, when they depend on prior decisions taken by the firm. While it has traditionally been difficult to use this approach to value American options, new techniques are being developed to address this shortcoming".[29]

[29] *Borison, A. and Triantis, A. J. (2001), "Real Options: State of the practice", Journal of Applied Corporate Finance.*



Source: Copeland, T. E. and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", U.K. Thomson Texere.

Monte Carlo simulation can be used to value many kinds of real options. But the specific way to apply Monte Carlo simulation is different for each type of real option. Furthermore, additional software packages can be used by practitioners. The application of Monte Carlo simulation to a simple real option on a traded asset, the payoffs of which undergo normal distribution, is conducted in the following manner:

1. Sample a random path for S (in a risk-neutral world).

2. Calculate the payoff of the real options.

3. Repeat steps 1 and 2 until there are enough sample values to provide a reliable estimate of the payoff of the Real-Option (in a risk-neutral world).

4. Calculate the mean of the sample payoffs to get an estimate of the expected payoff.

5. Discount this expected payoff (at the risk-free rate of interest) to get an estimate of the value of the real option.

4.5 Real Options as a complement

Real options are an add-on component to, not a substitute for, discounted cash flow analysis. Managers need to use both methods in order to pick the best growth projects. Putten and Mac Millan drew the conclusion that much of the problem lies in the unspoken assumption that the real option and DCF valuation methods are mutually exclusive. They believe that the two approaches can be integrated if managers are to make valuations that reflect the reality and complexity of their business's growth projects.

Real options allow managers to capture the substantial value of being able to ruthlessly abandon floundering projects before making considerable investments. That's why real options are an essential complement.

Traditional DCF analysis relies on the principle that an investment should be funded if it will create more value than it will cost. In other words, the net present value (NPV) of its future cash flows should not be negative. This works well if managers are predicting future cash flows from some historical context and they are almost certain of future trends. However, it doesn't work well if managers estimate future cash flows based on a myriad of assumptions about what the future may hold. In such cases, there is very little chance of accurately forecasting cash flows.

In DCF analysis, the cash flows have to be discounted at a high rate in order to reflect the long possibilities of achieving the projected returns. Consequently, the valuation implies all the risks of uncertainty, namely the prospect of actual cash flows being significantly lower than predicted. However, the possibility of rewards in the form of cash flows being unexpectedly high is overlooked in the valuation process. Managers can be led to reject highly promising, if uncertain, projects because of inherent bias.

Discounted cash flow valuation protects against the considerable risks of pursuing highly uncertain projects, but this method is conservative enough. The challenge is to find a method to recapture some of the value lost through the DCF method. This is where options enter. The probability that the project may fulfil the high end of potential forecasts, so hard for DCF analysis to take into consideration, is the driving force of option value. The probability of achieving a large upside gain combined with the fact that companies can usually abandon their projects before their investment in them has cost too much, influences real options value. Furthermore, the downside is limited. When the uncertainty and therefore the possible upside surrounding the underlying asset increases, whether that asset is financial or "real" the value of the option increases.

In consequence, discounted cash flow analysis and real options are complementary. A project's total value is the sum of their values as a base estimate of value is captured by the DCF

valuation and the option valuation adds in the impact of the positive possible uncertainty. Putten and Mac Millan notably state that a real options approach can only be used on projects structured somewhat like options. The projects can be abandoned before making considerable financial outlays if it becomes clear that things will not go well.

Putten and Mac Millan define project value as:

$$Total\ \text{Pr}oject\ Value = Net\ \text{Pr}esent\ Value + Adjusted\ Option\ Value + Abandonment\ Value$$

$$TPV = NPV + AOV + ABV$$

Both the AOV and the ABV are real option components. The adjusted option value gains value from the variability of the project's profit, adjusted for the variability of the project's cost. The abandonment value increases from the manager's opportunity to abandon the project.

If cost volatility exceeds revenue volatility, the volatility number for the calculation of AOV should be adjusted as follows:

$$adjusted\ volatility = project\ volatility \times \left(revenue\ volatility \div \cos t\ volatility\right)$$

If cost volatility does not exceed revenue volatility:

$$adjusted\ volatility = project\ volatility$$ [30]

Investment decisions should be based on an expanded net present value standard which includes the flexibility value of the combined options embedded in the project.

$$Expanded\ NPV = passive\ NPV + Flexibility\left(or\ Option\right)\ Value$$

An important way to bridge the gap between traditional corporate finance theory and strategic planning is matching up the real options method with game theory. It is a good way to take into consideration competitive counteractions. The flexibility or option value of

[30] *Putten, Alexander B. Van and MacMillan, Ian C. (2004, December), "Making Real Options Really Work", Harvard business review, 82 (12), 134-150.*

waiting must offset the strategic value of early commitment in influencing competitive behavior. In the expanded NPV there are two main effects on a company's value. The first effect is a flexibility or option value, which reflects management's ability to wait to invest under uncertain environment. Secondly, we have a strategic commitment effect which can pervade decisions made by competitors.

In addition, Smit and Trigeorgis define expanded NPV (reflecting total market value) as:

$$Expanded(strategic)\ NPV = (passive)\ NPV + flexibility(Option)\ Value + Strategic\ Value$$

This formula combines the three components of value presented in figure. [31]

According to real option theory, a company's market value is not just the net present value of its future cash-flows, which is derived from the company's assets in place, but also consists of the present value of a company's growth options. Therefore, the present value of growth options includes in their definition the potential options the company encompasses, as well as the evolving and future strategic position of the company. The strategic value of these growth opportunities forms a significant part of a company's market value, and explains any differential against competitors' apparently comparable collections of assets and future cash flows. The market value of a company is then expressed as follows:

$$Market\ Value(MV) = Assets\ in\ place(PV) + \mathrm{Pr}esent\ Value\ of\ growth\ options(PVGO)$$

Assets in place (PV) depicts the present value of earnings generated by assets in place and Present Value of growth options (PVGO) symbolizes the value of the growth opportunities.

We can estimate the PVGO either 'bottom up' or 'top-down'. The bottom-up approach requires a firm to recognize the various types of options (e.g., platform investment, expansion or divestment options, etc.) and to use option valuation methods for valuing the set of real options that exist in the firm and its businesses as organisation assets. On the other hand, the top-down (or 'market' method) goes around such modelling challenges by using the consensus market assessment of the company's set of embedded real options as reflected in its current stock price. [32]

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[31] *Smit, T. J. Han & Trigeorgis, Lenos (2004), "Strategic Investment: Real Options and Games", Princeton University Press.*

[32] *Smit, T. J Han and Moraitis, Thras (2010, February), " Serial Acquisition Options", Long Range Planning,43 (1), 85-103.*

There are thus two possibilities to use real options as an add-on component, either valuing all (possible) value derived from a firm's future growth (PVGO) or valuing a firm's strategic real options. The advantage of estimating all value derived from growth is the easy way to determine the other component (i.e. the static PV) in the equation of total company value. For a stock's value it is $\frac{EPS}{r}$ and for a firm's value it is $\frac{FCF}{WACC}$, where WACC is the weighted average cost of capital. The disadvantage of this method is the difficulty to estimate PVGO. The advantage of valuing a firm's strategic real options is that it is easier and more understandable than valuing a firm's PVGO. The disadvantage is that it is more difficult and a bit unclear how to estimate the present value of a company's future assets in place.[33]

We conclude that we can assume that the value of a company can be decomposed as in the following equation:

$$Company\ Value = Static\ PV + PVGO = Future\ Assets\ in\ place(PV) + strategic\ \mathrm{Re}al\ Options\ Value$$

$$static\ PV\ \mathrm{mod}el : Static\ PV + PVGO$$

$$Future\ assets\ in\ place(PV)\ \mathrm{mod}el : Future\ Assets\ in\ place(PV) + strategic\ \mathrm{Re}al\ Options\ Value$$

The static PV is the value a company holds when growth is not taken into account. The PVGO is the total value of a company considering the prospect of future growth. The present value assessed from assets in place is the future value which will be created from current assets. The strategic Real-Options value incorporates the value of all the strategic opportunities that a company can seize.

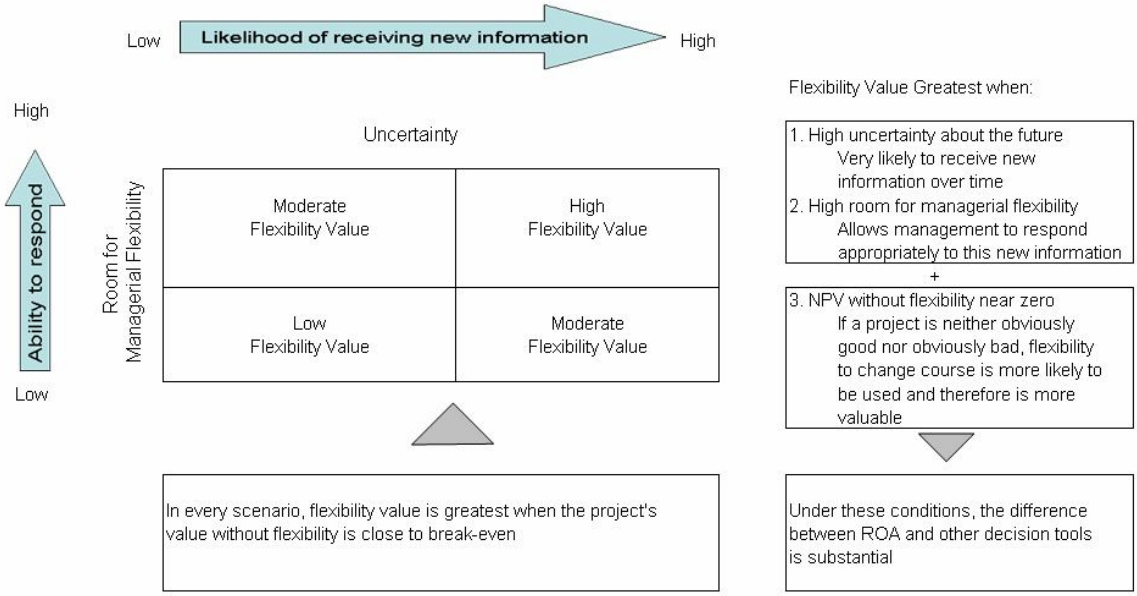
4.6 Functions of Real Options

Management Level

Real options provide the opportunity to improve the approach of valuation and the practice of management. According to Copeland and Antikarov, the net present value technique systematically undervalues everything because it fails to capture the value of flexibility. Additionally, the value of managerial flexibility is always positive, its value is overvalued.

[33] *Myers, S. C. (1984), "Finance Theory and Financial Strategy", Interfaces, 1984 (February), 126-137.*

Real options have the greatest value when uncertainty, managerial flexibility and NPV without flexibility near zero, come together. When there is high uncertainty about the future and when there is high room for managerial flexibility, real options are important. On the other hand, when the NPV is close to zero, the real option's value relative to NPV is high. When NPV is high, real options have very low probability of being exercised because of providing additional flexibility and have low relative value. If the NPV is extremely negative, the project can't be rescued. If NPV is near zero, flexibility creates additional value.[34]



Source: Copeland, T., Koller, T and Murrin, J. (2000), "Valuation: Measuring and Managing the Value of Companies", 3rd edition, New York, John Wiley & Sons.

The figure depicts the reasoning behind the value inherent to managerial flexibility on project-level. If future rewards are highly uncertain, but management is likely to receive a lot of information regarding these rewards in the future and management is able to defer some important decisions, a project may encompass high option value.

Borison and Triantis categorize real option's functions into the three following classes:

1. Real options as a way of thinking. Real options are used primarily as a language that applies a border and communicates decision problems qualitatively.
2. Real options as an analytical tool. They are used primarily to value projects with known specified characteristics.

[34] *Copeland, T. E., and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", U.K. Thomson Texere.*

3. Real-Options as an organisational change process, which includes both the previous two functions. This function is used by management to identify and exploit strategic real options. [35]

Project Level

Real options on project-level are those which influence the capital budgeting decision of a investment project of a company. Such real options are the option to defer a project or the option to abandon a project. The presence of these real options within a project can be conclusive for the start of a project. However, these options are not interested in provoking new projects in the future. In case the start of a project creates strategic growth options as well, strategic value should be incorporated in the capital budgeting decision. For example, developing and producing a certain innovative product can put the company in a favourable position to potentially exercise an option to create a successor. This option is relevant for this specific project. It is interesting for management as well. Therefore, such an option is both an option on project-level and on management-level. On project-level, real options can serve as a better valuation tool for capital budgeting decisions. Dixit & Pindyck state that their function is to correctly incorporate the value attached to the following factors in a project's capital budgeting decision:

1 Irreversibility

2 Uncertainty of future rewards

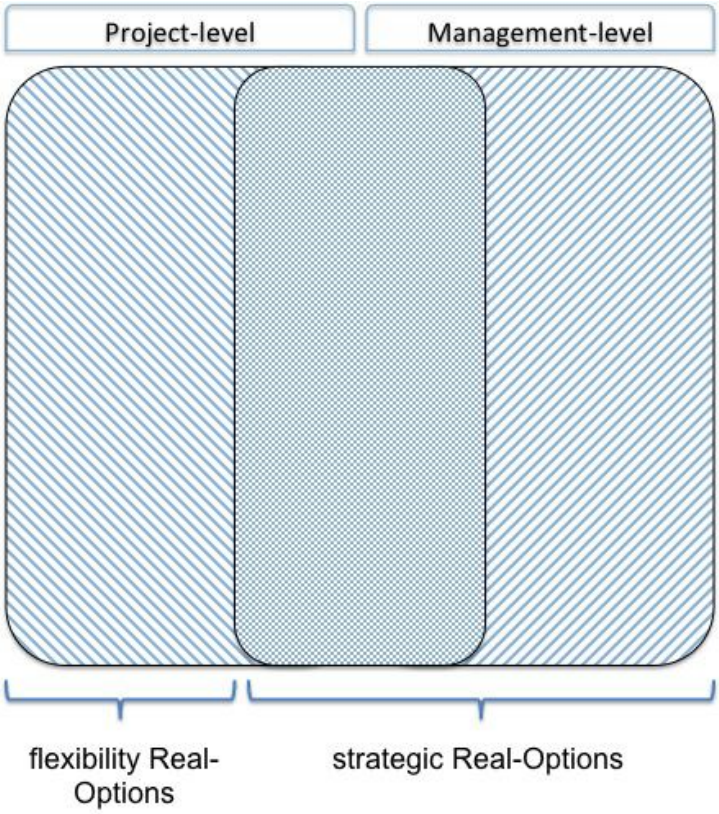
3 Timing or staging [36]

Real options on project-level are important in making correct capital budgeting decisions. In addition, they are to correctly draw the optimal decision-making path for management. If the project's value without flexibility is close to break-even and one or more of the three factors lead to managerial flexibility, these real options contribute the most.

Real options on management-level encompass all strategic real options of a firm. The value of some of the real options on management-level could already be included in the capital budgeting decision of a specific project. For example, the option to create a successor can be

[35] *Borison, A. and Triantis, A. J. (2001), "Real Options: State of the practice", Journal of Applied Corporate Finance.*
[36] *Dixit, A. K., and Pindyck, R. S. (1994), "Investment under Uncertainty", New Jersey: Princeton University Press.*

both an option on project-level and on management-level. It influences the capital bud getting decision of one specific project. It also encompasses strategic value too. The relationship between on the one hand, real options value on project level and management-level, and on the other hand, flexibility and strategic real options is depicted below.



CHAPTER 5
THE ENTERPRISE DISCOUNT CASH FLOW MODEL

The objective of this chapter is to analyze important inputs for the Real Option model. In this chapter, we give a comprehensive overview of the Discount Cash Flow Valuation model and its processes. Furthermore, we will analyze all relevant input parameters of the model, the "Static Present Value" and the "Future Present Value of the assets in place".

5.1 Enterprise Discount Cash Flow Model

According to Stowe, Robinson, Pinto and McLeavey, Discounted Cash Flow valuation considers that the present value of expected future cash flows is the inherent value of a security. We could use DCF analysis to value a company and its equity securities. We can manage it either valuing free cash flows to the firm, FCFF, or valuing free cach flow to equity, FCFE. If the DCF model is applied to dividends, the model will be the dividend discount model, DDM. Free cash flow models use as source the cash flows which are available to distribution, not only dividends which are paid to stockholders.

In contrast to dividends, FCFF and FCFE are not based on published available data. It is challenging to find required data and forecast future free cash flows, but analysts usually use available financial information to extract them. Analysts must understand a company's profile and financial statement, its operations and financing, its industry and its country's economy, its prospect and its ability to pay dividends. Then they find current cash flows and forecast future cash flows. [37]

According to Koller, Goedhart and Wessels, the valuation of a company's common equity according to the enterprise DCF model can be achieved by determining enterprise value and arriving at the company's common equity value.

[37] *Stowe, D. J., Robinson, R. T., Pinto, E. J. and McLeavey, W. D. (2007), "Equity Asset Valuation", United States of America, CFA Institute, John Wiley & Sons, Inc.*

The following steps must be completed:

- To value a company's operations, which are available to all investors, by discounting free expected cash flow (FCF) at the weighted average cost of capital.
- To identify and value non-operating assets and other equity investments. Company value is found by summing the value of operations and non-operating assets.
- To identify and value all debt and other non-equity demands, which include fixed-rate, floating-rate debt, unfounded pension liabilities, employee options, and preferred stock, against the company value.
- To determine the value of common equity by subtracting the value of non-equity financial demands from enterprise value. Equity value is divided by the number of current shares outstanding in estimating price per share.

The enterprise DCF process is an iterative process. If an analyst wants to value operations, he must reorganize the firm's financial statements with the aim od separating operating items from non-operating items and capital structure. Then he must investigate the company's historical performance, define and project future free cash flow over the short, medium and long run. Finally, he must discount income streams at the weighted average cost. [38]

Stowe, Robinson, Pinto and McLeavey state that common equity can be valued using FCFE model or FCFF model. In the second choice, one values the firm using FCFF and then subtracts the value of non common stock capital from FCFF with the ultimate aim the value of equity. [39]

5.2 Input Parameters

The enterprise Discount Cash Flow model discounts free cash flows, by Koller, Goedhart and Wessels. It is called the enterprise DCF model's measure. This valuation approach estimates enterprise value as the present value of future free cash flows discounted at the weighted-average cost of capital (WACC):

[38] *Koller, T., Goedhart, M. and Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

[39] *Stowe, D. J., Robinson, R. T., Pinto, E. J. and McLeavey, W. D. (2007), "Equity Asset Valuation", United States of America, CFA Institute, John Wiley & Sons, Inc.*

$$PV = \sum_{i=1}^{n} \frac{FCF_n}{(1+WACC)^n}$$

$$PV = \underbrace{\frac{\mathrm{FCF}_1}{1+\mathrm{WACC}} + \frac{\mathrm{FCF}_2}{(1+\mathrm{WACC})^2} + \ldots\ldots + \frac{\mathrm{FCF}_\mathrm{T}}{(1+\mathrm{WACC})^\mathrm{T}}}_{PV(free.cash.flow)} + \underbrace{\frac{PV_T}{(1+WACC)^T}}_{PV(terminal.value)}$$

The first equation is the usual way to value a firm according to the enterprise Discount Cash Flow model. In other words, firm value is computed as the discounted value of the future income streams up to a valuation horizon (T) plus the forecasted value of the business at the horizon, also discounted back to the present value. It is called terminal value. In this way, one does not have to forecast free cash flow to perpetuity, but he assumes that the company will grow steadily with a growth factor g after a certain valuation horizon. As the terminal value function converges to a finite sum, it is easy for present value of free cash flows to be calculated after the valuation horizon. [40]

The disadvantage of using and including a terminal value estimated with the infinity growth formula is that the choice of a certain forecast horizon could affect a company's value if it is associated with changes in the economic assumptions underlying the terminal value estimate. This can be avoided by appropriately determining how long the explicit forecast period should be. Terminal value approaches cannot provide an explanation for declining margins, and that is why when the explicit forecast period is over, it is recommended the company be operating at an equilibrium level. [41]

Valuing a company's operations by discounting free cash flow (FCF) at the weighted average cost of capital consists of three determining variables. They are *Discount Rate, Free Cash Flows* and *Terminal Value.*

[40] *Brealey, R. A., Myers, S. C. and Allen, F. (2011), "Principles of corporate Finance", (10th ed.). New York: McGraw-Hill/Irwin.*

[41] *Koller, T., Goedhart, M., & Wessels, D.,2010, Valuation: Measuring and Managing the Value of Companies (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

5.2.1 Discount Rate

Expected income streams are discounted because of the rationale that one dollar possessed today is worth more in the future. There are two reasons for that, the first of them being that one dollar today can be invested at the risk free rate of interest that will earn a return. Secondly, inflation decreases the future buying pay of money. The enterprise discount cash flow model discounts future FCF at the weighted-average cost of capital because the WACC represents rates of return required by the company's debt and equity holders blended together. In conclusion, it is the company's opportunity cost of funds.

Enterprise Value equals the Market Value of Debt plus the Market Value of Equity:

$$V = D + E$$

If one wants to investigate the components of firm's total market value, he will multiply the right side of the equation with a complex fraction equivalent.

$$V = (D+E)\left(\frac{D(1-T_m)k_d + CF_e - D(g)}{D(1-T_m)k_d + CF_e - D(g)}\right) \qquad \textbf{(1)}$$

where:

T_m=marginal tax rate

k_d=cost of debt

CF_e=cash flow to equity holders

g=growth in cash flow to equity holders

The fraction's numerator will be converted to FCF:

$$FCF = D(1-T_m)k_d + CF_e - D(g)$$

If the market value of debt equals the face value of debt, the cost of debt will equal the coupon rate, and D times kd will equal the company's interest expense.

$$FCF = Interest(1 - T_m) + CF_e - D(g)$$

Cash flow to equity (CFe) equals earnings before interest and taxes minus interest minus taxes minus net investment plus the increase in debt. If the ratio of debt to equity is constant, the annual increase in debt will equal D(g). When cash flows to equity are growing at g, the value of equity also grows at g. Assuming that the ratio of debt to equity remains constant (a key assumption), the value of debt must also grow at g. That has as a result:

$$FCF = Interest(1 - T_m) + EBIT - Interest - Taxes - Net \quad Investment + D(g) - D(g)$$

and

$$FCF = Interest - T_m(Interest) + EBIT - Interest - Taxes - NetInvestment$$

If we simplify by canceling the interest terms, we will have:

$$FCF = EBIT - \left[Taxes + T_m(Interest)\right] - NetInvestment$$

Operating taxes are the taxes which would be paid by a company if the company were financed entirely with equity. Operating taxes equal reported taxes plus the interest tax shield, it leads to the definition of free cash flow:

$$FCF = EBIT - OperatingTaxes - NetInvestment$$

We want to derive the weighted average cost of capital, so we use equation (1) and multiply CFe by $\frac{k_e - g}{k_e - g}$ where k_e is the cost of equity, then

$$V = (D+E)\left(\frac{FCF}{D(1+T_m)k_d + \frac{CF_e}{k_e - g}(k_e - g) - D(g)}\right)$$

If equity cash flows are increasing at a constant rate, the value of equity equals with E=$\frac{CF_e}{k_e - g}$, so we will have:

$$V = (D+E)\left(\frac{FCF}{D(1-T_m)k_d + E(k_e) - E(g) - D(g)}\right)$$

and

$$V = (D+E)\left(\frac{FCF}{D(1-T_m)k_d + E(k_e) - (D+E)g}\right)$$

If we divide the numerator and denominator by (D+E), we will have a new equation:

$$V = \frac{FCF}{\frac{D}{D+E}(k_d)(1-T_m) + \frac{E}{D+E}(k_e) - \frac{D+E}{D+E}(g)}$$

In addition, the weighted average cost of capital equals with:

$$WACC = \frac{D}{D+E}(k_d)(1-T_m) + \frac{E}{D+E}(k_e)$$

Hence, the equation (1) can be rewritten as:

$$V = \frac{FCF}{WACC - g}$$

It is worthwhile to mention how the after-tax cost of debt and the cost of equity are weighted by each security's market weight to enterprise value. That is why market-based values should be used to build the cost of capital, not their book or accounting values. That is also why cash flow stream should be discounted at the weighted average cost of capital to determine enterprise value. Someone can use a constant WACC over time only when leverage is expected to remain constant. [42]

The cost of capital is the obligatory rate of return, which should be demanded for a cash flow by investors. WACC is determined by the risk of these cash flows**.** In other words, the method to discount a company's FCF at the WACC is that the firm's cost of capital is faced as the best estimator for the enterprise's overall risk. Investors order a return to the extent of the risk they take. The higher the risk the higher the required return. The cost of capital is often taken into account as the opportunity cost of the suppliers of capital. If the suppliers of capital are creditors and stockholders, the needed rates of return for debt and equity are the after tax for the company under current market conditions.

WACC may also change over time as a firm's capital structure usually changes over time. Furthermore, a firm's capital structure may also be modified considerably in the future. That is the reason analysts often prefer target weights or current weights. [43]

Brealey, Myers, and Allen clarify that the WACC is not the same as the company's opportunity cost of capital or hurdle rate. Both the opportunity cost of capital and hurdle rate have the same meaning and are a measure of the opportunity lost. It is the return offered by equivalent investment alternatives while an investment is evaluated. [44]

Cost of equity

The most popular method of estimating the cost of equity, according to Graham and Harvey, is Capital Asset Pricing Model (CAPM). The cost of equity is determined usually by three factors. They are the risk free rate of return, the market-wide risk premium and a risk

[42] *Koller, T., Goedhart, M. and Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

[43] *Stowe, D. J., Robinson, R. T., Pinto, E. J. and McLeavey, W. D. (2007), "Equity Asset Valuation", United States of America, CFA Institute, John Wiley & Sons, Inc.*

[44] *Brealey, R. A., Myers, S. C. and Allen, F. (2011), "Principles of corporate Finance", (10th ed.). New York: McGraw-Hill/Irwin.*

adjustment that reflects each company's riskiness relative to the average company. The market-wide risk premium is defined as the expected return of the market portfolio less the return of risk-free bonds. The CAPM uses beta to regulate company-specific risk. Beta measures a stock's co-movement with the market and symbolizes the extent to which a stock may diversify the investor's portfolio. Stocks with high betas must have surplus returns that exceed the market risk premium, and the opposite.

The CAPM postulates that the expected rate of return on any security equals the risk free rate plus the security's beta times the market risk premium.

$$E(R_i) = r_f + \beta_i (E(R_m) - r_f)$$

where $E(R_i)$=expected return of security *i*
r_f =risk free rate
β_i =stock's sensitivity to the market
$E(R_m)$=expected return of the market

Koller, Goedhar and Wessels refer that:

⇒ *To estimate the risk-free rate in developed economies, use highly liquid, long-term government securities, such as the 10-year zero-coupon STRIPS.*
⇒ *Based on historical averages and forward-looking estimates, the appropriate market risk premium is between 4.5 and 5.5 percent.*
⇒ *To estimate a company's beta, use an industry-derived unlevered beta relevered to the company's target capital structure. Company-specific betas vary too widely over time to be used reliably.*

According to the CAPM, beta drives a stock's expected return. Beta measures how much the stock and entire market move together and how each of them influences the other. Analysts must estimate beta's value because it cannot be observed directly. Firstly, one must measure a raw beta using regression. Secondly, one must use an industry beta that is an average of betas of stocks in the same industry. A stock's historical return over the past 60 months forms the basis for a firm's beta.

Levered Beta

The weighted average beta of a company's assets must equal the weighted average beta of its financial claims:

$$\frac{V_u}{V_u + V_{txa}}(\beta_u) + \frac{V_{txa}}{V_u + V_{txa}}(\beta_{txa}) = \frac{D}{D+E}(\beta_d) + \frac{E}{D+E}(\beta_e)$$

The formal equation for equity beta is depicted below:

$$\beta_e = \beta_u + \frac{D}{E}(\beta_u - \beta_d)$$

If debt is risk free, the beta is of debt is zero, and β_d drops out and the equation is formulated as follows:

$$\beta_e = \left(1 + \frac{D}{E}\right)\beta_u$$

This equation is used for levering (and unlevering) beta when the risk of interest tax shield (β_{txa}) equals the risk of operating assets (β_u) and the firm's debt is risk free.

where

β_e=beta of equity

β_d=beta of debt

β_u=unlevered beta of equity

β_{txa}=beta of capital for tax shields

T_m=marginal tax rate

D=debt

E=equity

V_{txa}=present value of tax shields[45]

[45] *Koller, T., Goedhart, M., & Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

	Dollar level of debt fluctuates	Dollar level of debt is constant and debt is risky	Debt is risk free
Tax shields have same risk as operating assets $\beta_{tx,a}=\beta_u$	$\beta_e = \beta_u + \frac{D}{E}(\beta_u - \beta_d)$	$\beta_e = \beta_u + \frac{D}{E}(\beta_u - \beta_d)$	$\beta_e = \left(1+\frac{D}{E}\right)\beta_u$
Tax shields have same risk as debt $\beta_{tx,a}=\beta_d$	$\beta_e = \beta_u + \frac{D-V_{tax}}{E}(\beta_u - \beta_d)$	$\beta_e = \beta_u + (1-T_m)\frac{D}{E}(\beta_u - \beta_d)$	$\beta_e = \left[1+(1-T_m)\frac{D}{E}\right]\beta_u$

Source: Koller, T., Goedhart, M., & Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.

Cost of debt and tax

The WACC combines the cost of equity with the after-tax cost of debt. The yield to maturity of the company's long-term is used to estimate the cost of debt for investment-grade companies. According to Koller, T., Goedhart, M., & Wessels, we must multiply the estimate of the cost of debt by 1 minus the marginal tax rate if we want to determine the cost of debt on an after-tax basis. They contend that the yield to maturity is only a proxy for expected return. More specifically, the yield is actually a promised rate of return on a company's debt, assuming that all coupon payments are made on time and the debt is paid in full. Therefore, we cannot have a theoretically consistent enterprise valuation by relying on the yield to maturity, because an expected return is what makes us discount expected free cash flows, and not a promised yield. There is a very small chance of default for firms with investment-grade debt, and hence this inconsistency is insignificant, particularly if we compare it to the estimation error surrounding beta and the market risk premium. [46]

Taxes and a company's financial structure can interact to affect future investment decisions, the proportions of debt and equity. The Modigliani-Miller Theorem states that in the event that the total cash flows due to be distributed to a company's debt and equity holders is unaffected by the capital structure decision, then this decision will not affect the total value of the company's debt and equity. In other words, a manager who is considering whether it is cheaper to finance the firm mainly with junk bonds that have a very high yield, high-risk debt, or with equity and perhaps a small amount of high-quality debt should stop worrying.

[46] *Koller, T., Goedhart, M. and Wessels, D.(2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

In addition, the Modigliani-Miller Theorem is noteworthy because it provides a framework that gives the chance to managers to focus on factors, which are significant determinants of the optimal capital structure choice. There are different assumptions of the theorem. The first of all is that the sum of all future expected income streams distributed to the firm's debt and equity investors is not affected by capital structure. The second assumption is that there are no transaction costs. Finally, Modigliani-Miller assumption is the shortage of arbitrage. [47]

Debt financing has one important advantage under the corporate income tax system. The interest the company pays is a tax-deductible expense, and that is why the amount of corporate tax payable influences the cost of debt of a company. The tax deductibility of interest increases the total income that can be paid out to bondholders and stockholders. The return to bondholders escapes taxation at the corporate level. Tax shields can be valuable assets, which are likely less risky than the risk of the operating assets. The tax shields depend only on the corporate tax rate and on the ability of the company to earn enough to cover interest payments. It is commonly assumed that the risk of the tax shields is equal to interest payments generating them. [48]

Modigliani Miller derive for the WACC the following formulas: [49]

$$WACC = r_A(1 - T_c)\,\mathrm{L}$$

where $L = \frac{D}{V} = \frac{D}{D+E}$

and $r_E = r_A + (r_A - r_D)(1 - T_c)\frac{L}{1-L}$

$$Investment\ Payment = return\ on\ debt \times amount\ borrowed = r_d \times D$$

$$PV_{TaxShield} = \frac{T_c r_D D}{r_D} = T_c D$$

[47] *Grimblatt, M., Titman, S. (2002), "Financial Markets and Corporate Strategy", (2nd ed.), The McGraw-Hill Companies.*
[48] *Brealey, R. A., Myers, S. C. and Allen, F. (2011), "Principles of corporate Finance", (10th ed.). New York: McGraw-Hill/Irwin.*
[49] *Brealey, R. A., Myers, S. C. and Allen, F. (2011), "Principles of corporate Finance", (10th ed.). New York: McGraw-Hill/Irwin.*

$$PV_{TaxShield} = \frac{corporate\ tax\ rate \times investment\ \ payment}{\exp ected\ return\ on\ debt}$$

Debt /Equity Ratio

One should know a firm's targeted future debt to equity ratio in order to estimate a company's value. The definition, according to investopedia, is that the debt to equity ratio is a measure of a company's financial leverage. This leverage is calculated by dividing a company's total liabilities by stockholders' equity. This ratio indicates what proportion of equity and debt the company is using to finance its assets. [50]

According to Modigliani Miller Theorem, a company should take on as much debt as possible. This is a way to fully utilize the value inherent to tax shields. The trade-off theory and the pecking-order theory are the most influential theories about a company's debt to equity ratio.

The trade-off theory accentuates interest tax shields and the costs of financial distress. The value of the firm analyzes as:

Value if all-equity-financed + PV(tax shield) - PV(costs of financial distress)

According to the trade-off theory, the firm should increase debt until the value from PV(tax shield) is just offset, at the margin, by increases in PV(costs of financial distress). This theory balances the tax advantages of borrowing against the costs of financial distress. Corporations are supposed to choose a target capital structure, which maximizes their value. Companies with safe, tangible assets and plenty of taxable income to shield ought to have high targets. Unprofitable firms with risky, intangible assets ought to rely more on equity financing. Under the trade-off theory, high profitability should mean high debt capacity and a strong tax incentive to use that capacity.

Under the pecking-order theory, companies use internal financing when available and choose debt over equity when external financing is required. This explains why less profitable companies borrow more. These firms need more external financing and debt is next on the pecking order when internal funds are exhausted. This theory is an effect of asymmetric information. Managers know more about their firms' prospects, risks and values than outside investors. Under this theory, equity will be issued only when debt capacity is running out and

[50] http://www.investopedia.com/terms/d/debtequityratio.asp

financial distress threatens. The pecking-order theory stresses the value of financial slack. The lack of sufficient slack may land the firm at the bottom of the pecking order, and a choice will have to be made between issuing undervalued shares, taking out loans, and running the risk of facing financial distress, or letting go of and not taking advantage of positive NPV investment opportunities. [51]

5.2.2 Free Cash Flows

Free cash flow equals the cash flow generated by the company's core operations, less any reinvestment back into the business. In other words, free cash flow is the cash flow available to all investors, equity holders, debt holders, and any other nonequity investors after paying for all investments necessary for growth. It is independent of capital structure and is calculated as the following equation:

$$FCF = NOPLAT - \text{Net Investment}$$

Net operating profit less adjusted taxes (NOPLAT) represents the profits generated from the core operations of the business after deducting the income taxes related to the core operations.

Net investment is the rise in invested capital from one year to the next. [52]

Free cash flow is not the same with net income. They differ in several significant points:

• Income is calculated after interest expense and is the return to shareholders. Free cash flow is calculated before interest expense.

• Income is calculated after various non cash expenses, including depreciation. When we calculate free cash flow, we will add back depreciation.

• Capital expenditures and investments in working capital do not appear as expenses on the income statement. In contrast, they do reduce free cash flow.

Free cash flow can be negative for rapidly growing companies, even if they are profitable, because investment exceeds cash flow from operations. Negative free cash flow isn't

[51] *Brealey, R. A., Myers, S. C. and Allen, F. (2011), "Principles of corporate Finance", (10th ed.). New York: McGraw-Hill/Irwin.*

[52] *Koller, T., Goedhart, M. and Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

normally permanent, fortunately for the company and its stockholders. Free cash flow turns positive as growth slows down and the payoffs from prior investments start to roll in.

It is easy to become mesmerized by the numbers and just do it mechanically when we forecast cash flows. It is very significant to take a strategic view. We must wonder if the revenue figures are consistent with what we expect our competitors to do, and if the costs we have predicted are feasible. We should probe the suppositions behind the numbers to make sure if they are sensible. We must be particularly careful about the growth rates and profitability suppositions that drive horizon values. We must not suppose that the business we are valuing will grow and earn more than the cost of capital in perpetuity. This would be a nice outcome for the business, but not an outcome that competition will tolerate.

We should worry about firm's viability and we should also check whether the business is worth more dead than alive. Sometimes a firm's *liquidation value* exceeds its value as a going concern. Smart financial analysts sometimes discover idle or underexploited assets that would be worth much more if sold to someone else. [53]

5.2.3 Terminal Value

Unlike most projects, companies are potentially immortal. But that does not mean that you need to forecast every year's cash flow from now to eternity. Financial managers usually forecast to a medium-term horizon and add a terminal value to the cash flows in the horizon year. The terminal value is the present value at the horizon of all subsequent cash flows. Estimating the terminal value requires careful attention because it often accounts for the majority of the company's value. Of course, the business will continue after the horizon, but it's not practical to forecast free cash flow year by year to infinity. Moreover, this terminal value can change drastically in response to only minor changes in assumptions. [53]

Value of a firm equals

$$\sum_{t=1}^{t=n} \frac{CF_t}{(1+k_e)} + \frac{Terminal.Value_n}{(1+k_e)^n}$$

[53] *Brealey, R. A., Myers, S. C. and Allen, F. (2011), "Principles of corporate Finance", (10th ed.). New York: McGraw-Hill/Irwin.*

There are three ways to estimate terminal value.

- assuming a liquidation of the firm's assets in the terminal year and estimating what others would pay for the assets that the firm has gathered at that time.
- applying a multiple to the firm's earnings, revenues or book value in that year.
- assuming that the cash flows of the firm will grow at a constant rate forever.

Liquidation Value

In some valuations, we can suppose that the company will stop operations at a point in time in the future and sell the assets it has accumulated to the highest bidders. The estimate that emerges is called a liquidation value and there are two ways in which we can estimate the liquidation value. The first way is to base it on the book value of the assets, adjusted for any inflation during the period. The alternative method is to estimate the value based upon the earning power of the assets. For this estimation, we would first have to estimate the expected cash flows from the assets and then discount them back to the present, using an appropriate discount rate.

There is one additional step that we need to take when valuing equity. The estimated value of debt outstanding in the terminal year has to be deducted from the liquidation value to arrive at the liquidation proceeds for equity investors.

Multiple Approach

In multiple approach, the value of a company in a future year is estimated by applying a multiple to the company's earnings or revenues in that year. While this method is too much simple, the multiple has a huge effect on the final value and where it is obtained can be crucial. If the multiple is valued by looking at how comparable companies in the business today are priced by the market. The valuation becomes a relative valuation rather than a discounted cash flow valuation. If the multiple is estimated using fundamentals, it converges on the stable growth model.

On the whole, using multiples to estimate terminal value, when those multiples are estimated from comparable companies, results in a perilous mix of relative and discounted cash flow valuation. While there are benefits to relative valuation, a discounted cash flow valuation should provide us with an estimate of intrinsic value, not relative value. Therefore, the only consistent way of estimating terminal value in a discounted cash flow approach is to use either a liquidation value or a stable growth model.

Stable Growth Model

In the liquidation value method, we are supposing that a company has a finite life and that it will be liquidated at the end of that life. Companies, however, can reinvest some of their cash flows back into new assets and it has as a result to extend their lives. If we suppose that cash flows, beyond the terminal year, will grow at a constant rate forever, we can estimate the terminal value as:

$$\text{Terminal Value}_t = \frac{\text{Cash Flow}_{t+1}}{r - g_{stable}}$$

The cash flow and the discount rate used will depend upon whether we are valuing the company or valuing the equity. If we are valuing the equity, we can estimate the terminal value of equity as:

$$\text{Terminal Value of Equity}_n = \frac{\text{Cashflow to Equity}_{n+1}}{\text{Cost of Equity}_{n+1} - g_n}$$

We can strictly define the cash flow to equity as dividends (in the dividend discount approach) or as free cash flow to equity. If valuing a company, the terminal value can be written as:

$$\text{Terminal Value}_n = \frac{\text{Cashflow to Firm}_{n+1}}{\text{Cost of Capital}_{n+1} - g_n}$$

where the cost of capital and the growth rate in the method are sustainable forever.

In this section, we will begin by considering how high a stable growth rate can be, how to best estimate when a company will have a stable growth rate and what inputs need to be adjusted as a company approaches stable growth. [54]

In practice, the DCF growth formula is used to determine a company's terminal value in the enterprise DCF model. Approaches based on multiples could provide a further reality check. However, it appears that the terminal value can represent a large amount of total company value and that a small change in the assumptions can have a huge influence on the terminal value.

[54] *http://pages.stern.nyu.edu/~adamodar/New_Home_Page/valquestions/termvalapproaches.htm*

5.3 Static Net Present Value

5.3.1 Definition

Robert Mc Donald states that Static NPV is the net present value of a project at a point in time, paying no attention to the possibility of delaying adoption of the project.

Many of the most important decisions that firms make concern real assets, a term that widely includes factories, mines, office buildings, research and development, and other nonfinancial firm assets. It is possible to analyze investment and operating firm decisions for real assets using pricing models which are developed for financial options. For example, if a firm decides whether or not to build a factory, it will have two choices, call option or investment project. The first choice is the right to pay a strike price to receive the present value of a stream of future cash flows. And the second choice is the right to pay an investment cost to receive the present value of a stream of future cash flows.

Any investment project can be viewed as a call option, with the investment cost equal to the strike price and the present value of cash flows equal to the asset price. [55]

Investment Project	**Call Option**
Investment Cost	Strike Price
Present Value of Project	Price of Underlying Asset

5.3.2 Static NPV Estimation

Robert Mc Donald gives us an example. We can invest in a machine, costing $10, which will produce one widget a year forever. Each widget costs $0.90 to produce. The price of widgets will be $0.55 next year and will increase at 4% per year. The effective annual risk-free rate is 5% per year. We can invest, at any time, in one such machine. There is no uncertainty.

[55] *McDonald, L. R. (2003), "Derivatives Market", USA, Addison Welsey.*

$$NPV_{Invest\ today} = \$0,55 \times \left(\frac{1}{1,05} + \frac{1,04}{1,05^2} + \frac{1,04^2}{1,05^3} + ... \right) - \$0,9 \times \left(\frac{1}{1,05} + \frac{1}{1,05^2} + \frac{1}{1,05^3} + ... \right) - \$10 = \$27$$

If widget production were to start next year, we would pay $27 for the project, that's why it is called the project's Static NPV.

In the early years the project has an operating loss. If the project is activated today, then next year we will have negative operating cash flows, spending $0,90 to produce a $0,55 widget. In addition, at a 5% rate of interest, the opportunity cost of the $10 investment is $0,50 per year. Although the initial cash flows are negative, the widget price is increasing and we will make profit in the future. This eventual profitability due to NPV is positive. This analysis proposes that we might consider waiting until later to invest. Then, [56]

$$NPV_{five\ years\ later} = \frac{1}{1,05^5} \left((1,04)^5 \frac{\$0,55}{0,01} - \$28 \right) = \$30,49$$

We should not invest until annual widget revenue covers marginal production cost ($0,90) plus the opportunity cost of the project ($0,50), at least $1,40.

$$(1+0,04)^n \times 0,55 = 1,40 \Rightarrow n = 23,82 years$$

In others words, we should wait 23,80 years in order for widget price to reach a break-even level.

$$value\ today\ of\ waiting\ 23,82 years = \left[\frac{(1,04)^{23,82} \times \$0,55}{0,01} - \frac{\$0,90}{0,05} - \$10 \right] \times \frac{1}{(1+0,05)^{23,82}} = \$35,03$$

5.3.3 NPV rules

The NPV rule for making investment decisions involves two steps:

- Compute NPV by discounting expected cash flows at the opportunity cost of capital.

[56] *McDonald, L. R. (2003), "Derivatives Market", USA, Addison Welsey.*

- Accept a project only if its NPV is positive and it exceeds the NPV of all mutually exclusive alternative projects.

If we accept the project today, Static NPV ignores project delay. Static NPV measures the value of an action we could take, in other words to invest today. It at least provides a lower bound on the value of the project. [57]

5.3.4 Static NPV Model

The Static NPV model assumes that the firm's value can be found by adding Static net present value to the value of the growth opportunities (PVGO). As a result, we have the following equation,

$$Company\ Value = StaticNPV + PVGO$$

PVGO is the present value of cash flows to shareholders from the company's future investments.

5.4 Future Assets in place

5.4.1 Definition

The market value of the company consists of the value of assets in place and the present value of growth opportunities (PVGO). The PVGO reflects the value of future investments, which are expected to yield rates of return more than the opportunity cost of capital. When the competitive process is halted or delayed, then there are growth opportunities. Competitive process drives the rates of return on capital investment projects toward the company's cost of

[57] *McDonald, L. R. (2003), "Derivatives Market", USA, Addison Welsey.*

capital. In general, when there are limits to entry arising from economies of scale, product differentiation, brand loyalty, or patents, the company can delay the competitive process. The value of growth opportunities can be regarded as the present value of the company's options to make future investmenṭproviding that the company does not have the obligation to undertake all of its future investment opportunities.

An important portion of the market value of equity is accounted for by growth opportunities. Kester argues that the value of growth opportunities is half or more of the market value of equity for many firms. In addition, he finds that the fraction is about 70% to 80% in industries with high demand volatility. Pindyck calculates that the fraction of market value attributable to the value of capital in place should be only one-half or less for firms with reasonable demand volatility. More exactly he believes that if demand volatility is 0.2 or more, more than 50% of the company's value is accounted for by its growth opportunities. [58]

The present value of future growth opportunities combines both volatility and adaptability. Volatility involves not only project demand, but also technological change and competitive moves. PVGO may be normalized if it is expressed as percentage of the company's share price and can often be extracted from financial market data.

Total value consists of the net present value and the value of the growth opportunities. [59]

$$Expanded\ NPV = NPV + PVGO \text{ or } Expanded\ (strategic)\ NPV = direct\ NPV + PVGO$$

Where $NPV = V - I$

5.4.2 Estimating Assets in Place and Growth Option Value

We can estimate present value of growth opportunities in a direct or indirect way from the financial markets. If we choose the direct method, option valuation methods can be used to estimate the firm's set of strategic options. Identifying the individual strategic options for the firm and their interactions, and estimating their parameters are necessary to such direct valuation of the value of the growth option component using option valuation methods. These

[58] *Kee, H. Chung and Charlie Charoenwong, (2013), "Investment Options, Assets in Place, and the Risk of Stocks", Wiley, 21-33.*
[59] *Smit, T. J. H., Trigeorgis, L. (2004), "Strategic Investment, Real Options and Games", USA, Priceton University Press.*

estimation and valuation complexities by using the consensus market assessment of the company's bundle of strategic options aren't necessary to the indirect method. The second method deducts the static or non-growth component associated with continued current operations estimated from standard DCF techniques from the observed market equity value. The horizontal coordinate measures the value of assets in place minus the amount, which has already been invested (the direct net present value). [60]

5.4.3 The Future Assets in place model

The value of a firm could be established by adding a firm's strategic real options value to its future assets in place.

$$Company\ Value = Future\ Assets\ in\ Place + strategic\ \mathrm{Re}al\ Options\ Value$$

5.5 The enterprise DCF model in contrast to Real Options Approach

We have already analysed real options methods, binomial or trinomial lattices, decision trees and Monte Carlo simulation. The real options approach is not always required. If the investment is either incredibly valuable or a "total dog", real options approach can't change the result. However, real options analysis can help when many decisions need hard-headed thinking.

The enterprise DCF works well when there are no options at all or there are options but very little uncertainty. Traditional tools correctly value the business, which steadily produces the same or gently declining cash flows each year without further investment. In addition, traditional tools correctly value products that have no follow-on opportunities. The main disadvantage of DCF analysis is the fact that we must forecast sales, profit margin, the growth rate and a firm's terminal value. Another problem is that future investment decisions are fixed at the outset. Although the investment plans can be revised and updated, traditional tools

[60] *Smit, T. J.H., Trigeorgis, L. (2004), "Strategic Investment, Real Options and Games", USA, Priceton University Press.*

include only the initial plan. The real options approach recognises this uncertainty. Amram and Kulatilaka point out that uncertainty creates opportunities, and real options can function as a solution to estimating high growth, negative cash flow generating companies. In contrast to real options approach, traditional tools don't work well in the lack of positive cash flows.

The discounted cash flow approach produces a "show-stopping" dilemma. For example, if the option to abandon is used, the asset is abandoned having as a result no risk. If the option to abandon isn't used and the asset isn't abandoned, it is extremely risky to hold the option. These risky cash flows can't be discounted to the present. However, decision analysis and simulation models use the probabilities for each outcome and break discount rate problem while the enterprise DCF suffers from the discount rate dilemma.

- *DCF with scenario analysis.* If we choose the DCF analysis with scenarios, we must incorporate uncertainty, but each scenario on a single expected outcome and investment plan can't change. Consequently, we have no chance to choose between scenarios.
- *Decision tree analysis.* This method is a way to lay out decisions about the future and sources of uncertainty. It relies on subjective discount rates and assessments of probabilities, and preferences about the objective.
- *Simulation analysis.* In this analysis there are a lot of possible paths for uncertain variables. It depends on subjective discount rates and doesn't incorporate financial market data. Therefore, it is very difficult to interpret the results of simulation analysis.

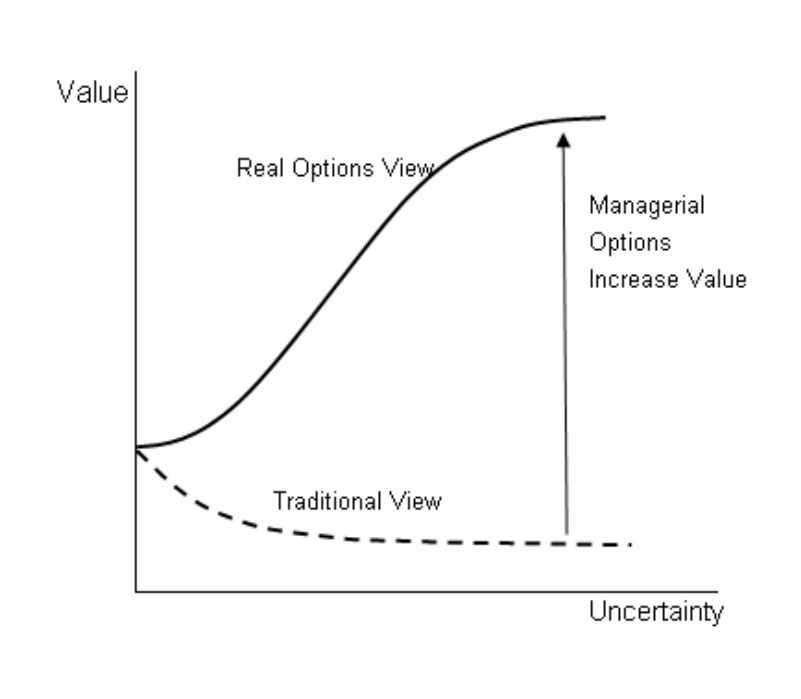
A real option analysis is required in the following situations:

- If there is a contingent investment decision, no other analysis can accurately estimate the type of opportunity except for real options approach.
- If uncertainty is big enough, it is sensible to wait for more informational data, avoiding repentance for irreversible investments.
- When value lies in a company's future growth potential instead of current cash flow.
- Only the real options analysis can value flexibility investments.
- In the event that projects are updated and strategy is corrected half way through the course of the plan. [61]

[61] *Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.*

Uncertainty increases Value

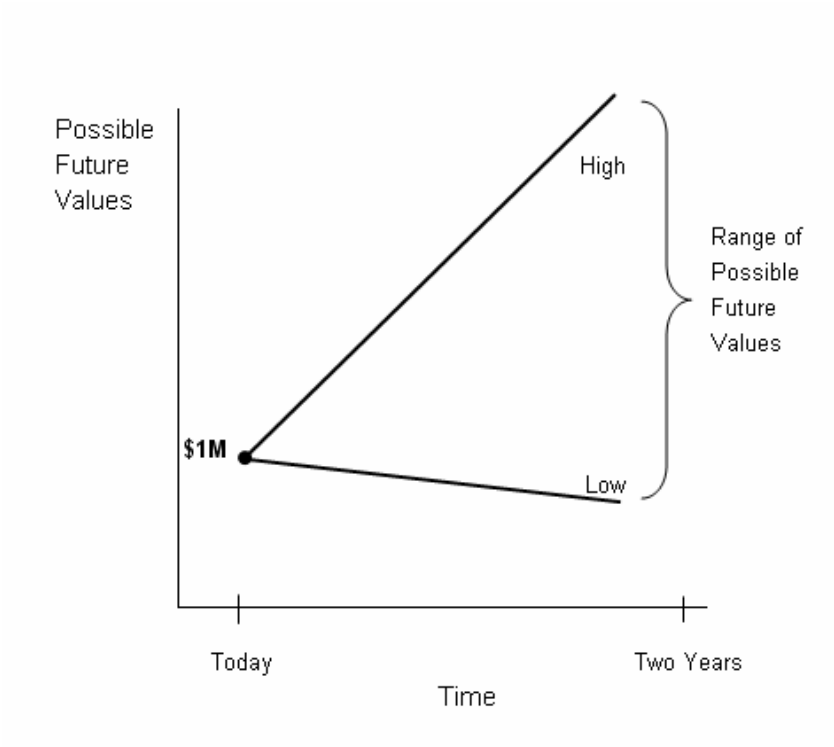
A lower asset value is caused by a higher level of uncertainty in the traditional view. Managers should recognize and take advantage of uncertainty because it creates opportunities. If managers succeed in identifying and using their options to flexibly respond to unfolding events, then the real options approach shows that increased uncertainty can lead to a higher asset value.



Source: Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.

The Resolution of Uncertainty

The resolution is the link between time and uncertainty. The following figure illustrates how value might evolve over time. The point "today" in the figure depicts today's value of the company, which is $1 million. The width of the range of outcomes depends on the length of the time horizon while the range of uncertainty increases with the time horizon. The cone of uncertainty has upward tilt, which means that the company's value is expected to grow during the two years.



Source: Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.

According to Amram and Kulatilaka, real options approach is an essential way of thinking about strategic investments. If managers succeed in using this way of thinking, identical results for some applications can be produced. [62]

[62] *Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.*

CHAPTER 6
REAL OPTIONS – COMPANY VALUATION- STRATEGIC PLANNING

The objective of this chapter is to ascertain the functions of real options. In the previous chapter we mentioned functions of real options, but in this chapter the goal is to state their possible functions. These possible functions should be used to improve the firm's valuation. In addition, we will state the possibilities and the need to put into use these functions. Finally, there will be evaluation as to when real options theory should be used from a theoretical perspective for the functions.

6.1 Strategy as a Portfolio of Real Options

Luehrmam defines strategy as a path from where organizations are now to where they want to be some years down the road. In competitive markets, no one expects to formulate a detailed long-term plan and follow it easily and directly. Creating the path, executives firstly learn about business conditions, competitors' actions, the quality of planning and they need to be flexible to what they learn. Regrettably, the financial tool relied on to estimate the value of strategy (discounted cash flow (DCF) valuation) supposes that we will follow a predetermined plan.

Incorporating both the uncertainty inherent in business and the active decision-making would be a better approach to valuation. This approach would be more likely to lead to a successful strategy, helping businesspersons to think in a strategic way by capturing the value. It would activate executives, discouraging passive management. This extra insight can be delivered by options. Luehrmam refers to business strategies as chains of real options. Valuation analyses can inform the creative activity of strategy formulation sooner rather than later. Financial insight might contribute to shaping strategy.

A business strategy looks more like a series of options than a series of static cash flows. Drawing a strategy always involves making a sequence of major decisions. Executives take

some decisions immediately and move on to actions, but they deliberately defer some others. Managers can optimize as circumstances evolve. Luehrmam defines the strategy as the framework within which future decisions will be made, leaving room for learning from ongoing developments and for discretion to act based on what is learned. [63]

Option pricing could be used to improve decision-making about the sequence and timing of a portfolio of strategic investments. It can help managers become more effective and estimate the value of the entire years' produce or sales. Real option theory is a special case of all possibilities to capture strategic growth value. Strategic growth value is the value derived from a firm's strategic real options and could be estimated either *bottom-up (customer-based)* or *top-down (market-based)* approach. Forecasts should be in accord with historical economy-wide evidence on growth. [64]

6.1.1 Build the Revenue Forecast

The enterprise discounted cash flow (DCF) relies on forecasted free cash flow, but FCF forecasts should be created indirectly by first forecasting the income statement, balance sheet, and statement of retained earnings. As noted earlier, to build a revenue forecast, an analyst can use a *top-down* forecast, in which he estimates revenues by sizing the total market, determining market share, and forecasting prices. Alternatively, with the *bottom-up* approach, he can use the firm's own forecasts of demand from existing customers, customer turnover, and the potential for new customers. The use of both methods can lead to establishing bounds for the forecast.

Any company can apply the top-down approach. For companies in mature industries, the aggregate market grows slowly and is closely tied to economic growth and other long-term trends, such as changing consumer preferences. In these situations, executives can rely on professional forecasts of the aggregate market, and focus their own efforts on forecasting market share by competitor. If they choose to do this, they must determine which companies have the capabilities and resources to compete effectively and capture share. Historical financial analysis is a good place to start with if they have already made sure to address how

[63] *Luehrmam, T. A. (1998), « Strategy as a portfolio of real options", Harvard Business Review, September-October 1998, 89-99.*
[64] *Koller, T., Goedhart, M. and Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

the firm is positioned for the future. For instance, if it has the required products and services to capture share, and if other competitors have products and services that will displace the firm's market position. Each of these issues will be addressed by a good forecast.

Over the short term, top-down forecasts should build on the company's announced goals and capabilities for growth. For example, retailers have well-mapped plans for new store openings, which are their primary driver of revenue growth. The top-down approach is especially helpful in emerging-product markets, but often requires more work than for established markets.

A bottom-up approach relies on forecasts of customer demand in contrast to a top-down approach, which starts with the aggregate market and projects penetration rates, price changes, and market shares. In some industries, a firm's customers will have calculated their own revenue forecasts and can give their suppliers a rough estimate of their own purchase predictions. By aggregating across customers, it is easy to determine short-term projections of revenues from the current customer base. Furthermore, the next step is to estimate the rate of customer turnover. If customer turnover is important, managers have to eliminate a portion of estimated revenues. Then the final step is to project how many new customers the firm will attract and how much revenue those customers will contribute. The resulting bottom-up forecast combines new customers with revenues from existing customers.

Despite the method, predicting revenues over long time periods is not exact. Customer preferences, technologies and corporate strategies change significantly. These unpredictable changes can profoundly affect the winners and losers in the marketplace. In addition, executives must constantly reevaluate whether the current forecast is in accord with industry dynamics, competitive positioning, and the historical evidence on corporate growth. [65]

6.1.2 Bottom-up Valuation Strategic Real-Options

It is important to explore the potential to value strategic real options value bottom-up. It indicates whether the future assets in place model could be operationalised in order to improve the enterprise discounted cash flow model (DCF). If executives can identify all

[65] *Koller, T., Goedhart, M. and Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.). Hoboken, NJ, USA: John Wiley & Sons, Inc.*

strategic real options, which a company possesses, and determine their joint possibility density function, a bottom-up valuation of a firm's strategic real options should be possible.

It is now recognized that standard discounted cash flow (DCF) techniques, when applied improperly, often undervalue projects with real operating options and other strategic interactions. In practice, many executives overrule passive net present value (NPV) analysis and use intuition and executive judgment to value future managerial flexibility.

Interactions among real options, which are present in combination generally, make their individual values non-additive. There is interaction between certain options, which is perceived by many readers. However, the nature and extent of these interactions as well as their positive or negative impact may not be negligible.

The combined value of operating options can have a large impact on the project value. On the other hand, the increasing value of an additional option is usually inclined to be lower the greater the number of other options already present. Neglecting a particular option while including others may not necessarily cause crucial valuation errors. Nonetheless, if we value each option individually and sum these separate option values, we can considerably exaggerate the value of a project. Configurations of real options, which can exhibit exactly the opposite behavior, are also identified. In spite of interactions, projects that are collections of real options preserve a number of the familiar option properties.

When options are written on distinct assets, additivity of individual option values isn't essential. On the other hand, when the options are written on the same unique underlying asset, option additivity is crucial. First of all, the value of the effective underlying asset for earlier options is increased by the mere presence of subsequent options. In effect, the whole portfolio of gross project value as well as the value of potential future options is the underlying asset of prior real options. At an extreme, the inseparability of real options from their underlying asset allows also the possibility of exercising a prior put option on the asset. For example, the option to abandon early, may eliminate or "kill" that asset. Because of the real asset's uniqueness and unavailability of other identical assets, this may preclude exercising future options on it.

The underlying asset itself and the value of subsequent options on it may be altered by exercise of a prior real option, thus causing a second-order interaction.

Although the values of real options may not be additive, the combined flexibility that they afford management may be as economically crucial as the value of the project's expected cash flows. Other situations where high interactions seriously invalidate option additivity are also

identified. In conclusion, interactions depend on the type, separation, degree of being in or out of the money, and order of the options involved. These factors impact on the joint possibility of exercise. Interactions between pairs of options may be positive or negative.

The incremental value of certain options may be reduced in the event that negative interactions are more prevalent in a given project. In this case, ignoring such negative interactions may not create significant errors in valuation. It has been confirmed by sensitivity analysis results that when there is a variety of interacting real options within projects, familiar option properties are preserved. [66]

Strategic Opportunities

A corporate investment opportunity is like a call option. The corporation has the right, not the obligation, to acquire the operating assets of a new business. If we could find a call option sufficiently similar to the investment opportunity, the value of the option would tell us something about the value of the opportunity. Most business opportunities are unique and this results in little likelihood of finding a similar option. The only solution is to construct a similar option. [67]

Today's investment changes the rules of the market or tilts a market outcome toward one competitor. Hence, blending insights from game-theoretic models of strategic market interactions with real options models of investment in uncertain markets are required. It is really hard to do this in a way that provides a general way of thinking about trade-offs. Companies use strategic investments either to shelter themselves from adverse outcomes while capitalizing on the good outcomes or to change the market structure itself enhancing upside benefits.

An investment opportunity can be viewed as the purchase of a "strategic growth option". This option allows the firm to capture the upside of a potentially good market. In addition, the option has the strategic effect of influencing competitor behavior. If we want to model the benefits of the growth option, we must capture a greater market share. The capabilities of taking advantage of future growth opportunities are obtained by investments. The competitive value of the capabilities may deter possible new entrants and limit the output of those who enter. This stylization captures the benefits and risks of an investment.

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[66] *Trigeorgis, L. (1993), "The Nature of Option Interactions and the Valuation of Investments with Multiple Real Options", March 1993, The Journal of Financial and Quantitative Analysis, 28 (1), 1-20.*

[67] *Luehrman T. A. (1998), "Investment Opportunities as Real Options: Getting Started on the Numbers", Harvard Business Review, July- August 1998.*

The strategy choice can be modeled as the option to wait or the growth option. The payoff to the growth option is volatile to the underlying because of early entry results in larger market share and higher profits. However, the payoff to the option to wait is flatter and allows a firm to avoid investment if the market value is unattractive.

The relative values of three variables, the cost to enter, the impact of the investment on the market structure and the level of uncertainty, determine the best strategy. The growth options sometimes are more volatile to uncertainty than the option to wait. [68]

Short-Term and Distant Strategic Opportunities

As short-term strategic real options we represent the opportunities, which are identified by managers before a certain time T in a DCF analysis. In the long term, after the time T in a DCF analysis, new investment opportunities will arise.

Before the time T, strategic opportunities are recognized by management or the market. Short-term strategic real options will be present both on project level and on the management level. Managers should monitor strategic real options and they should decide to execute then when they become in the money. Strategic real options could be estimated separately as valuation of this kind of compound, and rainbow options can be made. Joint valuation of this kind of options would be a challenge over and over again for each firm.

If a firm acts in a market with fast development, after the time T there will be a lot of possibilities to grow faster. There will be also a lot of risks, which can result in a lower growth than the long term rate of consumption growth for the industry's products or even in bankruptcy. If we suppose that every firm in a certain industry will possibly have the same opportunities, they will have the same distant strategic opportunities. Distant strategic opportunities could not be valued with the real options approach because it is necessary that the value drivers and the investment costs related to the opportunity be known. We should suppose that the future free cash flows of a firm after the time T will increase with a growth rate equal to the long-term rate of consumption growth for the industry's products plus inflation.

Identification of distant strategic opportunities might be possible. However, these opportunities cannot be translated to Real-Options. The value of distant strategic opportunities need to be known by using the long-term rate of consumption growth for the industry's

[68] *Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.*

products plus inflation for including FCF growth after time T. Hence, it should be possible to operationalise the valuation of strategic real options by a bottom-up valuation. We should use the expectation of the long-term rate of consumption growth for the industry's products plus inflation to take into account the value of distant strategic opportunities.

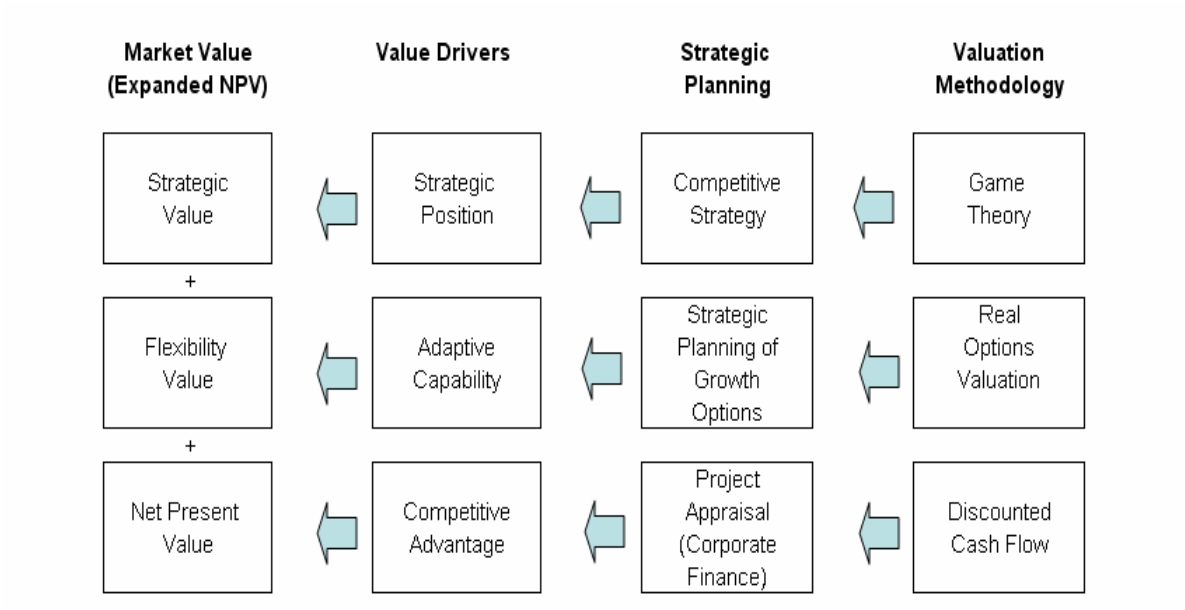
6.1.3 Bottom-up Valuation Present Value of Growth Opportunities

If executives can identify all flexibility and strategic real options, which are possessed by a company, and determine the potential density function, a bottom-up valuation of a company's PVGO should be possible. In addition, executives should incorporate all factors, which can cause deviations in a company's free cash flows, in a company's PVGO.

Because of identification of all flexibility and strategic real options, and determining their complex and time consuming interactions, a bottom-up valuation of a company's PVGO is more difficult in every aspect than a bottom-up valuation of a company's strategic real options. Operating managers can forecast the effect of market trends and flexibility of real options on an exact firm's FCF very well.

6.1.4 Top-down Valuation Present Value of Growth Opportunities

When a company trades in a dynamic environment, strategic adaptability is crucial in capitalizing on favorable future investment opportunities or responding appropriately to competitive moves. A company's growth opportunities and its strategic position in the industry are reflected in stock market prices. This doesn't mean that all stocks yield the same earnings stream or have the same growth potential. Growth stocks usually yield high price earnings and market to book ratios.



Source: Smit, T. J. H., Trigeorgis, L. (2004), "Strategic Investment, Real Options and Games", USA, Priceton University Press.

According to Smit and Trigeorgis, the broader strategy framework recognizes three levels of planning. These levels have an effect on the market value. First of all, project appraisal from corporate finance aims at determining the effect on the NPV of the projected cash flows resulting from establishing a competitive advantage. Furthermore, strategic planning of growth opportunities aims at capturing the flexibility value resulting from the company's adaptive capabilities through real options valuation. In addition, competitive strategy aims at capturing the strategic value from establishing, enhancing or defending a strategic position based on game theory analysis and industrial economics.

The table depicts that industries with higher volatility and market or total risk tend to have more valuable growth opportunities and a higher proportion of PVGO to price than other industries. Growth companies (e.g. information technology, pharmaceuticals) tend to have a higher option value component than income stocks. This means a higher option value. Moreover, growth companies tend to have a greater proportion of compound options, which results in higher option value. The higher option value is translated into higher market valuations. [69]

[69] *Smit, T. J. H., Trigeorgis, L. (2004), "Strategic Investment, Real Options and Games", USA, Priceton University Press.*

6.2 Forecast Valuation Parameters

The real options approach, as a method to valuation, is introduced by direct analogy to financial options. For example, if executives have this nonlinear payoff, they use the Black-Sholes formula and the five implement factors (the current value of the underlying asset, the leakage in value that accrues between decision points, the volatility of the underlying asset, private risk, risk free rate of return). It easy to suppose that forecasting is not required for real options valuation because financial market inputs are directly observable. It may also require estimates of several inputs, the convenience yield, the volatility of the asset and the private risk.

All valuation models need forecasting. The real options approach emphasizes the type of forecast needed, which is relevant to the risk and return dynamics of asset pricing. If assets are traded on financial markets, the asset price will embed the forecasts of the market players. However, if a financial or real option is valued using financial market information, the market's forecast will be used. When the underlying source of uncertainty in a real options approach isn't an asset traded in financial markets, the real options model proposes how to obtain the forecast in a manner relevant to the market pricing of risk. In addition, the structure of the option application accentuates discrepancies between subjective forecasts and market pricing. [70]

6.2.1 Discount Rate

The approaches to mathematical framing require forecasting the future or knowing the entire distribution of future values and the characterization of uncertainty could lead to subjectivity. In economic applications, a discount rate is needed. The weighted average cost of capital is a theoretically correct discount rate for a firm. Additionally, a tool to improve the establishment of the weighted average cost of capital isn't given by the real options theory. The models and the assumptions to establish the cost of equity, the cost of debt and tax, and the debt to equity ratio of a firm are therefore adopted. The cost of equity is sometimes adjusted for risks related

[70] *Amram, M. and Kulatilaka, N. (1999), "Real Options, Managing Strategic Investment in an Uncertain World", Harvard business school press, United States of America.*

to liquidity uncertainty or risks related to small firm uncertainty or for some others specific risks. Now it is crucial to mention that the real options theory is not suited to improve the establishment of risk premiums. However, the real options model is specifically suited to translate uncertainty to upside potential.

6.2.2 Free Cash Flow and Terminal Value

The amount of the future free cash flows to a firm plays a vital role in the valuation of the firm. Free cash flows are influenced by sales growth, the cost of sales, investments in fixed assets and the investments in working capital.

In the enterprise DCF model, free cash flow needs to be estimated for T years. After T years, it is usually assumed to grow with a constant growth rate g. If the growth rate g is fixed, the company is able to constantly invest against a premium over its WACC. The company's previous investments will remain competitive and will also earn a premium forever. All these assumptions are essential in determining a firm's terminal value with the perpetuity growth formula. Real options theory does not supply a better tool to determine a firm's terminal value. A growth-rate is used to establish a terminal value.

It is not possible to forecast most projects' actual cash flows accurately. DCF calculations do not call for accurate forecasts, however, but for accurate assessments of the mean of possible outcomes.

Executives can often make reasonable subjective forecasts of the operating variables they are responsible for, such as operating costs, market growth, market share, and so forth, at least for the future that they are actually worrying about. It is difficult for them to translate this knowledge into a cash flow forecast for year T. There are several reasons for this difficulty. First, the executive is asked to look into a far future he is not used to thinking about. Furthermore, he is asked to express his forecast in accounting rather than operating variables. Final, incorporating forecasts of macroeconomic variables is difficult. As a result, long term forecasts often end up as mechanical extrapolations of short-run trends.

It is easy to overlook the long-running pressures of competition, inflation, and technical change. Up to the moment T, forecasts of the development of free cash flow can be very good. Real options theory could assist with incorporating value inherent to managerial

flexibility. Flexibility and strategic real options could assist in regard to a firm's operational and strategic activities. Flexibility value, which is related to a company's assets in place, is in the short term often well understood and is therefore well incorporated in the forecast of free cash flow up to a moment T. As time T should be that point in time for which the business will operate at a balance level, value inherent to a company's flexibility of real options after time T is already included in the best possible way. Strategic real options value up to a moment T is usually partly embedded in the enterprise DCF model. It could be included by adjusting all the factors influencing free cash flow upwards as executives understand that they will profit from some currently unknown strategic opportunities in the future. Furthermore, it could also be included by modelling different scenarios related to future uncertainty.

To sum up, the enterprise DCF model forecasts the amount of free cash flows mostly as accurately as possible up to moment T, but that after moment T, parameters that can be subject to heavy criticism predict the amount of free cash flows. The determination of the variables, which are used in the enterprise DCF model, cannot be improved by real options theory. However, the real options approach can assist with including value inherent to managerial flexibility. The enterprise DCF approach takes value inherent to flexibility real options into account well. However, the enterprise DCF model can be improved for taking into account value inherent to strategic real options. Up to moment T, strategic real options value is not usually completed incorporated. This can be achieved either by adjusting critical parameters in the free cash flow forecast or by modelling different scenarios related to future uncertainty. Real options theory could aid with a complete and correct valuation of a firm's short-term strategic real options. After time T , strategic real options value is incorporated well. Market and private risks probably drive the way to apply real options theory to unforeseen investments. [71]

6.3 Option Space

Luehrmam introduces Option Space framework. According to him, option space is defined by two option value metrics, each of which captures a different part of the value related to be

[71] *Myers, S. C. (1984), « Finance Theory and Financial Strategy", Interfaces, 1984 (February), 126-137.*

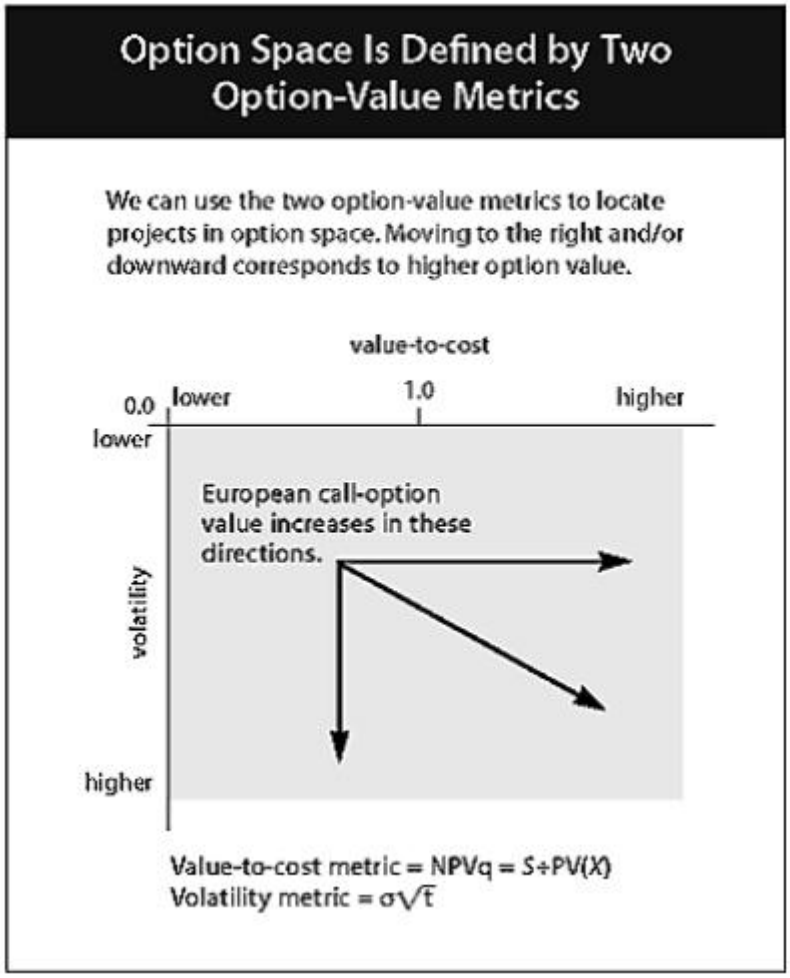
able to defer an investment. Option Space can help executives whether to invest or not, when the investment takes place, and what to do for the time being.

The first metric, NPVq, is defined as the value of the underlying assets a firm intends to build or acquire divided by the present value of the expenditure required to build or buy them. This metric includes all the usual information captured in the net present value plus the time value of being able to defer the investment. This metric is called value-to-cost and value and cost refer to the projects' assets, not to the option on those assets. The project is worth more than the present value of its cost, if the metric value-to-cost is more than one. On the contrary, the project is worth less than the present value of its cost if the metric is between zero and one.

$$Value-to-\text{cost}\ \ metric = NPVq = S \div PV\left(x\right)$$

The second metric is called volatility metric and it measures how much things can change before an investment decision must be made. The parameters which influence the metric are the future value of the assets in question (the voice of uncertainty and risk) and how long a decision can be deferred.

$$Volatility\ metric = \sigma\sqrt{t}$$



Source : Luehrmam T. A. (1998), "Strategy as a portfolio of real options", Harvard Business Review, September-October 1998, 89-99.

At the above graph, the horizontal axis depicts value-to-cost metric and the vertical axis depicts volatility. As we consider at the graph, while the value-to-cost is increasing, the volatility metric is increasing too. The volatility minimum value is zero. In addition, the option value is increasing as the value of either metric is increasing.

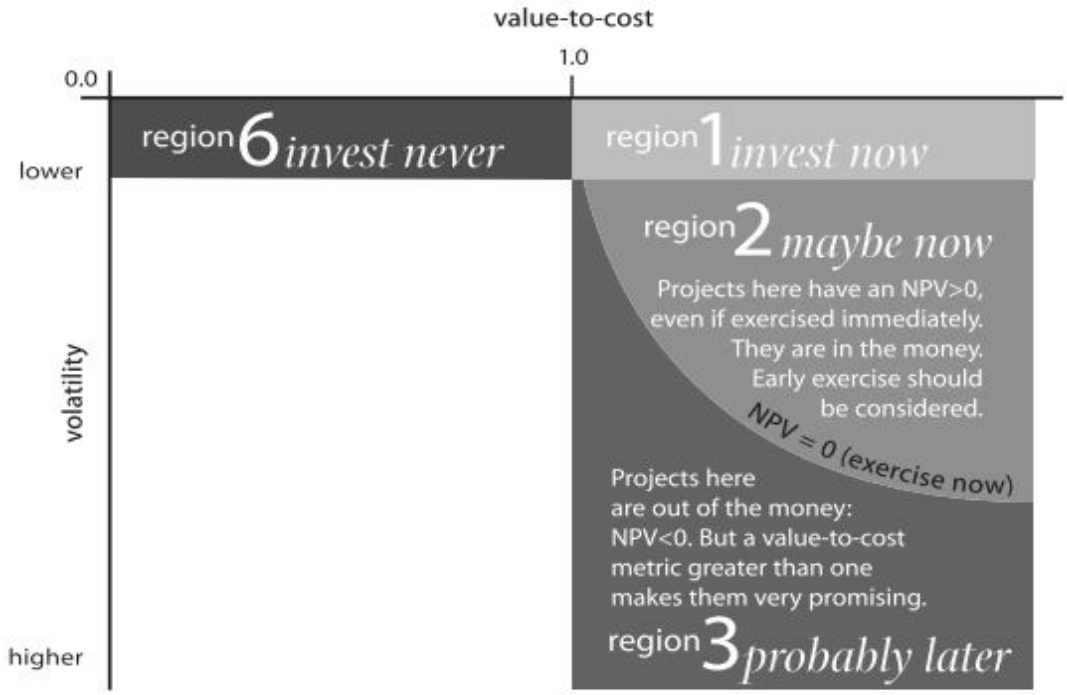
According to Luehrmam, option space helps a company with strategy. Traditional corporate finance gives only one metric, NPV, for evaluating projects and two potential actions. Invest or don't invest. Option space uses NPV, value-to-cost and volatility metrics and six possible actions. Option space suggests actions which reflect not only where a project is now but also the probability of it ending up somewhere better in the future. [72]

Top of the space: Now and Never

Right side of the space: Maybe Now and Probably Later

[72] *Luehrmam T. A. (1998), "Strategy as a portfolio of real options", Harvard Business Review, September-October 1998, 89-99.*

Left side of the space: Maybe Later and Probably Never



Source: Luehrman T. A. (1998), "Investment Opportunities as Real Options: Getting Started on the Numbers", Harvard Business Review, July- August 1998.

CHAPTER 7
REAL OPTIONS – OPERATIONALISATION

The difference between short-term strategic real options and distant strategic opportunities does not give any data about the expiration date of the short-term strategic real options and the time of the future cash flow streams after execution of these options. The FCF before and after the time T could be impacted by short-term strategic real options. Taking into consideration the interaction between strategic real options must be possible and will not be as complex as it is for real options with the same underlying asset, which we might meet on project-level. The real options that should be taken into account are the options that are currently considered as possible future opportunities, the short-term strategic real options.

The objective of this chapter is to operationalise the valuation of a company's short term strategic real options. We will use a model which combines real options theory with the enterprise DCF. We will frame an approach on how and when short term real options should be valued and incorporated into a company valuation model.

7.1 Real Options Analysis

Amram states that strategic planning needs finance. Present value calculations are needed as a check on strategic analysis and the other way around. Standard discounted cash flow techniques will be inclined to understate the option value attached to growing profitable lines of business. Corporate finance theory needs extension to deal with real options. [73]

Real options agree with the traditional views that value can be created through consolidation, as scale and the collection of high quality assets and capabilities alter the strategic position of the bidder and the industry structure can be modified. Nonetheless, the real options method deals with the uncertainties involved in a strategy better than traditional methods. Serial investment strategies have long term horizons, in which it is very likely for unforeseen economic events to take place. Real options analysis encourages flexible pursuit of a variety of possible transactions.

[73] *Amram, M. and Kulatilaka, N. (2000), "Strategy and shareholder value creation: the real options frontier" Journal of Applied Corporate Finance, 13.2 (Summer), 15-27. / Myers, S. C. (1984), "Finance Theory and Financial Strategy" Interfaces, 1984 (February), 126-137.*

In real options theory, the market value of companies isn't the NPV of its future cash flows. The theory incorporates the perspective value of its growth options. In other words, it encompasses the value of the potential options that might come the firm's way in the future, as well as the evolving and future strategic position of the firm. As a result, strategic value of growth opportunities adds up to a crucial part of a company's market value. [74] Thus:

$$Market\ Value(MV) = Assets\ in\ place(PV) + \Pr esent\ Value\ of\ growth\ options(PVGO)$$

Smit and Moraitis describe PVGO as the strategic value of a company, where according to Kester's definition, any value derived from growth is incorporated in a company's PVGO. We therefore adjust the term PVGO in the above equation to strategic real options value. So the previous definition becomes then as follows:

$$Market\ Value(\mathrm{MV}) = \mathrm{Assets}\ \ in\ place(PV) + strategic\ \ \mathrm{Re}al\ Options\ Value$$

Uncertain future opportunities can be valued with real options analysis too. Consequently, if we replace the present value of the assets in place with the present value of the future assets in place, we will have the following equation:

$$Market\ Value(\mathrm{MV}) = Future\ \ \mathrm{assets}\ \ in\ place(PV) + strategic\ \ \mathrm{Re}al\ Options\ Value$$

As we have seen in previous chapters, we can conclude at the equation:[75]

$$Company\ Value = Static\ PV + PVGO = Future\ Assets\ in\ place(PV) + strategic\ \ \mathrm{Re}al\ Options\ Value$$

Real options are a complement to, not a substitute for, discounted cash flow analysis by valuing a company's short-term strategic real options. Strategic and financial analyses could be aligned by the valuation of strategic real options. We should use the future assets in place (PV) model to integrate a bottom-up valuation of a company's strategic real options with a DCF analysis.

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[74] *Kester, W. C. (1984), "Today's Options for Tomorrow's Growth", Harvard Business Review, 62 (2), 153-160.*

[75] *Smit, T. J. H. & Moraitis, T., (2010), "Serial Acquisition Options", Long Range Planning, 43 (1), 85-103.*

The DCF valuation approach estimates enterprise value as the present value of future free cash flows discounted at the weighted-average cost of capital (WACC). We have already seen that:

$$PV = \sum_{i=1}^{n} \frac{FCF_n}{(1+WACC)^n}$$

$$PV = \underbrace{\frac{\mathrm{FCF}_1}{1+\mathrm{WACC}} + \frac{\mathrm{FCF}_2}{(1+\mathrm{WACC})^2} + \ldots\ldots + \frac{\mathrm{FCF}_\mathrm{T}}{(1+\mathrm{WACC})^\mathrm{T}}}_{PV(free.cash.flow)} + \underbrace{\frac{PV_T}{(1+WACC)^T}}_{PV(terminal.value)}$$

7.2 A practitioner's Guide

In this paragraph we will analyse the whole process to company valuation via the real options approach. First of all, we must examine in detail the company profile and then we must value the real options.

- Business Overview
- Real Options Analysis

7.2.1 Business Overview

Firstly, it is necessary to accumulate information about:

⇒ Where the firm trades, if the company is international or not

⇒ How many years the company has traded

⇒ What its knowledge and experience is

⇒ What its capabilities are

⇒ What its activity is (products or services)

⇒ Raw materials

⇒ Its goal, vision, the mission, the strategy and the culture

⇒ If there is corporate social straight

⇒ The number of employees and the management structure

⇒ Where company's headquarters, production plant, sales offices and sales points are

⇒ The total surface of the facilities

⇒ If there are agreements with selected resellers

⇒ Who are suppliers and clients

⇒ Company's shareholder structure and if it is in stock

⇒ Information about the industry

⇒ The competitors and the niche market

⇒ If there is strategic alliances with other companies

⇒ What its competitive advantage is

⇒ Market opportunities (Broaden product offering, develop new products and international expansion)

⇒ SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)

⇒ Financial statements

7.2.2 Real Options Analysis

To value the real options, we first have to identify a company's strategic real options. In case we cannot identify any strategic real options, we should look at market based indicators to make an estimation of whether the company possesses strategic real options value. Then, we should assess if the identified strategic real options have important value to take into account. If this isn't obvious, we should use Luehrman's option framework (value-to-cost and volatility metrics). Supposing that the strategic real options possess value, we must determine which risks drive the value of these real options, whether private risks can be isolated and how these real options should be structured. After the valuation of single real options, we must evaluate the effect of interaction between the short-term strategic real options.

7.2.2.1 Identification of Real Options

If a company's management has adopted real options thinking, they will see the general market opportunities and an industry's shared real options. If a company's management doesn't see opportunities for their company to broaden its product supply or to develop new products, as the identification of strategic real options, these opportunities will drop out.

Supposing that from the three future opportunities a company's management realizes, the opportunity to increase sales by using their excess capacity and invest additionally in their sales network is a flexibility real option. The exploitation of current assets in place will generally be a continuous debate between the operational manager and the sales manager. These managers should therefore be able to incorporate any future value derived from utilising company assets more effectively. It is therefore necessary that the effects of this possibility be taken into account in their FCF forecast for the value of the company's future assets in place.

7.2.2.2 Evaluating Strategic Real Options

A real option should be seen as a future opportunity that is created by today's investments. Furthermore, real options theory should be seen as a way of thinking that helps managers develop their strategic options. This statement implies that future strategic opportunities could be real options as well and that the use of financial option-pricing theory to value real options is not obligatory. There are four possible methods to determine the value of a strategic real option:

- Option-pricing methods in combination with decision analysis
- Decision analysis
- Option-pricing methods in combination with the MADD approach
- Option-pricing methods in combination with both decision analysis and the MADD approach

We should evaluate if the identified strategic real options are valuable enough to take into account. We can do this either using logical sense or using the Luehrman's option space framework. According to Luehrman, his option space framework (value-to-cost and volatility metrics) is effective and simple, as managers should determine the present value of a project's operating assets and the costs to acquire these assets also for a DCF analysis. This framework gives managers a way to organize the effects and offers a visual interpretation. However, Luehrman assumes that the practitioner's objective is the valuation of the opportunity, where our objective is to value a company. All nearly information that we need to actually value the strategic real options is the required information, the real options asset's value, its exercise price, its volatility and the applicable risk free rate. We are going to use some logical sense while this information is not usually available.

For example, if a company realises relatively high margins on its products, we assume that its main risk for turning its opportunities into a success is reaching a certain sales volume. Only management can assess this. In this case, we should include these strategic real options if management assesses that reaching a certain sales volume in the future is realistic, where nurturing the strategic opportunities is very significant. This is because management will probably evaluate that a certain sales volume is feasible in the future if they continue to nurture these strategic real options. Also we will include these real options and continue with our real options analysis.

7.2.2.3 Underlying Risk and Strategy

The value of real options can be influenced either by market risks or by private risks or by a combination of both. Market risks are risks captured in the price fluctuations of traded securities. Private risks are risks not captured in the price fluctuations of traded securities. Assets influenced by risks captured in the price fluctuations of traded securities are associated with a wider set of opportunities because one can always acquire, reduce, or reshape the risk through a position in traded securities. The type of risk underlying a real option has significant implications for the applicability of real options theory.

In literature, there is consensus about the use of real options theory to real options influenced by market risks. Amram and Kulatilaka give us an example showing us how market risks drive value.

"The following investment decision is under consideration: building a manufacturing plant whose raw materials (soybeans) and products (soybean oil) are both traded in the futures market.

To decide whether to build such a plant, Chicago Soy needs to calculate the net present value, whereby they incorporate the Real-Option to shut down the plant temporarily.

Chicago Soy produces soybean oil from soybeans. Besides other costs, the plant's profit is mainly driven by the spread between the spot price of soy beans and the spot price of soybean oil, the crush spread. Furthermore, the value of the plant is also driven by the volatility on the crush spread. If the spread is highly volatile, the company may want to hold off shutting down its plant, even when the spread narrows
to the point where the plant is unprofitable.

Because the trigger points are derived from traded securities, they align the plant's operations with the markets, ensuring that it operates in a way that maximises long-term shareholder value."

In addition, the literature agrees to some extent about the application of real options theory to real options that are influenced by a combination of market and private risks. Amram and Kulatilaka give us an example showing how both risk factors drive value and how real options theory could be applied.

"The following investment decision is under consideration: upgrade the information system, which would enable a mortgage selling company to significantly improve its customer service, leading to stronger growth. In order to implement such a system, the company faces large up-front expenditures.

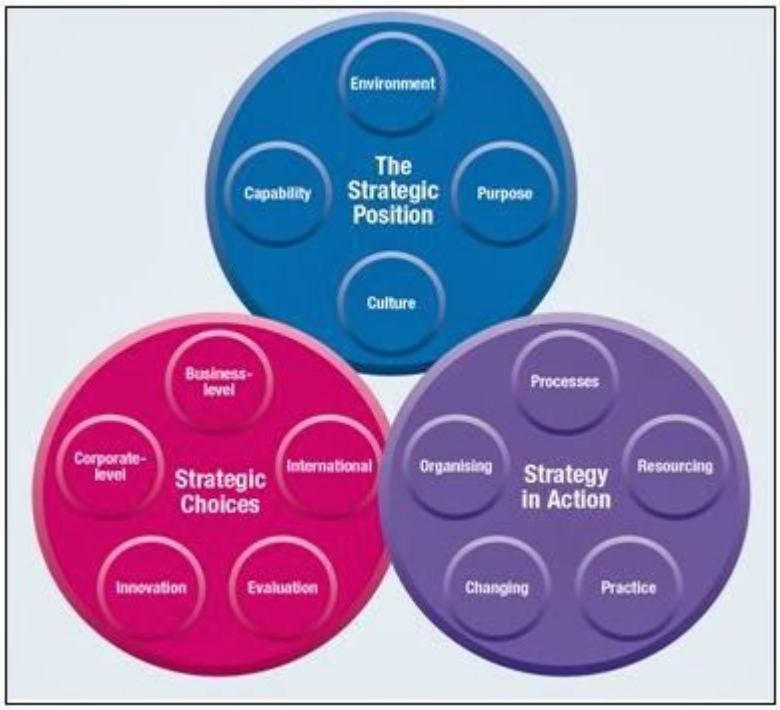
To decide whether to upgrade the information system, Eastern States Mortgage needs to calculate the net present value of the investment, whereby they incorporate the options created by the new platform for future upgrades and extensions. Furthermore, Eastern States Mortgage splits their investment decision into three stages, whereby they include an option to abandon after each stage. The investment decision is then described as follows:

- *Stage 1: A pilot project conducted in one region (will resolve private risks, after that point, risk in the project will be dominated by market-priced risks).*
- *Stage 2: Rolling out the technology on the retail side of the business.*
- *Stage 3: Rolling out the system to the rest of the company.*

By splitting the project into three stages, the company divides the amount of needed up-front investments over the three stages. After the first stage, the private risks are resolved. From then, the interest rate risk determines whether to continue to the next stage. Therefore, the interest rate risk is from there on the most important value driver of the project. If the interest rates rise to a level that damps overall mortgage demand, the project should probably be abandoned.

After stage one, the value of the project is solely influenced by interest rate risks (market risks), therefore Real-Options theory should be used to calculate the value of the Real-Options at the end of stage one. To calculate the value of the Real-Options at the beginning of stage one, subjective estimates about the development of the project's value through stage one should be made." [76]

Strategic management is characterised by its complexity because of the need to make decisions and judgements based on the conceptualization of difficult issues. Strategic management includes understanding the company's strategic position, making strategic choices and managing strategy in action. The following interconnected circles are designed to emphasize the nonlinear nature of strategy. Position, choices and action should be seen as closely related. None of them has priority over another.



Source: Johnson, G., Scholes, K. and Whittington, R. (2008), "Exploring Corporate Strategy", Prentice Hall-Finacial Times, 8th edition, 2008.

[76] *Amram, M. and Kulatilaka, N. (1999), "Disciplined decisions: aligning strategy with the financial markets", Harvard business review (February), 95-104. Amram, M. and Kulatilaka, N. (2000), "Strategy and shareholder value creation: The real Options Frontier", Journal of Applied Corporate Finance, 13.2 (Summer), 15-27.*

Strategic Position

Environment

Strategic position is concerned with identifying the impact on strategy of the external environment, a firm's strategic capability, the expectations and influence of stakeholders. The company exists in the context of a complex political, economic, social, technological, environmental and legal world. This environment changes constantly and it is very complex. How this affects the firm could include an understanding of environmental and historical effects, and expected or possible changes in environmental variables. Many of the variables will potentially give rise to opportunity. Other variables will possibly exert threats on the organization. The problem is that the range of variables is likely so great that it may not be feasible to identify and understand each one.

Strategic Capability

A company's strategic capability is made up of resources and competences. One way of thinking about the strategic capability of an organization is to consider its strengths and weaknesses. For example, where it is at a competitive advantage and disadvantage. The goal is to form a view of the internal influences on strategic choices.

Stakeholder expectations on a company's purposes

Goal is encapsulated in a company's vision, mission and values. The issue of corporate governance is significant. Who should the company primarily serve and how should managers be held accountable for this?

Culture

Cultural and historical influences can also influence strategy. Cultural influences can be organizational, sectoral or national. The impact of historical influences can be strategic drifts.

Strategic Choices

Strategic choices include options for strategy in terms of both the directions in which strategy might move and the methods by which strategy might be pursued. For example, an organization might have to choose between alternative diversification moves.

Business Level

Strategic choices in business level involve pricing and differentiation strategies and decisions about the way to compete or collaborate with competitors.

Corporate Level

Issues of corporate level strategy are concerned with the scope or breadth of a firm. These involve diversification decisions about the portfolio of products and the spread of markets. Furthermore, corporate level strategy is also concerned with the relationship between the separate parts of the business and the way corporate "parent" adds value to these various parts.

International Level

International strategy is a type of diversification into new geographical markets. In this level, companies have to make choices about which geographical markets to prioritize and how to enter them, by export, licensing direct investment or acquisition.

Innovation

Most organizations have to innovate constantly simply if these want to survive in a competitive environment. Managers have to take decisions about innovation and entrepreneurship. Entrepreneurship choices include issues of funding, building key external relationships and timing of exit. Innovation choices include issues such as being a first-mover into a market or simply a follower. One more issue is about listening to customers in developing new products or services.

Evaluation

Executives have to make choices about the methods by which they pursue organization strategies. Many companies prefer to build new business with their own resources. Others might develop by mergers, acquisitions, and/or strategic alliances with other companies.

Strategy in action

Strategy development processes

The strategies that a company actually pursues are typically a mixture of the intended and the emergent. Intended strategies are the product of formal strategic planning and decision

making. Emergent strategy is typically somewhat emergent involving bottom-up initiatives, rapid responses to unanticipated opportunities and threats.

Organizing

Structuring an organization includes organizational structures, processes and relationships.

Resourcing

Resourcing strategies in the separate resources areas (for example people, technology, finance, information) of a company support strategies. New strategies are built on the particular resource and competence strengths of a company.

Strategic Change

Managing strategy includes strategic change. This will include the need to understand how the context of a company should influence the method to change and different types of roles for people in managing change. It looks like styles which can be adopted for managing change and the levers by which change can be effected.

Practice of Strategy

The practice involves detailed activities, the people included in strategy, the activities they have to do and the kinds of methodologies they use to do it. [77]

7.2.2.4 Option characteristics

The option characteristics are significant for the valuation of strategic real options. However, they impede a general valuation guide for strategic real options valuation. We will discuss the significant option characteristics and their influence on the valuation. The influence of the option characteristics can be estimated for both strategic real options in the same way, because they have the same structure and the same underlying risks. It is necessary to use MADD approach for the value of the underlying asset, and the volatility of the underlying

[77] *Johnson, G., Scholes, K. and Whittington, R. (2008), "Exploring Corporate Strategy", Prentice Hall-Finacial Times, 8th edition, 2008.*

asset for modelling the project value through time. For the final valuation of the real options the other variables are needed.

Value of the Underlying Asset

We should conclude how to determine which approach should be used to model the underlying asset's value and to calculate the real option value. However, practitioners should research and understand the following steps:

- ✓ Market risks should be modelled with option-pricing techniques. So market and private risks should be separated when possible.
- ✓ Private risks should be valued by preference with the MADD method, as that will simplify the valuation process. Nonetheless, if the underlying distribution does in no way behave as a Geometric Brownian motion and could also not be described by a jump process (or any other underlying distribution), decision analysis should be used.
- ✓ If market and private risks could not be separated, these risks should by preference be valued with the MADD approach. If the underlying distribution does definitely not behave as a Geometric Brownian motion and could also not be described by a jump process (or any other underlying distribution), decision analysis should be used.

As we have already seen, the valuation method for real options driven only by market risk is basically the same as the valuation method for real options driven by market and private risks, which are only valued with the MADD approach. The difference between them is that the underlying asset's value and its volatility is not derived from the financial markets, but from subjective estimates. Decision analysis is totally different from these approaches and is not suited to operationalising. In addition, it is preferred to capture strategic real options value by operationalising the MADD approach, as the valuation of real options driven only by market risks is unambiguous. On the one hand, the MADD approach is the best method to simplify the valuation of strategic real options. On the other hand, this approach requires some strong assumptions that could easily be violated. Copeland and Antikarov are defenders of the MADD approach too.

Moreover, we have concluded that in order to value a company's short-term strategic real options bottom-up, we should identify them and determine their joint possibility density function. To identify short-term strategic real options, the requirement is that management

should adopt to real options way of thinking. An easy way to start is to investigate the enterprise DCF valuation if it is available. The FCF forecast incorporating the strategic investments as well as the different strategic scenarios that have to do with potential future investments of the company are able to illustrate to us the already identified short-term strategic Real-Options. Finally, it is imperative that management should identify all short-term strategic Real-Options that are under consideration. These should be evaluated and acknowledged as valuable by management because if some strategic opportunities are not considered valuable, they will never be implemented and will therefore not have any value.

The strategic real options are structured as compound options, thus there are more underlying assets. If we assume that there will be just one expansion stage, each compound option consists of two options. As the underlying assets are not traded in the financial markets and we are using the MADD approach, we will use the MAD assumption to determine the value of assets.

Exercise Price

The exercise price of the real options is equal to the required investments. It is reasonable to assume that the required investment amount will grow with the years. The growth rate could be set equal to the inflation rate and very close to real GDP growth. However, it could also be estimated more precisely, by deepening into the cost drivers of possible investments.

Time to Expiration

The longer time to expiration time furnishes more time for the value of the underlying asset to move, raising the value of both types of options. In case of call options, the buyer must pay a fixed price at expiration and the present value of this fixed price decreases as the life of the option increases, so the value of the call increases.

Triantis (1999) mentions that it is reasonable to assume that exercise price for many investment projects will go up with the risk free rate of interest, and this will neutralise the benefit of a longer time to expiration. In addition, if there is an expected “leakage" in the present value of the underlying asset or opportunity (which can be modelled with a dividend payout), due to for example the competition catching on, then the longer the time to expiration, the larger the decrease in the present value of the underlying asset.

Volatility of the Underlying Asset

Volatility is measured as the standard deviation of the rate of return of the underlying asset. It is common to express the volatility as an annual figure. It is not easy to find historical data about the real asset's market value. According to Luehrman (1998), we can estimate the volatility through an educated guess or through a twin security or historical data, or through a simulation model. Furthermore, Hevent (2001) accepted that a general method for an estimated guess begins with isolating the primary source of uncertainty. The volatility could be derived from the following set of equations through an estimation of the asset's value up (u) and down movements (d).

Risk Free Rate of Interest

The risk free rate of interest is the theoretical rate of return of an investment without risk. The value of the option has the same direction as the risk free rate. If the risk free rate increases, the option's value will go up too.

Dividend

Dividend is a payment to the shareholders usually as a distribution of profits. Not all companies pay dividend, which is why this variable is not always relevant in financial option pricing. Although real assets do not pay dividends, this variable is very important. In real options, a dividend is a cash outflow from the real asset. Therefore, it decreases the value of the asset.

7.3 A Four-Step Process for Valuing Real Options

In this paragraph, we will discuss a theoretical foundation, which makes simpler the process of applying real options methodology in real world settings. To value flexibility, the four-step process is used. The process helps us to reduce many sources of uncertainty to only one. Analysts face difficulties in analyzing a lattice, which is driven by more than two sources of uncertainty. They use two assumptions, the marketed asset disclaimer and cash flows, to

avoid this complexity. Cash flows fluctuate randomly. The MAD uses the present value of the underlying risky asset without flexibility as if it were a marketed security. [78]

A four-step process

	Step 1	Step 2	Step 3	Step 4
	Compute base case present value without flexibility using DCF valuation model	Model the uncertainty using event trees	Identify and incorporate managerial flexibilities creating a decision tree	Conduct Real Options Analysis (ROA)
Objectives	Compute base case present value without flexibility at t=0.	Understand how the prsent value develops over time.	Analyze the event tree to identify and incorporate managerial flexibility to respond to new information.	Value the total project using a simple algebraic methodology and an Excel spreadsheet.
Comments	Traditional present value without flexibility.	Still no flexibility this value sound equal the value from Step1. Estimate uncertainty using either historical data or management estimates as input.	Flexibility is incorporated into event trees, which transforms them into decision trees. The flexibility has altered the risk characteristics of the project, therefore, the cost of capital has changed.	ROA will include the base case present value without flexibility plus the option (flexibility) value. Under high uncertainty and managerial flexibility, option value will be substantial.

Source: *Copeland, T. E. and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", U.K. Thomson Texere.*

In the first step, we use a traditional discounted cash flow model to conduct a valuation of the investment project without flexibility. In other words, it is a standard net present value analysis of the project using traditional methods. We forecast the entity-free cash flow over the project's life. At a subsequent time, we will double check to be sure that our option-pricing solution reduces to equal the NPV result provided that there is no flexibility.

In the second step, we expand the DCF model into an event tree, mapping how the project's value evolves over time, using unadjusted probabilities and the WACC. We build an event tree based on the set of combined uncertainties that drive the project's volatility. At this stage, the model does not include flexibility. Thus, the present value of the project should equal the standard DCF value from the first step because of basing on discounting the cash flows in the event tree.

An event tree has no decisions built into it. Instead, it is planned to model the uncertainty that drives the value of the underlying risky asset through time. It is supposed that the

[78] *Copeland, T. E. and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", U.K. Thomson Texere.*

multiple uncertainties that drive the project's value can be combined, via a Monte Carlo simulation, into a single uncertainty: the distribution of returns on the project. All we need to build an event tree is this single volatility's estimate.

When all uncertainties are combined into the single uncertainty of the project's value, it is called the consolidated approach. In some circumstances, it isn't useful to combine uncertainties and we will use a separated approach. That means that two or more sources of uncertainty must be estimated separately.

In the third step, in the process of estimating the option value of a project we turn the event tree into a decision tree by identifying the types of managerial flexibility that are available. We build the flexibility into the nodes of the tree. Multiple sources of flexibility are possible at a single decision node, such as the option to abandon and expand. However, it is important to have clear priorities among them. We must be careful in establishing the sequence of decisions regarding flexibility, particularly when the decision tree has compound options.

The fourth and final step entails recognizing how the exercise of flexibility alters the risk characteristics of the project. In other words, it is the valuation of the payoffs in the decision tree using either the method of replicating portfolios or risk-neutral probabilities. If the risk driving the contingent cash flows is fully diversifiable, we will not need special modeling and can use DTA, discounting investment cash flows at the risk-free rate and the underlying project's cash flows at the weighted average cost of capital. If the risk is mostly nondiversifiable and priced in the market, the appropriate risk-adjusted discount rate for the project's cash flows is not any more the weighted average cost of capital used in the first step. In that case, we must use a real option valuation approach for the project with flexibility, using a replicating portfolio or risk-neutral valuation. [79]

[79] *Copeland, T. E. and Antikarov, V. (2003), "Real Options: A Practitioner's Guide", U.K. Thomson Texere. / Koller, T., Goedhart, M. and Wessels, D. (2010), "Valuation: Measuring and Managing the Value of Companies", (5th ed.), Hoboken, NJ, USA: John Wiley & Sons, Inc.*

CHAPTER 8
CONCLUSIONS

8.1 Key Points

We started with real options definition. Myers first (1977) stated that a real option is a decision opportunity for a corporation or an individual. A real option is the right to take an action in the future, rather than an obligation. The field of real options theory has been developing constantly for seldom 37 years. In addition, real options are a way of thinking, which help executives formulate their strategic options, the future opportunities are caused by today's investments without considering these future opportunities to be valued by option pricing theory

Furthermore, we cited value drivers and the types of real options. Lenos Trigeorgis mentions one more type of options, corporate growth options. This type of real options is another version of the option to expand of considerable strategic importance. This type sets the path of future opportunities. Many early investments can be seen as prerequisites or links in a chain of interrelated projects. The value of these projects may derive not so much from their expected directly measurable cash flows, but rather from unlocking future growth opportunities such as a new generation product or process, access to a new market or strengthening of the firm's core capabilities and its strategic positioning.

Smith and Trigeorgis state that the internal resources and capabilities of a firm are explicitly linked to environmental opportunities. The value of the growth options of a firm is influenced by uncertainty, time to maturity and interest rates. In addition, Smith and Trigeorgis make a classification of corporate real growth options.

Managerial choice is valuable under uncertain situations and when investment decisions are irreversible. Real options face risks of different nature. The value of real options can be influenced either by market risks or by private risks or by a combination of both. Real options value contiguous to market risks should be valued with option-pricing methods. Decision analysis should be used to calculate real options influenced by private risks. Real options value contiguous to market and private risks could be valued by either option-pricing methods

or decision analysis. On the other hand, decision analysis can be very complex and time-consuming, as every decision may be influenced by different variables and could have possible multiple outcomes.

Copeland and Antikarov recommend using the present value of the project itself without flexibility as the underlying risky asset. They make the assumption that the present value of the cash flows of the project without flexibility is the best unbiased estimate of the market value of the project were it a traded asset. They call this assumption the Market Asset Disclaimer (MAD). This assumption is often followed by the assumption that the value of the underlying asset behaves as a Geometric Brownian motion through time (other underlying distributions are also possible). The combination of these two assumptions will be referred to as the MADD assumption (MAD inclusive Distribution). The MADD approach makes it possible to calculate the value of real options influenced by all risk types. Decision analysis is theoretically a better method than the MADD approach to value real options influenced solely by private risks. Scenario analysis is a form of decision analysis. If the decision tree becomes too large and complex, the MADD approach will probably be a better method to use, considering the ease of use.

We have already described quantifications methods of real options:

- Binomial (or trinomial) lattices
- Decision – Tree Analysis
- Monte Carlo Simulation

The binomial tree is a diagram depicting different possible paths that might be followed by the asset price over the life of the option. In each time step, it has a certain probability of moving up with probability p by a certain factor u and it has a certain probability of moving down with probability $1-p$ by a certain factor d. The term binomial refers to the fact that the value of the underlying asset can take on two possible values during each short time interval in the model. The binomial lattice model can deal with market risks. In combination with the MADD assumption, it can also deal with private risks. The model is not suited to dealing with private risks without further assumptions. The binomial lattice model supposes that the asset price follows a random walk. On the other hand, Dixit and Pindyck argue that it is more realistic to model an economic variable as a process that makes infrequent but discrete jumps, a jump process. The binomial lattice model is suited to coping with other underlying distributions as well.

Decision analysis relies on subjective assessments of probabilities, subjective discount rates and preferences about the goal. According to Trigeorgis, decision-tree analysis helps

managers to structure the decision problem by mapping out all feasible alternative managerial actions contingent on the possible states of nature in a hierarchical manner.

Borison and Triantis state that: *"Monte Carlo simulation is a powerful technique that allows for considerable flexibility in the number and specification of the uncertainties in the decision problem. Based on assumed probability distributions for each uncertainty, a large number of possible scenarios are generated for the underlying project cash flows or value. The real option value is then calculated for each of these scenarios, and the average of these values is discounted back to the present. The Monte Carlo valuation approach is useful when the cash flows from a project are path dependent, that is, when they depend on prior decisions taken by the firm. While it has traditionally been difficult to use this approach to value American options, new techniques are being developed to address this shortcoming".*

Real options are an add-on component to, not a substitute for, discounted cash flow analysis. Managers need to use both methods in order to pick the best growth projects. Putten and Mac Millan drew the conclusion that much of the problem lies in the unspoken assumption that the real option and DCF valuation methods are mutually exclusive. They believe that the two approaches can be integrated if managers are to make valuations that reflect the reality and complexity of their business's growth projects. Real options allow managers to capture the substantial value of being able to ruthlessly abandon floundering projects before making considerable investments. That's why real options are an essential complement.

Discounted cash flow analysis and real options are complementary. A project's total value is the sum of their values as a base estimate of value is captured by the DCF valuation and the option valuation adds in the impact of the positive possible uncertainty. Putten and Mac Millan notably state that a real options approach can only be used on projects structured somewhat like options. The projects can be abandoned before making considerable financial outlays if it becomes clear that things will not go well.

We came to conclusion that the value of a company can be decomposed as in the following equation:

$$Company\ Value = Static\ PV + PVGO = Future\ Assets\ in\ place(PV) + strategic\ \mathrm{Re}al\ Options\ Value$$

Borison and Triantis categorize real option's functions into the three following classes:

1. Real options as a way of thinking. Real options are used primarily as a language that applies a border and communicates decision problems qualitatively.

2. Real options as an analytical tool. They are used primarily to value projects with known specified characteristics.

3. Real-Options as an organisational change process, which includes both the previous two functions. This function is used by management to identify and exploit strategic real options.

Another significant point is which real options should be taken into account in a company valuation. We emphasized flexibility and strategic real options, real options on project-level and management-level and short-term and distant strategic real options. The difference between flexibility and strategic real options is very important for the valuation of companies. Flexibility real options are relevant to a company's current or future operational activities and strategic real options are relevant to opportunities that can create new operational activities. Flexibility real options could be valued within a DCF analysis, but strategic real options could not. Therefore, it is crucial to identify a company's strategic real options, determine how these should be valued and add them subsequently to a DCF valuation without any incorporated strategic real options value. Moreover, strategic real options could be found on both project-level and management-level, where flexibility real options could only be found on project-level.

The market value of the company consists of the value of assets in place and the present value of growth opportunities (PVGO). The PVGO reflects the value of future investments, which are expected to yield rates of return more than the opportunity cost of capital. When the competitive process is halted or delayed, then there are growth opportunities. An important portion of the market value of equity is accounted for by growth opportunities. Kester argues that the value of growth opportunities is half or more of the market value of equity for many firms. The present value of future growth opportunities combines both volatility and adaptability.

Total value consists of the net present value and the value of the growth opportunities.

$$Expanded\ NPV = NPV + PVGO \text{ or } Expanded\ (strategic)\ NPV = direct\ NPV + PVGO$$

Where $NPV = V - I$

We can estimate present value of growth opportunities in a direct or indirect way from the financial markets. If we choose the direct method, option valuation methods can be used to estimate the firm's set of strategic options. The second method deducts the static or non-growth component associated with continued current operations estimated from standard DCF techniques from the observed market equity value. The value of a firm could be established by adding a firm's strategic real options value to its future assets in place.

$$Company\ Value = Future\ Assets\ in\ Place + strategic\ \mathrm{Re}al\ Options\ Value$$

Luehrmam defines strategy as a path from where organizations are now to where they want to be some years down the road. Incorporation both the uncertainty inherent in business ant the active decision-making would be a better approach to valuation. This approach would be more possible to lead to a successful strategy helping businesspersons to think with a strategic way by capturing the value. Luehrmam refers business strategies as chains of real options. Valuation analyses can inform the creative activity of strategy formulation sooner rather than later. Financial insight might contribute to shaping strategy.

Option pricing could be used to improve decision-making about the sequence and timing of a portfolio of strategic investments. It can help managers become more effective and estimate the value of the entire years' produce or sales. Real options theory is a special case of all possibilities to capture strategic growth value. Strategic growth value is the value derived from a firm's strategic real options and could be estimated either *bottom-up (customer-based)* or *top-down (market-based)* approach. Forecasts should be in accord with historical economy-wide evidence on growth.

Luehrmam introduces Option Space framework. According to him, option space is defined by two option value metrics, each of which captures a different part of the value related to be able to defer an investment. Option Space can help executives whether to invest or not, when the investment takes place, and what to do for the time being. Value-to-cost metric is defined as the value of the underlying assets a firm intends to build or acquire divided by the present value of the expenditure required to build or buy them. The second metric is called volatility metric and it measures how much things can change before an investment decision must be made.

Next, we described a four-step process for valuing real options.

- Step1: Compute base case present value without flexibility using DCF valuation model.

- Step 2: Model the uncertainty using event trees.
- Step 3: Identify and incorporate managerial flexibilities creating a decision tree.
- Step 4: Conduct Real Options Analysis (ROA).

Finally, we cited a practitioner's guide for company's short-term strategic real options with all basic steps.

8.2 Limitations of the Quantitative Approach to Real Options

The real options model is often advocated as a model that offers a positive and radical reassessment of the value of risk and exploration. However, there are some problems associated with using real options. It is significant to refer that the assumptions incorporated in most standard option valuation models can conflict with the conclusions reached by strategic analysis. Therefore, analysts who use real options approach should understand the quantitative aspects of these approaches and they often need to create a customized approach for each situation.

Analysts, who use a quantitative model to value strategic real options, face a number of implementation problems. These problems are about finding a model whose suppositions match those of the project being analyzed, determining the inputs to this model and being able to mathematically solve the option pricing algorithm.

Modeling Assumptions

The usefulness of a real options model to quantitative decision making is determined by the extent to which the characteristics of the investment proposal being evaluated match the suppositions of the option valuation approach being used. The analogy between financial and real options is imperfect, making the use of financial option valuation approaches problematic for real options. Strategic options don't often have some of the explicit features of exchange-traded options. These differences determine whether formal option valuation approaches (such as the Black-Scholes model) are helpful for managerial decision making.

Determining the Inputs

The effective use of a quantitative approach to value a possible strategic investment is limited by the need to calculate the approaches' inputs. If the inputs are incorrectly calculated, the results from using the approach will be incorrect. Companies face a number of problems in determining the values of the approaches' inputs. For example, stock price, volatility, time to expiration, exercise price.

8.3 The Role of Option Analysis in Strategic Planning

The real options model to strategic analysis because it presents planners with a dilemma. Options are a theoretically attractive way of thinking about the flexibility inherent in many investment proposals. On the other hand, the use of the methodology has many practical difficulties, which can lead users to make mistaken conclusions. The complexity of the options can also make it difficult to find errors in the analysis, or excessively ambitious suppositions used by optimistic project champions. The limited use of real options analysis in strategic planning may be explained by these practical difficulties.

One approach to solving these inherent difficulties is to create a more advanced, customized option valuation algorithm that better matches the characteristics of the investment proposal. The design, development, and computational solution of these advanced option models are often beyond the capabilities of executives. Given the practical difficulties in creating and solving these models, it is expected that advanced real options models are seldom used in strategic decision making.

A formal quantitative valuation model is only one part of the whole strategic planning and capital allocation process. Making these decisions, both financial and strategic analysis need to be performed by companies (Myers 1984). The different methods act as a check on each other, that's why multiple forms of analysis are advantageous. As an example, forecasting cash flows is infamously difficult, making it unresolved to use a capital allocation system that relies solely on financial analysis. In similar manner, strategic analysis does not depict whether the project offers a return that justifies its inherent risk. Within the quantitative analysis step, executives choose a suitable valuation tool (options or DCF), which matches the investment proposal.

Finally, one potential advantage of using the real options analytic approach is that it might change the type of investment proposals that are reviewed. As Kogut and Kulatilaka (2001) mention, the usual thinking about uncertainty absorption found in the organizational literature is reversed by an option perspective. If we face options as a legitimate approach to analyzing proposals, then more option-like proposals may be considered. This increase can come from both a change in the types of new proposals that are generated (executives look for options to invest in), and from rethinking non option proposals to convert them into options. Therefore, experimentation and the proactive exploration of uncertainty are encouraged by an options approach. This engagement in exploration is indeed a revolution in thinking.

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