REAL OPTIONS THEORY AND ITS APPLICABILITY TO ACQUISITION VALUATION

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Instructor: Petri Vehmanen

Deepinder Singh
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Objectives of the study

The aim of dissertation was to study and analyze the real options theory and its applicability to acquisition valuation. The study was aimed for a better understanding of the real options theory by breaking down the primary concepts of the theory into their essential parts. The applicability to acquisition valuation was partly argued through an illustrative case study.

Research method and data

The methodology of research was concept analysis, which was based on studies by other researchers. The studies were from fields of accounting, finance, investment, and management and organization.

Findings of the study

Real options theory can be seen as a new way of thinking in investment valuations, which can be used to complement the traditional discounted cash flow analysis. The real options theory builds upon the financial option theory and option pricing principles. However, the valuation of real options is not as straight-forward as that of financial options and this is often seen as the biggest stumbling block for a wider use of the theory in the corporate world.

Real options are inherently present in acquisitions. Particularly abandonment, growth and flexibility options can play an important and significant role in acquisition valuation. This was indicated by both literature and illustrative case study.

Key words

Real options, discounted cash flow approach, acquisition, valuation
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1 INTRODUCTION

1.1 Background

The current fast-paced and constantly changing business environment places companies in a position where they have to make important strategic investments decisions, such as corporate acquisitions, under uncertainty regarding future market conditions. This uncertainty around investment decisions results often in fearful and cautious reactions among decision-makers. (Amram & Kulatilaka 1999, 13; Triantis & Borison 2001) In addition, the shortcomings of the traditional decision and valuation tools, such as the Discounted Cash Flow (DCF) method, further increase the sense of frustration and the feeling of making decisions in dark. (e.g., Amram & Kulatilaka 1999; Luehrman 1998a; Trigeorgis 1995, 1996; Tong & Reuer 2007)

Flexibility and managerial discretion embedded in investment projects is valuable, a fact that has been acknowledged by corporate practitioners for a long time. However, the dilemma has been a quantitative valuation of this flexibility and incorporation of the same into investment decisions. Frustration and dissatisfaction with the available decision-making tools have primarily stemmed from their inability to properly capture management’s flexibility to adapt and revise previously made strategic decisions in response to unexpected and new market developments. (e.g., Luehrman 1998; Trigeorgis 1996,) Balwin even claimed already in 1987 that companies’ ability to build flexibility and optionality into their capital investments would place them in an advantageous position in the future as the financial and real markets are expected to become more and more volatile. (Landen & Pinches 1998, 540)

The most popular traditional investment evaluation approaches, which are based on the discounted cash flow method (DCF), assume that the forecast cash flows will be achieved without any kind of management intervention as long as the uncertainty is reflected in the (risk-adjusted) discount rate. In other words, the DCF method assumes the investment projects to be managed passively. (e.g., Alleman 2000; Dixit & Pindyck 1995; Lander & Pinches 1998) The consequences of the inability of the DCF method to adequately consider the opportunities and options available to the management can be severe and dire. This
because the management can end up making crucial strategic decisions relying on a quantitative analysis which may not correctly represent the investment problem at hand. (Trigeorgis 1996)

Committing to investments, which tie substantial amount of capital and require long-term engagements, on ad hoc or incomprehensive grounds is not exactly what the investors and financial markets expect from management. In order to maximize the value of the firm, which is what the shareholders expect, resource allocation has to be efficient, justifiable and transparent.

Real options theory has emerged as an approach that is capable of addressing the challenges of rapid change, great uncertainty and existence of flexibility more successfully than the traditional capital budgeting methods as it uses the theory and insights developed for pricing financial options while also using the discipline of decision analysis. (e.g., Kodukala & Papudesu 2006; Li, Madhavan & Mahoney 2007; Triantis & Borison 2001) Real options “thinking” demands and requires an active investment management, for it explicitly recognizes that future decisions designed to maximize value will depend on information that is often not available or obtained until after the initial investment has been made. (e.g., Amram & Kulatilaka 1999; Leiblein & Ziedonis 2007)

Valuation of an entire business has become one of the most central business-related issues in the free market economy. The valuation task is critical to a variety of interest groups; investors (both individual and institutional), venture capitalists, creditors, parties involved in mergers & acquisitions, companies contemplating buying back own shares, management keen to enforce the interests of the shareholders, auditors and tax authorities. (Kallunki & Niemelä 2007, 9)

Valuation of an entire business is also one of the most challenging tasks in the field of finance due to the nature and volume of variables and parameters to be considered and calculated. The task is even further complicated by the non-static nature of the variables which means that the value must be reassessed on a regular basis. These factors among many others tend to occasionally make the valuations highly doubtful, uncertain and risk-exposed. (Krishnamurti & Vishwanath 2008) The valuation tools based on the DCF method are the most popular and widely used in the corporate world when valuing investments even
though the rapidly changing and unstable economic environment has put the availability to modify investment decisions to the central stage of the investments’ financial success. (e.g., Amram & Kulatilaka 1999; Kodukula & Papudesu 2006; Trigeorgis 1996) Hence, we believe there is a great need for a more contemporary valuation approach which better reflects and considers the economic context in which companies around the globe have to operate today.

Flexibility is inherently present in acquisitions for they offer the acquiring party a variety of options that become available only once the acquisition is completed. (e.g., Dunis & Klein 2002; Smith & Triantis 1995; Whittington & Bates 2007, 55-56) The flexibility is not only present in acquisitions but can be of an immense importance and in firm’s value as well. Several studies in the past have indicated that, contingent on the circumstances and economic conditions in general, the value embedded in flexibility can account to a large portion (even up to 80 percent) of the total value of a firm. (e.g., Kester 1984; Trigeorgis 1995)

The traditional investment thinking, however, states that investment is worthy undertaking only if the net present value (hereafter referred to as NPV) is positive and that the investment proposal should be scrapped in case the NPV is negative. (e.g., Brealey, Marcus & Allen 2006; van Putten & MacMillan 2004, 135). The problem with the NPV and other DCF techniques is that they assume the investment to be managed passively, that is no changes can or will be made after the initiation. (e.g., Brealey et al. 2006; Dixit & Pindyck 1995, 107) The risk adjustments are mainly done by conducting sensitivity and scenario analysis or adjusting the employed discount rate. (Farragher, Kleiman & Sahu 1999, 138) In practice, however, in the case of acquisitions the acquirer has several options at disposal prior to making the deal and during the holding period which can significantly affect the financial performance of the acquisition. The three primary option types that are either present or could be created in acquisitions are namely abandonment, growth and flexibility options. (Smith & Triantis 1995, 136-137)

For instance, the would-be-acquirer has an option to delay the acquisition and wait more news about the economic conditions that may affect the prospects of the would-be-acquired firm. By taking advantage of the real option theory and option valuation models the would-
be-acquirer can optimize the timing of the acquisition (and in process maximize the value of the company as well) or avoid committing to a value destroying investment.

1.2 The aim and scope of report

The aim of this study can be condensed to as follows;

"Study and analyze the real options theory and its applicability to acquisition valuation"

The answers to the above aim are to be found through the following steps:

1. What are the main concepts of the real options theory?

The results of this step will give us a better understanding and knowledge of the theory, which will aid us in the subsequent steps. In order to gain a profound understanding of the theory, we will also have to study the main principles of the financial options.

2. How/What real options are present in acquisitions?

The purpose of this step is to explore the real options embedded in acquisitions.

3. Examine the applicability of the real options theory to our case-study problem

This step will illustrate the applicability of the real options theory to acquisition valuation situations through a real life case study. We will apply the theory to our case, and examine and analyze its merits in the same. We will also apply the DCF method in our case, for this will show us possible discrepancies between the results of these two methods.

1.3 Limitations

The primary aim of this dissertation is to profoundly study the real options theory and the option theory in general, which serves as a foundation for the real options theory, will be studied only briefly. The option valuation, however, will be discussed in more detail (two different techniques, namely Black & Scholes model and binomial model will be presented)
for its understanding is critical, if not imperative, in order to gain most out of the theory and its potential in real life situations. As we will see later on in this report, there are several other techniques also available for solving values of real options than the two mentioned above but the study of those is excluded from this report due to their limited and marginal use in real life situations.

Corporate acquisitions have been studied extensively by other researchers and ample literature is available about these. In this dissertation we, however, will not present the theory of acquisitions broadly for we feel it is not relevant vis-à-vis to our primary aim in this report. We also won’t be able to study the impact of all the different acquisition methods on the real options analysis due to the length limitation, hence we will view acquisitions as being more or less non-singular. In addition, we will present profoundly only one of the many acquisition valuation methods available and used in real world situations, namely the discounted cash flow (DCF) approach.

The DCF approach is chosen for in-depth analysis for two main reasons: first, it is the most commonly used method in real world acquisition valuations and secondly, the DCF analysis will be conducted in our case study at the end of this report as well. It should be mentioned here that in this report we will not make any distinction between the different ways of conducting an acquisition. Thus, an acquisition in this report is viewed like being any investment proposal which will be judged on its potential to be financially successful.

1.4 Review of literature

Stewart Myers and W. Carl Kester are considered to be the first scholars who spoke in favour of the existence of real options value, particularly in the form of growth options. Both of the scholars also pointed out that the value of real options cannot be solved by using conventional DCF analysis but instead should be valued in same manner as financial call options.

The real options theory builds upon the financial option theory and on the option-pricing models initially designed to solve the values of financial (stock) options. The invention of the Nobel prize-winning option valuation method by Black, Scholes and Merton in 1973 was a major event in the development of the real options theory. Binomial valuation method
presented by Cox, Ross and Rubinstein in 1979 offered simpler but yet powerful medium to value options (and subsequently real options) present in financial markets. These two methods remain even to this day the most common and popular techniques used valuing real life option problems.

The term “real options” was coined by Stewart Myers in 1977. Myers stated that firms’ growth opportunities could be seen as call options on real assets, in much the same way as financial call options. However, it was only in 1984 when the real options thinking started to gain support and acceptance thanks to Myers and Kester who discussed growth opportunities from strategic and competitive perspectives. The last 20 or so years have seen a great advancement and progress in real options literature and theory’s application to various fields of business life.

The real options research of last 20 or so years in the fields of finance and economics has resulted in development of a classification of common real options that are either embedded in investment projects or can be created. The so-called common real options, which are option to defer, option to stage investment, option to switch use, abandonment option, option to alter operating scale and growth options, have been studied and analyzed by many scholars and in a variety of contexts. Some of the most prolific scholars on this field of research are Lenos Trigeorgis, Myers, Kester and Nalin Kulatilaka to name a few.

Valuation of real options, despite the two methods mentioned above, has been a matter of great interest and debate. The valuation of real options in real life situations has been immensely influenced and helped by an idea and understanding that an option is possible to replicate by using a similar portfolio of traded securities. This recognition is the foundation of the binomial method. Ample research has been dedicated to valuing different real options separately but on the other hand, some scholars, like Trigeorgis, have intensively focused on the combined value of multiple real options.

Real options research has become recently increasingly popular and significant in strategy and competition where the real options theory offers a great potential making a difference. A great many research in this field has criticized the DCF method being inadequate and non-helpful in resource allocation and strategic decision making. Although the research has been conducted in various contexts and applications, the relevance and importance of
growth opportunities in strategic decision making, in particular, has gained a great attention of the scholars involved. Initially the research was focused on natural resource investments because of volatile nature of the industry and high-value investments required. In recent years more and more research has been directed to contexts such as land development, flexible manufacturing, research and development (R&D), new ventures and acquisitions.

Real options theory has become relevant in strategic acquisitions of companies, for an acquisition generally brings with it several real options such as growth, abandonment (known better as divestiture) and flexibility options. Research on these has not been as abundant as on some other topics in strategic management but there are some authors who have studied the topic like Smith & Triantis and Folta & O’Brien among others. Fortunately, the general study of common real options can be relatively easily applied to the field of strategic acquisitions as well.

Although there are increasingly more and more researches on the theoretical points of real options theory and its application to a variety of contexts, empirical studies of real options have been mainly missing, particularly large-scale studies. The empirical studies conducted have mostly focused on natural resource investments and real estate development.

1.5 Methodology

Business research can be conducted in three ways in terms of how knowledge is developed and judged, namely positivism, interpretivism and realism. The research philosophy of this report is positivism, as the real options theory and its applicability to acquisition valuation will be studied from an objective point of view and the data gathered in a value-free manner. In this approach, the role of the researcher is to be independent of the topic of the research. (Saunders, Lewis & Thornhill 2003, 83-84)

The method in which the data will be analyzed is concept analysis, for in this report we will try to gain a better understanding of the real options theory and its applicability to acquisition valuation by breaking down (analyzing) the primary concepts of the theory into their essential parts. (Beaney 2003) The concept analysis is based on studies by other researchers. The role of the empirical part at the end of the report is merely to demonstrate the applicability of the real options theory to acquisition valuation in that one case. The case
study is based on financial statements of companies studied.

1.6 Disposition

This dissertation has 7 chapters. Chapter 1 introduces the topic and sets out the objectives of this report. In Chapter 2 the real options theory is examined, and its contribution to the investment decision-making discussed. In Chapter 3 we study the main principles and the underlying foundations of the discounted cash flow approach. In Chapter 4 we present briefly the theory of acquisitions and their valuation. Chapter 5 examines the relevance and implications of the real options theory in acquisitions. Chapter 6 is reserved for case-study. In Chapter 7 the results of this study are discussed and presented. At the end, references used in this report are listed.
2 REAL OPTIONS THEORY

2.1 Option theory

Option gives its owner the right, but does not obligate, to purchase or sell the underlying asset at specified terms and conditions. The two most common types of options in the financial markets are a call and put option. A call option gives its owner the right to buy stock at a fixed price during a particular time period whereas a put option gives the holder the right to sell stock at a fixed price. At the time of making the option contract, exercise price, which is the price at which the holder can buy or sell the underlying asset, and the maturity date are fixed. If the option can be exercised only on one particular day, it is known as a European option; on the other hand, if the option can be exercised on or any time before the maturity date then it is called an American option. (e.g., Bodie, Kane, Marcus & Mohanty 2006, 720-724; Hull 2006; Krishnamurti & Vishwanath 2008, 115)

Mostly the underlying asset in option contracts is common stock but it can also be currency, bond or almost any commodity for which a market quote can be found. An option writer (seller) is obligated to perform when the option purchaser exercises his or her rights under the option contract. The amount the option buyer pays at the time of making the option contract is called an option premium. Option can be written by any investor. (Puttonen & Valtonen 1996)

An option is described as being in the money when its exercise would produce profits for its owner. For instance, a call option is in the money when the underlying asset’s market value is greater than the exercise price. If the exercise would be unprofitable then the option is said to be out of the money. Option is called to be at the money when the exercise price equals the asset’s market value. (e.g., Bodie et al. 2005, 721-722; Ross, Westerfield & Jaffe 2005, 619)

An option premium, the price of an option, builds up from two factors, namely intrinsic value and time-value. In case of a call-option the intrinsic value refers to the positive difference between the market value of the underlying asset (stock) and the exercise price. For a put-option the reverse is true. (e.g., Bodie et al. 2005, 768)
As option is a right and not an obligation its intrinsic value can never be negative, meaning that the holder can never lose more than the premium. General formula for the calculation of an intrinsic value is as follows:

\[
\begin{align*}
(1) \quad \text{Call-option} & \quad \text{Max} (0; S-X) \\
& \quad \text{Put-option} \quad \text{Max} (0; X-S)
\end{align*}
\]

where S refers to the current market value of the underlying asset and X is the agreed exercise price. (Knupfer & Puttonen 2004, 193)

The market price of an option is often higher than what the intrinsic value would indicate. The difference is commonly called the time value of an option. The existence of the time value is attributable to the fact that the option has time left to expiration, meaning that there exists a possibility that the price of the underlying asset might change so that the exercise could become profitable in the future. (e.g., Bodie et. al. 2005; Brealey, Marcus & Allen 2006, 554-555; Hull 2006) The time value decreases as the expiration date approaches and it is eventually zero at the expiration.

Time to expiration-factor is not the only variable that affects the option’s time value. Other determinants are volatility of the underlying asset and general interest rate level. The volatility of the underlying asset has a positive correlation with the price of an option, meaning that higher volatility increases chances that the asset’s value would be favourable at the time of expiration. The interest rate factor has a different kind of impact on a call and put option respectively. In case of a call option the rise in the general interest rate level brings down the present value of the required exercise price at the expiration and thus increases the value of the option. For a put option the impact is reverse for the rise in the general interest rate level decreases the present value of the to-be-received payment. (Bodie et al. 2005, 769-770)

In case of stock options the dividend payout policy of the firm also affects option values. A high-dividend payout policy slows, in case of a call option, the rate of growth of the stock price, for a higher dividend yield implies a lower expected rate of capital gain. The slackening effect on the potential appreciation of the stock lowers the potential payoff from the call option. Obviously with a put option the effect is opposite. (Bodie et al. 2005, 770)
The aim of the above was to lay the foundations for the discussion of the real options theory that follows for the real options theory builds upon the general option theory and financial option pricing models. (Triantis & Borison 2001) In next chapter the concept of real options is explained in detail and distinction made between the financial and real options.

2.2 Real options

The driving force behind the development of real options theory was the ever increasing dissatisfaction and frustration among both academics and those operating in corporate world with the so-called traditional decision-making and valuation tools to assist corporate practitioners efficiently in resource allocation. The traditional tools which are mainly based on the DCF method tend to ignore the managerial flexibility embedded in resource allocation decisions, such as investment decisions. (e.g., Amram & Kulatilaka 1999; Kodukula & Papudesu 2006; Tong & Reuer 2007; Trigeorgis 1995, 1996)

The importance and relevance of the managerial flexibility was recognized well before the advent of the real option concept but its proper consideration and incorporation into decision-making situations was hampered by the fact that the valuation of the flexibility remained an unsolved dilemma and stumbling block until the early 1970s. In 1973 Black, Merton and Scholes presented a groundbreaking option valuation model which paved the way for the development of the real options theory and valuation of the managerial flexibility. (e.g., Amram & Kulatilaka 1999; Trigeorgis 1995) The term real option itself was coined in 1977 by Professor Stewart Myers of MIT, but the first known account of the concept can be traced all the way back to writings of the Greek philosopher Aristotle (Krishnamurti & Vishwanath 2008, 116).

The concept of real options has been defined in various ways by different authors but they all more or less indicate and convey the same message. Real options, in a nutshell, can be defined as being options on real assets. These options provide and inject flexibility into investment decisions. Next we present some of the most commonly confronted definitions.

Trigeorgis (1995) has defined real options as being “discretionary decisions or rights, with no obligation, to acquire or exchange an asset for a specified alternative price”. In other
words, “real options refer to choices on whether and how to proceed with business investments”.

Reuer & Tong (2007, 35) and Dixit & Pindyck (1995, 105) state that capital investments are made in the hope of utilizing and creating financial opportunities. These opportunities, they argue, can be viewed as real options which enable and entitle the companies to take some action in the future. The opportunities are “real” for their underlying asset is generally physical or human asset (Reuer & Tong 2007, 35).

Brealey at al. (2006, 258) describe real options as being options to modify investment projects. Amram & Kulatilaka (1999, 6) define real options as options on real (non-financial) assets that are embedded in strategic investments and require identification and specification.

In this report we choose not to pick any one of the above definitions as our favourite as we strongly feel they all convey the same message though they differ in the way the concept is articulated and expressed in words. Next we proceed to find specific and unique qualities of the real options theory.

Real options theory principally states that the ability to change the pre determined course of actions in response to new information has an economic value under uncertain conditions. (Li, James, Madhavan & Mahoney 2007, 46) What makes real options special and useful is their ability to offer flexibility to the corporate practitioners to react to new market information in such a way that the upward potential of the project in hand can be retained while the possibility of losses declines. (e.g., Brealey et al. 2006; Dixit & Pindyck 1995; Trigeorgis 1996; van Putten & MacMillan 2004) This possibility of control over the financial repercussions of investment projects through active investment management indicates that the ability of the traditional decision-making and valuation tools to efficiently convey all the relevant information about investment targets might be impaired as they perceive the investments to be held passively that is no changes to be made after the initiation. (e.g., Kodukula & Papudesu 2006; Luehrman 1998b)

A real options oriented approach to capital budgeting as a whole represents very well the managerial decision-making process for in the real world the financial outcome of
investments is greatly determined by managerial discretion to act upon available options either by exercising, delaying or letting them expire. (Lander & Pinches 1998, 538) It is exactly this role of bringing financial decisions and strategy together that makes the real options theory relevant for corporate practitioners. (e.g., Luehrman 1998b)

According to, for example Trigeorgis (1995, 2) and van Putten & MacMillan (2004, 138) the value of an investment containing real option(s) can be described as follows:

\[(2) \text{"Extended" NPV} = \text{tNPV} + \text{OV}\]

where tNPV refers to the value of the project calculated using a conventional investment thinking and valuation tool (net present value) and OV refers to the values of real options embedded in the project. The above equation shows that the real options thinking does not make the traditional DCF approach void but rather complements it (e.g., Trigeorgis 1995; Slater, Reddy & Zwirlein 1998; van Putten & MacMillan 2004, 134).

As the use of real options thinking relies on active investment management as opposed to passive management, which the traditional method (DCF) suggest, the real options approach can be seen as a new way of thinking which gives the managers a tool to create value through their active management of strategic investments in an uncertain business environment. (Amram & Kulatilaka 1999; Kester 1984; Triantis & Borison 2001) Real options, unlike financial options, require identification and specification by corporation practitioners for they are embedded in investment projects or have to be created. (e.g., Amram & Kulatilaka 1999, Mun 2006, Triantis & Borison 2001) Due to this role of management, the internalization and know-how of the real option theory can be seen as a crucial business competence in a rapidly changing business environment, which may prevent management from making suboptimal investment decisions.

The valuation of investment projects using the option valuation formulas/tenets has a potential to take into account the flexibility by considering dynamic decision-making and thus it better projects the logic of managerial decision-making than the traditional DCF approach. (Luehrman 1998b) Alessandri, Lander & Bettis (2007) argue that those companies that tend to rely their capital budgeting decisions entirely on DCF approach must
be aware of the limitations of the method if they wish to allocate their resources effectively and stay competitive in their respective fields.

Seeing uncertainty in a constructive light as something that can be exploited for financial gain rather than as something to be afraid of or/and avoided, which is what real options theory implies, does not always add value in decision-making situations. It offers no relevant value in situations where the DCF calculations indicate that the investment is either clearly worth undertaking or completely disastrous (e.g., Amran & Kulatilaka 1999; van Putten & MacMillan 2004). Conventional valuation tools, naturally, also produce correct information when the project is exposed to very little uncertainty and there are basically no options embedded in investment. (Kodukula & Papudesu 2006, 58-59)

Real options thinking/ analysis is, however, crucial and valuable in the following situations (e.g., Amram & Kulatilaka 1999, 24; Mun 2006, 392):

1) When an investment decision depends on an uncertain outcome (also known as a contingent investment decision)
2) When there is so much uncertainty that it makes sense to delay some decisions until more information is available
3) When it seems that the value of the future growth options of the project are more valuable than the cash flows generated by the initial project itself
4) When investments offer the management flexibility in the future to modify projects in response to new information
5) When investments might be updated after the initiation and mid-course strategical corrections may be required

The two main factors that cause companies to think in terms of real options when evaluating investment projects are uncertainty and irreversible nature (investment cannot be reversed without losing much of its value) of most of the investments. (Amram & Kulatilaka 1999) The more uncertain the business environment the more important is the real options analysis as an investment management tool for it enables management to value and perceive decisions through the lens of active management, which offers decision-makers opportunity to modify investments projects in the planning phase and/or already running (Trigeorgis 1996; van Putten & McMillan 2004).
The real options analysis is capable of providing the decision-makers a better and more profound understanding of the problem and makes the decision maker better informed. The real options analysis or in fact any other framework cannot guarantee success for they all rely on certain factors that are subject to managerial effort, creativity, experience, knowledge and critical thinking. Some of these factors are as follows (Lander & Pinches 542, 1998):

1) Assumptions made about the investment project itself and the valuation method
2) Unfounded optimism or pessimism
3) Not understanding role of competitors and own strengths and weaknesses
4) Appropriate balance between short-term and long-term

Real options, though they build upon (financial) options theory are in many ways different from the latter. They mainly differ in two aspects, namely rights of ownership and tradability. Most of the real options (for example, investment opportunities) can be jointly held by or available for more than one party, thus making them non-exclusive. (e.g., Li et al. 2007; Trigeorgis 1996) But it should be noticed that not all the investment opportunities are shared; for example, a patent to develop a product which has no close substitute is available exclusively to the holder of the patent. (Nerkar, Paruchuri & Khaire 2007)

Second, the real options are generally not tradable in financial markets as they are often found in investment projects itself. Certain investment opportunities, such as patents to develop certain products, may be traded but this will require the seller to create the market for the product. (Trigeorgis 1996) Though real options are not traded in financial markets, they are rarely available free of cost. As mentioned earlier, some real options are embedded in investment projects while some can be created by management to position the firm better to meet the challenges of the future. Creating real options, often in the form of added flexibility, can be costly. (e.g., Landen & Pinches 1998, 538; Trigeorgis 1995, 8)

In addition, sometimes the value of real options is not limited to the value of the underlying asset as is the case with stock options. Some real options, when exercised, may lead to further discretionary investment opportunities. For example, a huge investment in R&D is not done merely for the underlying asset’s cash flow but also for new investment
opportunities that may arise. (e.g., Kulatilaka & Perotti 1998; Perlitz, Peske & Schrank 1999; Leiblein & Ziedonis 2007; Willner 1995)

In this chapter we have looked at the qualities which make real options theory unique and relevant in uncertain environments. In addition, we have made a distinction between the real and financial options. However, so far our study has remained fairly theoretical and abstract and hence, next we study in detail the most common real option types for this will aid us connecting the theory to concrete real life decision-making situations.

2.3 Overview of most common real options

There is basically no limit to what kind of or how many real options can be created in investment projects by a sagacious management. (Brueggeman & Fisher 2006, 382-383) However, in the real options literature usually six different types of real options are analyzed and presented. These are option to defer an investment, time-to-build option, option to change the operating scale, option to abandon, option to switch use and growth options. (e.g., Krishnamurti & Vishwanath 2008, 116-117; Li et al. 2007, Trigeorgis 1995, 3-4) These six real options can be further divided into inherent and created options. Inherent options that are option to defer, option to contract and option to abandon, are, as the name indicates, inherently present in investment projects, whereas the other three options must be created into the projects. (Trigeorgis 1996)

The six real options mentioned above give management operational flexibility. Next we present a general description of each of the option mentioned. The existence and relevance of these options in corporate acquisitions is analyzed in chapter 5.

Option to defer

In times of uncertain market prospects it may pay the firm to wait and delay its investment until more information about market conditions is available. This, deferring, gives the firm operational flexibility which places it in a position to choose the future course of the investment only after sufficient new information has been received. Option to defer is an excellent tool in investment management which can, in the best case scenario, prevent the firm from undertaking a value destroying project, but on the other hand allows the firm to
clear some uncertainty surrounding the investment. (Li et al. 2007, 35-36). Timing option is often high in demand among managers if the opportunity can be sustained, for a delay in investing often means that the initial investment is lower due to the time value of money. (Krishnamurti & Vishwanath 2008, 118)

The value of the option to defer increases as the uncertainty increases about the commercial prospects of the investment. The value of the option to wait is particularly great in highly uncertain industries which are known for long investment horizons, such as real estate development, resource extraction and paper production. (Trigeorgis 1995, 5-6; Krishnamurti & Vishwanath 2008, 119) The deferral option can be of massive relevance and value in fields of business such as chemicals, pharmaceuticals and petroleum for, according to estimates, in these industries often only 20 percent of R&D initiatives end up proving financially successful. Generally an option to delay investment does not require any expenditure, but in some fields, such as resource extraction, some sort of license must be acquired at some cost in order to procure a right to develop an oilfield (Leiblein & Ziedonis 2007, 230).

The option to wait is also particularly important when the investment is irreversible and the option is not shared with competitors. (e.g., Trigeorgis 1995, 1996) Pindyck (1991) concluded that the justification for making an investment is severely (negatively) affected by greater uncertainty. Deferring an investment when the option is not proprietary may sometimes actually prove to be a hazardous decision. For instance, when a firm is contemplating entering an emerging and relatively unknown market it has to think about the possibility and impact of someone else’s entry to the market while it is waiting for more information. In some cases entering the new market first entails huge advantages, which may in the long run have an enormous positive impact on investment’s financial performance. Thus, the actual cost of the option to delay can at times be significant in terms of lost marginal advantages resulting from an early investment, foregone cash flows and a possible action of a competitor (Leiblein & Ziedonis 2007).

Bulan, Mayer and Somerville’s (2006) empirical study on the impact of competition on the timing of real estate development concluded that competition negatively affects the value of the deferral option and thus firms facing competition are not capable of utilizing the timing option to same extent as monopolistic firms.
Option to abandon

Traditional investment valuation tools do not explicitly consider the possibility of management to abandon the project in exchange for its salvage value or switch use value if the investment turns out to be financially poor. (e.g., Kodukula & Papudesu 2006) In theory, management invariably possesses the flexibility to abandon its investments to avoid incurring the fixed costs of operations and receive the value of assets either selling them for their salvage value or using them in next-best use (Krishnamurti & Vishwanath 2008, 122). However, it should be noticed that there may be situations when it may be wise to keep unprofitable project running, for example due to its organizational capabilities or positive impact on firm’s other projects.

The recognition of an option to abandon increases the willingness of the firms to invest. The abandonment option is, naturally, more valuable in projects that have general-purpose capital assets compared to those that have more special-purpose assets. This is due to the reason that the general-purpose assets are easier to sell and use for other purposes than special-purpose assets. Special-purpose assets are often custom-made for investment projects. (Berger, Ofek & Swary 1996; Li y. 2007, 37) The value of an abandonment option is positively correlated with the uncertainty, that is the higher the uncertainty the more valuable is the abandonment option. (Krishnamurti & Vishwanath 2008, 122)

Abandonment options are most valuable in capital-intensive industries, in financial services and in new-product launchings to uncertain markets. (Trigeorgis 1995, 8) Option to abandon is a crucial valuation tool in mitigating the impact of poor investments and increasing the initial valuation of a project. (Hull 2006, 722)

Option to switch use

Switch use options are an incredibly powerful means to create operational flexibility in investment projects, which will equip management to confront possible surprises better and thus decrease the risk involved. (e.g., Li et al. 2007) This option is mostly not embedded in investment opportunities hence it often has to be created at some cost (Krishnamurti & Vishwanath 2006, 124-125)
The management has an option to create two kinds of flexibility in investment projects, namely product (output) and process (input) flexibility. Product flexibility, which is to have an option to change the output, offers the firm opportunity to switch among alternative output in response to changing market prospects. For instance, if the demand for the current products is declining then the firm can switch to producing products that are in demand. Building product flexibility can be costly as it often requires more flexible manufacturing system. Product flexibility is valuable in industries where the volatility of demand is high and production mix large, such as automobile and electronic industries. (Kulatilaka 1995, 104; Trigeorgis 1995, 1996)

Process flexibility, on the other hand, allows the firm to switch the inputs used in its processes. This enables the firm to use the cheapest possible raw material and technology, for instance. Process flexibility can be achieved in several ways, for example using advanced technology, maintaining relationships with a variety of suppliers or maintaining product facilities in various locations. This option is increasingly valuable in high energy consuming industries, where it gives some protection against rapid changes in commodity prices. (e.g., Kulatilaka 1995, 104; Oriani 2007; Trigeorgis 1995, 8)

The option to switch use is becoming increasingly relevant and important asset for competitiveness and survival in high-technology industries. Investments in innovation can create these options, which then can immensely and decisively influence financial performance of companies at the event of emergence of a new technology in a particular industry. (Oriani 2007)

**Time-to-Build Option**

Staging capital outlay / financing as a series of investments over time, instead incurring them as a single up-front investment, creates options to the firm and allows it to exit the project at any given stage if the performance of the investment is less favourable than expected. In this approach each stage can be seen as an option which is exercised if the investment has been profitable or/and the subsequent stages offer desirous outcome. Time-to-build option is an excellent investment management tool in limiting losses if the project turns out to be disappointment. This option is present and often highly valuable in most of
the R&D-intensive industries, real estate development, start-up ventures and in uncertain but rapidly growing markets. (Trigeorgis 1995, 8)

**Option to alter operating scale**

A firm has an option to react to new market information and circumstances by altering its scale of operations. For instance, if market conditions become more advantageous than previously estimated management has an opportunity to increase capacity or speed up production. The firm also has an option to contract, shut down or restart its operations in response to new market information. (e.g., Kodukula & Papudesu 2006, 63) An option allowing altering the scale of operations may often require some investment on behalf of the firm, such as acquiring higher technology capital assets. This option is commonly found in cyclical and natural-resource industries. (Trigeorgis 1995, 6-7)

Option to alter operating scale is often used in times of economic difficulties when production is cut and employees laid off. Assessing each and every repercussion of the exercise of this option is often next to impossible as its use can have an extensive impact on a firm’s financial performance, for instance, through damaged corporate image, strikes and severance pay. On the other hand, increasing or restarting operations may turn out be fairly costly procedures as well.

**Growth options**

Most of the investments in real assets are driven by the future opportunities the initial investment will entail. The future opportunities, which can be considered as corporate growth options, are of significant strategic importance to companies. (Li et al. 2007, 37) The initial project in isolation may produce negative NPV if viewed through the lens of traditional investment thinking, but often these investments create growth opportunities that are only available if the early investment is made. The value of many early investments, for instance pilot projects or R&D is not so much contingent on their direct cash flows than on the future growth opportunities they may expose. (e.g., Amram & Kuletilaka 1999; Kester 1984; Krishnamurti & Vishwanath 2008; Perlitz, Peske, Schrank 1999) Real options thinking is crucial in unlocking the true potential of an investment which itself would appear not to be feasible, for the traditional investment valuation techniques, such as DCF,
have tendency to ignore the full value of growth options attached to profitable and growing lines of business. (Willner 1995)

With growth options it is critical to notice that the so-called early or initial investment is a prerequisite for future opportunities. In fact, any investment can be seen as a growth option if it entails new investment opportunities, no matter how small or big in size. Growth options are in a central place when stock markets value securities, and in case of some companies, in particular rapidly growing ones, the value of growth options can amount a high proportion of their total market value. (Krishnamurti & Vishwanath 2008, 120) In a few empirical studies conducted on the importance and relevance of the growth options to companies’ (market) values, it has been showed that growth options represent more than half the (market) value for many firms and in case of precarious and volatile industries the percentage can be as high as 80. (Kester 1984; Trigeorgis 1996)

The value of a subsequent investment, such as launching a new product, emanating from the initial capital outlay, like a market survey, is contingent on early investment and hence the initial expenditure can be interpreted as being the cost required to create and take advantage of possible future opportunities arising from it. (Leiblein & Ziedonis 2007, 229; Li et al 2007) Traditional investment valuation tools tend to undervalue investments containing future opportunities and hence they may limit companies’ growth by underinvestment. (e.g., Amram & Kulatilaka 1999; Kulatilaka & Perotti 1998)

Growth options are to be found in all industries where investment processes involve sequential projects, but in particular they are a matter of great importance and relevance in industries involving high technology and those where a great amount of resources are tied to Research & Development (R&D). (Trigeorgis 1995, 8-9) Understanding and awareness of growth options in investment projects is critical if the firm wants to avoid doing underinvestment. As we will see later in this dissertation, growth options are of an immense value in strategic corporate acquisitions for they entail some future opportunities to the acquirer which would not have been possible and available without the acquisition.

Option to defer and growth options are often considered to imply contradictory advices to managers, for the deferral option is seen as a rational choice in times of great uncertainty, but on the other hand growth options often appear also tempting under high uncertainty due
to higher upside potential in future benefits. Folta and O’Brien’s (2004) study on this ostensible conflict showed that under uncertainty the deferral option eclipses the growth option even when there are early-mover benefits. They, however, found that in case of extremely uncertain conditions (defining this as meaning above 93rd percentile) the value of the option to delay is overtaken by the value of growth options.

On the other hand, Kulatilaka and Perotti’s (1998) examination on the effects of these two options on investments concluded that when the advantages involved with an early move (they called this a pre-emptive effect) are taken into consideration the value of growth options overshadowed the value of the deferral option even under less than extremely high uncertainty.

So far we have focused on individual real options and their significance and benefits for management. However, in the real world investment projects have often a collection of real options embedded in them, which even tend to interact with each other. (Anand, Oriani & Vassolo 2007, 276) Real options interaction, depending on the degree of interaction, can mean that the value of an option in the presence of other options may deviate from its value in isolation and that the combined value of options may differ from the value gained valuing each option individually and then adding the results. At an extreme, exercise of one option can lead to the elimination of all the other options embedded in the project. (Trigeorgis 1995, 21-22)

According to Trigeorgis (1996, 232-240) the magnitude and the degree of interaction among different real options generally depends on the following aspects:

1) On the type of real options
2) On the degree of being “in the money”
3) On the order of the options
4) On the separation of their exercise times

If, for example, an investment project has two real options that are of opposite type in a way that they are optimally used under opposite circumstances then the conditional probability of using the later option when the earlier one has been exercised is smaller than the probability of using the later option alone. In a situation like this, the magnitude of
interaction will be small and therefore the options would be roughly additive, that is their combined value is close to their added value when evaluated in isolation.

The order of real options in investment project can also have an enormous effect on their respective values. For instance, if an earlier option is a put its use can destroy all other options in the project whereas in case of a call the interaction can be positive so that the combined value of the options is far greater than their separate values.

If the earlier option, whether a put or a call, is clearly “in the money” so that its use is profitable, this affects the value of later option(s) for the exercise of the earlier option dictates the availability and possible benefits of the later options. The degree of being “in the money” affects positively the possible use of the option thus it has clear correlation with the later option depending on their types and order.

The separation of exercise times affects the interaction positively. If the separation is great it reduces the magnitude of interaction as it is likely that conditions may change and therefore the use of the earlier option does not directly imply that some action will be taken with the later option(s).

Next we will take on one of the most challenging issues in real options theory, valuation. This is an extremely important topic for proper and profound use of real options theory demands that options to be valued.

2.4 Application of real options analysis

So far in this report we have discussed about real options theory as a concept and examined a variety of qualities of different types of real options. Through these two aspects we have shown the importance of real option thinking in uncertain market circumstances. However, recognizing that real options approach avails firms to have flexibility in investment project is only first half of the story, for in order to comprehensively incorporate the new way of thinking into decision-making real options must be also valued (Amram & Kulatilaka 1999, 29).
In their discussions with several corporate practitioners Triantis and Borison (2001) recognized three different ways of using real options in the real world, namely real options as a way of thinking, real options as an analytical tool and real options as an organizational process.

Utilizing real options approach only as a way of thinking means that the theory and its implications are merely used qualitatively in decision-making whereas in case of using the theory as an analytical tool real options and option pricing models are used to value those investment proposals that have option characteristics. Real options approach can at times be used as an organizational tool to assist management in recognizing and benefiting from available strategic options. (Triantis & Borison 2001, 10)

Injecting real options thinking into capital budgeting decisions will ensure that many crucial questions, which often are sidelined, will be addressed. Some of these issues are as follows (Kester 1984, 160):

1) How to create options into investment projects?
2) What role options play in company value?
3) What is required financially from the company to capitalize and take advantage of existing or would-be-created options?

Real options theory clearly indicates that the managerial discretion, judgement and experience can have an immense impact on companies’ resource allocation processes. (Kester 1984) However, as mentioned above, in order to use the real options approach to the best of its potential, it is imperative to be able to value the options on real assets. The valuation / application process of real options is a process containing several steps (see below) (Kodukula & Papudesu 2006, 97)

The 1997 Nobel Prize winning financial option valuation breakthrough by Fisher Black, Robert Merton and Myron Scholes laid the foundation for valuing options on real assets. The breakthrough led to Black-Scholes equation which is widely used in solving the values of financial options. (Amram & Kulatilaka 1999) The equation, however, is not generally used in real options context due to its limitations and hence other solutions, such as binomial method, have emerged to address the problem (Kodukula & Papudesu 2006, 94).
In the real options literature, mainly these above two solution methods for option valuation are analyzed and discussed. Due to their importance both of the methods are explained in detail below. These two valuation methods are principally designed to solve values of financial options and therefore their application to the real options realm poses certain problems and limitations (e.g., Amram & Kulatilaka 1999, van Putten & MacMillan 2004, 139).

These two valuation methods require several inputs and assumptions that are at times problematic to obtain for real options. In particular, a reliable estimation of volatility parameter can be difficult and cumbersome to obtain for there are often no historical data available of the underlying asset’s price change on which corporate practitioners could rely on. (e.g., Amram & Kulatilaka 1999; Gitelman 2003; van Putten & MacMillan 2004, 139)

The volatility of real options can be estimated using a variety of methods but one of the simplest and easiest ways is what is called project proxy approach. In this method the volatility is estimated using the historical data of a comparable project. If no comparable project is found then management assumption approach can be used. The management assumption approach relies on management’s estimations of optimistic, pessimistic and average expected cash flows over project’s lifetime. On the other hand, simulations, such as Monte Carlo simulation, can be also used. (Kodukula & Papudesu 2006, 88-92).

Luehrman (1998a, 52) has presented the following depiction as how to link the parameters used to value financial (call) options to real options context:

<table>
<thead>
<tr>
<th>(Call) Option</th>
<th>Investment opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of the underlying stock price</td>
<td>PV of forecast cash flows Exercise</td>
</tr>
<tr>
<td>Time to expiration</td>
<td>cost of the investment project</td>
</tr>
<tr>
<td>Risk-free interest rate</td>
<td>time period the opportunity exists</td>
</tr>
<tr>
<td>Volatility of the stock</td>
<td>Riskiness of cash flows</td>
</tr>
</tbody>
</table>

29
Kodukula & Papudesu (2006, 97-100) and Amram & Kulatilaka (1999, 89-105) present simple but yet clear process for solving the values of real options using the option valuation principles and techniques. The process contains the following steps:\footnote{The process presented by Amram & Kulatilaka (1999) has only four main steps but it, however, contains all of the six steps laid out by Kodukula and Papudesu (2006).}

1. Framing the application
2. Identifying the input parameters
3. Option parameter calculation
4. Building the binomial tree or using the B&S formula
5. Calculation of the option value
6. Analyzing the results

The first task in valuing real options is to frame the application. Framing the application includes such tasks as describing the situation in words and images, identification of real option(s) and clearly pointing out possible decisions and rules regarding the decisions. The application becomes more complex as the number of decisions (options) increases, thus it is crucial to be aware of any dependencies between different options. The key to a successful problem framing is to keep it both simple and intuitive and involve as many experienced managers as possible, for this step is the most important step in applying real options analysis to investment projects.

When framing the real option application it is critical for success to identify the sources and forms of uncertainty related to the problem. Finding the source of uncertainty for a real option may at times be a cumbersome task as real options can be very complex, but this task is essential and should not be overlooked for the sources of uncertainty can often trigger the execution of options. In order to keep computations simple it is wise to include only those sources of uncertainty that are most important for decision-making, whether private or market-priced. If the source of uncertainty is market-priced then it might be that the risk is captured best by looking to the financial markets.

The framing step is the foundation for building successful and applicable real options analysis and it should be kept simple and transparent as to make it easier to convey the message to those involved in decision-making.
The next steps in the process are identifying and calculating the input parameters. The parameters in question generally are the value of underlying asset, cash flows, option life, exercise price, volatility for each source of uncertainty and risk-free interest rate. The calculation of these parameters is not as straightforward as with financial options due to the fact that real options lack proper structure and that their value derives from the underlying asset for which finding values of certain parameters can be difficult. In case of solving the values using the binomial model, calculation of option parameters such as up and down factors and probabilities are required before being able to arrive at option value (see binomial model below).

The next step, if the Black & Scholes method is used, is to simply calculate the option value. On the other hand, if the binomial method is used then the next steps are to construct a binomial tree, calculate the asset values at each node of the binomial tree and calculate the option values at each node starting from the future point and moving towards present moment (see binomial model).

The last step in the application process is the analysis of the results. In this phase, the outcome should be compared to that of gained by using DCF method and the results should be discussed critically in order to measure the validity and reliability of the results. At extreme, the review of the results could lead to redesigning the initial framework of the application to better describe the problem in hand.

The real options application process described above is easy to follow, straightforward, and requires understanding of real options theory as a way of thinking, analytical and strategical tool. The key task is the framing which places responsibility on corporate practitioners as its outcome is directly related to the skills of them. The understanding of real options makes the practitioners well positioned to identify options embedded in projects thus enables them to make right decisions.

Our aim in laying out the real options analysis process in detail is to highlight the fact that real options analysis is much more than a simple set of equations or models. It is rather a comprehensive decision-making and valuation process which supplements the traditional analysis methods. Most of the value in real options analysis comes from merely thinking about it. (Mun 2006, 385)
Successful implementation of real options analysis does not only require right tools but essentially it boils down to the quality of resources available in the process. The most important and critical resource in the process is human capital, for its contribution and inputs will ultimately determine the quality of the foundation of the analysis, that is the framework of the application, which in turn affects everything that follows. (Mun 2006, 386)

The importance of human capital in real option analysis is also extremely critical due to the fact that the value of real options in most investment projects is manageable by increasing the present value of cash inflows, decreasing the present value of cash outflows, controlling the uncertainty in cash flows, extending investment opportunity’s duration and reducing the value lost by deferring the investment (Krishnamurti & Vishwanath 2008, 125-126).

The application process presented above will be used in our case study in Chapter 6. Next we will look at the valuation of real options in more detail as valuation tools and the principles behind these are analyzed and presented.

2.5 Valuation of real options

Valuation of real options is not feasible with the traditional valuation models (DCF) used for valuing an asset because two variables, namely expected cash flows and discount rate, required to be known to calculate the value of any asset are difficult to determine with options. The expected cash flows are cumbersome to gain but nonetheless possible, but finding the discount rate, which reflects the risk of an asset is an impossible task, for the risk of an option is not stationary. The risk changes with the changes in the value of an underlying asset and therefore a single discount rate is not an appropriate in describing the measure of risk involved with options. (Brealey et al. 2006, 565-566)

In the literature, two ways of calculating option values are generally presented, namely replicating portfolio method and risk-neutral valuation method:

1) The idea behind the replicating portfolio method is to find the right combination of underlying asset and loan that replicates an investment in the option. Since the combination, known as a tracking portfolio, gives the same payoffs as the option, then by the Law of One Price (no arbitrage conditions), the two assets must have the same current value. (Amram & Kulatilaka 1999, 32-33; Brealey et al 2006, 566-567).
The method was devised by Fisher Black, Robert Merton and Myron Scholes in 1970s, and earned them the 1997 Nobel Prize in Economics. Black and Scholes also came up with a mathematical formula based on their notion of tracking portfolio to solve the value of a call option. This formula is presented below in this report.

2) Risk-neutral valuation method assumes that investors are indifferent about risk and therefore the expected return on the underlying asset is supposed to equal the current risk-free interest rate. (Brealey et al. 2006, 568). The method was developed by Cox, Ross and Rubinstein in 1976. The binomial option valuation method, which is, in addition to Black & Scholes formula, the most commonly used method, is an application of the risk-neutral approach. (Amram & Kulatilaka 1999, 36).

In addition to these two methods, there are also other alternative ways to value options, such as simulation models. The most popular simulation method is Monte Carlo simulation. (Amram & Kulatilaka 1999) However, because these other methods are not very commonly used in practice we will not discuss them in this report. Next we will look at the two most commonly used calculation techniques, namely B&S formula and Binomial method in more detail.

2.5.1 Binomial method

The use of binomial model in option valuations was introduced by Cox, Ross and Rubinstein in 1979. In binomial approach the development of option’s underlying asset’s value via a binomial lattice (tree) for the time period between valuation moment and maturity is tracked down by using a discrete-time framework. (Page 1998, 67)

The changes in the underlying asset’s value are limited to two, the value can go either “up” or “down” by a given probability. The model is based on the assumption of no arbitrage and risk-neutral valuation. (e.g., Brealey et al. 2006; Bodie et al. 2005; Hull 2006) Option valuation task can also be performed with more complex variations of lattice methods, such as trinomial and quadral lattices. (Mun 2006; Lander & Pinches 1998, 543) These methods, however, are not widely used and therefore excluded from this report.
The binomial method is widely used in calculating (real) option values for a variety of reasons. First, it depicts the underlying instrument over time, as opposed to the Black & Scholes which models the same at one point. Second, the binomial method works far better than the B & S in valuing complex real options and can be used for a greater number of applications (Perlitz, Peske & Schrank 1999). Third, the method, though being in alignment with the option pricing principles, is user friendly for it keeps the appearance of the discounted cash flow analysis. Fourth, the binomial method clearly and visually conveys to its user the sources of uncertainty, decision-making points and the predicted development of the key variable over time. (Amram & Kulatilaka 1999, 36-37)

The method’s key shortcoming is its naïve assumption of having only two possibilities of change in key variable. The problem can be partly reduced by shortening the time period between the decision points. (Brealy et al. 2006, 570) Secondly, the use of a discrete-time framework as opposed to continuous-time assumption may make the handling of the solutions more difficult. (Perlitz et al. 1999, 264) Third, as the binomial model is basically a tree, it can at times become too a big and complex if the number of time periods included is big. (Lander & Pinches 1998, 545)

The process of calculating option values using the binomial model resembles closely the process of solving decision trees. The key insight in solving option values is to start at some point in future and move back through the lattice to current moment. (Brealey et al. 2006). The exhibit 1 below depicts the binomial tree and shows logic behind the method. The underlying asset has current value A which will increase either to Au or decrease to Ad at the end of the one period. By the same same logic the possible values at the end of the second period are Auu, Aud or Add. As we can see the model has two possible future developments at each node and hence the name binomial method. (Trigeorgis 1996, 76)

Exhibit 1
Next we will illustrate the process of solving option values using the Binomial approach through a simple example. We will assume that a stock is priced at $S$ at the moment and the price of the stock will either go up to $Su$ or go down to $Sd$ by the end of the period $t$. In addition, let’s suppose that the probability of having the stock valued at $Su$ is $q$ and $Sd$ is $1-q$. This information can be illustrated as follows:

Exhibit 2

\[
\begin{array}{c}
\text{q} \\
\text{S} \\
\text{1-q}
\end{array}
\begin{array}{c}
\text{Su} \\
\text{Sd}
\end{array}
\]

Next we will assume that there is a call on this particular stock. In order to find the option value we must specify some other parameters, such as current interest rate ($R$) and the exercise price of the stock ($X$). The interest rate will be the current risk-free rate as this approach is based on risk-neutral principle. The risk-neutral assumption entails two crucial implications; the expected rate of return on all investments equals the risk-free rate, and the present value of any cash flow can be determined by discounting it at the risk-free rate.

The value of the option at the moment $t$ will be either $Cu$ or $Cd$. This information can be illustrated as follows:

Exhibit 3

\[
\begin{array}{c}
\text{C} \\
\text{Max} (Su-X,0) \\
\text{Max} (Sd-X,0)
\end{array}
\]

Now the value of the option can be presented as follows:

\[
(3) \quad C = \frac{qCu + (1-q) Cd}{R}
\]
The probability term $q$ can be reduced from the equation, for we know, as per the risk-neutral principle, that the expected rate of return on the stock is $R$. Henceforth, the expected price of the stock $S$ at the end of the period can be written as follows;

$$E(S) = qS_u + (1-q)S_d = SR$$

From the above equation, the probability term $q$ can be solved; $q = (R-d)/(u-d)$. Replacing the term $q$ with this, the value of option $C$ can be expressed as follows;

$$C = \frac{Cu \cdot (R-d)/(u-d) + Cd \cdot (u-R)/(u-d)}{R}$$

In the real world, however, the risk-neutral principle does not naturally hold but its use in option valuation is validated for it can be shown that the option value is not linked to risk preferences of investors. This is one of the most groundbreaking insights of the option theory. (Puttonen & Valtonen 1996, 99-102)

The value of an option can also be solved with the binomial approach using the replicating portfolio method. Once the parameter $C$, the option value, is only unknown term we can construct a portfolio that replicates exactly the payoff of the option. (Brealy et al. 2006, 572)

We must mention here that though we are illustrating the use of the binomial approach considering only one time step the solution process is similar in situations where there are more than one time steps. In these cases the option value will be calculated at each node of the tree starting from the furthest future date and then moving backwards all the way to the present moment. (Bodie et al. 2005, 706-707). The possible option values at the moment $t$ are again:

$$Cu = \max(Su - X, 0)$$

$$Cd = \max(Sd - X, 0)$$

To construct a tracking portfolio we require following assets (Smit & Trigeorgis 2004, 156-159);
a) Purchase amount A of the underlying asset S at the current price
b) Borrow amount B at risk-free rate r

In order to the above combination to produce the same outcome as the option the following must hold:

\[(8) \quad C_u = (S_u)A - rB\]
\[(9) \quad C_d = (S_d)A - rB\]

At the end of the period the borrowed amount will be repaid including the interest, hence rB is deducted (r > 1) in the equation. In the equations we have two unknowns, namely A and B. The two unknown parameters can be solved as follows:

\[(9) \quad A = \frac{(C_u - C_d)}{(S_u - S_d)}\]
\[(10) \quad B = \frac{(S_d * C_u - S_u * C_d)}{(S_u - S_d)(1 + R)}\]

As we assume that financial markets operate efficiently, i.e. no arbitrage opportunities exist, the value of the call option C must be \(C = AS - B\), and therefore we have:

\[(11) \quad C = \left[\frac{(C_u - C_d)}{(S_u - S_d)}\right]S - \left[\frac{(S_d * C_u - S_u * C_d)}{(S_u - S_d)(1 + R)}\right]\]

2.5.2 Black & Scholes formula

Black & Scholes formula, unlike the binomial method presented above, offers a solution to value options when there is an infinite number of sub-periods and the value of an underlying asset changes continuously. (Hull 2006). The popularity of the formula is not only based on it being user friendly but also on its flexibility to solve values of not only stock options but foreign currency, bond and commodity options as well. (Brealey et al. 2006, 577)

The formula has a few advantages over the binomial model. First, calculation of option values using the Black & Scholes formula is less time-consuming task than with the binomial model. (Kodukula & Papudesu 2006, 67) Second, the formula is the best way to solve values of simple options, when there is only one source of uncertainty and maturity
date is known. (Landes & Pinches 1998, 543-544) Third, almost all the variables required in
the formula are easily observable. The volatility of the underlying asset is the only
parameter that is not easily obtainable and its estimation is at user’s discretion. (Bodie et al.
2005, 786)

Black & Scholes equation for a call and put option (European) is as follows: (Hull 2006,
295)

\[
\begin{align*}
C &= S_0 \text{N}(d_1) - X e^{-rT} \text{N}(d_2) \\
P &= X e^{-rT} \text{N}(-d_2) - S_0 \text{N}(-d_1)
\end{align*}
\]

where

\[
\begin{align*}
d_1 &= \ln \left( \frac{S_0}{X} \right) + (r + 0.5 \sigma^2) T \\
&\quad \frac{1}{\sigma} \sqrt{T} \\
d_2 &= d_1 - \sqrt{T}
\end{align*}
\]

$C =$ Current call option value
$S_0 =$ Current price of the underlying asset
$N (d_1/d_2) =$ values of the standard normal distribution at $d_1$ and $d_2$
$X =$ Exercise price
$e =$ 2.71828
$r =$ Risk-free interest rate
$T =$ Number of periods to exercise date, in years
$\sigma =$ Volatility of the underlying asset (annualized)

The Black & Scholes formula has some important underlying assumptions that should be
considered when interpreting the results (Black & Scholes 1973, 640):

- the underlying asset (e.g. stock) pays no dividends or other distributions
- No transaction costs
- the option can be exercised only at expiration date ("European")
- Riskless arbitrage opportunities do not exist
- Risk-free interest rate is known and constant
The price of the underlying asset follows a random walk.

To tackle some of the limitations new variants of the model have been created. For example, the formula can be modified to deal with both call and put options on dividend-paying asset by making relevant adjustments to two variables, namely the value of the underlying asset and the volatility. (Hull 2006, 305)

Above we have mainly discussed about benefits that real options theory offers to corporate practitioners in making strategic investments under uncertainty. We have seen that the approach offers a new way of thinking which complements the traditional investment thinking which is based on passive investment management and on the importance of DCF calculations. The real options theory is a great tool for managing managerial flexibility embedded in most of the investment projects and it also enables managerial discretion to have a role and real impact in performance of investment projects.

In addition, by the help of the option valuation methods the flexibility can be valued and thus the discipline of financial markets can be brought to strategy decisions, which enables better resource allocation. (Gitelman 2002) However, in order to make this analysis more comprehensive and unbiased we will next look at some of the main challenges (problems) with the approach.

2.6 Challenges with real options approach

Regardless of widely reported benefits of real options analysis, it is not used widely used in corporate world. (e.g., Kodukula & Papudesu 2006, 201; van Putten & MacMillan 2004) Lander and Pinches (1998, 543) name three reasons why real options theory is not widely accepted by corporate practitioners:

1) Lack of understanding or knowledge of the theory and valuation models
2) Valuation models require a set of assumptions which corporate practitioners consider being either too cumbersome to estimate or too impractical to project the real world conditions
3) Calculations tend to become too complex too quickly
In addition, it has been argued that real options analysis is too bold and different departure from the traditional way of thinking. Also, lack of proper structure has been widely sited as been a stumbling block for the wider use of the theory in the real world. (e.g., Brealey et al. 2006; Mun 2006, 392-393; Lander & Pinches 1998, 547)

According to Brealey et al. (2006, 614) real options approach as a concept is straightforward and relatively easy to grasp but its practical applicability to real world situations is what often causes challenges and problems to corporate practitioners. Real options in real world investment situations can be fairly complex and multi-layered hence the valuation process can take ample time and be mathematically challenging and cumbersome. (e.g., Luehrman 1998, 51; Rizzuto 2006, 152)

According to Sick (2002) it might be due to this perceived technical complexity of real option valuation that has and is hindering the “breakthrough” of the real options approach among corporate practitioners. On the other hand, if the real options analysis can be kept simple and straightforward it is relatively understandable even for managers who have no finance background (Luehrman 1998a). The key in keeping the real options analysis understandable and clear is to focus on getting a good rather than a perfect answer to the problem. (Brealey et al. 2006, 614; Luehrman 1998a)

Another challenge with real options is lack of structure. Unlike financial options, the variables required to calculate value of a real option are not to be found from financial markets but must be obtained manually. (e.g., Brealey et al. 2006, 615; Trigeorgis 1996) A great amount of criticism against real options theory is based on the notion that the theory is not practical but rather just another tool to increase the value of an investment. (Mun 2006, 392-393) According to Whittington and Gates (2007, 55) the use of real options theory in valuing corporate acquisitions poses risk of overestimating the future cash flows which may be hazardous as acquisitions already tend to be overvalued rather than undervalued.

Sick (2002) even claims that the use of traditional capital budgeting methods in certain industries, such as oil industry, causes pro-cyclical investment pattern, which in turn results in a boom and bust economy. The use of real options analysis can even out the deployment of asset demand for it requires investment decisions to be made based on future forecasts.
rather than on historical data and results, which is the case with some capital rationing techniques.

Sick (2002) also states that the real options approach is not in alignment with current corporate compensation systems and short-term (quarter-to-quarter) thinking, for these do not favour real options thinking as this often dampens short-term cash flow, causes firms to incur extra costs and appears occasionally to support inaction in terms of delaying investment projects.
3 DISCOUNTED CASH FLOW APPROACH

3.1 Traditional investment thinking

Traditional investment thinking embarks from the idea that the sole purpose of a business is to maximize its profits and henceforth the wealth of its owners, shareholders. The theory implicitly supposes that the financial consequences of investments, such as an acquisition, can be expressed in terms of cash flows. The traditional value calculation methods, such as DCF, are based on this notion. The investment decisions are to be based on the calculations; hence the calculation methods are seen as what is called answer machines. According to this way of thinking, an investment is worth undertaking if, for example, the net present value of an investment is positive, for this investment increases the wealth of the shareholders. (Bodie & Merton 2000)

In the real world, however, expressing the financial consequences of an investment accurately is often far-fetched. This is particularly true when market conditions are uncertain and management has flexibility to change the course of an investment as new information is available. Traditional investment thinking and techniques project investments to be managed passively and hence they are not always able to capture the true value of an investment. In addition, the traditional investment approach ignores possible competitive interactions among different investments, which can lead to a serious undervaluation of an investment. (Trigeorgis 1995, 1-2)

Real options approach, on the other hand, utilizes not only the above investment theory but also takes advantage of financial theory and strategic considerations. (Dias & Ryals 2002) Several studies have shown that the compatibility of investment decisions and strategy is an essential factor of a successful investment. This is also further validated by empirical evidence which shows that in the real world investment decisions are not always made based on calculations, but for example, their relevance and consistence with corporate strategy can often be the primary criteria. (Farragher et al. 1999, 145)

It seems that the instructions of the traditional investment theory are not perfectly applicable to real life situations. This gap appears to be growing, for the thinking in business life is
quickly moving towards a more comprehensive stakeholder thinking in which the shareholders are no more the interest group which needs and expectations are above others. (Carroll & Bucholtz 2006) Also the increasing uncertainty and the quick pace of change are undermining, at least to some extent, the principles of this traditional investment thinking. (Amram & Kulatilaka 1999)

In addition to above problems, Kasanen, Virtanen, Laine and Matinpalo (1993) argue that the traditional investment thinking considers only the decision-making moment and calculations but ignores other phases of investment decision-making process. The decision-making process is often influenced by organizational actors, such as employees and other groups within the entity, who can have, potentially, a significant role in firm’s decision-making process. Kasanen et al. continue that the traditional approach also treats investments as being easily incorporated into firm’s other operations, and it also pays no attention to possible issues related to the implementation of an investment.

In reality, however, the implementation phase of any investment can be cumbersome and pose challenges which may require modifications to the investment even before it kicks off. Such challenges can emerge not only from corporate world but also from surrounding society in general, for example, in the form of labour strikes or environmental issues.

The real options approach is, as mentioned above, capable of tackling some of the problems as it recognizes the managerial flexibility and interaction among different investment projects. However, even the real options approach is exposed to issues such as the impact of organizational actors.

The discounted cash flow approach is the most widely used investment evaluation method in corporate world and it is based on the principles of traditional investment valuation thinking. (Farragher et al. 1999, 138) Next we will study the DCF method in detail.

**3.2 Discounted cash flow method**

The main principles behind the discounted cash flow method are foundation for hundreds of different calculation models. (Kodukula & Papudesu 2006, 17) The net present value (NPV) and internal rate of return (IRR) are the most widely used investment valuation techniques
in the corporate world. (Psunder & Ferlan 2007, 18) Apart from these two, the discounted-
payback model is also commonly used for its simplicity. (Farragher et al. 1999, 144) None
of these or other techniques is the “best” model, for they all have pros and cons. The choice
of the technique should, ideally, depend on the underlying characteristics of the asset or
investment. The model chosen should be adjusted to meet the characteristics of the asset or
investment to be valued. (Damodaran 1996, 502)

The process of solving a value of any asset or investment by using the DCF method consists,
generally, of four steps as follows (e.g., Brealey et al. 2006, Damodaran 1996, 485):

1) Estimation of all the relevant cash flows generated by the asset/investment for the
   expected lifetime
2) Estimation of the residual value of the asset/investment at the end of the estimation
   period. The residual value, in case of an asset, refers to the amount owner anticipates
   to receive from selling asset at the end of its useful life (Ross et al. 2005, 904).
3) Estimation of a discount rate. This rate should reflect the risk associated with the
   cash flows
4) Calculation of the present value of these cash flows

The process of solving the value of any asset/investment may vary among different models,
but more or less the most popular models use the described steps in some way or another.
Next we will discuss about advantages of, and challenges with the DCF method.

3.2.1 Advantages of DCF approach

The DCF approach is not only the most commonly used investment evaluation approach in
the real world situations but it has become even more widely accepted method over the last
few decades. (Psunder & Ferlan 2007, 18) This, naturally, indicate that it must offer ample
benefits to corporate practitioners; otherwise its popularity would not be justified.

DCF approach is a useful and effective tool in valuing any asset/investment if there is not
much uncertainty regarding the cash flows, and the investment does not bring with it any
options, meaning that the investment can be managed with a quite passive approach.
(Amram & Kulatilaka 1999, 24)
In addition, the use of DCF approach exposes corporate practitioner to the underlying characteristics of an asset/investment to be valued. This enables and requires the practitioner to understand the valuation target and assumptions made. (Damodaran 1996)

Brealey et al. (2006, 88) name three additional advantages of using the discounted cash flow approach, in particular the NPV, in valuing any asset/investment. First, the DCF models acknowledge the concept of time value of money. This understanding clearly conveys to practitioners the risk involved with any cash flows expected from the future, for the future is always unknown. Second, the approach only considers forecast cash flows. The use of cash flows enables that valuations are not influenced by discretionary factors, such as company’s choice of accounting method or profitability of company’s other independent investment projects. Third, the present value thinking permits practitioner to add up the values of different projects, thus preventing the company from accepting a package of investments with a positive present value which includes poor projects.

3.2.2 Challenges with DCF approach

Perhaps the biggest critique of various DCF techniques is their inability to properly incorporate management’s discretion to adjust initial investment decisions in response to new market information. In reality, management often revises decisions as investment is underway in order to capture new opportunities or mitigate losses due to unexpected and not desirous market conditions. The DCF techniques fail to acknowledge this contingency, even though management is aware of these prospects at the time of making investment decisions. (e.g., Dixit & Pindyck 1995; Dunis & Klein 2002; Kodukula & Papudesu 2006; Tong & Reuer 2007; Trigeorgis 1996)

According to Myers (1987), the most severe shortcoming of DCF method is the failure to consider the linkage between different investment projects. A decision to launch an investment project may affect not only the cash flows of other assets but it often also affects future opportunities firm will encounter.

Another major challenge with DCF techniques is how to determine the discount rate to be used. (e.g., Kodukula & Papadesu 2006; Trigeorgis 1995) The determination of the correct rate is extremely critical, for a difference of just one or two percentage points can make a
big difference in present value. In addition, the higher the rate the less valuable are the cash flows forecasted far in the future which can lead for preference of investments that generate most of the cash flows during earlier years of the life of an investment.

There are different opinions on how the rate should be determined, which itself speaks for the complexity of the issue. The two approaches most commonly confronted in the real world are cost of capital rate and risk-adjusted discount rate. The cost of capital approach refers to using company’s opportunity cost of capital rate, which can be defined as “the expected return on a portfolio of all company’s existing securities”, as a discount rate for every investment project proposal. This thinking is not always applicable for an individual project which risk-wise may differ from the risk associated with company in general. The company opportunity cost of capital should rather serve as a starting point. (Brealey et al. 2006, 217-218).

Discount rate should, if uncertainty exists regarding cash flows, consider two components, namely time value of money and risk premium. In case of certain cash flows, risk-free rate is an appropriate discount rate for the time value of money can be captured by using the risk-free rate. The risk premium, on the other hand, should reflect riskiness of cash flows. (Trigeorgis 1996) However, the determination of the risk premium is not often an easy task, which greatly undermines effectiveness of DCF techniques. One way to arrive at an appropriate risk premium is through utilizing capital asset pricing model (CAPM). In the CAPM, the risk premium is determined by investment project’s beta coefficient. The estimation of beta, however, is not a straightforward task for individual investment projects that have no history (or comparable projects) to base expected cash flows on, and even if a comparable can be founded it is not guaranteed that its historical volatility can serve as a good indicator for the future volatility. (Slater, Reddy & Zwirlein 1998, 449) The general approach is that higher the risk higher the discount rate (risk premium), but this thinking has own pitfalls. (Damodaran 1996)

According to Kodukula & Papudesu (2006, 48) and van Putten & MacMillan (2004), if discount rate is increased in correlation with uncertainty, as is advised, then only downside risk is considered but upward potential is ignored. However, as per risk principles, when the downside risk increases so does the upward potential. This means that attitude towards highly uncertain projects is biased.
We said earlier that DCF analysis is an effective tool valuing an asset/investment when there is no uncertainty associated with forecast cash flows. This assumption, however, is not very realistic, for even the most certain cash flows can become vulnerable if market environment is affected by some drastic unforeseen events which affect almost everyone in economy. Risk pertaining to whole economy is known as market or systematic risk (Bodie et al. 2005). To tackle this problem, the traditional DCF analysis is complemented by adding different scenarios and sensitivity analysis in valuation situations. (e.g., Brealey et al. 2006) These two methods can provide some additional insights and views about the financial viability of an asset/investment, but their shortcoming is that they, too, are predetermined and fixed based on market knowledge at the time of valuation and decision-making. (Kodukula & Papadesu 2006, 47-50).

DCF techniques implicitly assume that an investment is irreversible and that funds must be committed in full amount at the time of initiation. Irreversibility means that the investment cannot be delayed or cancelled without losing most of its value. (Amram & Kulatilaka 1999) In the real world, investments can be often delayed without serious financial repercussions and management has often an opportunity to stage the investment. This irreversibility assumption may result in starting investments at suboptimal times or scrapping potentially valuable investments because of the need and urgency to make decision.
4 ACQUISITIONS

4.1 Acquisition

In an acquisition the acquirer company purchases a significant part of the target company’s assets, and the control of these assets is transferred in the transaction to the acquirer party. In the real world we rarely see any discussion about acquisitions alone but instead a term Mergers & Acquisitions (M&A) is used. A merger is an activity where assets of two separate companies are combined in order to create a completely new legal entity. However, most of the M&A activities are in reality only acquisitions. (Buckley & Ghauri 2002, 1-2)

The acquisition can be initiated in two ways: making a merger proposal or a tender offer. In a merger proposal the company interested in the purchase establishes direct negotiations with the to-be-acquired company’s management and/or board of directors, whereas in the case of a tender offer the acquirer party makes a direct offer to the target company’s shareholders. Due to their nature tender offers are viewed as hostile takeovers. (Sankaran & Vishwanath 2008, 1)

Payment in acquisitions can be made in cash, securities (shares) of an acquirer or in some other assets that seller considers valuable. (Sherman & Hart 2006, 11) Acquisitions, in the literature, are classified into three types, namely horizontal, vertical and conglomerate. Horizontal acquisition refers to an acquisition of a competitor within the same industry, whereas in vertical acquisition the acquirer buys a firm with whom it has a so-called value linkage. The acquired firm can be, for example, a supplier or a client in its production process. Conglomerate acquisition is in question when the acquirer company and the target company are operating in unrelated businesses. (e.g., Brealey et al. 2006; Buckley & Ghauri 2002, 2)

Acquisitions are major strategic events, which project acquirer firm’s strategy and vision. An acquisition can be relatively lengthy process, which can cause dissatisfaction and opposition among work force in both acquiring and target company. Despite some challenges acquisitions are often seen as events worth undertaking for they bring ample opportunities for the acquirer company. (Angwin 2007)
Acquisitions are and can be done for a variety of reasons, but in this report we will briefly present only those reasons that are considered most important in the literature. These are as follows:

1) *Synergy.* An acquisition presents an opportunity to achieve greater production levels (economies of scale) and lower fixed and operating costs by combining and consolidating resources of two companies. (e.g., Angwin 2007, 3; Dunis & Klein 2002)

2) *Entering a new market.* By acquiring another company the acquirer party can get an effective and direct access to new market and to information regarding operating there. (Sherman & Hart 2006, 13).

3) *Taxation.* An acquisition of a loss making firm can lessen tax liabilities of a profitable acquirer company. However, the benefits that an acquiring company can gain from purchasing a loss making company depend largely on country-specific legislation. (Ross, Westerfield & Jaffe 2002, 827-828).

4) *Diversification.* An acquisition, notably conglomerate acquisition, can create product/market diversification which can protect the acquirer in difficult times in one market sector. (Dunis & Klein 2002)

5) *Management.* Management can play a major role in acquisitions in several ways. Some managers are interested in building larger companies, because that way they feel more powerful. In some cases, an acquisition may be done to acquire management skills of a target company. (Angwin 2007). On the other hand, some companies can be targeted for an acquisition because of their inefficient management. Acquiring a company and then removing management could result in increased value through better management. (Ross, Westerfield & Jaffe 2002, 826-827).

6) *Marketing gains.* By doing horizontal acquisition an acquirer company can eliminate competition and thus gain larger market share, which can lead to monopoly power within a specific industry. (Ross, Westerfield & Jaffe 2002, 825).
Next in this report we will look at how acquisition targets are valued. We will present briefly only the most common techniques and after this look how the DCF approach is applied to acquisition valuation.

4.2 Acquisition valuation

The price paid for an acquisition target is the most salient point both for seller and buyer. Valuation of the target company, however, is not an exact science and the price paid eventually can even differ substantially from the result of the valuation process. The valuation serves more as an indicator for parties involved, for the possible transaction price will be eventually determined by the market. (Sherman & Hart 2006, 131-132).

The valuation’s goal is to help interested buyer to assess whether acquisition would be profitable investment from shareholders’ point of view (Whittington & Bates 2007, 31). Each interested buyer will value target differently, for valuation is based on appraiser’s understanding of the target’s business (Sherman & Hart 2006). The valuation can be performed either by prospective buyer or it can be outsourced to a third party, such as an investment bank, specialised in valuing acquisition targets.

Several valuation techniques have emerged to assist interested parties to gain an insight into the value of potential acquisition targets. The valuation techniques can be, generally, divided into three different approaches, namely Discounted Cash flow Valuation (DCF), Relative Valuation and Contingent Claim Valuation. (Damodaran 1996, 9)

The DCF approach and techniques which fall under it rely on present value concept, where the value of can be calculated by finding the present value of the expected cash flows (Brealey et. al 2006). The valuation techniques of the relative approach, such as Price-Earnings (PE) ratio, use the prices of “comparable” assets in valuations. The contingent claim valuation models, such as Real Options analysis, take advantage of option pricing models in valuing assets/investments having option characteristics. (Damodaran 1996)

The valuation is, as mentioned earlier in this report, important, crucial and imperative task for several parties. What makes the study of acquisition valuation techniques even more appealing is the fact that most of acquisitions end up being un成功的 for the acquirer,
which indicates that a part of the blame could be placed upon the price paid (Whittington & Bates 2007, 27-28).

The value of synergy is an important consideration when valuation of any target company is undertaken (E.g. Copeland et al. 1996, 448) Synergy occurs when the efforts of two or more parties are combined so that the results of the same are greater than what the sum of the efforts in isolation would suggest. (Angwin 2007) In business, synergies as a result of an acquisition can be categorized into three different classes, namely universal, endemic and unique. (Copeland et al. 1996, 448)

Advantages resulting from, for example, economies of scale and possibility of hiking prices are known as universal synergies for they are available to every acquirer company which has an adroit management and adequate resources. On the other hand, the endemic synergies, such as economies of scope, are often possible to attain only in horizontal acquisitions, i.e. acquisitions within the same industry. Unique synergies refer to those opportunities that are to be captured only by a specific acquirer. (Copeland et al. 1996, 448-449)

4.3 DCF approach in acquisition valuation

DCF approach is one of the most popular valuation methods used in valuing acquisition target firms. In this approach, as mentioned above, the value of a target company (asset) is thought to be the future cash flows discounted at a rate that takes into account the risk associated with the forecast cash flows. (Vishwanath & Krishnamurti 2008, 65)

The use of the DCF method in acquisition valuation is justified for its unambiguous treatment of cash flows. In other words, the cash flows are not affected by accounting policy of the target company. The second reason why the use of the DCF approach can be considered good is that it views an acquisition as a capital investment decision. The use of the DCF approach enables management to compare the financial viability of an acquisition with that of other investment opportunities and this comparison gives management possibility to choose only the best investment, whether it is an acquisition or some other capital investment. Placing acquisition decisions under the same roof with other capital
investment decisions makes sense, for they both are seen (or should be seen) as alternatives. (Whittington & Bates 2007, 54-55).

The third advantage of the DCF method is that it forces appraiser to focus on fundamentals behind the target company’s projected cash flows. An analysis of the fundamentals enables the acquirer to understand the target’s business and the prerequisites of future financial development. From the would-be-acquirer company management’s perspective this means turning attention to those factors that are critical in maximising the target’s value in the long-run rather than focusing on factors impacting the short-term profit development (Kallunki & Niemelä 2007, 110).

There are several different techniques available to value an acquisition target using the DCF approach. In this report, however, we will present a calculation technique called as free cash flow model (FCF) because it the most commonly discussed method in the literature. According to Kallunki and Niemelä (2007, 110), the FCF model is also the most commonly used technique in practice. However, the choice of model should always depend on unique characteristics of the target, thus is cannot be said that there is one best model. (Damodaran 1996)

The DCF approach and models based on it, such as the FCF, bring with them some dilemmas into valuation situations. Perhaps the most pressing problem with the DCF models mentioned in literature is their requirement of ample inputs and information regarding the valuation target. These inputs are often not only cumbersome to attain but, in addition, they can be manipulated by an organizational actor to press through his/her own personal aims (Kasanen et al. 1993).

Another disadvantage of the DCF approach can be that the cash flows generated by the target company may not always serve as a useful measure for understanding its performance in any given year, for the cash flows are, to some extent, affected by the choices made by management. For instance, capital expenditure is one of the items that can be manipulated to project a better view of company’s cash flow generating power. (Copeland et al. 1996)

Next we will present the process of valuing a business using the FCF model. We will use this approach also in the DCF analysis in our case study in Chapter 6.
The first step in the FCF technique is determining future financial statements of the target company. The success of this step relies mainly on four important factors, namely a profound understanding of the target’s business operations, a knowledge of historical financial results, a reasonable forecast horizon and various assumptions to be made. (Sherman & Hart 2005, 138)

The next step is the calculation of free cash flow. Free cash flow refers to the amount left for all investors, both stockholders and creditors, after investments (cash outflows) in operating working capital and capital equipment and taxes are deducted. (E.g., Kallunki & Niemelä 2007; Vishwanath & Krishnamurti 2008, 67) Free cash flow, thus, includes both interest payments on debt and possible dividends. (Copeland et al. 1996, 139). The above can be summarized as follows:

\[
\text{Free cash flow} = \text{Net Operating profit after Tax (NOPAT)}+ \text{Depreciation} - \text{Capital Expenditure} - (+) \text{Increases (Decreases) in working capital investment}
\]

The third step and perhaps the trickiest one is the estimation of a suitable discount rate. As the free cash flow includes all the capital providers, the discount rate should, naturally, reflect this. Hence, the discount rate will be the weighted average cost of capital (WACC). (E.g., Copeland et al 1996, 139; Kallunki & Niemelä 2007, 111). The discount rate used can be the acquirer company’s WACC post acquisition if the purchase does affect the risk involved with the acquirer’s business. (Vishwanath & Krishnamurti 2008, 68). The cost of capital to each investor class is the rate of return they could earn on other investments of similar risk characteristics. (Copeland et. al 1996, 139)

As we mentioned earlier, an appraiser party must choose a reasonable forecast horizon for which the free cash flows are projected. The forecast period (commonly 5-10 years) is often set for a period of high growth after which the target company will achieve a phase of stable growth. (Vishwanath & Krishnamurti 2008, 68-69). The impetus for forecasting free cash flows only to a near future is that the farther the cash flow the less valuable and relevant it is due to a higher discount factor. In addition, forecasting free cash flows, let’s say beyond the fifth year become extremely difficult if not next to impossible. For these reasons, what is called a terminal or continuing value is calculated (Copeland et al. 1996, 139; Sherman & Hart 2006, 139).
The terminal value can be estimated in two ways, namely assigning some growth rate for free cash flows or by using multiples. (Sherman & Hart 2006, 140) The assumption of a growth rate is an extremely critical phase, for, evidently, most of the target’s value can be abridged to the terminal value. The use of multiples in determining the terminal value is also acceptable. The terminal value can be determined as a multiple of book value or earnings. (Vishwanath & Krishnamurti 2008, 70-71) Once free cash flows for forecast period and terminal value are attained the present value of these two can be calculated. The value attained can then be divided into the value of debt and value of equity. (Copeland et al 1996, 139) This value should serve as a starting point due to the shortcomings of the FCF technique and challenges associated with the valuation process. (Sherman & Hart 2006)

Hence, the value of the target can be simply presented as follows:

\[ Value = \text{Present value (PV) of cash flows during forecast period} + \text{Terminal value} \]

Before applying the above FCF analysis to our case study and comparing the results with the real options analysis, we will look how and in which nature real options are present in acquisitions.
5 REAL OPTIONS IN ACQUISITIONS

The shortcomings of DCF approach have prompted managers from different industries including the M&A to embrace real options thinking and analysis in their decision-making. (Mun 2006) In addition, several studies have indicated that the majority of acquisitions turn out to be financially unsuccessful for the acquirer party, whereas all the other parties involved, such as lawyers, investment banks and original sellers seem to benefit from the acquisition. (e.g., Eccles, Lanes & Wilson 1999; Krishnamurti & Vishwanath 2008; Whittington & Bates 2007)

Three main reasons why an acquisition turns out to be a value destroyer are namely poor corporate governance, unsuccessful valuation of the target company or failed post-acquisition management. The use of a new tool in valuation process is not enough to ensure correct valuation if the assumptions made about the business prospects of the would-be-acquired company are incorrect or unfounded. Thus, the understanding of target company’s business and profit generation concept is far more crucial than the methodology used in valuation (Whittington & Bates 2007, 57)

Overoptimistic valuation is often more likely in situations where there are many bidders competing for same target company. This phenomenon is known as “winner’s curse” and results from the need not to lose the bidding and hence resulting in unfounded beliefs of acquisition’s future prospects. (Whittington & Bates 2007, 57) In bidding games, the heterogeneity and asymmetry of information between rival bidders has an impact on the premium paid for the target company. In order to avoid mistakes or lapses in valuations, due diligence should be conducted properly (Smit, Van Den Berg & De Maeseneire 1, 2005)

The use of real options approach in valuing investment projects can result in different investment decisions than if the valuation had been done using discounted cash flow approach (e.g. Trigerogis 1996, Luehrman 1998). However, it should be noted that within

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2 Due diligence, on the one hand, can be viewed as a real option which a potential bidder acquires incurring certain amount of cost. The pay off of this real option is the information that will help the potential acquirer to arrive upon a certain value for the target company. (Smit et al 1-2, 2005).
one approach the use of alternative/different assumptions and estimations can change the initial investment decision as well. (Alessandri et al. 2007, 460)

Several surveys around the world have shown that most of companies base their investment decisions on DCF analysis even though the approach has been a target of great criticism for more than two decades. (Alessandri et al. 2007, 662) Correct and efficient allocation of resources is critical for the long-term survival of any firm, for a firm can, in fact, be seen as nothing more than a collection of projects. (e.g., Alessandri et al. 2007; Farragher et al. 1999)

Corporate acquisitions generally come with a variety of options that may substantially impact the financial outcome of an acquisition. (e.g., Dunis & Klein 2002) Hence, valuation based on a single projection of future events ignoring effects of various real options (whether already present or to be possibly created) over the life of acquisition conveys fairly narrow-minded and vulnerable picture of investment’s future. (Gaughan 548-549, 2007)

Bruner (2004, 424) identifies four reasons why real options competence/thinking is required and critical for corporate practitioners involved in acquisitions;

1) Real options are inherently embedded in acquisitions. Real options in acquisitions are often described by terms such as rights, flexibility or commitments.

2) In an aggressively growing firm, real options can constitute a large part of the firm’s value. In addition, ownership of some unique assets (tangible or/intangible), and competence and skills to take actions which are difficult to emulate by rivals are situations where real options thinking may make a drastic difference.

3) Ability to utilize available real options to their fullest potential, and creation and development of new real options into acquisitions is largely dependant on the skills and competence of those involved in acquisitions.

4) Real options analysis complements traditional DCF techniques, which fails to capture the value of discretion and flexibility involved in acquisitions. The DCF techniques alone have tendency to undervalue an asset.
Real options are essential part of corporate acquisition valuation and inclusion of real options thinking in acquisition valuations invariably increases the value of the firm. (DePamphilis 2008, 332) However, according to Whittington and Bates (2007) this can be a serious problem for there is already a tendency to overvalue rather than undervalue acquisitions.

The traditional valuation thinking and techniques based on the DCF method, however, have tendency to overlook certain critical and crucial aspects of acquisitions such as the development of growth opportunities, flexibility options and abandonment options. (DePamphilis 2008; Smith & Triantis 1995, 136) Real options embedded or to-be-created in acquisitions give their holder chances to mitigate downside risk while maintaining upside potential, thus putting management in a position where it can better affect and control the outcome of its investment.

Acquisition is often an important (sometimes the only) instrument of growth for companies and hence their success or failure can immensely affect the perceptions and the value of the company in financial markets. (e.g., Angwin 2007; Carey 2000) Acquisitions often create and bring with them, as mentioned above, valuable growth options, which can justify, for example, a fairly steep price for a firm who is making losses and has no track record of profits. This phenomenon was famously (or infamously) prevalent in the late 1990s and early 2000s when during the so-called dotcom-boom established companies acquired loss making start-up Information Technology (IT) ventures at exorbitant prices. These acquisitions were predominantly explained by the value of growth options the acquired firms brought with them, which, in a retrospect, were completely overestimated and misunderstood.

The main shortcoming of real option analysis in acquisition situations can, again, be the difficulty to value them correctly due to their complex nature. Real options possess certain unique qualities, such as contingency of several variables and lack of proper structure, which may cause problems and frustration in valuation situations. (Bruner 2004, 425)

The challenges involved with valuing real options, however, should not serve as an excuse to discard real options analysis in acquisitions situations, for the real options analysis serves also as an effective qualitative thinking tool which can help in pointing out importance of
the options present in acquisitions and guide the acquirer party in decision-making and deal designing even if exact valuation of real options turns out to be a cumbersome and complex exercise. (Bruner 2004)

The real options analysis does give a more comprehensive and realistic tool for decision-making and valuation situations but, nonetheless, it faces still some criticism and resistance in the field of corporate acquisitions due to the added complexity it brings into valuation situations. (Gaughan 2007) Another factor which results in resistance among managers is the difficulty of estimating required input parameters and the naivety of assumptions the analysis requires. (e.g., Kodukula & Papudesu 2006; Luehrman 1998; Trigeorgis 1995) Survey conducted by Bain & Company's in 2000 showed that only 9% from senior management had embraced the real options theory as a part of overall management tool. (Kodukula & Papudesu 2006, 201)

There are three main real options available to acquirer, namely growth, flexibility and abandonment options. (Smith & Triantis 1995, 136) These real options and their relevance in acquisitions are discussed and analyzed below.

5.1 Growth options

The research on growth options has become a salient part of management research. (Laamanen 1999, 149) A value of any firm is a function of the value of its assets in place and the value of growth opportunities that the firm possess. Future growth opportunity is analogous to a call option and the firm who holds the opportunity has discretion over its future action regarding this opportunity (e.g., Leiblein & Ziedonis 2007, 229; Trigeorgis 1996, 8).

Growth through acquisitions can be captured in various ways. An acquisition of another company can be driven, for example, by needs of entering a new market or developing further some entrepreneurial concept by relying on established functions of the acquiring entity. Growth may at times demand an acquisition of another firm as some growth opportunities can be exclusively available for the target company or alternatively, the acquirer’s growth options may demand an acquisition in order to move forward with the existing growth opportunities. (Smith & Triantis 1995, 138-139)
Occasionally, an acquisition, particularly horizontal one, may be driven by potential benefits of combining shared growth options between acquirer and target. A horizontal acquisition entails, at least, three important options to the acquirer; first, the customer base of the acquirer is enlarged by the acquisition by gaining an access to customer details of the acquired firm. Second, an acquisition increases the option value of another acquisition within the same industry as the operational synergies would be greater. Hence, every new acquisition can be seen having a higher value from acquirer’s long-term growth’s perspective. Third, a horizontal acquisition can serve as a vehicle to eliminate potential future competition and maintain a competitive advantage by “taking out” the target firm of the market place. (Smith & Triantis 1995, 139)

In highly competitive market conditions taking optimal benefits from future growth opportunities require early investments. According to Kulatilaka & Perotti (1998), strategic advantage is a crucial factor when considering the value of growth options; having such an advantage makes growth opportunities more tempting under uncertain conditions, whereas lack of that tend to make opportunities look rather risky.

Growth options are immensely important in acquisitions of small but growing companies. According to Laamanen (1999), an acquisition of a small business is oftentimes used as a real option to acquire competence, such as technological superiority, or enter a new business area. He, however, concluded, based on his study, that the option nature of acquisitions depends on several factors, such as the newness of the acquired firm’s competencies, the exclusiveness of these competencies and the research & development intensity of the acquiring firm.

The results of his study can be rationally generalized to apply to other industries as well. For instance, the newness of the acquired firm’s competencies can be also interpreted being the newness of any small company’s business plan or concept. The exclusiveness of the competencies can be seen as exclusivity of growth opportunities the acquired firm holds, for instance. Laamanen (1999, 164) also concluded that, in general, small businesses can be referred to as being options, particularly growth options.

Alessandri et al. (2007) found in his study that the value of growth options can range from 75 to 85 percent. According to them, the value of growth options in any company’s market
value depends on three factors: (1) the general macroeconomic conditions; (2) the industry to which the firm belongs and; (3) firm specific factors.

Folta and O’Brien’s (2007) large-scale empirical study to determine what effects the real options present in acquisitions have on managers and their ultimate decision. They studied more than 28,000 acquisitions in the U.S. and found that managers tend to give extra emphasis to growth options and that growth options have tendency to lower the investment threshold, i.e. increase likelihood to acquire the target company. Folta and O’Brien, however, acknowledged that the increased likelihood to make an acquisition may also be due to management’s selfish motives to increase the size of the firm.

5.2 Flexibility options

Some real options in corporate acquisitions are derived through a consolidation of resources. The consolidation of resources offers the acquirer firm flexibility options which are linked to the existence of uncertainty and strategic diversification opportunities. For instance, a switch-use option, which offers one form of flexibility, is often present in manufacturing industry where production capacity is rarely used to the fullest. Availability of the capacity offers the firm options to better utilize the same and also protect own operations from changes in the business environment through acquisitions. The value of switch-use option is highest when the degree of uncertainty surrounding the demand for a current output is high and the correlation between the demand for firm’s current output and target firm’s output is low. (Smith & Triantis 1995, 143-144)

Another flexibility option available in acquisitions is the time-to-build option. This option enables the would-be-acquirer to start acquiring an interest in the target firm at stages, i.e. doing a series of acquisitions, which will help the would-be-acquirer to gain knowledge of the business while offering it an option at each stage to decide whether to expand ownership or not. (Dapena & Fidalgo 2003, 17; Krishnamurti & Vishwanath 2008, 127-128)

Staged acquisition can be very tempting alternative to one-time payment but it has own pitfalls as well. The would-be-acquirer’s intentions to complete an acquisition in stages can be easily interpreted by other bidders, which can subsequently increase the price of the target firm’s shares to the level beyond what the initial bidder was willing to pay. (Dapena
On the other hand, an aggressive upfront acquisition attempt may lead to a hostile takeover and thus losing the acceptance of the board and the management of the target firm. (DePamphilis 2008, 332)

The value of flexibility options is often substantial in acquisitions where a great amount of real estate is present. In fact, acquisition valuations tend to often overlook and underestimate the value of flexibility offered by real estate. Real estate is often one the most flexible asset as it can, subject to zoning and other regulations, be easily converted to other uses and thus, it offers the acquirer firm a great deal of flexibility in operations in the present or future. (Smith & Triantis 1995, 144)

The option to delay is perhaps the most obvious option available to the would-be-acquirer prior making the deal. Consideration of timing of a business action, such as an acquisition, is fundamentally about trade-off between commitment and flexibility under uncertainty. Research on timing has shown that exercise of a deferral option has, under uncertainty, potential to increase the expected value of an investment. Three points require close examination when deferral option is to be considered, namely the threat of pre-emption, whether the option is simple or compound and whether the option is exclusive or shared. (Miller and Folta 2002)

Pre-emptive action by competitors can increase the cost of the option or prelude the investment. On the other hand, an early commitment to an investment often can result in strategic pre-emptive effects, such as discouraging entry by rivals and an increase in market share, which may justify the early entry/timing of an investment (Kulatilaka & Perotti 1998, 1021). An acquisition confers exclusive information about the firm, industry and, above all, opportunities for future investments (Dapena & Fidalgo 2003), thus making the acquisition a compound option which can affect the value of the deferral option. (Miller & Folta 2002) Exclusivity of an option means that the holder is the only party that has the investment opportunity thus giving it more freedom as to whether to exercise the deferral option related to the opportunity. In case the investment opportunity, such as an acquisition, is shared the exercise of the deferral option can result in losing the opportunity completely. (e.g., Kester 1984)
The deferral option in acquisitions is, occasionally, even available after closing the deal; an acquirer firm’s investment may be contingent upon the actual performance of the target firm’s cash flows compared to the forecasted cash flows. The acquirer may negotiate itself into a position to precipitate the investment if the actual numbers are above the forecasted or, on the other hand, it may choose to delay the investment, or in some cases even discard, if the actual numbers are below the forecasted. (DePamphilis 2008, 332-333)

5.3 Abandonment option

An acquirer invariably receives what is called divestiture option with every acquisition. The divestiture option can be seen as an abandonment option as it allows the holder to undo the acquisition, partially or wholly, by selling it in the future if the acquisition turns out to be disappointment. (Smith & Triantis 1995, 146; Bruner 2004, 427) Existence of a divestiture option significantly mitigates downside risk and hence increases firms’ willingness to acquire other businesses. (Li et al. 2007, 37)

After an acquisition is completed, management has an option to abandon business operations for its assets’ exit value or resell it\(^3\). Possibility to divest an acquisition can be viewed as having an insurance policy which becomes valuable if the acquisition’s performance is unsatisfactory. In acquisitions, the value of an abandonment option is negatively correlated to specialized nature of firm’s assets, for the specialized assets are less likely to be deployed to other operations at low cost or liquidated at high value and their value to potential third party is likely to be less than in case of general assets. (Berger, Ofek & Swary 1996)

There can be various reasons for divestiture, such as poor performance, great performance or getting an approval for a merger (Reed, Lajoux and Nesvold 2007, 736). It should be, however, noted that the exercise of a divestiture option relies heavily on two factors, namely the level of financial distress and managerial action. Management can be reluctant to liquidate the assets even when the firm is under severe financial distress for this would

\(^3\) Berger et al. (1996) study found that the book value and exit value had the following relationship for main asset classes; for receivables one dollar’s book value resulted in 0.725 exit value, for inventory the quote was 0.55 $ and for fixed assets 0.54$. 

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result in some serious consequences for the management, such as a loss of power and position. (Berger et al. 1996)

Divestiture option can even be the main motivation behind acquisitions for some investors, such as private equity firms and venture capitalists, whose main goal is to hold on to acquisitions as long as they develop desirously, and then eventually resell them. For these investors, the optimal timing of sell off (and acquisition) is immensely important as their profit comes from selling at a higher price than what was paid at the time of the acquisition. (Bierman 2003)

The abandonment (divestiture) option in case of acquisitions is often difficult to value and its relevance is not always obvious for two particular reasons: first, as already mentioned above, real options unlike financial options have no proper structure (predetermine exercise price and exercise date) which makes the valuation of abandonment option difficult and less straight-forward. Second, abandonment option is problematic to value and its impact difficult to measure for in response to poor financial performance of an acquisition it is possible that management is more inclined to modify the investment rather than to abandon it completely. (Guler 2007) On the other hand, the value of a divestiture option can be calculated relatively easily if the would-be-acquired firm’s assets have easily attainable market values. These are more easily available for general assets, such as real estate, than to customized ones.

Abandonment option, according to the study of Kaplan and Weisbach, is very heavily used tool in the real world, for 44 % of acquisitions in their study were sold off some time after the purchase (Rizzuto 2006, 150).
6 ILLUSTRATIVE CASE STUDY

In this chapter we aim to illustrate through a real life example how real options theory applies to corporate acquisition valuation situations. The primary aim of this case study is to illustrate and compare the decision-making and valuation situation using two different approaches, namely DCF and Real options approach. The case study will be kept quite simple as we want to mainly illustrate what kind of value real options thinking can bring in acquisition valuations.

6.1 Introduction

Finland-based company, which is operating in very competitive industry, is contemplating a horizontal acquisition. The company has three potential acquisition targets which only slightly differ from each other in terms of product range and financial condition.

Valuations of these three companies will require us to make a variety of assumptions and estimations which are no way undisputable. These assumptions and estimations are based on the data available about the companies and industry in general. However, we must mention here that the data we have are no way enough to conduct a profound and realistic analysis, and therefore we had to, at times, resort to, to some extent, ad hoc estimations and assumptions. But we tried best to keep these assumptions and estimations as realistic as possible. It must be noted that changes in these assumptions and estimations can easily lead to a drastically different valuations even within one approach, and thus these assumptions and estimations are of a great importance and relevance to the outcome of the analysis (Dunis & Klein 2002).

First we will value the acquisition targets using the FCF model presented in this report. After this we will perform real options analysis, both qualitatively and analytically. At the end of this chapter we will discuss about the results.

Before embarking on our valuation voyage we present some relevant information about the targets that has important implications to our analysis:
Target A

- Turnover of 25.8 M€ in 2007
- Operations in Finland, Estonia and Russia

Target B

- Turnover of 8.7 M€ in 2007
- Operations in Finland and Russia

Target C

- Turnover of 5 M€ in 2007
- Operations only in Finland

6.2 FCF (DCF) analysis

FCF analysis below was conducted based on previous years’ (2004-2007) financial statements of the targets and estimations of future prospects. The estimations were based on the past development of and other information about the targets. In addition, the discount rate was assumed to be same for all the three targets (15%). The long-term (beyond 4th year) growth rates are estimated to be in line with long-term inflation, for this was common practice confronted in the literature.

The discount rate is extremely difficult to estimate and in addition, it plays an important role in valuations. Hence, a sensitivity analysis was conducted by changing the discount rate both upwards and downwards. The discount rates used in our analysis were based on industry-specific information and are in line with those employed in the industry. The values (in €) of the targets under specific discount rates were as follows:
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<th>DISCOUNT RATE</th>
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<tr>
<td></td>
<td>12%</td>
<td>15%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>TARGET A</td>
<td>7 400 000</td>
<td><strong>5 600 000</strong></td>
<td>3 900 000</td>
<td></td>
</tr>
<tr>
<td>TARGET B</td>
<td>6 400 000</td>
<td><strong>4 700 000</strong></td>
<td>3 200 000</td>
<td></td>
</tr>
<tr>
<td>TARGET C</td>
<td>2 500 000</td>
<td><strong>1 900 000</strong></td>
<td>1 400 000</td>
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The discount rate FCF analysis reflects the risk associated with firm. The firms, naturally, are non-singular in terms of risk, but it is reasonable to assume them having a fairly similar risk and hence same discount rates. However, from the above calculations we can clearly see how even a small change in the discount rate affects the final value.

The above analysis was conducted by applying the main principles of the DCF approach and the FCF method in particular. As we have seen in this report, the DCF approach might not be able to project the true value of a firm if certain conditions exist. Next we will look whether these targets possess option characteristics which could warrant complementing the above analysis with real options analysis.

**6.3 Real options analysis**

The major corporate acquisition process phases in our case study, namely strategic planning and post-acquisition integration, are ideal for real options analysis for real options are pervasive in both of these two phases. (Bruner 2004, 430; Krishnamurti & Vishwanath 2008)

In strategic planning phase, real options thinking allows us to assess the acquisition’s financial repercussions in terms of options from the following point of view; how does the acquisition fit in flexibility-irreversibility continuum. Some acquisitions can create flexibility whereas others may destroy it. Committing to an acquisition which is of an irreversible nature poses far more risks to the acquirer than if the acquisition entails strategic flexibility. (Bruner 2004, 430-431).

Our analysis will follow the process outlined in this report. The first step will be framing the problem at hand, that is, identifying real options and contingent decisions. After this the input parameters will be identified. Once this is done calculation model will be chosen and calculations conducted. At the end, results will be analyzed.
“Framing” the problem

In our case, we can see that each acquisition target will bring with it some future opportunities which should be taken into consideration. Three primary real options in our case study companies are namely abandonment, flexibility and growth options. This recognition puts us in a position where we can see that FCF analysis alone perhaps was not adequate enough to project the true value of the firms. However, it is important to notice here that we might not be able to calculate the values of all these options as required inputs may not be available to us, but even the recognition of these options will assist us in our analysis as we might consider there impact qualitatively. Next we will explore how and in which nature the three options mentioned above are present in our target companies.

Abandonment (Divestiture) option

Real options literature puts an immense importance on divestiture option, which is ignored by DCF approach. In our case study, we can recognize that each one of the target comes with an abandonment option which could be valuable in case the would-be-acquired firm performs below expectations or it turns out to be value destroyer in some other way. The acquirer then can either resell the whole business or selected parts. It might also happen that as a result of synergy some of the parts of the acquired firm become useless and not required, and thus divestment of certain parts of the business could also be justified.

Flexibility option (Option to delay)

The acquisition decision can be delayed if uncertainty regarding the future market or company conditions is great enough to warrant not making the acquisition decision. In our case study, the acquisition is under consideration at the time (Mid-2008) when there is a great uncertainty regarding the short and medium-term macroeconomic development due to the financial crisis (credit crunch) emanating from the U.S. Hence, it would seem justified to make the calculations but wait until enough information is available about the ramifications and implications of the credit crunch.
Another flexibility option that is available to the would-be-acquirer is time-to-build option, which offers it an opportunity to stage the acquisition, if one-time upfront payment appears too risky.

**Growth option**

Targets A and B have operations outside Finland whereas the would-be-acquirer operates exclusively in Finland. An acquisition of one of these two firms would enable the would-be-acquirer to build network and business outside Finland and enter new markets. The acquisition of one of these companies would also result in acquiring the know-how of doing business in foreign locations, which often is not only expensive but time-consuming as well. In addition, the industry in Finland is very competitive and scope for growth limited and thus the entry to new markets seem to be tempting option considering that both of these companies have operations in Russia, which can be considered as one of the biggest economies in the world. The entry to new markets can later on expose new growth opportunities.

Next we will aim to value these real options using the data available about these companies and industry in general.

**Identification of input parameters, choosing the method and calculation of the values of real options**

**Abandonment option**

The value of an abandonment option can be calculated using the balance sheet data. In our example, we will use the results gained by Berger et al. (1996) in assigning exit values for asset classes based on their book values. Berger et al. found that a dollar’s book value results in following exit values for major asset classes; receivables 0.72; inventory 0.55; fixed assets 0.54.

We assume that due to uncertain market conditions the would-be-acquirer firm can sell off the acquired business at the end of two years for exit value, which would be calculated using the above ratios for targets’ asset classes. The two-year period (from mid-2008 to
mid-2010) is estimated to be crucial for the long-term success of the targets as there exists a
great uncertainty regarding the development of market conditions during this time period.

We will use the Black & Scholes equation for a put option (see p. 40) in our calculations,
for it fits best to this situation because we know exactly what the exercise price and maturity
date of the abandonment option are. The inputs required for calculations are as follows:

So=the PV of expected cash flows
X=the exit value (calculated based on latest (2007) balance sheet)
r=risk-free interest rate (estimated at 5%)
T=2 years
σ=volatility
e=2.71828

Next we will calculate the values of abandonment options for our three acquisition targets.

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<th>TARGET A</th>
<th>TARGET B</th>
<th>TARGET C</th>
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<tbody>
<tr>
<td>So</td>
<td>5 600 000</td>
<td>4 700 000</td>
<td>1 900 000</td>
</tr>
<tr>
<td>X</td>
<td>6 430 000</td>
<td>2 940 000</td>
<td>2 100 000</td>
</tr>
<tr>
<td>r</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>T</td>
<td>2 years</td>
<td>2 years</td>
<td>2 years</td>
</tr>
<tr>
<td>σ</td>
<td>35%</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>e</td>
<td>2.71828</td>
<td>2.71828</td>
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The values are as follows:

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<th></th>
<th>TARGET A</th>
<th>TARGET B</th>
<th>TARGET C</th>
</tr>
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<tbody>
<tr>
<td>1 228 200</td>
<td>106 500</td>
<td>371 500</td>
<td></td>
</tr>
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</table>
We must keep in mind that the above values are calculated assuming a discount rate of 15% for expected cash flows (So). In addition, assuming a different maturity date (or changing other parameters) for this option would affect the values as well.

*Flexibility option (Option to delay)*

Unfortunately, we do not have data to calculate the values of deferral options in our targets. The required data in this valuation is often based on profound knowledge of the industry and the key variables, such as prices and costs of products and services. For instance, if the key variable is price of a core service then it can be estimated what that price could be after certain period of time (optimistic and pessimistic scenario, for instance), if current market conditions are uncertain.

In the literature, value of a deferral option is mainly calculated using Binomial method as it is able to visually convey the sources of uncertainty, decision-making points and predicted development of the key variable over time.

*Growth option*

The growth option is our case study is an opportunity to enter a new market which could be potentially very valuable in the future. Targets A and B have operations in Russia, which we believe offers a great potential for growth. Unfortunately, again, we do not have required data to calculate the values of growth options in Target A and B. However, we will try to illustrate through an example how valuable a growth option could be in our case study targets. Here we will use the B&S formula (call option) for its simplicity.

Let’s assume that the would-be-acquirer believes that combining its know-how with that of Target A it could stand a chance to succeed in Russia and increase market share there. Its estimations about using the growth option are as follows:

So=the PV of expected cash flows= 5 000 000
X=the cost of the investment= 4 500 000
r=risk-free interest rate= 5%
T=2 years (time period the opportunity exists)
\begin{align*}
\sigma &= 40\% \text{ (high due to great uncertainty)} \\
e &= 2.71828
\end{align*}

The value of the growth option that Target A would bring with is: 1,540,000 €. This is 27.5 % of the total value of the target calculated by using the FCF analysis. As mentioned above, this was merely an illustrative example and had no linkage to the real world (though we tried to keep this quite realistic), for we did not have the data required to calculate the true value of this growth option. The data required for this option is often estimated based on the knowledge of doing business in that new market.

### 6.4 Results and discussion

In this chapter we have applied both FCF and real options analysis to our case problem. The FCF analysis was conducted as per the principles outlined in this report and in addition, sensitivity analysis was done. We saw that the discount rate plays an important role in acquisition valuation and therefore an extra effort should be done in arriving at a correct discount rate. The FCF analysis was based on previous years’ financial statements, and estimations about the future were made relying on these. We did not have much data about the possible future developments in the industry and therefore our valuations might be, to some extent, risk-exposed and vulnerable. However, our main aim was to show how the FCF analysis is done and then look whether real options analysis can add value to that.

Real options analysis was applicable to our case study problem as we recognized that the acquisition situation itself and the targets brought certain real options to the would-be- acquirer that the FCF analysis overlooked. The real options analysis was able to point out to us three main real options, namely growth, delay and abandonment option. The FCF analysis itself ignores the deferral and abandonment option completely. The growth option is possible to incorporate into calculations if its effect on forecast cash flows can be substantiated, but even then the option nature of this opportunity would not come around in FCF calculations.

We were able to value abandonment option in all our targets assuming that the option is available for 2 years. We saw that in case of Target A its value was more than 20 percent of the total company value generated by the FCF analysis. Also, in case of Target C the
abandonment option appeared relatively valuable. The calculations of the abandonment options alone indicated that the FCF analysis alone was not adequate enough in our case problem. Unfortunately, we were not able to value the two other real options as we lacked sufficient data, but we showed through an example that the growth option in Target A (and B) could be potentially valuable. The deferral option, as the framing section indicated, is very relevant in our case problem due to uncertainty regarding short-term market conditions. Even though we were not able to value the deferral option, the qualitative analysis (framing) was able to give us valuable insight into our case problem.

According to literature, the value of any investment should be seen as follows:

Extended NPV = NPV + real options

Thus, in our case study problem the value of a target should be viewed as follows:

Value = FCF + real options

Hence, we can conclude that, even though we were not able to calculate the values of deferral and growth options, the value gained from FCF analysis was less than that of indicated by adding the values of real options. This outcome is in line with what we found in the literature, that is, real options analysis increases the value of an investment.

All in all, we can conclude that real options theory is very much applicable to our case study problem, and the valuations gained through FCF analysis were less than if real options analysis was added. As real options are inherently present in acquisitions, they should be taken into consideration, at least qualitatively.
7 SUMMARY AND DISCUSSION

7.1 Summary

Our aim in this report was to study and analyze the real options theory and its applicability to acquisition valuation. The method of study was concept analysis which was based on previous studies by other scholars and researchers. We studied the applicability possibilities of the real options theory to acquisition valuation through a small illustrative case study as well.

In our study we found that traditional investment valuation and decision-making tools, which are based on discounted cash flow approach (DCF), are, under certain conditions, inadequate to assist corporate practitioners in investment valuations. The major shortcoming of the DCF approach is its inability to recognize and incorporate managerial flexibility and discretion embedded in investment proposals into valuations.

Real options theory, which is based upon option theory and option pricing models, has emerged as a valuation and decision-making tool, which is capable not only recognizing the flexibility but also incorporating the same into investment valuations. Real options enable management to revise previously made decisions and change its investment strategy in response to new market developments. Thus, the real options theory places a value upon active investment management. There are six main real options available at management’s disposal which can augment investment’s potential to generate revenue while offering a protection against losses.

Real options can be valued using option valuation principles and methods originally developed for valuations of financial options. The Black & Scholes and Binomial model are the two most commonly used methods. However, we found that the use of these methods is not as straightforward with real options as with financial ones due to some unique features of real options such as lack of proper structure and complexity. We also found that real options are, for most of the time, not tradable, and can be shared among several market operators.
Real options theory also recognizes the interconnection between decision-making and corporate strategy. However, we found that real options theory does not make DCF approach invalid but rather complements it. The value of an investment project having real options can be seen as being what is called extended NPV, which is the sum of NPV and value of real options.

Real options theory, though it offers ample potential and insights, is not widely used in real life. A variety of reasons have been listed for this phenomena, such as complexity of real options in real life investments, lack of proper understanding of the theory and its implications among corporate practitioners, and difficulties confronted in valuing real options. However, real options theory can be extremely useful and provide critical advice even if the real options cannot be valued exactly. Thus, real options theory is often seen as a way of thinking rather than as a mere valuation tool.

In this report we also studied acquisitions and their valuation. The value of a firm is an immensely important factor for several parties. There are three main methods used in practice to value a firm, namely Discounted Cash flow Valuation (DCF), Relative Valuation and Contingent Claim Valuation. We found that the most commonly used valuation method is Free Cash Flow (FCF) method. However, this method, as other DCF based methods, has some shortcomings. The biggest challenge is the estimation of a proper discount-rate, which should reflect the risk associated with forecast cash flows. FCF method also fails to recognize value of real options, which, we found, are invariably present in acquisitions.

The existence and recognition of real options tend to increase the value of an investment. According to some, this can be dangerous in case of acquisition valuations, for several surveys of acquisition performance indicate that acquisitions are often already overvalued rather than undervalued. However, we found that is phenomena may be attributable to other factors such as rigorous bidding competition for a target company.

Understanding of real options theory by corporate practitioners has a potential to bring critical inputs into acquisition valuation, which could make the value of a target company look very different from that obtained by using other valuation methods. Three main real options present in acquisition situation are namely flexibility, abandonment and growth options. The deferral option is the most obvious flexibility option, which has a potential to
increase the expected value of investment. However, the exercise of this particular option may turn out to be a wrong choice if the acquisition opportunity is not exclusive, for the delay could result in losing the opportunity completely.

We found that the existence of a divestiture option can significantly mitigate downside risk and hence increase firm’s willingness to acquire a target business. Growth options can often be the primary motivation behind the acquisition, and the value of growth options can constitute a significant portion of a firm’s value. We found that even though real options are clearly present in acquisitions, their valuation can be often quite difficult and cumbersome. Hence, many researchers suggest that real options should be mainly used as a way of thinking, i.e. qualitatively, and not too much focus should be placed on valuing real options as accurately as possible.

In our illustrative case study, we found that DCF (FCF) analysis alone was not adequate enough as it overlooked real options embedded in acquisition targets. Even though we were not able to calculate the option values of deferral and growth option due to lack of data, we can agree with the literature that merely thinking of real options gave us important insights into our case study problem. We conclude that real options theory is applicable to acquisition valuation as there are, at least, three kinds of real options present in acquisitions for most of the time, namely deferral and abandonment option. The use of real options thinking in acquisition valuations is further validated by the fact that the cash flow based methods ignore these aforesaid real options even though there existence is recognized by corporate practitioners. In our case study, we also found that the value of an acquisition target is greater if real options are taken into calculations. This difference in valuations can be significant.

7.2 Discussion

Real options theory, we believe, has a great potential to assist corporate practitioners in investment decision-making as it is capable of recognizing the inevitable flexibility embedded in investment projects. The literature of real options is, in our opinion, biased as too many scholars focus on only the benefits but tend to ignore the challenges that come with using the theory. For example, in theory real options tend to be straight-forward and simple but in the real world real options are often fairly complex and intertwined.
We are not surprised that the theory has not got its breakthrough in the corporate world yet for a few reasons. First, real options theory is fairly new tool as opposed to traditional investment valuation and decision-making methods. Second, the valuation of real life real options can often become painstakingly difficult and cumbersome task as real options in real life tend to be quite complex. Therefore, we believe that the valuation of real options should be made simpler and more understandable.

As far acquisitions are concerned, we, again, believe that the theory has a lot to offer as real options are essential part of acquisitions and can be immensely valuable. However, here again the same challenges prevail as with the theory in general, that is, valuations tend to become challenging and required inputs are often difficult to obtain.
REFERENCES


