The Applicability of Real Options in Strategic Capital Budgeting: An IT Industry Acquisition Case Study

Bachelor’s Thesis
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Abstract

This thesis studies the applicability of real options in strategic capital budgeting decision-making. The study utilizes insights gained from a practitioner to whom the writer has presented the real options theory as well as developed a real options model for modeling acquisition synergies. The study is thus conducted as a case study on a Finnish IT company in which an interview was conducted to collect and analyze managerial insights.

The real options theory has persisted as an appealing capital budgeting method that can effectively account for managerial flexibility in volatile environments. The use of this theory has nevertheless been very limited mainly due to its complexity. This thesis aims to further enhance the understanding of the barriers as well as proponents for the applicability of the real options theory in strategic capital budgeting.

The synergy option model developed by the writer aimed to enhance and visualize the understanding of the functioning of real options in the case company management. The interview questions examined the real options faced in the strategic context of the case company and aimed to gain insight into the relevancy of different real options for the case company.

The research findings support to a degree the classic notion of the complexity of real options being a barrier to their usage. However, in the context of the case company, the complexity of real options was not necessarily a barrier to the adaptability of real options as a more straightforward and subjective approach (MAD approach of Copeland and Antikarov (2001), uses present value calculations as a basis for the analysis) to the implementation of real options sufficed the particular needs of the case company.

In addition to the practical applicability of real options, this thesis also gained insight into the strategic aspects of the applicability of real options. This thesis argues that optimism, culture, and strategy influence the appeal of certain real options. In the context of the case company, these factors seem to be favoring the usage of strategy-advancing, incremental options and hindering the usage of flexibility-creating options.

Keywords Real options theory, Capital budgeting, Strategy, M&A
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1. INTRODUCTION

For a long time now, academics and practitioners have recognized the need to account for uncertainty and flexibility within corporate investments. The fundamental concept of managerial flexibility has existed in the form of what-if, sensitivity, and scenario analyses as well as simulations (Lander & Pinches, 1998). These methods are still not entirely capable of capturing and quantifying the value of flexibility in volatile environments. Thus, the real options framework developed as an efficient tool for valuing managerial flexibility within investments while simultaneously providing an attractive alternative to traditional static present value calculations (Trigeorgis, 1993a; Dixit & Pindyck, 1995; Luehrman, 1998).

Despite real options being highly effective in valuing these flexible investments (Quigg, 1993; Brouthers & Brouthers, 2008) the implementation of real options in capital budgeting has been very limited (Block, 2007; Horn et al., 2015). This thesis thus aims to broaden the understanding of the applicability of real options in capital budgeting by constructing a real option pricing model for an actual acquisition case of an IT company.

The questions that this thesis aims to answer are:

- How largely does the complexity of real options limit the usage of them?
- What are the factors that affect the utilization of real options in strategic capital budgeting decision-making?
- What is the effect of these factors?

The writer introduced the real options framework to the case company and illustrated an actual implementation of real options analysis with the aforementioned model. Furthermore, the case company was interviewed about the applicability of real options within their strategic realities.

The limitations of this case study arise largely from the fact that the research data of this thesis has been collected from a single source and from a single practitioner. The case company merely represents a single industry and has its unique strategic positioning. In addition, the case company management was unfamiliar with the real options theory prior to this study. Thus, the views from the case company management might not be as sophisticated as they could be.
This thesis starts with a literature review of real options (2) which first focuses on the background and formation of the real options theory (2.1) and then continues by reviewing its role and functioning in capital budgeting and strategic decision-making (2.2) and in the end, reviews some of the empirical and current literature surrounding the theory as well as criticism towards it (2.3).

The thesis then proceeds with an overview of the research methods and data collection (3) after which the actual research results are presented (4). The review of research findings starts by presenting the developed real options model (4.1) and then proceeds to give an overview of the interview results (4.2). Lastly, this thesis breaks down and analyzes the findings (5) and makes conclusions based on them (6).

The findings of this thesis suggest that the issue of complexity in the use of real options can be overcome with simpler approaches in the implementation of real options. This is given that the simpler approach is sufficient for the needs of the practitioners. However, this study also suggests that the level of applicability of real options depends on the strategic and cultural realities of the company as well as the experienced optimism of the practitioners in it.

Vocabulary

**Binomial lattice/tree model** – Lattice-based option pricing model with discrete value realizations of the underlying asset

**Black-Scholes model** - A closed-form equation for solving a price for a European option

**Geometric Brownian motion** – A stochastic process in which the value of an asset follows a random walk with a drift

**Stand-alone target company** – The target company of the acquisition without the synergetic effects of the acquisition

**Synergy multiple** – A factor that multiplies the sales of the target company for the shared clients, defines the amounts of synergies

**Synergetic target company** – The target company of the acquisition whose value depends on its stand-alone value and synergies

**Underlying asset** – The asset that can be bought/sold with the option

**u- and d-state factors** – The factors with which the values of the underlying asset are multiplied periodically in the binomial tree option pricing model

**Volatility** – The standard deviation of the asset value development

**WACC** – Weighted average cost of capital of a project
2. REVIEW OF REAL OPTIONS THEORY LITERATURE

2.1 Formation of real options theory

A financial option is a right but not an obligation to either buy (call) or sell (put) a financial security (A) at a predetermined price (exercise price, EX). A financial option can be obtained by paying the option price (C). The profit of a call option is calculated as \( \text{MAX}(A - EX, 0) - C \) and of a put option as \( \text{MAX}(EX - A, 0) - C \). Real options theory (ROT) utilizes this basic idea of financial option payouts but applies them in the value cycle of corporate real assets. In this sense, the real assets are presumed to entail similar rights but not obligations to exercise managerial decisions during the lifecycle of an asset which then affects the value of the asset. These rights embedded in these real assets, real options, are largely analogous to their financial counterparts but do nevertheless differ greatly.

The basis for the real options theory was formed amidst the rise of the development in the field of financial options pricing and valuation models during 1970. The well-known and widely used Black-Scholes model formed by Black and Scholes (1973), and refined by Merton (1973), and its discrete-based counterpart, the binomial tree/lattice model, formalized by Cox et al. (1979) work to this date as the analytical valuation tools for both real options and financial options (see e.g., Agaton’s (2021) application in carbon capture and storage industry investments). These option and corporate liability valuation models were built upon the assumption that option prices should not reflect any financial arbitrage opportunities. These models thus introduced the first market equilibrium models into the field of option valuation.

The first adaptation and conceptual layout for the real options theory was presented by Myers (1977). His work included the notion of the ultimate value of the real assets of a firm to be attributable to the options embedded within them. He introduced the idea of the distinction between real assets and real options which are the opportunities the firm possesses in obtaining real assets on potentially favorable conditions.

This notion of embedded opportunities, or discretionary future investments (Myers, 1977), within the real assets of a firm, constitutes a foundation for the real options theory. He went as far as to characterize corporate assets as call options. Later
generalizations of the real options framework were built upon this initial characterization of asset valuation through options by Myers (Trigeorgis, 1993a).

Later on, the main characteristics of corporate real options were researched and an initial framework for the qualities of real options was formed. In the field of real option studies, several types of real options were discovered and researched. The main categories of these real options include (but do not limit to) the options to defer an investment, stage an investment, alter the operating scale, abandon an investment, switch inputs/outputs, and grow (e.g., Trigeorgis, 1993a; Lander & Pinches, 1998; Tong & Reuer, 2007). Compound options which are options that interact with other options are sometimes also included in this listing, as in Trigeorgis (1993a).

The option to defer was one of the first real options to be studied at the end of the 1970s. The option to defer an investment was studied e.g., by Tourinho (1979) in the context of natural resources, Titman (1985) in the context of urban building, and McDonald and Siegel (1986) in general. These studies have shown that the option to defer an investment can be valuable even though it could entail costs (cf. option price).

Similar general and context-bound studies have been conducted in options to stage (e.g., Majd & Pindyck, 1987), alter operating scale (e.g., McDonald & Siegel, 1985), abandon (e.g., Myers, & Majd, 1990), switch inputs/outputs (e.g., Margrabe, 1978) and grow (e.g., Myers, 1977). As real options tend to interact with each other, compound options and option interactions have also been studied (building on Geske’s (1979) initial work on the valuation of financial compound options) as their presence is prevalent in the field of real options (e.g., Trigeorgis, 1993b). These studies, among others, have identified the potential within real options and laid out a theoretical framework around them.

Among these studies, a general philosophical framework for real options theory was formed. The basic idea of a capital budgeting measure which has the objective of shareholder value maximization and the ability to evaluate investments and uncertainty as well as to quantify the value of managerial flexibility constitutes the basic principles of real options theory. However, at least five distinct approaches in the implementation of real options theory have formed during this time (Borison, 2005). These five different categories differ in their inherent assumptions and investment analysis mechanics. More on the matter in 2.3.
2.2 Role in strategic decision-making and capital budgeting

The enthusiasm surrounding the evolution of real options theory can be largely credited to its ability to evaluate uncertainty, flexibility, and contingencies within corporate investments. Real options calculations have been, on multiple occasions, compared with the more traditional discounted cashflow or net present value calculations (DCF/NPV) as e.g., in Kemna’s (1993) study where she evaluated embedded options within investment cases of Shell. The study indeed concluded that real options are indeed better equipped to assess the flexibility in these case investments.

The ability of real options analysis to capture the value of uncertainty and managerial flexibility in corporate investments has been intuitively illustrated in e.g., HBR articles of Dixit and Pindyck (1995) and Luehrman (1998). The quantified value of this flexibility is additive to the value estimated by e.g., static NPV calculations. This naturally entails systematically greater values for investments with managerial flexibility. The difference between these static estimates and real option valuations grows when the scale of uncertainty, volatility, rises.

This attainable value from uncertainty and flexibility rises from the fact that options are designed to be exercised only in those scenarios where the option is in the money. The option philosophy inserts that the cost of acquiring (and exercising) an option is predetermined while the potential payout of the option is attributable to the volatility of the underlying asset. This ability to account for uncertainty is largely emphasized as a core benefit in the real options framework over the conventional capital budgeting calculations (e.g., NPV) in the fundamental textbook literature surrounding real options (e.g., Dixit & Pindyck, 1994; Trigeorgis, 1996).

In practice, with e.g., investments with staging options, a firm would forego future investment outlays if market conditions weren’t favorable enough. This would not be accounted for in a traditional naïvely static NPV calculation which assumes a predetermined investment lifecycle with no flexibility (to decide whether to exercise an option).

So, the real options framework makes for a great rival for traditional capital budgeting measures such as NPV calculations. The abilities of real options are not, however, limited to this. The embedded incentives in real options tools also have certain broader
implications in strategic management. ROT does not merely provide analytical tools for individual capital budgeting decisions but can be expanded to broader strategic and conceptual levels.

Trigeorgis and Reuer (2017) describe the function of real options reasoning (ROR) in corporate strategy. ROR is not an analytical valuation model of real options but rather a rhetorical and logical tool for creating, maintaining, and exploiting the real options a firm has in its portfolio. ROR heuristic can be used to utilize the qualitative insights of options theory (Trigeorgis & Reuer, 2017). These qualitative insights lead to the incentivization of 1. undertaking more investments under uncertainty (manages the biases people have in investing under uncertainty), 2. staging investments under uncertainty (limiting costs while maintaining growth potential), 3. managing the contingencies within these options (to allow future modification depending on market conditions), and 4. viewing corporate investments as a portfolio of many low-cost and staged investment bets (Trigeorgis & Reuer, 2017).

Trigeorgis and Reuer (2017) also lay out the possibility of ROT addressing core issues in strategy such as dilemmas between commitment versus flexibility as well as competition versus cooperation. Trigeorgis and Reuer approach the examination of ROT in strategic management by making claims about ROT’s linkages to firm heterogeneity. It is argued that real options emerge from firm heterogeneity while simultaneously when pursued successfully, they enhance it.

As discussed earlier, the uncertainty surrounding the underlying assets of real options increases option value. The ability to value uncertainty in capital investments aids in the dilemma of commitment versus flexibility (Trigeorgis & Reuer, 2017). Being able to efficiently manage strategic commitment versus flexibility can provide opportunities in the value creation of a firm. Trigeorgis and Reuer give examples regarding firm first-mover advantages created by early commitments via e.g., R&D. These early commitments may at times even create follow-on options and thus enhance the future flexibility of a firm. The option to defer as a flexibility-creating option must thus generally be assessed against the commitment-related benefits of pre-empting competition as well as any early acquirable/learnable and valuable insight/experience attributable to committing early.

Trigeorgis and Reuer (2017) expand this ability of ROT to assess the commitment versus flexibility dilemma to the dilemma of competition versus cooperation.
Competition versus cooperation decisions similarly creates flexibility as well as incremental future options.

Decisions made regarding these dilemmas can have strategic significance as they ultimately affect the commitments of corporate resources. These decisions are made under great uncertainty regarding rivalry as well as technological and other market threats. These decisions may also have long-term implications of embedded future options within these commitments. ROT is thus argued to be an efficient tool of strategic management as it can more proactively manage this described uncertainty surrounding these decisions. (Trigeorgis & Reuer, 2017).

Real options theory may provide useful insights into strategic management in other respects as well. As stated before, Myers (1977) coined the notion of corporate asset value being attributable to the embedded options within them. This notion gave rise to the so-called option lens with which an organization’s resources are viewed as a bundle of options for future strategic choices (Bowman & Hurry, 1993).

Bowman and Hurry (1993) make the distinction between flexibility options and incremental options and illustrate the so-called option chain. The option chain includes the recognition of shadow options which become the real options of the firm when discovered and nurtured correctly. The future striking of these real options then depends on the concurrent market conditions. The striking of these options creates further options for the firm (shadow options to be discovered).

In this option chain the incremental call and put options either create or extinguish these future options respectively (with the acquiring and selling of assets) (see also e.g., Copeland & Keenan, 2005; Li & Chi, 2013). These incremental options work as the promoters of the incremental strategy of a firm. The firm thus has a strategic direction dictated by these options. Flexibility options in turn are options that give an opportunity to change the strategic direction by creating different sets of future options for the firm.

So, the role of ROT in strategic management can be viewed as creating, maintaining, and nurturing the value-creating options of the firm. These can also create strategic flexibility for the firm. On the other hand, having the view of corporate strategy via the option chain enables the view of a strategy as a pathway dictated by options. This can be viewed as analogous to the usage of decision tree analysis (DTA) (as is inherently
the case with lattice-based models). However, the focus with ROT and ROR naturally lies more on option characteristics and their linkages (Trigeorgis & Reuer, 2017). DTA itself is incapable of capturing the actual option value in the investment lifecycle (Copeland & Antikarov, 2001) even if it can account for flexibility to some degree.

2.3 Empirical research, current literature, and critique

Numerous empirical studies on applications of real options have been conducted after the formation of the real options theory. Among these empirical studies of real options theory is Quigg’s (1993) empirical study of real option-pricing models. She ran statistical tests on late 1970s real estate transactions. She compared the intrinsic value and market price of land slots with the price of an option-based (to defer) pricing model. She estimated a mean option premium of 6% additive to the intrinsic value. This largely followed the market values of these slots. She thus concluded that the real option-pricing model does indeed have explanatory power in the real world. In other words, this particular study supports the notion that the option to wait does have value.

Another, yet a different kind of, empirical study in 1993 was conducted by Kemna, as stated earlier. Her case study involved an examination of three distinct investment cases of Shell company in which she evaluated (utilizing Black-Scholes and its variations) 1. a timing/deferring option regarding an oil/gas reserve development to a plant, 2. a growth option embedded in a pioneer venture which, given favorable market conditions, would be expanded to a commercial venture and, 3. an abandonment option of a crude distillery.

Kemna argued that, even though ROT has advantages over traditional capital budgeting measures (regarding e.g., quantifying flexibility in investment projects), convincing management of real options methods’ abilities can be quite challenging due to their complexity. However, she was able to conclude that simple option models (such as the ones used in the study) were able to provide management with great intuition regarding these cases under ROT evaluation. Kemna asserted that the main benefits of ROT lie in helping management structure investment opportunities and handle flexibility within investment projects.

Empirical studies surrounding real options theory and its wide range of adaptations have proven to enhance firm performance (Brouthers & Brouthers, 2008; Hawk &
Yeung, 2013; Ipsmiller et al., 2019). Recent empirical literature shows that corporate management favors more conceptual and heuristic (referred to as ROR earlier) approaches in the implementation of ROT rather than analytical valuation-based (real option valuation, ROV, see Trigeorgis & Reuer, 2017) approaches (Ipsmiller et al., 2019). ROT utilization on the corporate level has nevertheless been very limited (Lander & Pinches, 1998; Driouchi & Bennet, 2012; Ipsmiller et al., 2019).

The poor implementation percentage of ROT among corporations is largely attributable to the complexity of option pricing models and the difficulties faced in the approximation of the parameters of these models (Kemna, 1993; Lander & Pinches, 1998; Trigeorgis & Reuer, 2017; Ipsmiller et al., 2019). However, the inertia in the implementation of ROT isn’t limited to this. In addition to the lack of required theoretical skills of practitioners Lander and Pinches (1998) assert that the violation of real option modeling assumptions and the additional assumptions required for mathematical tractability that limit the scope of applicability as the main challenges in practical implementations of ROT.

A survey of 279 Fortune 1000 companies (Block, 2007) listed the lack of top management support, NPV calculations being a literature favorite, excessive sophistication, and encouragement of risk-taking as the top 4 reasons for not using real options. Another survey (Horn et al., 2015) of the largest Scandinavian companies, showed that only 6% of respondents had used real options while 70% of the respondents reported not being familiar with the relevant concepts.

Recent empirical studies also address the problems in ROT implementation regarding the approximation of irreversibility, use of a constant uncertainty estimate, competition examination, estimation of growth opportunities, the inclusion of cost in flexibility/switch options, assessment of option exercise timing/circumstances, acknowledgment of option linkages, management biases and the evaluation of option decision performance (Ipsmiller et al., 2019).

So, the evolution of the use of ROT in practice has not unfolded without difficulties. Some of the criticism of ROT is specific to its different approaches. As stated before, real option valuation in investments has at least five distinct approaches with differing valuation mechanics and inherent assumptions. These approaches are the classic, the subjective, the MAD, the revised classic, and the integrated approach (Borison, 2005).
The classic approach is built on the assumption that the underlying asset value development can be imitated with a replicating portfolio consisting of market-traded assets which in turn allows the usage of e.g., the Black-Scholes model by additionally assuming that the value development of the portfolio follows a geometric Brownian motion. The subjective approach is essentially the same as the classic approach but with the parameters of the replicating portfolio being estimated on a completely subjective basis rather than on market data. (Borison, 2005).

The MAD (Marketed Asset Disclaimer) approach (Copeland & Antikarov, 2001) doesn’t rely on market data and uses in replacement of the replicating portfolio the subjectively assessed static NPV of a project (with no flexibility in it). The NPV calculations are run through a Monte Carlo simulation. The resulting distribution of outcomes and probabilities are then used to estimate the parameters for an option pricing model which then calculates the option value of the project. The only market data used in this approach is the risk-adjusted cost of capital (discount factor). (Borison, 2005).

The revised classic and integrated approaches are derived from the classic approach. The revised classic divides investments between investments whose risk pricing is dominated by either public or private factors. It then either applies the classic approach or other evaluation tools (decision tree analysis or dynamic programming) respectively depending on whether the risk pricing of the investment is dominated by public or private factors. The dynamic approach on the other hand recognizes that investments can include both characteristics and employs the classic approach for publicly priced risks of the investment and other tools for the privately priced risks of the investment. (Borison, 2005).

The last two approaches mitigate the problems faced with the classic approach. The major problem with the classic approach has to do with the accuracy of the replicating portfolio replicating the real asset characteristics (see e.g., Amram & Kulatilaka, 1999). The last two, however, distinguish between the risks efficiently priced on the markets from those that are not and are thus viable solutions to this issue (Borison, 2005). Of course, these models are even more complicated and do not thus contribute much to the problem stated before regarding the complexity of ROT.

The problem of the two subjectivity-based models (the subjective and the MAD approach) on the other hand lies largely in the subjective assessment itself as well as
the weak/odd linkages between these subjectively assessed parameters and the market assumptions regarding e.g., no-arbitrage assumption and/or geometric Brownian motion of asset prices (Borison, 2005). On the other hand, a comparison between these models with e.g., the widely used NPV calculations could argue that even these models provide some contribution to investment analysis. After all, NPV calculations are also often largely based on subjective assessment and data.

3. RESEARCH METHODS AND DATA COLLECTION

This study is conducted as a case study that is built on insights gained from a Finnish IT company.

This study is a qualitative case study with the aim to strengthen the understanding of a relatively widely researched capital budgeting tool, real options. The focus lies on the practical applicability of the real options theory. The concept of an illustrative case study that contributes to the refinement of a theory (Keating, 1995) would thus characterize this study as this study indeed focuses on the demonstration of the capability of an unappreciated tool of management. On the contrary, this study also has characteristics of a counterpoint case study that contributes to the refutation of a theory (Keating, 1995) as this study also investigates the barriers to the application of ROT in real life. However, this study is strictly limited to the highlighting of possible deficits in the theory as opposed to the refutation of a whole theory.

The theoretical literature on ROT is somewhat extensive and many studies on the application have also been conducted. Empirical studies have nevertheless shown a minimal implementation percentage among companies which became apparent as soon as the writer started to screen for possible case companies. This study aims to further clarify the reason behind this poor level of implementation by introducing real options analysis as well as real options reasoning to a Finnish IT company. In addition to introducing the theory, the writer, in cooperation with the case company management, incorporated a real options approach in a past acquisition case of the firm.

The re-evaluation of the acquisition case is conducted so that real-world realities are considered, and certain compromises (deviations from the textbook implementations) are made in utilizing real options. Thus, the study aims to conduct a qualitative study in a way that takes a step away from the so-called textbook view, economics view as
well as consultancy view (Vaivio, 2008). The purpose of conducting the case analysis was not to “sell” real options theory to the management but rather to highlight its abilities and initiate management’s reflection on the benefits and pitfalls of the theory in the strategic context of the case company.

The case company management has not used real options in its investment analysis before and the understanding of the theory is elementary. The study is thus limited to the analysis of ROT’s possible fit to the strategic context of the case company. So, it is noteworthy that the understanding of the theory in the case company might not be sufficient, even with the orientating of the writer, for them to make decisive conclusions regarding the applicability of ROT in the context of the company. It has nevertheless been proven that ROT can provide management with substantial intuition regardless of its complex nature (Kemna, 1998; Trigeorgis & Reuer, 2017).

The case company provided the writer with a foregone acquisition case of a target company. In cooperation with the management of the company, the writer was tasked to model the acquisition synergies of the acquisition as option payouts. The modeling of synergies as option payouts is rare but studies of option premia valuation with real options have been conducted on a market level (Dunis & Klein, 2005) as well as on a single case level (Čirjevskis, 2020) as types of event studies.

The model was provided with a run-through and an analysis to aid the management in understanding the application of real options in this case. This analysis was made to provide the management with insight into the use of real options in capital budgeting. The model is then compared with their original calculations. Special attention was given to the behavior of the option model with different parameters. The actual performance of the analysis was ignored as it could have biased the views of the practitioners.

After the analysis was presented, management was given time to reflect on it. Afterward, an interview was conducted (see Appendix A) utilizing the key insights gained from the real options model as well as the orientation provided by the writer. Then a director in the case management was inquired about the level of understanding of the theory and views advocating and opposing the implementation of real options in the context of the case company. The interviewed director of this study is largely involved with the strategy and acquisitions of the case company.
The interview was conducted as a semi-structured interview (Appendix A) in May of 2023. The interview lasted a total of one hour. The interview revolved around four subjects: 1. capital budgeting process in the case company, 2. real options in the case company, 3. the synergy option model, and 4. strategic aspects of real options in the case company.

The analysis of the interview is intended to conclude the level of applicability of ROT in the case company. This study is oriented toward the applicability of ROT in strategic aspects. So, special attention is given to the match between ROT and case company strategic realities.

The findings and conclusions of this thesis are subject to the obvious limitations that rise from the nature of the study. The collected data is limited to a single source. In addition, the views from the practitioner are limited to utilizing the orientating of the writer and a limited reflection of the synergy option model.

4. A REVIEW OF THE RESEARCH FINDINGS

4.1 The synergy option model

The case company provided the writer with material on the calculations of possibly attainable synergies from the acquisition as well as of the value estimations of the target company. The private equity target was valued with different multiples on EBITDA and the required synergies for the case company to break even were calculated as the difference between the multiple-based value of the target company and the present value of its anticipated free cash flows for the next 5 years.

The target company and the case company shared a few clients. The target was expected to make certain amounts of sales with these clients during the next 5 years. The additive number of sales (synergies) for these clients from the case company was expected to be attributable to a “synergy multiple” on the sales of the target company (e.g., 100 EUR of sales in the target company for a shared client would then result in synergy sales of 200 EUR with a synergy multiple of 2).

The writer was tasked to model the uncertainty and flexibility associated with the realization of this synergy. So, an assumption was made that the case company would not conduct synergy-creating activities if they were to result in negative synergies. This
way the function of call option payouts, \( \text{MAX}(A - EX, 0) \) or \( \text{MAX}(\text{Synergetic target company value} - \text{Stand-alone target company value}, 0) \), was deemed viable for depicting synergy realizations as they would never be negative. Thus, the writer constructed an option pricing model (Black-Scholes + binomial lattice, see parameters in Table 1.) to estimate an option value for the possible synergies to be gained.

The volatility parameters \( u, d, \) and \( \sigma \) (u and d were assumed to be recombining as in Cox. et al. (1979)) were reliant on an adjustable synergy multiple. The average growth of the synergetic target company (target company value plus value attributable to synergies) for the following five years of the acquisition was used as the \( u \)-state factor in the binomial lattice model. Thus, it was straightforward to define the recombining \( d \)-state factor and the volatility \( \sigma \) that is equivalent to these factors.

The model left the synergy multiple undefined so that the case company management could then conduct sensitivity analysis with the differing synergy multiple values. The synergy multiple was after all the most subjective estimate of the model.

Given that the acquisition had a defined weighted average cost of capital (WACC), the writer also defined the implicitly assumed objective probabilities of \( u \)- and \( d \)-state factors for illustrative purposes. These probabilities are not relevant for option pricing as all the risks are already reflected in the value of the asset (with WACC) (Copeland & Antikarov, 2001).

Based on the provided WACC, a present value was then calculated for this synergetic target company \( A \). Thus, the option pricing parameter of the underlying asset \( A \) of the option pricing parameters in addition to the volatility parameters \( (u, d, \sigma) \) was also reliant on the synergy multiple.

Other parameters such as option maturity \( T \) (time of the full realization of synergies) and for the binomial lattice model the incremental change of time between value realizations \( \Delta T \) were estimated by the management. The risk-free rate \( r_f \) was taken as the interest rate average of 5-year Finnish government bonds (Bank of Finland, n.d.) of the year of the acquisition.

The exercise price \( EX \) of the option pricing model was defined so that it would represent the EBITDA multiple-based future value of the stand-alone target company.
Table 1. Option pricing parameters and sources

<table>
<thead>
<tr>
<th>Option pricing parameters</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the underlying asset at time 0 ((A_0))</td>
<td>The calculated present value of the synergetic target company. PV depends on the synergy multiple</td>
<td>Case material, dependent on the synergy multiple</td>
</tr>
<tr>
<td>The exercise price ((EX))</td>
<td>The EBITDA multiple based future value of the target company at maturity</td>
<td>Case material, varies depending on the chosen multiple of the target</td>
</tr>
<tr>
<td>Domestic risk-free rate ((r_f))</td>
<td>Average interest rate of 5-year Finnish government bond</td>
<td>Bank of Finland, the acquisition year</td>
</tr>
<tr>
<td>Time of option maturity ((T))</td>
<td>The anticipated realization time of all of the attainable synergies</td>
<td>Case material, managerial view</td>
</tr>
<tr>
<td>Value realization interval ((\Delta T))</td>
<td>The interval of value development realization</td>
<td>Case material, managerial view</td>
</tr>
<tr>
<td>Up-state factor ((u))</td>
<td>The average of the growth multipliers of the synergetic target company</td>
<td>Case material, based on the case calculations, dependent on the synergy multiple</td>
</tr>
<tr>
<td>Down-state factor ((d))</td>
<td>The uncertainty associated with the realization of anticipated synergies</td>
<td>Defined so that the value can recombine in ud or du scenarios = 1/u, as in Cox et. al. (1979)</td>
</tr>
<tr>
<td>Volatility of the underlying asset ((\sigma))</td>
<td>The volatility that corresponds to the anticipated (u) (\ln(u) / \sqrt{\Delta T}), as in Cox et. al. (1979)</td>
<td></td>
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The future value of the stand-alone target company was thus dependent on the chosen EBITDA multiple and the anticipated EBITDA of the stand-alone company at maturity.

The approach chosen for this model was largely analogous to the one presented by Copeland and Antikarov (2001), the MAD approach. Even though there was no simulation conducted for the model due to a lack of relevant data and a pursuit of high simplification, the value movements of the underlying asset were still based on the NPV calculations as is the case in the MAD approach (Copeland & Antikarov, 2001).

The constructed model was then presented to the management so that they were able to interact with the model by inserting different synergy multiples as well as exercise prices (different EBITDA multiples) to observe its influence over the European option value generated by the Black-Scholes and binomial lattice models.

4.2 Views from the practitioner

4.2.1 The capital budgeting process

The case company uses primarily traditional present value calculations and payback period estimations as tools in analyzing investment opportunities and acquisitions. These tools were seen as simple means of obtaining a numerical value for an investment. It is noteworthy that the capital budgeting calculations themselves are not crucial to the decision-making of the case company. Instead, they are used as mechanical tools in supporting a more important qualitative analysis of the investments. The approvers of investments in the case company (the board) thus value more the managerial experience, expertise, and intuition in assessing these investments.

The analytical capital budgeting calculation models work merely as a means of assuring that investment opportunities are assessed from as many perspectives as possible. The case company management nevertheless views that the used capital budgeting calculation models are not sufficient in capturing the complexity of these investment opportunities. The main point of concern lies in the fact that the used NPV calculations are simply way too straightforward.

The management reported a need for more complex models that would better take into account the complexity, uncertainty, and flexibility within these investments. These
aspects are considered merely via manual and coarse sensitivity analyses on the input variables of these models. This is regarded also as insufficient and too simplistic regarding the assessment of varying and volatile conditions that the investments face within their lifecycles. This sensitivity analysis also leaves out the possibility to utilize managerial flexibility which is nevertheless acknowledged to exist.

Even if the case company recognizes a need for more sophisticated capital budgeting models, they still recognize the downsides of such models. These downsides primarily include the recognition of their complexity itself. In addition, the assumptions that make the use of such models possible are considered a source of concern as well.

The case company reported that their current capital budgeting models have not been able to take into consideration the volatile market conditions we have lived through.

In addition to the aforementioned sensitivity analyses, in the context of acquisitions, the case company controls uncertainty and related risks by heavy due diligence and by assuring that the target companies are profitable and growing businesses. This should then pre-empt the volatility of returns in the future.

The lifecycles of investments are, however, monitored to some degree. Upon unfavorable market conditions, the case company resort to boosting their sales. The management assesses that unfavorable market conditions can be tackled by boosting the intensity of sales work. This is something that is assumed to be possible within the investment lifecycle but is not accounted for in any way in the analysis of the investments/acquisitions.

Unfavorable scenarios in investment lifecycles are assumed to be resolvable simply by focusing more on sales activities. This sort of managerial flexibility is recognized but not considered in the analysis phase of capital budgeting. Considering larger scale negative scenarios in the investment lifecycle are not regarded as relevant as the acquired businesses for example are already considered to be profitable and growing.

4.2.2 Real options of the investments

Regarding real options faced in their operations, the case company faces deferral options the most. The company’s market positioning is so favorable that they are overwhelmed by the ever-emerging opportunities in e.g., business acquisitions as well
as client projects. In this regard, the company must prioritize and continuously exercise the option to defer an investment. This real optionality is accounted for on a conceptual level and has thus far seemed sufficient in this field.

The option to grow is accounted for very much analogously to the deferral option. The case company acknowledges a portfolio of growth opportunities. They similarly frequently exercise these options as they have been growing as an industry as well as a company. The case company actively executes its growth strategy by exercising these growth options that consist primarily of acquisitions. Actively managing this portfolio of these opportunities with the options to defer and grow is a key concept in the culture and strategy of the case company.

The option to abandon is not regarded as relevant nor appropriate for the case company. The case company culture and “business-minded” orientation causes these options to become irrelevant because the case company prefers to stick to made decisions. The case company in this regard also recognizes the opportunities that their less profitable services generate. The option value in these services (as in that they could entail the sales of other services) really fits in well with the portfolio approach of the company. This trade-off is regarded as the reason to ignore these options to abandon investments.

The case company management sees a trade-off in the benefits of continuing optimizations and utilizations of higher margin services between the benefits of maintaining a portfolio of services that have embedded options within them. This latter is regarded as more suitable for the case company culture and strategy. This has again been assessed on a conceptual level.

The option to stage an investment is just as well regarded as irrelevant for the case company as it doesn’t quite fit the strategy and culture of the company. The way in which the case company conducts its growth strategy is tied to making larger early investments in order to capitalize on the potential growth and pre-emption of competition. In a sense, flexibility is created by having a large portfolio of highly developed services.

The options to alter the operating scale, as well as the option to switch inputs/outputs of production, are unsurprisingly neither viewed as fitting for the strategy/culture of
the company. This is also taken into account in the trade-off dilemma between optimizing operations and maintaining a portfolio of highly developed services. No optimization in this regard is preferred in order to maintain such a portfolio.

4.2.3 Insights from the synergy option model

The writer was not able to build a comprehensive understanding of the synergy option model in the case company management. The management was nevertheless able to understand the underlying assumptions and the functioning of the model on a crude level. The intuition, as well as the meaning and implicitly recommended actions regarding the acquisition of the model, was understood clearly. The option value itself was intuitive.

The model was seen as useful. It was regarded as just as relevant as the already used methods in capital budgeting. In this sense, the role of this model would be the same as of the others: forcing the management to see and analyze the investment/acquisition in yet another way. The model was not seen as a replacing straightforward solution for the deficient models that are used but as a complementary tool for the analysis.

The model nevertheless proved itself as being able to evaluate the uncertainty and flexibility of the acquisition. Better so than the originally conducted calculations and sensitivity analyses.

The geometric Brownian motion assumption was seen as a reasonable assumption for the behavior of the value development of the target company. The assumption that the payoffs of a privately accessible investment opportunity could be replicated with a replicating portfolio (option-free investment + risk-free borrowing (Copeland & Antikarov, 2001)) was seen as somewhat unintuitive but the resulting option value with this seemed to give enough reason for the use of this approach. The assumption of the ability to prevent negative synergy was seen as reasonable for the model as well.

4.2.4 Strategic aspects of real options

As stated earlier, there is a trade-off of early mover advantages and the thus gainable portfolio of highly developed portfolio of services and embedded options between the advantages of keeping one’s options open. The former has been deemed as a cornerstone in the strategy of the case company. The trade-off has been assessed on a
conceptual level without any real option-based analytical or heuristic models to support the assessment.

The management views that the real options theory could potentially help this sort of assessment. The case company by default prefers the former due to their culture but the management would welcome a real option framework to support this assessment. It is viewed as beneficial, especially for the modeling of uncertainty and flexibility in the comparison of these two approaches.

In the context of expanding business over borders, the case company would however consider utilizing and accounting for the aforementioned options to abandon and stage an investment. Expanding to other countries is viewed as such a risky and volatile action that the ability to conduct as extensive due diligence and utilize managerial experience and expertise in a similar fashion as with other investments can be viewed as limited. In this field of growth strategy, the case company would be ready to sacrifice some of its cultural and strategic preferences.

The case company has been able to take advantage of the organic growth of the IT industry for quite some time. The management does not see that this growth would turn down in the future. Neither do they view considering any options for such scenarios to be necessary.

In the acquisitions of new businesses, attainable capabilities and human capital are considered the most important assets. The case company recognizes the embedded options within these capabilities and works partly as the main motivators of the acquisitions. This consideration is yet again conducted on a conceptual level. An analytical model is considered to be too complex and hard to implement in these analyses.

Regarding the option chain framework in the context of conceptualizing and understanding the strategic options, the management gave some mixed views on the matter. On one hand, the view of incremental options that advance the company are viewed as a relevant concept for the case company. On the other hand, the case company views the flexibility-creating options of the option chain framework as unsuitable concerning the strategy and culture of the case company.
Overall, the management sees potential within the real options framework. The ability to account for flexibility in uncertain and volatile lifecycles of investments is viewed as the key benefit of real options. The consideration that must be made of several possible scenarios and related activities is also viewed as a substantial benefit. But as stated earlier, real options are not considered superior to other capital budgeting measures but rather a complementary tool for other models and for broader qualitative analysis.

The real options analysis itself is viewed as a complicated valuation model that would be difficult to reason to the people (the board) responsible for the approval of strategic investments. However, the management views that a type of “black box” model could be used in this context. Regardless of the complexity of option pricing, the binomial lattice model is seen as an intuitive representation of option value derivation and thus has some value in the analysis process as such.

5. DISCUSSION

The construction of the synergy option model was conducted by following the basic intuition behind the MAD approach of Copeland and Antikarov (2001). The choice of this approach was clear-cut as it is relatively straightforward and requires merely the present value calculations of an investment (Copeland & Antikarov, 2001). However, even this approach was difficult to explain to the management of the case company. The adaptation of option pricing in the field of capital budgeting was seen as complex and unintuitive at first.

The criticism of the MAD approach (Borison, 2005) regarding the ignoring of the possibility of the existence of a replicating portfolio (market traded) of the asset as well as the assumption of geometric Brownian motion being a flimsy assumption of the behavior of the underlying asset was not relevant to the management of the case company. Even if the management did not necessarily possess the required level of expertise to assess the credibility of these underlying assumptions, the constructed model would nevertheless fit their particular needs. After all the objective of these capital budgeting methods for the case company is not to be decisive. From the subjectivity point of view, the model did not much differ from the ones already in use.

In the context of the case company, the actual assumptions and functioning of the real option pricing are not given much significance largely due to their capital budgeting
decision-making realities. Real options analysis would play just as important a role as their other capital budgeting measures. The utilization of real options analysis would, however, answer the expressed need for a tool that takes flexibility and uncertainty into consideration (Lander & Pinches, 1998).

The management of the case company has well established a notion of the irreversibility of investments via e.g., the recognition of having to screen out the best alternatives from the roster of possible investment opportunities. The options to defer and grow are conceptually considered in this context. Thus, the option value of deferring an investment (Majd & Pindyck, 1987) is fully recognized although not assessed analytically. The writer as well as the management see a clear solution to this problem in using the real option analysis to support these decisions the company faces.

The real options analysis framework would undoubtedly support the case company in these dilemmas. Even better so, if this analysis is paired with the usage of the more heuristic model, the option chain framework of Bowman & Hurry (1993). In the context of advancing one’s strategy via incremental options and by actually recognizing the underlying shadow options of an investment, the analysis and framework would fit in quite well with the strategy of the case company.

Surprisingly, however, the options that create strategic flexibility (e.g., altering operating scale/abandoning) were regarded as irrelevant and unsuitable for the culture and strategy of the case company. This is somewhat counterintuitive parallel to the literature surrounding real options. The notion that strategic flexibility options are appealing and valuable (Bowman & Hurry, 1993; Damaraju et.al., 2015) appears to hold little value to the management.

It became apparent that the case company has experienced strong growth (both as a company and as an industry) during its recent history. Maintaining this growth would continue to be a high priority in the future. Thus, the realities dictated by the industry as well as human optimism could influence this view on the relevance of such flexibility-creating options. The presence of commitment bias is thus also possible.

Fused in this emphasis on growth in the strategy as well as the optimism of the growth persisting is the actual goal of creating and maintaining a highly developed portfolio of businesses/services. The use of such a diverse portfolio is intentional. This sort of
strategic positioning where substantial commitments are made early in order to create efficient growth works effectively in the creation of future flexibility as well (Bowman & Hurry; 1993; Trigeorgis & Reuer, 2017). Conceptual real options reasoning would be more than capable of giving insight into this sort of positioning and its tradeoffs. Real options reasoning as well as analysis as a management tool would incentivize efficient creation, maintenance, and exploitation of the real options in this portfolio (Trigeorgis & Reuer; 2017).

The case company has clearly assessed the industry to be favoring first-mover advantages. Industries that have a lot of shared growth opportunities certainly favor making larger strategic commitments early on to pre-empt rivalry (Trigeorgis & Reuer; 2017). The IT industry could be regarded as such as the management even mentioned the growing presence of AI and its implications to the industry competition. The emergence of AI certainly creates shared options in the IT industry.

Of the most common real options, the option to grow was clearly the most important and relevant to the strategy of the case company. Real investments (incl. acquisitions) hold strategic value in this regard with the growth opportunities they possess as well as with their potential effect on competitors (Kulatilaka & Perotti, 1998; Trigeorgis & Reuer, 2017). Proper valuation of these investments should consider this value in addition to the alternative value of not investing (maintaining flexibility) as the strategic benefit of pre-empting rivalry does not always exist in different investment opportunities (Kulatilaka & Perotti, 1998).

Despite the culture and strategic realities of the case company, the management nevertheless deemed the expansion of business over borders as a field in which increased managerial flexibility could be of use. The optimism of the management does not thus seem to reach this field of growth strategy. Understandably the perceived uncertainty in this field is greater than in the expansion of core business domestically. After all, as the volatility of an investment increases the value of flexibility-creating options increase (Majd & Pindyck, 1987; Trigeorgis & Reuer; 2017) while the appeal of early commitment decreases (Kulatilaka & Perotti, 1998; Trigeorgis & Reuer; 2017).
6. CONCLUSION

The purpose of this thesis was to enhance the understanding of the barriers as well as the proponents of the applicability of real options. In order to achieve this goal, the writer familiarized the management of a Finnish IT company with real options and initiated a reflection on the insights gained from the synergy option model (created by the writer). An interview was conducted with one of the directors from the management. Finally, this interview was reviewed and analyzed to achieve the goal of this thesis.

The following aims to conclude the answers to the following research questions presented at the beginning of this thesis:

- How largely does the complexity of real options limit the usage of them?
- What are the factors that affect the utilization of real options in strategic capital budgeting decision-making?
- What is the effect of these factors?

In conclusion, the most prevalent barriers to practical implementation, (Lander & Pinches, 1998) of real options for the case company were overlooked. The complexity issue of real options analysis was simply overlooked and partly resolved with the usage of a simpler real options approach. Similarly, the critique regarding the functioning of the MAD approach was also dismissed. Real options analysis could indeed be used in the context of the case company due to the non-decisive role of capital budgeting to begin with. In this sense, real options would indeed answer the needs of the case company.

In the broader context of strategic positioning, the fit of real options is a bit awkward. The overwhelming optimism surrounding the continuing success and growth of the case company as well as the IT industry as a whole hinders the consideration of flexibility-creating options. On the contrary, the case company realizes the value of strategy advancing incremental options. This became apparent in the discussion about the commitment versus flexibility trade-offs of the company.

This thesis asserts that the cultural and strategic preferences of a company can largely affect the adaptability of real options in strategic capital budgeting decisions. Largely growth-oriented businesses and industries could be more likely to view strategy
advancing or incremental options (Bowman & Hurry, 1993) as relevant and worth accounting for as well as creating, managing, and exploiting them. Simultaneously these strategic and cultural realities can overlook flexibility-creating options.

This thesis, however, recognizes that even with optimistic and growth-oriented cultures a company can utilize flexibility-creating options if the expected uncertainty is large enough.

All in all, the case company of this thesis possesses several situations where the use of real options analysis, valuation as well as reasoning would be beneficial. From the practical point of view, the utilization of a subjectivity-based MAD approach suffices their needs. The cultural and strategic realities of the case company nevertheless limit the utilization of all the real options faced in the real world.

Further research on the applicability of the real options could extend this line of research to other industries with differing strategic positioning preferences to also give insight into the effect that e.g., the optimism and growth of industry have on the attitude toward the relevance of real options. This research could also study the effect that the competitive market position of a company has on this matter.
References


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7. APPENDIX A. INTERVIEW STRUCTURE

Which capital budgeting methods do you use in assessing investments?

Who are responsible for the approval of investment decisions and how are they convinced of the goodness of the investment?

Have you felt that the used capital budgeting methods have been sufficient in analysing and capturing the value of the investment?

Have you felt a need for more sophisticated capital budgeting methods?

What are the weaknesses of your current capital budgeting methods?

Do you monitor the factors that affect the value of an investment during its lifecycle?

Do you react to the changes in these factors?

How do you manage and evaluate the uncertainty in the investment lifecycle?

Does your company face and take into account the following real options within your investment:

- The option to defer
- The option to grow
- The option to contract
- The option to stage an investment
- The option to alter the operating scale
- The option to switch inputs/outputs?

Should these options be taken into account in the capital budgeting decision making?

Were you able to understand the synergy option model? Did you understand the option value and what it implies to the acquirer?

Is it meaningful to model synergies in such a way?

How credible are the assumptions about:

- Geometric Brownian motion
- Replicating portfolio of synergy payouts
- The ability to prevent negative synergy

Did the model help to recognize the uncertainty and flexibility within the acquisition?

Do you weigh off the benefits of early mover advantages and maintaining flexibility?

Could real options benefit this analysis?

Could real options benefit the assessment of expanding your business abroad?

Do you consider the human capital and capabilities as well as the options that they create for you in the acquisitions of new businesses?

Have you considered any options to the scenario where the organic growth of the IT industry would turn down?

Is the option chain framework useful for your strategy?

Give some supporting and opposing views for the implementation of real options in the assessment of strategic investments of your company.