Norwegian School of Economics

Bergen, Fall 2018

Why is the adoption rate of real options valuation low among practitioners?

A multiple case study

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Master Thesis in Finance

NORWEGIAN SCHOOL OF ECONOMICS

Executive Summary

Real options valuation has been advocated as an appropriate valuation method for high-risk projects. Despite its popularity in literature, adoption among practitioners continues to be low. This paper researches why the adoption of real options analysis remains low by studying three topics; how companies value high-risk projects, to what extent managers incorporate real options thinking, and to what extent managers find real options analysis suitable for their businesses.

The paper aims to develop new insights for the low adoption rate of real options analysis through an exploratory multiple case study. We have conducted interviews with top executives and managers that are involved in project valuations and have authority to make investment decisions. From these interviews, the study provides insight into how companies value and evaluate high-risk projects, how managers incorporate real options thinking in project assessments, and how practitioners perceive real option valuation.

Generally, findings from our study support existing literature. None of our interviewed firms used real options analysis for project valuations, because managers lacked familiarity with the models. After interviewees were explained the basics of real options valuation, they argued against the method because it was perceived as costly to implement, they lacked the competence to perform the analysis, managers could not always exercise relevant real options, and confidence in employed methods reduced the need for additional sophisticated analysis. Nevertheless, all participants exhibited real option heuristics as they intuitively included the value of real options in investment evaluations.

A potentially interesting finding from our study is that participating companies reported prioritizing non-financial investment criteria over valuations. As valuation was not the most important criterion for project assessments, the willingness to invest in sophisticated analysis diminished. Further studies on the prevalence and effects of this priority may increase the understanding of why real option adoption continues to be low.

Acknowledgments

The completion of this thesis would not have been possible without all the help and support we have received.

First, we would like to thank our supervisor, Kyeong Hun Lee, for your contagious engagement, comments, and valuable feedback. You were quick to answer all our questions and never ceased to amaze us with your ideas and suggestions.

Second, we want to extend our gratitude to all of our interviewees for taking time off from their busy schedules to participate in interviews. Your perspectives, insights, knowledge, and expertise were tremendously interesting, both from an academic and a non-academic perspective.

Finally, we want to express our gratitude to our families and friends who have provided us with their support, feedback, and comments. We would like to especially thank Nils Foldal and Torhild Solbak for their help in facilitating interviews.

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1. Introduction

With the emergence of rapidly changing technologies, research and development (R&D) have become the backbone of many enterprises for organizational survival and growth. Innovation and technology can offer a leading edge over competitors, which has become critical considering the ever-growing domestic and international competition. (Cooper et al., 2001; Wang and Hwang, 2007; Thamhain, 2014; Lee et al., 2017). The paramount number of project failures across industries remind us of the difficulty of predicting the success of R&D projects. (Chapman and Ward, 2003, Kulkarni et al., 2004, Gulla, 2012). Surveys from several researchers reveal that the success rate of new product development is still low, mainly due to the high risks of developing new technology (Griffin, 1997; Keizer et al., 2005; Wang and Yang, 2012, cross-cited in Shin et al, 2018). Therefore, the ability to efficiently allocate resources to R&D projects has become vital for enterprises' prosperity and survival.

There have been ample studies on approaches, techniques, and methods for valuing R&D investments. While conventional methods such as the net present value model (NPV) and discounted cash flow model (DCF) are widely praised for their simplicity (Kjærland et al., 2015), they fail to capture the value of managerial flexibility and dynamics of risks in high-risk projects. As a result, DCF analysis tends to underestimate the value of high-risk projects (Myers, 1984; Dixit and Pindyck, 1994; Wang and Hwang, 2007; Steffens and Douglas, 2007). Consequently, researchers have advocated the use of real options analysis for project valuations (Trigeorgis, 1996; Copeland and Antikarov, 2001; van Putten and MacMillan, 2004).

Several illustrations of the use of Real Options Valuation across different industries have been published by researchers (Panayi and Trigeorgis, 1998; Pennings & Lint, 2000; Jensen & Warren, 2002; Hartman and Hassan, 2006). Researchers have been optimistic for the adoption of real options valuation among practitioners, and described the method as "dominating" and "revolutionary" when compared to other capital budgeting methods (Coy, 1999; Copeland and Antikarov, 2001). However, contradicting the predictions of literature, practitioner surveys by Bain and Company (2001), Block (2007) and Kjærland et al. (2015), suggest that real option valuation remains the least favored technique compared to conventional valuation methods.

As real option valuation is not being employed by practitioners, it is interesting to study how practitioners value high-risk projects and why they are not utilizing real options analysis. Therefore, this paper has developed the following research question:

"Why is the adoption rate of real options valuation low among practitioners?"

This paper follows an exploratory qualitative research methodology in order to gain deeper insights into why adoption rates continue to remain low and to capture the perspective of practitioners with minimal interference from the presumptions of the authors. Case studies may shed new light on the practical challenges associated with real option valuation, bridge the gap between academia and practitioners, and support further development of operational real option valuation models. Stake (1995) recommended researchers to choose cases where they can learn the most from the phenomenon of interest. This paper studies the following companies: Otello Corporation ASA, The Pure Water Company AS, EVRY AS, and Arvato Finance AS. All of these companies are either actively involved in the development of new technology or engaged in high-risk investments. Therefore, the companies can provide interesting and diverse insights into the operational valuation of high-risk projects and perspectives on the use of real options valuation in practice.

2. Structure of the Thesis

In section 3, we will review the existing literature and argue for why a study on the adoption rate of real options valuation is important. In section 4, we will present our chosen academic framework and the methodology for the thesis. In section 5-8, we will present findings from each of the four companies. In section 9, we will discuss our findings and compare them to existing literature, and give a brief conclusion to our discussion and findings. Finally, we will discuss limitations and suggestions for future research in section 10.

3. Literature Review

This section will first provide a brief explanation of literature's most debated methods for high-risk project valuations: discounted cash flow analysis (DCF)/net present value analysis (NPV) and real option valuation (ROV). Then, we will present discussions concerning challenges for valuation of high-risk projects. Finally, we will present previous research on the adoption of real options analysis and its operational challenges.

3.1 Overview of Discounted Cash Flow method and Real Options Valuation method

3.1.1 The Discounted Cash Flow Method (Net Present Value Method)

Discounted cash flow analysis is a method used to value assets. The method discounts projected cash flows over T time periods using a risk-adjusted annual rate of return r, to arrive at a present value of an asset's cash flows. The net present value of a project can be used to evaluate the attractiveness of an investment. The NPV of a project is calculated by discounting all positive and negative cash flows associated with the analysed asset:

$$\mathrm{NPV} = \sum_{t=0}^{T} \frac{CFt}{(1+r)^T}$$

In which:
T is the total time length of the project
CF_t is the projected cash flow at period t
r is the discount factor

The principle behind NPV analysis is that a project should be adopted if it has a positive net present value, NPV > 0. An investment will have positive NPV if the present value of cash inflows exceeds the present value of cash outflows.

The internal rate of return (IRR) and payback period are some of the popular measures that are based on DCF analysis. The internal rate of return is the discount rate that brings the NPV of an investment equal to 0, while the payback period measures the time it would take before investments into an asset are paid back by asset's cash outflows. The payback period can both be calculated based on present value cash flows and non-discounted cash flows. Comparing IRR, payback period and NPV, the NPV is widely praised as the most reliable measure for asset valuation (Trigeorgis, 1996; Brealey, Myers and Allen, 2009).

In order to derive the value of an asset, the DCF method has to rely on a number of forward-looking assumptions that analysts need to consider to arrive at reliable valuations (Damodaran, 2011; Larrabee, 2012). One of these assumptions is a constant cost of capital. The discount factor remains static throughout a DCF analysis and reflects the assessment of investment risk at the time of the valuation. Hence, DCF analysis does not account for how capital risk can change over the lifetime of a project. For projects with high levels of uncertainty, risks naturally change as uncertainty resolves. The DCF model is therefore suitable for less risky projects, where capital risks remain more or less constant throughout the project (Thiele and Cetinkaya, 2014).

DCF valuation also ignores the value of managerial flexibility - managers' ability to revise actions upon the revelation of new information. Managers can scale up, scale down, delay and liquidate projects based on new information they receive during the lifetime of a project. As DCF valuation does not take into account these options, it tends to overestimate the costs of risks and underestimate the value of high-risk projects (Wang and Hwang, 2005). The discount rate in DCF analysis is based on the beta of the CAPM model. Using a market beta to calculate risks for high-risk projects has been criticized in literature, as there is often a high level of idiosyncratic risk in such projects (Steffen and Douglas, 2007). Consequently, the market beta may not fully account for project risks, thereby underestimating the cost of capital.

3.1.2 Option Theory and Real Options

3.1.2.1 Option theory

According to Berk & DeMarzo (2014), a financial option gives the owner the right, but not the obligation to purchase or sell an asset at a fixed price at some future date. There are two

distinct types of options: a call which allows owners the right to buy the assets, and a put which offers owners the right to sell an asset. Option values depend on the value of underlying assets. Examples of underlying assets for financial options include stocks, currencies, stock indices and other commodities. Financial options are usually used for risk hedging and speculation.

The two most common forms of options are American and European options. American options can be exercised any time up until maturity, while its European counterpart can only be exercised on the expiration date. Flexibility to exercise the option at any time, everything else equal, makes the American option more valuable, and generally much more difficult to analyze compared to a European option. However, the American option's time value in addition to its intrinsic value makes it less optimal to exercise American option too early, especially for non-dividends paying stocks (Hull, 2015).

There are two sides of an option contract, transacting parties can either hold a long position (buying the option) or hold a short position (selling the option). Option payoffs are determined by the contract positions and the underlying value of the option.

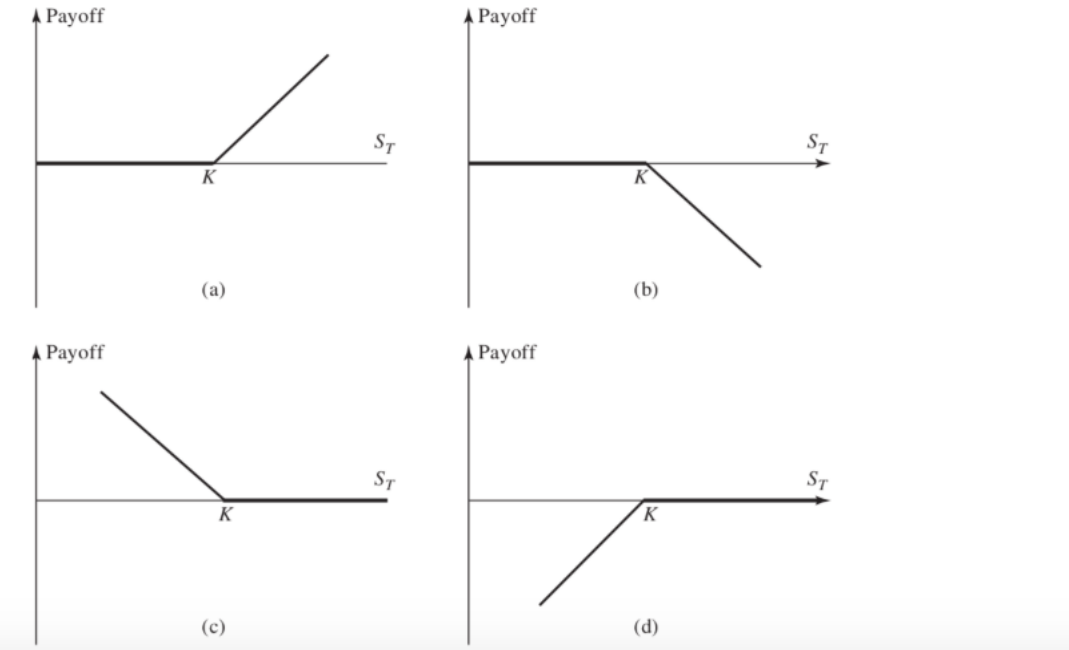

Figure 1: Payoffs from positions in European options: (a) Long call, (b) Short call, (c) Long put, (d) Short put (Hull, 2015)

The payoff from a long position in a European call option is max(ST - K, 0); the payoff from a short position in a European call option is min(K-ST, 0).

The payoff from a long position in a European put option is max(K - ST, 0); the payoff from a short position in a European put option is min(ST - K, 0).

3.1.2.2 Real Options

The term "Real options" was first introduced by Myers in 1977 and referred to the application of option pricing theory for option valuations of non-financial assets or "real" investments (Schulmerich, 2010). The key distinction between real options and financial options is that the underlying assets are not traded in financial markets (Berk and DeMarzo, 2014).

Trigeorgis (1996) provided an analogy between terminology used to describe financial options and corresponding terms used to describe real options:

Call option on stock	Real option
Current value on stock	Gross PV of expected cash flow
Exercise price	Investment cost
Time to expiration	Time opportunities last
Stock value uncertainty	Investment value uncertainty
Risk-free rate	Risk free rate

Table 1: An analogy between the financial option and real option(Trigeorgis, 1996)

Trigeorgis (1998) also offered a classification of different types of real options, namely: The option to defer, the option to abandon, the option to expand, the option to contract and the option to switch.

3.1.2.3 Real Options Valuation

An abundant number of papers have extensively illustrated the use of real options approaches for real-life practitioners. Schulmerich (2010) provided two distinguishing avenues to categorize real options valuation methods: analytical methods and numerical methods.

Analytical methods mainly consist of closed-form and approximative analytical solutions. These models seek to offer solutions to simplified problems that seldom reflect reality (Schulmerich, 2010). Trigeorgis (1996) illustrated how analytical models could value options to defer, options to switch and options to abandon. However, Schulmerich (2010) claimed that analytical approaches could not accommodate for complex real options and the interaction between multiple real options.

Numerical methods are therefore required to evaluate more complex real options. Numerical methods can be classified into two subcategories: (i) models that estimate the partial differential and (ii) models that estimate underlying stochastic processes. The first category includes numerical integrations and explicit/implicit finite difference methods. These models are more complex, more mechanical, and can be used to evaluate both American and European options. The second subcategory of numerical methods is simpler, more intuitive, and more flexible in handling stochastic processes (Trigeorgis, 1996). To estimate underlying stochastic processes, lattice models and Monte Carlo simulation are commonly employed.

In the following section, we will provide a brief overview of the most popular and fundamental models and techniques used for pricing of real options.

The Binomial Pricing Model

The Binomial Pricing model was developed by Cox, Ross, and Rubinstein in 1979. The model assumes perfectly efficient markets without arbitrage opportunities. Furthermore, the model assumes that the price of underlying assets follows a binomial distribution (Benaroch and Kauffman, 1999). The model's ability to track the value of options over time, make it useful for valuations of American options and options for dividend-paying assets.

The Black - Scholes Model

The Black-Scholes model (also known as the Black-Scholes Merton model) is a continuous-time option model which was developed by Fischer Black, Myron Scholes and Robert Merton in 1973. This is perhaps one of the world's most well-known models for option pricing (Benaroch and Kauffman, 1999). The model is used to price European options on non-dividend stocks. The model assumes that returns of underlying assets are lognormally

distributed, that a constant risk-free rate exists, that the volatility of the underlying asset is known and that the market is efficient without transaction costs.

Figure 2 represents the Black-Scholes formula to value an European call and put option:

$$c = S_0 N(d_1) - Ke^{-rT} N(d_2)$$

$$p = Ke^{-rT} N(-d_2) - S_0 N(-d_1)$$

where

$$d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = \frac{\ln(S_0/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

Figure 2: Valuation of European put and call option using the Black-Scholes model (Hull, 2015).

In which:

c: value of the call option
p: value of the put option
σ: volatility of the underlying asset
S_0: current stock price
K: Strike price of the option
r: risk-free rate
T: time to maturity
N: cumulative standard normal distribution
ln: natural logarithm

As both the binomial pricing model and the Black-Scholes model originally were developed to value financial instruments, researchers debate the legitimacy of using these models for real options valuation (Benaroch and Kauffman, 1979). According to some researchers, assumptions underlying these models need to be revised if the models are going to provide reliable valuations of real options (Angelis, 2000; Bollen, 1999; Bowman and Moscowitz, 2001).

Decision Tree Analysis

Decision tree analysis (DTA) graphically represents potential outcomes and decisions paths of projects. The quadratic nodes typically represent decision points, where decisions are made if the node is reached. Circular nodes typically represent chance points, where outcomes are assigned probabilities. In decision tree analysis, project values are calculated by summing up the expected value for all potential outcomes.

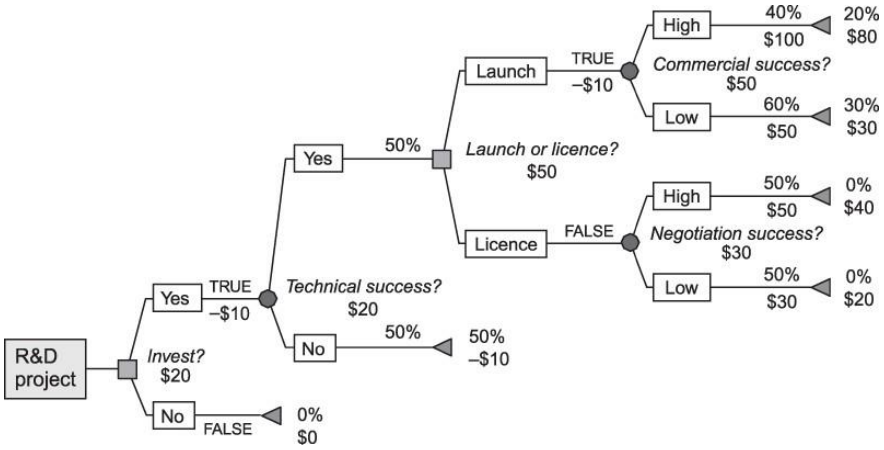

Figure 3: An example of a decision tree(Business Jargon, 2018)

Compared to the traditional DCF method, decision tree analysis allows analysts to value the results of following different decision paths (Thiele and Cetinkaya, 2014). By doing so, the model incorporates the value of managerial flexibility into the analysis. As the analysis allows for managerial flexibility, it is particularly useful for analyzing complex sequential investment decisions (Schulmerich, 2010).

However, similar to traditional DCF valuation, cash flows are discounted using a fixed cost of capital. Using a fixed cost of capital is arguably inadequate to account for the dynamic nature of risks in R&D and high-risk projects. In order to properly account for dynamic risk levels, the discount rate can be adjusted depending on the state of nature in project analysis. However, this approach appears to be hard to carry out in operational practice (Schulmerich, 2010; Thiele and Cetinkaya, 2014).

Decision tree analysis has been criticized because decision trees quickly can grow into a complex web of decision nodes and outcomes. If a project goes over a long time horizon, entail many potential outcomes and managerial decisions, the decision tree may turn into a "decision bush", which may pose significant challenges for operational analysis (Raiffa, 1968). Nevertheless, DTA is in general regarded as easy to implement and comprehend in

practice, which explains its widespread employment in valuations of R&D projects (Perlitz et al., 1999).

3.2. Valuations of R&D projects - approaches suggested in the literature

Research and Development (R&D) refers to "the work a business conducts toward the innovation, introduction, and improvement of its products and procedures" (Investopedia, 2018). Many researchers have stressed the vital role of R&D for firms' survival and growth under increasing competition from global markets (Wang and Hwang, 2005; Thamhain 2014, Lee et al. 2017). However, valuations of R&D projects are often met with substantial challenges. Valuation inputs are often uncertain and difficult to obtain at the time of a project proposal, leading to valuations that are "at best uncertain and worst very unreliable" (Wang and Hwang, 2005; Thamhain, 2014). Contributions from R&D projects are also difficult to separate from other business activities, which increases the difficulty of estimating accurate returns (Poh et al., 2001).

Researchers have long recognized similarities between R&D investments and real options. For this reason, ROV has become a dominating approach for R&D valuation literature. Myers (1984) was first to question the suitability of traditional DCF models to value high-risk projects, claiming that real option values should be included in valuations. Myers favored the real options approach for its ability to capture managerial flexibility. Valuing managerial flexibility is particularly useful when valuing technological ventures with higher elements of uncertainty (Morris et al., 1991; McGrath and MacMillan, 2000; MacMillan et al., 2006). The use of real options for project valuations has since been warmly advocated by highly regarded researchers, such as Dixit and Pindyck (1994), Trigeorgis (1996); Amram and Kulatilaka (1998), Boer (2000), Copeland and Antikarov (2003), Damodaran (2011).

To deal with the multi-phase nature of R&D projects, Panayi and Trigeorgis (1998) developed a multistage option model that involved first stage capital commitment, and option opportunities for scaling up investments later down the line. Panayi and Trigeorgis' approach gives a good reflection of real-world practices, where R&D projects are usually broken down into three stages: research, technological development, and commercialization.

Cassimon (2004) further developed the multistage option model to include investments that required multiple phases of development.

Several researchers advocated the use of the Black-Scholes and the Cox-Ross-Rubinstein models for R&D project valuation (Trigeorgis, 1996, 1998; Bowman and Moskowitz, 2001, Boer, 2000; etc.). However, researches also uncovered technical limitations in the original assumptions of these models. For example, assumptions of lognormally distributed returns and assumptions of constant volatility appear to be unrealistic in light of the volatile nature of cash flows from high-risk projects (Angelis, 2000; Bollen, 1999; Bowman and Moscowitz, 2001). Bollen (1999), Bowman and Moscowitz (2001) called for more customized approaches for valuations and strategic analysis of real options. Angelis (2000) relaxed the lognormal and non-negative return assumptions from the original Black-Scholes model and suggested using costs and revenue cash flows associated with the project to measure the value of the option, and thus should be simpler and more practitioners to apply in real life. As assumptions of constant volatility appear to be unrealistic, Culik (2015) introduced the ROV model which takes into account dynamic volatility to better reflect the dynamic risks of real-life projects.

Firm-specific risks related to R&D projects can also challenge the use of real options valuation. Theoretically, a financial option can be valued based on contingent claim analysis (Sheu and Luo, 2009). Contingent claim analysis assumes a perfect capital market and a risk-free discount rate. Through an appropriate long and short position, the stochastic components of an investment can be exactly replicated by using a riskless portfolio consisting of the risky project and other investment assets (Insley and Wirjanto, 2008). This no-arbitrage assumption avoids the necessity of calculating a risk-adjusted discount rate, and the value of the project can be determined by estimating the value of a replicating portfolio. However, the use of a risk-free rate may not properly account for risks associated with R&D projects, as most of the R&D risks are idiosyncratic. Therefore, replicating portfolio valuation may result in wrong valuations. Thus, Dixit and Pindyck (1994), Trigeorgis (1998), Bollen (1999) proposed the use of a customized discount rate for which the firms have risk-neutral attitudes towards R&D projects. Boer (2000) argued that high firm-specific risks may substantially hurt the value of the investments and advised decision makers to reduce idiosyncratic risk associated with R&D projects by diversifying investments.

3.3. Real options valuation in practice

Numerical valuations

In literature, real options valuation is considered a more accurate and effective tool for assessing high-risk projects compared to the NPV-method (Myers, 1984, Kjærland et al., 2015). Real option valuation methods have been predicted to become the normative approach for valuing projects with high levels of uncertainty (Copeland and Antikarov, 2001, cited in Kjærland et al., 2015). However, real options valuation is not broadly adopted by practitioners. In a survey of Fortune's 1000 largest companies, only 14.3 % of respondents reported using real options in their capital budgeting process (Block, 2007). Out of the respondents reporting the employment of real option valuation methods, 92% reported using either binomial lattices, risk-adjusted decision trees or Monte Carlo simulations. Only 3% reported using the Black-Scholes model. 45% of respondents utilizing real options, used it as a primary tool for capital budgeting decisions, while the rest used it as a supplemental tool or to shadow the results of more common valuation methods. In another survey of 1500 Scandinavian CFOs, only 6 % reported using real options, whilst 74 % reported using the net present value method (Kjærland et al., 2015). In contrast to Block's survey (2007), zero users reported using real options as their primary tool for capital budgeting in the Scandinavian study. The NPV-method still seems to be the normative method employed by practitioners, despite its shortcomings in valuations of risky projects.

Real option thinking

A study by Ford and Lander (2011) found that subjects understood the value of real options and how their value increase with uncertainty. The results from the study suggest that managers may incorporate real option thinking into their capital budgeting decisions. Thus, subjects of quantitative surveys may report little employment of real options methods, but at the same time incorporate intuitive valuations of real options into project assessments. However, the validity of Ford and Lander's study is limited as subjects in the study may not accurately reflect practicing risk managers. Thus, more research is needed in order to improve Ford and Lander's preliminary conclusions. Studying real options thinking is important, as a deficiency in real options thinking can be seen as a barrier to successful implementation of real options analysis.

As real options valuation methods are considered more accurate and effective in valuing risky projects, it is interesting that it is not widely adopted by practitioners. The next section will look further into why real options are not the used by managers.

3.3.1 Challenges for using real option valuation in practice

DCF is proven and sufficient

In a survey of Fortune top 1000 companies (Block, 2007), 26% of managers reported viewing DCF analysis as proven and sufficient. Thus, there was no need to engage in additional capital budgeting methods. Furthermore, if a DCF analysis concludes with a positive NPV, there is also no need to perform real options analysis as DCF valuations consistently undervalue risky projects (van Putten & Macmillan, 2004, Smith, J & Nau, R.F, 1995). Consequently, real options analysis is only useful to evaluate projects when the traditional NPV analysis is negative or slightly positive (van Putten & Macmillan, 2004). Following this reasoning, it is not surprising that managers using real options only view it as a complement to other capital budgeting tools. However, this argument does not explain why so many managers do not use real options or lack familiarity with the method.

Complexity, difficulty of use, familiarity, education

In an extensive study of 1500 Scandinavian companies, Kjærland et al. (2015) found that the main reason for not using real options was a lack of familiarity. 70% of all respondents were not familiar with the principles and techniques of real options valuation. Similarly, Baker, Singleton & Veit (2011, cited from Kjærland et al., 2015) suggested that the dominant reason for not using real options was a "lack of expertise and knowledge". Among those familiar with real options techniques, respondents reported they lacked the knowledge or competence to perform the analysis (Kjærland et al., 2015). Managers thought the method and its workings were not easily understood and were afraid of misuse. Similarly, Block (2007) found that 20% of managers viewed real options analysis as to sophisticated. Familiarity, knowledge, and competence with real option methods can increase over time, especially if educational institutions increase focus on the methods. However, not all managers have higher education. Therefore, it seems to exist a need for the development of less complex and more operational real option valuation methods.

Exaggerated valuations

Bain and Company (2000, cited in Copeland & Tufano, 2004; Teach, 2003) also found that managers were skeptical towards real options analysis because of exaggerated valuations following the dot-com bubble. Van Putten & Macmillan (2004) also reported that CFO's believed real options analysis lead to exaggerated valuations. Van Putten & Macmillan argued that this fear may be legitimate, as real options analysis tends to focus on revenue volatility instead of cost volatility. The margin on which costs are underestimated is larger than the margin on which costs are overestimated. There is no upper ceiling for underestimations of costs, so a high-cost volatility should decrease the total value of a project. Van Putten & Macmillan suggested that problems of cost volatility can be corrected by adjusting down project volatility when cost volatility exceeds revenue volatility, thereby reducing the value of real options when cost volatility is high. Furthermore, the authors argued that managers should not be too concerned with accurate project valuations, as all capital budgeting methods are flawed when valuing high-risk projects. Instead, real options can be used as an effective tool for ranking project proposals. Over time, it is more important for managers to select the best project proposals rather than having accurate valuations for those projects. Shifting focus away from accuracy can decrease fears of exaggerated valuations and reduce the competence required by managers to perform an effective analysis. However, this argument does not apply equally well to external project proposals that are transacted (bidding, licenses, M&A, partnerships etc.), as inputs are usually not fixed for such transactions.

Parameter assumptions

Real options valuation developed from financial option pricing. Applying the same assumptions to value real options may seem simplifying and risky to managers (van Putten & Macmillan, 2004). Obtaining input parameters for real option valuation can also be difficult. For real options, parameters such as volatility, time to maturity and value of the underlying assets are simply often unavailable (Block, 2007). Real options included in analysis can also be difficult to exercise in practice. From a political point of view, abandonment options may be especially challenging to exercise in an organization (Block, 2007). Even though the firm theoretically can close down or liquidate projects, it may be difficult for managers to do so in practice as they risk losing reputation by shutting down a project they initiated. Consequently, incentives of decision makers and owners may be

poorly aligned for effective real options analysis. According to Block, rewarding managers that shut down unprofitable projects can help solve this incentive problem. Real options can also be used as solid reasoning for abandonment. By pointing back to the initial real options analysis, managers can prove that they were aware of project risks.

Lack of flexibility in organizations

Managers in the public-sector have also stated that real options analysis is not applicable to their organizational structure, as decisions are made at higher political or bureaucratic levels (Kjærland et al., 2015). Consequently, some managers have little flexibility and lack the authority to exercise the options included in valuations.

3.3.2 Importance of bridging the gap between theory and practice

Ford and Lander (2011) argued that increasing the understanding of managers' perceptions of real options is critical to improving the operational use of models. Ceyland and Ford (2002) argue that research is needed to bridge the gap between current option theories and practice. Block (2007) highlights the importance of researching the practitioner's concerns regarding real option valuation. In-depth research on the practical challenges of real options valuation can increase the understanding of why real option adoption is low. New insight can be used to develop more efficient and more operational methods.

4. Methodology

4.1 Research Approach and Research Purpose

In their well-known book on research methodology, Saunders et al. (2016) described three main approaches for theory development. A deductive approach tests hypotheses and evaluate how they match up with empirical data; while an inductive approach builds a conceptual framework, draw conclusions and generalizes based on collected data.

Abductive research is considered a middle ground between the two aforementioned approaches. Abductive research gathers data to explore phenomena, themes, and patterns in order to develop a framework or a likely explanation of a phenomenon, which can ultimately be tested through additional research. Abductive research is an oscillating process, where researchers both collect data and build on existing academic literature to gain insight. The abductive approach has been praised for its usefulness for "theory development", as it enables exploration in new and innovative ways (Dubois and Gadde, 2002; Patokorpi and Ahvenainen, 2009).

This paper tries to explain why the adaption of real options valuation is low by researching three topics; how companies value high-risk projects in practice, to what extent managers incorporate real options thinking and operational perspectives on real option valuation. The research aims to develop new insights which can support bridging the gap between academia and real-world practitioners. As there is no clear-cut explanation of why adoption of real options analysis is low, an abductive approach will be appropriate to develop new hypotheses to be tested.

4.2 Research Design

According to Saunders et al. (2016), research design provides a general framework for how researchers plan to answer the research question at hand. In this section, we will discuss the purpose, method, strategy and time horizon of our research.

4.2.1 Methodological choice

The methodological approach should be influenced by the research area and purpose (Ghauri and Grønhaug, 2010). The three most common approaches are quantitative, qualitative and a mix of the two. While the quantitative method seeks to answer the questions of "how many" and "how much", qualitative research tries to clarify the "what", "why" and "how" for the topic of interest. Therefore, a quantitative approach will be the optimal choice if data is best expressed in numerical terms, and a qualitative approach works better for data that are not easily expressed in numbers. As this research aims to develop new insights for why the adoption of real options valuation is low, a qualitative methodology is arguably appropriate. A qualitative method will enable the research to capture the perspectives of practitioners with minimal interference from the presumptions of researchers.

As the research tries to develop new insights for why the adoption of real options analysis is low, it is best characterized as exploratory. Adam and Schvaneveldt (1991, cited in Saunder et al., 2016) compared an exploratory study with the activities of an explorer, meaning that the exploratory researcher tries to set the phenomenon under a new light to learn new insights, by asking "experts" open questions. Advantages of doing an exploratory study are its flexibility and adaptability. An exploratory research allows the researcher to change the direction of a study after new information is revealed (Saunders et al., 2016).

4.2.2 Research Strategy

Research strategy refers to how researchers plan to answer the research question (Saunders et al., 2016) We have chosen a multiple case study, as a multiple case study allows for an in-depth understanding of several objects, (Hodkinson and Hodkinson 2011). Case studies are also the preferred strategy when researchers try to answer "how" and "why" questions, have little control over events, and studies a phenomenon in a real-life context (Yin, 2014). Following Yin's reasoning, a case study will be suitable to answer why the adoption of real options analysis is low.

The logic of replication provides the basis for multiple case studies. The researched case object must be carefully selected so they either (1) predict similar results or (2) predict contradictory results with anticipatable reasons (Yin, 2014). The authors of this paper identified companies that engage in R&D and high-risk projects as suitable case objectives.

The authors also made an effort to contact companies of different sizes with various product and service offerings to provide a more diverse perspective. In the end, four companies agreed to participate in the study: EVRY, Otello, Arvato and The Pure Water Company. These companies differ in term of size and operating sector. Furthermore, all researched companies engage in R&D or high risks projects.

4.2.3 Time Horizon

The data for our study will be collected over a few weeks. Interviews are done in a cross-sectional manner (Saunders et al., 2016). Even though it would be interesting to observe the evolution of operational valuation methods and real options perspectives in response to market changes, the time constraint of this master thesis makes a longitudinal study infeasible.

4.3 Data Collection

Data is categorized into primary data and secondary data (Saunders et al., 2016). Primary data is the new data collected for the research, while secondary data is data originally collected for other purposes, but can be reused to support new research (Hox and Boeije, 2005). In this section, we will provide a brief explanation of our primary and secondary data sources.

4.3.1 Primary Data: In-depth semi-structured interviews

In-depth semi-structured interviews are chosen to be the primary tool for data collection in our study. According to Saunders et al. (2016), semi-structured interviews allow researchers to have a list of themes and questions to be asked during interviews, but the order and content of the list may vary for each interview. The interviewer can choose to omit or add more questions depending on the situation, or even diverge from the list to ask follow-up questions. Semi-structured interviews enable researchers to study the topic of interest while exploring new aspects of the studied phenomenon.

Preparation for the interviews

We created a semi-structured interview guideline to avoid diverging too far off topic during interviews. A semi-structured interview guideline also allowed us to probe further into specific themes later on. The interview guideline consisted of open questions to avoid leading questions. We informed interviewees about the general topic of interviews, without revealing the scope of the thesis in order to keep interviewees open and unbiased. Interviewees were also informed about the approximate interview length. Time, location and mode of communication for interviews were flexible to accommodate the busy schedules of interviewees.

Execution of interviews

We have interviewed top executives, decision-makers or analysts involved in the valuation and evaluation of projects. We emphasized the importance of individuals with the authority to decide on projects, in order to research which factors that matter for a final call on a project. To obtain a broad set of perspectives, our sample consisted of interviewees with different educational backgrounds and job positions. Interviewees were chosen based on positions and referrals from other interviewees. Interviews took from 40-75 minutes and were held until saturation was achieved (Saunders et al., 2016). The majority of interviews were face-to-face, however, two interviews were conducted through Skype due to geographical differences. Interviewers were open-minded, avoided leading questions and allowed interviewees to elaborate on what they found to be relevant and important.

4.3.2. Secondary data

In addition to the primary data from the interviews, we also collected secondary data from company presentations, website, financial reports, and newspapers. These documents provided us with an overview of the company and acted as useful guidance for interview preparations. The secondary data also helped us to avoid general and basic questions during interviews, thereby, allowing us to use interviews efficiently to dig deeper into topics of interest. Understanding the researched organization prior to interviews, also diminished the likelihood of misinterpreting interviewees.

4.4 Data Analysis

Data preparation

Interviews were attended by both authors and were recorded to avoid memory bias. Recordings allowed interviewers to focus more on the subject at hand, instead of taking notes. Two recording devices prevented low-quality recordings and reduced the chance of potential technical problems. Recordings were transcribed right after the interviews, followed by peer comparisons and cross-checking to ensure that both researchers shared a similar understanding of interviews.

Data Analysis

For data analysis, we adopted Eisenhardt's suggested method (1989). First, notes and transcriptions were sorted. Next, we looked for the similarities and assigned categories, or "codes" from all the emerging patterns. The broad categories were later reassembled into different grouping based on overall themes to appropriately present accumulated data. The aggregated themes from groupings are "Organization and flow of projects", "Valuation", "Evaluation", "Real options thinking" and "Perspectives on real options valuation".

After sorting the data, first- and second order analysis was performed. Collected data has been reported following a thematic structure. The authors have tried to honestly reflect the perspectives and words of interviewees. For the second-order analysis, we have provided in-depth discussions regarding the most prominent findings and patterns across all study objects.

4.5 Research Quality

Reliability and validity are used as measurements of research quality. Reliability measures the consistency of findings; to what extent similar findings will reappear if the study is repeated. Validity measures to what extent findings correspond to the real world (Yin, 2014; Saunders et al., 2016).

Some researchers claim that the results of in-depth, semi-structured interviews are not intended to be repeatable, as they only reflect findings at a specific time (Johannessen et al.,

2011; Saunders et al., 2016). Our study is not repeatable, as it is cross-sectional in nature and only reports findings at a certain point in time. If the study is repeated in the future, the findings may not be the same, as the organizational structures and business environments of the studied companies continually change. A changing environment would also likely affect the answers of interviewees, which again could result in different conclusions, especially considering the use of semi-structured interviews. Furthermore, our interpretations of findings are influenced by our own knowledge and background. Therefore, other researchers may interpret findings differently, and come up with dissimilar conclusions even if they were presented with the same data set. However, it is still possible that a similar study on the same or new companies would yield similar conclusions. Nevertheless, the study is likely unreliable. Still, the research may provide value because of its explorative design which is appropriate to develop new insights which can be used for future research.

Yin (2014) classified validity into three concepts; construct validity, internal validity, and external validity. Construct validity measures to what extent the research measures the phenomenon of interest. In order to assure construct validity, questions were formulated to cover topics of interest, interviewees were informed in details about the thesis' purpose prior to closing questions, and feedback on the research was continually received from our supervisor. External validity measures to what extent study findings can be generalized to other situations. Our study lacks external validity due to its small sample size. To improve external validity, the authors have studied multiple cases. Although similar trends can be observed in all of the cases, large-scale quantitative studies would have to be performed in order to draw any external valid conclusions. This section will not elaborate further on internal validity, as it is inapplicable in an exploratory study (Yin, 2014).

4.6 Ethical Considerations

Research ethics refer to "the standards of behavior that guide your conduct in relation to the rights of those who become the subject of your work or are affected by it" (Saunders et al., 2016). We tried to behave ethically at all the stages in the research process. All interviewees were asked for their consent to voluntarily participate in the study. Participants were also briefly explained the general topic of the thesis prior to the interview, enabling them to take an informed decision whether they wanted to contribute to the researched topic. All interviewees were also explicitly asked for permission for interviews to be recorded.

Personal data and information have been anonymized, and all collected data will be deleted after the completion of the project. From our perspective, it is of great importance to report collected data with the utmost objectivity and integrity. Thus, we strive to not influence findings with personal bias. The paper also strives to correctly reference all sources and report study limitations in an honest manner.

Findings

Findings from each interviewed company will be presented on a case-by-case basis. Company reports include company introductions, valuation methods, evaluation criteria, real options thinking and perspectives on real options valuation. EVRY's perspective on real options valuation is not included, as we ran out of time before we could ask for the interviewee's perspective on real options valuation.

5. Otello Corporation ASA

5.1 Introduction of Otello Corporation

Otello Corporation ASA (formerly known as Opera Software ASA) is a Norwegian holding company that is involved with mobile advertising, apps and games. Otello has an annual revenue of $419 million and primarily operates in America, Europe, Middle East and Africa (EMEA), and the Asia Pacific regions (Otello, 2017). Its market cap is approximately $3.3 billion and the company is currently traded at Oslo Stock Market (Bloomberg, 2018).

Otello was founded in 1995 as a browser company under the name of Opera. From 1995, the company has developed in other industries, such as advertising and mobile apps, as a result of product development and acquisitions. The name changed at the end of 2017, following a divestment of its browser business. Nowadays, Otello operates through three subsidiaries: AdColony, which provides mobile advertising solutions; Bemobi, which offers subscription services for mobile games and applications; and Skyfire, which offers video compression services to telecommunication companies for faster video streaming. AdColony and Bemobi are currently the main sources of revenue for Otello and generated more than 99% of the revenue last year (Otello, 2017).

Otello faces fierce competition and has to rely on technology development in order to survive. In 2017, Otello's most valuable subsidiary, Adcolony, experienced a decline in revenues as competitors developed competitive technology:

"..We became a high-end premium in-app partner for game developers and also for companies who want to spend money advertising with us. We were very successful and but then there were a lot of companies inside the market... They (small tech companies) copied a bit of our technology and they are better at machine learning."

"..We have a lot of data, but one thing is to have data and the other thing is to deal with it in a smart way. These small tech companies went to our customers and said: Listen, we can help monetize your app better as we are better at predicting which app your customers will respond better to using advanced machine learning algorithms"

"..The market has become denser, (which) creates high-pressure margin, but it doesn't mean you can't make good money there. We, of course, have to try to catch up now...We have really been focusing on turning around (at AdColony) for the last twelve months... It's time to start growing and winning back the market.

Otello Corp acknowledges the paramount importance of developing unique and relevant products to make the company stand out in the market. In order to achieve that, the company emphasizes the importance of having an innovative company culture. Therefore, Otello is constantly engaged in high-risk projects in order to keep a competitive edge. Research and development are viewed as a fundamental factor for the company's survival and growth.

We have interviewed 4 top executives at Otello in order to study how the company value and evaluate projects, to what extent the company incorporates real options thinking, and how the company perceives real options valuation.

5.2 R&D projects at Otello

"..We did everything: we did M&As, we also evaluate if we could make it ourselves, and this "make or buy" thinking is very common with technology companies."

Otello's R&D projects arise internally or externally. The company can choose to develop a competitive edge based on internal ideas and resources. The company tried to provoke thoughtful ideas and creativity from its employees to foster its innovation culture:

> *"..When it comes to internal ideas, we had different methods here. We even had a period of time when we really want us to be creative, so we actually allowed people to spend 20% of their time just working on new ideas. We had committee they could go to evaluate the ideas and if it could be qualified as a project, they would get resources. Now we have changed that but there is still the opportunity to come up with ideas."*

Internal ideas could be a new product or technology, or simply an improvement to current technologies. Internal projects were aimed to improve Otello's competitive edge:

> *".. We allowed people to basically think outside the box and come across with an idea really relevant for the business. It could be a completely new product, or it could figure that could fit into what we are currently doing and then we would have this committee who evaluate these ideas.."*

The most common types of external projects at Otello are M&A and joint partnerships. Otello can choose to purchase a company which has already developed a technology of interest. Alternatively, the company can offer a partnership which may benefit the target through support with technological development, distribution and sales thanks to Otello's large customer base and global network. Throughout Otello's history, there has been a vast number of M&A deals. One of the reasons behind a large number of deals has been that the executive board place immense emphasis on the "time to market" factor, how long it takes for the technology to go from the lab to mass commercialization. In many cases, Otello chose to acquire an existing technology instead of building one from the scratch in order to swiftly adapt to market demands. New projects most often arise in one of the following ways; either engineers in the company actively search for existing solutions in the market, or the company receives incoming requests from small tech companies that want to offer Otello a new technology.

> *"..We have a lot of engineers working on different technologies. They also have time to think about new ideas. Sometimes they came across new technology in the market that could be valuable for monetization."*

"..We looked for smaller companies which were very promising and we could help them with distribution and sales"

"..There is also a source of incoming ideas when startup companies came to us and said this (technology) would work well with our core business."

The ultimate goal of technological development is to leverage the company's core competencies.

5.3 Otello's valuation and evaluation process

In this section, we will present both Otello values and evaluates projects. All of our interviewees emphasized that Otello does not rely purely on quantitative measures when selecting new project proposals. Although financial measures are important, other criteria are more dominant in the project assessments. All new projects should support the strategy that has been set by the board and the management team, bring synergies to the business, meet a demand, and finally offer vigorous financial value. As such, the quantitative measurement is closely intertwined with non-quantitative assessments. By presenting Otello's valuation and evaluation approach as a whole, we aim to bring a complete picture of how the company value and evaluates projects.

5.3.1 Evaluation of external projects in Otello

External projects are valued and evaluated differently from internal projects, as external projects usually require some sort of upfront investment and is not an integral part of the company's daily activities. Due to the complex nature of undertaking these projects, external projects need to be evaluated both on qualitative and quantitative criteria. Furthermore, interviewees repeatedly stated that financial valuations only "comes at the very end of the process". More formal screening is first carried out to see whether targets comply with Otello's strategy and corporate culture, offer synergies, are feasible and are motivated to succeed.

> *"So typically what you do, is you do a screening. You have a ton of limitations. For us, obviously the size of acquisitions you can do from a monetary perspective. That's a limiting factor. Also, the size itself is. Even if we had the money, how big of an organization could we merge into our business?"*

> *"2-3 of them are too big or too small. 2-3 of them have crazy expectations. 2-3 of them don't want to sell. It narrows the scope of opportunities quite a bit. You end up with the financials pretty late."*

The evaluation process at Otello went as follows: First, Otello's M&A team perform due diligence on the external project. If the target company is deemed as a quality company and a profitable investment, the proposal is passed up to the top level.

> *"They (the M&A team red anm.) will come to me every month, present the deals they are working on, which ones we are getting closer to, something I should decide on."*

Top level management then evaluates the company based on four criteria ranked after the order of importance: 1. Synergies, 2. Demand for the company's services, 3. Management, 4. Financials. Following these criteria, the company is willing to reject proposals that do not fit into their current ecosystem of companies, even if the target is deemed as a financially profitable investment.

> *"As a company, you cannot just buy a company just because it's cheap, it has to fit with what we do, with the mandate from the board and the mandate we have from our shareholders."*

> *"So even though people come with a business case or something which is a good business, but nothing we can integrate into our business. Then I was not interested. This is because the strategy is to increase revenue and profits by integrating the services. So, if it was a good business, but not relevant for what we do, then I was not interested."*

According to Otello's executive board, the prospects of synergies and a capability to successfully implementing the acquired technology are important:

"The financials for us will come in pretty late because when we want to acquire someone, we are not only motivated by money. Especially for the companies we want to acquire and they notice that we typically do earnout. The company we acquired, they have to believe that they can be successful under our umbrella because if they do not believe we can help them, they will not go for the earnout."

"It was not only about the price we offer, it's a lot about selling what we can do for them, what we can help them achieve otherwise they cannot achieve on their own. We had actually a situation when we were able to acquire a company even though we paid less than the competitors. They got higher offers, but they would rather work with us because they saw that it's better for themselves and for the employees.

"The things that you can be flexible with are financials. You arrive at a different estimation if you set a very low discount rate or change terminal growth. When you do a discussion about the strategic fit, the firm culture, the people, etc., the difference is that these things are pretty much set. You want to deal with all the things you cannot change first before you go to the things that you can change."

5.3.2 Valuation of external projects

Even though the financials arrive pretty late, this does not mean that the company does not put emphasis on the pricing and the financial valuation of external projects. A potential investment must both be seen as a profitable investment in order to go through.

"So we were very like focused on like hey, you only take businesses that are going to drive profit. So we were brutal about it. It was always a profitable outcome we paid for. We never paid for like, zero profit revenue."

For external projects, mainly M&A deals, Otello relies on a market-based approach. The firm compares the prices of the assets available on the market using multiples. Otello takes into consideration the most common profit multiples such as sales/EBITDA, enterprise value to EBITDA (EV/EBITDA), and Price-to-earning(P/E). The company only considered buying companies were multiples were at a discount compared to Otello's own market multiples. By

using multiples to compare peers companies across the industry, the firm seeks to identify potential acquisition targets. In comparison to the DCF approach, the relative approach is fairly easy to conduct and require less data input. It also provides a fair value of how much the companies worth in the market compared to the DCF's intrinsic approach.

> *"It (profit) was fundamental. All the multiples we did was on profit."*

> *"We have access to transaction market and we know how much companies are going to pay. We looked at the market price and we discounted it. Especially in a trading market, you pay with lower multiples that the multiples from the public trading market. Of course, it's not always the case because sometimes people will pay higher multiples due to synergies, but we are very disciplined about how we price deals. The most important thing is that you never pay a higher multiple than we traded at. You always want to pay less than what you traded so that if you buy for 5 times profit, you traded 10 times the profit."*

> *"My experience is that DCF always gives too high valuations, so we relied more on multiples. The problem is the WACC - your cost of capital is too low, it does not take into account properly the risks"*

> *"From an academic standpoint, the WACC is typically derived from the market beta, and the market beta does not fully reflect the risks of these small companies".*

In order to further boost the objectivity and reliability of the valuation, Otello recruits an investment bank to perform an independent valuation of the acquired firms. Together, the results are presented to the board to justify the financial value of the target. The Otello board employ a fairly standard approach to valuation. The approach was reflected in the words of a top-level manager.

> *"For us it is quite simple, if it (the target company) is cheaper than us and we can keep the synergies on top, then the deal makes sense"*

5.3.3 Internal projects - Evaluation and valuation

For Otello, it is difficult to measure and estimate the returns of internal projects as different departments in the company all contribute to company returns. Impacts of new technology on performance is also very uncertain, which makes it difficult to estimate future cash flows following a product development. Thus, accurate valuation is often infeasible for singular R&D projects.

> *"If you switch up something and you ask which of these things brought up sales by 10%, it is hard to calculate. Even after its done, well, did we get the return we expected?"*

Instead, the company uses an internal ranking system which ranks development projects based on four criteria: expected return (both economic and other non-economic goals), feasibility, timeline and resources needed to develop the project. All projects are rated as either high/medium/low for all of these four criteria. In the final ranking of internal projects, the management team makes an intuitive judgment based on how the potential projects scored for each criterion. As an example, a project has scored perfectly if it has a high expected return, a high feasibility, a short timeline, and needs little resources to be developed.

The scorings of projects change over time as uncertainty resolves. Rankings are continually adjusted to reflect new scores as new information flows in. Highly ranked projects get priority on company resources.

> *"The way we try to do metrics of it: If we do this successfully, how much will it impact revenue? We view this as high, medium, or low. And doing this, how easy it is to do? High, medium or low? And how many resources will it require? And also, how much time will it take?"*

> *"You never are going to find a lot of similar terminology for different projects, so you basically have to put it up like that. And then what you need to put kind of all your projects in like this, and then you start putting out a number to each of them, and based on that, you create a ranking."*

> *"Very often the ranking changes, especially when more reliable figures and data about returns, prospects, and resources arrive.."*

The company prefers having solid data to measure economic returns. This allows the board to make better informed economic decisions. However, as it is seen as difficult and sometimes impossible to estimate the impact on cash flows.

> *"We quantify it, but we are not able to get down to a dollar number. It ends up with: we believe this will put us in a better position, we believe this will make us 10% faster. But then, what is 10% faster compared to a million dollars? Very often we go with the hard number, because that is something we can quantify."*

Consequently, it is more important to rank internal projects and allocate resources to the most pressing ones. In the short-run, the company has fixed inputs of employees and the employees have to do something when they are at work. If the company does nothing, it gets nothing in return. Thus, it is more important to prioritize rather than value.

> *"We have to base it more on internal ranking, as opposed to objective valuation, because. Let's say we have 10 product managers, with 20 potential different projects. Maybe project number 9 or 10 is not even profitable. But by doing nothing, you get zero out, and you still are going to have the costs. We have a finite amount of resources, so how do we get the most out of our resources?"*

However, the executive explains that some development projects are possible to value. An example is a project in which a customer has threatened to end his business with Otello if a technology development is not carried out. In such scenarios, the company can estimate how much revenue is depending on the technology development. In such a scenario, the company will categorize the expected dollar return on the project as either high, medium or low, and rate the project on the three other internal ranking criteria: feasibility, timeline, and resources.

5.4 Real options thinking in Otello

Although Otello does not use any real options models for valuation, the company exhibits real options thinking. According to Ford and Lander (2011), real options thinking is defined as understanding the drivers behind the value of real options. The value of real options increases with uncertainty. Otello exhibits real options thinking because it pays for flexibility by using earnouts and pre-tests.

Earnouts

Otello incorporates real options thinking by paying to reduce uncertainty and to increase flexibility. They do so, by acquiring firms using earn-outs. An earnout is a contract where the seller has the opportunity to be awarded additional compensation given that the asset he sells performs according to agreed KPIs (Investopedia, 2018)

> *"Earn-out can be a very elegant way of buying a company without using too much cash".*
>
> *"We typically paid from one-third to two-thirds upfront and the rest was earnout, and we tended to do the earnout over two to four years."*
>
> *"For example, if you are unsure whether this is a good investment and you do not want to pay $100. Let's say I will offer you $30 but you can get up to $150 instead of $100 if you deliver these KPIs. If he actually delivers these results, it would be so much better for our valuation so we can easily pay him. If it does not work out, we do not pay him $100, we only pay him $20. It's safer and more pragmatic."*

By using earnouts, Otello can acquire firms and technology for a lower initial investment, but at the expense of paying more once uncertainty is resolved. This serves two purposes:

1. Flexibility: Increases investment opportunities today, as the company has more cash available for additional investments.

2. Reduced risk: The company reduces the risk associated with projects. A lower project risk reduces the discount rate, which in turn increases project NPV.

Nevertheless, the company perceives certain aspects of earnouts as negative. These concerns include expensive negotiations, higher risk of disputes, less control from the acquirer's side, and incentive problems after an earnout is completed. However, the executive manager believes the benefits from this type of guerilla acquisition justify the risks. With experience, Otello has developed M&A competencies and found the right balance to resolve earnout problems. The company's competencies have been profoundly proved by its 17 successful acquisitions using earnouts.

> *"It's very important that we set up the earn-out in a way that the entrepreneurs actually run the business independently. Earn-out only works if there is an element of independence. You need to make the entrepreneurs feel they have the control over the results."*

> *"We as a buyer has a certain control as well, there are some certain things we don't want them to do as it may hurt the business. There is always complicated negotiation process but we are highly successful in the acquisition side"*

> *"A lot of businesses are the mobile businesses, and for any tech companies, or mostly, what you buy is that you buy people and you gotta keep them. Of course, there is the risk that when the earnout is over, the founders want to be independent and walk away. But at least this earn-out structure kept them for at least 2-3 years and it gave you time to get the business integrated to your core business, and gave you time for the transition and plan for the exit"*

Milestones for internal projects

When internal ideas are approved as a project, project managers will receive resources for further development. However, projects need to reach milestones in order to receive additional funding. Each milestone has certain KPIs that the project manager needs to deliver on and based on how well these criteria are met, an evaluation committee can decide if they will expand, contract, defer or abandon a project. The existence of a milestone system is crucial to risk management and allows the management team to make informed decisions about the project as time progresses and uncertainty resolves.

"There is the committee, with different sorts of people to evaluate new ideas, and if an idea is qualified as a project, the person would get resources and become a project manager. He/she has to agree on the research milestones, and if the person passes the research milestones, you would get more and more funding until it becomes a real product."

Test and Rollout

In the past, Otello used to launch new product and services to its whole network in just a day. This "all-or-nothing" approach proposed major challenges for the monitoring of new product returns.

"You release a new product all over the network in one day, but every single day is different. If the revenue increases by 2%, we are not sure if it is because of the rollout, or if we do nothing, we will get a return of 5%?"

In order to increase monitoring of returns and managerial flexibility, Otello has implemented a "Test and Rollout" approach.

"But now we do a test and rollout. You roll out 5% first and you kept 95% as a test. You incrementally increase the rollout ratio and then watch how these two numbers affect the returns."

By incrementally launching new products on the network, Otello is able to estimate more precisely the impact of new products revenue and performance. As the impact of new technology can be measured, it allows Otello to make informed decisions whether to continue the product launch and whether to invest more in the technology.

5.5 Perspectives on real options valuation

Most of the interviewees expressed a positive attitude towards the existence of real options valuation but doubted whether it would benefit the company and whether it was possible to implement in Otello. One interviewee argued that earnouts reduced the need for real options analysis for external projects.

> *"I can see how that (ROV) can be a good way to look at stuff when you have to pay all the money upfront. But again, we reduce uncertainty by paying based on performance. It's like we pay as we go so we don't have to worry about different scenarios.*

Real options valuation was also criticized for being speculative. Assigning probabilities to scenario analysis or estimating option volatility was viewed as guesswork. Multiples were also argued to be more reliable as they are objectively measured and can be compared to actual market prices.

> *"You can use multiples to figure out how much companies are going to pay for a business. That's really ultimately what they are worth."*

It was also pointed out, that real options valuation is useless when project returns are hard to quantify. As some projects could not be quantified, the demand for real options valuation was reduced. Some real options were also perceived as being hard to carry out in practice. One interviewee explained that it would be hard to abandon a failed R&D project, as a failed R&D project cannot be sold.

> *"It is hard to implement this approach for internal projects that have no value for a third-party."*

> *"If it works, we're going to do more of it. If it doesn't work, we're going to stop it. But if it doesn't work, we can't really sell it to anyone."*

Interviewees also stated that it would require a highly complex real options model to account for all the complexities of R&D in the company. Risks, inputs and potential scenarios would be difficult to estimate. As an example, it was mentioned that problems of measuring returns made it difficult to estimate how much the company would be willing to invest in expansion options.

> *"It would be hard for us to estimate how much more we could invest in expansions, as it is hard for us to measure the contributions of singular projects."*

Furthermore, interviewees stated that Otello did not have the resources to support such models. Interviewees also stated that the company lacked in-house capabilities to perform the real options valuation. Given the company's current resources and needs, the management team believed the models they used were sufficient for decision making, which reduced the need for real options analysis.

6. The Pure Water Company

6.1 Introduction to The Pure Water Company

The Pure Water Company is a provider of filtered water solutions targeting businesses, hotels, and restaurants. The company installs filter systems, tubes, C02 containers, and water coolers in the buildings of their customers. Customers can then tap chilled and filtered water (sparkling and non-sparkling) from tapping points spread across the building in exchange for a monthly subscription fee.

The company's vision is to bring a pure future that contributes to a more sustainable planet. The Pure Water Company prides itself in being an environmentally friendly business by reducing the demand for transported (bottled) water. Less transported water reduces plastic waste and carbon emissions.

The Pure Water company has two main project categories: core-business projects and product development projects. Their core-business is defined as selling, installing and maintaining filtered water systems. Product development projects are defined as all projects aimed to improve products, services, and solutions. The company is currently operating in Norway, the UK, and Sweden.

6.2 The Pure Water Company's valuation process

6.2.1 Valuation of core-business projects

The Pure Water Company evaluates both core-business and product development projects. The company relies on historical data to estimate costs for core-business investments. Based on the cost estimations, the company sets a subscription price for their service which satisfies a payback period of 15 months (not discounted) for the initial investment and service costs.

All indirect costs are not incorporated into cost estimations, because they are hard to assign to each project. Instead, the company has over time experienced that a 15 month payback

period is profitable, results in acceptable prices for customers, and sufficiently accounts for capital risks and project costs. Secondly, the company has many small investments in its core business. Using a simple measure like the payback period is a quick and intuitive way to implement financial analysis for employees without financial backgrounds. The payback method has for these reasons been mandated by shareholders.

> *"If we cannot pay back the original investments within 15 months, it is not beneficial for them (the shareholders) over time to invest in the company."*

> *"The 1.3 years payback period makes us a more interesting company to invest in, and overall increases the value of the company. You need to be attractive to your investors. If not, you won't have the money to fund new opportunities like this".*

By employing the payback period, the company does not directly value projects but uses the payback period as a yardstick to select and price projects.

6.2.2 Valuation of R&D projects

Product development projects are viewed as less secure and associated with more risk in the company. As product development projects are not part of Pure's core business, projects are screened prior to financial analysis. Projects that do not fit the company's story of being environmentally friendly and clean, are rejected. Hence, qualitative criteria are prioritized over quantitative criteria.

> *"I can be presented to product development proposals I immediately reject prior to any financial analysis because they do not fit our story."*

> *"The most important thing we do when we set up new investments, is that it is linked to our vision and strategy."*

If the project fits the story of the company, the project is subject to further financial analysis. The company estimates how much customers' willingness to pay will increase following a successful product development. Similar to the valuation of core business projects, the main criteria for approval is a requirement of a 15 month payback period of the initial investment. In contrast to core business projects, the company may still consider product development

projects exceeding a 15 months payback period if the R&D project can lead to potential new business opportunities.

6.3 Real options thinking in The Pure Water Company

Options to expand

The company has incorporated options to expand into the analysis of its latest two product development projects. Although not quantitatively analyzed, options to expand were instrumental for investment decisions in both projects.

For the first project, the initial quantitative analysis only considered sales in their current customer segment. The result of the analysis was below their 15 months payback requirement. However, a successful product development would open up for an opportunity to expand into the retail market, which the company viewed as a very attractive investment. Hence, the company decided to invest in the project.

For the second project, the initial financial analysis considered increases in sales to their current customer segment and cost savings through lower maintenance and service costs following the product development. The analysis concluded that the initial investment would be paid back within their 15 months requirement. However, a potential option to expand the project further increased confidence in the project. Contingent on a successful product development, the company could invest in the development of a product extension in the form of a digital platform, which would increase exposure to new customer segments. The option to expand was not analyzed financially but were intuitively regarded as a highly profitable opportunity by the executives of the company.

The company also believed that successful product developments lead to more core business investment opportunities through a stronger brand, word of mouth, sales and better customer experiences. Although these effects are not included in valuations, they may push a slightly non-go project (payback period exceeding 15 months) over to an approved project. Thus, expansion options are intuitively included into valuations of a project. When questioned why these investment opportunities are not quantitatively included in valuations, the interviewee explained that they were hard to quantize. However, the interviewee felt certain they were existent, as long as the product development was in alignment with the company's story.

Options to abandon

When Pure Water invests in new product development, they first invest in what they call a pre-project. In the pre-project, Pure Water pay a potential contractor for an experimentation period to resolve initial uncertainty. The contractor then estimates costs, feasibility and the timeline of the project. By doing the pre-project, the company reduces investments until uncertainty resolves and increases its chances to negotiate a fixed price for the product development. If cost estimations after a pre-project are high, the company can abandon the project with a small loss or contact another contractor. Thus, the company is willing to pay to lower costs of abandonment. Hence, the company pays for flexibility and exhibits real options thinking.

> *"It can happen that we choose to abandon a project after a pre-project. After the pre-project, it will also be easier to negotiate for a fixed price. To go ahead with a large project without a pre-project is too risky."*

> *"A pre-project can also lead to us switching suppliers."*

6.4 Perspectives on real options analysis

When questioned about the suitability of implementing real options analysis to value projects, the managers of the company highlighted that complicated financial analysis takes the focus away from business tasks and strategic project criteria. Keeping financial analysis simple was therefore viewed as more effective. Qualitative investment criteria were also perceived as more important than financial, which reduces the need for sophisticated financial analysis. Financial analysis was still viewed as important, however, after a reasonable analysis had been done, further analysis was perceived as redundant and could lead to over analysis and inaction. One interviewee was also skeptical towards assigning subjective probabilities to real options decision trees. Estimating probabilities of outcomes was viewed as giving a false sense of security.

> *"Real options analysis would not offer us much more. Assigning probabilities to different outcomes feels speculative. I view it as difficult to assign 40% or 80% probability to a certain outcome. If these probabilities are important for the outcome of the valuation, I find it hard to see how this model would offer us any value. It is important to be thorough with your analysis, but it is still important to rely on intuition and your belief in the project."*

The interviewee also preferred to make estimates based on the best guess outcome instead of dividing up the future into multiple scenarios. Another interviewee was positive to real options analysis. Nevertheless, both interviewees stated that they lacked the competence to perform such analysis. Consequently, the positive effects of real options valuation were offset by the costs of hiring in necessary competence.

> *"Whatever risk we could reduce by having a better model would be beneficial. However, competence would be required in order to perform this analysis, and bringing in necessary competence, for instance through a consultant, would increase costs. For our projects, I don't think they are large enough to justify these increases costs."*

7. Arvato

7.1 Introduction to Arvato

Arvato is a subsidiary of the Bertelsmann SE & Co conglomerate and offers clients order-to-cash services. Arvato aids clients that sell consumer goods by providing non-cash payment solutions. Payment solutions vary from credit, to invoice to partial-payment services. From their order-to-cash business, Arvato has evolved into debt collection and the industry of non-performing loans (NPLs). In the NPL industry, companies' sell of debt assets to creditors, usually through an auction. Participants in auctions buy debt claims in an attempt to collect as much as possible of the face value, accumulated interests, and service fees in order to make a profit. We have interviewed a business analyst in Arvato responsible for valuing, analyzing and bidding on high-risk portfolios of non-performing loans in Arvato's Nordic division.

7.2 How Arvato values projects

The first part of the valuation process is forecasting a NPL portfolio's cash flow. Forecasts are based on historical data and vary with parameters such as debt category (e.g. consumer goods, financial services), face value, time past maturity and borrower demographics. The cash flow predictions become more accurate if the company has more data on similar debt portfolios.

> *"You use historical data to predict cash flows. You see how different categories of debt perform as a share of the face value, how performance varies with time past maturity and borrower demographics. You try to compare an apple with an apple."*

After an initial cash flow analysis, Arvato measures projects based on several key performance indicators (KPIs). The company simulates IRR, return on invested capital, money multiplier (total CF/price) and gross payback time. However, the most important measure Arvato uses for portfolio valuation is economic value added (EVA). In Arvato's EVA calculation, the company uses a fixed cost of capital to value projects. The cost of

capital is meant to reflect business risk and opportunity costs for what the company could earn in its other businesses. The final valuation of a NPL-portfolio is equal to the maximum investment needed for a valuation analysis to result in zero economic value. A project has zero economic value added when summarized cash flows and costs of capital for all periods equal zero.

> *"How much is our maximum price? Then, you just use excel solver to adjust the initial investment to the point where the EVA is equal to zero. But this is the maximum price, which is at a level where we don't want it to be."*

When the project valuation and analysis is finished, a valuation report is passed on to a credit committee who has the final call on the maximum bid. The credit committee adjusts proposed maximum bids up or down based on strategic criteria which will be discussed in the next section.

7.3 Real options thinking in Arvato

The maximum willingness to pay for a NPL-portfolio can be adjusted upwards because of a portfolio's strategic value. The strategic value can be in the form of added experience into a new debt segment or strengthened customer relations to sellers of NPL-portfolios. If Arvato lacks experience in a debt segment, collecting data from that segment will be valuable as it can be used to value future NPL-portfolios in the same segment. Thus, buying a portfolio in a new segment opens up for new business opportunities. To acquire such options, Arvato is willing to pay a price that is higher than the valuation of a NPL-portfolio.

> *"If we don't win, we don't get the data. If we win, we get the data and our database becomes more valuable. This is very often the argument for strategic pricing. If we are considering a segment we are not currently in, we're willing to give more."*

7.4 Perspectives on real options valuation

When Arvato has successfully invested in and acquired NPL-portfolios, the company can incorporate flexibility into projects by decreasing or increasing operating costs for debt

collection, abandon claims on debt to reduce government fees, and sell of debt assets. However, operating costs are adjusted independently from the team analyzing and investing in NPL-portfolios. Hence, the analysts do not have as much insight into what factors that affect adjustments of operating costs, nor do the analysts have the authority to affect these decisions. As a consequence of organizational structure, the interviewee states that it would be difficult to account for cost adjustment options reliably in investment analysis. Reducing government fees by abandoning claims on debt would also have little effect on total operating costs. Therefore, including such options would offer little extra value in valuations. Finally, Arvato never sell NPL-portfolios although it theoretically could. This is because selling debt assets to competitors would not make strategic sense. Thus, it should not be included in valuations as an abandonment option, as the company never exercises abandonment options in practice.

> *"The operation department continually adjust costs to maximize earnings. However, their decisions are not on a portfolio-level. Instead, they consider the total workload for all debt assets across portfolios."*

The interviewee also emphasized that time is a valuable resource at work. Increasing the complexity of analysis by implementing real options valuation would reduce the volume of analyzed projects. Reducing the volume of analyzed projects would, in turn, reduce the number of NPL-portfolios Arvato could acquire, and ultimately reduce revenue.

> *"There is always a lack of available time, but always a lot of opportunities. So, even if the company had the necessary competence to perform real options analysis, you would have to give up potential opportunities because there is a time cost to complicated analysis."*

The interviewee also added that the company gets continuous feedback on the quality of their valuations, and can adjust valuations based on this feedback. If Arvato consistently undervalues NPL-portfolios, the company misses out on projects and can follow the stock prices of competitors to monitor NPL-performance. If Arvato consistently overvalues NPL-portfolios, they win a lot of auctions with poorly performing NPLs. This feedback both adjusts and increases confidence in current valuation methods and reduces the need for more sophisticated analysis.

8. EVRY

8.1 Introduction to EVRY

EVRY is Norway's biggest IT- and software company (EVRY, 2018). The company offers IT-solutions and software to domestic and international clients. EVRY have 8500 employees and had revenues of 12.6 billion NOK in 2017.

We have interviewed a business unit manager with responsibility to approve and monitor large-scale development projects for one of EVRY's main segments, financial services (EVRY, annual report 2017). The financial services segment is responsible for delivery of all of EVRY's services to bank and finance customers. These services include end-user interfaces, transaction systems, payment solutions and card services. The projects in the financial services segments are divided into three categories: delivery (already existing services), assignments (smaller one time projects) and development projects. This paper will focus on product development projects. Development projects are most often initiated on demand from one or more existing customers. EVRY then analyzes if the potential new product will be in demand for other existing customers and make an analysis on whether the product will be commercially viable or not. If a development project is finished, the project is later categorized as a delivery project and is then sold as subscriptions to existing and new customers.

8.2 EVRY's valuation process of the development project

EVRY starts the valuation process by estimating revenue with conservative estimates on how many customers a new product will sell to and how much customers will be willing to pay. The reasons behind the conservative approach are is the uncertain nature of EVRY's industry. Cost estimations are mainly based on how many hours of developing a project will require, for instance, a large-scale development project might require 8000 hours of development. From revenue and cost estimations, the company can estimate cash flows for projects. Cash flows are not discounted, however, a project needs a margin of 20% - 40% in

order to be approved. The reasons for requiring a high margin were not stated in the interview.

> *"We need to show a positive margin. It should be a two-digit margin, something between 20% to 40%."*

Scenario analysis

The company also utilizes scenario analysis to value projects. The company set up a spreadsheet with three likely scenarios for how many customers the new product will sell to. Each scenario is assigned probabilities which can be used to calculate the expected value of the project. Some parameters for the project can usually be changed for sensitivity analysis. The scenario analysis is limited to two periods, now and the future outcome.

> *"On the revenue side, it is easy to say what is expected revenue, by adding the number of customers and setting the price level that is in proportion with the basic service."*

> *"The cost side is very difficult. Let's say, what is the cost of maintaining this part if you already have the basics. It is very difficult to say. Is it one man year? Is it 5 man years?"*

8.3 Real options thinking in EVRY

EVRY exhibits real options thinking in two ways. Firstly, the company takes on high-risk projects in order to increase future investment opportunities. Taking on high-risk development projects can turn out to be costly for the company in the short run. However, high-risk projects are a source of additional development projects in the long run. The project opportunities arise as taking on risky development projects builds good customer relationships, keeps things interesting for employees, increases technological competence in the firm, strengthens the EVRY brand and lead to new customer referrals.

"We consider them (future options) all the time. We failed on all of the first three projects and asked ourselves whether to shut them all down. But we didn't, because we believed that the projects would materialize in some shape or form in the future."

"If we do not take risks, we are more secure. But in the end, we will not be the forward leaned provider we want to be and will be bypassed by competition."

Secondly, EVRY is willing to subsidize smaller customers early on if they believe the customer can become a large and profitable client in the future. EVRY name such investments "Strategic investments". These customers are typically small start-up fintechs.

"We will not charge for a full project. We will invest in a way that we will charge a subsidized price regarding the onboarding costs maybe, or give them lower prices in the first two years. So they can grow, and if they continue to grow, that will give us a positive business case."

Summary of findings from all cases

	Otello Corp. ASA	The Pure Water Company	Arvato Finance AS	EVRY
Company profile	Conglomerate specializing in mobile advertising and mobile applications.	Provider of filtered water solutions to businesses, hotels and restaurants	Provider of non-cash payment solutions.	IT- and software provider
Valuation method	Market multiples and multi-criteria project rankings	Payback method	Economic value added, internal rate of return, return on invested capital, money multiplier (CF/price), and gross payback time.	Combination of cost-benefit estimations with scenario analysis. Requires a profit margin of 20%-40%.
Real options thinking	Pays for flexibility by using earnouts and pre-tests.	Intuitively considers expansion options in project evaluations. Pays for flexibility by using pre-tests.	Bids on NPL-portfolios can exceed valuations in order to open up for new business opportunities.	Takes on high-risk projects and subsidizes small customers to acquire future investment options.
Perspective on real options valuation (ROV)	Not familiar with ROV Thinks it might be useful, but has concerns regarding the complexity and costs of the model.	Confident in the current models. ROV is too costly to implement.	Trust its own models. ROV is difficult due to organizational structure. Too time consuming.	N/A

Table 2: Summary of findings from all cases

9. Discussion and conclusion

9.1 How companies value and evaluate high-risk projects in practice

Investment criteria - non-financial criteria are prioritized

All of our study objects utilized both quantitative and qualitative investment criteria in project evaluations. Out of the 4 firms, only one firm viewed financial analysis as the most important criteria for project evaluation. Naturally, the importance of accurate financial valuation diminishes as the importance of non-financial investment criteria increase. Consequently, interviewees were less willing to invest resources into sophisticated valuation methods.

Taking project decisions based on both quantitative and qualitative criteria appeared to be critical for all companies participating in the study. Examples of non-financial evaluation criteria reported by interviewees included: strategic fit, market demand, regulations and time to market. Literature has also recommended this multi-criteria approach. Pure reliance on financial analysis may harm a strategic product portfolio and lead to inefficient allocation of resources (Liberatore, 1987, Lee et al., 2017). Thus, interviewed companies follow evaluation strategies suggested by the literature. According to surveys by Cooper et al. (2001) and Thamhain (2014), mixed approaches for R&D projects are increasingly becoming commonplace in the business world. Our study supports these findings.

Valuation methods

Nevertheless, it is worth noting that while financial valuation was not the most important criterion, it was still one of the most important criteria for project assessments. A number of quantitative approaches were employed by our study objects. Interviewees utilized the payback method, multiples, return on investment, economic value added, cash flow projections and scenario analysis. Previous studies, suggest that these methods are commonly employed by practitioners (Rimer and Nieto, 1995; Poh et al., 2001; Cooper et al., 2001; Thamhain 2014). Our study also supports the findings of Block (2007) and

Kjærland et al. (2015). The adoption rate of real options analysis for high-risk project evaluation is low, despite academic advocacy (Myers, 1984; Trigeorgis, 1996; Coy, 1999; Copeland and Antikarov, 2001). None of our interviewees proclaimed to be using real options analysis and they were not familiar with the approach.

9.2 Valuation concerns

Complexity and uncertainty of inputs make cash flow projections over longer time horizons difficult

Several researchers have raised their concerns about the drawbacks of traditional capital budgeting methods for high-risk project valuations. The findings from our paper support the views of these researchers. Poh et al. (2001) questioned the reliability of cash flow estimations over longer time horizons. All of the participating companies in our thesis stated that organizational complexity and uncertainty of input variables, make it challenging and even infeasible to estimate accurate cash flow projections. Our interviewees all agreed that short-term estimations (ie. next month or next quarter) are already immensely difficult. Thus, providing trustable predictions over longer time horizons were perceived as even more challenging. In fact, most of the interviewees admitted that analysts had to adjust cash flow projections frequently upon revelations of new information.

Assumptions of the DCF model does not account properly for risks

Ormala (1986, cited in Poh et al., 2001) showed that valuation models are well justified, only if stringent assumptions are met. One of our interviewees argued that the DCF model tends to overestimate the value of risky projects. According to our interviewee, WACC estimations underestimate the cost of undertaking R&D, because of low market betas and interest rates. This finding supports the proposals of Steffen and Douglas (2011) and Thiele and Cetinkaya (2014). These researchers argued that risks of R&D are correlated with the business's idiosyncratic risks. Thus, using a market-based risk approach underestimates the cost of risks. To properly account for risks, the interviewee suggested valuing projects based on comparable market multiples.

Benchmark returns are used to account for capital costs instead of discount rates

Thiele and Cetinkaya (2014) argued that a fixed discount rate cannot account for the varying risk profiles for high-risk projects. Some of the participating companies in our research dealt with this issue by not discounting cash flows. Instead, the companies had incorporated benchmarks to account for capital costs. Interviewees trusted these benchmarks as they were developed and tested over time based on previous business experience.

Ranking over accurate valuation

Poh et al. (2001) found that it is highly difficult to measure and separate contributions of R&D projects from those of other business activities. Our findings from Otello support Poh's findings. Executives in Otello viewed it as demanding to quantify impacts of R&D projects. They saw returns as a combined result of all of the company's business activities and projects. Separating contributions from a singular project was therefore viewed as infeasible.

Consequently, executives thought that it was more important to rank projects in order of importance, instead of providing accurate valuations. They pointed out that a company has fixed inputs over the short-term, and may, therefore, engage in unprofitable projects regardless of valuations, because inputs are sunk. This finding supports the argument developed by Van Putten and Macmillan (2004). They argued that the valuation of highly uncertain projects will most often be flawed no matter which valuation method a manager chooses. Thus, the most important task of a manager is not getting an accurate valuation, but rather a consistent measure to rank project proposals. However, in contrast to Otello, Van Putten and Macmillan argued that the best measure for project ranking is real options valuation.

9.3 Real options thinking

A study by Ford and Lander (2011) found that while empirical surveys report little operational employment of real options models, managers still understand the value real options and intuitively include them in project assessments. Our study supports this conclusion, as all participants exhibit a certain level of real options heuristics in their decision-making. Studying real options thinking is important, as a lack of real options

thinking arguably can be seen as a barrier to successful implementation of real options analysis.

Options to expand and abandon

Otello exhibited real options heuristics through its use of earnouts. The company acquired companies for low initial investments. Additional payment to targets was only released if profitable KPIs were met. The KPIs work as an exercise price for scaling up investments contingent on successful outcomes. Conversely, Otello's earnout structure also lowered costs of abandonment, as initial investments were kept to a minimum until uncertainty resolved. Otello showed that it valued this flexibility, as executives claimed it was cheaper to buy a company upfront compared to buying a company through an earnout.

The pre-test, or "test and rollout" practices undertaken by Otello and The Pure Water Company is another form of real options thinking. Successful pre-tests were required to scale up projects. The companies increased flexibility by lowering initial investment costs until risks were reduced. Again, the companies were willing to pay for flexibility, as pre-tests were more expensive compared to immediate full-scale investments.

Arvato exhibited real options thinking through its practice of strategic pricing. If the company is not in a debt segment, it lacks experience and data before it can reliably make profitable investments in that segment. In order to collect such data, the company was willing to pay more for NPL-portfolios than initial valuations would recommend. The company would do so in order to open up for new opportunities in new segments. Hence, the company intuitively included the value of expansion options in project assessments.

In EVRY, the company believed that undertaking risky projects led to future investment options through accumulated experiences, better customer relations, and a stronger brand. To acquire investment options, EVRY were willing to take on risky development projects which can be economically costly in the short run. EVRY's strategic investments in the form of subsidizing services for small start-up companies are another form of investments in real options. If the small startups succeed and grow, EVRY can profit substantially by providing additional non-subsidized services.

Overall, we observe that all of the interviewed companies intuitively include the value of real options in project assessments. However, they were generally skeptical towards

implementation of real options valuation. The challenges of implementing real options analysis will be discussed in the next section.

9.4 Why are managers not using real options valuation?

Lack of familiarity

Our study also confirms Kjærland et al. (2015)'s finding that the most astounding barrier to the adoption of real options valuation is familiarity, knowledge and experience with the method. None of our interviewees were familiar with the real options valuation prior to interviews. Only one interviewee seemed to recall upon hearing the term, but again needed an elaboration of the method.

Too complex

After a brief explanation of real options valuation models, the majority of interviewees thought the existence of such models could be helpful to value projects. However, interviewees stated that their businesses lacked internal competence to utilize the models. Previous papers have also pointed out that managers familiar with real options valuation report a lack of competence to perform the analysis (Block 2007; Kjærland et al., 2015). Interviewees generally raised concerns regarding the resources needed to implement real options analysis. Although real options valuation methods were viewed as capable of providing additional analytical value, benefits were generally perceived as being outweighed by costs.

Decision authority over real options were separated from analysts

Another interviewee also pointed out that organizational structure separated decision makers from analysts. The analyst had little insight into why real options were exercised or not at later stages in a project. Also, the analyst could not exercise any real options as authority over decisions shifted after investments were made. Hence, a separation of analysts and decision makers complicated the process of real options valuation. These findings partially support the previous findings of Kjærland et al (2015). Kjærland found that organizational structure can remove flexibility for managers in the public sector because decisions are made at higher bureaucratic levels. Our study suggests that similar problems of organizational structure also exist in private companies.

Valuation feedback and experience reduces the need for sophisticated analysis

Two companies reported that feedback and experience with employed valuation methods increased confidence in valuations over time. The Pure Water Company found that a 15 months payback period worked well to account for indirect costs and capital risk. Similarly, Arvato used feedback in the form of competitor stock performance, the number auction winnings, and the accuracy of previous valuations to adjust future valuations. This feedback increased the accuracy of valuations. Consequently, the need for sophisticated analysis diminished. These findings are similar to the findings of Block (2007). Some managers reported that there was no need to engage in additional capital budgeting methods when utilized methods were viewed as proven and sufficient.

9.5 Bridging the gap between academia and practitioners

Managers will only implement real options analysis if benefits outweigh costs

Companies in our study did not prioritize financial valuation when assessing projects and were not willing to increase resources substantially to improve the accuracy of valuations. If this observation is prevalent among firms, costs of implementing real options analysis need to decrease in order for real options adoption to increase. Costs of implementation can be decreased by developing intuitive and less complex real options models. However, decreasing complexity of methods can come at the expense of valuation accuracy. For example, removing dynamic discount rates simplifies the analysis, but also reduces the accuracy of capital costs. Thus, the tradeoff between adoption and accuracy will need to be considered. Increasing competence and knowledge with real options valuation is another way implementation costs can be reduced. If managers already have competence with the method, then, the costs of utilizing the method are lowered. More focus on real options analysis in higher educational programs can also increase competence and knowledge among practitioners over time.

9.6 Conclusion

This study has researched why the adoption of real options analysis is low among practitioners. In general, most findings support existing literature. None of our interviewed firms used real options analysis. The foremost reason was a lack of familiarity with the method as none of our interviewees were familiar with real options valuation. After interviewees were explained the basics of real options valuation, they argued against the method because it was too costly to implement, they lacked the competence to perform the analysis, managers could not always exercise relevant real options, and confidence in employed methods reduced the need for additional sophisticated analysis. Nevertheless, all participants exhibited real options heuristics as they intuitively included the value of real options in investment evaluations.

We also observed that firms prioritized strategic criteria over financial criteria in high-risk project evaluations. Consequently, the willingness to spend resources on sophisticated analysis diminished because accurate valuation was viewed as less important. If future research shows that our observation is not only case-specific but prevalent among firms, literature should focus on decreasing the costs of implementing real options analysis to increase adoption. Decreasing the costs of implementation can be done by developing real options models that are easily understood, taught and applied, and by increasing competence and familiarity with the analysis.

10. Implications, limitations, and suggestions for future research

10.1 Implications of the study

Overall, our study has contributed to the stream of literature on valuation and evaluation in practice. While academia has long proposed the use of real options valuation for risky projects, our research supports Block's and Kjærland et al.'s findings that the popularity of real options valuations is still questionable. Furthermore, our study helps to narrow the gap between academia and practitioners by researching practitioners' reasons to opt for alternative valuation methods, as well as studying their concerns and perspectives in regards to real options valuation.

10.2 Limitations of the study and suggestions for future research

First, the time constraint placed on interviews makes it difficult to explain real options models thoroughly to managers who are not familiar with the method. Managers who just learned the basics of the model have less insight and practical experience with the model. Therefore, they are arguably less qualified to discuss the practical implications of real options analysis. On the other hand, the goal of the research is to explain why managers do not adopt the method. Arguably, the managers who do not have practical experience with real options analysis, are the managers who can provide the most insight for why they are not using the models. These managers can also use their operational experience from other valuation methods to reason why real options analysis is valuable or not from a operational perspective.

Second, the limited number of companies participating in the thesis will affect the extent of which results can be generalized. There will be firm- and industry-specific elements that cannot be applied to other companies or business sectors. Thus, future studies can increase validity by increasing sample sizes, the range of researched industries and geographical

variation of study objects. Alternatively, future studies could focus on specific industries of interest to improve validity for chosen sectors.

Third, our study has a discrepancy between the number of interviewees from each company. We got four interviewees from one company, two interviews from another, and only one interview with the other two. This resulted in an imbalance in the depth of findings. Future research should consider the same number of interviews from each sampled company to improve the consistency of findings.

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Appendix 1: Interview Guideline

Warm-up

Short introduction to our thesis research question: what we are doing and what we aim to achieve. Inform interviewees that interviews will be anonymous. Ask interviewees if we can record the interview.

- Could you give a short presentation of who you are, what you do in in the company, and your history in the company?
- In what ways are you involved in decisions regarding new project proposals?

Purpose: Obtain an impression of the interviewee's knowledge of the valuation methods used in the company and the interviewee's influence over new project decisions.

Finding new projects

- How do new projects arise?

Purpose: Get an understanding of how new project opportunities arise in the interviewed company

Section 1: Companies' valuation and evaluation approaches

- What do you find to be the most important criteria for giving new projects a go ahead? (Are these criteria used throughout the organization?)
- Who are involved in the decision making process?
- How are new project proposals valued?
- What are the pros and cons of current methods? (methods, forecasting etc)?
- Why are projects being evaluated like this?
- In your opinion, how should the company ideally value and evaluate new projects?

Purpose: Uncover how the company values and evaluates projects and why are they doing it the way they do it.

Section 2: To what degree does the researched company implement real option analysis

This part is split into two sub-sections. In the first part, we research to what extent they apply real options thinking in order to avoid biased answers after introducing interviewees to real options models. In the second part, we will figure out to what extent they apply real options valuation models.

1) Real option thinking

Ford and Lander (2011) defines real option thinking as understanding the drivers behind the value of real options. The value of a real option increases with the uncertainty of outcomes, everything else being equal. Understand how interviewees incorporate uncertainty into decision making "verbally" or "conceptually".

Flexibility

- To what extent do you pursue flexibility for new projects? (examples of flexibility: experiments to resolve uncertainty, options to abandon, options to expand, options to defer)
- How do you value flexibility for new projects?
- What determines how much you are willing to pay for flexibility?
- Volatility: To what extent do you assess the risk associated with a project? What are the most important factors in assessing risks?
- How does the willingness to pay for flexibility vary with the uncertainty associated with a project?
- What are common sources of flexibility in your projects?
- To what extent are projects inflexible?

Scenario analysis

- To what extent are different outcomes of a project visualized before the project is initiated? (examples: delayed development, high product demand, underestimated costs)
- Follow up: How is this visualization helpful?

2) Real option valuation models

- How familiar are you with real options valuation methods?

If they are familiar:

- To what extent do you use real options to value projects?
- How do you perceive using real options to value projects in your company?
- What are the pros and cons of applying real options models in your company?

If they are not familiar:

Explain the method briefly. Ask them for their perception of the cons and pros of utilizing this method in their company.

- What would be the challenges (if any) of implementing real options valuation in your company?
- What would be the benefits (if any) of implementing real options valuation in your company?

Wrapping up and Follow up questions

- Any final thoughts or comments you want to add?
- Can we come back to you with follow up questions?