

The Use of Real Options Theory in Scandinavia's Largest Companies

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Abstract

We survey the CFOs of 1500 largest companies from Norway, Denmark and Sweden (500 from each country) about their capital budgeting process with focus on the real options analysis. Only 6% of the respondents use real options, whereas the most used technique, the net present value, is used by 74% of the CFOs. Real options are more often used by companies in the energy and biotech sectors, large companies and companies with high capital and R&D expenditures. Lack of familiarity is the most important reason for non-use, where 70% of respondents report to not be familiar with real options concepts and techniques. For the respondents familiar with the framework, the complexity of real options is the main hinder for implementation.

Key words: real options, capital budgeting, survey

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1 Introduction

The business environment faced by today's managers is characterized by increased uncertainty and rapid changes. Traditional valuation techniques such as net present value (NPV) are adequate for valuing relatively safe and certain cash flows, but they do not account properly for the value of flexibility. This might lead companies to undervalue opportunities and misallocate resources (Myers, 1984; Schwartz & Trigeorgis, 2001). Therefore, numerous academics recommend the use of real options analysis for valuation of the projects under consideration (e.g. Trigeorgis 1988, 1993; van Putten & MacMillan, 2004).

Since the introduction of real options in the 1970s and 1980s, academics developed analytical valuation models and demonstrated real options' applicability to a broad range of industries and managerial decisions (e.g. McDonald and Siegel, 1986; Dixit & Pindyck, 1994; Trigeorgis, 1996; Amram and Kulatilaka, 1999). Copeland & Antikarov (2001) argued: "Real options will become the central paradigm for investment decisions within ten years." However, surveys of financial executives show that real options rank behind almost all other capital budgeting techniques in terms of popularity in corporate world (e.g. Graham & Harvey, 2001; Ryan & Ryan, 2002; Baker, Dutta, & Saadi, 2011).

Only two large-scale surveys dedicated to real options practices have been conducted in the past, both in North America (Block, 2007; Baker et al., 2011a)². We study companies from Denmark, Norway and Sweden. Our survey is the first large-scale survey dedicated to real options practice outside North America and one of the largest surveys overall. Furthermore, past surveys seldom address respondents' reasons and motivations for applying or discarding the techniques. We combine widely-distributed questionnaires with follow-up interviews of selected CFOs to study whether companies use real options and why they do or do not do so. Contribution of our paper is twofold. Practitioners can learn how their peers use real options and this might motivate them to start using real options themselves. Academics can learn what are the main hinders in real options use and therefore search for such real options techniques which are more likely to be used by practitioners.

The remainder of this paper is organized as follows. Chapter 2 describes the survey methodology and characteristics of the respondents. Chapter 3 describes the findings of our survey. Chapter 5 concludes.

² List of real options surveys is provided in Appendix A.

2 Survey Design and Respondent Characteristics

The main objective of this survey is to identify to what extent larger Scandinavian companies use real options in their capital budgeting decisions. The term “real options can refer to either an analytical tool, or just a way of thinking, as defined by Triantis and Borison’s (2001). Since grasping the way of thinking through a self-administered questionnaire might be challenging, we study real options defined as an analytical or organizational tool CFOs are using. Following Block (2007) and Baker (2011a) we further investigate if there is a relationship between use of real options and different parameters such as size of companies, education of the CFO and R&D intensity of the company.

We select our population from the most recently compiled lists ranking firms by 2010 revenue, similar to the Fortune 1000. Eligible companies for these lists are all firms that are authorized to do business in Sweden, Norway and Denmark, including companies in the public sector. The list of Sweden’s 500 largest companies, VA500, was obtained from the financial media firm Veckans Affärer. Eniro, a leading Nordic search company, provided us with the list of the 500 largest Norwegian companies. In Denmark we selected the first 500 companies in top1000.dk’s recognized list of Denmark’s 1000 largest companies³.

We refine the lists by removing subsidiary companies under the same management as a parent company on the list. Furthermore, companies that have either merged or gone bankrupt since the lists were compiled in 2011, and companies from which we are unable to collect the CFO’s contact information, are excluded⁴. The final sample consists of 405 Norwegian companies, 382 Danish companies and 390 Swedish companies, and a total of 1177 Scandinavian companies.

Following Graham and Harvey (2001), we aim for the CFO to respond on behalf of the company. In the case where CFO is not an employed title, we target the highest ranked financial officer. We refer to the highest ranked financial official as the CFO throughout the paper.

³ Due to difficulties in obtaining the contact information of Danish CFOs, we chose to include an additional 100 companies in order to obtain populations of similar size in the respective countries. Hence in Denmark, we target the 600 largest companies.

⁴ In the case where a company appears on more than one country list, we investigate whether the company has fairly independent management and operations in the respective countries. If this requirement is satisfied, we allow the company to be included on several country lists.

2.1 Designing and Developing the Survey Instrument

All CFOs receive a personally addressed e-mail with a cover text and a link to the web-based questionnaire. Following Brounen et al. (2004) and Block (2007), we supplement the web survey with follow-up phone calls to selected companies. CFOs are provided with both an English and a native language version of the questionnaire. To increase the response rate we offer all respondents a copy of the final report. The English version of the final questionnaire is attached in Appendix B.

The survey was e-mailed to the Norwegian CFOs at the beginning of October 2012, and to Swedish and Danish CFOs in early February 2013. In order to increase the response rate, we sent non-respondents a reminder two weeks after the first e-mailing. We set a cutoff for responses two weeks after this reminder.

2.2 Testing for Non-Response Bias

We use a three-fold approach to test for non-response bias: (1) Comparing the characteristics of respondents and non-respondents, (2) comparing responses from the surveys returned on time with those returned after the second e-mail, and (3) comparing responses of respondents to the responses from randomly selected and interviewed non-respondents. Statistical testing of independence was performed by Fisher's exact test. In the first bias test, proposed by Moore and Reichert (1983), we compare company size and industry classification of responding and non-responding firms. In the second approach, proposed by Wallace and Mellor (1988), we compare responses from the officials that complete the survey on time with the managers that respond after the second e-mail. The latter group is viewed as a sample from the non-response group, and if the two groups' answers are similar, non-response bias is unlikely to be a major problem. In both cases we conclude that non-response bias is non-existent or very weak in our data.⁵ In addition to these two tests, we conduct a telephone follow-up of 25 randomly selected non-respondents, similar to Block (2007). Only five of these companies answer our inquiry. Telephone follow-ups do not indicate any non-response bias either.

2.3 Response

We received a total of 384 completed questionnaires, of which 162 from Norwegian companies, 121 from Danish companies and 101 from Swedish companies. This

⁵ Results are available upon request.

corresponds to an overall response rate of 33%. To our knowledge, this is one of the higher response rates achieved in larger capital budgeting surveys⁶. The response rate is also quite exceptional considering that we target senior officers at the particular firms. A possible explanation for the high response rate is the relatively horizontal structure of Scandinavian companies. Due to the less hierarchical organization, senior managers may be more prone to answer inquiries. Additionally, the Norwegian University of Science and Technology is a recognized academic institution in Scandinavia. With a total of 384 responses this survey is one of the larger capital budgeting surveys in general⁷, and the largest survey specifically targeting real options use. Comparing with the two other extensive real options surveys, Block (2007) received a total of 279 responses while Baker et al. (2011a) obtained 214 responses.

2.4 Respondent Characteristics

Comparing with Block's (2007) U.S. respondents, the most prominent difference in industry classification is the lower percentage of technology companies in Scandinavia (5% to Block's 13%). As a measure of company size, we use the firms' revenues, similar to most previous capital budgeting surveys (e.g. Graham and Harvey, 2001; Ryan and Ryan, 2002; Block, 2007; Baker et al., 2011a). Median revenue among the Scandinavian respondents is \$368 million, which is significantly smaller than for the respondents in Block's survey who had a median revenue between \$4 and \$6 billion. Regarding the R&D intensity of Scandinavian companies, we find that 59% of the respondents spend less than 1% of revenues on R&D. This is notably lower than the R&D intensity of Block's respondents, where only 5% of companies report to spend less than 1%. The low number of technology companies in Scandinavia may explain the comparatively lower R&D intensity. Concerning CFOs' level of education, we separate between MBA and non-MBA master's degrees⁸, similar to Graham and Harvey (2001) and Baker et al. (2011a). A great majority of responding CFOs have either an MBA or a non-MBA master's degree as their highest level of education. Only 16% have a bachelor as their highest degree, whereas in Graham and Harvey's (2001) survey, 41% of the CEOs have bachelor degree.

⁶ Baker et al. (2011a), 28%; Block (2007), 27%; Ryan and Ryan (2002), 20%; Graham and Harvey (2001), 9%; Brounen et al. (2004), 5%.

⁷ The quantitative surveys at the lower end have around 50 responding firms (Oblak & Helm, 1980; Kester & Chong, 1998), while the very largest ones have between 300 and 400 respondents (Graham & Harvey, 2001; Brounen et al., 2004).

⁸ In Scandinavia, the major business schools offer 5-year programs leading to a Master of Science in Business and Administration degree. This might resemble the North American MBA degree, but in Scandinavia MBAs are typically marketed towards more experienced professionals.

3 Results and Discussion

We present a discussion on the use of real options in Scandinavia, characteristics of real options users, real options applications and techniques, real options familiarity, as well as reasons for not adopting the techniques. Additionally, we examine the use of standard capital budgeting techniques. Finally, we extend the analysis by performing multivariate regressions on the dataset in order to further investigate relationships between real options use and familiarity and different industry characteristics.

3.1 Use of Real Options

We asked respondents: “Does your company use real options analysis to evaluate projects/investments?” Only 23 of the 384 respondents answered “yes” to this question, corresponding to a real options utilization rate of 6.0% in Scandinavia. This is lower than findings in recent studies, notably 14.3% in Block’s (2007) survey of U.S. companies and 16.8% in Baker et al.’s (2011a) survey of Canadian firms. As we will see next, Scandinavian companies are smaller in size, have lower R&D intensity, and a lower fraction of technology companies, all of which are expected to negatively effect real options use. Our results are more in line with earlier findings by Rigby (2001), who reports a utilization rate of 6.5% among U.S. companies. We do, however, find that real options seem to be advancing in Scandinavia, as the use has increased from 0% in Sweden during the past decade (Sandahl & Sjögren, 2003).

Table 1: Real options use

	Real options utilization	Respondents
Denmark	4.1 %	121
Norway	8.0 %	162
Sweden	5.0 %	101
	6.0 %	384
Independence test: P-value = 0.394 (do not reject independence)		

3.2 Characteristics of Real Options Users

Next we analyze the use of real options conditional on firm characteristics. To test for possible relationships we apply the same Fisher’s exact test as for the non-response bias investigation.

Triantis and Borison (2001) find that users of real options often come from industries featuring large investments and uncertain returns, such as oil and gas or biotech. Block's (2007) survey results strongly support these notions, as 75% of real options users came from the technology, energy, or utilities sectors. Our survey results align well with these earlier findings, as a majority of the users come from energy, oil and gas, and healthcare. We find a significant relationship between real options use and industry classification. In the financial sector however, we find surprisingly low adoption of real options. This is in line with Block (2007), who was surprised to find only two users within the industry. Triantis and Borison (2001) were likewise perplexed by the apparently low interest for real options within the banking and insurance industry, as one would expect a greater financial expertise from these companies.

Table 2: Industry classification and real options use

Industry	Real options utilization⁹	Respondents
Bank/finance & insurance	5 %	41
Communications & media	12 %	17
Construction	2 %	42
Energy	24 %	29
Food & beverages	3 %	38
Healthcare	19 %	16
Oil/gas & oil service	10 %	21
Retail & wholesale	2 %	54
Technology	10 %	21
Transportation	3 %	32
Other	1 %	73
	6 %	384
Independence test: P-value = 0.001 (reject independence)		

Survey literature however, e.g. Baker et al. (2011a), find that large companies are more likely to use real options than smaller ones. This effect is attributed to the size of the capital budget, which is strongly correlated with company size. A large capital budget implies more resources at stake, hence companies are willing to devote more resources to this process and use more advanced and time-consuming techniques.

⁹ Real options utilization is the percentage of respondents within each industry who report to use real options.

Thus, even though smaller firms may have a higher intensity of growth options, they might not have the necessary resources to evaluate those options formally. In line with previous findings, our results suggest that there is positive relationship between real options utilization and company size in Scandinavia as well.

Table 3: Revenue quartiles and real options use

Revenue quartile	Real options utilization
1 st quartile	3 %
2 nd quartile	4 %
3 rd quartile	5 %
4 th quartile	11 %
Independence test: P-value = 0.094 (reject independence)	

We also find a strong positive relationship between R&D intensity and real options use. In the most R&D-intensive group, 20% of respondents use real options, compared to only 3% among companies spending less than 1% of revenues on R&D.

Table 4: R&D intensity and real options use

R&D intensity	Real options utilization	Respondents
0 – 1%	3 %	225
1 – 2%	9 %	70
2 – 3%	10 %	30
3 – 4%	0 %	7
4 – 5%	0 %	9
5 – 6%	29 %	7
6 – 7%	0 %	2
7 – 8%	0 %	4
>8%	20 %	30
	6 %	384
Independence test: P-value = 0.004 (reject independence)		

Graham and Harvey (2001) find that the use of real options is independent of the CEO's education. Baker et al. (2011a) report that firms managed by CEOs with an MBA are in fact less likely to use real options. The authors suggest that this can be attributed to MBA programs focusing primarily on traditional techniques, covering less of real options. Our results show no significant relationship between CFOs' highest level of education and real options use. However, it is worth noting that a quarter of firms whose CFO has a PhD use real options.

Table 5: Highest education level of CFO among real options users

Highest education	Real options utilization	Respondents
Bachelor	6 %	64
Master	6 %	147
MBA	6 %	143
PhD	25 %	8
Other	0 %	22
	6 %	384

Independence test: P-value = 0.267 (do not reject independence)

3.3 Real Options Applications and Techniques

The Scandinavian real options users state that real options are largely a supplemental tool, and no respondents use them as their primary capital budgeting technique. In comparison, Block's (2007) survey found that almost half of users indicated major utilization.

Table 6: Position of real options

	% of users	Respondents
Supplement to other methods	65 %	15
One of several techniques	26 %	6
Primary capital budgeting technique	0 %	0
Other	9 %	2
	100%	23

Through the interviews we do, however, find evidence that real options have a very strong position with some of the companies who report to use real options as one of several techniques. "I don't think we have realized it yet, but we have probably reached a point where real options have taken over as the leading technique," one CFO elaborates.

Real options users were further asked to specify which decision problems they apply real options analysis to. The most frequent application is found in mergers and acquisitions, followed by new product introductions and R&D.

Table 7: Types of applications of real options

	% of users	Respondents
Mergers and acquisitions	83 %	19
New product introduction	48 %	11
Research and development	30 %	7
International investments	22 %	5
Other decisions	9 %	2

Smith and Triantis (1995) argue that many of the strategic synergies in an acquisition should be seen as growth options that are acquired, developed, and potentially exercised in the future if they prove fruitful. Yet we are surprised to find that 83% of Scandinavian real options users apply the technique to M&A decisions, as this is relatively novel phenomenon (Triantis, 2005). In comparison, respondents to Block's survey only ranked M&A as the third most frequent type of application. Triantis and Borison (2001) found that several managers were using real options techniques as part of their M&A processes, but most of them found a conceptual approach more useful than a numerical analysis. Similarly, one of the Scandinavian CFOs states that real options are especially helpful as a qualitative tool to clarify uncertainties in M&A investment opportunities.

Users of real options were asked to select which techniques they use in their analysis. The categories were the same as those offered by Block (2007), who asked only for the primary method of utilization, whereas we allow for multiple choices.

Table 8: Application of real options techniques

	% of users	Respondents
Risk-adjusted decision trees	67 %	14
Monte Carlo-simulation	38 %	8
Black-Scholes option pricing model	33 %	7
Binomial trees	10 %	2
Other methods	19 %	4

The most popular technique is risk-adjusted decision trees. This technique can be viewed either as an extension of traditional decision trees that properly accounts for risk, or as a generalized version of the binomial model. Compared with Block's findings, Scandinavian real options users seem to apply more sophisticated techniques than their U.S. counterparts.

Although the Black-Scholes model has been used extensively in financial markets, it can only accurately value real options under very restrictive conditions. Despite these restrictions, the model can be very helpful for quick valuations or to check the results from other methods. Our respondents indicate that the Black-Scholes model is largely a supplemental technique, as all but one of the seven respondents using it also report to use one or two more advanced techniques. These observations align well with findings in Block's (2007) survey, where only one of 40 real options users considered Black-Scholes their primary technique.

3.4 Familiarity with Real Options

Before investigating participants' reasons for not using real options, we wish to determine whether respondents have any knowledge of the methodology. The issue of real options familiarity is not addressed in Block's (2007) survey, although Baker et al. (2011a) find that the dominant reason for non-use is a "lack of expertise and knowledge". In order to distinguish between respondents unfamiliar with the techniques and those who feel that real options are too complex, we ask: "Are you familiar with the principles and techniques for real options analysis?" 70% of all our respondents gave a negative answer to this question. This finding sheds new light on the limited utilization of real options, which has largely been attributed to top management attitudes or the complexity of the techniques (Teach, 2003; Block, 2007; Baker et al., 2011a). Due to top management's limited knowledge of real options, most companies in our survey might never have actively considered applying the technique to their business. One CFO reports reading up on the subject after our inquiry, and finding that real options would be highly applicable to their capital budgeting process.

Familiarity with real options varies strongly between countries. The lower familiarity among Swedish CFOs could be attributed to the high fraction of retail and transportation companies, where sophisticated analysis might be less common.

Table 9: Real options familiarity

	Real options familiarity
Denmark	30 %
Norway	37 %
Sweden	19 %
	30 %
Independence test: P-value = 0.008 (reject independence)	

Furthermore we test for relationships between CFO's familiarity of real options and different company and CFO characteristics. We find that company size is significantly associated with the familiarity, where CFOs from large companies are more likely to be acquainted with real options than those from smaller companies.

Table 10: Revenue quartiles and real options familiarity

Revenue quartile	Real options familiarity
1 st quartile	22 %
2 nd quartile	24 %
3 rd quartile	26 %
4 th quartile	48 %
Independence test: P-value = 0.008 (reject independence)	

Real options familiarity is also significantly associated with the companies' industry classification. Banking/finance and insurance, healthcare, and oil and gas display familiarity rates between 46% and 56%, while only 20% of CFOs in construction is acquainted with real options. We further find that CFOs in firms with high R&D intensity are more likely to be familiar with real options.

Table 11: Industry classification and real options familiarity

Industry	Real options familiarity
Bank/finance & insurance	46 %
Communications & media	35 %
Construction	17 %
Energy	41 %
Food & beverages	19 %
Healthcare	56 %
Oil/gas & oil service	50 %
Retail & wholesale	17 %
Technology	45 %
Transportation	28 %
Other	23 %
Independence test: P-value = 0.001 (reject independence)	

Regarding CFOs level of education we also uncover a significant and positive relationship.

Table 12: CFO's education and real options familiarity

Highest education	Real options familiarity
Bachelor	13 %
Master	38 %
MBA	31 %
PhD	29 %
Other	18 %
Independence test: P-value = 0.002 (reject independence)	

In light of Baker et al.'s (2011a) findings that companies managed by CEOs with an MBA degree were less likely to apply real options, we investigate real options familiarity among CFOs with non-MBA master's degrees compared with those with only MBAs (and no other master's degree). The familiarity rate in the former group is 38%, while only 28% in the latter, which may indicate that CFOs with only an MBA are in fact less likely to be familiar with real options than those with another master's degree. As Baker et al. argue, this might be a reflection of MBA programs focusing more on the traditional capital budgeting techniques and less on the more complex ones.

Table 13: CFO's education and real options familiarity

Master's degree	Real options familiarity
Non-MBA Master	38 %
Only MBA	28 %
Independence test: P-value = 0.092 (reject independence)	

3.5 Reasons for Not Using Real Options

The non-users familiar with real options were asked to give their reasons for not adopting the approach. Respondents could select from three alternatives or write their own answer.

Table 14: Reasons stated for not using real options

	% of non-users	Respondents
Require too much sophistication	58%	52
Lack of top management support	7%	6
Encourage too much risk taking	2%	2
Other	42%	38

Among other reasons was suggested e.g. that real options lack clarity and transparency, and considers them a “black box”. This echoes the criticism raised by Teach (2003). Managers will be hesitant to implement real options if they fear that the complexity may cause deliberate or unintentional misuse that is difficult to detect. However, the main reason for not using real options is clearly that they require too much sophistication. Our results align with Block (2007) and Baker et al. (2011a), who find that real options’ required level of knowledge among practitioners is a hinder for further implementation.

Similar to the findings of Block (2007) and Baker et al. (2011a), four respondents state that the more traditional DCF techniques are proven and sufficient methods. The high portion of non-users unfamiliar with real options suggests that the majority of Scandinavian CFOs share this view.

Several CFOs from public-sector companies state that real options concepts are not applicable to their capital budgeting process, as they have very limited investment mandates. In general, both the size and timing of investments are determined at a higher political or bureaucratic level. Since these organizations have little managerial flexibility, real options analysis offers very little additional value. This observation aligns with Graham and Harvey’s (2001) findings that regulated firms were less likely to use real options than unregulated firms.

Although they don’t formally use real options analysis, seven surveyed companies state that they use real options as a way of thinking. In a paper by Teach (2003), Triantis argues that real options as a concept is already ubiquitous among managers: “Discounted cash flow is going to look at an average scenario. But if you talk to any manager, that’s not how they think. They think about contingencies—what’s going to happen, how would we react?” Our telephone interviews add support to this notion, as most of the managers we spoke to incorporated flexibility in their capital budgeting considerations.

3.6 Use of Standard Capital Budgeting Techniques

In order to learn more about respondents’ capital budgeting processes we ask them to select which traditional techniques their company applies. In line with the most recent North American surveys (e.g. Graham & Harvey, 2001; Ryan & Ryan, 2002; Baker et al., 2011a), we find that NPV is the most popular capital budgeting technique.

Table 15: Use of other capital budgeting techniques

Technique	% of respondents
NPV	74 %
Payback period	66 %
IRR	51 %
Hurdle rate	46 %
Earnings multiples	25 %
Other	16 %

When comparing with previous European surveys from around a decade ago (Arnold & Hatzopoulos, 2000; Brounen et al., 2004), it appears that the practices of capital budgeting are becoming more sophisticated and better aligned with the recommendations of finance theory. In Sweden for instance, we find that utilization of DCF methods (IRR and NPV) has increased from 65% in 2003 (Sandahl & Sjögren) to 82%.

Similar to previous research (eg. Graham & Harvey, 2001; Brounen et al., 2004) we find that large companies are more likely to use DCF techniques than smaller firms. We further find, like Graham and Harvey (2001), that companies whose CFO has an MBA are more likely to use present value techniques than those with non-MBA master's degrees. As pointed out, this might be a result of MBA programs focusing more on standard capital budgeting techniques. Furthermore, industry is related to DCF use. In the oil/gas and oil service industry, 95% of respondents report use of DCF, while the number is only 69% among the respondents from the retail sector.

Regarding the interaction between real options and other capital budgeting techniques, van Putten and MacMillan (2004) argue that managers are reluctant to apply real options because they believe that real options and DCF methods are mutually exclusive. Along with Triantis (2003), they stress that real options need not be viewed as a stand-alone approach, but rather an addition to passive NPV estimates. Users certainly seem to have adopted this theoretically recommended approach, as 21 of 23 real options users also use NPV. One official states: "We first calculate the static NPV. We then calculate the real option value, and we add this value to the passive NPV." Such an approach also reduces unnecessary complexity in situations with little uncertainty and limited managerial flexibility. If the real option value is negligible, a traditional NPV analysis is sufficient for making a decision.

An important observation in the context of this section is that real options rank far behind all other capital budgeting techniques in terms of utilization. This has largely been the case in almost all survey research to date.

3.7 Multivariate Regression Analysis

Through independence testing we have uncovered several relationships between respondent characteristics and factors such as real options use and familiarity. Although our findings mostly align well with academic theory and previous survey findings, independence tests alone cannot provide a complete picture of the relationships between factors. Real options use appears to be influenced by industry, company size, and R&D intensity, yet it is unlikely that these variables are independent of each other. To address these issues, we run multivariate regressions on our dataset.

We run regressions with three different dependent variables: use of real options, familiarity with real options¹⁰, and use of DCF techniques. As these three dependent variables are binary, we use a binary response probit model. Our regression models incorporate as regressors all the company and CFO characteristics discussed throughout the chapter, which have been converted to dummy variables. Industry is treated as a binary variable, where oil and gas, energy, technology, and healthcare are assigned value 1. These industries were selected based on the real options literature, which emphasises their suitability for real options analysis. The R&D variable is also binary, taking on value 1 for respondents spending more than 3% of revenues on R&D. Education is treated as a categorical variable, where respondents with either a bachelor degree or “other” as their highest education are grouped together. Respondents with a master’s degree form a second category, and MBAs and PhDs are grouped together in a third category. Besides the survey variables, we also analyse differences between countries. Revenue¹¹ is a continuous variable. Among the 384 survey respondents, six did not respond to the question on real options familiarity, and have been excluded from the regression dataset.

¹⁰ Even though we ask question about familiarity only non-users, we implicitly assume that users of real options are familiar with them. Therefore, we have the same number of observations for each question.

¹¹ We use the natural logarithm of revenue in our analysis.

Table 16: Multivariate probit regression on complete set of responses.

	Real options use	Real options familiarity	Use of DCF techniques
Revenue (log.)	0.31***	0.27***	0.26***
Industry	0.76***	0.46***	0.32
R&D intensity	0.63**	0.49***	-0.13
Master's degree	-0.2	0.61***	0.21
MBA or Ph.D.	-0.07	0.38*	0.61***
Denmark	0.03	0.53***	-0.30
Norway	0.28	0.53***	0.00
Constant	-3.99***	-3.2***	-0.99*
McFadden R ²	0.19	0.13	0.10

Coefficient estimates marked with *, **, *** are statistically significant at a 10%, 5%, and 1% confidence level. Each regression is estimated on complete set of N=378 observations.

In the first regression, use of real options is the dependent variable. The results show that revenue and R&D intensity both have a significant and positive effect on real options use. We also find a relationship with industry association where the hypothesized real options industries are more likely to use real options than the other industry group. We do not find evidence that firms run by higher educated CFOs are more likely to use real options. Nor do we find any significant difference in real options use between the three Scandinavian countries. The findings from the probit regression are the same as those from the independence tests earlier in the chapter. This indicates that the previously observed and discussed relationships between real options use and company and manager characteristics hold, and were not caused by cross-correlations.

Secondly, we perform the same regression on real options familiarity, and find significant, positive effects from all regressors. A larger company size and high R&D intensity is associated with greater knowledge of real options, as do higher levels of education. CFOs from companies within the hypothesized real options-industries are also more familiar with real options. Furthermore, we find differences between countries, as Danish and Norwegian respondents are more likely to be familiar with real options than their Swedish counterparts. Again the findings from the probit regression are consistent with the observations from the independence tests on real options familiarity discussed earlier. As argued previously, it makes intuitive sense that highly educated CFOs in large, R&D-intensive high-tech firms have greater knowledge of real options. Yet it is remarkable that every single one of these factors has a positive and statistically significant impact.

Our final regression is on the use of DCF techniques. There is a significant and positive relationship between DCF use and company size. Additionally, we find a positive effect from respondents having an MBA or PhD. Apart from these factors, we find no significant effects from any other survey variable or nationality. The results from the regression are again consistent with the independence tests that we have elaborated on. Moreover, we observe that the regression of DCF use has lower explanatory power than the regressions of real options use or familiarity.

However, revenue is not always an accurate descriptor of company size, particularly for multinational firms whose core operations and decision-making are performed elsewhere, with only sales and distribution in Scandinavia. Within the empirical finance literature, the book value of assets is sometimes considered a more appropriate measure of company size. Thus, we attempt to gather asset data from the firms in our sample in order to further investigate the relationship between company size and real options. In order to strengthen our analysis we also attempt to collect capex data from the firms in our sample from financial statements and annual reports¹². Reliable data is obtained from 212 respondents. Results of regressions remain basically the same when we replace revenue by assets or capital expenditures (CAPEX). All these three variables are highly correlated and reflect mostly size of the company. Moreover, CAPEX intensity (CAPEX/assets) variable is not significant either. These results are therefore not included in the paper and are available upon request and in previous versions of this paper.

4 Conclusion

We survey the CFOs of the largest companies of Scandinavia about their capital budgeting process. Real options are the least utilized technique from all the considered methods. Among 384 respondents, only 23 use real options. The utilization rate found is lower than in recent studies from the U.S. and Canada. This finding can be explained by smaller firm size, lower R&D intensity, and lower fraction of technology companies among the Scandinavian firms. Larger companies and companies with higher R&D intensity and capital expenditures are more likely to use real options analysis. The use of real options depends also on industry classification, with higher usage among companies in the energy, oil and gas, healthcare and technology industries. The dominant reason for non-use is a lack of familiarity, where 70% of respondents report to not be familiar with real options concepts and techniques. This sheds new light on the limited use of real options,

¹² For asset data we use the 2010 year-end book value of assets from the balance sheet. For capex data we use an estimate of annual capital expenditures based on the reported investment activities from cash flow statements in 2009, 2010 and 2011.

which has largely been attributed to a lack of top management support and complexity of the techniques. We find that highly educated CFO's from large companies with high R&D- and capex intensity are more likely to be familiar with real options. Additionally, we find that CFOs with MBAs are less likely to be acquainted with real options than those with non-MBA master's degrees. Among non-users familiar with real options, the complexity of the techniques is the greatest hinder for implementation. However, several of the non-users apply real options informally as a way of thinking. Reducing the complexity of the real options approach would help to increase use of real options among practitioners. Our findings support Triantis's (2005) hypothesis that practitioners require simplified real options heuristics rather than advanced computational methods.

5 References

- Amram, M., & Kulatilaka, N. (1999). *Real Options: Managing Strategic Investments in an Uncertain World*. Cambridge, MA: HBS Press.
- Arnold, G. C., & Hatzopoulos, P. D. (2000). The Theory-Practice Gap in Capital Budgeting: Evidence from the United Kingdom. *Journal of Business Finance and Accounting* , 27 (5&6), 603-626.
- Baker, H. K., Dutta, S., & Saadi, S. (2011). Management Views on Real Options in Capital Budgeting. *Journal of Applied Finance* , 21 (1), 18-29.
- Baker, H. K., Singleton, J. C., & Veit, T. (2011). *Survey Research in Corporate Finance: Bridging the Gap between Theory and Practice*. New York: Oxford University Press.
- Block, S. (2007). Are "Real Options" Actually Used in the Real World? *The Engineering Economist* , 52 (3), 255-267.
- Brounen, D., De Jong, A., & Koedijk, K. C. (2004). Corporate Finance in Europe: Confronting Theory with Practice. *Financial Management* , 33 (4), 71-101.
- Busby, J. S., & Pitts, C. G. (1997). Real options in practice: an exploratory survey of how finance officers deal with flexibility in capital appraisal. *Management Accounting Research* , 8 (2), 169-186.
- Copeland, T., & Antikarov, V. (2001). *Real Options: A Practitioner's Guide*. New York: Texere.
- Dixit, A. K., & Pindyck, R. S. (1994). *Investment under Uncertainty*. Princeton, NJ: Princeton University Press.
- Geddes. (1999). Méthodes d'évaluation retenues pour les transactions. *Capital Finance* , 472, 20.
- Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: evidence from the field. *Journal of Financial Economics* , 60 (2-3), 187-243.
- Kester, G. W., & Chong, T. K. (1998). Capital Budgeting Practices of Listed Firms in Singapore. *Singapore Management Review* , 20 (1), 9-23.
- Kulatilaka, N., & Marks, S. G. (1988). The strategic value of flexibility: reducing the ability to compromise. *The American Economic Review* , 78 (3), 574-580.

- McDonald, R. L., & Siegel, D. R. (1986). The Value of Waiting to Invest. *Quarterly Journal of Economics* , 101, 707-728.
- Moore, J. S., & Reichert, A. K. (1983). An Analysis of the Financial Management Techniques Currently Employed by Large U.S. Corporations. *Journal of Business Finance and Accounting* , 10 (4), 623-645.
- Myers, S. C. (1984). Finance Theory and Financial Strategy. *Interfaces* , 14 (1), 126-137.
- Oblak, D., & Helm, R. (1980). Survey and Analysis of Capital Budgeting Methods Used by Multinationals. *Financial Management* , Winter.
- Philippe, H. (2005). Corporate Governance: A New Limit to Real Options Valuation? *Journal of Management and Governance* , 9, 129-149.
- Rigby, D. (2001). Management Tools and Techniques: A Survey. *California Management Review* , 43 (2), 139-160.
- Ryan, P. A., & Ryan, G. P. (2002). Capital Budgeting Practices of the Fortune 1000: How Have Things Changed? *Journal of Business and Management* , 8 (4), 355-364.
- Sandahl, G., & Sjögren, S. (2003). Capital budgeting methods among Sweden's largest groups of companies. The state of the art and a comparison with earlier studies. *International Journal of Production Economics* , 84 (1), 51-69.
- Schwartz, E. S., & Trigeorgis, L. (2001). *Real Options and Investment Under Uncertainty: Classical Readings and Recent Contributions*. Cambridge, MA: MIT Press.
- Siddle, R., & Rigby, D. (2002). *Which management tools are most popular?* European Business Forum.
- Smith, K. W., & Triantis, A. J. (1995). The Value of Options in Strategic Acquisitions. In L. Trigeorgis, *Real Options in Capital Investment* (pp. 135-149). Westport, Ct: Greenwood Publishing Group, Praeger.
- Teach, E. (2003, July/August). Will Real Options Take Root? *CFO Magazine*, pp. 72-76.
- Triantis, A. (2005). Realizing the Potential of Real Options: Does Theory Meet Practice? *Journal of Applied Corporate Finance* , 17 (2), 8-16.
- Triantis, A., & Borison, A. (2001). Real Options: State of Practice. *Journal of Applied Corporate Finance* , 14 (2), 8-24.
- Trigeorgis, L. (1988). A Conceptual Options Framework for Capital Budgeting. *Advances in Futures and Options Research* , 3 (1), 145-167.
- Trigeorgis, L. (1993). Real Options and Interactions with Financial Flexibility. *Financial Management* , Autumn, 202-224.
- Trigeorgis, L. (1996). *Real Options: Managerial Flexibility and Strategy in Resource Allocation*. Boston, MA: The MIT Press.
- van Putten, A. B., & MacMillan, I. C. (2004). Making Real Options Really Work. *Harvard Business Review* , 82 (12), 134.
- Vollrath, R. (2001). Die Berücksichtigung von Handlungsflexibilität bei Investitionsentscheidungen - Eine empirische Untersuchung. In U. Hommel, M. Scholich, & R. Vollrath, *Realoptionen in Der Unternehmenspraxis: Wert Schaffen Durch Flexibilität*. Berlin: Springer.
- Wallace, R. S., & Mellor, C. J. (1988). Nonresponse Bias in Mail Accounting Surveys: A Pedagogical Note. *British Accounting Review* , 20 (2), 131-139.

6 Appendix A – Real Options Surveys

Author (Year)	Population	Response and use of real options
Busby & Pitts (1997)	All firms in the FTSE 100 index in the U.K	44 completed and usable replies. No firms report use of real options.
Geddes (1999)	U.K and Irish companies	2% of the interviewees usually or almost always use real options.
Rigby (2001)	Over 5000 companies from over 20 countries in North America, Europe, Asia, Africa and South America	451 completed surveys globally of which 245 North American responses (and 200 European). 10% real options use globally and 6.5% usage in North America.
Triantis & Borison (2001)	34 selected U.S. companies using real options	Interviews with 39 individuals from these companies. About one third of companies have only adopted only a conceptual real options approach
Vollrath (2001)	A selection of German's largest companies	Real options are the least popular technique and only 30-35% are familiar with real options methodology
Graham & Harvey (2001)	4400 U.S. firms with managers in the Financial Executives Institute	392 completed responses. 27% report use of real options.
Siddle & Rigby (2002)	Over 5000 companies from over 20 countries in North America, Europe, Asia, Africa and South America	440 completed surveys globally of which 245 North American. 9% real options use globally.
Ryan & Ryan (2002)	All the Fortune 1000 companies	205 usable responses. 11% of respondents report to use real options always, often or sometimes.
Sandahl & Sjögren (2003)	Sweden's 500 largest companies	129 responding firms, of which none (0%) report to use real options analysis.
Brounen et al. (2004)	6500 companies from the U.K, Germany, France and the Netherlands	313 completed responses. 29% use real options always or often in the U.K, 34% in the Netherlands, 44% in Germany and 53% in France.
Block (2007)	All the Fortune 1000 companies	279 completed responses. 14.3% report to use real options.
Baker et al. (2011)	The 847 Canadian firms listed on the Toronto Stock Exchange	214 usable responses. 17% report to use real options for capital budgeting decisions.

7 Appendix B – Survey Instrument

Demographic Questions

1. What level of education does your company's CFO have? (Select all that apply)
 1. Undergraduate degree
 2. Non-MBA master's degree
 3. MBA or equivalent
 4. PhD
 5. Other

2. What is your company's CFO's field of education? (Select all that apply)
 1. Business/management
 2. Science/engineering
 3. Other

3. My company/organization primarily operates within the following industry:
 1. Oil/gas & oil service
 2. Energy
 3. Construction
 4. Retail & wholesale
 5. Transportation
 6. Food & beverages
 7. Bank/finance & insurance
 8. Communications/media
 9. Healthcare
 10. Technology (software, biotech, etc.)
 11. Other

4. What is your company's profit margin (EBITDA margin)?
 1. <0%
 2. 0-4%
 3. 5-9%
 4. 10-14%
 5. 15 - 19%
 6. >20%
 7. Not applicable

5. What percentage of total revenue is spent on R&D activities?
 1. 0-1%
 2. 1-2%
 3. 2-3%
 4. 3-4%
 5. 4-5%
 6. 5-6%
 7. 6-7%
 8. 7-8%
 9. >8%

Main Objective Questions

6. Does your company use real options analysis to evaluate projects/investments?¹³
1. Yes
 2. No
7. Which of the following capital budgeting techniques does your company use? (Select all that apply)
1. Net present value (NPV)
 2. Internal rate of return (IRR)
 3. Hurdle rate
 4. Earnings multiple approach
 5. Payback period
 6. Other

Main Questions for Non-Users

8. Are you familiar with the principles and techniques for real options analysis?
1. Yes
 2. No¹⁴
9. Why does your company not use real options analysis?
1. Lack of top management support
 2. Requires too much sophistication
 3. Encourages too much risk taking
 4. Other

Main Questions for Users

10. How does your company use real options analysis?
1. Primary capital budgeting technique
 2. One of several techniques
 3. To supplement and support results from other methods
 4. Other
11. My company uses real options analysis for the following decisions: (Select all that apply)
1. New product introduction
 2. Research and development
 3. Mergers or acquisitions
 4. Foreign investment
 5. Other

¹³ Response to this question initiates branching

¹⁴ Respondents selecting this answer are directed out of the questionnaire

- 12.** Which techniques does your company use for real options analysis? (Select all that apply)
1. Binomial lattices
 2. Risk-adjusted decision trees
 3. Monte Carlo simulation
 4. Black-Scholes option pricing model
 5. Other
- 13.** Does your company continue to use real options analysis once an investment decision has been made (e.g. to decide whether to expand or abandon a project)?
1. Yes
 2. No
- 14.** Would you like us to e-mail you a PDF version of our completed study?
1. Yes
 2. No