

Behavioral Biases in Capital Budgeting: An Experimental Study of the Effects on Escalation of Commitment Given Different Capital Budgeting Methods*

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Abstract. This study examines if decision-makers using less sophisticated capital budgeting methods, such as Net present value and Payback, display a higher level of escalation of commitment to a failing project, compared to decision-makers using more sophisticated capital budgeting methods, such as Real options. Past studies advocates superiority in decision-making when incorporating more sophisticated models into a company's capital budgeting. The findings coincide with previous studies; that decision-makers explicitly using Real options display a lower escalation of commitment compared to decision-makers using Net present value. However, no difference in escalation of commitment was recorded between decision-makers using Payback and decision-makers using Real options.

Аннотация. Это исследование рассматривает особенности использования более простых методов бюджетирования капитала – таких как чистая приведенная стоимость и окупаемость – в сравнении с более сложными методами, такими как реальные опционы. Предшествующие исследования доказывают преимущества использования более сложных моделей при принятии решений. Результаты совпадают с предыдущими исследованиями: руководители, использующие в явном виде реальные опционы, показывают меньший рост эскалации обязательства по сравнению с теми, кто принимал решения на основе чистой приведенной стоимости. Однако разницы в эскалации обязательства не было отмечено между руководителями, принимающими решения на основе метода окупаемости, и теми, кто использовал реальные опционы.

Key words: Real options, Net present value, Payback, capital budgeting, escalation of commitment.

1. INTRODUCTION

This study examines if decision-makers using less sophisticated capital budgeting methods, such as Net present value and Payback, display a higher level of escalation of commitment to a failing project, compared to decision-makers using more sophisticated capital budgeting methods, such as Real options. The definition of escalation of commitment is when decision-makers continue to dedicate resources to a failing project influenced by previously invested resources (Staw, 1976).

In previous research, Denison (2009) conducted an experiment testing the effects of escalation of commitment to a failing course of action, by comparing investment recommendations between participants

using explicitly Net present value and Real options. Denison's results of the experiment indicated that participants using Real options were less likely to exhibit escalation of commitment compared to participants using Net present value, and were also more likely to abandon unprofitable projects.

Advocates arguing to incorporate Real options in capital budgeting claim that more sophisticated capital budgeting leads to superior decision-making compared to less sophisticated capital budgeting methods (Antikarov and Copeland, 2001). The superiority of sophisticated capital budgeting methods derives from the higher quality of information being available to the decision-makers (Denison, 2009). Less sophisticated capital budgeting methods, such

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as discounted cash flow models, serve as appropriate valuation methods for cash cow businesses, but fall short when implementing substantial growth opportunities, R&D expenditure, intangible assets and abandonment value in valuation analysis (Myers, 1984). With discounted cash flow models understating the option value attached to growing, profitable businesses (Myers, 1984), the information used in these methods is presumed inferior to the information used in real options analysis. Studies have claimed that by exclusively using Real options analysis, the option of project abandonment becomes more cognitively accessible to decision-makers (Denison, 2009), and helps overcome “antifailure bias” (McGarth, 1999). This would suggest that decision-makers using Real options in their capital budgeting would be likely to display a lower level of escalation of commitment in failing projects compared to decision-makers using Net present value and Payback.

Regardless of theoretical superiority of incorporating a higher sophistication in capital budgeting, empirical findings suggest that in real life, managers oppose incorporating real options into capital budgeting (see Pike, 1996; Graham and Harvey, 2001; Sandahl and Sjögren, 2003; Block, 2007; Brunzell, Liljebloom and Vaihekoski, 2011). Block’s (2007) findings suggest that inadequate understanding of real options in top management, and not wanting to shift decision-making to mathematicians and decision scientists, makes managers oppose the usage of real options, and instead rely on discounted cash flow and payback models, which they understand.

Irrational behavior due to escalation of commitment exists according to Friedman *et al.* (2007) in the real world on a grand scale. Decision-makers justify continuous resource spending into failing projects with the amount of resources already been spent, instead of considering abandonment. A few real world examples of escalation of commitment behavior can be illustrated with the Coke and Pepsi wars, Campeau auction, Maxwell House and Folgers advertising war and NASA’s space shuttle Columbia, all resulting in an unnecessary spending of resources (Friedman *et al.*, 2007). If instead decision-makers would become aware of the irrational behavior because of the escalation of commitment bias, it could potentially prevent project cost overruns. The purpose of this paper is to examine if more sophisticated capital budgeting methods lead to lower escalation of commitment, thereby preventing project cost overruns and leading to more profitable investment decisions.

To answer the research question, an experiment was conducted in which participants used one of

three capital budgeting methods: Real options, Net present value, or Payback. By evaluating a project using the assigned capital budgeting method, the participants’ recommendations to continue an unprofitable project were measured. Since in the experiment, a uniform decision should have been made regardless of capital budgeting method used, deviating behavior between capital budgeting methods was due to behavioral effects.

The difference between this study and previous studies (see Denison, 2009) is the inclusion of the capital budgeting method Payback. Payback is included in this study because of its historically persistent extensive use in capital budgeting (see Pike, 1996; Graham and Harvey, 2001; Sandahl and Sjögren, 2003; Brunzell, Liljebloom and Vaihekoski, 2011), and low sophistication.

The findings in this paper indicate that participants using Real options were not only more aware of a potential project failure compared to Net present value and Payback participants, but were also more likely to abandon a failing project compared to Net present value participants. However no difference was recorded in the likelihood of project abandonment between participants explicitly using Real options compared to participants explicitly using Payback. The lower escalation of commitment in Real options compared to Net present value participants was recorded even though all participants were provided the same information about cash flows, abandonment value and sunk costs.

The remainder of this paper is structured as follows. Section 2 presents relevant literature related to the behavioral biases escalation of commitment and sunk cost fallacy, followed by a review of the three capital budgeting methods used in the experiment. Section 3 formulates and presents the hypothesis. Section 4 describes the methodology of the experiment and statistical methods used. Section 5 presents and analyzes the results of the experiment, provides limitations of the study and concluding remarks.

2. THEORY

2.1. BACKGROUND

Expected utility theory (EUT) suggests that rational investors pursue utility maximization in their investments. In 1979 Daniel Kahneman and Amos Tversky found human behavior violating the axioms of EUT, and proposed an alternative model for determining decision-making under risk. Kahneman and Tversky’s (1979) prospect theory motivates that a person’s behavior is changing depending on if the person is winning or losing. If a person is winning (situated in the

gain domain) the person will display risk aversion behavior (favor certainty before uncertainty), while if the person is losing (situated in the loss domain) the person will display risk seeking behavior (favor uncertainty before certainty). Further research based on prospect theory (see Thaler, 1980; Statman and Caldwell, 1987) developed behavioral theories such as mental accounting, behavior enhanced with emotions of pride/regret and escalation of commitment, which all influence abandonment decisions in executive management.

Statman and Caldwell (1987) argued, based on Kahneman and Tversky's idea, that: "Behavioral finance provides a framework, supported by experiments, that is consistent with the tendency to resist project termination". Managers opposing project abandonment will overinvest in projects, thereby diverging from profit maximization decisions.

The two main behavioral biases discussed in this paper, which influence abandonment decisions, are Escalation of commitment and Sunk cost fallacy. Both behavioral biases emerge from mental accounting, introduced by Thaler (1980) and exemplified by Statman and Caldwell (1987).

2.2. MENTAL ACCOUNTING

While making decisions of abandonment or continuation, managers are faced with making choices based on uncertain cash flows. Managers that follow the net present value analysis, frame the cash flows according to economic accounting (Statman and Caldwell, 1987). But instead of using economic accounting managers use mental accounting to frame future cash flows, thereby including sunk costs in their decision-making (Statman and Caldwell, 1987).

Kahneman and Tversky's (1979) prospect theory divides the decision-making process into two phases. Firstly the manager frames the project by establishing mental accounts. Secondly the manager evaluates the project given the mental accounts created.

Consider the following example:

A project has lost \$2,000 and the manager is given two options:

1) Continue the project with equal probability to gain \$2,000 or gain nothing.

2) Abandon the project and gain \$1,000 for sure.

Depending on if the manager ignores the sunk costs or not, it will either put the manager in the loss domain (include sunk costs) or gain domain (ignore sunk costs) of the value function.

According to economic accounting the initial loss of \$2,000 should be considered a sunk cost, meaning that the account should be closed with a realized loss of \$2,000. The options should then be considered as a 50–50 gamble of \$2,000 or nothing for alternative 1, or \$1,000 for sure for alternative 2. According to prospect theory a person displays risk aversion behavior in the gain domain (if ignoring sunk costs), and option 2 should therefore be chosen, as certainty is favored before uncertainty.

Conversely, if the manager is reluctant to realize losses, the first account will not be closed but instead it will be evaluated with the two options. When including sunk costs in the decision-making, the manager frames the alternatives in the loss domain of the value function. This leads the manager to frame the options as either a sure loss of \$1,000 if option 2 is chosen, or a 50–50 gamble of outcome 0 or a loss of \$2,000 if option 1 is chosen. According to prospect theory people are reluctant to realize sure losses and will instead display risk-seeking behavior in the loss domain in hopes of turning the loss into a gain or at least to get even. This type of behavior usually leads to even greater losses and was named "get-evenitis" by Shefrin (1999), and defines the behavior of holding on to a failing investment in hopes of getting even.

2.3. BIASES AND HOW THEY RELATE TO EXIT STRATEGIES

Kahneman and Tversky's (1979) prospect theory and Statman and Caldwell's (1987) mental accounting theory provide explanations to behavioral biases displayed by managers in project termination decisions. Horn *et al.* (2006) divides the decision-making process for project termination into three steps: An analysis step, a decision step and a step to proceed



Figure 1. 3-step decision-making process for project termination by Horn *et al.* (2006) including behavioral biases. In the first step the company analyzes if their projects are meeting expectations or not. If not, in the second step the company decides if they should terminate the project or continue with it. If a termination decision occurs, in the third step, the executive management works out the details around the project termination (for example the price of the project if it will be sold).

with the abandonment. In Figure 1 the three steps toward project termination and behavioral biases affecting each corresponding step are presented.

This study focuses on step 2, the decision step of project termination, and the effects of the behavioral biases escalation of commitment on project abandonment decisions.

2.3.1. Escalation of commitment and sunk cost fallacy

“Escalation of commitment and the sunk cost fallacy are essentially the same phenomenon: both lead decision-makers to exaggerate investments following previous commitment of resources. One distinction is that escalation may be associated with forms of commitment other than previous expenditures of economic resources, or sunk costs” (Camerer and Weber, 1999).

According to Statman and Caldwell (1987) commitment has both positive and negative behavioral sides in people. The positive side of commitment according to Statman and Caldwell (1987) is the persistence in pursuing goals, a motivator to work harder and accomplish more, and also to generate the force needed to complete difficult projects. Conversely commitment also entraps people in losing projects.

When evaluating a project, a manager committed to the project will take all costs into consideration when making the decision to abandon the project or not. In fact, variables such as sunk costs should be disregarded from the calculations. Statman and Caldwell (1987) argue that the tendency to become committed is deeply rooted in us, and that we lack a mechanism to turn it off or regulate it.

Few studies have been made examining the effects of capital budgeting methods on escalation of commitment, and if different capital budgeting methods result in a diverging level of escalation of commitment. Denison (2009) found indications of more sophisticated capital budgeting models, like real options (RO), resulting in a lower level of escalation of commitment in failing projects compared to less sophisticated capital budgeting models, like net present value. The effects of different capital budgeting methods on escalation of commitment are unclear, and apart from Denison’s study, no other studies have examined the direct effects of capital budgeting methods on escalation of commitment.

2.4 Capital Budgeting

A variety of methods and techniques are available for managers to alleviate capital budgeting procedures (Horngren, Foster, and Datar, 1997). The use of these capital budgeting methods and techniques deviate between different managers (Brijlal, Quesada, 2011),

or are by some ignored altogether in the decision-making process (McDonald, 2000). But over the past 3 decades companies have started to realize the importance of incorporating the possibility of project failure in capital budgeting decisions (Pike, 1996), thereby beginning to use more sophisticated capital budgeting methods to a higher extent. Some researchers argue that a higher degree of sophistication leads to optimal investment strategies (see Lander and Pinches, 1998; Block, 2007; Antikarov and Cope-land, 2001), primarily by using RO. Other studies contradict the theory of more sophisticated capital budgeting methods being superior by arguing, “Empirical research has provided some, but very limited, support for the real-world applicability of real options models” (Chance and Peterson, 2002).

Regardless of the theoretical superiority of using RO in capital budgeting, in practice companies seem to continue using Payback (PB) and Net present value (NPV) as their main capital budgeting methods (see Pike, 1996; Graham and Harvey, 2001; Sandahl and Sjögren, 2003; Brunzell, Liljebloom and Vaihekoski, 2011). Block (2007) argues that sophisticated capital budgeting methods like RO are rarely used apart by certain industries such as, technology, energy, and utilities, where management is composed of specialists in science and math.

A brief description of each of the capital budgeting methods used in the experiment is provided in the following section.

2.4.1 Payback

Payback is a simplistic method calculating the number of periods required to pay back the net investment. A shorter PB period is considered superior to a longer one, since it allows the resources to be reused more quickly (Farris *et al.*, 2010).

Academic literature has repeatedly illustrated problems associated with simple capital budgeting techniques such as PB, as it leads to non-firm value maximization investment decisions (Hatfield *et al.*, 2011). The 2 main problems emerging from PB analysis in capital budgeting, are that firstly it neglects time value of money, and secondly that it disregards cash flows generated by the investment after the PB period.

A common problem with PB analysis is that projects with a high cash flow in the beginning of the project are preferred, because of a shorter PB ratio, to projects with stable cash flows over a long period of time, regardless of their discounted cash flow value. If projects with lower value are chosen because of their shorter PB ratio, the company is not maximizing shareholder value. Regardless of the critique, the

usage of these simple methods is justified by easily interpreted results and calculations, requiring little or no knowledge in finance (Bower and Lessard as cited in Hatfield *et al.*, 2011).

No research has been made examining the relationship between PB and behavioral biases such as escalation of commitment. However, assuming PB being a hurdle rate whether to accept a project or reject it, research claims that self set hurdle rates by decision-makers result in lower escalation of commitment, compared to organization set hurdle rates (Cheng *et al.*, 2003).

An approach to decrease escalation of commitment in decision-makers that use the capital budgeting method payback would be to let the decision-maker set his own hurdle rate for when a project should be accepted or rejected (Statman and Caldwell, 1987; Cheng *et al.*, 2003).

2.4.2 Net present value

Net present value incorporates time value of money and presents the difference between the sum of discounted cash inflows and the sum of discounted cash outflows. Therefore if NPV is positive the project should be undertaken, whereas if NPV is negative the project should be abandoned. Variations of NPV calculations also take into account the abandonment value often comparing it to the NPV of the cash flows to determine if a project should be continued or abandoned (Denison, 2009). If the NPV of cash flows is greater (lower) than the abandonment value, the project should be undertaken (abandoned). This NPV variation resembles real options valuation discussed further below.

Literature suggests that NPV in theory is superior to other capital budgeting methods, since it consistently chooses the projects that maximize firm value and thereby shareholders' wealth (Hatfield *et al.*, 2011). Primary critique against NPV is that contrary to RO it does not take into account managerial flexibility in project valuation and assumes the cash flows being fixed. This undervalues the projects by not taking into consideration the options value.

Past research claims that decision-makers using NPV in capital budgeting display a higher level of escalation of commitment compared to decision-makers using RO. The higher level of escalation of commitment from using NPV derives from the inferior quality of information available to decision-makers (Denison, 2009). Myers (1984) argues that the type of information used in NPV valuations neglects the value of abandonment, growth opportunities and intangible assets. Neglecting the abandonment value in capital budgeting further leads to a lower construct accessibility of a possible project abandonment in

managers, thereby leading to a higher level of escalation of commitment (Denison, 2009).

2.4.3 Real options

The term of real options was introduced by Myers (1977) and defined as real options are growth opportunities for a firm whose value depends on the firm's future investments. This would divide the value of a firm into the value of the firm's assets and the value of the firm's growth options (Collan and Kinnunen, 2009). RO determines firm value by taking into account the variety of possible management options (managerial flexibility) in an investment opportunity. The RO valuation incorporates options such as expansion or abandonment of the investment in the calculated value, where the highest of the possible values is chosen. Denison (2009) explains, "The use of real options in capital budgeting basically involves considering possible decision points that could arise as a project unfolds and the best response of management at each of these decision points. The value of the project should management choose the best option at each of these points is calculated, and a weighted average of these possible outcomes is taken based on their probability of occurrence".

A potential shortfall in RO is the level of sophistication the model requires. Complicated mathematical models intimidate managers whose choice is to instead use simplistic capital budgeting models that they feel comfortable using and interpreting (Lander and Pinches, 1998). Additionally the assumptions required for performing RO modeling are often violated in practice (Lander and Pinches, 1998).

2.5 HYPOTHESIS

Accessibility of cognitive constructs, such as personality traits, attitudes and choice options, is defined by psychology as the ease with which these constructs can be brought to mind (Higgins, 1996). The construct accessibility can be increased through repetition (Higgins and King, 1981) or through task instructions (Higgins and Chaires, 1980)

By failing to incorporate RO in the decision phase, executive management ignores the value of managerial flexibility of early project termination. However managers that do incorporate RO models in their capital budgeting, will repeatedly be exposed to the option of early abandonment in contrast to managers that only use NPV or PB. This will result in RO users having an increased construct accessibility of early project abandonment due to the construct of early project termination being activated more frequently through written instructions in RO participants compared to NPV or PB participants (Higgins *et al.*, 1982).

Additionally Posavac *et al.* (1997) states that when decision alternatives are salient, the decision-maker will be more likely to choose the preferred alternative. However, if the decision alternatives are left unspecified, the decision-maker will have to access the construct from memory, which potentially leads to a complete negligence of the preferred alternative. The negligence of the preferred alternative occurs according to Posavac (1997) when the accessibility is insufficient to retrieve the preferred alternative from memory.

Since the preferred alternative in this experiment is early project abandonment, decision-makers using the capital budgeting method RO, which has task instructions and salient decision alternatives about early project abandonment, should display a lower level of escalation of commitment compared to decision-makers using NPV or PB.

Hypothesis 1:

Project abandonment decisions in the case of unprofitable projects will be more probable when Real options are used explicitly for project decision-making compared to solely using Payback or Net present value.

Hypothesis 2:

Project abandonment decisions should not vary between capital budgeting methods Payback and Net present value, which do not take into account early project abandonment value in their calculations.

3. METHODOLOGY

The experiment was a quantitative study conducted through an online survey. In order to constrain unauthorized people from having access to the experiment, the survey was only accessible to selected participants at Gothenburg School of Business, Economics, and Law chosen prior to the experiment.

A potential shortfall of the experiment is the simplified experimental setting used, distant from capital budgeting situations in reality. This should not have an effect on the results, as there is a close similarity between experimental surveys and realistic field studies in research on organizational behavior (Locke, 1986). Additionally Griffin and Kacmar (1991) argue that experimental surveys provide a valid and useful approach in many situations.

3.1 Participants

The participants consisted of 293 past and current MSc Finance, MSc Economics, and Bachelor students with Corporate Finance major from University of Gothenburg School of Business, Economics, and Law in Gothenburg, Sweden.

The distribution of participants was 147 Corporate Finance students (50.17%), 107 Finance students

(36.52%) and 39 Economics students (13.31%). The participants were chosen because of their theoretical knowledge of the capital budgeting methods used in the experiment. Use of students as subjects is consistent with the recommendations in Gordon *et al.* (1987) and is justified by the findings of Ashton and Kramer (1980) displaying similar results with students and nonstudents in decision-making studies.

A total of 48 students completed the experiment, yielding a 16.38% response rate and were divided accordingly among each capital budgeting method: 16 NPV responses, 15 RO responses, and 17 PB responses. The average age of the 48 participants completing the experiment was 23.46 years and 39.58% were female.

3.2 CASE GIVEN TO PARTICIPANTS, APPENDIX B

The case provided to each participant regarded a development of a new cell phone hard drive. This new hard drive had a higher storage capacity while maintaining production costs and dimensions constant compared to current cell phone hard drives. Each of the participants played the role of a controller for Ericsson AB who was responsible for project evaluations, and was given an example with calculations of how to use their assigned capital budgeting method. The example provided was given to the participants to guarantee an understanding on how to solve the case, and the participants could at any time refer back to the example while performing their own calculations. Furthermore the participants received information about the forecasted cash flows, project lifetime, probability of success/failure and abandonment value of the Ericsson cell phone HDD project. PB participants received exclusive information about a historical average accepted payback period of 3 years for past projects undertaken by Ericsson to use as a reference point in their investment recommendations.

Performing the calculations correctly for the Ericsson Cell Phone HDD project, NPV and RO calculations yielded values of positive \$26,000,149.51 and \$29,091,031.42 respectively, while PB yielded a payback period of 2.27 years. Correct calculations by the participants should therefore unambiguously lead to funding the project regardless of capital budgeting method used.

After performing the initial project evaluation, additional information explaining a project setback was presented to all case participants. The setback was due to an unexpected competitor entering the market with a superior product. All participants received information about current level of project completion, sunk costs and modified forecasted cash flows based on new demand. Forecasted cash flows became

definite after the project setback and the calculations for NPV and RO yielded the same positive project value of \$42,272,795.23, while the payback period for the project increased to 5 years. Simultaneously Ericsson AB could sell the project for 65% of invested capital, thereby yielding an abandonment value of \$55,250,000, being \$12,977,204.77 higher compared to the calculated NPV and RO value. Correct calculations would indicate an abandonment being more profitable compared to a project continuation, which therefore should lead to an unambiguous choice of project abandonment in NPV and RO participants. The calculated payback period would exceed the average accepted payback period of 3 years, and, correspondingly to NPV and RO, should lead to project abandonment.

3.3 PROCEDURE FOR CASE STUDY

The participants were randomly assigned one of the three capital budgeting methods (RO, NPV and PB), and contacted by email inviting them to participate in the experiment. In the email, participants were asked to take part in an experiment by solving a case study explicitly using the assigned capital budgeting method.

After having read the Ericsson Cell Phone HDD case, each participant was asked to value the project by using the appropriate capital budgeting method. Based on the project value each participant provided a recommendation of whether to fund the project or not on a 10-point scale (1 not likely at all and 10 extremely likely) and a short motivation (1–2 sentences) defending their choice. Because of the apparent decision to accept the project, recommendations below 5 indicated a lack of understanding of the capital budgeting method used or incorrect calculations. 2 participants using RO calculations (4.17% of total, 13.33% of total RO participants) answered with recommendation values below 5, and therefore their values were excluded from the future analysis.

After the initial recommendation the participants were informed about a setback in the project. They were asked to revalue the project by using the same capital budgeting method as for their initial valuation, and provide a recommendation whether to continue the project or not on a 10-point scale (1 not likely at all and 10 extremely likely) and a short motivation (1–2 sentences) defending their choice.

3.4 MANIPULATION CHECK AND DEMOGRAPHIC QUESTIONS

Following the project valuation and investment recommendations participants were asked to answer a series of manipulation check questions and state-

ments. The answers were measured on a 10-point scale with 1 being “Strongly disagree” and 10 being “Strongly agree”. The questions were “To what extent do you agree that the firm uses the given capital budgeting method to evaluate its investment decision?”, “I considered the possibility that the cell phone HDD project could fail before making my recommendation about whether to undertake the project”, “I considered the possibility that the cell phone HDD project could fail before making my recommendation as to whether to continue developing the project”, “The case was difficult to do”, and “The case was very realistic” defining variables Eval, PFail1, PFail2, Diff and Rea respectively.

Following the manipulation check questions, all participants were asked the same demographic questions to determine the focus of study, previous work experience, age, gender and theoretical knowledge and practical usage of the three capital budgeting methods.

3.5 STATISTICS

The experiment was a repeated measure design where participants were assumed to be the same across the three capital budgeting methods. The between-subjects variable was the capital budgeting method (CapBud), which was manipulated at three levels (RO, NPV, PB). The within-subjects variable, time of recommendation (Time), was manipulated at two levels (Time1 and Time2).

CapBud, the first independent variable, was manipulated at three levels. Participants were randomly assigned to one of the three capital budgeting methods used and asked to explicitly use the assigned method (PB, NPV, or RO) in their investment calculations. The second independent variable, Time, was manipulated at 2 levels. Participants were asked to provide investment recommendations at two points in time, the first being the initial investment decision (Time 1) and the second deciding whether to continue the project after the setback or not (Time 2).

The dependent variable to test both hypotheses is the recommendation to continue the project (RCP) and is measured at two different times. At Time 1, RCP was measured to validate knowledge of the participants and to eliminate potential outliers skewing the results, and at Time 2 measuring the degree of escalation of commitment. A higher RCP score at Time 2 would indicate a higher degree of escalation of commitment due to opposition of project abandonment by the participant.

The most common method of measuring escalation of commitment is in monetary commitment. In this experiment, similarly to Kadous and Sedor (2004)

and Denison (2009), escalation of commitment is measured on a scale indicating the likelihood of recommending a project continuation.

3.6 BIAS AND OTHER DATA ISSUES

Due to a low response rate two tests were run to investigate possible non-response bias. To do this an additional email was sent out to all participants asking those that did not participate in the case to answer two questions. The questions established age and determined knowledge in the three capital budgeting methods RO, NPV and PB.

Assuming only participants not having done the case study replied to the email a total of 86 (29.35% of total number of participants) new replies were recorded. The answers from both groups (those having done the case and those that did not do the case) were statistically compared to each other to determine if the sample was a good representation of the population. The questions to establish age and determine knowledge in the capital budgeting methods used were the same for both groups.

No difference was recorded between the knowledge in NPV and PB since all participants (100% of those that did the case and those that did not do the case) answered they were familiar with the two capital budgeting methods. A statistical comparison was therefore only made for age and familiarity with RO.

The answers from the follow-up email defined two variables: The variable RO was as a dummy variable measuring if they had previous knowledge about RO (1 had knowledge or 0 did not have knowledge) and Age measuring the age of the respondents. The two variables were compared between groups (those having done the case and those that did not do the case) to test if the sample of students having done the case was a good representation of the population.

The results showed that both tests were not significantly different from each other and therefore indicated that the sample was a good representation of the population (RO $p=0.721$ and Age $p=0.422$).

4. EMPIRICAL RESULTS

4.1 MANIPULATION CHECK QUESTIONS

4.1.1 Manipulation check questions results

The results in Table 1 show the mean value for each of the manipulation check questions and Table 2 shows the significance between the different capital budgeting methods for each question. The manipulation check questions displayed significant differences in three out of five questions (see Table 2). Variables Diff ($p=0.168$) and Rea ($p=0.454$) measuring: How dif-

Table 1. Mean values for Manipulation check questions.

Mean	RO	NPV	PB
Eval	9.46	7.94	6.06
PFail1	9.15	6.06	5.00
PFail2	8.85	6.19	4.53
Diff	2.62	1.88	2.71
Rea	7.69	7.06	7.71

Mean value of manipulation check questions on a 10-point scale labeled (1 "Not likely at all" and 10 "Extremely likely") for capital budgeting methods RO, NPV and PB. Definition of variables: Eval "Evaluation of capital budgeting method", PFail1 "Awareness of project failure at Time 1", PFail2 "Awareness of project failure at Time 2", Diff "Difficulty of the case" and Rea "Realism of the case".

icult the case was, and How realistic the case was, were between the capital budgeting methods not significantly different from each other (see Table 2). The p -value for variable Diff and Rea indicates that the participants found the case of equal difficulty and equally realistic, independent of capital budgeting method assigned.

Variables Eval, PFail1, and PFail2, measuring the evaluation of capital budgeting method used and awareness of project failure at Time1 and Time2, each had a significance of $p<0.05$, thereby indicating a difference between the three capital budgeting methods (see Table 2).

Since a rejection of the null hypothesis ($H_0: m_1=m_2=m_3$, where m_1 = Mean of RO, m_2 = Mean of NPV and m_3 = Mean of PB) in Table 2 only indicates a significant difference between three variables, but not between which variables, a *post hoc* test is required to determine which variables are significantly different from the rest. A *post hoc* Bonferroni test was used to identify which capital budgeting method (s) the significance derived from (see Table 6 Appendix A)

Table 6 indicates that RO ($p=0,00$) and NPV ($p=0,042$) were considered as significantly better capital budgeting methods compared to PB for project evaluation. Regarding variable PFail1 the participants demonstrated a higher awareness of project failure in their initial calculations by using RO compared to NPV ($p=0,00$) and PB ($p=0,00$). For PFail2, awareness of project failure after the setback was again significantly higher in participants using RO compared to NPV ($p=0,00$) and PB ($p=0,00$), but also between NPV and PB ($p=0,008$).

4.1.2 Manipulation check questions analysis

A significant difference in variable Eval was anticipated. This can be explained through academia arguing

Table 2. One-way ANOVA for Manipulation check questions.

		Sum of Squares	df	Mean Square	F	Sig.
Eval	Between Groups	86.999	2	43.500	9.788	.000
	Within Groups	191.109	43	4.444		
	Total	278.109	45			
PFail1	Between Groups	132.783	2	66.392	19.739	.000
	Within Groups	144.630	43	3.363		
	Total	277.413	45			
PFail2	Between Groups	137.744	2	68.872	30.732	.000
	Within Groups	96.365	43	2.241		
	Total	234.109	45			
Diff	Between Groups	6.600	2	3.300	1.858	.168
	Within Groups	76.356	43	1.776		
	Total	82.957	45			
Rea	Between Groups	4.242	2	2.121	.805	.454
	Within Groups	113.236	43	2.633		
	Total	117.478	45			

One-way Anova output. The table displays between group significance in manipulation check question variables. Statistically significant difference between capital budgeting methods when Sig > 0,05.

that more sophisticated capital budgeting methods yields superior results (Lander and Pinches, 1998; Block, 2007; Antikarov and Copeland, 2001), and students influenced by academia support the same opinion. Surprisingly there was no significant difference between RO and NPV ($p=0.178$), meaning that the participants rated both as equally good methods for project evaluation.

The RO results for both PFail1 and PFail2 validated previous research indicating a higher construct accessibility of the possibility of early project abandonment when incorporating RO in capital budgeting (see Denison, 2009). This means that the RO participants, by including the abandonment value of the project in their calculations, increased their construct accessibility of early project termination through written task instructions, in contrast to NPV and PB participants.

The higher awareness of project failure between NPV and PB might derive from NPV yielding a negative value at Time 2 for certain participants (section 4.3.1). The negative NPV would indicate that the project has failed, thereby increasing NPV participants' awareness of project failure at Time 2 compared to PB participants.

4.2 RECOMMENDATION OF CONTINUING PROJECT

4.2.1 Recommendation of continuing project Results

The two-way Anova test results in Table 3, display the variable Time ($p=0.000$) and the interaction between Time and CapBud ($p=0.001$) both being significant between capital budgeting methods RO, NPV and PB. The interaction between Time and CapBud suggests that the change in RCP between Time 1 and Time 2 was significantly different between the capital budgeting methods.

Table 4 presents the mean RCP2 value for all three capital budgeting methods used. Since, in the case of the experiment, the economically profitable decision was to abandon the project, a higher RCP2 value indicated a higher degree of escalation of commitment. According to Table 4, NPV participants displayed the highest level of escalation of commitment (4.688) among the three capital budgeting methods, followed by PB (3.588) and RO (2.077) participants.

Table 5 displays the results of the one-way Anova *post hoc* Benferroni test, measuring differences in RCP2 given different capital budgeting methods. The results presented in Table 5 show that RO par-

Table 3. Two-way ANOVA within-subjects effect.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	680.421	1	680.421	211.711	.000
Time * CapBud	49.019	2	24.510	7.626	.001
Error (Time)	138.198	43	3.214		

Two-way Anova within-subjects effect output. Determining significance of Time and Time*CapBud between capital budgeting methods using RCP for Time 1 and Time 2.

Table 4. Average RCP for initial and continuing decision.

Capital Budgeting		Mean
RO	RCP2	2.077
NPV	RCP2	4.688
PB	RCP2	3.588

Average RCP value at time 2 (RCP2) for RO, NPV and PB.

Participants displayed a significantly lower level of escalation of commitment compared to NPV participants ($p=0.008$) but not compared to PB participants ($p=0.200$). No significant difference in RCP2 was noted between NPV and PB participants ($p=0.465$).

4.2.2 Recommendation of continuing project analysis

The results for Time being a significant variable (Table 3) suggest that the participants were aware of a decrease in profitability after the project setback. As a result, the participants lowered their investment recommendation for project continuation compared to their initial investment recommendation. The result strengthens the validity of the experiment as it indicates a non-random difference in RCP between Time 1 and Time 2.

Combining the results from Table 5 and Table 2 indicates that RO participants not only had a higher awareness of project failure, but also were more likely to abandon an unprofitable project compared to NPV users. These findings are consistent with the findings of Denison (2009) and Posavac *et al.* (1997), which advocate higher construct accessibility given salient decision alternatives. PB participants, who were least aware of the possibility of a project failure (see Table 1), did not display a significantly higher level of escalation of commitment compared to NPV ($p=0.465$) or RO ($p=0.200$) participants. The insignificant difference in RCP2 between RO and PB indicates that no difference in escalation of commitment exists among the participants using RO and PB, which potentially could explain the extensive use of

PB by companies (see Pike, 1996; Graham and Harvey, 2001; Sandahl and Sjögren, 2003) and leads to a rejection of hypothesis 1. The statistically insignificant difference between PB and RO could potentially derive from the inclusion of sunk costs by all PB participants. When case participants included sunk costs in their calculations of RCP2, it resulted in negative RO and NPV valuations and a payback ratio exceeding the average accepted payback ratio for the project, thereby informing the participant to terminate the project. The reason why more participants using PB included sunk costs in their calculations compared to participants using NPV and RO could derive from the lack of academic support (Hatfield *et al.*, 2011) for PB, resulting in a lower construct accessibility of sunk costs for PB calculations in the case participants.

4.3 CALCULATIONS AND SHORT MOTIVATIONS OF INVESTMENT RECOMMENDATIONS

4.3.1 Calculated project value

For each of the capital budgeting methods the participants were asked to calculate the value of the project (for NPV and RO) and the payback period (for PB).

For variable RCP2, 31.25% (5) of NPV and 23.08% (3) of RO participants included sunk costs in their calculations of the project value, thereby yielding a negative project value. For NPV 68.75% (11) and for RO 76.92% (10) of the participants did not include sunk costs in their calculations, thereby yielding a positive project value.

All of the PB participants included the sunk cost in their calculations, which resulted in a PB of 5 years.

4.3.2 Statements defending RCP recommendation

Results

The participants provided short motivations formulated in 1–2 sentences defending their investment recommendation. The results provided are a summary of the comments defending the participants' investment recommendations for RCP2. Real values are provided within brackets.

For RO 61.54% (8) argued that the abandonment value was greater than the project value and the project should therefore be abandoned, 23.08% (3) argued for an abandonment of the project because of negative project value, and 15.38% (2) did not provide any arguments for their investment decision.

For NPV 37.50% (6) did not provide a motivation, 31.25% (5) argued that the NPV is positive and the project should therefore be undertaken, 18.75% (3) claimed that the NPV was negative and the project should be abandoned, and 12.50% (2) argued for abandoning the project due to the abandonment value being higher than the NPV.

For PB 35.29% (6) argued for a project abandonment by pointing out that the calculated PB ratio exceeded the average accepted payback ratio given in the case, 29.41% (5) argued that it might be more beneficial to abandon the investment and sell it but provided no calculations, 29.41% (5) provided no motivation, and 5.88% (1) wrote that the investment should be continued because of no other investment opportunities were presented.

Analysis

An incorrect calculation of the project value for RO (23.08%) and NPV (18.75%) resulted in the participants claiming the project value being negative and argued for an abandonment of the project. The negative project value was calculated when including sunk costs in the project value and using the initial investment value of \$100,000,000 instead of the remaining investment required of \$15,000,000. Including sunk costs in the project value calculations for this experiment resulted in contradiction of the escalation of commitment bias (See Statman and Caldwell, 1987). Statman and Caldwell (1987) state that due to mental accounting a manager will be more likely to continue investing in a failing project if previous investments into the project have been made, whereas in the case of Ericsson cell phone HDD project, including sunk costs in the calculation leads to the opposite action among the participants. The contradiction of Statman and Caldwell's (1987) theory might potentially

Table 5. Post Hoc Bonferroni Significance of CapBud on RCP 2.

(I) Capital Budgeting		Sig. RCP2
RO	NPV	.008
	PB	.200
NPV	RO	.008
	PB	.465
PB	RO	.200
	NPV	.465

Statistical significance (Sig.) between capital budgeting methods for dependent variable RCP at time 2 (RCP2).

derive from the participants not being fully committed to the project investments. The participants' lack of commitment to the project could be because of the fictitious experimental setting, and therefore no real risks in the case of making a wrong decision.

4.4 RESULTS LINKED TO INITIAL HYPOTHESIS

4.4.1 Test of Hypothesis 1:

Hypothesis 1 was rejected based on the results from the experiment. A *post hoc* Bonferroni test (see Table 5) proved that the difference in RCP2 (measure of escalation of commitment) between the different capital budgeting methods was significant at 5% for RO and NPV ($p=0,008$) but not significant at 5% for RO and PB ($p=0.2$). The results therefore lead to a rejection of the initial hypothesis 1, which presumed RO being a superior method in decreasing escalation of commitment compared to both NPV and PB. The results additionally contradicted theories (see Pike, 1996; Lander and Pinches, 1998; Block, 2007) stating that more sophisticated capital budgeting models lead to superior results, and instead gave justification of empirical findings of PB being the most widely used capital budgeting method in companies (Pike, 1996; Graham and Harvey, 2001; Sandahl and Sjögren, 2003).

A possible explanation for escalation of commitment not being significantly higher in PB participants compared to RO participants might stem from PB's inclusion of sunk costs. All PB participants included sunk costs in their calculations and concluded that a payback of 5 years (calculation after setback) was longer than the company's average accepted payback ratio of 3 years, and therefore chose to abandon the project. A similar trend was observed in the NPV participants. Participants explicitly using NPV that included sunk costs in their calculations argued

similarly to PB participants for an early project termination. In the case of this experiment, including sunk costs in the calculations resulted in an indication of early project abandonment, which also was the preferred decision case participants should have made. However, PB participants demonstrated a rigid and low construct accessibility of sunk costs inclusion, which could act in their disfavor given a different experimental setting.

4.4.2 Test of Hypothesis 2:

Hypothesis 2 stated that: since neither PB nor NPV took into account abandonment value in their calculations for the examples provided with the case, participants using PB or NPV should not display different levels of escalation of commitment to a failing project. The hypothesis 2 was not rejected with a p-value of 0.465, and the results of the experiment displayed no difference in escalation of commitment between PB and NPV participants.

4.5 LIMITATIONS

A higher degree of escalation of commitment might have been displayed in NPV participants simply because they were following the case example instructions. The case example portrayed only one course of action, which was evaluating the project and recommending a continuation or not. Since the calculations for NPV yielded a positive project value at Time 2, participants following the instructions might have recommended a continuation of the project simply basing it on the case instructions informing them to do so. If instead a comparison between two options, continuation or abandonment, would have been made, it could have potentially lead to a lower escalation of commitment among NPV participants.

Similarly a lower escalation of commitment might have been recorded in PB participants. Since the instructions did not inform the participants to neglect sunk costs at Time 2, the calculated PB ratio violated the average accepted PB ratio for the company. Participants following the instructions provided would therefore abandon the project. However, all the information necessary to compare the two options of project abandonment or continuation to each other was provided to all participants. It was the participants themselves who decided whether to ignore the information or to include it in their calculations.

The participants were also a limitation of the study. Although students should display the same behavioral biases as managers, it is unclear if the results would have been the same. Additional experiments are necessary to establish a potential difference.

Another limitation to the study is the simplicity of the experiment. The case provided to the participants is distant and simplified compared to actual capital budgeting situations in reality. The psychological effects should be assumed the same in reality and in the experiment, but additional unknown factors might affect the results.

5. CONCLUSION

The aim of this study was to examine if decision-makers using less sophisticated capital budgeting methods, such as Net present value and Payback, lead to a higher level of escalation of commitment in a failing project, compared to decision-makers using more sophisticated capital budgeting methods, such as Real options. The results indicated that participants explicitly using Real options were more aware of the possibility of project failure, both during their initial calculations and also after the project setback, compared to participants using Net present value and Payback. Additionally participants using Real options displayed a lower level of escalation of commitment to a failing project compared to participants using Net present value, but not to participants using Payback.

Similar findings that indicate lower levels of escalation of commitment in students using Real options compared to students using Net present value were presented by Denison (2009). Consistent with Denison's (2009) study the superiority of Real options derived from a higher construct accessibility of early project termination, stemming mainly from the case instructions and resulting in a lower level of escalation of commitment. Neglecting early project abandonment leads to a higher RCP2 value for Net present value and Payback participants and was interpreted as a higher level of escalation of commitment. The negligence of the preferred alternative, in this case project abandonment, was consistent with Posavac *et al.*'s (1997) findings of decision-making with unspecified decision alternatives, and indicates that capital budgeting methods with salient decision alternatives yield superior results.

This study contributed to validating Denison's findings and contributed to the escalation of commitment literature by integrating a broader range of capital budgeting methods and their effect on escalation on commitment, compared to previous studies. The findings of this experiment additionally contradicted theories supporting a negative correlation between sophistication of capital budgeting methods and level of escalation of commitment, and contributed to justifying the extensive usage of payback in capital budgeting by managers.

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7. APPENDIX

7.1 APPENDIX A

Table 6. *Post Hoc* Bonferroni for Manipulation check questions.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.
Eval	RO	NPV	1.524	.787	.178
		PB	3.403	.777	.000
	NPV	RO	-1.524	.787	.178
		PB	1.879	.734	.042
	PB	RO	-3.403	.777	.000
		NPV	-1.879	.734	.042
PFail1	RO	NPV	3.091	.685	.000
		PB	4.154	.676	.000
	NPV	RO	-3.091	.685	.000
		PB	1.063	.639	.311
	PB	RO	-4.154	.676	.000
		NPV	-1.063	.639	.311
PFail2	RO	NPV	2.659	.559	.000
		PB	4.317	.552	.000
	NPV	RO	-2.659	.559	.000
		PB	1.658	.521	.008
	PB	RO	-4.317	.552	.000
		NPV	-1.658	.521	.008

Post hoc Bonferroni results to determine difference between capital budgeting methods for variables Eval, PFail1 and PFail2. Statistically significant difference between capital budgeting methods when Sig > 0,05.

7.2 APPENDIX B: CASE GIVEN TO PARTICIPANTS

Initial project:

A new project proposal is put on your table for a new cell phone hard drive (Cell phone HDD) that's able to increase current storage capacity by up to 100 percent while retaining costs and dimensions to their current level. The product has already been developed by the R&D department, but the project will require an additional \$100,000,000 to build the production technology. This production technology can be sold at 65 percent of the value invested to date at any point during project development if the project is discontinued. The marketing department has reported that the project's expected cash will depend upon demand. There is a 60 percent chance that demand for the product will be high, with net cash flows of \$60,000,000 per year, and a 40 percent chance that demand will be low, with net cash flows of \$20,000,000 per year (learning which outcome will occur as soon as development is complete). Thus, the expected cash flows for the project are \$44,000,000 per year ($0.6 * \$60,000,000 + 0.4 * \$20,000,000$). The project is expected to last 5 years and Ericsson's required rate of return is 22 percent, yielding a discount factor of 2.8636.

PB calculations:

Investment/Expected cash flow = $100,000,000/44,000,000 = 2.27$ years

NPV calculations:

Expected cash flow * Discount factor – Investment = $44,000,000 * 2.8636 - 100,000,000 = 25,998,400$

RO calculations:

High cash flow: High cash flow * Discount factor = $60,000,000 * 2.8636 = 171,816,000$

Cash flow low: Low cash flow * Discount factor = $20,000,000 * 2.8636 = 57,272,000$

Abandonment value: Amount invested * Abandonment value = $100,000,000 * 0.65 = 65,000,000$

Since the abandonment value is higher than the Cash flow low, the project should be abandoned in the case of a low cash flow from the project.

Total value: High cash flow * Probability of occurrence + Abandonment * Probability of occurrence – Investment = $171,816,000 * 0.6 + 65,000,000 * 0.4 - 100,000,000 = 29,089,600$

Setback:

The initial prediction about the cell phone hard drive development project has proven inaccurate. An unexpected competitor has developed a superior product, thereby changing the expected cash flows for the project. New market research shows that the project will have a lifetime of 5 years with a certain cash flow of \$20,000,000 per year. As of today we are approximately 85% into the project and need to re-evaluate the decision. We need to decide whether to continue this project as planned or abandon it.

PB calculations:

Investment/Expected cash flow = $100,000,000/20,000,000 = 5$ years

NPV calculations:

Expected cash flow * Discount factor – Investment = $20,000,000 * 2.8636 - 100,000,000 * (1-0.85) = 42,272,000$

RO calculations:

Because of certain cash flows the calculations for RO will yield the same value as for NPV above.

Expected cash flow * Discount factor – Investment = $20,000,000 * 2,8636 - 100,000,000 * (1-0.85) = 42,272,000$

Abandonment value:

Investment made * Abandonment value = $100,000,000 * 0.85 * 0.65 = 55,250,000$

Since the abandonment value is greater than the RO and NPV value, the participants should choose to abandon the project in order to maximize firm value.