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CEO stock options and risk taking: is a bird in the hand worth two in the bush?

Name student: C. J. van der Meij

Student ID number: 543592

Supervisor: Prof. J. BAE

Second assessor: Prof. T. Welten

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1. Abstract

Adding to the effort to unravel how stock options incentivize CEOs, this thesis examines both the CEO's risk-aversion with respect to accumulated stock option wealth, and the risk-incentive with respect to potential future gains to stock option value. This is done by employing the behavioral agency model, which incorporates insights from behavioral theory into conventional agency theory. By modelling strategic risk-taking as a mixed gamble, this thesis finds that CEOs are simultaneously affected in opposite direction by both current wealth and prospective wealth. Both the 'force' of risk-aversion due to current accumulated stock option wealth, and the 'force' of a risk-incentive due to stock option holding are found, simultaneously. Additionally, the results suggest that incentives are stronger for relatively overconfident CEOs and differ over time with the accumulation of stock option value. However, unlike prior research, the results suggest that prospective wealth does not reduce the risk-aversion inducing effect current wealth. These results imply that practitioners need to carefully evaluate a CEO's characteristics and current wealth, when using stock options to align their risk-preference with shareholders. Additionally, this thesis adds to stream of literature that uses the behavioral agency model, by warning researchers for using results and methods from prior literature that this thesis fails to replicate.

2. Introduction

It is puzzling that after decades of research, there is still ambiguity as to the role of compensation structures in executive risk taking (Martin et al., 2013). After the financial crisis, the negative popular opinion[1] on high bonusses, and increasing scrutiny from standard setters, emphasized the ongoing need for a solid understanding of incentives and risk-taking in corporate executive settings. Conventionally, academic arguments for big stock option grants are built upon agency theory. This theory proposes that there is a misalignment in risk preference between principals (stockholders) and agents (CEOs), where the agents are risk-averse and the principals are risk neutral (Eisenhardt, 1989). The interests can be aligned by tying the compensation of CEOs to company performance, for instance by granting stock options. Stock options give CEOs the right, but not the obligation to buy their company's stock at a set price in a set period (Hall & Murphy, 2002). This allows the holder to capture the value of the stock price over and above the exercise price of the options. Agency theory holds, that CEOs will align their risk-preferences with shareholders, since their interests are aligned.

[1] Documentaries like *Inside Job* (2010) attributed the financial crisis to governance shortcomings, which likely has a negative effect on public opinion and thus on standard setters' scrutiny.

However, behavioural research repeatedly shows that traditional agency theory's assumptions do not always hold in reality (Tversky & Kahneman, 1979; Wiseman & Gomez-Mejia, 1998). This implies that the prediction of risk-preference alignment does not hold as well. The behavioural agency model (BAM) therefore, incorporates findings from behavioural research into agency theory, to improve our understanding of agency problems. The BAM proposes that stock options lead to loss-aversion, contrary to agent theory's prediction. A person is assumed to see the current accumulated value in unexercised stock options as their own wealth, which is an investment in risk. In this thesis, I examine the question whether stock option holding increases or decreases an agent's strategic risk-taking. Considering that the valuation of the future value of stock options might be biased by behavioural characteristics, I examine the moderating influence of overconfidence on the relation between stock options and risk-taking. Additionally, I examine whether the incentives from stock options differ across levels of accumulated stock option value.

Prior literature found that stock options might either mitigate or exacerbate risk aversion by CEOs (Devers et al., 2007; Martin et al., 2013). In a refined[2] version of the BAM, strategic decision making is modelled as a mixed gamble, where the CEOs decisions are affected by his desire to protect his current wealth and increase his future wealth through risky corporate investments[3]. Based on the idea of a mixed gamble, I argue that two factors are especially relevant for the governance literature, standard setters, and corporate practice: the agent's loss aversion with respect to protecting current wealth and the agent's confidence in achieving sufficiently high performance in the future. Standard setters and boards of directors, are unable to make the right decisions with respect to stock options grants, if they do not know how stock options really incentivize CEOs. This thesis aims to advance the academic knowledge of the relation of stock options and strategic risk taking. To achieve this, I create a proxy for strategic risk taking, by factor analysing three accounting measures. I then analyse the effect that the current stock option wealth and prospective future stock option wealth have on strategic risk taking for the years 2008-2017. I define current wealth as the current value of stock options plus salary. I create a new proxy for prospective wealth, by predicting the increase of the companies' stock price with the analyst's consensus EPS forecasts. The value of prospective wealth is the difference between the exercise value and the predicted future stock value of the stock options. Following the refined BAM (Martin et al., 2013), I predict to find a positive

[2] Details on the differences between the BAM and the refined BAM follow in the theory section.
[3] Appendix C shows a simple graphic to understand the intuition behind the simultaneous influence of probable future gains and risk to current wealth.

relation between the interaction of prospective wealth and current wealth. This would imply that the prospective wealth reduces the risk aversion of an agent with respect to his accumulated stock option wealth. Furthermore, I predict a moderating effect of overconfidence, which is examined by splitting the main sample into a HIGH and LOW overconfidence sample. Lastly, I examine the difference of incentives across levels of accumulated stock option value by comparing HIGH and LOW sub-samples of accumulated stock options.

In the main analysis, I find evidence that is consistent with the basic predictions of agency theory and the BAM. I find a positive association between prospective wealth and risk taking, which indicates a positive incentive for risk taking. I find a negative relation between current wealth and risk taking, which indicates that agents are loss averse with respect to their accumulated stock option wealth. However, I fail to find supportive evidence for Martin et al.'s (2013) prediction of a positive moderation of prospective wealth on current wealth. The results suggest that while both the forces of a risk incentive and loss aversion are present in strategic risk taking, both forces do not mitigate each other. Prospective wealth does not reduce loss aversion, as Martin et al. (2013) find. I fail to find the same interaction effect for overconfident CEOs, which suggests that prospective wealth does not reduce risk aversion, even if a manager is overly optimistic about the future. However, the total influence of stock options (i.e. the influence of prospective wealth, minus influence of current wealth) is positive overall, which is consistent with conventional agency research. The total influence is greater for relatively overconfident managers, which is in line with prior evidence for managerial optimism (Malmendier & Tate, 2005). Finally, I find that the level of accumulated stock option value in current wealth has a significant influence on the influence of prospective wealth and current wealth on risk taking. CEOs with relatively less accumulated stock option value take on less risk in general, and are not incentivized to take on risk by potential future gains to wealth.

The extant research in multiple disciplines have up to this date not been able to come to a conclusion on the relation between stock options and risk taking (Hoskisson et al., 2017). This thesis aims to add to the stream of literature that compliments agency theory with insight from behavioural research. Up to this point, this literature has uncovered that stock options do not solely provide an agent with a risk-taking incentive (Wiseman & Gomez-Mejia, 1998). Evidence suggests that the risk-taking incentive does not remain equal over time, as the accumulated value of stock options changes (Devers et al, 2008). The behavioural approach to agency theory opens the door for new research. In this thesis, a better measure of prospective wealth is proposed, to advance future research using the BAM. Secondly, this thesis tries to replicate and confirm the revised version of the BAM as put forward by Martin et al. (2013). I expand these prior findings by examining differences between accumulated stock options value. Finally, this thesis attempts to shed light on the factor of overconfidence in the BAM. However, I am unable to replicate the finding of a moderating effect of prospective wealth on current wealth of Martin et al. (2013). Since I fail to replicate these findings, this thesis is a warning call to other researchers that have been using parts of the BAM. More research is required to understand the potential relation between current wealth and prospective wealth. Additionally, I find evidence that is consistent with the basic predictions of agency theory and the BAM, which carries policy implications. Boards of directors should take into account that stock options do not provide the agent with solely upward potential, but also create loss aversion over accumulated stock option value. Ideally, practitioners would take into account CEO characteristics when determining the level of stock options in compensation packages. The results in this thesis suggest that more research is required to find a realistic approximation of agent's prospective wealth, taking into account both rational expectations of future cash flows and subjective valuations of those cash flows.

The remainder of this thesis is divided into sections as follows. First, literature on stock options and risk taking is examined from the viewpoint of agency theory and the BAM. In Chapter 4, the development of hypothesis is discussed. The fifth chapter deals with the methods employed to test the hypotheses. In Chapter 6, the empirical results are presented. Finally, in the seventh and last chapter, the results are discussed and conclusions drawn. Additionally, the appendices respectively contain the 'Libby boxes' (Appendix A), a list of definitions of the variables that are employed (Appendix B), and an explanatory graphic for the relation of risk, current wealth, and prospective wealth in the refined BAM (Appendix C).

3. Theoretical background

This thesis builds on the governance literature on the effect of stock options on executive decision making and risk taking. This governance literature is spread out over multiple disciplines, including finance, management, and accounting. Also, behavioural research with respect to risk taking is conducted and referred to in multiple disciplines (Birnberg, 2011). I therefore use multidisciplinary reviews as a starting point to identify key papers for my thesis: Devers et al. (2007) and Hoskisson et al. (2017). To build the theoretical grounds for my hypotheses, I will discuss agency theory and the BAM. In line with the focus of this thesis, I will only discuss the parts of the literature that are relevant with respect to risk taking of CEOs and the impact of stock option grants. In this thesis, stock options are viewed from the perspective of CEOs who receive stock options as part of their compensation. Stock options give the right to buy a certain number of shares at a set price and within a set period. Generally, the period is ten years after grant, where the options 'vest' (i.e. become exercisable) in parts over the years (Devers et al., 2008). The value for the CEO is therefore in the spread between the real stock price, and the exercise price of the options. In practice, this value is realised by buying the shares underlying the stock options against the exercise price, and immediately selling them against the real stock price.

3.1 Agency theory

Agency theory addresses the problem of risk sharing that arises when principals and agents have different risk appetites (Eisenhardt, 1989). In listed companies, stockholders are the principals and CEOs are agents. One of the propositions of agency theory is, that agents are more risk-averse than principals. Since most of the CEOs wealth is tied to his firm, he is relatively "underdiversified" (Sanders & Hambrick, 2007). Stockholders are regarded as risk-neutral, since they have the opportunity to diversify and thus lose all firm-specific risk (Hoskisson, Chirico, Zyung, & Gambeta, 2017). Secondly, agency theory proposes that agents are boundedly rational decisionmakers, that evaluate decisions according to the expected utility framework (Eisenhardt, 1989; Wiseman & Gomez-Mejia, 1998). This means that agents evaluate risky decisions based on the weighted expected final outcomes of the available options, and choose the option that will lead to the best expected outcome. Agents are further assumed to have stable risk preferences over the evaluations of all decisions (Wiseman & Gomez-Mejia, 1998).

Furthermore, agency theory draws on financial economics to argue that stockholders prefer taking larger risks than agents, since risk and return are (historically) correlated (Sharpe, 1964; Fama, 1976; Jensen & Meckling, 1976). Agency theory therefore predicts that principals will try to induce agents to take bigger risks. One way to do so, is to align the interests of the shareholders and CEO, by tying the compensation of a CEO to the performance of the firm he manages. The idea behind this, is that the CEO is incentivized to increase the firm's value, since he privately benefits from a higher firm value. Performance-based compensation can be achieved via multiple methods, like cash bonusses for achieving targets, stock rewards, and stock option grants. Stock options give CEOs the right, but not the obligation, to buy a set amount of their company's shares (Hall & Murphy, 2002). Stock options are in that sense costless to the holders, especially since they are not immediately marketable at the moment of granting (Devers et al., 2008). Therefore, agency theory posits that stock options provide the agent with unlimited upward potential and limited downside risk, which reduces risk aversion.

3.2 Behavioural agency model

Eisenhardt (1989) argues that agency theory should be complemented by other theories, since the economic view on man is insufficient to capture man's complexion. One of such attempts at a richer theory, is the BAM, which complements agency theory with behavioural insights. The BAM[4] was developed by Wiseman and Gomez-Mejia (1998), as a response to inconsistencies in assumptions of the agency model with respect to behavioural theories (Pepper & Gore, 2015). Drawing on prospect theory (Tversky & Kahneman, 1979; 1992), the BAM assumes that agents are not just risk-averse, but rather loss-averse. The concept of loss-aversion means that an agent is more sensitive to losing wealth than to increasing wealth. In contrast to the assumption in agency theory, behavioural research found that agents risk preferences are not stable (Barberis, 2013). According to prospect theory, an agent will frame a problem as either a gain or a loss situation with respect to a reference point. This reference point is generally formed by the status quo (current wealth), and might be influenced by ambition or historical performance (Thaler & Johnson, 1990; Wiseman & Gomez-Mejia, 1998). In loss situations the agent exhibits risk-seeking behaviour and in profit frames the agent will be risk averse (Tversky & Kahneman, 1979). This is illustrated in Figure 1, where the valuation functions for a prospect theory agent are plotted on the grey line. The agent's valuation function is convex over losses and concave over gains and steeper for loss frames than gain frames. This finding in prospect theory was derived by observing people's choice behaviour in gambles. For example, in Tversky and Kahneman (1979) the following two gambles were presented to experiment subjects:

> *(I) In addition to whatever you own you have been given 1000\$. Now choose between A = (1000\$, p=0,5) and B = (500\$, p=1,0).*
>
> *(II) In addition to whatever you own you have been given 2000\$. Now choose between A = (-1000\$, p=0,5) and B = (-500\$, p=1,0).*

Tversky and Kahneman (1979) found that subjects were more likely to choose B in (I) and A in (II). This is inconsistent with the expected utility theorem, which holds that people make choices based on final outcomes. The final outcomes in (I) and (II) are both 1500\$, but subjects

[4] Figure 1 in Wiseman & Gomez-Mejia (1998) shows the proposed framework of the BAM. This thesis deals with stock options and risk taking, thus only proposition 1 and proposition 5a and 5b from the original paper are described. These propositions deal with the influence of problem framing on risk taking, the mediating factor of risk bearing and the influence of endowment on risk bearing.

had changing preferences over both problem frames. From these results they derived the concept of reference dependence. People are found to be risk averse over gain frames, (i.e. rather gain 500$ for sure, than 1000$ with fifty percent chance), and risk seeking over loss frames (i.e. rather lose 1000$ with fifty percent chance, than 500$ for sure).

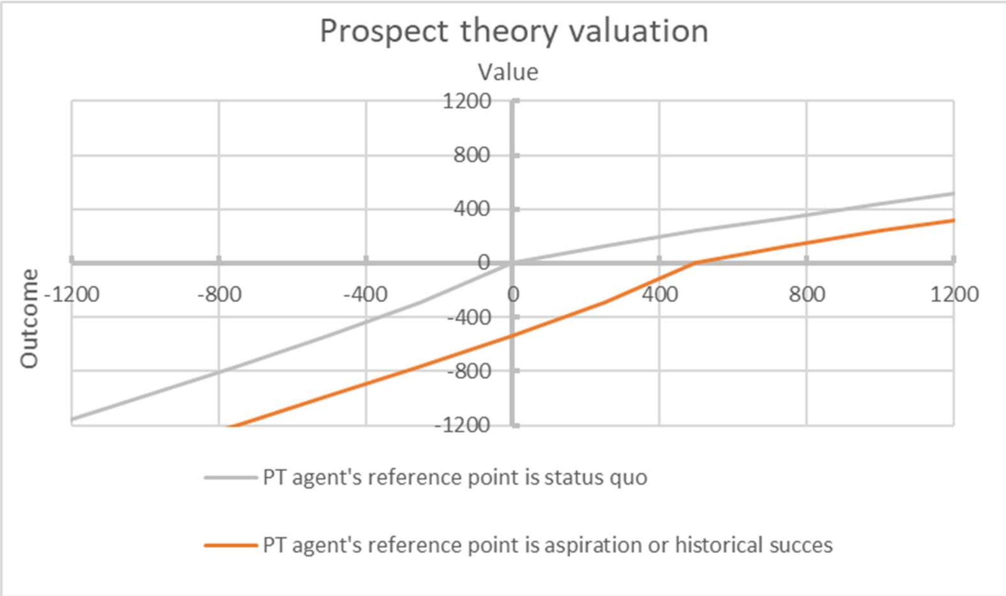

Figure 1: The prospect theory valuation curve as proposed by prospect theory, based on (Tversky & Kahneman, 1979). The grey line represents the valuation of the outcome of a gamble, by a prospect theory agent that uses the status quo as his reference point, whereas the orange line represents an agent that shifts his reference point to a gain of 500, due to aspirations or historical successes. The valuation function over gains and loss frame is defined as $v(x) = \begin{cases} x^{\alpha} & if\ x \geq 0 \\ -\lambda(-x)^{\beta} & if\ x < 0 \end{cases}$ *where x is the final outcome, α and β capture the diminishing sensitivity, and λ is the captures the agent's loss-aversion. This graph is plotted based on historical estimates of α=β=0.88 and λ=2.25.*

In the former example, the reference point is the current wealth: 1000$ in problem (I) and 2000$ in problem (II). However, Thaler and Johnson (1990) suggest that reference points can be determined by past performance. This is illustrated in Figure 1, where the orange line reflects another agent's valuation curve. Let's call this agent John. John has had a high past performance, and based on that developed an ambition for future high performance. John will therefore view all positive outcomes that are lower than the positive outcomes in the past as a loss. Now, consider the following set of problems:

(III) Choose between A = (250$, p=1,0) and B = (500$, p=0,5)

(IV) Choose between A = (1000$, p=1,0) and B = (2000$, p=0,5)

In problem (III), John will choose B, instead of A, while an agent that uses his status quo (0$) as a reference point, will chose A. This changes in problem (IV), where the outcome of 1000$ for certain is above the reference point of both agents, which means both will be risk averse under prospect theory. In problem (IV) both agents will choose A.

Secondly, using the concept of instant endowment (Thaler, 1980; Thaler & Johnson, 1990), Wiseman & Gomez-Mejia (1998) argue that stock options will increase risk bearing of the agent and thus induce risk averse behaviour. Instant endowment means that people immediately calculate received money as personal wealth. As a proposition of the BAM, it is argued that the accumulated value in unexercised stock options will be likewise perceived as current wealth by the stock option holder. In contrast to agency theory's view that stock options provide limited downside risk, the BAM thus proposes that an agent will perceive accumulated stock option value as a risky investment. This happens because the agent perceives the holding of in-the-money stock options as a private investment in the firm he works at, since the value of stock options is directly tied to share prices. According to prospect theory's predictions, this will lead to risk-averse behaviour. Note, that this is only true for options that are in-the-money, since the agent will not endow value from out-of-the-money options. Agency research usually focusses on the incentives of stock options at the granting moment, but the BAM holds that it is important to investigate the incentives of stock options over time (Devers et al., 2008).

Martin et al. (2013) refined the BAM after mixed findings in prior research. According to them, decision making by CEOs can be framed as a mixed gamble. In traditional agency theory, stock options provide the agent with *prospective wealth* (PW), that is, potential future gains to wealth, while limiting down-side risk. Agency theory predicts that stock options increase the CEOs risk taking behaviour. BAM uses the concept of *current wealth* (CW) up to this point, meaning that agents through instant endowment calculate the accumulated cash value of stock options into personal wealth, thus making it a risky investment. BAM predicts that, since agents are loss-averse, agents prefer to protect current wealth. However, Martin et al. (2013) try to bring mixed empirical findings together by formulating both predictions in a single framework. Taken together, a mixed gamble between protecting current wealth and increasing future wealth through new risky investments presents itself to the agent in every business decision. However, if the increase in prospective wealth through a risky investment is large enough, this can offset the negative effect of risk on current wealth. A graphical representation of this mixed gamble is presented in Appendix C. In the remaining part of this thesis, the abbreviation *BAM* is used to refer to the 'first-generation' model by Wiseman and Gomez-Mejia (1998). To avoid confusion, I will refer to the refined version that is based on the mixed-gamble argument as *refined BAM* or abbreviated *RBAM*.

3.3 CEO overconfidence and the prospective wealth function

Under the RBAM, in the moment an agent makes an investment decision, he will decide whether the additional risk to his current wealth is offset by the potential gains to future wealth. As the future wealth of his options are a function of his firm's performance, CEO confidence or optimism will play a role. Overconfidence is a well-documented and debated concept in (agency) literature. Here, it is not my goal to elaborate on all there is to say about overconfidence. However, at this point it is necessary to realise that prospective wealth is not a wholly rational forecast of CEOs. It has been documented that managers are severely miscalibrated when forecasting future market returns and own firms' return (Ben-David et al., 2013). Overconfidence is the tendency of people to systematically overestimate the accuracy of their forecasts and their ability relative to others (Malmendier & Tate, 2005). It is therefore a small step to propose that overconfidence is one of the behavioural traits to influence the subjective valuation of prospective wealth. An overconfident CEO will value his prospective wealth relatively higher, and might thus be more inclined to take on risk. When the marginal costs of holding stock options exceed the marginal benefits[5], a CEO should exercise the options (Lambert et al., 1991; Hall & Murphy, 2002). Malmendier and Tate (2008) argue that the threshold for exercising stock options is determined by the remaining time till expiration, personal wealth, the degree of underdiversification, and risk aversion. If a CEO fails to take one or more of these rational factors into account, a behavioural explanation is justified. Therefore, CEOs that hold on to vested options longer then rationally optimal are seen as overconfident (Malmendier & Tate, 2005). Contrary to this overconfidence view, Sawers, Wright and Zamora (2011) find in an experiment that managers with in-the-money options are loss averse. However, their findings do not take into account the mixed gamble between protecting current wealth and increasing future wealth. Therefore, their evidence is not conclusive on whether the overconfidence view for prospective wealth holds.

4. Hypothesis development

Agency theory predicts that stock option grants lead to an increase in agent's risk taking. The idea behind this prediction, is that stock options present the agent with unlimited upward potential of increasing wealth, while having limited down-side risk. Considering the historic correlation of risk and return, an agent should be inclined to take on more risk when receiving stock options. This is the effect of prospective wealth on risk taking. Rajgopal and Shevlin

[5] In this context, the marginal cost of holding stock options is expressed in the magnitude of downside risk. The marginal benefit is the upward potential.

(2002) find supportive evidence for an increase in risk taking due to stock options in extractive industries. Sanders and Hambrick (2007) find that it is even possible for CEOs with too many stock options, to become risk lovers. However, other research suggests that once value has accumulated in stock options, an agent might take less risk (Sawers et al., 2011; Martin et al., 2013). This strand of literature holds that an agent will perceive accumulated value as a risky investment in the firm. Since the agent is relatively underdiversified, he will be inclined to take on less risk, because he is relatively more exposed to company-specific risk than other investors. This is the effect of current wealth on risk taking, which means that an agent is risk averse with respect to the wealth tied to the firm he works for. Martin et al. (2013) argue that both effects are present at the same time in decision making, which they call a mixed gamble. In a mixed gamble, the positive utility of an increase in prospective wealth is weighed against the risk of losing current wealth. Following the mixed gamble argument from Martin et al. (2013), I hypothesize that prospective wealth mitigates the negative effect that current wealth has on risk taking[6] (see Appendix A for Libby boxes). Formally:

H1: Prospective wealth positively moderates the negative relation between current wealth and risk.

Building on the first hypothesis, I predict that the effect of prospective wealth will be stronger for confident CEOs. At the moment of decision-making, a CEO knows what the approximate value of his current wealth is. However, the valuation of prospective wealth is a subjective function of the beliefs of the CEO. A more optimistic CEO will more readily expect positive outcomes then a more pessimistic CEO. Therefore, it is not a far stretch to assume that the subjective valuation of prospective future wealth is influenced by a salient CEO characteristic, like overconfidence. Based on survey data from CEOs, prior research found that CEOs are severely miscalibrated when predicting market returns, which supports the overconfidence view (Ben-David et al., 2013). They also found, that managers that were miscalibrated with respect to market returns, were more miscalibrated with respect to their own firms' returns.

It has been theoretically shown that rational and risk-averse CEOs heavily discount the value of stock options compared to the shareholders' valuation of those options (Lambert et al.,

[6] The wording of the hypothesis can be somewhat confusing. The assumption is, that there is a negative relation between current wealth and risk taking (consistent with BAM). However, prospective wealth positively moderates, i.e. reduces the negative effect of current wealth on risk taking. This can be understood better by picturing the risk-taking function as being determined by two forces that each push in a different direction. There is the force of risk aversion (CW) that pushes the risk-taking down, and the second force of risk-taking incentive (PW) that pushes risk-taking up (see Appendix C for the graphical representation).

1991). Consistent with this theoretical evidence, Fu and Ligon (2010) find that often CEOs exercise their options as soon as they vest, to be able to diversify. Malmendier and Tate (2005) therefore argue, that CEOs that hold on onto exercisable stock options for longer than a rational benchmark, are overconfident. Overconfidence here means that CEOs overestimate their ability to earn risk adjusted returns over their stock options 'investment'. However, Sawers et al. (2011) mimic vested in-the-money options in an experiment, and find that managers are loss averse. This would be inconsistent with the overconfidence view. Martin et al. (2013) do not distinguish between vested and unvested options, when they test the same Hypothesis 1. Therefore, if the sample that Martin et al. (2013) uses consists of relatively more vested options (i.e. relatively more overconfident CEOs), the results might be biased towards prospective wealth. Therefore, I hypothesize that for CEOs with only stock options that are not vested, the moderating effect of prospective wealth is not as strong as for CEOs with vested options. Formally:

H2: The moderating effect of prospective wealth on the negative relation between current wealth and risk is stronger for vested options than not-yet-vested options.

Research using the BAM, accentuates that there is a difference between stock options that are at the money (e.g. usually at the moment of grant), and stock options that are in-the-money (i.e. have a positive spread between stock price and exercise price). Devers et al. (2007) therefore call for a consideration of accumulated value in stock options. However, prior empirical research shows conflicting evidence for the way the effect of stock options on risk taking changes with the accumulation of stock option value. Some previous research using the BAM model, found that CEOs with a higher level of in-the-money stock options are more risk-averse (Hoskisson et al., 2017). The question arises, how this evidence fits prior evidence for manager overconfidence. For example, Devers et al. (2008) argue that a higher value of stock options points at historical success, which in turn might lead to manager overconfidence (Malmendier & Tate, 2005). As argued for Hypothesis 2, an overconfident manager is expected to be more risk taking, instead of less risk taking. Also, aside from miscalibration, an overconfident manager might overweigh the possibilities of positive outcomes due to the *illusion of control*[7], which would similarly lead to higher risk taking.

There is yet another reason to believe past successes influence risk taking. Past successes might influence the reference point an agent uses to evaluate potential outcomes (Thaler &

[7] Illusion of control refers to a form of overconfidence, where an agent overestimates the extent to which he can control future performance.

Johnson, 1990). If an agent has had high past performance in the past, his reference point could move from the status quo (current wealth) to a higher aspirational level of performance as illustrated in Figure 1. An outcome that is higher than zero but lower than his ambition, will be regarded as a loss. Thus, he will more often frame his decisions as a loss. Remember, that prospect theory predicts higher risk taking over loss frames.

Finally, Devers et al. (2008) find a curve-linear positive relation between vested stock option value and risk taking. For stock options that are exercisable, they find that first the increase in stock option value is accompanied by an increase in risk taking. However, after a certain level of stock option value, the relation between stock option value and risk taking becomes insignificant. This suggests that the effect of stock options on risk taking might diminish at high levels of stock option value. Due to these unclear signs of theory and prior literature, I formally hypothesize H3 in null-form.

H3: The moderating effect of prospective wealth on the relation between current wealth and risk is equally strong for all levels of accumulated options value.

5. Research design

In this thesis, I perform an empirical analysis of archival data from 2006 to 2018. This data period is largely determined by the availability of estimated stock option values in Execucomp databases. Since the introduction of FAS 123R, firms need to report the true estimated value of stock options held by their executives. Prior to this date, researchers had to estimate this value themselves. The year 2019 is not included in the sample due to unavailability of institutional holding data. In the first paragraph of this chapter, I discuss the RBAM in more detail, while especially focussing on my adaptions in the operationalization of the model. The second paragraph deals with the empirical model, which is continued with the discussion on the creation of the risk-taking score variable in paragraph three. In the fourth paragraph the control variables are discussed. Finally, the fifth paragraph deals with a more detailed discussion of the sample data.

5.1 Operationalization of the BAM

Martin et al. (2013) employ a refined BAM model, which conceptualizes decision making as mixed gambles for CEOs. In a mixed gamble, the CEO is "influenced by two forms of option wealth: (1) *prospective wealth* and (2) *current wealth"* (Martin et al., 2013, p. 452). The basis of this conceptual relation is the influence of prospective wealth (PW), as predicted by agency theory, and the influence of current wealth (CW), as predicted by the original BAM. The interaction of both PW and CW determines whether the prospect of future wealth can offset the agent's risk aversion with regards to losing current wealth. Martin et al. (2013) create a proxy for risk-taking by factor-analysing a single variable from three forms of strategic risk-taking (R&D expense, CAPEX and long-term debt). This riskscore was then regressed on prospective wealth and current wealth[8]. For my thesis, I adapt their model according to my needs. An overview of the conceptual relations and the operationalization thereof, are shown in the predictive validity framework, which can be found in Appendix A.

Definitions for independent variables prospective wealth (PW) and current wealth (CW) in the original model of Martin et al. (2013) follow:

(1) *Prospective wealth = number of options held * [(average increase of DowJones-index^{time} * stock price) – stock price].*

(2) *Current wealth = number of options * spread*

The intuition is, that PW is the wealth that a manager expects to receive from his stock options in the future, based on the knowledge he has today. The knowledge about increasing his stock option value through increasing the stock price of his company, is proxied by the average increase of the Dow Jones index over the sample period. This is an easily obtainable, but somewhat counterintuitive measure, since it assumes that CEOs predict the performance of their own company based on market-wide performances. This implies that CEOs do not believe in their own ability to improve stock prices, but only rely on global economic trends. This is also inconsistent with the practice of stock option grants as an incentive for CEOs to take on risk and thereby increase the value of the company. Investors would not deem stock options a worthwhile stimulus if CEOs do only react to market wide trends anyway.

On top of that I can show, that PW based on such a fixed growth rate is a highly volatile measure, which differs greatly depending on the time period that is chosen in the analysis. Martin et al. (2013) find an average yearly growth of 6.82% over the years 1996-2009. The standard deviation of this sample is 17,44%, which shows that the growth rate is highly subject to change over the selection of sample period. To illustrate this, consider that choosing the period 1998-2009 results in a yearly average growth of 4,0%, while choosing 1996-2007 results in 9,21%. For my sample, I calculate the same measure for the periods 2007-2017 and 2009-2017. The first period results in an average yearly growth of 7,77% (standard deviation 15,53%) and the second period selection results in an average yearly growth of 12,55% (standard

[8] Martin et al. (2013) also interact current wealth and prospective wealth with CEO hedging options (as a proxy for CEO option risk management) and an indicator variable for three-year decline (as a proxy for CEO vulnerability.

deviation 8,91%). Martin et al. (2013) find that their results are robust to choosing growth percentages between 2% and 20%[9]. However, I argue that proxying by a fixed growth rate is entirely contrary to the concept of PW. Remember that PW is a measure that should proxy for the agent's *beliefs* about future gains over current stock option holdings. If the growth rate is arbitrarily fixed, the beliefs of an agent are limited to sign (gains or no gains), while neglecting the magnitude of gains. Secondly, it does not allow for changing beliefs over the sample period, which is highly improbable in both my sample period and the sample period of Martin et al. (2013), since both contain years of stock market optimism and market crashes.

Therefore, instead of using the original variable in Martin et al. (2013), I construct a different proxy for PW, which better reflects the real-world way an agent will evaluate his future prospects. I argue that managers will not value their prospective wealth using the average increase of the stock market over the sample period. Instead, their beliefs in company growth will be based on private (management) forecasts. This I will proxy for by using analyst EPS forecasts, from which I calculate growth rates. This method gives me the benefit of extracting information for a single firm at a single moment in time. By multiplying the current stock price with this growth rate, I estimate the expected stock price on the date of expiration of the stock options. I believe analyst forecasts are a better proxy for a firms' prospects, because they are based on an analysis of the firm-level reality. As an analogy, this can be understood by contrasting the information an investor requires, when choosing between investing in the total market, or investing in a specific firm. An investor that invests in the total market, will be satisfied by information about global trends, on the market level. However, the investor who invests in a single firm, will evaluate specific business operations, analyse the trends of specific products or services the firm delivers, and get to know the value drivers of the firm, before investing a single dollar. Information on the market-wide trends would be as useful to the single-firm investor as a weather forecast to a cook who tries to cook his steaks medium-rare – it is useful information, but not sufficient and surely not most important. Therefore, since the closest I can get to the private information a CEO has, is analyst forecasts, I believe this is the best proxy for PW I can use.

For the CW, instead of calculating the estimated value of the stock options as conventional before 2006, I use the estimated stock option value as reported under FAS 123R. This is a

[9] I am unable to replicate the findings of Martin et al. (2013) when using the arbitrary fixed growth percentages in additional tests (untabulated). Using the growth percentages of 6,82%, or 7,77%, or 12,55%, results in a PW measure that is too strongly correlated with CW (R > 0,800).

different definition from Martin et al. (2013), as shown in equation (2). However, this deviation is more or less of a practical kind. Additionally, because Larraza-Kintana et al. (2007) show that managers are loss averse with respect to their base pay, I will include base salary into the measure for current wealth. Both forms of wealth fit the concept of CW, namely: future cash-flows that are endowed into current wealth. However, as long as the cash-flow is not yet received, it is 'invested' in the firm, and thus at risk. The formal definitions for PW and CW in this thesis follow:

(3) *Prospective wealth = number of options held * [(analysts' forecasted EPS growthrate*$^{time\text{-}to\text{-}expiry}$ ** stock price) – stock price]*

(4) *Current wealth = base salary + current stock option value.*

5.2 Empirical model

To test my hypothesis, a regression model is constructed. The regression defines strategic risk taking as a function of PW and CW, and an interaction of both. Additionally, a range of controls are included, as described in Paragraph 5.3. Since PW and CW are measured over year *t*, and the final value calculated at the end of fiscal year *t*, I measure strategic risk taking in year *t+1*. Intuitively, an agent will only react to PW and CW, once their value becomes somewhat salient. I cannot determine at what moment in time an agent determines or changes his beliefs about the values of his CW and PW, but it is reasonable to assume that the fiscal year-end is a moment of reconsideration for agents. Therefore, the empirical model employed in this thesis is:

$$(5)\ Strategic\ Risk_{i,t+1} = \beta_1\ PW_{i,t} + \beta_2\ CW_{i,t} + \beta_3\ PW_{i,t}{*}CW_{i,t} + \{Controls\} + \{Year\ dummies\}$$

When examining panel data, standard OLS could give biased results, due to autocorrelation, contemporaneous correlation, and heteroskedastic error terms (Certo & Semadeni, 2006). To account for this problem, it is generally possible to use either generalized least squares (GLS) models, or models with fixed effects or random effects. However, GLS models require the sample to have more time periods *T,* than unit observations *N.* In my sample, this requirement is not met. Certo and Semadeni (2006) advise using either fixed effects or random effects in this case. A Hausman (1978) specification test, shows whether to use fixed effects or random effects. A random-effect model requires the assumption that the panel error term is uncorrelated with any of the independent variables. The Hausman test tries to reject the null hypothesis that, this is true. The Hausman test rejects the null hypothesis in my sample with $p < 0{,}000$ ($\chi^2 = 118{,}81$), therefore, I employ firm fixed effects in the regressions.

To test H1, I run the regression for the full sample. For H1 I expect to find a positive and significant coefficient β_3. Additionally, β_1 and β_2 are expected to respectively show a positive and negative sign, which reflect the predictions of traditional agency theory and BAM. The test of the first regression can be regarded as the main model, which produces a basis for the additional tests of H2 and H3.

To test H2, I need a measure of overconfidence. Since overconfidence is not readily measurable, based on the sparse data on CEO characteristics I have, I need to find another way of extracting variance caused by overconfidence from the data. To do so, I follow Malmendier and Tate (2005) by defining managers that hold on to exercisable stock options for longer than a rational benchmark, as overconfident. However, using any of the measures they developed would result in too few observations in my small sample. Therefore, I take a less detailed approach, by dividing the sample in two subsamples. To do so, I first create a variable that weighs the relative weight of exercisable stock option value compared to unexercisable options value. Then, I split the sample in two equal parts, using the median relative weight as a cutting point. This results in a 'HIGH' and a 'LOW' sample. Note that this does not necessarily mean that exercisable option value < unexercisable option value for any observation in the low-sample. Following the findings of Malmendier and Tate (2005), I can assume that the CEOs in the HIGH sample are more overconfident than CEOs in the LOW sample. I use a t-test to determine whether the HIGH and LOW sub-samples generate significantly different coefficients. If the coefficient β_3 in the LOW-sample is significantly lower than the HIGH-sample, I reject H2. This approach is less detailed then the measures Malmendier and Tate (2005) developed, which will increase the chance of a type 2 error, but it is a more powerful test then the alternatives.

Finally, to test for H3, I will in a similar fashion create a HIGH and LOW sub-sample, based on the accumulated stock option value in current wealth. I will run the regression for Equation 5 and I expect positive and significant coefficients β_3. Then I will test for differences, and expect coefficient β_3 in the HIGH-sample to be significantly different from β_3 in the LOW-sample. If the coefficient in the high-sample is significantly more positive than the low-sample, this would be consistent with the overconfidence view of Ben-David et al. (2013), who hold that managers are miscalibrated when predicting future returns of both the total market and their own firms. If it is significantly more negative, this would be consistent with the notion of loss aversion, as in the BAM.

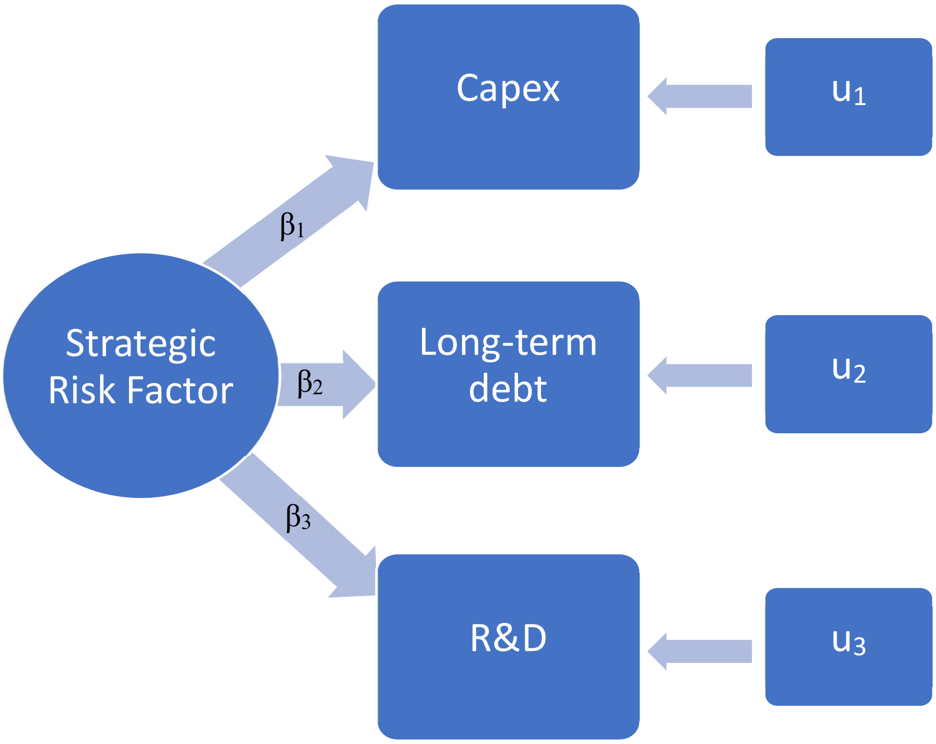

Figure 2: Relation between risk factor and risk proxies

5.3 Creating a risk-taking proxy

Since the risk-taking of CEOs cannot be directly measured, researchers usually use (a combination of) accounting measures that can be regarded as the revealed beliefs measures of risk taking by CEOs. In my thesis I follow Miller and Bromiley (1990), who find that R&D expense (R&D), capital expenditures (CAPEX) and long-term debt (DEBT) together can be used as proxies for strategic risk (see Table 1 for summary statistics of the variables). Following prior BAM research, I therefore limit my sample to manufacturing firms (SIC 2000-4000), which rely heavily on R&D and CAPEX for future success (Benischke et al., 2019). I employ Factor Analysis (FA) to create a risk score that will serve as a proxy for strategic risk taking, following prior BAM research by Martin et al. (2013) and Devers et al. (2008). To use FA on a set of variables, a researcher needs to assume an underlying common factor which determines variance in the variables. I assume that an agent's strategic risk-taking behaviour is the underlying cause of variation in the accounting measures CAPEX, DEBT, and R&D. The relation between the assumed Strategic Risk Factor and the accounting measures is illustrated in Figure 2 (adapted from Grace-Martin (2020)). The latent Strategic Risk Factor *causes* the risk-taking proxies. The part of the variance in the risk proxies that is not caused by the risk factor, is captured in the measure-specific error term *u*. The FA weighs the relation between the Strategic Risk Factor and the risk proxies through a series of regressions:

(a) $Capex = \beta_1 * Strategic\ Risk\ Factor + u_1$

Table 1					
Panel A – Summary statistics of the risk measures.					
Variable	***N***	**Mean**	**St. Dev.**	**99% Conf. Interval**	
Capex	5676	219,335	554,551	200,369	238,301
Long-term debt	5676	1511,682	3764,307	1382,938	1640,426
R&D	5676	294,055	868,049	264,367	323,743

Panel B - Correlation matrix of risk measures in FA.			
Variable	**Capex**	**Long-term debt**	**R&D**
Capex	1,0000		
Long-term debt	0,7573	1,0000	
R&D	0,6395	0,6789	1,0000

Table 1: Summary statistics and correlation matrix for the FA procedure.

(b) *Long-term debt* $= \beta_2$ * *Strategic Risk Factor* + u_2

(c) *R&D* $= \beta_3$ * *Strategic Risk Factor* + u_3

The FA procedure is conducted over all 5676 observations in the sample that have data on these variables, which means that CEO-firm-years that are dropped in the final analysis due to data restrictions of analyst forecast data are still used in the FA[10]. The standard deviations in the data are high due to outliers, and the means are of different magnitudes across the variables. Therefore, the variables are winsorized before conducting FA. Different magnitudes of means might cause factor loadings to be biased, therefore I standardize the variables with a mean of 0 and a standard deviation of 1. After standardizing, the Cronbach's alpha for scale reliability is 0.8708, which suggests the scales are reliable for FA. To make sure the sample is adequate for the use of FA, several additional tests are conducted.

Firstly, the correlation matrix between the risk measures presented in Table 1 shows that the variables are considerably correlated, which is necessary for data reduction methods like FA (UCLA, 2020). To be sure, I conduct a Bartlett's test of sphericity, which tries to reject the null-hypothesis that there is no correlation in the population of the variables. This hypothesis is rejected with $p<0.000$ ($\chi^2 = 8741{,}104$; df=3), which means I am justified in performing FA on these variables. Finally, a Kayser-Meyer-Olkin (KMO) test for sampling adequacy is conducted. A KMO test compares the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients, which results in a value between 0 and 1,

[10] A robustness check with a factor analysis using only observations from the final sample produces substantially the same results.

Table 2

Panel A - Factor analysis

			Observations	5676
Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	1,9688	2,0579	1,1328	1,1328
Factor2	-0,0891	0,0527	-0,0513	1,0816
Factor3	-0,1417	0,0000	-0,0816	1,0000

Panel B - Factor loadings

Variable	**Factor1**	**Uniqueness**	**KMO**
Capex	0,8239	0,3212	0,7127
Long-term debt	0,8518	0,2744	0,6840
R&D	0,7513	0,4355	0,7991
Overall			0,7254

Table 2: Results from the factor analysis on Capex, Long-term debt, and R&D. Only the first factor is retained, since its eigenvalue is greater than 1.

where higher values are better. Values of above 0.5 are recommended for using FA. Overall, I find a KMO score of 0.7254, which means I am justified in employing FA. The FA[11] results in one factor with an eigenvalue greater than 1 (Table 2). A rule of thumb for including factors in an analysis, is that the factor must be included if the eigenvalue is greater than 1 (UCLA, 2020). An eigenvalue represents the part of common variance that is explained by the factor. An eigenvalue of above 1 means that the factor explains more of the common variation in the sample than any of the individual variables. The second factor has a negative eigenvalue, which means it is of no added value. Factor 1 has factor loadings of 0.8239, 0.8518, and 0.7513 respectively. Factor loadings can be seen as the correlations of each risk measure with the Strategic Risk Factor. Finally, the risk score is created using the *predict* function with the regression method in STATA. The weights of the accounting measures in the risk score are 0.3487, 0.4249, and 0.2398 for CAPEX, DEBT, and R&D respectively. In the remainder of the thesis, the risk score will be referred to as Strategic Risk Score.

5.4 Controls

In this paragraph, I will describe the control variables that are needed in the regression model. The exact definitions and source tables of all (control) variables can be found in Appendix B. All variables are winsorized, to account for the influence of extreme outliers. First of all, I need to control for company stock that is held by the CEO, since stock ownership will

[11] Rotating the data potentially makes the proposed relation more prominent in the FA. However, when only selecting a single factor from the analysis, rotating the data does not have any effect.

probably affect risk taking in a similar way as stock options, and might even be correlated with stock option value. Since I do not scale the risk variables to firm size, and due to a proposed correlation in firm size and risk taking (Larraza-Kintana, et al., 2007), I control for firm size directly by adding it as an independent variable. To prevent omitted variable bias[12], I will use the relevant control variables that Martin et al. (2013) dropped because of insignificance, since they potentially influence agent's risk taking: CEO tenure, a dummy for CEOs that are chairman of the board of directors, and a dummy for years where there is a change of CEO[13]. Since behavioural research found relations between risk taking and gender, I need to control for the gender of the agents (Barber & Odean, 2001). However, since I employ a regression with fixed effects, any influence of gender is captured in the fixed effects of the CEO-firm unit. This also solves any remaining heterogeneity problems that could arise across industries.

Furthermore, controlling for endogeneity is crucial in this type of research, due to reverse causality in risk and compensation (Rajgopal & Shevlin, 2002; Sanders & Hambrick, 2007; Low, 2009; Gormley et al., 2013). I follow the method of Martin et al. (2013) and Sanders and Hambrick (2007) to control for endogeneity due to reverse causality in option pay, and risk taking and performance. Therefore, I regress lagged CEO stock option values on twice-lagged firm and CEO characteristics, and industry and year dummies. These characteristics are number of options held, stock price performance, stock options' time to expiry, price volatility, R&D intensity, capital intensity, and firm size. I run Regression 6, and retain all significant variables.

(6) $Option\ Value_{i,t-1} = \beta_1\ Options_{i,t-2} + \beta_2\ StockPerformance_{i,t-2} + \beta_3\ Time\text{-}to\text{-}expiry_{i,t-2} + \beta_4\ Volatility_{i,t-2} + \beta_5\ R\&Dintensity_{i,t-2} + \beta_6\ CapitalIntensity_{i,t-2} + \beta_7\ Size_{i,t-2} + \{Industry\ dummies\} + \{Year\ dummies\}$

The results for this regression are presented in Table 3. For brevity, year-dummies and industry-dummies are suppressed. Most of the industry dummies and year dummies are insignificant predictors of next year's stock option value, as well as capital intensity, R&D intensity and stock price volatility. Using the significant coefficients as weights, I calculate the

[12] Initially, a dummy variable for institutional holding above 5% of the shares was employed. In the sample however, this dummy was 1 for all companies, and thus omitted from the model. A dummy for CEO age was dropped because of severe multicollinearity.

[13] Intuitively, CEO changes should not occur in the final sample, considering the restriction of three consecutive years of data. However, in the final dataset, three unique CEO-firm-years are labelled as the first year the person became CEO, even though they are simultaneously labelled as CEO of the same company in earlier years. A closer inspection of the data shows that the label is given due to a change in Title. Since in other instances a change of Title is not regarded as being a 'new' CEO, it is unclear whether this is a data error or a change of such significance that it carries real information. I therefore decide to include the dummy variable, to control for its unknown explanatory power. Omitting the three observations does not produce substantially different results.

Table 3

Predictors of CEO stock option value.

	Observations	3.319
	Prob > F	0,000
	Adj. R2	0,4054

Variable	Coefficient	P>|t|
$OPTIONS_{i,t-2}$	7,882***	0,000
$STOCKPERFORMANCE_{i,t-2}$	567,229***	0,000
$TIME\text{-}TO\text{-}EXPIRY_{i,t-2}$	0,287	0,984
$VOLATILITY_{i,t-2}$	1600,404***	0,000
$R\&DINTENSITY_{i,t-2}$	-1921,289	0,246
$SIZE_{i,t-2}$	1486,334***	0,000
$CAPITALINTENSITY_{i,t-2}$	41,54241	0,934
2-DIGIT SIC	YES	
YEAR-DUMMIES	YES	
CONSTANT	-10276,770***	0,000

*Table 3: Significance levels are denoted by: * p<.05; ** p<.01; *** p<.001. Some of the year-dummies and industry-dummies were significant. The significant coefficients are used to create the endogeneity control, including the unreported dummies.*

predicted value of CEO stock option value in year *t*, which I include in my model as an endogeneity control. The included significant year-dummies and industry-dummies carry a significant weight in the calculation of the endogeneity control, with coefficients ranging between about 3.000 and 15.000. This suggests that macro-economic trends can be a significant influence in the valuation of stock options, which validates the earlier argument against a fixed growth rate in PW. By including the predicted stock option value as a control in my regression model, the influence of risk on stock option value will show on the endogeneity control, and will not affect the betas of stock option value.

Finally, I add year dummies, which control for potential contemporaneous correlation within the data, as advised by Certo and Semadeni (2006). According to Certo and Semadeni (2006), the presence of year dummy variables does not have a negative influence on regressions with fixed effects. Neither does it produce a significant loss of degrees of freedom, when the number of observations *N* greatly exceeds the number of time periods *T,* as is the case in my sample.

5.5 Data

The data for this thesis are retrieved from CRSP, Compustat, Execucomp, I/B/E/S, and Thomson Reuters 13F databases. I use data from 2006 up till 2018. In 2006 the new FAS 123R accounting rule came into effect, which required companies to reflect the fair value of stock-options and other equity related compensation arrangements in their statements (WRDS, 2020). Before 2006, researchers had to estimate the fair value of stock options themselves. On top of that, Hayes et al. (2012) suggest that the use of stock options prior to FAS 123R were mostly driven by accounting benefits relative to equity compensation alternatives. Including stock option data prior and after the introduction of FAS 123R might lead to noise in the data, since companies and CEOs have other incentives to react to stock options. In order to keep the valuation of stock options consistent, I therefore only use data from 2006 and onwards. The calculation of the endogeneity control requires twice lagged information. Also, the Strategic Risk Score as a dependent variable is regressed in *t+1,* which means that ultimately, the years 2008 till 2017 are studied.

Executive compensation data for the years 2006 till 2018 results in a dataset of 21.165 observations (see Table 4). Each observation is a unique CEO-firm combination in a certain year. Although generally data for other executives are available, the scope of this thesis requires me to retain only the data on CEO compensation. To ensure the relevance of the risk-variables, I follow Martin et al. (2013) in limiting the sample to manufacturing firms (SIC-codes between 2000 and 4000), which leaves me with 8.390 observations. To calculate the predictors of stock option value, which are used to create an endogeneity control, I need at least three consecutive years of data on each CEO-firm unit. This restriction sets the number of observations back to 4984. After that, I merge the compensation data with the analyst compensation data and accounting data, which results in 1.930 missing links. The sample consists therefore of 3.054

Table 4

Stepwise deletion of observations

CEO compensation observations	21.165
Drop ≠ SIC 2000-4000	-12.775
CEO compensation obs.	8.390
Three consecutive years requirement	-3.406
Retained compensation observations	4.984
Risk measures / analyst forecast missing	-1.930
Retained observations	3.054
Examine Risk in year *t+1*	-717
Final sample	**2.337**

Table 4: Stepwise selection of the observations in the sample. Compensation data was selected based on years and position. I delete firms that are not in SIC 2000-4000, following Martin et al. (2013). To create the endogeneity control, I require at least three consecutive years of data for each CEO-firm combination. Finally, missing data for accounting measures or analyst consensus forecasts are deleted from the sample.

CEO-firm-years of observations. Finally, since the dependent variable is examined in $t+1$, I lose another 717 observations and retain a final sample of 2.337 CEO-firm-years.

6. Empirical results and analysis

6.1 Descriptive statistics

Table 5 displays the summary statistics and correlation matrix of the variables in the main model, prior to standardization. Note that the variables are presented as they are prior to standardization, except for the Strategic Risk Score, which itself is calculated using standardized variables. The variables PW, CW, and Endogeneity Control, have considerably different magnitudes than the other variables. The compensation variables are measured in thousands of dollars. Size is calculated as the natural logarithm of total assets, which makes it more compressed and less skewed. Although the compensation data, as well as the Strategic Risk Score are skewed, I refrain from taking the natural logarithm of those measures, as to not lose 'good variation' in the skewness. There are only three instances of a change of CEO in the sample. As noted in the methodology section, I keep this variable to prevent omitting useful information. About 41% of the CEOs in the sample are simultaneously chairman of the Board of Directors of their company. At first glance, the correlation matrix shows a negative correlation between tenure and company stock owned by the CEO, and risk taking. As predicted, PW is positively correlated with the Risk Score. However, unexpectedly, CW is also positively correlated with the Risk Score at first glance. Furthermore, the size of a company is positively correlated with compensation. Tenure is only slightly correlated with PW and CW, however, strongly correlated with the percentage of shares owned by the CEO. This intuitively tells us, that CEOs with a longer tenure might have exercised their stock options, and held on to the stocks instead of selling them. Of course, an alternative explanation is that CEOs have received company stock during their tenure as bonusses, apart from stock options. In both cases, the CEO will be exposed to company-specific risk, and thus be under-diversified, although in the scenario of stock option exercise, the story is more in line with the overconfidence view that I hypothesize in Hypothesis 2.

6.2. Regression results

Since obviously, mere correlation is little informative about true relation or causation, I perform regression analysis on the data. To show the importance of firm-Fixed Effects in the regression, I add the results of a 'naïve' regression, for which I use an OLS approach. Results of the regression (5) are presented in Table 6. In both models, the coefficient of PW is positive and significant, which is consistent with prior findings in agency research. Similarly, the

Table 5

Panel A - Summary statistics of variables

No	**Variable**	**Obs**	**Mean**	**Std. Dev.**	**99% conf. Interval**	
(1)	Strategic Risk Score	2337	0,026	1,000	-0,028	0,079
(2)	PW	2337	4825,808	11025,610	4237,851	5413,76
(3)	CW	2337	14855,190	14855,190	13599,390	16111,0
(4)	Endogeneity Control	2337	12679,970	126479,970	11920,990	13468,9
(5)	Size	2337	7,357	7,357	7,269	7,445
(6)	% Shares owned	2337	1,247	3,070	1,084	1,411
(7)	Tenure	2337	7,597	0,934	7,261	7,933
(8)	Ceochange	2337	0,001	0,036		
(9)	Chairman	2337	0,419	0,494		

Panel B - Correlation matrix

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
(1)	1,000								
(2)	0,444	1,000							
(3)	0,255	0,634	1,000						
(4)	0,397	0,493	0,636	1,000					
(5)	0,683	0,498	0,388	0,532	1,000				
(6)	-0,132	-0,099	-0,077	-0,121	-0,289	1,000			
(7)	-0,118	0,003	0,099	0,051	-0,181	0,446	1,000		
(8)	-0,014	-0,015	-0,016	-0,035	-0,048	-0,001	-0,043	1,000	
(9)	0,209	0,205	0,177	0,200	0,270	0,146	0,141	0,042	1,000

Table 5: Summary statistics and correlation matrix of all variables used in the main model, regression (5). The variables presented are unstandardized, but are winsorized at the 99% level. The Strategic Risk Score is standardized, since it is created with standardized variables. PW, CW, and Endogeneity Control, are in thousands of dollars, Size is the natural logarithm of total assets in millions of dollars. All correlations greater than 0.053 are significant at $p<0.01$.

coefficient of CW is negative and significant in both models, which is consistent with prior BAM research. The naïve regression has a negative and significant coefficient for the interaction between PW and CW. This is inconsistent with H1. However, the Fixed Effects model fails to find a significant effect of the interaction of PW and CW on risk taking. Overall, the naïve model shows higher magnitudes on the coefficients, which accentuates the need for a Fixed Effects regression. In the remainder of the results section, the naïve regression will not be considered.

Table 6

Main model regression

Variable	Naïve regression		Fixed effects model	
	Coefficient	P-value	Coefficient	P-value
PW	0,324***	0,000	0,096***	0,000
CW	-0,090***	0,000	-0,023**	0,005
PW*CW	-0,043***	0,000	0,003	0,328
ENDOGENEITY CONTROL	0,013	0,589	-0,021*	0,033
SIZE	0,592***	0,000	0,114***	0,000
% SHARES OWNED	0,089***	0,000	0,005	0,731
TENURE	-0,013	0,482	0,061*	0,010
CEOCHANGE	0,378	0,347	0,027	0,838
CHAIRMAN	-0,020	0,531	-0,004	0,838
2-digit SIC dummies	YES		NO	
YEAR-DUMMIES	YES		YES	
CONSTANT	0,099	0,354	0,047**	0,009
R2 (overall)	0,525		0,380	
N	2.337		2.337	

*Table 6: Significance levels are denoted by: * p<.05; ** p<.01; *** p<.001. The variables of interest are PW (prospective stock option wealth), CW (current stock option wealth), and the interaction between both. The naïve regression is an OLS regression, using the same variables as the Fixed Effects regression, except for the addition of 2-digit SIC dummies. In both regressions, the dependent variable is the Strategic Risk Score, which is factor analysed from CAPEX, Long-Term Debt, and R&D spending. The difference between the two models accentuates the influence of unobserved heterogeneity between firms, which biases results. The Fixed Effects approach results in more moderate results.*

The coefficient on the endogeneity control is negative and significant at the 5% level, which is similar to the results in Martin et al. (2013). Similarly, the dummies for a change of CEO and for CEOs that have a double position as chair of the Board of Directors, are insignificant. Presumedly, the better part of variance explained by the latter variable is captured in the Fixed Effects. This is to be expected, since the between variation of firms is held fixed, thus only within firm's variance over time will show up. Since the Strategic Risk Score has no direct economic interpretation, it is hard to make direct inferences about the influence of PW and CW on real strategic risk taking. In the Fixed Effects model, the coefficient for PW is 0.096 and for CW it is -0.023. These numbers can be interpreted as that a standard deviation increase in PW, will change the Strategic Risk Score with 0,096. Remember that the Strategic Risk Score is also standardized with a mean of 0 and a standard deviation of 1. This implies that a change of 1 in the standardized variable is equal to a change of 1 standard deviation. However, since the Strategic Risk Score, PW, and CW are not normally distributed, but skewed, the interpretation is not valid for the increase of PW over each magnitude of PW. Instead, the coefficient should be interpreted as the average effect of PW on strategic risk taking, where an increase of 1 standard deviation on average changes the Strategic Risk Score with 9,6% of a standard deviation. Similarly, the effect of CW should be interpreted that an increase of 1 standard deviation on average leads to a decrease of 2,3% of a standard deviation in the Strategic Risk Score[14].

6.3 Exercisable or unexercisable options

To test the second hypothesis, I divide the main sample into a HIGH-sample and a LOW-sample. The HIGH-sample contains the observations with a relatively high ratio of exercisable options to unexercisable options. Remember that this does not necessarily mean for each observation in the HIGH-sample that exercisable option value > unexercisable option value. The results are presented in Table 7. The LOW-sample produces results that are fairly similar to the main model. PW is positive and significant, although with a smaller coefficient than the main model. CW is negative and significant, with a slightly larger coefficient than the main model. The interaction between PW and CW is insignificant as well. The HIGH-sample

Table 7

HIGH-LOW overconfidence subsample regression for H2

	HIGH		LOW	
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
PW	0,319***	0,000	0,088**	0,001
CW	-0,076***	0,000	-0,031*	0,011
PW*CW	-0,053***	0,000	0,004	0,383
ENDOGENEITY CONTROL	-0,025*	0,015	-0,022	0,180
SIZE	0,045	0,067	0,158*	0,015
% SHARES OWNED	-0,000	0,949	0,012	0,885
TENURE	0,005	0,097	0,013	0,073
CEOCHANGE	-0,022	0,777	0,067	0,814
CHAIRMAN	-0,011	0,544	0,005	0,904
2-DIGIT SIC DUMMIES	NO		NO	
YEAR-DUMMIES	YES		YES	
CONSTANT	-0,086*	0,030	0,069	0,313
R2 (overall)	0,370		0,390	
N	1.169		1.168	

*Table 7: Significance levels are denoted by: * p<.05; ** p<.01; *** p<.001. The HIGH and LOW sub-samples are divided based on high and low relative exercisable option value. The variables of interest are PW (prospective stock option wealth), CW (current stock option wealth), and the interaction between both. In both regressions, the dependent variable is the Strategic Risk Score, which is factor analysed from CAPEX, Long-Term Debt, and R&D spending.*

[14] Exploring the unique effect of PW and CW on the dependent variable by employing the *margins*-function in STATA, shows me that the effect is relatively greater for higher levels of the independent variables. I.e., moving from the first to the second standard deviation of CW (PW) has a smaller effect on the dependent variable, than moving from the second to the third standard deviation.

produces very different results compared to the LOW-sample. PW and CW have the same signs and significance levels, but are clearly of a much larger magnitude. Also, the interaction of PW and CW is highly significant. While the signs of PW and CW are consistent with the predictions, the sign of the interaction term is negative, which is the opposite result of the prediction in H1 and H2. To test whether the coefficients are statistically significantly different between the samples, a t-test with unequal variance is conducted on the coefficients. The coefficient of PW on strategic risk taking in the HIGH-sample is 0.319, which is significantly larger ($p < 0.001$), then the coefficient of 0.088 in the LOW-sample. The coefficient of CW in the HIGH-sample is -0.076, and in the LOW-sample -0.031. The coefficient of CW on strategic risk taking is significantly smaller in the HIGH-sample than in the LOW-sample ($p < 0.027$). When adding up the coefficients for PW, CW, and the interaction, the combined effect of stock options on risk taking is higher in the HIGH-sample (0.19) than the LOW-sample (0.057).

6.5 Accumulation of stock option value

Similar to the method for testing H2, in H2 I create a HIGH-sample and a LOW-sample. The distinction is made based on the accumulated value of the total amount of stock options a CEO holds at the end of a certain year. The median value is used as a cut-off point for dividing the main sample into HIGH and LOW sub-samples. The results are presented in Table 8. The results are clearly different from earlier results in the main model. First of all, the CONSTANT values are of a significant size and sign, positive in the HIGH-sample and negative in the LOW sample. This suggests that in general the observations in the HIGH-sample contain higher Strategic Risk Scores than observations in the LOW-sample. A mean comparison test shows that the Strategic Risk Score is significantly higher in the HIGH-sample than the LOW-sample. To investigate what the basic difference of risk taking between the subsamples is, I create 99% confidence intervals of the Strategic Risk Score. The 99% interval for Strategic Risk Score in the HIGH-sample is $0,147 < \mu_{\text{-HIGH}} < 0,328$; while the interval for the LOW-sample is $-0,282 < \mu_{\text{-LOW}} < -0,211$. This suggests that the distinction between high and low levels of accumulated stock option value is simultaneously a clear distinction between high and low risk taking. By examining the PW more closely, I find that the average growth rate of stock option value based on analyst's forecasts is significantly higher for the HIGH-sample than for the LOW-sample. The estimated average growth rate is about twice as large in the HIGH-sample (1,76%) than in the LOW-sample (0,89%). On top of this, the number of stock options held is higher for agents in the HIGH-sample than in the LOW-sample ($P < 0,001$). This implies that the division of sub-samples based on accumulated stock option value, is simultaneously a division based on prospects.

Table 8

HIGH-LOW accumulated stock option value subsample regression for H3

	HIGH		LOW	
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
PW	0,073**	0,005	-0,042	0,713
CW	-0,028*	0,028	-0,639***	0,000
PW*CW	-0,006	0,216	-1,480***	0,000
ENDOGENEITY CONTROL	-0,026	0,122	-0,011*	0,048
SIZE	0,161*	0,016	0,045**	0,001
% SHARES OWNED	0,009	0,920	-0,002	0,732
TENURE	0,134*	0,010	0,017	0,081
CEOCHANGE	0,071	0,812	-0,001	0,978
CHAIRMAN	-0,015	0,745	-0,012	0,165
YEAR-DUMMIES	YES		YES	
2-digit SIC dummies	NO		NO	
CONSTANT	0,277***	0,000	-0,304***	0,000
R2 (overall)	0,325		0,241	
N	1.168		1.169	

*Table 8: Significance levels are denoted by: * p<.05; ** p<.01; *** p<.001. The HIGH and LOW sub-samples are divided based on high and low levels of accumulated stock option value. The variables of interest are PW (prospective stock option wealth), CW (current stock option wealth), and the interaction between both. In both regressions, the dependent variable is the Strategic Risk Score, which is factor analysed from CAPEX, Long-Term Debt, and R&D spending.*

The HIGH-sample shows similar results as the main regression in Table 6. The coefficient for PW is significant and positive, while the coefficient for CW is negative and significant at the 5% level. The interaction term is insignificant, which is inconsistent with H3. The magnitudes of the coefficients are of similar size as in the main regression.

The LOW-sample produces results that are in sharp contrast with the HIGH-sample[15]. The coefficient on PW is highly insignificant. However, CW is highly significant and of a considerably higher magnitude then the main regression. On top of that, the interaction between CW and PW is highly significant and negative. This should be interpreted as that a higher PW negatively moderates the effect of CW on risk taking, i.e. a higher prospective future wealth makes the agent more risk averse with respect to his current wealth. This is inconsistent with the main effect in H1, which predicted a positive effect. Due to unclear signs in prior literature, H3 was stated in the null-form. The null-hypothesis that the effect of PW on CW is equal across all levels of accumulated stock options value can be rejected.

[15] The signs and significance levels of PW, CW, and the interaction term remain substantially the same when restricting the LOW-sample to observations with an accumulated stock option value greater than 0, which eliminates 178 (15,2%) of the observations in the subsample.

6.5 Additional tests

6.4.1 Removing salary from current wealth

For theoretical reasons, I defined CW differently than Martin et al. (2013) did in their paper. However, for comparison's sake, it is interesting to see side-by-side whether salary is a salient factor in a CEOs risk aversion. Secondly, it is important to see whether my results are driven by the inclusion of salary into the equation. To analyse this, I define $CW_{alternative}$ as the current stock option value. I also add salary as a separate variable, to control for omitted variable bias. As in the main analysis, I winsorize the variables at the 1% level and standardize with a mean of 0 and standard deviation of 1. In Table 9 I present the results of the main analysis side-by-side with the alternative version.

As in the main model, the alternative model produces a positive and significant coefficient for PW, and a negative and significant coefficient for CW. Also, the interaction term is insignificant. A clear distinction between the two models is the change of sign of the CONSTANT. On top of that, the coefficient for SIZE is insignificant in the alternative model. Instead, SALARY is highly significant. The R^2 is higher for the alternative model, which

Table 9

Alternative definition of CW

	Alternative model		**Main model**	
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
PW	0,091***	0,000	0,096***	0,000
CW	-0,022**	0,008	-0,023**	0,005
PW*CW	0,003	0,317	0,003	0,328
SALARY	0,001***	0,000		
ENDOGENEITY CONTROL	-0,021*	0,033	-0,021*	0,033
SIZE	0,056	0,078	0,114***	0,000
% SHARES OWNED	0,004	0,795	0,005	0,731
TENURE	-0,012	0,642	0,061*	0,010
CEOCHANGE	0,025	0,849	0,027	0,838
CHAIRMAN	-0,015	0,504	-0,004	0,838
YEAR-DUMMIES	YES		YES	
CONSTANT	-0,364***	0,000	0,047**	0,009
R2 (overall)	0,461		0,380	
N	2.337		2.337	

*Table 9: Significance levels are denoted by: * p<.05; ** p<.01; *** p<.001. The HIGH and LOW sub-samples are divided based on high and low levels of accumulated stock option value. CW in the alternative model is defined as just the current stock option value, whilst in the main model CW is defined as the current stock option value plus salary. In both regressions, the dependent variable is the Strategic Risk Score, which is factor analysed from CAPEX, Long-Term Debt, and R&D spending. The PW (prospective stock option wealth) variable is used analogously in both regressions.*

suggests that this is the more powerful test. However, since the variables of interest do not change substantially, I conclude that either including or excluding SALARY in CW does not have a significant impact on the analysis.

6.4.2 Separate risk measures

Following the method of prior BAM research, I created a risk measure from a factor analysis of three predictors of strategic risk. In the factor analysis, it became clear that the first factor explained most of the common variance in the accounting measures. The argument for using factor analysis was built on the assumption that the common variance in the three accounting measures reflect the underlying strategic risk taking of agents. However, this means that any unique variance in the accounting measures that potentially reflects something of the strategic risk taking by agents is lost in the factor analysis. Therefore, it is interesting to see in retrospect how using the individual measures changes the regression results. Radically different or conflicting results would point out problems with the Strategic Risk Score. The analysis is conducted by adapting the main model, and interchanging the Strategic Risk Score for the

Table 10

Regression using separate risk measures

	CAPEX		Long-Term Debt		R&D	
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**	**Coefficient**	**P-value**
PW	0,150***	0,000	0,052	0,065	0,090***	0,000
CW	-0,022*	0,035	-0,011	0,418	-0,044***	0,000
PW*CW	-0,010**	0,009	0,012*	0,012	0,004	0,190
ENDOGENEITY CONTROL	-0,003	0,834	-0,049**	0,003	0,002	0,872
SIZE	0,078*	0,042	0,086	0,090	0,211***	0,000
% SHARES OWNED	0,002	0,899	0,008	0,741	0,003	0,839
TENURE	-0,012	0,682	0,151***	0,000	0,005	0,840
CEOCHANGE	0,001	0,998	0,051	0,815	0,021	0,885
CHAIRMAN	0,006	0,837	-0,017	0,642	0,003	0,904
YEAR-DUMMIES	YES		YES		YES	
2-digit SIC dummies	NO		NO		NO	
CONSTANT	0,020	0,377	0,067*	0,024	0,048*	0,019
R2 (overall)	0,384		0,080		0,272	
N	2.337		2.337		2.337	

*Table 10: Significance levels are denoted by: * p<.05; ** p<.01; *** p<.001. The table presents the results for the regressions on the accounting measures that in the main analysis were combined in a single risk measure. The risk proxies are standardized and winsorized at the 1% level. The variables of interest are PW (prospective stock option wealth), CW (current stock option wealth), and the interaction between both.*

individual accounting measures. These measures are CAPEX, Long-Term Debt, and R&D, which are standardized with a mean of 0 and a standard deviation of 1. As in the main model, the dependent variable is studied in *t+1*. All independent variables are used analogously to the main model.

Results for each regression are presented in Table 10. The first column shows the results with CAPEX as the dependent variable, which shows similar results as the main model. A positive and significant coefficient PW, a negative and significant coefficient CW. The interaction term is negative and significant, which is different from the main model. The second column shows the results for Long-Term Debt, which are surprisingly different from the main model. The coefficients for PW and CW are insignificant, although having the expected signs. The interaction term is significant and positive, as predicted under H1. This is contrary to the other regressions, where the interaction term was either insignificant or negative. Finally, the third column shows the expected positive sign on PW and negative sign on CW. In line with the main model, the interaction term is insignificant.

Between the columns, there is a clear distinction between CAPEX and R&D on the one side, and Long-Term Debt on the other side. The former two are both in line with the main analysis, and the latter shows different signs and insignificant results. There are two explanations for this. First, the R^2 of the Long-Term Debt regression is a lot smaller than the R^2 of CAPEX and R&D. This shows that the model fit is not as good as in the other analyses. Combined with the fact that the average number of observations per group is only 3,9, it is possible that the model is too restricted to show significant results. A second explanation is, that Long-Term Debt explains a different part of the underlying Strategic Risk taking by agents than the other two variables. Taken on its own, the interpretation is that agents decide to take on more long-term debt in reaction to higher prospective wealth from stock options. The significantly positive interaction term shows that the risk aversion due to current wealth, is mitigated by the prospect of future gains through an increase in stock option value. In the main analysis in paragraph 6.2, this effect was not found, since the effect does not carry over to strategic risk as defined by CAPEX and R&D. Although the second explanation is attractive in light of the hypotheses, the low fit of the model urges me to conclude that there is still insufficient evidence for rejecting H1. Suffice to say, none of the individual regressions show evidence against the use of the Strategic Risk Score in the main analysis.

7 Discussion and conclusions

In this thesis, agency theory and behavioural agency theory are compared in their ability to explain reality. In the hypothesis section, I predict what I expect to find in reality, based on prior research. In this chapter, I briefly recall each hypothesis and interpret my findings in light of prior literature.

7.1 Discussion of Hypothesis 1

The first hypothesis in this thesis forms the base effect, to which the second and third hypotheses are compared. In the basis, the first hypothesis is that the RBAM as a mixed gamble is a good explanation of reality. Agency theory was found to lack explanatory power with respect to the behavioural side of agents (Wiseman & Gomez-Mejia, 1998). The goal of the RBAM is to better explain reality than agency theory does. The first hypothesis therefore, is formulated in such a way that rejecting the null-hypothesis is in favour of the RBAM as formulated by Martin et al. (2013). According to the RBAM, it is expected that the current value of stock options creates loss aversion, and the potential future gains in stock options provide an incentive for risk taking. The positive value of future gains actively reduces the los aversion of the agent with respect to his currently accumulated stock option wealth.

In the analysis for H1, the coefficients for CW and PW were respectively negative and positive. The negative coefficient for CW can be interpreted in line with the BAM. This is the risk aversion of a CEO with respect to the value that is currently accumulated in his stock options. This also shows that agency theory misses the mark, when predicting that stock options provide an agent with exclusively upside potential and no downside risk. This might be true for out-of-the-money options, but certainly does not hold for stock options that have accumulated value over time. The positive coefficient on PW is in line with the prediction of agency theory that stock options provide the agent with an incentive to take on more risk. The coefficient for the interaction of PW and CW is insignificant. This means that I cannot reject H1, which hypothesized that the negative relation of current wealth and risk taking, would be positively moderated by prospective wealth. Obviously, the results show that the coefficient of PW is larger than the coefficient of CW. From this it can derived that, overall, agents are inclined to take on more risk due to stock option holding, which is consistent with prior literature (e.g. Rajgopal and Shevlin (2002), Devers et al. (2007), and Sanders and Hambrick (2007)). However, based on the evidence in this research, I cannot conclude that the PW actively reduces the negative relation of CW and risk-taking. This is inconsistent with the RBAM and Martin et al.'s (2013) findings.

7.2 Discussion of hypothesis 2

The second and third hypotheses are built on the main effect that was predicted in the first hypothesis. The second hypothesis is that the hypothesized effect in H1 is stronger for vested options than not yet vested options. The idea behind this, is that CEOs with relatively more vested options, are relatively more overconfident. I divided the main sample into a HIGH and LOW sample based on the median relative weight of vested stock options value in the total option value an agent has at each year. Since I did not find the base effect in H1, the hypothesis practically is about finding the positive moderation of PW on CW in the HIGH-sample, and not finding the effect in the LOW-sample. Since overconfident managers respond stronger to risk-taking incentives, if the moderating effect of PW on CW is present, it should show up in the subset of most overconfident CEOs of the sample. In the LOW-sample I find results that are similar to the main sample. In the HIGH-sample however, I find a negative coefficient for the interaction between PW and CW. This is contrary to the hypothesized relation in H1 and H2. The interpretation of this coefficient is that the CW negatively moderates PW. In other words, the risk-taking incentive of PW is reduced by the risk aversion with respect to CW. Based on this evidence, I fail to reject Hypothesis 2.

To understand the results better, I consider the values of the coefficients of CW and PW in both sub-samples. To compare the coefficient between the sub-samples, I employ simple t-tests with unequal variance assumed. Compared to the LOW-sample, I find a significantly greater coefficient of PW and CW in the HIGH-sample. Overconfidence does not make the positive moderation between PW and CW stronger. However, the coefficients of PW and CW are higher for more overconfident managers. To explore this, I compare the base levels of PW and CW in both sub-samples. The level of PW (CW) is approximately four (six) times larger in the HIGH-sample than in the LOW-sample. Since the amount of CW is higher, the overconfident CEOs still experience more loss aversion then CEOs in the LOW-sample. However, overall, the effect of PW is higher in the HIGH-sample, especially considering that the CEOs in the HIGH-sample have relatively more CW than PW. This affirms I was successful in dividing the sample based on overconfidence, since a stronger reaction to PW is expected for more overconfident CEOs (Malmendier & Tate, 2005; Fu & Ligon, 2010). This makes it less likely that instead of overconfidence, there is an unknown factor that produces the difference in results compared to the main analysis. The only weakness in the sub-samples, is the loss of sample size. However, since the R^2 remains substantially the same, the reduced sample size could not produce differences in the results of this magnitude. Again, when adding up the coefficients of PW, CW, and the interaction term, the positive result suggests that stock option grants incentivize agents to take on more risk, and that this effect is stronger for overconfident CEOs, which is consistent with prior literature (e.g. Rajgopal and Shevlin (2002), Devers et al. (2007), and Sanders and Hambrick (2007)). I conclude, that I find results that are consistent with the overconfidence view, and still fail to confirm the results of Martin et al. (2013). This confirms my prior findings for H1, since the expected moderating effect of PW on CW is expected to be more prominent for overconfident CEOs. If an effect is not found in the group where it is most likely to be found, this strongly suggests the effect is not there.

7.3 Discussion of hypothesis 3

For the third hypothesis, I analyse a HIGH and LOW sub-sample based on accumulated stock option values. The hypothesis is formulated in the null-form, since it is not clear from prior literature what to expect. Agency theory does not have a prediction for changing levels of risk taking over the accumulation of stock option value. However, BAM predicts less risk taking with the increase of stock option value, since the agent is risk averse with respect to the accumulated wealth in his stock options (Hoskisson et al., 2017). Behavioural research and managerial overconfidence literature predict the opposite (Thaler & Johnson, 1990; Malmendier & Tate, 2005; Devers et al., 2008). Because an agent attributes the accumulation of stock option value to his prior successes, he will be confident in achieving these successes again. Thus, higher accumulated stock option value will lead to higher risk taking instead of lower risk taking. The results for the HIGH-sample are similar to the results in the main sample. However, the LOW-sample shows a radically different result. The coefficient of PW is insignificant, while both the coefficient on CW and the interaction term are highly significant and negative. This means that the potential higher wealth in the future does not incentivize the CEOs to take on more risk. At the same time, the CEOs are very risk averse with respect to their current wealth. The interaction term shows that PW negatively moderates the effect of CW on risk taking. This suggests that the CEOs' risk aversion with respect to CW reduces the risk-inducing effect of PW. The coefficients on the interaction term are not consistent with the main prediction of H1. The results on CW are not consistent with the prediction of the BAM, since the CW in the LOW-sample is greater than in the HIGH-sample. Based on behavioural research and overconfidence literature, I predicted a higher PW in the HIGH-sample than in the LOW-sample. Technically, I found this exact result. However, the coefficient for PW is insignificant in the LOW-sample, which directly contradicts prior findings in this thesis and in agency research (e.g. Rajgopal and Shevlin (2002) and Sanders and Hambrick (2007)). This suggests that there might be a different explanation for the results.

To better understand the results, I examined the differences in the characteristics of the two sub-samples. The mean Strategic Risk Score and the underlying estimated growth rate for the LOW-sample are significantly lower than for the HIGH-sample. This implies that in my sample CEOs with prior successes, and thus larger accumulated stock option value, have brighter expectations for the future, and also take more risk. Interestingly, even though the estimated growth rates for the LOW-sample are still positive, the PW does not have a significant effect on strategic risk taking. This shows the limits of agency theory, which posits unlimited upside potential and limited downside risk. Even though these agents have positive prospects, they do not increase risk taking, because the risk aversion with regards to their current wealth is too strong (as shown by the negative interaction term). The question remains, how this clear distinction between the HIGH-sample and LOW-sample came to be[16]. The results show a base level of higher risk taking for higher amounts of accumulated stock option value. This finding is consistent with the overconfidence view and the reference dependence from prospect theory. This suggests, that the heterogeneity in risk taking is caused by a behavioural factor, that can change over time. Using the concept of reference dependence, I can explain the results by assuming that the CEOs in the LOW-sample might have had a low past performance and thus a low reference point, which leads to risk-averse behavior. This would go as far as that the stock options do not entice the CEO to take on more risk in the LOW-sample. On the other hand, the HIGH-sample contains CEOs with higher past performance, which would make them to have higher reference points. This would lead them to be in a loss-frame, thus more risk-seeking. Considering the evidence, I reject H3 and conclude that the accumulated stock option value significantly impacts the incentive of stock options. The evidence shows a positive association between stock option accumulation and risk taking. The evidence is consistent with reference dependence (Thaler & Johnson, 1990), although the extreme risk aversion in the LOW-sample leaves room for future research. Alternatively, I cannot entirely rule out that there is an unknown factor that makes CEOs in the LOW-sample unresponsive to PW.

7.4 Discussion of additional tests

I performed two additional tests. The first one was a test for robustness of the CW measure. I removed salary from the CW variable and repeated the main analysis. Earlier research argued that salary becomes an important factor in the CW if a company is in distress (Hoskisson et al.,

[16] Since a significant part of the CEO-firm combinations occur in both HIGH and LOW groups, the results are not likely to be driven by a salient characteristic that makes CEO's select into one of both groups. Differences in compensation designs are also unlikely to cause these results, since I control for most forms of compensation that might change over time.

2017; Larraza-Kintana et al., 2007). The reference point of a CEO that faces dismission will change from the targets that are tied to bonusses (reference point is 0), to the critical point of performance where he expects to be dismissed. In my thesis however, the results do not change substantially when using the alternative CW-measure, which leads me to conclude that the CW measure is a robust measure. Secondly, I repeated the main analysis while using the separate accounting measures of risk. Although there were some interesting distinctions between the coefficients in the three regressions, I conclude that the results did not raise concerns about the validity of the Strategic Risk Score that is used elsewhere in my thesis.

7.5 Implications of results and acknowledgement of limitations

To summarize, I am unable to find supportive evidence for the hypothesis that PW positively moderates CW. This finding is no different among samples of relatively more overconfident CEOs or among CEOs with relatively more accumulated stock option value. Following this conclusion, this thesis sends out a warning call to researchers that have been building on the RBAM. Several papers have been written using parts of the RBAM, but my thesis shows that the concepts proposed by the RBAM are not conclusive, and more empirical evidence is yet to be gathered to understand the incentivizing effect of stock options. For instance, Benischke et al. (2019) use the PW measure analogously to Martin et al. (2013)[17]. As argued in the methodology section, this measure is flawed at least. Additionally, I find evidence that PW is positively moderated by overconfidence. Future research ought to take into account that PW is not a completely rational concept from the agent's point of view. Secondly, I find evidence consistent with both of the basic predictions of agency theory and the BAM. Stock options incentivize an agent to take more risk due to a potential increase in wealth (agency theory) and simultaneously create loss aversion with respect to currently accumulated wealth in stock options (BAM). Regardless of the lack of evidence for an interaction between PW and CW, there is a policy implication in these findings. Boards of directors need to consider both the PW and CW of their CEOs, and evaluate their values over time. At the moment of the first grant, stock options might solely provide the CEO with upward potential, but after several years of accumulating stock option value, the same stock options create risk aversion. Therefore, to create a perfect alignment of interests between CEOs and stockholders, boards need to take these changes over time into account. Ideally, boards would try to determine the subjective valuation of PW, by taking into account behavioural characteristics of their CEO. More research

[17] Strangely, Benischke, Martin, and Glaser use PW based on a growth rate of 6,82%, while the average yearly growth rate in their sample period is 3,78%.

is required to find a realistic approximation of the true subjective valuation of potential future cash flows for an individual person. In this thesis I employed a proxy for PW based on ratio. However, the results pointed out significant differences in the incentives of stock options, between behavioural traits (overconfidence) and circumstances that are rationally approachable (accumulated stock option value). A realistic valuation of PW would require taking into account both rational expectations of future cash flows and the subjective valuation of those future cashflows. The subjective valuation might encompass diminishing sensitivity to marginal wealth (as assumed in prospect theory by Kahneman and Tversky (1992)), overconfidence, and CEO personality traits (e.g. Benischke et al. (2019)). A behavioural definition of PW might also explain the insignificant influence of PW in the sub-sample with CEOs with relatively low accumulated stock option value.

Finally, I have to acknowledge some limitations of this thesis. Firstly, a lot of observations were lost on the merging and linking of databases. On top of that, the data was limited to a single country and a subsection of industries. Research is needed to find reliable proxies for strategic risk taking for other countries and industries, to be able to expand the number of datapoints considerably. Although the number of observations in this thesis was sufficient to get significant results, the generalizability of results could be improved if future research could gather more data. Secondly, although I refined the PW measure with regards to prior research, the question still remains how the subjective valuation of future prospects is performed by the CEO. In that line of thought, I am pleased with research like Benischke et al. (2019), who are examining how personality traits fit in the association of risk taking and performance-based compensation. Future research might be able to use new proxies for PW in testing the RBAM. Lastly, I used a somewhat crude (although effective) method to distinct between relatively overconfident managers. Future research could make use of the richer proxies developed by Malmendier and Tate (2005; 2008) to be able to make more detailed inferences. Again, to be able to use these proxies, a larger number of observations will be required.

8 References

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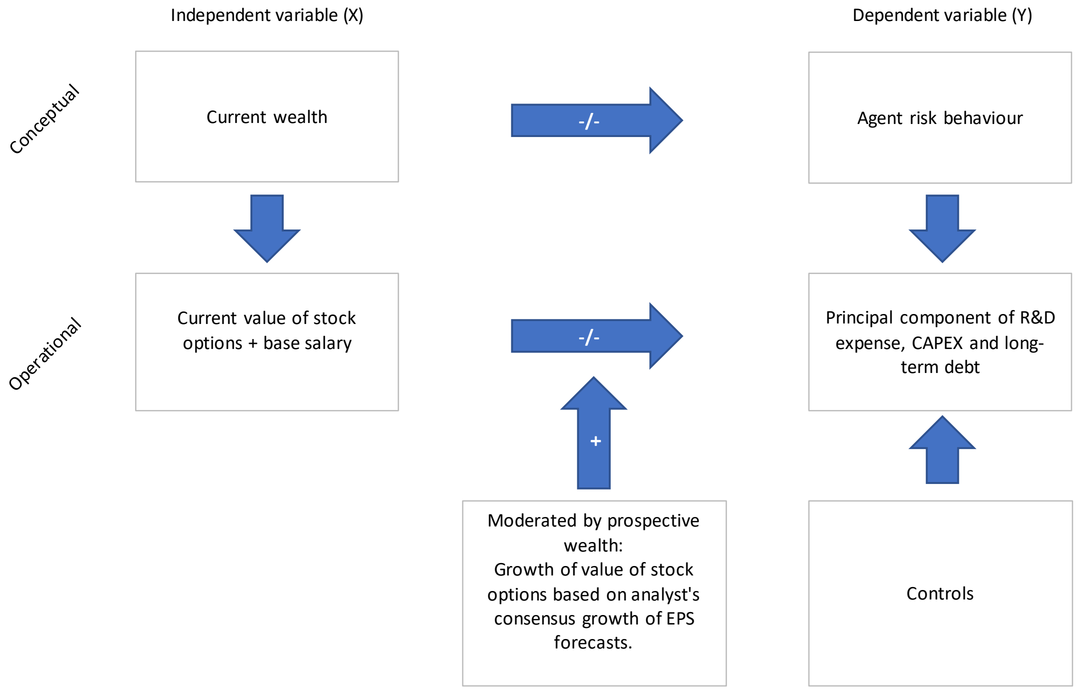
Appendix A: Libby boxes

The predictive validity framework as shown, represents Hypothesis 1. For hypothesis 2 and 3, the intuition is that CEO (over)confidence positively moderates the value of prospective wealth. However, confidence is not reasonably measurable in my setting, so instead of interacting a measure of confidence, I try to isolate relative degrees of confidence in HIGH and LOW subsamples, and then test for differences in the variables of interest.



Appendix B: List of variables used

No.	Name	Abbrevation	Definition	Source
1	Prospective Wealth	PW	*Prospective wealth = number of options held * [(Prospective growth^time to expiry * stock price) – stock price].*	
1.1	No. Of options	OPTIONS	The number of options held by a CEO at the end of fiscal year t.	Compustat execucomp
1.2	Analyst EPS growth forecast	Prospective Growth	I calculate the growth rate for one, two and three years from year *t*, and take the average growth rate from that. To do so, I use the diluted EPS including extraordinary events at time t as a base rate. This growth rate is multiplied by the stock price at the end of fiscal year *t*, to proxy for a growth in stock price and thus in stock option value.	
1.2.1	Forecast period indicator	FPI	An indicator for the number of fiscal year-ends ahead of *t*=0 the analyst is forecasting.	I/B/E/S
1.2.2	Estimated earnings per share	EPS	The forecasted earnings per share at fiscal year-end. For analyst forecasts, the first forecast after the publication of annual reports is taken as the forecast for the next year.	I/B/E/S
1.2.3	Earnings per share	EPS	The actual earnings per share at the end of fiscal year *t*.	CRSP/Compustat merged fundamentals
1.2.3	Stock Price	StockPrice	Closing price of company stock at the end of fiscal year *t*.	Compustat Execucomp
1.3	Time to expiry	EXPIRY	The weighted average time to expiry of stock options held by a CEO at the end of fiscal year *t*.	Compustat Execucomp
2	Current Wealth	CW	*Current wealth = base salary + current stock option value.*	
2.1	CEO base salary	SALARY	The reported base salary for a CEO in fiscal year *t*.	Compustat execucomp
2.2	Stock option value	OPTIONVALUE	The current value of stock options held by a CEO at the end of fiscal year, as reported under FAS123R.	Compustat execucomp
3	Strategic Risk score	Strategic Risk	The risk score calculated from R&D, CAPEX and Long-term Debt. Weights are derived from the factor loadings on the first factor from common factor analysis.	
3.1	R&D expenses	R&D	The reported R&D expenses in fiscal year *t*.	CRSP/Compustat merged fundamentals

3.2	Capital expenditures	CAPEX	The reported Capital expenditures in fiscal year *t*.	CRSP/Compustat merged fundamentals
3.3	Long-term debt	DEBT	The reported value of long-term debt at the end of fiscal year *t*.	CRSP/Compustat merged fundamentals
4	CEO stock ownership	STOCK	The proportion of shared outstanding that are held by the CEO at the end of fiscal year *t*.	Compustat Execucomp
5	Firm size	SIZE	The size of a firm, measured by the natural logarithm of assets at the end of fiscal year *t*.	CRSP/Compustat merged fundamentals
6	CEO tenure	TENURE	The number of years a CEO holds his position at the current company, as calculated at the end of fiscal year *t*.	Compustat Execucomp
7	CEO age	AGE	The age of the CEO at the end of fiscal year *t*.	Compustat Execucomp
8	Institutional ownership	INSTOWN	A dummy variable that is 1 if total institutional ownership exceeds 5% in year *t*.	Thomson Reuters 13F
9	CEO is chairman	CHAIR	A dummy variable that is 1 if the CEO is simultaneously chair of the board in year *t*.	Compustat Execucomp
10	Gender	GENDER	A dummy variable that is 1 if the CEO is male, and zero if otherwise.	Compustat Execucomp
11	Change of CEO	CHANGE	A dummy variable that is 1 if there is a change of CEO in year *t*.	Compustat execucomp
12	Endogeneity controls	ENDCONTROL	Predicted stock option value for year *t*, according to equation 6.	
12.1	Options value	OPTIONVALUE	as in 2.2	
12.2	Stock performance	PERFORM	The average of monthly total return.	CRSP/Compustat merged Security
12.3	Time to expiry	EXPIRY	As in 1.3	
12.4	Stock price volatility	VOLATILITY	The standard deviation of monthly stock prices over the fiscal year.	CRSP/Compustat merged Security
12.5	R&D intensity	R&DINT	The R&D expenses scaled by revenues.	
12.6	Capital intensity	CAPINT	Total assets scaled by revenues.	
12.7	Revenues	SALES	The reported value of revenues for fiscal year *t*.	CRSP/Compustat merged Fundamentals
12.8	Firm size	SIZE	As in 5.	

Appendix C: Explanatory graphic for the refined BAM

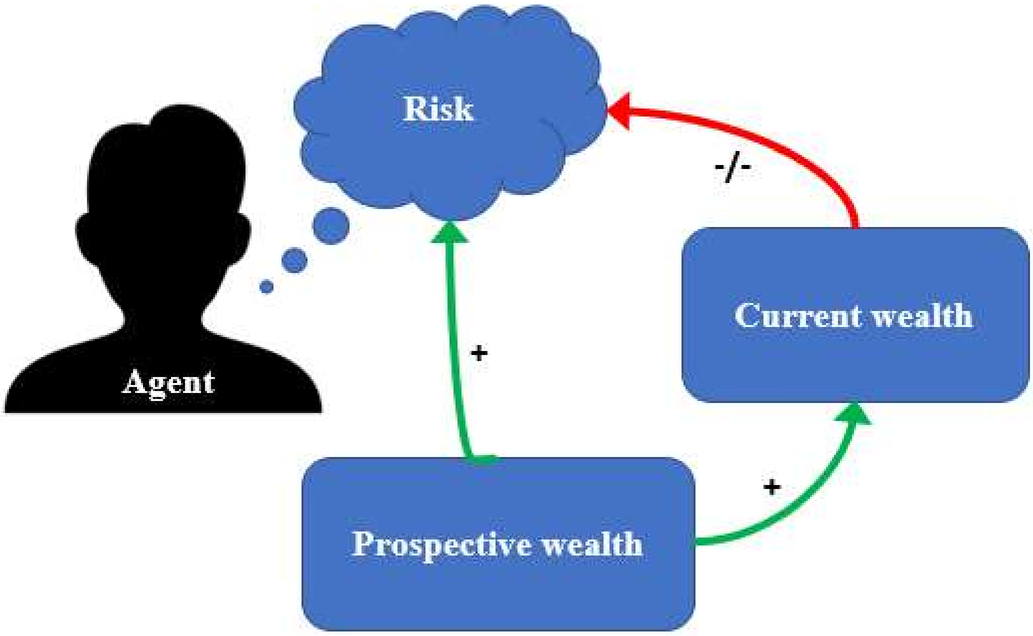


Figure C-1: The explanatory graphic for the relation of prospective wealth, current wealth, and risk taking in the refined behavioural agency model.

The explanatory graphic shows the intuition in the refined BAM. There is an agent, that makes a decision under risk. At that moment, he is influenced by two 'forces.' The first force is prospective wealth, which is wealth that might or might not be added to his personal wealth, through the outcome of his decision. The second force is current wealth, which is at risk through the decision. The agent evaluates the options in his decision according to their expected outcomes and the risk they carry. The force of current wealth accentuates the potential of losing money due to the risk that each of the options carry. The force of prospective wealth accentuates the possibility of increasing wealth with each positive expected outcome. Now, using the refined behavioural agency model, Martin et al. (2013) found evidence that the prospective wealth also positive moderates the force of current wealth. This means, that in the presence of a positive value of prospective wealth, the negative value of current wealth becomes smaller.