
# Mitigating firm characteristics of CEO overconfidence and its effect on firm performance

*Master Thesis Financial Economics*

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## ABSTRACT

This thesis examines mitigating firm characteristics of the CEO overconfidence bias. Next to that, it tests the effect of CEO overconfidence on firm performance and expenditures and the interaction effect of CEO overconfidence and higher expenditures on firm performance to test whether the bias must be mitigated. The sample consists of 10,447 firm-year observations, using panel data of S&P 1500 firms between 2000 and 2019. Results show that a higher proportion of female directors and higher leverage significantly mitigate CEO overconfidence. However, CEO overconfidence has a slight positive impact on firm performance measured by the return on assets (ROA) and a significant impact on firm growth opportunities measured by Tobin's Q. Results also show that CEO overconfidence only increases firm capital expenditures. Lastly, Tobin's Q is higher when an overconfident CEO chooses higher capital expenditures and research and development expenses. Findings display which firm characteristics mitigate CEO overconfidence, but it can be debated if the bias must be mitigated since it positively impacts firm performance and growth opportunities.



Keywords: Behavioral corporate finance, behavioral biases, CEO overconfidence, firm characteristics, firm performance

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## 1. Introduction

Recent empirical behavioral financial literature broadly examined CEO overconfidence. Overconfidence is a bias in which individuals overestimate their capabilities and underestimate risks (Barberis & Thaler, 2003; Broihanne et al., 2014). Overconfidence is generally divided into two effects: miscalibration and the better-than-average effect. Miscalibration causes agents to overestimate their ability to predict the future and underestimate the volatility of random effects (Liechtenstein et al., 1977). The better-than-average effect causes agents to overestimate their ability or skills relative to the average, believing they can outperform the market (Svenson, 1981; Alicke, 1985). Since more than 80% of CEOs think they are better than average, it is a highly relevant topic to research (Malmendier & Tate, 2005).

CEO overconfidence is associated with miscalibration and the better-than-average effect (Hribar & Yang, 2016). The bias is most commonly displayed in M&A since takeovers are an individual decision, and managers are not experienced, which leads to overbidding (Roll, 1986). As a result, they tend to complete more (value-destroying) deals (Malmendier & Tate, 2008; Ferris et al., 2013). Overconfident CEOs also tend to pay out fewer dividends, they make excess investments and have higher research and development (R&D) expenses (Deshmukh et al., 2013; Pikulina et al., 2017). This is expected only to have positive effects in the most innovative industries (Hirshleifer et al., 2012). The impact of a CEO on firm performance is more important than industry effects and firm effects (Mackey, 2008). In financial crises, CEO overconfidence is associated with higher loan defaults and lower firm performance (Ho et al., 2016). However, an overconfident CEO in regular times could positively affect firms, ultimately positively affecting firm value and firm performance (Vitanova, 2019). Moreover, higher managerial overconfidence will improve firm performance (Salehi & Moghdam, 2019). CEO overconfidence negatively affects firm value but does not necessarily harm firm performance.

The downsides of CEO overconfidence indicate it could be beneficial to mitigate the bias. CEO overconfidence is mitigated when directors have corporate social responsibility expertise (Sauerwald & Su, 2019). A higher proportion of independent directors and a higher percentage of female directors also seem to mitigate the effect of CEO overconfidence (Brown & Sarma, 2007; Chen et al., 2019). Furthermore, Malmendier & Tate (2005) found CEO sensitivity to investment cash flow in the most equity-dependent firms, suggesting that leverage mitigates CEO

overconfidence. This thesis tests multiple mitigating firm characteristics of CEO overconfidence, and therefore the research question for this thesis is:

*Which firm characteristics mitigate CEO overconfidence?*

For the study, data is retrieved on S&P 1500 firms between 2000 and 2019. The final sample consists of 10,447 firm-year observations. The first part of the thesis aims to find mitigating firm characteristics of CEO overconfidence. The mitigating firm characteristics that will be used to test its effect are the gender ratio of the board, firms leverage ratio, the number of directors on the board, and the proportion to which there is an international director presence on the board.

An option-based proxy for CEO overconfidence is used to test the mitigating effect of the firm characteristics on CEO overconfidence. This proxy measures the extent to which stock options of CEOs are in-the-money. The proxy is based on the tendency of CEOs to hold on too long to their stock options. It is optimal for these stock options to be early exercised due to these options' under-diversification and risk adversity (Hall & Murphy, 2000, 2002). By holding on to these options, CEOs systematically overexpose themselves to the high idiosyncratic risk of their firm (Malmendier & Tate, 2005).

After that, the impact of CEO overconfidence on firm performance, growth opportunities, and firm expenditures will be tested to investigate whether the bias must be mitigated. Mitigating the bias, when it reveals to have a positive effect on firm performance measures, would be illogical and destroy firm value. Also, the collective impact of an overconfident CEO with higher firm expenditures will be tested on firm performance measures. If this result is positive, firms will benefit by hiring an overconfident CEO if they have relatively high expenditure levels. In the second part of the study, the proxy for CEO overconfidence will be the binary *Holder 67* variable, which construction is in line with Hirshleifer et al. (2012). CEOs are classified as overconfident if they hold options that were at least once in the sample above the threshold of 67% in-the-money.

Results of the first part of the study found that the fraction of females sitting on the board and the firm's leverage ratio significantly mitigates CEO overconfidence. The impact of the number of directors and the nationality mix of the board did not have a significant impact on CEO overconfidence. These results indicate that firms who want to mitigate CEO overconfidence must hire more female directors to achieve an equal board or choose higher leverage levels.

The second part of the thesis showed that an overconfident CEO positively impacts firm performance and firm growth opportunities. This result suggests that it would be beneficial for firms to hire overconfident CEOs, both for their performance and growth opportunities, instead of taking actions to mitigate CEO overconfidence. However, CEO-firm matching is also possible since firms can choose to hire overconfident CEOs to improve growth opportunities, especially in periods of successful innovation (Galasso & Simcoe, 2011; Hirshleifer et al., 2012). Furthermore, CEO overconfidence positively impacts capital expenditures to a small extent, where it does not significantly influence R&D expenses. The lack of finding the relation between CEO overconfidence and R&D expenses is probably due to the absence of some firm data on expenditures since previous literature found a clear relation between the bias and R&D expenses (Hirshleifer et al., 2012; Deshmukh et al., 2013; Pikulina et al., 2017). Last of all, results show that CEO overconfidence, combined with higher capital expenditures or R&D expenses, does not significantly impact firm performance but does significantly impact firm growth opportunities.

Since this thesis looks at the difference between multiple mitigating firm characteristics of CEO overconfidence and after that looks at whether they must be mitigated at all, this thesis is a contribution to the existing empirical literature. Findings show that the gender ratio of the board and the leverage ratio of a firm significantly mitigated CEO overconfidence. However, this thesis suggests that instead of undertaking actions to mitigate CEO overconfidence, firms would benefit from overconfident CEOs. This thesis takes that point of view by looking at firm performance and growth opportunities, whereas looking at firm value could lead to other executive hiring policies. However, drawing clear conclusions on the impact of CEO overconfidence on firm performance remains challenging since it is unrealistic to assume that CEO overconfidence is an exogenous variable and is influenced by firm hiring policy.

## 2. Literature Review

This section will overview the relevant literature in corporate finance and behavioral corporate finance related to the research conducted, with a comprehensive overview of the existing literature on overconfidence bias, especially among CEOs. Next, a literature review of the relevant firm characteristics will be displayed, and an overview of relevant literature on firm performance.

### *2.1 Traditional Corporate Finance*

Traditional Corporate Finance theories are built on the thought that agents behave rationally and constantly update their beliefs, and markets are assumed to be efficient. These traditional theories of Corporate Finance try to explain how firms are structured and how agents may react to corporate decisions. The most traditional theory on capital structure is the Modigliani and Miller (1958) theory. This theory states that a firm's value always remains the same with changing capital structures, and therefore the theory concludes capital structure irrelevance. However, the theory has a lot of unrealistic assumptions. The most influential capital structure theory that followed the capital structure irrelevance theory was the pecking order theory by Myers and Maljuf (1984). The pecking order theory states that firms have preferences in their capital structure. According to the theory, firms first internally finance themselves with internal funds preferred over dividends. Then, when firms finance themselves externally, they prefer to finance themselves with debt over equity. Firms will first try to get to their debt capacity before issuing equity (Myers, 1984) (Shyam-Sunder & Myers, 1999). The preference for internal funds over external is based on information asymmetry, where investors demand a premium on top of their investment in firms (Akerlof, 1970).

More recent studies into firms' capital structure added the presence of market timing, where firms buy back equity when stock is undervalued and issue more equity when stock is overvalued. Firms' capital structure then depends on the manager's belief in the value of their company (Baker & Wurgler, 2002). Huang and Ritter (2005) find that firms offer more often equity than the pecking order theory predicts and that equity is offered when the expected equity risk premium is low. Even when managers were asked, they admitted that they tried to time the market with their own beliefs in the over-or undervalue of their stock (Graham & Harvey, 2001).

### *2.2 Behavioral Corporate Finance*

Traditional corporate finance theories assume that managers and agents behave rationally and that they make decisions that are consistent with the expected utility framework. This implies that agents and managers base their decisions on the best possible outcome and make this decision entirely rational. However, behavioral corporate finance theories add that agents and managers can behave irrationally and that some economic phenomena cannot be explained by traditional corporate finance theories (Barberis & Thaler, 2003). Also, the assumption of maximizing expected utility is dropped in behavioral finance (Ritter, 2003). Some irrational decisions of managers and agents are not random but can take on a systematic form of irrationality, which can also be referred to as behavioral biases.

Behavioral corporate finance is generally based on two theories; Limits to arbitrage and psychology (Barberis & Thaler, 2003). Price deviations of fundamental values are expected to be restored by rational managers. However, they face fundamental risk, noise trader risk, and implementation costs, limiting them from fully arbitrating the mispricing. On the other hand, the psychology part of behavioral finance focuses on the irrational decisions of managers that are not random and can take on a systematic form of irrationality, creating mispricing. Further research into behavioral finance looked at two different approaches, the irrational investor approach and the irrational managers approach (Baker et al., 2007). The irrational investors view the action of managers as rational, and the irrational managers approach looks at irrational decisions of managers and their effect on the firm. This irrationality of managers leads to managerial biases that affect decisions of the firm and their performance, which will be focused on mainly.

#### *2.2.1. Overconfidence Bias*

Overconfidence is a bias in which individuals tend to overestimate their capabilities (Barberis & Thaler, 2003), underestimate risks (Broihanne et al., 2014), and overestimate their ability to control events (Langer & Roth, 1975). The overestimation of the ability to control events is displayed chiefly in the illusion of knowledge and illusion of control. Overconfidence is generally divided into two main processes: miscalibration and the better-than-average effect.

The miscalibration effect causes agents to overestimate their ability to predict the future and underestimate the volatility of random effects (Liechtenstein et al., 1977). It is an underestimation of the range of possible outcomes. Ben-David et al. (2013) found CFOs to be severely miscalibrated, also associated with more intense corporate investment and higher debt leverage. The 80% confidence intervals of returns of CFOs tend to be correct only 36% of the time. This finding confirms that these executives underestimated the volatility of returns, making them miscalibrated. In terms of trading intensity, both the miscalibration and the better than average effect explain overconfident individuals' higher trading activity (Deaves et al., 2009).

The better-than-average effect of overconfidence causes agents to overestimate their ability or skills relative to the average (Svenson, 1981; Alicke, 1985). The better-than-average effect causes investors to believe that they can outperform the market. Overconfident investors tend to have a higher investment intensity and trade more (Grinblatt & Keloharju, 2009). However, individuals who trade the most perform the worst (Barber & Odean, 2000). Moreover, in times of financial distress, overconfident investors seem to be an explanation for the high volatility of returns during a global financial crisis (Abbes, 2013). Investors think they outsmarted the market by switching to online trading well before others trade more but earn less (Barber & Odean, 2002). This also emphasizes that overconfident investors think they are better than average. Finally, men are also expected to be more overconfident, causing them to trade more actively (Barber & Odean, 2001). This better-than-average effect is mainly examined by CEOs, which will be discussed next.

### *2.2.2 CEO Overconfidence*

The overconfidence bias in the earlier empirical literature is most thoroughly investigated among CEOs. All previous literature on the impact of CEO overconfidence in takeovers and on firm value and performance will be discussed, both negative and positive. It is relevant since more than 80% of CEOs think they are better than average (Malmendier & Tate, 2005). The hubris hypothesis makes investigating CEO overconfidence in takeovers also interesting. There is little evidence that acquisitions create value for the acquirer, and they still tend to be many acquisitions (Roll, 1986). The hubris hypothesis of CEO overconfidence can give a plausible explanation since executives are overconfident and have the illusion of control. CEO overconfidence is associated with miscalibration and the better-than-average effect (Hribar & Yang, 2016).

Overconfidence is greatest for complex tasks, forecasts with low predictability, and undertakings lacking clear feedback (Barber & Odean, 2002; Yates, 1990; Griffin & Tversky, 1992). Corporate investments such as capital expenditures and M&A meet these criteria.

Moreover, CEO overconfidence is most commonly displayed in M&A since takeovers are individual decisions, and managers are not experienced, which leads to overbidding in acquisitions (Roll, 1986). The compensation of CEOs also tends to increase rapidly after an acquisition, as it is linked to company size, providing incentives for an overconfident CEO to engage in M&A (Yim, 2013).

Malmendier & Tate (2005) investigated overconfident CEOs and sensitivity to internal cash flows. They found overconfident CEOs to be more sensitive to investment-cash flow, mainly in equity-depended firms. CEOs overinvest if they have sufficient internal funds, and overconfident CEOs may underinvest if they do not have sufficient internal funds. Issuing new equity may signal overvaluation of their firm's stock (Myers & Maljuf, 194). Overconfident CEOs tend to complete more deals, do mainly stock acquisitions, and are more likely to make (value-destroying) diversifying acquisitions (Malmendier & Tate, 2005, 2008; Ferris et al., 2013; Hwang et al., 2020). Overconfident CEOs are even 65% more likely to make an acquisition. The market reacts significantly more negatively if the acquiring CEO is overconfident (Malmendier & Tate, 2008). The CEO's overconfident probability also increases if the CEO has more power (Hwang et al., 2020).

CEO overconfidence has also been shown to have positive implications. CEO overconfidence leads to greater innovation output, measured in R&D expenditures and the number of patents in innovative industries (Hirshleifer et al., 2012). In these innovative industries, overconfident CEOs are more effective in exploiting growth opportunities and translating them into firm value. The relationship between overconfidence and innovation is largest in competitive industries (Galasso & Simcoe, 2011). An overconfident CEO could benefit firms because they are more likely to take their firms in a new technological direction. However, later research found that a significant increase in R&D expenditures is more beneficial for firms with non-overconfident CEOs than their overconfident CEO counterparts (Chen et al., 2014).

The presence of an overconfident CEO also impacts the dividend policy of firms. Miscalibration associated with CFO overconfidence is negatively related to dividends payout, causing overconfident CFOs to pay out fewer dividends (Ben-David et al., 2007). Later research into CEO

overconfidence and payout policy also found that firms with overconfident CEOs tend to pay out fewer dividends (Deshmukh et al., 2013) and overestimate current cash flows to predict future cash flows. Overconfident CEOs pay out less cash to shareholders since they want to maintain cash for repurchase activities (Banerjee et al., 2013). They do so because they believe they can earn higher returns by investing in their firms' projects (Cordeiro, 2009). Overconfident CEOs prefer financing their projects with internal finance since they believe their stock is undervalued, causing them to pay out fewer dividends.

The effect of CEO overconfidence on a firm's decisions, such as dividend policy, is widely examined. However, the effect of CEO overconfidence on firm value is tested to a lesser extent in financial literature. In general, the influence of a CEO on corporate performance is substantially more important than industry effects and firm effects (Mackey, 2008). Overconfident CEOs earlier seemed to have higher R&D expenditures (Hirshleifer et al., 2012), which had a positive effect on the long-term performance of their firms (Chen et al., 2014). CEO overconfidence could have a positive signaling effect on firms that ultimately positively affect firm value and firm performance (Vitanova, 2019). However, in financial crises, CEO overconfidence is associated with higher loan defaults and lower firm performance (Ho et al., 2016). Overall, CEO overconfidence is associated with misprediction of future performance, but not necessarily with worse firm performance in healthy economic times (Hribar & Yang, 2016). However, increasing levels of overconfidence in managers will lead to improvement in firm performance measured by the return on assets (Salehi & Moghdam, 2019).

Compared with other managers, overconfident managers create value for firms through higher stock returns and risk-taking actions in innovative and non-innovative industries (Baharati & Doellman, 2016). In contrast, earlier research found CEO overconfidence positive in the most innovative industries (Hirshleifer et al., 2012). Therefore, the effects of CEO overconfidence on firm performance will be tested to discuss whether it even must be mitigated.

The overconfidence bias is related to higher investments, increasing with more substantial levels of overconfidence (Pikulina et al., 2017). Overconfident CEOs tend to have higher corporate investments, and they are even 65% more likely to make an acquisition, frequently value-destroying ones (Malmendier & Tate, 2008). Overconfident CEOs tend to have higher investments in capital expenditures (Ben-David et al., 2007), which is even higher when they have ample internal funds. However, they curtail investment when they require external financing (Malmendier

& Tate, 2005) since they value their shares higher than the market prices. Over 43% of firms with overconfident CEOs overinvest in assets relative to sales growth. Over 56% of firms with overconfident CEOs have capital expenditures more significant than the median firm in the industry (Ahmed & Duellman, 2013). CEOs have higher corporate investments and invest more in their firm in research and development (Chen et al., 2014), which is expected to positively affect the most innovative industries (Hirshleifer et al., 2012). A final test of this study will analyze the effect of CEO overconfidence and higher investments in capital expenditures and research and development across all industries and investigate if this relationship will be positively translated into firm performance.

### *2.2.3 Overconfidence Measures*

CEO overconfidence in previous literature has been measured in several ways. In a study into the miscalibration of CFOs, they were asked to predict the future performance of the stock index of their firm (Ben-David et al., 2013). Other survey-based studies into overconfidence used self-reported surveys, where data is based on a limited number of individuals, and turnover affects an investor's desire to respond to the survey, negatively impacting results (Grinblatt & Keloharju, 2009). CEOs who are particularly concerned about shortsightedness are more likely to respond to survey questionnaires, causing sample sizes to not fully represent the whole population (Poterba & Summers, 1995). Due to the sample size bias of survey-based research, other confidence measures are more robust.

Stock options are an equity form of compensation that gives employees the option to buy shares of the company at a pre-set price in the future, also referred to as the grant price. Employees will benefit if the stock price exceeds the stock option price. The benefit for employees is the profits between the grant price and the company's share price at the selling point. Companies often use this form of compensation to motivate employees or executives. It has been shown to have a significant, positive relation between firm performance measured by Tobin's Q and the percentage of equity-based employee compensation (Frye, 2004). Large firms use stock options as a part of the CEOs' compensation to align the incentives of CEOs and firms. Research finds that equity-based compensation affects managers' risk-taking behavior, impacting shareholder wealth (Williams & Rao, 2006; Low, 2009). Furthermore, high option compensation is associated with

income-decreasing choices of executives in periods leading up to option award dates (Baker et al., 2003). CEOs still receive large portions of their income as stock options and cannot trade them to maximize the incentive effects of these options (Malmendier & Tate, 2005). Since they cannot trade these options, it is optimal for the stock options of these CEOs to be early exercised due to the under-diversification and risk adversity of these options (Hall & Murphy, 2000, 2002).

Most recent studies into the impact of CEO overconfidence follow the option-based measure of CEO overconfidence of Malmendier & Tate (2005). If a CEO consistently exercises his options later than is suggested by the benchmark, he believes that under his regime, prices will rise and, therefore, overestimate the firm's performance in the future. Malmendier & Tate (2005) classify a CEO as overconfident when he systematically overexposes himself to the high idiosyncratic risk of their firm, although research showed it is optimal to early exercise their stock options. They consider the subsample of CEOs who at least twice during the sample period had options valued above the threshold, 67% in-the-money options, during the fifth year. If a CEO postpones the exercise of options at least 67% in the money twice, they consider that specific CEO overconfident during his entire tenure. This is a reasonable assumption since overconfidence is presumed to be a persistent trait in the psychological literature (Klayman et al., 1999; Johnson & Fowler, 2011). An extra stock option-based overconfidence variable is based on the duration the CEO holds on to his stocks. If a CEO holds his options to the expiration of the stocks, a CEO can also be classified as overconfident (Malmendier & Tate, 2005, 2008), giving the label "longholder" to a CEO. The failure to exercise these options is impossible to explain with reasonable levels of risk adversity of these options created by the Hall & Murphy (2002) model.

Another often used overconfidence measure is based on the purchasing behavior of extra stocks of CEOs. For a higher portfolio diversification, it would be better if CEOs would avoid buying additional stocks of their firm. CEOs that buy additional stock on top of their equity compensation make CEOs even more exposed to the idiosyncratic risk of their company and indicate the CEO's belief that under his regime, firm performance improves (Malmendier & Tate, 2005). To construct the *Net Buyer* variable, Malmendier & Tate (2005) restricted the sample to CEOs active for at least 10 of the 15 years in our sample and were classified as overconfident if they were net buyers of company stock during their first five years in the sample. The restricted assumption for CEO tenure will decrease the sample size heavily. Therefore, for testing the effect

of CEO overconfidence on firm performance, the *Net Buyer* variable will not be used as the dependent variable but added to the model as a robustness check.

The last often-used measure of CEO overconfidence is the media portrayal of CEOs. This is an addition to the option variable, in which the overexposure to the idiosyncratic risk of their firms was measured, and will estimate the press portrayal of the different CEOs in the media and whether they are classified as overconfident or not (Malmendier & Tate, 2008; Hribar & Yang, 2016; Hirshleifer et al., 2012). Overconfidence was first a dummy variable whether the CEO is overconfident or not. In the media portrayal variable, CEO overconfidence is measured as the number of overconfidence synonyms noted by the applicable CEO in top journals, such as The Wall Street Journal and The Economist. The press portrayal variable of CEO overconfidence captures how outsiders look at the CEO and how he is portrayed in the media. Different terms relating to overconfidence will be counted upon in financial media with the help of a continuous variable, which will give more precise results since some executives are mentioned in the press more often than others (Brown & Sarma, 2007). Characterization as confident or optimistic is significantly positively correlated with the option-based measure of overconfidence (Malmendier & Tate, 2008). However, this press-based variable of CEO overconfidence will not be used due to the lack of availability and subjectivity of the data.

### *2.3 Firm Characteristics*

There are varying firm characteristics that could mitigate the effect of CEO overconfidence. For example, sensitivity to investment cash flow, associated with overconfidence, is significant only for the most equity-dependent firms (Malmendier & Tate, 2005). Therefore, not only the effects of leverage but also the effect of board characteristics on CEO overconfidence will be displayed in this section.

#### *2.3.1 Board Characteristics*

The role of the board of directors as a governance mechanism is broadly examined in the literature. First, choosing board size is a difficult task for firms, where the benefits and costs of extra directors must be weighed up. Small boards seem to lead to higher market valuation and

provide more substantial CEO performance incentives (Yermack, 1996). After board size, the board's composition is also necessary for performance. Independent directors seem to affect firm performance positively, but a mix of insider and outside directors appears to provide an appropriate board structure for most companies (Baysinger & Butler, 1985). After 2002, following the adoption of the Sarbanes-Oxley act, listed firms in the United States were forced to compose a board with a majority of independent directors to improve monitoring and corporate governance (United States, 2002). Finding a correlation between board composition seems beneficial for shareholders if the board recognizes a CEO being overconfident and subsequently fires and replaces him (Goel & Thakor, 2008). It also seems that when outside directors have corporate social responsibility (CSR) expertise, CEO overconfidence is mitigated (Sauerwald & Su, 2019). A higher proportion of independent directors also seems to mitigate CEO overconfidence and CEO dominance (Brown & Sarma, 2007).

The probability of an overconfident CEO is also mitigated when there is female board representation (Chen et al., 2019). Female directors are even more critical in industries with a high overconfidence prevalence and are associated with less aggressive investment policies, better acquisition decisions, and improved financial performance. Banerjee et al. (2018) find that the most substantial mitigating effect on overconfident CEOs occurs in those firms that appoint a female to the board for the first time and diminishes afterward. CEO turnover is higher in firms with more gender-diverse boards. However, the average effect of gender diversity on firm performance is negative, and therefore mandating gender quotas for directors can reduce firm value for well-governed firms (Adams & Ferreira, 2009). Where previous studies found board size to have an insignificant effect on CEO overconfidence (Malmendier & Tate, 2008), in this research, board size is expected to influence the mitigation of CEO overconfidence. However, board size tends to harm the value creation of acquisitions (Amar et al., 2011). In addition, larger boards are associated with poor communication and decision-making problems, often resulting in a substantial negative impact on profitability, Tobin's Q, and share returns (Guest, 2009). Better governed firms have a lower chance of CEO overconfidence, and if so, its benefits are more significant than with weak governance (Banerjee et al., 2015). Previous literature has not extensively examined the effects of a more international-oriented board of directors on CEO overconfidence. However, foreign directors harm bank performance (García-Meca et al., 2015).

### *2.3.2 Leverage*

Greater CFO miscalibration, also associated with overconfidence, seems to be associated with higher debt leverage (Ben-David et al., 2013). Overconfident managers choose higher leverage levels and take on more new debt (Hackbarth, 2008). Nevertheless, this extra debt they take on is usually short-term debt with a due date within 12 months (Huang et al., 2016). Also, in a financial crisis, overconfident managers take on more debt in advance of the crisis, making them more vulnerable (Ho et al., 2016). Taking on more but short-term debt could incentivize overconfident CEOs to undertake riskier projects that require fast returns. Managers who believe their firm is undervalued view external financing as overpriced, especially equity financing (Malmendier et al., 2011). As previously mentioned, Malmendier & Tate (2005) found executive sensitivity to investment cash flow only in the most equity-dependent firms, suggesting that leverage might mitigate CEO overconfidence.

## 3. Empirical Predictions

This section will discuss the research question and with the help of which hypotheses they will be tested. The study will consist of two parts: first, examining which firm characteristics mitigate CEO overconfidence. After that, the effect of CEO overconfidence on firm performance and expenditures will be tested. This section will also explain and visualize the constructed framework for all models.

### *3.1 Hypothesis development*

The most important part of the study is testing which firm characteristics mitigate CEO overconfidence, and therefore the main research question of this paper is:

*Which firm characteristics mitigate CEO overconfidence?*

As earlier discussed in the literature section, firm characteristics can influence if CEOs are overconfident. Both an increasing fraction of female directors and an increasing number of directors are expected to mitigate CEO overconfidence. Also, the first section will test international director presence to see whether a more significant part of directors from other countries will mitigate CEO overconfidence. Lastly, firms' leverage ratio is tested on the effect of CEO overconfidence. Considering all tested mitigating effects of firm characteristics on CEO overconfidence, the following hypotheses are constructed to answer the research question:

*H1a: Lower gender ratio on boards (i.e., more females on board) mitigate CEO overconfidence*

*H1b: Larger boards increase CEO overconfidence*

*H1c: International director presence mitigates CEO overconfidence*

*H1d: Higher leverage mitigates CEO overconfidence*

For the second part, the effects of CEO overconfidence on firm performance will be tested, measured by firm performance and firm growth opportunities. The thesis expects that CEO overconfidence will positively affect firm performance. Furthermore, CEO overconfidence is expected to affect firm performance positively and is also expected to lead to higher capital expenditures and research and development costs. Last, this thesis will investigate the effect of CEO overconfidence, combined with capital and R&D expenditures. The following hypotheses will be tested regarding the effect of CEO overconfidence on firm performance and expenditures:

*H2: CEO overconfidence positively impacts firm performance and growth opportunities*

*H3: CEO overconfidence increases capital and R&D expenditures*

*H4: In firms with higher capital & R&D expenditures, overconfidence will positively impact firm performance and growth opportunities*

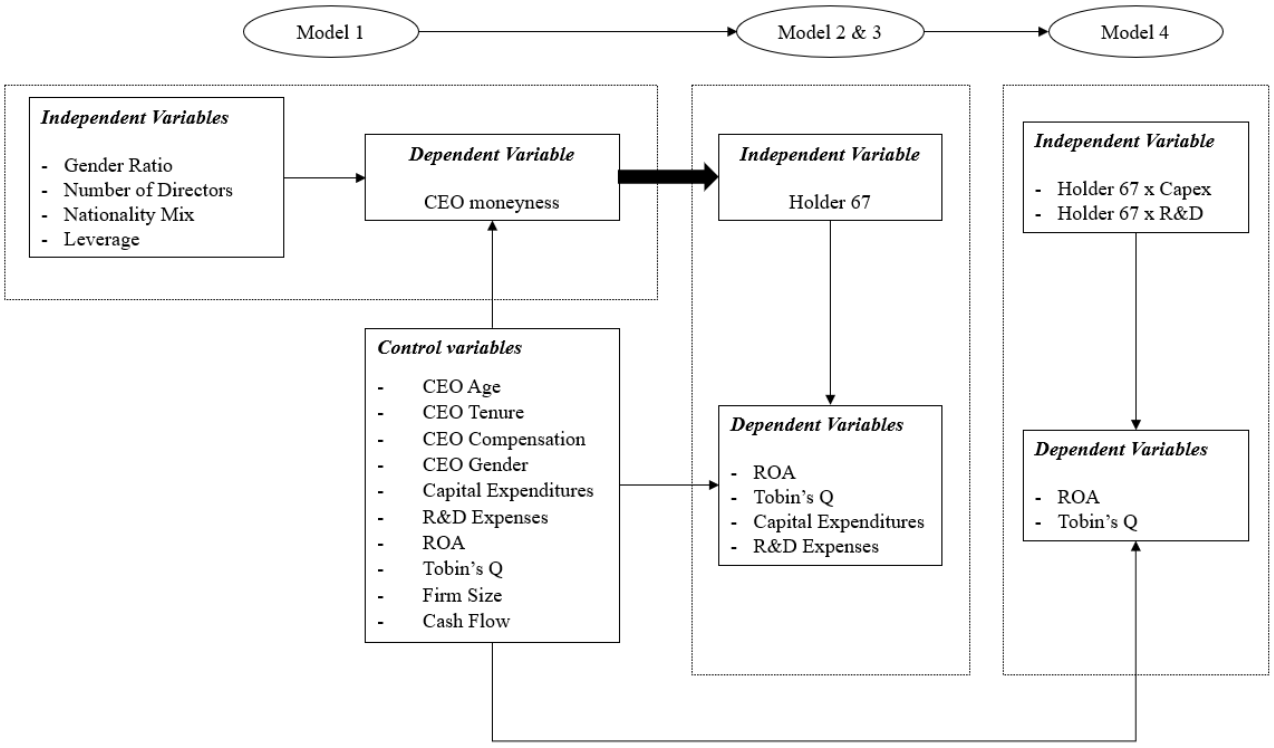
### *3.2 Conceptual Framework*

Since this thesis consists of two topics, the conceptual framework of the analyses is different to some extent. The conceptual framework of all constructed models is shown in Figure 1. In the first model, a proxy for CEO overconfidence will be used as the dependent variable, which construction will be explained in the methodology section. The independent variables that are used in the first model are the mitigating firm characteristics, of which the effect on overconfidence will be tested. The figure shows all control variables that will be used in the research.

The conceptual framework of models 2 and 3 in Figure 1 examines the effects of CEO overconfidence on different firm variables. In contrary to the first model, a proxy for CEO overconfidence will be used as the independent variable. The return on assets (ROA) and Tobin's q will be the dependent variable in model 2. Model 3 measures the impact of CEO overconfidence on firm expenditures. In model 4, an interaction term between CEO overconfidence and higher capital expenditures and research and development expenses will also be constructed. This model tests whether CEO overconfidence, combined with higher expenditures, will translate into higher firm performance and growth opportunities. The same control variables will be added to models

2,3, and 4, as shown in Figure 1. More information on the baseline regressions for each model can be found in the methodology section.

Figure 1: Conceptual framework of all tested models.



## 4. Data and Methodology

The data and methodology section describes the methods used to conduct the study that is necessary to test the hypotheses and answer the research question. Additionally, this section describes the methods used to conduct the study, how the data is collected, and why some data or variables are filtered.

### *4.1 Data Sources and Collection*

The data used for both studies into CEO overconfidence are from companies in the S&P 500 index, which consists of the 500 largest U.S. listed companies, the S&P 400 index, which consists of mid-cap equity companies in the U.S., and the S&P 600 index, which covers the small-cap U.S. listed companies. The choice for the so-called S&P 1500 index comes from the desire for a large amount of data and to have more robust results since considering only large firms might bias the results of CEO overconfidence. The sample period is from 2000 to 2019 and thus ends up with a panel dataset with firm-year observations.

Data on firm characteristics are retrieved from Compustat, data on CEO characteristics executives is retrieved from Execucomp, and data on board characteristics are retrieved from BoardEx. All three databases are a part of Wharton Research Data Services (WRDS), which can be accessed via the Erasmus University Rotterdam. Data of all three databases are downloaded by Ticker code of the S&P 1500 firms, and duplicates are immediately filtered. First, Compustat data is merged by gvkey (Compustat ID) and year with Execucomp data, while first eliminating Execucomp data when the executive is not the CEO. After that, this combined dataset of Compustat and Execucomp is merged by Ticker and year with BoardEx data. Merged data is only kept if the data are a match. The lost amount of data due to merging the datasets can be seen in Table 1.

After merging all three databases, some extra variables will be generated for testing our hypotheses, such as firm performance measurements or CEO overconfidence proxies, and creating lagged variables, which will be explained later in the methodology section. Based on SIC codes, financial and utility firms are dropped from the model since financial firms are highly levered, and regulation is an essential factor in the capital structure decisions of utilities (Fama & French, 2005). When all necessary extra variables are created, observations with a missing variable in our model

will be dropped to get equal observations and all our conducted regressions. Since missing lagged observations are dropped from the model, the year 2000 is entirely dropped from the sample. Final observation calculations when dropping unusable observations can be seen in Table 1.

**Table 1: Cleaning and merging of final dataset**
Table 1 shows the cleaning and merging process of the databases. Firm year observations are downloaded from S&P 1500 firms with a sample period from 2000-2019. Financial and Utility firms are excluded bases on SIC codes. Finally, observations with missing values for one of our dependent, independent or control variables are dropped to get equal observations across all regressions.

| **Sample cleaning procedure** | **# Observations** |
|---|---|
| Compustat S&P 1500 firm data | 31,959 |
| *Removing duplicates* | - 5,493 |
| Merging with Execucomp CEO data | - 4,634 |
| Merge with BoardEx board characteristics | - 908 |
| *Remove remaining duplicates* | - 1 |
| Drop financial & utility firms | - 5,722 |
| Deleting missing observations for necessary variables | - 4,754 |
| **Final sample of CEO year observations** | **10,447** |

### *4.2 Variable Measurement*

All the dependent, independent, and control variables are discussed in this section. The way new variables are constructed will be explained, and the use of a few robustness tests on the results for both parts of the study will be discussed. The first part of the study will examine which firm characteristics mitigate CEO overconfidence. The second part will examine the effects of CEO overconfidence on firm performance. Both studies will thus have different dependent and independent variables since they differ in what they test.

#### *4.2.1 Dependent Variables*

As a proxy for overconfidence in the first part of the study, the variable *CEO moneyness* will be used as the dependent variable. The variable *CEO moneyness* measures the estimated moneyness of the CEOs' stock options. As earlier explained in the literature section, it is optimal for the stock options of CEOs to be early exercised, due to the under-diversification and risk adversity of these options (Hall & Murphy, 2000, 2002), and therefore rational CEOs will exercise

their options early. Overconfident CEOs overestimate the mean returns of their investment projects and will hold these options for a postponed period (Malmendier & Tate, 2005), and these deep-in-the-money options will thus suggest overconfidence of CEOs. To construct the variable *CEO moneyness*, a modified version of the Malmendier & Tate (2005) variable is used, in line with Campbell et al. (2011) and Hirshleifer et al. (2012), due to the lack of data on Execucomp. To test the model with the *CEO moneyness* proxy for CEO overconfidence, the variable is expected to be linear, which implies that higher in-the-money options signal higher overconfidence. This assumption is in line with earlier research (Campbell et al., 2011; Hirshleifer et al., 2012).

The variables needed to construct the variable *CEO moneyness* were subtracted from Execucomp, to estimate the extent to which CEOs are overconfident. The following variables from Execucomp will be used to construct our dependent variable: *prcc_f*, which is the stock price at fiscal year-end, *OPT_UNEX_EXER_EST_VAL*, which is the estimated value of in-the-money unexercised exercisable options, and *OPT_UNEX_EXER_EST_NUM*, which is the number of unexercised exercisable options. The final calculation for the measure of *CEO moneyness* is constructed in three steps. The first step is calculating the average realizable value per option by dividing the value of in-the-money unexercised exercisable options by the number of unexercised exercisable options. The second step is to calculate the average exercise price by subtracting the average realizable unexercised value per option from the stock price at the fiscal-year end, to get an estimate of the average exercise price of these options of CEOs. In the final step, *CEO moneyness* is calculated by dividing the stock price at the fiscal year-end by the average exercise price of these options minus one, which will give the average percentage moneyness of these unexercised options of CEOs.

$$Average\ realizable\ value = \frac{Value\ of\ unexercised\ options}{Number\ of\ unexercised\ options}$$

$$Average\ exercise\ price = Stock\ price\ at\ fiscal\ year\text{-}end - Average\ realizable\ value$$

$$CEO\ moneyness = \frac{Stock\ price\ at\ fiscal\ year\text{-}end}{Average\ exercise\ price} - 1$$

After the construction, the *CEO moneyness* variable had some extreme outliers that impact the mean value of the variable. Therefore, the variable *CEO moneyness* will be winsorized at the 5% level. By winsorizing, the mean value of *CEO moneyness* drops to 0.71, consistent with earlier research (Campbell et al., 2011; Hirshleifer et al., 2012; Chen et al., 2019).

For the second part of the study, the dependent variables will be measurements for firm performance and firm growth opportunities. Return on Assets (ROA) will be used for firm performance and Tobin's Q for firm growth opportunities. ROA is calculated by dividing a company's net income by its total assets. Tobin's Q can be calculated in different ways. However, for consistency reasons, Tobin's Q of Malmendier & Tate's (2005) construction will be used. Tobins' Q is then calculated as total assets plus market equity minus book equity, divided by total assets. The stock price calculates market equity at the fiscal year-end multiplied by shares outstanding. Tobin's Q ratio measures the cost to replace a firm's assets compared to its stock value. It is also referred to as market valuation, where a high Tobin's Q ratio implies market overvaluation of a firm's assets compared to the book value.

As robustness tests, CEO overconfidence in Return on Equity (ROE) and the market-to-book ratio will also be tested instead of ROA and Tobin's Q. The ROE is calculated by dividing net income by shareholder's equity, equal to the market equity. The market-to-book ratio of firms, calculated by dividing market equity by book equity, tests whether the firm's market value is higher than its book value. Observations with missing data on ROA, ROE market-to-book ratio, and Tobin's Q will be dropped from the model. ROA and ROE are winsorized at the 1% level. The calculations of the firm performance variables are shown below.

$$ROA = \frac{Net\ income}{Total\ assets}$$

$$Tobin's\ Q = \frac{Total\ assets + Market\ equity - Book\ equity}{Total\ assets}$$

Not only the impact of CEO overconfidence on firm performance will be tested in the second part of the study, but also the impact on capital expenditures and research and development costs, and how this will relate to firm performance. For the impact of CEO overconfidence on capital expenditures (Capex) and research and development (R&D) expenses, the variables will be

normalized by firm size, since expenditures are influenced by a firm's size considerably (Chauvin & Hirschey, 1993). For calculations of the dependent variable of Capex and R&D expenses, both will be divided by the firm's total assets of the concerning year. Observations with missing data on capital expenditures or research and development expenses are given the value of 0 since these firms abstained that year from investments.

### *4.2.2. Independent Variables*

Different firm characteristics will be used as independent variables for the first part of the study. Then, the independent variables will be tested against the dependent variable, *CEO moneyness*. The first independent variable is the gender ratio of the board, extracted from BoardEx. The variable is estimated by dividing the number of male directors by the number of total directors. Decreasing levels of the gender ratio display higher female board members since a gender ratio of 1 represents a total male-dominated board of directors. Therefore, decreasing levels of the gender ratio are expected to have mitigate CEO overconfidence. The second independent variable of which its mitigating effect is tested on *CEO moneyness* is the size of the board, which is extracted from BoardEx. Next to that, the board characteristic that will be used as an independent variable to test its mitigating effect on CEO overconfidence is the nationality mix of the board. The Nationality Mix variable is a proportion of international directors, which increases if more directors with non-U.S. nationalities enter the board. The last firm variable expected to mitigate CEO overconfidence is firms' leverage. The variable leverage is estimated by dividing the sum of long-term and short-term debt by shareholder's equity, in line with earlier research (Allayannis & Weston, 2001). Since there were a few unrealistic outliers, the leverage variable will be winsorized at the 1% level. Observations with missing data of one of the independent variables will be dropped from the model to get equal observations across all regressions.

For the second part of the study, to test the impact of CEO overconfidence on different firm measurements, a proxy for CEO overconfidence is the independent variable. Contrary to the first part, the proxy for CEO overconfidence in the second part of the side is the *Holder 67* variable, in line with Malmendier & Tate (2005). The *CEO moneyness* variable is needed to create the *Holder 67* proxy for overconfidence, which calculated the extent to which CEOs' unexercised exercisable stock options were in the money. The construction of the *Holder 67* variable by Malmendier &

Tate (2005) had some restrictions, which only considered the sample of CEOs who were valued during the fifth year. This restriction considerably limited the number of observations of their study. Due to the lack of data, the moneyness of the stock option of the CEO of the corresponding year will be looked at in line with earlier research (Campbell et al., 2011; Hirshleifer et al., 2012). If the option's value exceeds the threshold of 67% in-the-money at that year, the CEO is labeled "overconfident" that year. Moreover, Hirsleifer et al. (2012) performed a robustness test that showed unchanged results if CEOs held options at least once in the sample above 67% in-the-money. Therefore, if a CEO exceeds the threshold of 67% in-the-money options at least once, he is labeled "overconfident." This label lasts his entire tenure since overconfidence is a persistent trait (Klayman et al., 1999). The *Holder 67* proxy for the overconfidence variable is a dummy variable, which takes a value of 1 if the CEO is labeled "overconfident" and 0 if not.

In the last model, the combined impact of CEO overconfidence with higher capital expenditures and higher research and development expenses on firm performance will be tested by interaction terms. The interaction terms are constructed by multiplying the Capex/R&D expenses with CEO overconfidence, as measured with the *Holder 67* variable. The variables of Capex and R&D expenses are normalized by the divided by the firm's total assets of the concerning year.
The interaction terms will be *Holder 67 * (Capex / Firm size)*, for the combined impact of Capex and CEO overconfidence and *Holder 67 * (R&D / Firm size)*, for the combined impact of R&D expenses and CEO overconfidence. In addition, to ensure the robustness of results, Capex/R&D expenses and the binary variable *Holder 67* for overconfidence will be added to the model to test whether the combined impact of CEO overconfidence higher Capex/R&D expenses positively impacts firm performance and firm's growth opportunities.

### *4.2.3 Control Variables*

Several control variables will be added to both models since they could influence outcomes. All CEO control variables are retrieved from Execucomp. The first CEO characteristic that will be added as a control variable is the executive's age since someone's age consists of many factors that significantly affect financial decisions (Agarwal et al., 2009). Younger CEOs are also more likely to change corporate strategy and have more substantial incentives to invest in capital expenditures (Wiersma & Bantel, 1992; Yim, 2013). CEO tenure is also added as a control variable, representing

the time the executive sits in his position. Since the variable CEO tenure has very few unrealistic outliers, it will be winsorized at the 1% level. Both Age and CEO tenure are continuous variables. Next, there will also be control for CEO gender since men overestimate future returns and are thus expected to be more overconfident than women (Barber & Odean, 2001). CEO gender is a binary variable that takes the value 1 if the executive is a woman. The last CEO characteristic added as a control variable is CEO ownership to avoid problems with the measurement of overconfidence and incentive implications of option exercises (Chen et al., 2019). CEO ownership is measured by the proportion of company stocks owned by the CEO, excluding options. CEOs' compensation is highly sensitive to firm performance, and excess CEO compensation will lead to firm underperformance independent of poor governance variables (Kato & Kubo, 2006; Brick et al., 2006). If one of the variables on CEO characteristics is missing, the observation will be dropped from the model.

All firm control variables are retrieved from Compustat. First, firms' size is included since talented CEOs tend to work for larger firms (Edmans & Gabaix, 2011). The logarithm of firm size will be used since firm size has a significant standard deviation. The firm size equals the logarithm of the firm's total assets. Cash availability is also added to the models since overconfident CEOs are more sensitive to cash flows in their investment decisions (Malmendier & Tate, 2005). Overconfident CEOs overestimate current cash flows to predict future cash flows (Deshmuk et al., 2013). The logarithm of cash flow will be used, due to the large standard deviation of the variable.

Next to that, the research and development expenses are added since high R&D investments will significantly impact firm innovations (Hirsleifer et al., 2012). Capital expenditures will also be controlled since CEOs tend to have corporate investments. The firm's total assets normalize both capital expenditures and R&D expenses since expenditures are considerably influenced by a firm's size (Chauvin & Hirschey, 1993). Observations with missing values on one of the expenditure variables will be returned 0 since they likely did not engage in research and development expenses or capital expenditures in that year.

The ROA measure for performance will also be controlled in both models since experiencing successful performance in the past will lead to a higher chance of being overconfident (Hilary and Menzlyy, 2006). ROA will also be added in the second part when examining the impact of CEO overconfidence on firm performance and growth opportunities since prior performance is likely to affect current performance (Eisenberg et al., 1998; Yermack, 1996). Since CEOs tend to

work at the more innovative firms, there must also be control for Tobin's Q when measuring the impact on the probability of a CEO being overconfident. Hence, when testing for firm performance and growth opportunities, lagged variables of Tobin's Q and ROA (t-1) will be added.

### *4.3 Descriptive Statistics*

Table 2 shows the descriptive statistics of the entire sample that will be used for all models. The sample consists of S&P-1500 firms from 2000 to 2019. After merging and cleaning the datasets, which can be found in Table 1, the sample consists of 10,447 firm-year observations. Since missing lagged variables were dropped for some variables, the year 2000 was entirely dropped from the sample. The dependent variable for testing model 1 is *CEO moneyness,* which will be used in models 2,3, and 4 to construct the *Holder 67* proxy for CEO overconfidence. The variable has a minimum of 0 and a maximum of 3.3. The mean of the variable is substantially higher than the median of the variable, signifying that the variable is right-skewed. Since the median is below the 67% threshold of overconfidence, it would indicate that more than half of executives are overconfident. This can be explained by the fact that CEOs are classified as overconfident for their entire tenure if their option holding behavior exceeds the benchmark once.

Looking at the summary statistics of the independent variables of model 1, there can be concluded that at least half of the boards have only 12,5 percent or fewer female directors. By looking at the Female board presence variable, there could even be concluded that almost 25% of boards are male-dominated. The median board size is 9. Looking at the Nationality mix of the board, you see that at least half of the boards do not have any international diversity, and are thus American dominated. But, there are some diverse boards regarding nationalities. The last independent firm variable leverage, as measured by short-term and long-term debt, and normalized by stockholder's equity, is winsorized at the 1% level. The median indicates that the average firm is for less than 20% of stockholder's equity leveraged in short-term and long-term liabilities.

The interaction terms are constructed variables between the *Holder 67* proxy for CEO overconfidence, multiplied by Capex and R&D expenses. The expenditure variables are both ratios since they are normalized by firm size, and therefore the regular and the interaction variables seem to have plausible values. The minimum value of the expenditure variables is 0 since some firm-year observations do not have capital expenditures or research and development

expenses. The group of CEO characteristics also shows no irregularities. CEO Tenure is winsorized at the 1% level due to some impossible outliers, which are now disappeared. The mean of the binary variable CEO Gender, which takes the value of 1 if the executive is female, is 0.027, indicating that only 2,7% of CEOs are female. Furthermore, ROA, ROE, and market-to-book are winsorized at the 1% level. Lastly, the *Holder 67* variable, which will be used as a proxy for CEO overconfident, has a mean of 0.685, signifying that 68,5% of executives are overconfident. This value is in line with empirical literature of CEO overconfidence (Campbell et al., 2011; Hirshleifer et al., 2012).

Looking at the different tables for overconfident and non-overconfident CEOs, you see that the dependent variable *CEO moneyness* is substantially different, in line with the construction of the *Holder 67* proxy variable for CEO overconfidence. Next to that, there are no substantial differences in the independent variables between the subgroups. The value of the interaction variables for the non-overconfident subgroup is 0 since the binary variable *Holder 67* will take the value 0. For the control variables of CEO characteristics, there are also no substantial differences between the subgroups. You can see that the mean of the binary *CEO Gender* variable does not differ between the overconfident and non-overconfident subgroups, implying no gender differences in CEO overconfidence. The differences are also similar between ROA and ROE and Tobin's Q and market-to-book. It looks like CEOs tend to work at firms with more innovative firms. This finding is in line with earlier research (Galasso & Simcoe, 2011; Hirshleifer et al., 2012). Lastly, overconfident CEOs tend to work at slightly smaller firms, while non-overconfident CEOs have a much higher cash availability.

**Table 2: Descriptive statistics**

This table presents the descriptive statistics of all dependent, independent and control variables that are used for the analyses. The sample period for all models is 2000-2019. The top table lists the number of observations, the mean value, the standard deviation, the minimum and maximum value, and the median value for all variables. The table below shows the differences between CEO's that are classified as overconfident (if the binary *Holder 67* variable is 1) and CEO's that are not, with their corresponding mean value and standard deviation for all variables.

| Variable | N | Mean | S.D. | Min | Median | Max |
|---|---|---|---|---|---|---|
| *CEO moneyness* | 10,447 | 0.729 | 0.872 | 0 | 0.412 | 3.335 |
| Gender Ratio | 10,447 | 0.860 | 0.105 | 0.333 | 0.875 | 1 |
| Number of Directors | 10,447 | 9.564 | 2.251 | 3 | 9 | 22 |
| Leverage | 10,447 | 0.315 | 0.474 | 0 | 0.173 | 3.117 |
| Nationality Mix | 10,447 | 0.107 | 0.168 | 0 | 0 | 0.9 |
| Female board presence | 10,447 | 0.774 | 0.418 | 0 | 1 | 1 |
| Holder * (Capex / Firm size) | 10,447 | 0.032 | 0.045 | 0 | 0.019 | 0.663 |
| Holder * (R&D / Firm size) | 10,447 | 0.024 | 0.062 | 0 | 0 | 1.426 |
| CEO Age | 10,447 | 56.257 | 6.943 | 30 | 56 | 88 |
| CEO Tenure | 10,447 | 7.931 | 6.821 | 0.534 | 5.982 | 34.998 |
| CEO Compensation | 10,447 | 1281.84 | 1803.577 | 0 | 967.5 | 71633.85 |
| CEO Gender | 10,447 | 0.027 | 0.163 | 0 | 0 | 1 |
| Capex / Firm size | 10,447 | 0.045 | 0.045 | - 0.033 | 0.032 | 0.663 |
| R&D Expenses / Firm size | 10,447 | 0.033 | 0.068 | 0 | 0.007 | 1.426 |
| ROA | 10,447 | 0.055 | 0.089 | - 0.379 | 0.060 | 0.291 |
| Tobin's Q | 10,447 | 2.183 | 1.530 | 0.345 | 1.744 | 26.992 |
| ROE | 10,447 | 0.030 | 0.099 | -0.606 | 0.047 | 0.206 |
| Market-to-book | 10,447 | 3.400 | 2.574 | 0.759 | 2.592 | 11.004 |
| Firm Size | 10,447 | 11882.38 | 36511.76 | 7.702 | 2613.56 | 797769 |
| Cash Flow | 10,447 | 263.771 | 922.417 | 0 | 14.474 | 14888 |
| Holder 67 | 10,447 | 0.685 | 0.465 | 0 | 1 | 1 |

| | Overconfident CEO's *Holder 67* = 1 | | | Non-overconfident CEO's *Holder 67* = 0 | | |
|---|---|---|---|---|---|---|
| Variable | N | Mean | S.D. | N | Mean | S.D. |
| *CEO moneyness* | 7,154 | 0.978 | 0.947 | 3,293 | 0.188 | 0.192 |
| Gender Ratio | 7,154 | 0.861 | 0.106 | 3,293 | 0.857 | 0.103 |
| Number of Directors | 7,154 | 9.373 | 2.213 | 3,293 | 9.969 | 2.281 |
| Leverage | 7,154 | 0.275 | 0.427 | 3,293 | 0.795 | 0.553 |
| Nationality Mix | 7,154 | 0.104 | 0.169 | 3,293 | 0.113 | 0.166 |
| Female board presence | 7,154 | 0.764 | 0.425 | 3,293 | 0.795 | 0.404 |
| Holder * (Capex / Firm size) | 7,154 | 0.047 | 0.048 | 3,293 | 0 | 0 |
| Holder * (R&D / Firm size) | 7,154 | 0.035 | 0.072 | 3,293 | 0 | 0 |
| CEO Age | 7,154 | 56.944 | 7.010 | 3,293 | 54.765 | 6.551 |
| CEO Tenure | 7,154 | 9.373 | 7.153 | 3,293 | 4.799 | 4.706 |
| CEO Compensation | 7,154 | 1259.084 | 1824.03 | 3,293 | 1331.279 | 1757.581 |
| CEO Gender | 7,154 | 0.027 | 0.162 | 3,293 | 0.029 | 0.167 |
| Capex / Firm size | 7,154 | 0.047 | 0.048 | 3,293 | 0.041 | 0.038 |
| R&D Expenses / Firm size | 7,154 | 0.035 | 0.072 | 3,293 | 0.030 | 0.057 |
| ROA | 7,154 | 0.063 | 0.087 | 3,293 | 0.037 | 0.090 |
| Tobin's Q | 7,154 | 2.395 | 1.713 | 3,293 | 1.724 | 0.861 |
| ROE | 7,154 | 0.035 | 0.084 | 3,293 | 0.019 | 0.126 |
| Market-to-book | 7,154 | 3.700 | 2.678 | 3,293 | 2.749 | 2.196 |
| Firm Size | 7,154 | 9822.072 | 24811.38 | 3,293 | 53509.55 | 53509.55 |
| Cash Flow | 7,154 | 193.257 | 661.076 | 3,293 | 416.961 | 1309.958 |

*4.4 Methodology*

All thesis tests use Ordinary Least Squares (OLS) regressions since it is the most suitable quantitative research method. An OLS model estimates the parameter of linear regressions and minimizes the sum of the squared errors. In the linear regressions, the change in the mean of the dependent variable is given for a one-unit change in the independent variable. The OLS method is widely used since it is easy to implement and interpret. In addition, it can process a large amount of data and provides accurate predictions.

The OLS model does have some disadvantages. First of all, a large dataset is necessary to provide accurate predictions since the model results are sensitive to different functional forms if the error term is not interpreted sufficiently. Next, outliers in the model can heavily impact the model's results since outliers can serve as an anchor for the estimates and, therefore, negatively impact the model. To prevent this, winsorization will be applied to variables with outliers. Other problems with OLS regressions, such as heteroscedasticity and high correlations between control and independent variables, will be investigated. Although the OLS model has some disadvantages, the advantages outweigh the disadvantages.

A standard OLS model will be sufficient if the regression residuals are uncorrelated across both firms and time (Thomposon, 2011), which is an unrealistic assumption. Therefore, year-fixed effects are added to the models, just as robust firm-clustered standard errors, to account for heteroscedasticity across clusters of observations. Industry-fixed effects are also added to the models based on the SIC codes of the companies. However, since the model has robust firm-clustered standard errors, all industry effects are omitted since firm fixed effects already implement those related industries. A random-effects model can help with this.

In choosing between a model with fixed effects with omitted industry fixed-effects or a model with random effects without omitted industry fixed effects, a Hausman test is conducted to determine which model best suits the panel data. In his test, the null hypothesis states that a model with random effects fits the model better (Hausman,1978). Across all models in the conducted research, the null hypothesis is rejected ($p=0.000$), concluding that a model with fixed effects suits the data better. Thus, industry-fixed effects will be added but are omitted. However, since firm fixed effects are used, industry fixed effects are likely to be captured (Krueger & Summers, 1988).

Heterogeneity is captured by adding robust firm-clustered standard errors, (omitted) industry fixed effects, and year fixed effects.

For the first part of the study, mitigating effects of firm characteristics on the dependent variable *CEO moneyness* will be tested. None of the variables will be lagged since the variable *CEO moneyness* is measured at the fiscal year-end. The following baseline regression for model 1 will be estimated to test the mitigating firm characteristics:

**Model 1**

$$\text{CEO moneyness}_{i,t} = ß_1 \text{ Firm characteristic}_{i,t} + ß_2 \text{ Control CEO}_{i,t} + ß_3 \text{ Control firm}_{i,t} + \text{Industry}_i + \text{Year}_t + e_{i,t}$$

*CEO moneyness* is the extent to which the stock options of CEOs are in-the-money. The independent firm characteristics will vary in testing the hypotheses. The firm characteristics used are the gender ratio, the number of directors, the nationality mix of the board, and the firm's leverage ratio. CEO control variables include gender, age, compensation, ownership, and tenure. Firm control variables include firm size, performance (ROA), growth opportunities (Tobin's Q), cash flow, R&D expenses, and capital expenditures. Furthermore, there will be controlled for industry and year fixed effects, and robust standard errors are clustered at the firm level.

In the next part of the study, three models will be constructed, first for measuring the impact of CEO overconfidence on firm performance, firm growth opportunities in model 2, and the impact on capital expenditures and R&D expenses in model 3. The following baseline regressions will be estimated to test models 2 and 3.

**Model 2**

$$\text{ROA/Tobin'sQ}_{i,t} = ß_1 \text{ Holder 67}_{i,t} + ß_2 \text{ Control CEO}_{i,t} + ß_3 \text{ Control firm performance ratio}_{,t-1} + \text{Control Expenditures}_{i,t} + \text{Control firm}_{i,t} + \text{Industry}_i + \text{Year}_t + e_{i,t}$$

**Model 3**

$$\text{R\&D/Capex} = ß_1 \text{ Holder 67}_{i,t} + ß_2 \text{ Control CEO}_{i,t} + ß_3 \text{ Control firm ratio}_{i,t} + ß_4 \text{ Control Expenditures}_{i,t-1} + ß_5 \text{ Control firm}_{i,t} + \text{Industry}_i + \text{Year}_t + e_{i,t}$$

In estimating the second and third models, the firm dependent variable differs to examine the impact of CEO overconfidence. In model 2, the dependent variables are firm performance as measured by ROA and firm growth opportunities as measured by Tobin's Q. In model 3, the dependent variables are capital expenditures and research and development expenses. The *Holder 67* binary variable is a proxy for CEO overconfidence. In the second model, which measures the impact on ROA and Tobin's Q, the firm ratios are lagged since prior performance is likely to affect current performance (Eisenberg et al., 199; Yermack, 1996). In the third model, there will be control for prior year expenditures since the best predictor of current investments is prior investments and, therefore, must be controlled for (Hirsleifer et al., 2010; Eberly et al., 2012).

Model 4 estimates the combined impact of CEO overconfidence and higher Capex/R&D expenses on firm performance and growth opportunities. Therefore ROA and Tobin's Q are the only two dependent variables. An extra interaction variable will be added to measure the combined impact of CEO overconfidence and higher Capex/R&D expenses. The CEO control and firm control variables are similar in the first regression.

**Model 4**

$$\text{ROA/Tobin's } Q_{i,t} = ß_1 \text{ Holder } 67_{i,t} * \text{Capex/R\&D expenses}_{i,t} + ß_2 \text{ Holder } 67_{i,t} + ß_3 \text{ Control CEO}_{i,t} + ß_4 \text{ Control firm ratio}_{,t-1} + \text{Control Expenditures}_{i,t} + \text{Control firm}_{i,t} + \text{Industry}_i + \text{Year}_t + e_{i,t}$$

*4.5 Robustness Tests*

After testing the above-mentioned baseline regressions, several tests will be conducted to ensure the robustness of the results. All models in the thesis are also checked with lagged independent variables, and saw a drop in adjusted $R^2$, implying the models drop in explanatory value when lagging independent variables.

In the first model, the mitigating effect of the continuous variable female directors will be tested by using an alternative measure, which is the binary variable of female board presence. This binary variable will take the value 1 if there is at least one female on the board. Furthermore, the effect of mitigating firm characteristics will not only be tested on the continuous *CEO moneyness* variable, but also on the binary *Holder 67* variable, to test whether results of the first model are robust to a change of the proxy for CEO overconfidence. In drawing conclusions about the firm's

leverage effect, caution must be exercised since overconfident managers choose higher leverage levels and take on more new debt (Hackbarth, 2008). Reverse causality might arise, meaning that leverage is not a mitigating or strengthening firm characteristic of CEO overconfidence. Therefore, a model with lagged (t-1) leverage will be tested as a robustness test.

In models 2,3 and 4, the dependent *Holder 67* variable will be replaced by the binary *Net Buyer* proxy for CEO overconfidence, and the continuous *CEO moneyness* proxy for CEO overconfidence, to test if the results are robust to changes of the proxy for CEO overconfidence. Testing with the *Net Buyer* sample will affect the sample size negatively. The *Net Buyer* variable exploits whether CEOs buy additional company stock against sound levels of portfolio diversification. The construction of the variable is in line with Malmendier & Tate (2005). Data on shares owned by the executive is retrieved from Execucomp. To be classified as *Net Buyer*, CEOs must have bought net on the stock in more years than they sold on net during the first five years of their tenure. If the CEO is once classified as *Net Buyer*, the variable will return the value 1 during the entire sample period. Only CEOs who are considered who are at least ten years in position during the sample period and the first five years of CEOs' tenure are excluded.

Additionally, a robustness test for model two and four, when testing the impact of the *Holder 67* variable, and the interaction variable on firm performance and firm growth opportunities, the ROE ratio will replace the ROA ratio for firm performance, and the market-to-book ratio will replace Tobin's Q, to measure impact on firm growth opportunities.

High correlations between control variables and independent variables can create problems in an OLS model. If a high correlation exists, the model results might be disturbed. Table 3 displays the Pearson correlation matrix. Statistical significance is denoted by asterisks *, **, *** at the 10%, 5%, and 1%, respectively. Table 3 shows that most variables are not highly correlated, except for a few, which will be displayed. First, the *Holder 67* and the *CEO moneyness* correlation coefficient is 0.421, which could be expected since the value of the *CEO moneyness* variable is used to construct the *Holder 67* variable. Next, female board presence is highly correlated with the gender ratio of the board, which is acceptable since it is used as a robustness test for the gender ratio. The number of directors is highly correlated with Firm Size since both are proxies for firm size. Lastly, both ROA and ROE and Tobin's Q and market-to-book ratio are highly correlated. The proxies are used as robustness tests for firm performance and growth opportunities. After reviewing the Pearson correlation matrix, there are no concerns about the presence of collinearity.

**Table 3: Pearson Correlation Matrix**

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. *CEO moneyness* | 1 | | | | | | | | | | | | | | | | | | |
| 2. Gender Ratio | 0.065*** | 1 | | | | | | | | | | | | | | | | | |
| 3. Number of Directors | -0.118*** | -0.309*** | 1 | | | | | | | | | | | | | | | | |
| 4. Nationality Mix | 0.006 | -0.128*** | 0.177*** | 1 | | | | | | | | | | | | | | | |
| 5. Female Board presence | -0.069*** | -0.721*** | 0.425*** | 0.109*** | 1 | | | | | | | | | | | | | | |
| 6. Leverage | -0.202*** | -0.065*** | 0.134*** | -0.019* | 0.081*** | 1 | | | | | | | | | | | | | |
| 7. CEO Gender | -0.011 | -0.220*** | 0.025** | 0.036*** | 0.078*** | 0.009 | 1 | | | | | | | | | | | | |
| 8. CEO Age | -0.003 | -0.043*** | 0.064*** | -0.017* | 0.026*** | 0.068*** | -0.041*** | 1 | | | | | | | | | | | |
| 9. R&D / Firm size | 0.062*** | 0.101*** | -0.175*** | 0.030*** | -0.118*** | -0.177*** | -0.012 | -0.115*** | 1 | | | | | | | | | | |
| 10. Capex / Firm size | 0.060*** | 0.034*** | -0.014 | -0.039*** | -0.014 | 0.041*** | 0.001 | 0.061*** | -0.128*** | 1 | | | | | | | | | |
| 11. ROA | 0.225*** | -0.072*** | 0.046*** | 0.016 | 0.062*** | -0.303*** | 0.014 | 0.024** | -0.292*** | 0.065*** | 1 | | | | | | | | |
| 12. Tobin's Q | 0.393*** | -0.048*** | -0.111*** | 0.051*** | 0.012 | -0.309*** | 0.003 | -0.057*** | 0.373*** | 0.004 | 0.272** | 1 | | | | | | | |
| 13. ROE | 0.111*** | -0.051*** | 0.088*** | 0.008 | 0.055*** | -0.295*** | 0.011 | 0.036*** | -0.215*** | 0.043*** | 0.721*** | 0.021** | 1 | | | | | | |
| 14. Market-to-book | 0.344*** | -0.132*** | 0.041*** | 0.092*** | 0.088*** | -0.239*** | 0.035*** | -0.063*** | 0.190*** | -0.011 | 0.255*** | 0.635*** | 0.052*** | 1 | | | | | |
| 15. CEO Tenure | 0.124*** | 0.132*** | -0.132*** | -0.076*** | -0.147*** | -0.036*** | -0.074*** | 0.424*** | 0.022** | 0.051*** | 0.024** | 0.039*** | 0.018* | -0.022** | 1 | | | | |
| 16. Firm Size | -0.089*** | -0.344*** | 0.616*** | 0.240*** | 0.382*** | 0.220*** | 0.039*** | 0.102*** | -0.258*** | 0.041*** | 0.083*** | -0.185*** | 0.119*** | 0.023** | -0.119*** | 1 | | | |
| 17. Cash Flow | -0.075*** | -0.187*** | 0.341*** | 0.132*** | 0.133*** | 0.004 | 0.041*** | 0.051*** | -0.035*** | 0.003 | 0.076*** | -0.008 | 0.070*** | 0.078*** | -0.067*** | 0.514*** | 1 | | |
| 18. CEO Compensation | 0.002 | -0.027*** | 0.204*** | 0.045*** | 0.059*** | 0.047*** | -0.012 | 0.113*** | -0.085*** | 0.015 | 0.054*** | -0.048*** | 0.077*** | -0.001 | 0.057*** | 0.282*** | 0.159*** | 1 | |
| 19. Holder67 | 0.421*** | 0.017* | -0.124*** | -0.025** | -0.034*** | -0.123*** | -0.004 | 0.146*** | 0.030*** | 0.061*** | 0.136*** | 0.204*** | 0.078*** | 0.172*** | 0.311*** | -0.072*** | -0.113*** | -0.018* | 1 |

As an additional robustness test, potential multicollinearity between independent and control variables will be examined in both parts of the study. Multicollinearity is a problem where multiple predictors are highly correlated. The VIF (Variance Inflation Factor) will be estimated by testing all three models to check for multicollinearity. The VIF is a measure of multicollinearity between independent variables and control variables in a multiple regression model. Multicollinearity does not hurt the predictable power but reduces the significance of tested independent variables. A commonly used threshold for VIF when testing for multicollinearity is 10 (O'brien, 2007). If the estimated VIF of one of the used variables exceeds this variable, multicollinearity will be present. The inverse of VIF will also be displayed (1/VIF), with a threshold maximum of 0.1 for multicollinearity to be a problem. In the first two tests in Table 8 and Table 9 in the appendix, all coefficients are not close to 10, so multicollinearity is not a problem. In testing for multicollinearity for model 4 in Table 10 in the appendix, all interaction expenditure variables and the standard expenditure variables show higher variables. The interaction variable takes the same value as the standard expenditure variable if the CEO is overconfident. Therefore, the moderate VIF value is still acceptable (Alin, 2010; O'brien, 2007). Lastly, since robust standard errors are clustered at the firm level, there will be accounted for within-group dependence, and thus results are robust to heteroscedasticity.

There are some endogeneity concerns, especially in the second part of the thesis. It is unrealistic to assume that overconfident CEOs are randomly assigned to firms, and it is much more assumable to expect that companies hire overconfident CEOs to improve growth opportunities, especially in periods of successful innovation (Galasso & Simcoe, 2011; Hirshleifer et al., 2012). If CEO-firm matching occurs, the CEO overconfidence variable in the models will not be an exogenous variable anymore, impacting the validity of results. CEO personal characteristics can also impact the extent to which CEOs are overconfident. By adding CEO and firm control variables and creating firm-year fixed effects by clustering robust standard errors at the firm level, the thesis tries to minimalize endogeneity concerns. However, it is unrealistic to expect that CEO overconfidence is a fully exogenous independent variable in the thesis, and therefore conclusions must be drawn with caution.

## 5. Results and discussion of findings

The result section will display all findings of conducted regressions for the constructed models and findings for robustness checks of the results. First, results of the mitigating firm characteristics of CEO overconfidence are shown. The second part will show the different tests for measuring the impact of CEO overconfidence and firm performance and firm growth opportunities. After that, the impact of CEO overconfidence on firm expenditures is displayed. Lastly, the impact of CEO overconfidence combined with higher expenditures is examined on firm performance and firm growth opportunities.

### *5.1 Mitigating Firm Characteristics of CEO Overconfidence*

Table 4 presents the results of the first part of the study. All columns use ordinary least squares (OLS) regressions with *CEO moneyness* as the dependent variable and different firm characteristics as independent variables. In addition, all columns include both year and industry fixed effects, and robust standard errors are clustered at the firm level.

Looking at the first column, where the impact of the gender ratio of the board of directors is measured on *CEO moneyness*, you can see that the Gender Ratio has a significant positive effect on *CEO moneyness* in the first column, significant at the 10% level. Expanding the gender ratio of the board represents an increase in the proportion of males on the board. Hence, an increase in the proportion of females on the board decrease the dependent variable of *CEO moneyness*, and thus female directors mitigate CEO overconfidence. The coefficient of 0.312 can be interpreted as follows; a ten percent increase in the proportion of females on the board decreases the dependent variable *CEO moneyness* by 3,1%. Therefore, it decreases CEOs' tendency to hold options beyond the optimal point of the exercise of the stock options.

The second column tests the impact of board size, as measured by the number of directors, on *CEO moneyness*. The second column displays that board size does not significantly impact CEO overconfidence. In column (3), the Nationality Mix of the board does not impact the extent to which CEOs hold on to their options, and international director presence has thus not significantly impacted CEO overconfidence. In column (4), a firm's leverage has a negative impact on the dependent variable *CEO moneyness*, significant at the 1% level. The coefficients are easily

interpreted since the independent variable leverage is a ratio between total debt and stockholder's equity. The coefficient of -0.352 indicates that an increase of 10% in firm leverage, ceteris paribus, has a decreasing impact on the option holding behavior of CEOs, as measured by the dependent variable *CEO moneyness*, of 3.5%. This finding could indicate that CEOs change their option holding behavior if the firm is increasingly leveraged since leverage decreases the dependent variable *CEO moneyness*. Leverage brings the costs of financial distress, which could be a reason that CEOs do not hold on to the options, but sells them early.

In the last column, all variables are combined to measure its mitigating effect on CEO overconfidence. It is noticeable that the effect of female director presence still has a significant adverse effect on the dependent variable at the 10% level. The leverage effect is still significant at the 1% level. The number of directors and nationality mix still do not significantly impact the dependent variable. Female board presence and leverage mitigate CEO overconfidence. The leverage effect is more significant, and the coefficient is higher, concluding that the leverage ratio has the most significant mitigating effect on CEO overconfidence.

A few things can be concluded from the control variables across all regressions in Table 4. First of all, by looking at CEO characteristics, you can see that the executive's age and ownership do not significantly influence the dependent variable. CEO gender also does not significantly impact the dependent variable, from which it can be concluded that there are no significant differences in gender for CEO overconfidence. This could be due to the relatively small sample of female executives. CEO tenure does have a significant positive effect on *CEO moneyness*, indicating CEOs become more overconfident when they are longer in office. CEO compensation also significantly impacts CEO overconfidence, albeit inconsiderable.

Firm control characteristics show that a firm's capital expenditures do not significantly impact the dependent variable *CEO moneyness*. Firm performance, as measured by ROA, and firm growth opportunities, as measured by Tobin's Q, both have a considerable positive significant effect on *CEO moneyness*. The probability of a CEO being overconfident increases if firm performance increases. The impact of an increase in firm performance on *CEO moneyness* is more significant than the impact of firm growth opportunities. R&D expenses have a large significant negative impact on *CEO moneyness*, concluding that an investment in R&D expenses mitigates CEO overconfidence. *CEO moneyness* is also significantly negatively impacted by a firm's size, denoting that CEO overconfidence is less displayed in larger firms. Finally, cash availability to

CEOs, measured by cash flow, negatively impacts CEO overconfidence, albeit the coefficient is considerably small.

**Table 4: Mitigating firm characteristics of CEO overconfidence**
This table presents the results from OLS regressions, measuring mitigating effects of firm characteristics on CEO overconfidence. The dependent variable of the model, *CEO moneyness*, is used as the measurement for CEO overconfidence. Columns (1) to (4) are used to measure the stand-alone impact of the different firm characteristics on *CEO moneyness*. Column (5) reports results of all firm characteristics combined. The number of observations and adjusted R-squared can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | Dependent variable: *CEO moneyness* | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Gender Ratio | 0.312* | | | | 0.281* |
| | (0.173) | | | | (0.169) |
| Number of Directors | | -0.007 | | | -0.009 |
| | | (0.009) | | | (0.009) |
| Nationality Mix | | | 0.049 | | 0.031 |
| | | | (0.117) | | (0.115) |
| Leverage | | | | -0.352*** | -0.352*** |
| | | | | (0.039) | (0.039) |
| CEO Age | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| CEO tenure | 0.009** | 0.009** | 0.009** | 0.009*** | 0.009*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| CEO compensation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| CEO gender | 0.144 | 0.119 | 0.119 | 0.122 | 0.145 |
| | (0.096) | (0.096) | (0.096) | (0.092) | (0.092) |
| R&D / Firm size | -1.289** | -1.281** | -1.292** | -1.493** | -1.460** |
| | (0.551) | (0.550) | (0.552) | (0.548) | (0.548) |
| Capex / Firm size | 0.284 | 0.286 | 0.297 | -0.029 | -0.047 |
| | (0.418) | (0.418) | (0.417) | (0.405) | (0.407) |
| ROA | 1.172*** | 1.170*** | 1.172*** | 0.778*** | 0.780*** |
| | (0.128) | (0.128) | (0.128) | (0.131) | (0.131) |
| Tobin's Q | 0.258*** | 0.258*** | 0.258*** | 0.253*** | 0.253*** |
| | (0.028) | (0.028) | (0.027) | (0.028) | (0.027) |
| Ln (Firm size) | 0.133*** | 0.136*** | 0.131*** | 0.159*** | 0.166*** |
| | (0.038) | (0.039) | (0.038) | (0.039) | (0.039) |
| Ln (Cash flow) | -0.024* | -0.024* | -0.024* | -0.029** | -0.028** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 |
| Adjusted R-squared | 0.220 | 0.219 | 0.219 | 0.236 | 0.236 |

Adjusted $R^2$ increases when adding control variables, boosting the explanatory value of the regressions. Adjusted $R^2$ for the first three regressions is around 0,22, implying that 22% of the

data fit the regression model. In addition, the explanatory value of the model increases when adding the leverage variable, denoting that the leverage variable is essential in explaining option holding behavior by executives.

### *5.2 Impact CEO Overconfidence on Firm Performance*

The first part showed that the leverage ratio and the proportion of females on the board mitigated CEO overconfidence. However, it remains questionable whether CEO overconfidence must be mitigated if it positively influences firm performance. It is not broadly reported that CEO overconfidence harms firm performance, and therefore it is interesting to examine this is the case.

The effect of the constructed *Holder 67* proxy for overconfidence on firm performance and growth opportunities is displayed in Table 5. The dependent variables for firm performance and growth opportunities are regressed on the independent *Holder 67* variable, controlling for some firm and CEO characteristics. Control variables on ROA and Tobin's Q will be lagged one year (t-1) since prior performance is likely to affect current performance (Eisenberg et al., 1998; Yermack, 1996). Furthermore, this model will also control for industry and year fixed effects, and robust standard errors will be clustered at the firm level.

The first column in Table 5 displays that the *Holder 67* proxy for CEO overconfidence positively impacts firm performance as measured by the return on assets (ROA). The coefficient size is not large but does indicate that CEO overconfidence has a positive effect on firm performance, significant at the 1%. Firms with overconfident CEOs tend to outperform non-overconfident CEOs with 0.9%, as measured by the return on assets. This finding implicates that CEO overconfidence has a significant positive effect on firm performance. Two-thirds of executives in the sample are classified overconfident, which could cause the marginal effect. The robustness test with the *Net Buyer*, where less executives are considered, will show what an alternative sample does with the results.

Control variables show that the CEOs' age, tenure, and gender do not significantly impact firm performance, while CEO compensation does, although the effect is minuscule. A firm's R&D ratio has a significant negative effect on firm performance. If a standard firm increases its spending on R&D by 100%, firm performance as measured by the return on assets will be 54.7% lower. The firm's Capex ratio does not significantly impact firm performance. Prior year performance and prior

year growth opportunities have a significant positive impact on current performance. Lastly, firm size significantly decreases firm performance, indicating that smaller firms in the sample are more profitable than larger ones. Cash flow does not significantly impact firm performance.

The second column in Table 5 denotes that the *Holder 67* proxy for CEO overconfidence positively impacts firm growth opportunities as measured by Tobin's Q, significant at 1%. Firms with overconfident CEOs tend to be valued 20.6% higher by the market than firms managed by non-overconfident CEOs. The finding implies that CEO overconfidence positively affects firm market valuation, measured by Tobin's Q. The finding signifies that the market will value the firm's assets, compared to its book value, higher if an overconfident CEO manages it. Revealing that the market has more trust in the future growth opportunities of firms managed by overconfident CEOs. Control variables show similar to the results for the second column. CEOs tenure, age, and gender do not significantly impact Tobin's Q, while CEO compensation does, albeit very small.

Firm control variables display that R&D has an enormous impact on the dependent variable. If a firm increases its spending on R&D by 100%, Tobin's Q is 500% higher. This finding is in line with earlier research showing that Tobin's q rises in reaction to announcements of increases in R&D expenses since it creates competencies to generate growth opportunities (Szewczyk et al., 1996). The firm's asset valuation by the market increases since spending on R&D is associated with innovation, improvements in the efficiency of existing processes, and cost reduction. The Capex ratio does not significantly impact Tobin's Q and prior year performance. However, the prior year Tobin's Q significantly impacts the current year Tobin's Q, as was displayed for the ROA ratio in the first column. Firm size has a large significant decreasing effect on Tobin's Q, signifying that market overvaluation of a firm's assets, compared to its book value, is higher for smaller firms compared to larger firms. Cash flow has a small significant impact.

CEO overconfidence positively affects firm performance, measured by return on assets. Moreover, the effect is even more positive on the market valuation of a firm's assets if managed by an overconfident CEO. Results show positive results for companies to hire overconfident CEOs instead of undertaking actions to mitigate CEO overconfidence, measured by both firm performance and growth opportunities. However, as earlier explained, there are some endogeneity concerns with this statement. CEO-firm matching is possible, since firms can choose to hire overconfident CEOs in high innovative times. Nonetheless, the results seem to indicate it is beneficial to hire overconfident executives.

Furthermore, what attracts attention is that increases in R&D expenses negatively impact firm performance, while it powerfully contributes to an increase in Tobin's Q. An increase in R&D expenses decreases a firm's net income and thus decreases the return on assets. In contrast, the increase in spending on R&D creates competencies to generate growth opportunities, and therefore market valuation of a firm's assets increases since R&D expenses are associated with innovation.

The adjusted $R^2$ value is higher for the model that tests the impact of CEO overconfidence on Tobin's Q. The coefficients implicate that the explanatory value of CEO overconfidence on firm growth opportunities is higher than the explanatory value of the impact of CEO overconfidence on firm performance.

**Table 5: Effect Holder 67 on firm performance measures**
This table presents the results from OLS regressions, measuring the impact of the *Holder 67* proxy for CEO overconfidence on ROA and Tobin's Q. Column (1) and (2) have all the control variables included in the model. The number of observations and adjusted R-squared can be found at the bottom All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROA<br>(1) | Tobin's Q<br>(2) |
|---|---|---|
| Holder 67 | 0.009***<br>(0.002) | 0.206***<br>(0.029) |
| CEO Age | -0.000<br>(0.000) | 0.004*<br>(0.002) |
| CEO tenure | 0.000<br>(0.000) | -0.002<br>(0.003) |
| CEO compensation | 0.000***<br>(0.000) | 0.000**<br>(0.000) |
| CEO gender | -0.005<br>(0.006) | -0.010<br>(0.077) |
| R&D / Firm size | -0.547***<br>(0.050) | 4.995***<br>(1.294) |
| Capex / Firm size | -0.000<br>(0.051) | 0.363<br>(0.424) |
| ROA (t-1) | 0.247***<br>(0.023) | 0.202<br>(0.245) |
| Tobin's Q (t-1) | 0.014***<br>(0.002) | 0.481***<br>(0.044) |
| Ln (Firm size) | -0.016***<br>(0.003) | -0.365***<br>(0.043) |
| Ln (Cash flow) | 0.001<br>(0.001) | 0.021*<br>(0.011) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 10,447 | 10,447 |
| Adjusted R-squared | 0.229 | 0.417 |

*5.3 Impact CEO overconfidence on Firm Expenditures*

Table 6 displays the impact of CEO overconfidence on firm expenditures is displayed. Dependent variables for expenditures are capital expenditures and research and development expenses, normalized by firm size since expenditures are considerably influenced by a firm's size (Chauvin & Hirschey, 1993). The effect of the constructed *Holder 67* proxy for overconfidence is tested on both expenditure variables, with controls for some firm and CEO characteristics. The expenditures control variables are lagged (t-1) since the best predictor of current investments is prior investments and, therefore, must be controlled for (Hirsleifer et al., 2010; Eberly et al., 2012). Industry and year-fixed effects are added to all models, and robust standard errors will be clustered at the firm level.

The first column in Table 6 shows that CEO overconfidence in capital positively impacts expenditures in both models, significant at the 1% level. The coefficient implies that overconfident CEOs have 0.3% higher capital expenditures than their non-overconfident peers. This finding aligns with earlier research that showed that overconfidence bias is related to higher investments (Ben-Davit et al., 2007; Pikulina et al., 2017). However, the difference between overconfident and non-overconfident executives of 0.3% is relatively small.

None of the CEO characteristics have a significant impact on capital expenditures. R&D expenses have an unsubstantial impact. As was envisioned, prior year capital expenditures have a significant positive impact on current-year capital expenditures. Furthermore, ROA does not have a significant impact, while Tobin's Q does to a small extent. Finally, firm size has a small significant decreasing impact on capital expenditures, while cash flow does not impact the dependent variable.

The second column in Table 6 shows that the independent *Holder 67* variable does not significantly impact the dependent expenditure variable. This result implies that CEO overconfidence does not significantly impact the level of research and development expenses by firms. As for the earlier tested impact on capital expenditures, CEO characteristics do not significantly impact the dependent expenditure variable, apart from the almost non-existing coefficient of CEO compensation. The level of prior year R&D expenses positively impacts the current year R&D expenses, in line with our expectations. Capital expenditures do not impact R&D expenses. Furthermore, return on assets negatively impacts R&D expenses, while Tobin's Q shows

a positive impact, significant at the 1% level. Last of all, firm size significantly decreases the level of R&D expenses, and cash flow does not have any impact.

**Table 6: Effect Holder 67 on firm expenditures**
This table presents the results from OLS regressions, measuring the impact of the *Holder 67* proxy for CEO overconfidence on capital expenditures and research and development expenses, both normalized by firm size. Column (1) and (2) have all the control variables included in the model. The number of observations and adjusted R-squared can be found at the bottom All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | Capex / Firm size | R&D / Firm size |
|---|---|---|
| | (1) | (2) |
| Holder 67 | 0.003*** | 0.001 |
| | (0.001) | (0.001) |
| CEO Age | -0.000 | -0.000 |
| | (0.000) | (0.000) |
| CEO tenure | 0.000 | 0.000 |
| | (0.000) | (0.000) |
| CEO compensation | 0.000** | 0.000*** |
| | (0.000) | (0.000) |
| CEO gender | -0.003 | -0.000 |
| | (0.002) | (0.002) |
| R&D / Firm size (t-1) | -0.016* | 0.333*** |
| | (0.009) | (0.058) |
| Capex / Firm size (t-1) | 0.309*** | 0.006 |
| | (0.037) | (0.011) |
| ROA | 0.010 | -0.105*** |
| | (0.006) | (0.019) |
| Tobin's Q | 0.002*** | 0.005*** |
| | (0.000) | (0.001) |
| Ln (Firm size) | -0.004*** | -0.012*** |
| | (0.001) | (0.002) |
| Cash flow | 0.000 | 0.000 |
| | (0.000) | (0.000) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 10,447 | 10,447 |
| Adjusted R-squared | 0.178 | 0.280 |

When testing the impact of CEO overconfidence on firm expenditures, the results showed that CEO overconfidence positively impacts a firm's capital expenditures, albeit to a small and almost not impactful extent. While earlier research found that overconfident CEOs chose higher R&D expenses (Hirshleifer et al., 2012), there was not a significant impact on R&D expenses in this thesis. This lack of finding significant results could be because the sample returned a value of 0 to observations with missing data on R&D expenses, which concerned quite a lot of observations

in the dataset. Some firms with missing data on R&D expenses did engage in those expenditures, while they were valued at 0 in our sample, possibly affecting the results.

The adjusted $R^2$ value is higher for the model that tests the impact of CEO overconfidence on R&D expenses, implicating that the explanatory value of the impact on R&D expenses is higher than the explanatory value of CEO overconfidence on capital expenditures.

*5.4 Interaction Effect CEO Overconfidence and Higher Expenditures*

Table 7 displays the impact of the interaction terms of CEO overconfidence with higher firm expenditures on firm performance and firm growth opportunities. To construct the interaction terms, the *Holder 67* proxy for overconfidence will be multiplied by the two measurements for firm expenditures, Capex and R&D expenses. Both expenditure variables are normalized by firm size. The impact of the interaction variables *Holder 67 * (Capex / Firm size)* and *Holder 67 * (Capex / Firm size)* are tested separately on ROA and Tobin's Q and their collective impact. CEO and firm control variables are added to the models. The singular *Holder 67* variable will be added to all models. As before, control variables on ROA and Tobin's Q will be lagged one year (t-1) since prior performance is likely to affect current performance (Eisenberg et al., 1998; Yermack, 1996). Furthermore, this model will add industry and year-fixed effects, and robust standard errors will be clustered at the firm level.

In the first three columns of Table 7, the results of firm performance, as measured by the return on assets, are displayed. All three first columns show no significant impact of the interaction terms on firm performance. Thus, an overconfident CEO who chooses higher firm expenditures does not impact firm performance, as measured by the return on assets. Across all three models, the stand-alone impact of the *Holder 67* variable remains to have a significant impact on firm performance, comparable in size as in Table 5. The result of higher firm performance if an overconfident CEO manages the firm stays around 1%, comparable to the second model. The control variables' impact also shows similar to the results in Table 5.

The last three columns of Table 7 display the results of the interaction terms on firm growth opportunities, as measured by Tobin's Q. The fourth column shows that the interaction term with higher capital expenditures shows now significant impact. In contrast, the stand-alone impact of the *Holder 67* variable does have a significant impact on firm growth opportunities. The fifth

column shows that the interaction term with higher R&D expenses has a considerable impact on Tobin's Q, which is significant at the 1% level. The coefficient of 4.542 implies that if a firm managed by an overconfident CEO raises its spending on R&D by 100%, the market will value the firm's assets, compared to their book value, 454.2% higher, than if a non-overconfident CEO would manage the firm. The last column, where both interaction terms are added, displays that both interaction terms become significant at the 1% level, thus significantly impacting firm growth opportunities. The results indicate that if firms managed by overconfident CEOs raise the levels for both Capex as well as R&D by 100%, their Tobin's Q ratio will be 5.92 points higher. This indicates that the market values the firm's assets 592% higher if an overconfident CEO manages the firm. This result implies that the market has high expectations of firm growth opportunities if their overconfident CEO raises spending's in both Capex and R&D.

Furthermore, the model shows that the *Holder 67* variable becomes insignificant, meaning that the combined effect of CEO overconfidence with higher expenditures is more critical for a firm's market valuation than just being managed by an overconfident CEO. Control variables on CEO characteristics show similar results as in Table 5. It is striking that the control variable of R&D expenses is large and significant in the fourth column while becoming insignificant when adding the interaction term of R&D expenses. This result implies that an overconfident CEO who chooses higher spending on R&D is more important for a firm's relative market valuation than just higher spending on R&D. Furthermore, prior year, Tobin's Q has a significant impact on the current year Tobin's Q. In contrast, growth opportunities are considerably more significant for smaller firms.

Overall, Table 7 shows that the combined effect of CEO overconfidence with higher firm expenditures has no significant impact on firm performance. In contrast, it does have a sizeable significant impact on firm growth opportunities. Table 6 showed that CEO overconfidence did not significantly impact R&D expenses. However, if an overconfident CEO does choose to have higher spending’s in research and development, the market values it highly, given the large impact of the interaction terms of higher expenditures with CEO overconfidence. A possible implication of this result is, that firms with high expenditures benefit by hiring an overconfident CEO. However, a more plausible explanation of the result is that firms with high expenditures choose to hire overconfident CEOs, since they can translate these expenditures into higher growth opportunities. This would indicate that CEO overconfidence is not an exogenous variable, and is influenced by

firm policy. Measured by adjusted $R^2$, the explanatory value is higher for the models testing the impact on Tobin's Q than the models testing the impact on ROA.

**Table 7: Interaction Effect of extra expenditures on firm value**

This table presents the results from OLS regressions, measuring impact of the interaction terms of CEO overconfidence and higher expenditures on ROA and Tobin's Q. Column (1), (2), (4) and (5) measure the individual impact of the independent interaction terms, while in column (3) and (6), both interaction terms are added to the models. Control variables are added to all regressions. The number of observations and adjusted R-squared can be found at the bottom All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROA | | | Tobin's Q | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Holder 67 * (Capex / Firm size) | 0.074 | | 0.069 | 0.584 | | 1.378*** |
| | (0.062) | | (0.062) | (0.499) | | (0.471) |
| Holder 67 * (R&D / Firm size) | | -0.038 | -0.032 | | 4.414*** | 4.542*** |
| | | (0.058) | (0.058) | | (0.929) | (0.929) |
| Holder 67 | 0.006* | 0.010*** | 0.008** | 0.182*** | 0.079*** | 0.018 |
| | (0.003) | (0.002) | (0.003) | (0.035) | (0.031) | (0.035) |
| CEO Age | -0.000 | -0.000 | -0.000 | 0.004 | 0.004* | 0.004* |
| | (0.000) | (0.000) | (0.000) | (0.002) | (0.002) | (0.002) |
| CEO tenure | 0.000 | 0.000 | 0.000 | -0.002 | -0.002 | -0.002 |
| | (0.000) | (0.000) | (0.000) | (0.003) | (0.003) | (0.003) |
| CEO compensation | 0.000*** | 0.000*** | 0.000*** | 0.000** | 0.000** | 0.000** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| CEO gender | -0.005 | -0.005 | -0.005 | -0.010 | -0.023 | -0.023 |
| | (0.005) | (0.006) | (0.006) | (0.077) | (0.072) | (0.072) |
| R&D / Firm size | -0.547*** | -0.515*** | -0.520*** | 4.994*** | 1.298 | 1.187 |
| | (0.050) | (0.059) | (0.059) | (1.295) | (1.006) | (1.000) |
| Capex / Firm size | -0.061 | -0.000 | -0.056 | -0.114 | 0.364 | -0.762 |
| | (0.068) | (0.051) | (0.068) | (0.467) | (0.426) | (0.464) |
| ROA (t-1) | 0.247*** | 0.247*** | 0.247*** | 0.280 | 0.271 | 0.271 |
| | (0.023) | (0.023) | (0.023) | (0.245) | (0.244) | (0.243) |
| Tobin's Q (t-1) | 0.014*** | 0.014*** | 0.014*** | 0.481*** | 0.471*** | 0.470*** |
| | (0.002) | (0.002) | (0.002) | (0.044) | (0.043) | (0.043) |
| Ln (Firm size) | -0.016*** | -0.016*** | -0.016*** | -0.365*** | -0.381*** | -0.383*** |
| | (0.003) | (0.003) | (0.003) | (0.043) | (0.045) | (0.045) |
| Ln (Cash flow) | 0.001 | 0.001 | 0.001 | 0.021* | 0.000** | 0.026** |
| | (0.001) | (0.001) | (0.001) | (0.011) | (0.000) | (0.011) |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 |
| Adjusted R-squared | 0.229 | 0.229 | 0.229 | 0.417 | 0.426 | 0.426 |

*5.5 Results Robustness Tests*

Numerous robustness checks will be conducted to test whether the results are robust to changes independent and independent variables. The first model found that the fraction of females on the board and the leverage ratio mitigated CEO overconfidence. The independent variable Gender Ratio of the board will be replaced by the binary variable Female Board Presence, which takes the value of 1 if there is at least one female on the board of directors. Results in Table 11 in the appendix show that the model is robust to a change in the independent variable since Female Board Presence still significantly impacts the dependent variable. The model with lagged (t-1) leverage in Table 11 showed that leverage still decreased CEO overconfidence, significant at the 1% level. A 100 percent increase in prior year leverage decreases *CEO moneyness* by 24.1%. The effect is slightly smaller than in the initial model but still considerable. There are thus no large concerns for reverse causality in the model.

The dependent variable *CEO moneyness* in model 1, which measures the option holding behavior of the CEO, will be replaced by the binary *Holder 67* variable used in models 2,3, and 4. In Table 12, the results, unfortunately, display that the gender ratio of the board does not have a significant mitigating effect on CEO overconfidence anymore. The nationality mix and number of directors still have no significant mitigating effect on CEO overconfidence. At the same time, the firm's leverage ratio remains to mitigate CEO overconfidence, significant at the 1% level. However, the coefficient of the leverage ratio is smaller than in Table 4 but remains to have a significant impact. The model's explanatory value that uses the *Holder 67* variable is lower than for the model that uses the *CEO moneyness* variable, denoted by adjusted $R^2$. Thus, the impact of the gender ratio of the board is not robust to a change of the proxy for CEO overconfidence, while the leverage ratio of a firm is.

For testing the impact of CEO overconfidence on firm performance and firm characteristics, the dependent firm variables will be substituted to test whether the results are robust to changes in the dependent variables. Return on equity (ROE) will act as an alternative measure for firm performance. The market-to-book ratio will act as an alternative measure for firm growth opportunities. Table 13 in the appendix displays the results of this robustness test. The *Holder 67* variable positively impacts both alternative measures, significant at the 1% level. The impact on ROE is similar to the impact on ROA. The impact on the market-to-book ratio is more significant

than the impact on Tobin's Q. This could be due to the construction of the variable since the construction of Tobin's Q adds firm size to the formula, whereas the market-to-book ratio is calculated by only the market value of assets over the book value of assets. The impact of prior year ROA on current year ROE and prior year Tobin's Q on current year market-to-book ratio show similar results as in Table 5. The results of model 2 are robust to alternative measures of dependent firm proxies for firm performance and firm growth opportunities.

The same alternative measures have been used for model 4 to test whether results are robust to changes in the dependent variables. Table 14 displays the impact of the interaction terms tested on the alternative measures ROE and market-to-book ratio. Unfortunately, Table 14 shows that the results of model 4 lose significance when changing the measure of the dependent firm variable.

As an extra robustness test, the constructed *Holder 67* proxy for CEO overconfidence will be replaced by the *Net Buyer* variable in models 2,3 and 4, in line with Malmendier & Tate (2005). The construction of Malmendier & Tate (2005) will be followed closely, and there will not be concern about the significant drop in observations. The descriptive statistics of the *Net Buyer* sample are displayed in Table 15 in the appendix. The sample size dropped from 10,447ino 4,615 observations, as was expected due to the stricter procedure of constructing the variable. The percentage of CEOs that are classified as overconfident is much smaller. 25.3% of CEOs are now considered overconfident, whereas 68.5% were considered overconfident in the *Holder 67* sample. Also, average compensation is considerably higher for CEOs classified as *Net Buyer*. Strikingly, there are no females classified as *Net Buyer* in the sample.

Table 16 in the appendix displays the results of the alternative measure for CEO overconfidence on ROA and Tobin's Q. The independent *Net Buyer* proxy for overconfidence positively impacts firm performance, as measured by ROA, and firm growth opportunities, as measured by Tobin's Q, both significant at the 1% level. Therefore, the impact of CEO overconfidence on ROA and Tobin's Q are robust to changes in the independent variable. The results are even twice as positive as the impact of the *Holder 67* variable. A plausible explanation for this could be that there is a significantly smaller percentage of CEOs classified as *Net Buyer*, concluding that the executives that remain to be labeled as overconfident have a larger impact on results compared to less overconfident executives. All control variables show similar coefficients as in Table 5. Table 17 in the appendix displays the results of the alternative measure for CEO overconfidence on Capex and R&D expenses. The results of model 3 showed that CEO

overconfidence had a significant impact on firm capital expenditures. Unfortunately, the results of Table 17 show that the impact loses significance, and therefore results are not robust to the change to the alternative *Net Buyer* independent variable. Regrettably, Table 18 shows that these results lose significance when testing with the *Net Buyer* variable. The lack of power when changing to the *Net Buyer* variable could be due to the drop in percentage of CEOs that are classified as overconfident, and it is therefore difficult to conclude whether the overconfidence bias causes it. The only remarkable result of this robustness test is that the interaction term between *Net Buyer* and capital expenditures has a significant negative effect on firm performance, as measured by the return on assets. This result implies that if overconfident CEOs engage in capital expenditures as classified by the alternative *Net Buyer* variable, their firm performance is significantly lower.

Only model 2 was robust to a change of the independent *Holder 67* proxy for CEO overconfidence to the *Net Buyer* proxy, and models 3 and 4 were not. This raises the question of whether the results are reliable or if the *Holder 67* variable is not appropriate to measure CEO overconfidence. As an extra robustness test, the *Holder 67* variable will be dropped. The independent variable used to construct the *Holder 67*, the continuous *CEO moneyness* variable, will be the independent variable to test all models. The sample is identical to the initial tests.

Table 19 in the appendix displays the impact of the independent variable *CEO moneyness* on firm performance and growth opportunities. The results show that the impact of *CEO moneyness* is still significant on both firm performance and growth opportunities. Table 19 displays the results of the third model, denoting that the results are not robust to a change of the *Holder 67* variable to the dependent *CEO moneyness* variable. Table 20 shows that the *CEO moneyness* variable does not significantly impact capital expenditures. However, it significantly decreases firm research and development expenses, although the effect of 0.1% is minimal. Finally, the alternative measure of *CEO moneyness* is also used to test the robustness of results for model 4. Table 21 displays that the interaction term of CEO overconfidence and higher R&D expenses significantly impacts Tobin's Q, signifying that increasing levels of CEO overconfidence, combined with increased spending on R&D, results in a higher market valuation. This result was also shown in the preliminary test of model 4 in Table 7, implying that this result was robust to a change of the *Holder 67* variable to the *CEO moneyness* variable. However, higher interacted levels of *CEO moneyness* and capital expenditures did not significantly impact Tobin's Q, and therefore this result was not robust to the change of the independent variable.

## 6. Discussion and limitations

As for most academic research, the generalizability of results is difficult. To explain, this thesis used a sample of S&P 1500 companies between 2000 and 2019. In contrast, the results would improve if multiple geographical locations were considered, and thus future studies could implement a global study.

Regarding the results of the models, the most significant limitation of the first part of the study is that not all board characteristics were considered. Therefore, it cannot be stated that leverage and the board's gender ratio mitigate CEO overconfidence the most; they only mitigate the CEO overconfidence bias in this thesis. Future research into mitigating firm characteristics could be enhanced if multiple firms and board characteristics are added to the model, such as the effect of independent directors and the duality of the executive on the board, to compare all possible influential variables on CEO overconfidence.

In the second part of the study, the third and fourth models lost significance in the robustness tests, and therefore these conclusions are less powerful. The sample size reduction with the construction of the *Net Buyer* can be a possible solution. However, non-robustness of results is also shown when using the continuous *CEO moneyness*, and therefore drawing clear conclusions must be tempered. Further research could enhance the robustness of results across all models in the thesis. For example, the research could add the press portrayal measure of overconfidence across all models to boost the power of the thesis results.

Furthermore, this thesis did not consider the impact of CEO-firm matching. Robust standard errors were clustered at the firm level, and several CEO and firm control variables were added to minimalize endogeneity concerns. However, it is unrealistic to expect that CEO overconfidence is an entirely exogenous independent variable in the thesis. Reasons to assume this are CEOs' behavioral traits, such as CEO overconfidence, related to corporate financial policies (Graham et al., 2013). Also, companies hire overconfident CEOs to improve growth opportunities, especially in periods of successful innovation (Galasso & Simcoe, 2011; Hirshleifer et al., 2012). This implies that firm policy is correlated with the appointment of overconfident managers, which could impact the validity of results since CEO overconfidence is not an exogenous variable. Future research could strengthen results by controlling for this, which could be highly influential.

## 7. Conclusion

The primary purpose of this thesis was to examine mitigating firm characteristics of the CEO overconfidence bias. After that, the thesis continued to investigate the effects of CEO overconfidence on firm performance and firm growth opportunities, and firm expenditures to test whether the bias must be mitigated if the impact on firms turns out to be positive. Testing multiple mitigating firm characteristics of CEO overconfidence combined with testing the bias on firm variables is not broadly examined. Therefore, this thesis contributes to the existing empirical literature.

Model 1 found that the fraction of females sitting on the board and the firm's leverage ratio significantly mitigated CEO overconfidence. The result of the gender ratio of the board was robust to changes in the independent variable. The results of model 1 indicate that firms who want to decrease the effect of CEO overconfidence must either hire more female directors to achieve an equal board or choose higher leverage. CEOs could change their option holding behavior if the firm is increasingly leveraged since leverage decreases the dependent variable *CEO moneyness*. Leverage brings the costs of financial distress, which could be why CEOs do not hold on to the options but sell them early. Malmendier & Tate (2005) found CEO sensitivity to investment cash flow in the most equity-dependent firms, indicating that overconfident CEOs avoid leveraged firms or change their option holding behavior if the firm is increasingly leveraged.

In model 2, the impact of the *Holder 67* proxy for CEO overconfidence was tested on firm performance and growth opportunities. Results display that an overconfident CEO positively impacts firm performance and firm growth opportunities. Both results are robust to a change of dependent and independent variables. The results of model 2 indicate that it would be beneficial for firms to hire overconfident CEOs, both for their performance and growth opportunities, instead of undertaking actions to mitigate the bias. However, CEO-firm matching is possible since firms can choose to hire overconfident CEOs to improve growth opportunities, especially in periods of successful innovation (Galasso & Simcoe, 2011; Hirshleifer et al., 2012). In addition, the overconfidence variable is not expected to be exogenous since the firm policy is likely to correlate with overconfident managers' appointments. Nonetheless, the results indicate it is beneficial to hire overconfident executives instead of undertaking actions to mitigate them.

In model 3, the effects of the *Holder 67* proxy for CEO overconfidence were tested on firm expenditures, measured by capital expenditures and research and development expenses, both normalized by firm size. The results show that CEO overconfidence positively impacts capital expenditures, though the effect is minimal and the results are relatively weak. CEO overconfidence does not significantly influence R&D expenses. Model 3 of the thesis did not find a clear impact of CEO overconfidence on firm expenditures. Important empirical literature on the CEO overconfidence bias by Malmendier & Tate (2005) found that overconfident CEOs had substantially higher capital expenditures. Next top of that, Hirshleifer et al. (2012) found that CEO overconfidence significantly impacted research and development expenses. The lack of finding this relation could be due to two reasons. First, the sample returned a value of 0 to observations with missing data on expenditures, which concerned quite a lot of observations in the dataset. Some firms with missing data on capital expenditures or R&D expenses probably did engage in those expenditures, while they were valued at 0 in our sample, affecting the results.

Lastly, model 4 tested the interacted impact of CEO overconfidence with higher expenditures on firm performance and growth opportunities. The constructed interaction terms are between the *Holder 67* proxy for overconfidence with capital expenditures and R&D expenses. The results show that both interaction terms do not significantly impact firm performance, measured by ROA. However, they significantly impact firm growth opportunities, measured by Tobin's Q. Unfortunately, this finding is not robust to a change of dependent variable to ROE and market-to-book and not robust to a change to the *Net Buyer* proxy for overconfidence. The lack of power when changing to the *Net Buyer* variable could be due to the drop in the percentage of CEOs classified as overconfident. It is, therefore, difficult to conclude whether the overconfidence bias causes it. However, if the independent variable is changed to *CEO moneyness*, the combined impact of CEO overconfidence and a higher level of R&D expenses is still positive for their firm's market valuation. A possible implication of this result is that firms with high expenditures benefit by hiring an overconfident CEO. However, a more plausible explanation is that firms with high expenditures choose to hire overconfident CEOs since they can translate these expenditures into higher growth opportunities. This indicates that CEO overconfidence is not an exogenous variable and is influenced by firm policy.

Overall, results show that the fraction of female directors and leverage ratio of companies mitigated CEO overconfidence. However, model 2 showed that CEO overconfidence positively

impacts firm performance and growth opportunities. Therefore, instead of undertaking actions to mitigate CEO overconfidence, it would be beneficial for firms to hire overconfident CEOs. Furthermore, as earlier noted, CEO overconfidence did not significantly impact R&D expenses. However, if an overconfident CEO does choose to have higher spending on research and development, the market values it highly. The thesis found that the CEO overconfidence bias had positive implications for firms. However, the question remains if the CEO's overconfidence provides the impact or if the firm chooses the overconfident CEO since it wants to exploit its current policy into growth opportunities. But, independent of who makes the choice that sets the overconfident CEO in its position, the impact on performance and the market valuation are positive.

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## Appendix

| **Table 8: Variance Inflation Factor (VIF) first model** | | |
|---|---|---|
| Variable | VIF | 1/VIF |
| Ln (Firm Size) | 2.40 | 0.417 |
| Female Board Presence | 2.38 | 0.420 |
| Gender Ratio | 2.30 | 0.435 |
| Number of Directors | 1.76 | 0.567 |
| R&D / Firm size | 1.58 | 0.634 |
| Tobin's Q | 1.50 | 0.667 |
| ROA | 1.50 | 0.668 |
| Cash Flow | 1.43 | 0.700 |
| CEO Tenure | 1.30 | 0.770 |
| Leverage | 1.29 | 0.778 |
| CEO Age | 1.28 | 0.780 |
| CEO Compensation | 1.11 | 0.900 |
| Nationality Mix | 1.09 | 0.919 |
| CEO Gender | 1.07 | 0.933 |
| Capex / Firm size | 1.03 | 0.969 |
| Mean VIF | 1.53 | 0.707 |

| **Table 9: Variance Inflation Factor (VID) second and third model** | | |
|---|---|---|
| Variable | VIF | 1/VIF |
| Ln (Firm Size) | 1.61 | 0.619 |
| R&D / Firm size | 1.53 | 0.654 |
| Tobin's Q | 1.49 | 0.672 |
| Cash Flow | 1.41 | 0.710 |
| CEO Tenure | 1.37 | 0.729 |
| ROA | 1.36 | 0.736 |
| CEO Age | 1.27 | 0.785 |
| Holder 67 | 1.18 | 0.845 |
| CEO Compensation | 1.10 | 0.907 |
| Capex / Firm size | 1.03 | 0.975 |
| CEO Gender | 1.01 | 0.992 |
| Mean VIF | 1.31 | 0.784 |

| **Table 10: Variance Inflation Factor (VIF) fourth model** | | |
|---|---|---|
| Variable | VIF | 1/VIF |
| Holder 67 * (Capex / Firm size) | 5.93 | 0.169 |
| Holder 67 * (R&D / Firm size) | 4.96 | 0.201 |
| R&D / Firm size | 4.86 | 0.206 |
| Capex / Firm size | 4.56 | 0.219 |
| Holder 67 | 2.70 | 0.370 |
| Ln (Firm Size) | 1.62 | 0.618 |
| Tobin's Q | 1.52 | 0.659 |
| Cash Flow | 1.41 | 0.710 |
| CEO Tenure | 1.37 | 0.729 |
| ROA | 1.36 | 0.733 |
| CEO Age | 1.27 | 0.785 |
| CEO Compensation | 1.10 | 0.907 |
| CEO Gender | 1.01 | 0.992 |
| Mean VIF | 2.59 | 0.784 |

**Table 11: Robustness tests mitigating firm effects of CEO overconfidence**

This table presents the results from OLS regressions, measuring the mitigating effect of *Female Board Presence* and lagged leverage (t-1) on CEO overconfidence, as robustness tests. The dependent variable of the model, *CEO moneyness*, is used as the measurement for CEO overconfidence. All control variables are included in the model. The number of observations and adjusted R-squared can be found at the bottom All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | Dependent variable: *CEO moneyness* | |
|---|---|---|
| | (1) | (2) |
| Female Board Presence | -0.069* | |
| | (0.041) | |
| Leverage (t-1) | | -0.241*** |
| | | (0.037) |
| CEO Age | 0.001 | 0.001 |
| | (0.003) | (0.003) |
| CEO tenure | 0.009** | 0.009** |
| | (0.003) | (0.003) |
| CEO compensation | 0.000 | 0.000 |
| | (0.000) | (0.000) |
| CEO gender | 0.119 | 0.113 |
| | (0.096) | (0.094) |
| R&D / Firm size | -1.275** | -1.384** |
| | (0.550) | (0.550) |
| Capex / Firm size | 0.290 | -0.199 |
| | (0.417) | (0.414) |
| ROA | 1.172*** | 1.023*** |
| | (0.129) | (0.127) |
| Tobin's Q | 0.259*** | 0.255*** |
| | (0.028) | (0.027) |
| Ln (Firm size) | 0.138*** | 0.135*** |
| | (0.038) | (0.039) |
| Ln (Cash flow) | -0.025* | -0.030** |
| | (0.013) | (0.013) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 10,447 | 10,447 |
| Adjusted R-squared | 0.220 | 0.228 |

**Table 12: Robustness check mitigating firm characteristics of CEO overconfidence**

This table presents the results from OLS regressions, measuring mitigating effects of firm characteristics on an alternative measure for CEO overconfidence. The alternative *Holder 67* variable will be used as dependent variable. Columns (1) to (4) are used to measure the stand-alone impact of the different firm characteristics on *CEO moneyness*. Column (5) reports results of all firm characteristics combined. The number of observations and adjusted R-squared can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | Dependent variable: *Holder 67* | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Gender Ratio | 0.163 | | | | 0.155 |
| | (0.101) | | | | (0.100) |
| Number of Directors | | 0.002 | | | 0.002 |
| | | (0.005) | | | (0.005) |
| Nationality Mix | | | 0.014 | | 0.004 |
| | | | (0.068) | | (0.067) |
| Leverage | | | | -0.163*** | -0.163*** |
| | | | | (0.022) | (0.022) |
| CEO Age | 0.003 | 0.003 | 0.004 | 0.003 | 0.003 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| CEO tenure | 0.023*** | 0.023*** | 0.023*** | 0.023*** | 0.032*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| CEO compensation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| CEO gender | 0.033 | 0.019 | 0.020 | 0.021 | 0.033 |
| | (0.073) | (0.072) | (0.072) | (0.070) | (0.071) |
| R&D / Firm size | 0.094 | 0.084 | 0.091 | -0.001 | 0.001 |
| | (0.203) | (0.203) | (0.203) | (0.197) | (0.197) |
| Capex / Firm size | 0.861*** | 0.869*** | 0.867*** | 0.716*** | 0.714*** |
| | (0.183) | (0.183) | (0.183) | (0.180) | (0.180) |
| ROA | 0.319*** | 0.319*** | 0.319*** | 0.137* | 0.138* |
| | (0.074) | (0.075) | (0.075) | (0.076) | (0.076) |
| Tobin's Q | 0.056*** | 0.056*** | 0.056*** | 0.054*** | 0.054*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| Ln (Firm size) | 0.056*** | 0.053** | 0.055*** | 0.068*** | 0.068*** |
| | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) |
| Ln (Cash flow) | 0.004 | 0.003 | 0.003 | 0.001 | 0.002 |
| | (0.007) | (0.007) | (0.007) | (0.006) | (0.006) |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 |
| Adjusted R-squared | 0.167 | 0.166 | 0.166 | 0.179 | 0.180 |

**Table 13: Effect Holder 67 on alternative firm performance measures**

This table presents the results from OLS regressions, measuring the impact of the Holder 67 proxy for CEO overconfidence on ROE and the market-to-book ratio. Column (1) and (2) have all the control variables included in the model. The number of observations and adjusted $R^2$ can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROE | Market-to-book |
|---|---|---|
| | (1) | (2) |
| Holder 67 | 0.013*** | 0.541*** |
| | (0.003) | (0.072) |
| CEO Age | -0.000 | -0.013* |
| | (0.000) | (0.008) |
| CEO tenure | 0.000 | 0.005 |
| | (0.000) | (0.008) |
| CEO compensation | 0.000*** | 0.000* |
| | (0.000) | (0.000) |
| CEO gender | 0.001 | 0.129 |
| | (0.007) | (0.235) |
| R&D/ Firm size | -0.305*** | 0.105 |
| | (0.061) | (1.414) |
| Capex/ Firm size | -0.013 | 2.185* |
| | (0.065) | (1.123) |
| ROA (t-1) | 0.230*** | -0.461 |
| | (0.025) | (0.429) |
| Tobin's Q (t-1) | 0.003** | 0.451*** |
| | (0.001) | (0.062) |
| Ln (Firm size) | -0.005 | -0.559*** |
| | (0.004) | (0.100) |
| Ln (Cash flow) | -0.000 | 0.026 |
| | (0.001) | (0.028) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 10,447 | 10,447 |
| Adjusted R-squared | 0.086 | 0.170 |

**Table 14: Interaction Effect of extra expenditures on alternative measures for firm value**

This table presents the results from OLS regressions, measuring impact of the interaction terms of CEO overconfidence and higher expenditures on alternative measures ROE and market-to-book ratio. Column (1), (2), (4) and (5) measure the individual impact of the independent interaction terms, while in column (3) and (6), both interaction terms are added to the models. Control variables are added to all regressions. The number of observations and adjusted $R^2$ can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROE | | | Market-to-book | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Holder 67 * (Capex / Firm size) | 0.114<br>(.103) | | 0.133<br>(0.104) | 2.153*<br>(1.278) | | 2.039<br>(1.311) |
| Holder 67 * (R&D / Firm size) | | 0.097<br>(0.084) | 0.109<br>(0.084) | | -0.842<br>(1.300) | -0.669<br>(1.321) |
| Holder 67 | 0.008<br>(0.005) | 0.010**<br>(0.004) | 0.004<br>(0.006) | 0.452***<br>(0.090) | 0.565***<br>(0.079) | 0.476***<br>(0.101) |
| CEO Age | -0.000<br>(0.000) | -0.000<br>(0.000) | -0.000<br>(0.000) | -0.014*<br>(0.008) | -0.014*<br>(0.008) | -0.014*<br>(0.008) |
| CEO tenure | 0.000<br>(0.000) | 0.000<br>(0.000) | 0.000<br>(0.000) | 0.005<br>(0.008) | 0.005<br>(0.008) | 0.005<br>(0.008) |
| CEO compensation | 0.000***<br>(0.000) | 0.000***<br>(0.000) | 0.000***<br>(0.000) | 0.000*<br>(0.000) | 0.000*<br>(0.000) | 0.000*<br>(0.000) |
| CEO gender | 0.002<br>(0.007) | 0.001<br>(0.007) | 0.001<br>(0.007) | 0.128<br>(0.235) | 0.129<br>(0.235) | 0.129<br>(0.235) |
| R&D / Firm size | -0.306***<br>(0.061) | -0.387***<br>(0.086) | -0.398***<br>(0.086) | 0.099<br>(1.410) | 0.810<br>(1.695) | 0.647<br>(1.705) |
| Capex / Firm size | -0.107<br>(0.115) | -0.014<br>(0.066) | -0.122<br>(0.116) | 0.425<br>(1.494) | 2.185*<br>(1.120) | 0.518<br>(1.511) |
| ROA (t-1) | 0.230***<br>(0.025) | 0.230***<br>(0.025) | 0.230***<br>(0.025) | -0.459<br>(0.429) | -0.459<br>(0.428) | -0.458<br>(0.429) |
| Tobin's Q (t-1) | 0.003**<br>(0.001) | 0.003**<br>(0.001) | 0.003**<br>(0.001) | 0.451***<br>(0.062) | 0.453***<br>(0.062) | 0.453***<br>(0.062) |
| Ln (Firm size) | -0.005<br>(0.004) | -0.006*<br>(0.004) | -0.006*<br>(0.004) | -0.561***<br>(0.100) | -0.556***<br>(0.100) | -0.558***<br>(0.100) |
| Ln (Cash flow) | -0.000<br>(0.000) | -0.000<br>(0.000) | -0.000<br>(0.000) | 0.026<br>(0.028) | 0.025<br>(0.029) | 0.025<br>(0.029) |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 |
| Adjusted R-squared | 0.086 | 0.087 | 0.087 | 0.170 | 0.170 | 0.170 |

**Table 15: Descriptive statistics Net Buyer**

This table presents the descriptive statistics of all dependent, independent and control variables that are used for the analyses. The sample period for all models is 2000-2019. The top table lists the number of observations, the mean value, the standard deviation, the minimum and maximum value, and the median value for all variables. The table below shows the differences between CEO's that are classified as overconfident (if the binary *NetBuyer* variable is (1) and CEO's that are not, with their corresponding mean value and standard deviation for all variables.

| Variable | N | Mean | S.D. | Min | Median | Max |
|---|---|---|---|---|---|---|
| Net Buyer * (Capex / Firm size) | 4,615 | 0.010 | 0.026 | 0 | 0.021 | 0.345 |
| Net Buyer * (R&D / Firm size) | 4,615 | 0.010 | 0.031 | 0 | 0 | 0.599 |
| CEO Age | 4,615 | 55.184 | 6.944 | 32 | 55 | 85 |
| CEO Tenure | 4,615 | 7.771 | 6.718 | 0.539 | 7.502 | 23.666 |
| CEO Compensation | 4,615 | 1252.082 | 1831.018 | 0 | 945.75 | 43511.54 |
| CEO Gender | 4,615 | 0.023 | 0.151 | 0 | 0 | 1 |
| Capex / Firm size | 4,615 | 0.042 | 0.041 | 0 | 0.030 | 0.399 |
| R&D / Firm size | 4,615 | 0.036 | 0.062 | 0 | 0.007 | 1.165 |
| ROA | 4,615 | 0.062 | 0.085 | -0.379 | 0.063 | 0.291 |
| Tobin's Q | 4,615 | 2.180 | 1.413 | 0.345 | 1.756 | 19.549 |
| ROE | 4,615 | 0.036 | 0.090 | -0.606 | 0.049 | 0.206 |
| Market-to-book | 4,615 | 3.485 | 2.579 | 0.758 | 2.667 | 11.042 |
| Firm Size | 4,615 | 13338.68 | 49965.14 | 7.702 | 2568.551 | 797769 |
| Cash Flow | 4,615 | 272.395 | 1188.631 | 0 | 15.794 | 36112 |
| Net Buyer | 4,615 | 0.253 | 0.435 | 0 | 0 | 1 |

| | Overconfident CEO's *Net Buyer* = 1 | | | Non-overconfident CEO's *Net Buyer* = 0 | | |
|---|---|---|---|---|---|---|
| Variable | N | Mean | S.D. | N | Mean | S.D. |
| Net Buyer * (Capex / Firm size) | 1,169 | 0.040 | 0.040 | 3,446 | 0 | 0 |
| Net Buyer * (R&D / Firm size) | 1,169 | 0.039 | 0.052 | 3,446 | 0 | 0 |
| CEO Age | 1,169 | 56.656 | 6.797 | 3,446 | 55.363 | 6.683 |
| CEO Tenure | 1,169 | 7.014 | 1.048 | 3,446 | 8.027 | 4.390 |
| CEO Compensation | 1,169 | 1471.477 | 3055.279 | 3,446 | 1177.655 | 1141.727 |
| CEO Gender | 1,169 | 0 | 0 | 3,446 | 0.031 | 0.173 |
| Capex / Firm size | 1,169 | 0.040 | 0.040 | 3,446 | 0.042 | 0.042 |
| R&D / Firm size | 1,169 | 0.039 | 0.052 | 3,446 | 0.029 | 0.064 |
| ROA | 1,169 | 0.067 | 0.086 | 3,446 | 0.030 | 0.084 |
| Tobin's Q | 1,169 | 2.182 | 1.287 | 3,446 | 2.180 | 1.453 |
| ROE | 1,169 | 0.036 | 0.097 | 3,446 | 0.036 | 0.087 |
| Market-to-book | 1,169 | 3.570 | 2.571 | 3,446 | 3.457 | 2.582 |
| Firm Size | 1,169 | 13079.25 | 35630.83 | 3,446 | 13426.68 | 53974.07 |
| Cash Flow | 1,169 | 348.428 | 1600.451 | 3,446 | 246.602 | 1010.545 |

**Table 16: Effect Net Buyer on firm performance measures**

This table presents the results from OLS regressions, measuring the impact of the alternative *Net Buyer* proxy for CEO overconfidence on ROA and Tobin's Q. Column (1) and (2) have all the control variables included in the model. The number of observations and adjusted R-squared can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROA | Tobin's Q |
|---|---|---|
| | (1) | (2) |
| Net Buyer | 0.023*** | 0.399*** |
| | (0.005) | (0.141) |
| CEO Age | 0.004*** | 0.009 |
| | (0.001) | (0.017) |
| CEO tenure | -0.003*** | 0.034 |
| | (0.001) | (0.022) |
| CEO compensation | 0.000 | 0.000 |
| | (0.000) | (0.000) |
| CEO gender | -0.079*** | 0.788 |
| | (0.014) | (0.682) |
| R&D / Firm size | -0.518*** | 2.730 |
| | (0.144) | (1.670) |
| Capex / Firm size | 0.156** | 0.396 |
| | (0.067) | (0.824) |
| ROA (t-1) | 0.209*** | 0.393 |
| | (0.034) | (0.279) |
| Tobin's Q (t-1) | 0.014*** | 0.456*** |
| | (0.005) | (0.093) |
| Ln (Firm size) | -0.011* | -0.465*** |
| | (0.006) | (0.078) |
| Ln (Cash flow) | 0.001 | 0.005 |
| | (0.001) | (0.016) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 4.615 | 4.615 |
| Adjusted R-squared | 0.227 | 0.375 |

**Table 17: Effect Net Buyer on firm expenditures**

This table presents the results from OLS regressions, measuring the impact of the alternative *Net Buyer* proxy for CEO overconfidence on capital expenditures and research and development expenses, both normalized by firm size. Column (1) and (2) have all the control variables included in the model. The number of observations and adjusted R-squared can be found at the bottom All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | Capex / Firm size | R&D / Firm size |
|---|---|---|
| | (1) | (2) |
| Net Buyer | -0.003 | 0.002 |
| | (0.004) | (0.002) |
| CEO Age | 0.000 | 0.001* |
| | (0.000) | (0.000) |
| CEO tenure | -0.001** | -0.000 |
| | (0.000) | (0.000) |
| CEO compensation | 0.000 | 0.000*** |
| | (0.000) | (0.000) |
| CEO gender | -0.004 | -0.027** |
| | (0.003) | (0.011) |
| R&D / Firm size (t-1) | -0.011 | 0.201** |
| | (0.011) | (0.081) |
| Capex / Firm size (t-1) | 0.302*** | 0.018 |
| | (0.044) | (0.017) |
| ROA | 0.024*** | -0.115*** |
| | (0.009) | (0.030) |
| Tobin's Q | 0.002*** | 0.003* |
| | (0.000) | (0.002) |
| Ln (Firm size) | -0.004** | -0.016*** |
| | (0.002) | (0.004) |
| Ln (Cash flow) | 0.000 | 0.001 |
| | (0.000) | (0.000) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 4,615 | 4,615 |
| Adjusted R-squared | 0.158 | 0.182 |

**Table 18: Interaction Effect of extra expenditures on firm value**

This table presents the results from OLS regressions, measuring impact of the interaction terms of CEO overconfidence and higher expenditures on ROA and Tobin's Q, with the alternative *Net Buyer* variable. Column (1), (2), (4) and (5) measure the individual impact of the independent interaction terms, while in column (3) and (6), both interaction terms are added to the models. Control variables are added to all regressions. The number of observations and adjusted $R^2$ can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROA | | | Tobin's Q | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Net Buyer * (Capex / Firm size) | -0.251** | | -0.234* | -1.441 | | -1.361 |
| | (0.127) | | (0.130) | (1.782) | | (1.816) |
| Net Buyer * (R&D / Firm size) | | -0.247 | -0.236 | | -1.184 | -1.118 |
| | | (0.241) | (0.244) | | (2.728) | (2.758) |
| Net Buyer | 0.033*** | 0.031*** | 0.040*** | 0.461*** | 0.438** | 0.495*** |
| | (0.008) | (0.008) | (0.009) | (0.171) | (0.171) | (0.187) |
| CEO Age | 0.004*** | 0.005*** | 0.005*** | 0.008 | 0.010 | 0.010 |
| | (0.001) | (0.001) | (0.001) | (0.016) | (0.017) | (0.017) |
| CEO tenure | -0.002*** | -0.003*** | -0.002*** | 0.036 | 0.033 | 0.035 |
| | (0.001) | (0.001) | (0.001) | (0.022) | (0.023) | (0.023) |
| CEO compensation | 0.000* | 0.000* | 0.000* | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| CEO gender | -0.081*** | -0.080*** | -0.081*** | 0.778 | 0.786 | 0.777 |
| | (0.014) | (0.014) | (0.015) | (0.668) | (0.683) | (0.669) |
| R&D / Firm size | -0.518*** | -0.475*** | -0.477*** | 2.729 | 2.936 | 2.923 |
| | (0.144) | (0.154) | (0.155) | (1.671) | (1.988) | (1.989) |
| Capex / Firm size | 0.205** | 0.156** | 0.203** | 0.681 | 0.393 | 0.668 |
| | (0.081) | (0.067) | (0.081) | (1.019) | (0.826) | (1.020) |
| ROA (t-1) | 0.208*** | 0.209*** | 0.208*** | 0.387 | 0.456 | 0.387 |
| | (0.034) | (0.035) | (0.035) | (0.276) | (0.280) | (0.277) |
| Tobin's Q (t-1) | 0.014*** | 0.014** | 0.014*** | 0.457*** | 0.456*** | 0.457*** |
| | (0.005) | (0.005) | (0.005) | (0.093) | (0.094) | (0.093) |
| Ln (Firm size) | -0.011* | -0.012* | -0.012* | -0.465*** | -0.467*** | -0.467*** |
| | (0.006) | (0.006) | (0.006) | (0.078) | (0.079) | (0.079) |
| Ln (Cash flow) | 0.001 | 0.001 | 0.001 | 0.005 | 0.006 | 0.006 |
| | (0.001) | (0.001) | (0.001) | (0.016) | (0.016) | (0.016) |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 4.615 | 4.615 | 4.615 | 4.615 | 4.615 | 4.615 |
| Adjusted R-squared | 0.228 | 0.228 | 0.229 | 0.376 | 0.376 | 0.376 |

**Table 19: Effect alternative measure *CEO moneyness* on firm value**

This table presents the results from OLS regressions, measuring the impact of the alternative measure *CEO moneyness* for CEO overconfidence on ROA and Tobin's Q. Column (1) and (2) have all the control variables included in the model. The number of observations and adjusted $R^2$ can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROA | Tobin's Q |
|---|---|---|
| | (1) | (2) |
| *CEO moneyness* | 0.013*** | 0.342*** |
| | (0.001) | (0.024) |
| CEO Age | -0.000 | 0.004 |
| | (0.000) | (0.002) |
| CEO tenure | 0.000 | -0.000 |
| | (0.000) | (0.003) |
| CEO compensation | 0.000*** | 0.000 |
| | (0.000) | (0.000) |
| CEO gender | -0.006 | -0.048 |
| | (0.005) | (0.076) |
| R&D / Firm size | -0.538*** | 5.213*** |
| | (0.050) | (1.267) |
| Capex / Firm size | -0.003 | 0.408 |
| | (0.051) | (0.411) |
| ROA (t-1) | 0.237*** | 0.006 |
| | (0.023) | (0.242) |
| Tobin's Q (t-1) | 0.013*** | 0.447*** |
| | (0.002) | (0.043) |
| Ln (Firm size) | -0.016*** | -0.363*** |
| | (0.003) | (0.041) |
| Ln (Cash flow) | 0.001 | 0.029 |
| | (0.001) | (0.011) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 10,447 | 10,447 |
| Adjusted R-squared | 0.243 | 0.468 |

**Table 20: Effect alternative measure *CEO moneyness* on firm expenditures**

This table presents the results from OLS regressions, measuring the impact of the alternative measure *CEO moneyness* for CEO overconfidence on capital expenditures and research and development expenses, both normalized by firm size. Column (1) and (2) have all the control variables included in the model. The number of observations and adjusted R-squared can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | Capex / Firm size | R&D / Firm size |
|---|---|---|
| | (1) | (2) |
| *CEO moneyness* | 0.000 | -0.001** |
| | (0.000) | (0.001) |
| CEO Age | 0.000 | -0.000 |
| | (0.000) | (0.000) |
| CEO tenure | 0.000 | 0.000 |
| | (0.000) | (0.000) |
| CEO compensation | 0.000** | 0.000*** |
| | (0.000) | (0.000) |
| CEO gender | -0.003 | 0.000 |
| | (0.002) | (0.002) |
| R&D / Firm size (t-1) | -0.016* | 0.331*** |
| | (0.009) | (0.058) |
| Capex / Firm size (t-1) | 0.310*** | 0.007 |
| | (0.037) | (0.011) |
| ROA | 0.011 | -0.103*** |
| | (0.007) | (0.019) |
| Tobin's Q | 0.002*** | 0.006*** |
| | (0.000) | (0.001) |
| Ln (Firm size) | -0.004*** | -0.012*** |
| | (0.001) | (0.002) |
| Ln (Cash flow) | 0.000 | 0.000 |
| | (0.000) | (0.000) |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 10,447 | 10,447 |
| Adjusted R-squared | 0.177 | 0.281 |

**Table 21: Interaction Effect of extra expenditures on firm value with alternative measure *CEO moneyness***
This table presents the results from OLS regressions, measuring impact of the interaction terms of the alternative measure *CEO moneyness* for CEO overconfidence and higher expenditures on ROA and Tobin's Q. Column (1), (2), (4) and (5) measure the individual impact of the independent interaction terms, while in column (3) and (6), both interaction terms are added to the models. Control variables are added to all regressions. The number of observations and adjusted R-squared can be found at the bottom. All models include year and industry fixed effects, based on SIC-codes, and robust standard errors are clustered at the firm level and shown in parentheses. Statistical significance is displayed by asterisks *** p<0.01, **p<0.05 and *p<0.01.

| | ROA | | | Tobin's Q | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *CEO moneyness* * (Capex / Firm size) | -0.015 | | -0.013 | 0.009 | | 0.356 |
| | (0.023) | | (0.023) | (0.353) | | (0.370) |
| *CEO moneyness* * (R&D / Firm size) | | 0.014 | 0.013 | | 2.242*** | 2.261*** |
| | | (0.015) | (0.016) | | (0.713) | (0.717) |
| *CEO moneyness* | 0.014*** | 0.013*** | 0.013*** | 0.342*** | 0.248*** | 0.229*** |
| | (0.002) | (0.001) | (0.002) | (0.030) | (0.027) | (0.036) |
| CEO Age | -0.000 | -0.000 | -0.000 | 0.004 | 0.005** | 0.005** |
| | (0.000) | (0.000) | (0.000) | (0.002) | (0.002) | (0.002) |
| CEO tenure | 0.000 | 0.000 | 0.000 | -0.000 | -0.002 | -0.002 |
| | (0.000) | (0.000) | (0.000) | (0.003) | (0.003) | (0.003) |
| CEO compensation | 0.000*** | 0.000*** | 0.000*** | 0.000 | 0.000 | 0.000* |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| CEO gender | -0.007 | -0.007 | -0.007 | -0.048 | -0.064 | -0.060 |
| | (0.005) | (0.005) | (0.005) | (0.076) | (0.071) | (0.070) |
| R&D / Firm size | -0.538*** | -0.554*** | -0.552*** | 5.212*** | 2.670* | 2.630* |
| | (0.050) | (0.055) | (0.055) | (1.267) | (1.384) | (1.382) |
| Capex / Firm size | 0.016 | 0.003 | 0.014 | 0.401 | 0.418 | 0.113 |
| | (0.052) | (0.051) | (0.052) | (0.490) | (0.415) | (0.478) |
| ROA (t-1) | 0.236*** | 0.237*** | 0.237*** | 0.006 | 0.015 | 0.021 |
| | (0.023) | (0.023) | (0.023) | (0.242) | (0.243) | (0.244) |
| Tobin's Q (t-1) | 0.013*** | 0.013*** | 0.013*** | 0.448*** | 0.437*** | 0.438*** |
| | (0.002) | (0.002) | (0.002) | (0.043) | (0.042) | (0.042) |
| Ln (Firm size) | -0.016*** | -0.016*** | -0.016*** | -0.363*** | -0.369*** | -0.368*** |
| | (0.003) | (0.003) | (0.003) | (0.041) | (0.043) | (0.043) |
| Ln (Cash flow) | 0.001 | 0.001 | 0.001 | 0.029** | 0.032*** | 0.032 |
| | (0.001) | (0.001) | (0.001) | (0.011) | (0.011) | (0.011) |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 | 10,447 |
| Adjusted R-squared | 0.243 | 0.243 | 0.243 | 0.468 | 0.491 | 0.491 |