CEO Overconfidence and Firm Performance During COVID-19

An examination of the effect of CEO overconfidence on firm performance and investment during the COVID-19 crisis

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Abstract

This study aims to examine the relationship between CEO overconfidence and firm performance as well as level of corporate investment during times of crisis. With data from 2013 – 2021, CEO overconfidence during the recent COVID-19 pandemic is studied. After several OLS regressions a negative relationship between Tobin's Q and CEO overconfidence is proven. Subsequently, a positive relationship between level of investment and CEO overconfidence is indicated. This research contributes to several fields within behavioural economics and further develops the research domain on CEO overconfidence and firm performance.

Keywords: CEO Overconfidence, Firm Performance, Investment, COVID-19, Crisis

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Disclaimer

"The content of this thesis is the sole responsibility of the author and does not reflect the view of either the supervisor, second assessor, Erasmus School of Economics or Erasmus University."

1. Introduction

Overconfidence is a behavioural trait visible in everyday life. Daniel Kahneman (2011) even goes so far as stating that overconfidence is "the most significant of the cognitive biases". It is also a trait most of us possess. Ola Svenson (1981) proved this with her experimental study, which found that 93 percent of U.S. drivers claim they are better at driving than the median, which is statistically impossible. In this thesis, the behavioural trait of overconfidence is examined in a business environment.

Central in this business environment are CEOs. Empirical evidence indicates that the effect of the personality trait overconfidence is especially greater for CEOs than for the rest of the population (Gervais, Heaton & Odean, 2011) and although this CEO overconfidence might directly spark the assumption of a negative relationship, it can also be beneficial at times. Researchers noted that a certain degree of confidence is essential for business success as confident CEOs tend to increase self-esteem and feelings of self-worth within the workforce (Koehler et al.,2002). Multiple studies have shown that these important traits contributing to a person's general well-being ultimately contribute to better firm performance (Peterson et al., 2009; O'Reilly et al., 2014). On the other hand, researchers also shed light on the negative side of CEO overconfidence. They find that excessive overconfidence can result in improper assessments of risk and investment valuation, leading to suboptimal decision-making (Dittrich et al., 2005). The previous literature in this field is thus unclear about the directionality of this relationship. To further examine this phenomenon and give more insight on the directionality of this relationship, a sample with firm-CEO years from 2018 to 2020 is examined in this study. With this sample, the effect of CEO overconfidence on firm performance during COVID-19 can be tested. This pandemic has held the world in captivity since 2020 and although vaccination programs are established at a fast pace, a return to the "old normal" is still far away. The results of this test will further clarify how CEO overconfidence will affect firm performance, especially in tough economic times. This can then direct further research to eventually understand the entire relationship – both in difficult and prosperous economic times - between CEO overconfidence and firm performance.

This study proposes a negative relationship between CEO overconfidence and firm performance during COVID-19. This proposal is based on previous studies of multiple

researchers (E.g. Dittrich et al., 2005; Svenson, 1981; Thakor, 2008), and is supported by theoretical reasoning. This reasoning suggests that an overconfident CEO might be willing to pursue risky investments despite the pandemic and poor economic decisions. This potentially causes further deterioration of company performance. Given that the COVID-19 pandemic is an exogenous crisis, caution is required when a company is led by an overconfident CEO. Overconfident CEOs who pursued a high-risk but high-value investment before the pandemic outbreak were not able to incorporate the COVID-19 crisis in their (limited) risk analysis. This extra component of COVID-19 risk on top of their already high-risk strategy might negatively affect the firm's overall performance.

In addition, the assumption that CEO overconfidence increases investment levels during COVID-19 crisis is tested. To test the hypotheses multiple OLS regressions are performed on level of investment and several firm performance measures. For the quantification of CEO overconfidence, I follow the well-cited article by Malmendier and Tate (2005). The proxies, Net Buyer and Holder67, investigate share and option acquisition behaviour of CEOs as indication for their overconfidence level. Net buyer considers a CEO as overconfident if he or she has bought additional company shares in a year more than two times in a five-year sequence. To alleviate endogeneity and non-transitory concerns, only CEOs with a tenure longer than five years are taken into account and the first five years of their tenure are not used. Holder67 considers a CEO overconfident if he or she persistently withholds from exercising options that are in-the-money. This namely means that the CEO is convinced that under his leadership, the stock price will keep rising and he wants to profit from this expected price increase by holding the options. To establish a minimum threshold after which options are considered "enough" in-the-money, Malmendier and Tate look at a theoretical framework constructed by Hall and Murphy (2002). The writers eventually settle on 67% in-the-money as a threshold, and this threshold is used in this article for consistency matters as well.

The results report that overconfident CEOs negatively affect Tobin's Q by -0.077 and -0.148 for net buyer CEOs and holder67 CEOs respectively. The study also finds support for the second hypothesis arguing that CEO overconfidence has a positive effect on the amount of investment during the COVID-19 crisis as results do only show a significant relationship for Holder67. Previous studies have found a relationship between CEO overconfidence and investment levels (e.g. Glaser & Weber, 2010). I find this relationship as well, but in interaction with the crisis dummy I only find support in the regression on Holder 67 (0.004^{**}). This does

suggest that macro-economic fluctuations like the pandemic do affect or increase the severity of the relationship between CEO overconfidence and investment levels. As a robustness test, a propensity score matching model is constructed. This model resulted in a similar negative relationship for Tobin's Q (-0.102^{***}) and positive insignificant coefficient for Investment and strengthened the findings for the first hypothesis.

This thesis contributes to the academic literature by including data from recent years and specifically examining the impact of CEO overconfidence in a period of crisis. In addition, the paper adds to the research by Malmendier and Tate (2005) by looking at firm performance rather than only corporate investment. This research could also potentially have implications for further firm decisions. If firms want to hire a CEO, they must consider the possibility that another pandemic or crisis hits the financial markets. This research indicates that overconfident CEOs further deteriorate firm performance in these times. Bearing this in mind, the outcomes of the study might thus persuade firms to choose a non-overconfident CEO for challenging times. The research also suggests that when firms are hiring a CEO and consider the risk of entering crisis years, they have to incorporate the risk of an overconfident CEO increasing the level of (risky) investment significantly more than a non-overconfident CEO.

The remainder of this thesis is structured as follows. In the next chapter the relevant literature on CEO overconfidence, investment and crisis is reviewed. In chapter 3 and 4 the methodology, data and hypotheses will be discussed. Chapter 5 focusses on the results of the analysis. Chapter 6 focusses on robustness tests and the last chapter concludes and elaborates on limitations of this thesis. In addition, suggestions for further research will be made.

2. Literature Review

To elaborate on the relationship between overconfident CEO's and firm performance, I first examine the previous literature on this relationship.

2.1 Overconfidence

Among many behavioural researchers, Daniel Kahneman (2011) states that overconfidence is "the most significant of the cognitive biases". Ola Svenson (1981) confirms this, finding that overconfidence is one of the largest and most appearing of the many psychological biases to which individual judgement is exposed. In her experimental study, 93 percent of U.S. drivers claim they are better at driving than the median, which is statistically impossible. Overconfidence is also associated with the belief of a person to be superior and better than others. When individuals rate themselves above the median, this phenomenon is called *the better-than-average effect* (Moore & Healy, 2008). In addition, overconfidence leads to an excessive certainty about the accuracy of one's own predictions (Benos, 1998). If the accuracy of one's judgements exceeds the objective standards, the person is considered overconfident (Tang, Li &Yang, 2015). Psychologists also determine that overconfidence leads to an underestimation of risk and an exaggeration of one's level of control. A high locus of control reflects the belief of a person to control events (Hiller & Hambrick, 2005). Furthermore, overconfident individuals believe they will experience more positive events and less negative events than the average person in the future (Weinstein, 1980).

2.2 CEO Overconfidence

Empirical evidence indicates that the effect of the personality trait overconfidence is especially greater for CEOs than for the rest of the population (Gervais, Heaton & Odean, 2011). For example, a paper by Goel and Thakor (2008) specifically addresses overconfidence among CEOs. The authors propose a CEO selection model. They suggest that when appointing CEOs, the selection is made based on a specific set of characteristics. With the selection process favouring these specific characteristics, CEOs will predominantly display these. When managers are competing for promotion, the one who is overconfident has the highest chance of becoming CEO. This leads to the subsequent conclusion that CEOs are more likely and more incentivized to be overconfident. In line with this, Graham, Harvey, and Puri (2013) surveyed 1,180 CEOs and found that CEOs are more likely to be risk-tolerant and optimistic than people in the general population.

In finance and economics, the implications of managerial overconfidence have gradually become an area of interest over the years. Empirical evidence has shown that managerial traits such as risk aversion and optimism are highly related to corporate decision-making and that the identity of the CEO matters for firm performance (Bertrand & Schoar, 2003; Kaplan et al. 2012). Ben-David, Graham, and Harvey (2007) support this belief and argue that overconfidence depends on personal characteristics.

Interestingly enough, previous research addresses both positive and negative effects of overconfidence. On the one hand, researchers noted that a certain degree of confidence is essential for business success as confident CEOs tend to increase self-esteem and feelings of self-worth within the workforce (Koehler et al.,2002). Multiple studies have shown that these important traits contributing to a person's general well-being ultimately contribute to better firm performance (Peterson et al., 2009; O'Reilly et al., 2014). Moreover, an optimistic CEO who is less risk averse can be desirable when high-risk but high-value investments should be made (e.g., Hirschleifer et al., 2012; Graham et al., 2013). Hirshleifer, Low, and Teoh (2012) also find a relation between the degree of managerial overconfidence and innovation level. Their findings show a positive relation for a company's innovation performance, implying that firms with managerial overconfidence tend to invest more in innovative ideas. Goel and Thakor (2008), argue that overconfidence, or moderating biases, could enhance the value by decreasing effects of aversion to risks. A slightly different approach on overconfidence targets managerial compensation. Otto (2014), stresses that it could be beneficial for the value of the firm to have overconfident managers, when their compensation packages are related to the firm's equity value.

On the other hand, researchers also shed light on the negative side of CEO overconfidence. They find that excessive overconfidence can result in improper assessments of risk and investment valuation, leading to suboptimal decision-making (Dittrich et al., 2005). Based on the 'miscalibration' effect introduced by Svenson (1981), Ben-David et al. (2007) examined the impact of overconfidence by developing a behavioural finance model that tests whether top executives are mis calibrated (a common measure of overconfidence) and whether this observed miscalibration affects corporate investment and financial decisions. The results indicate that CFOs are on average mis calibrated in assessing the risk-return relationship of investments. If so, this natural behaviour of top executives in the investment context should be

restrained as it negatively affects investments decision-making (Glaser & Weber, 2010). Goel and Thakor (2008) moderate between negative and positive influences of overconfident CEOs. They claim that when the overconfidence of the CEO is moderate, it can bring beneficial consequences to the firm but, when this behaviour becomes too extreme, the company could suffer from it.

2.3 CEO Overconfidence and Investments

Overconfident CEOs complete more mergers and acquisitions, while investors are more sceptical about these mergers when the CEO is seen as overconfident (Malmendier and Tate, 2005). This follows the reasoning of Roll (1986), stating that hubris makes CEOs over-valuate deal synergies resulting in money-losing acquisitions. As for capital structure, overconfident managers tend to view their stocks as undervalued and therefore have a higher tendency to invest with internal funds (Malmendier and Tate, 2005). Banerjee et al. (2013) find that overconfident CEOs view their company to be undervalued by the market and therefore engage in more share repurchasing activities, thereby trying to increase the share price. In line with previous findings Ben-David et al. (2007) find that overconfident CEOs have higher debt levels, pay-out less dividends and have more performance-based executive compensation.

Regarding M&A volumes, Malmendier and Tate (2008) empirically studied CEO overconfidence and M&A and concluded that there is evidence that overconfident CEOs are 62% more likely to engage in mergers and acquisitions than non-overconfident ones. However other studies indicate that overconfident CEOs tend to believe that their firm is undervalued by investors and this could lead to wanting to avoid taking external funding, since this is essentially giving partial ownership to outsiders who could then also benefit from this undervaluation. This results in less M&A deals (Roll, 1986).

The previous literature suggests that the psychological phenomenon of overconfidence could prevent managers from making rational decisions. While CEOs have the incentive to maximize firm value, certain behavioural impediments will undermine this value creation. These behavioural obstacles could be internal such as behavioural costs, which are costs associated with managerial valuation errors. The valuation errors are made due to cognitive imperfections or emotional effects. Such behavioural influences could drive managers to make investments that are suboptimal for the firm value (Shefrin, 2001). As discussed, researchers are still not clear whether CEO overconfidence has on balance a negative or positive effect on firm

performance. Of interest for my thesis is the effect of CEO overconfidence on firm performance during the COVID-19 crisis.

2.4 CEO overconfidence and firm performance during COVID-19 crisis

Hermann (1972) defines a crisis as "*a situation that threatens the high priority goals of the organisation, restricts the amount of time available for response, and surprises decision makers by its occurrence, thereby engendering high-levels of stress*". Hay (1996), describes a crisis as a moment of exchange and decisive intervention, and Seeger et al. (1998) define a crisis as "*specific, unexpected, and non-routine events or series of events that create high levels of uncertainty and threat or perceived threat to an organization's high-priority goals*". These quotes illustrate the variation of opinions on what a crisis exactly is. The literature does show some consensus about the characteristics of a crisis: a crisis is dynamic and chaotic, and represents instability, uncertainty and disruption of the core values and life as we know it (Boin & Hart, 2003). Disruptions of the core values and of life as we know it inherently bring risk.

The recent crisis used in this study is the COVID-19 crisis. This pandemic has held the world in captivity since 2020 and although vaccination programs are established at a fast pace, a return to the "old normal" is still far away. Due to the fact that the end of the pandemic has not been reached yet, the full economic impact is difficult to measure. However, when looking e.g., at initial numbers in the US, the virus is clearly the greatest threat to US prosperity since the Great Depression. For example, in April 2020, the first full COVID-19 month in the US, the employment to population ratio was 51.5%. Historical trends predicted a ratio of 61.3%, meaning that a shocking 9,8% of unemployment was caused by factors other than historical trends, most likely the pandemic (Census, 2021). Another example can be found in a U.S. Census Bureau report stating that the COVID-19 crisis led to dramatic swings in household spending. Retail sales, which primarily consists of consumer goods sales, declined 8.7 percent from February to March 2020. This was the largest month-to-month decrease since the Census Bureau started tracking the data (U.S. Census Bureau, 2020). These facts and many more show that the U.S. economy, and therefore U.S. companies, took a hard hit. How different CEOs performed and are performing during this crisis, remains unclear.

Simple reasoning suggests that an overconfident CEO can be harmful in case of high risk. Excessive overconfidence can result in improper assessments of risk and investment valuation, leading to suboptimal decision-making (Dittrich et al., 2005). Additionally, as mentioned,

previous studies noted that optimism and less risk-aversion among confident CEOs can be desirable when high-risk but high-value investments should be made (Hirschleifer et al., 2012; Graham et al., 2013). However, in a crisis when company performance is hit, it may be wise to postpone or cancel such investments. An overconfident CEO might be willing to pursue such investments no matter what, potentially risking further deterioration of company performance. Given that the COVID-19 pandemic is an exogenous crisis, caution is required when a company is led by an overconfident CEO. Overconfident CEO's who pursued a high-risk but high-value investment before the pandemic outbreak were not able to incorporate the COVID-19 crisis in their (limited) risk analysis. This extra component of COVID-19 risk on top of their already high-risk strategy might negatively affect the firm's overall performance.

3. Hypothesis Development

An examination of the existing literature in the fields of CEO overconfidence and firm's performance exposed some helpful insights concerning the relationship between the two. As discussed, I propose to examine the directionality of multiple aspects of that relationship during the COVID-19 crisis. My main research question therefore is:

How did CEO overconfidence affect firms during the COVID-19 crisis?

The first hypothesis looks into the relationship between firm performance and CEO overconfidence. I follow the reasoning of Roll (1986), stating that hubris makes CEOs over-valuate deal synergies and make more non-accretive acquisitions. These money-losing acquisitions would admittedly increase a firm's asset-base but would result in a lower net income at a lower rate of return. In addition to Roll (1986) theory, this article also acknowledge Malmendier and Tate (2005) who state that overconfident managers tend to view their stocks as undervalued and therefore have a higher tendency to invest with internal funds. These internal funds (equity) will potentially be used for money-losing acquisitions. The potential relationship of CEO overconfidence on firm performance in a crisis is also supported by Malmendier and Tate (2005). They state that overconfident CEOs complete more mergers and acquisitions, while investors are more sceptical about these mergers when the CEO is seen as overconfident (Malmendier and Tate, 2005). This scepticism would potentially only increase during a crisis, resulting in a decrease in share price and thus market value. If overconfident

CEOs indeed make more acquisitions (Roll, 1986), this would mean asset base would increase. Naturally this leads to the following hypothesis:

H1: CEO overconfidence has a negative effect on firm performance during the COVID-19 crisis

For my second hypothesis this study specifically investigates overconfident CEO's and their investment behaviour during a crisis. In the examined theory it has been established that overconfident CEO's complete more mergers and acquisitions (Malmendier and Tate, 2005) and that there is a positive relation between managerial overconfidence and investment in innovative ideas (Hirschleifer et al., 2012). These would both increase a company's asset base. I argue that the gap in investment behaviour between overconfident CEO's and unbiased CEO's remains constant in periods of crisis, meaning overconfident CEOs still invest more during a crisis. The hypothesis that follows:

H2: CEO overconfidence has a positive effect on the amount of investment during the COVID-19 crisis

4. Methodology and Data

The Methodology and Data section shows the method used to conduct the study to answer the research question. In addition, this section describes how the relevant data would be collected and which measurements are used to test the various hypotheses of the research.

4.1 Specification of Research Strategy

My research question and hypotheses imply a correlation between CEO overconfidence and firm performance and a correlation between CEO overconfidence and investment behaviour. To examine this correlation, I use the most suitable quantitative method available, the Ordinary Least Squares (OLS) Regression. In this linear regression, the change in the mean of dependent variable is given for a one-unit change in the independent variable. The quantitative technique provides accurate predictions; therefore, it could be determined as the ultimate model for the given hypotheses. In addition, the method is easy to implement and could be quickly applied, even to a large amount of data. However, there are some constraints. For instance, if the data contains outliers the regression could not be performed well. Extreme observations can make the prediction less accurate. I will winsorize variables were needed to remove such outliers.

3.2 Measurements

To measure the specific independent, dependent and control variables used, several exact measurements and proxies are used. The measurements are discussed below.

3.2.1 Independent variable: CEO Overconfidence

As a proxy for CEO overconfidence, I again examine previous literature to find a widely used proxy. A paper often cited by researchers in the field of CEO overconfidence is the paper by Malmendier and Tate (2005). They used three different option-based approaches to measure managerial overconfidence.

Their first measure is called Holder 67, in which CEOs are deemed overconfident if they persistently exercise their options later than the benchmark. As a benchmark, 67% is used as the minimum in-the-money tier at which the executives should need to exercise their options after the vesting period. The second measure concerns the long holders. If a CEO holds his or her options to the end of the duration, they are deemed overconfident.

Their third measure is called the Net Buyer measurement, in which CEOs would be classified as overconfident if they increase their number of options in the company. This method is supported by the notion that undiversified executives prefer to avoid additional firm options. Therefore, it is seen as overconfident if the focus is on the purchase of additional firm options despite the firm's high-risk exposure fostered by the CEO (Malmendier & Tate, 2005).

The press-based measure is an alternative measurement provided in more recent literature, in which the characterizations of the CEO in the press are investigated (Brown & Sarma, 2007). A significant number of words such as "confident" and "optimistic" used to describe the CEO in the press could identify the characteristic of overconfidence (Malmendier & Tate, 2008). In addition, Grinblatt and Keloharju (2009) use the psychological profiles of individuals to identify overconfident behaviour. In this study, the press-based measurements will not be used due to subjectivity and the lack of data availability. As an overconfidence measure for this research study the net buyer technique will be used due to the high availability of data and limited noise in the measurement. In the robustness section, an attempt is made to check the Net-Buyer findings with the use of the Holder67 method.

4.2.2 Net-Buyer

The Net Buyer method exploits the under-diversification of CEOs as a proxy for their confidence. The proxy assumes that CEO compensation regularly contains large quantities of shares and option grants and that these options are limited, meaning the sale of these shares and the exercisability of the options might be restricted by the firm. Firms restrict this to maximize the incentives intended by this form of compensation and thus ensuring that the CEO won't use his position to perfectly hedge himself against the risk of the company. In addition, the proxy acknowledges the fact that CEOs are invested in the firm with human capital, and potentially lose outside employment options. This combined means a CEO is more heavily invested in his or her firm than a regular, hedged outside investor. The trade-off for these CEOs between options or shares of their company and under-diversification is what the Net Buyer method looks at. From an objective perspective, CEOs should diversify and divest their stock. Overconfidence, however, might irrationally convince a CEO that the share price will continue to increase under his or her leadership.

In order to measure this proxy of overconfidence I follow Malmendier and Tate (2005). I only look at CEOs with a tenure longer than 5 years. Although this will significantly reduce my sample size, it will aid in the relief of endogeneity concerns. For the remaining CEOs, I look at their share acquisition behaviour over 5 years. Thus, a CEO is considered overconfident if the number of shares owned is larger in t=5 than in t=1. Lastly, the variable is made binary.

4.3 Dependent Variables

4.3.1 Firm Performance

To measure firm performance, I use *Return on Assets (ROA), Return on Equity (ROE) and Tobin's Q*. These are profitability measurements widely used by well-cited papers (e.g., Brown et al., 2004; Bhagat et al., 2008). Tobin's Q is calculated slightly different in articles from different fields. For consistency, Malmendier and Tate's (2005) Tobin's Q is computed. This is computed as total assets plus market equity minus book equity over total assets. Market equity is shares outstanding multiplied by the closing price of the fiscal year. Book equity is stockholder equity plus deferred tax minus preferred stock liquidating value, investment tax credit and post-retirement assets. The formulas for calculating *ROA, ROE* and *Tobin's Q* are as follows:

$$ROA = \frac{Net\ income\ (loss)}{Total\ assets}$$

$$ROE = \frac{Net\ income\ (loss)}{Common\ shares\ outstanding * price\ closed\ fiscal\ year}$$

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

4.3.2 Investment

To test the second hypothesis, whether overconfident CEO's also result in more capital investment during the COVID-19 crisis, the variable Investment is computed and made binary. I again look at Malmendier and Tate (2005). They compute investment as capital expenditures normalized by beginning of the year capital. As all data concerns balance sheet data and thus end of the fiscal year figures, t-1 capital is used to normalize expenditures.

$$Investment = \frac{Capital\ Expenditures_{\ t}}{Total\ Assets_{t-1}}$$

4.3.3 Control Variables

To isolate the effect of CEO overconfidence on the chosen independent variables, I control for some firm specific and CEO specific variables. I control for Firm size (log of total assets), market to book ratio, CEO age, CEO gender, CEO tenure, Firm leverage ratio, CEO compensation, CEO ownership percentage and CEO Duality (CEO is also chairman of the board). I also control for lagged ROA (T-1), lagged ROE, lagged Investment and lagged Tobin's Q. I will also control for crisis experience. This binary variable will be 1 if the CEO in question has experienced the financial crisis at his or her firm as well. Due to the fact that multiple articles (E.g., Malmendier, Tate and Yan,2011; Schoar and Zuo, 2017; Malmendier and Nagel,2011) find that past macro-economic experiences influence decision making, I suspect crisis experience could contribute to the overall effect. The regression will also contain firm fixed effects.

To examine the effect during COVID-19, a crisis dummy is made. Crisis_2020 is a binary variable that is 1 for the year 2020 and 0 for other years. Although COVID-19 might already be noticeable in some 2019 fiscal years, the generally accepted COVID-19 equity decline date is 20 February 2020 (Brown, Koller and Stumpner, 2021). Therefore, I choose to only use fiscal year 2020 as a crisis year.

After establishing the dependent, independent and control variables the extended regression model can be computed:

$$Firm\ Performance = \beta_0 + \beta_1\ (Net\_Buyer * Crisis\_2020) + \beta_2\ Firm\ Size + \beta_3\ Market\ to\ Book\ ratio + \beta_4\ CEO\ Age + \beta_5\ CEO\ Gender + \beta_6\ CEO\ Tenure + \beta_7\ Leverage\ Ratio + \beta_8\ CEO\ Compensation + \beta_9\ CEO\ Ownership\ percentage + \beta_{10}\ CEO\ Duality + \beta_{11}\ ROA_{(t-1)} + \beta_{12}\ ROE_{(t-1)} + \beta_{13}\ Tobin's\ Q_{(t-1)} + \beta_{14}\ Investment_{(t-1)} + \beta_{15}\ Crisis\ experience + Firm\ Fixed\ Effects + \varepsilon_{it}$$

4.4 Data Description and Cleaning

To examine my hypotheses a sample of US listed firms is used. I extract data on CEOs of US listed firms from 2013-2021. Of this data, the first 5 years (2013-2017) will be used to calculate my independent variables for the years 2018 to 2021. My final dataset will thus hold the Firm-Year observations of US listed firms from 2018 to 2021. Data on the CEO characteristics and personal share activity is obtained from Execucomp. Data on the corresponding firm and its performance is retrieved from Compustat. Access to both databases is provided by the WRDS subscription of the Erasmus University Rotterdam. I commence with a Compustat database of 101,894 observations and an Execucomp database of 81,378 observations. After merging these datasets on the variable "Ticker", "Year" and "SIC industry code" a dataset of 95,341 observations remains. This dataset still contains multiple types of directors. To only look at CEOs I delete observations that have no value for the variable "Annual CEO Flag" meaning they are non-CEO executives. This narrows my dataset down to 17,752 observations. My final dataset holds 2,610 observations of 1,067 unique firms. The cleaning process is described in the table below.

Table 1: Cleaning Procedure of the Final Dataset

Table I displays the cleaning process of the used dataset. I delete firm observations before 2017 after I computed the CEO overconfidence variable, as these firm observations are only needed to examine the share purchase behaviour of the CEO in the following fiscal years. I exclude financial services firms because firm performance measures do not address their different use of debt and assets.

Sampling procedure	**N**
Compustat firm year observations matched with Execucomp corresponding CEO observations	95,341
Less: Non-CEO Executives	- 77,589
Less: Observations with missing values	- 4,104
Less: CEO's that have been CEO for less than 5 years	- 2,392
Less: Firms with less than 5 consecutive CEO-year observations	- 1,413
Less: CEO-year observations not in the years 2018-2021	- 7,000
Less: CEO-firm observations of Financial Services firms	- 233
Final sample for testing the hypotheses	**2,610**

Table 1

4.5 Descriptive Statistics

Table 2: Summary Statistics of Net Buyer Sample

Statistic	**N**	**Mean**	**St. Dev.**	**Min**	**Pctl(25)**	**Pctl(75)**	**Max**
Total Assets	**2,610**	19,413.40	64,683.60	4	1,370.7	12,677.5	1,115,862
Capital Expenditures	**2,610**	559.91	1,891.11	0	16.2	292.4	40,140
Duality	**2,610**	0.45	0.50	0	0	1	1
Ownership Percentage	**2,610**	0.027	0.058	0.00	0.0015	0.0121	0.6809
Age	**2,610**	59.16	7.08	35	55	63	90
Total Compensation	**2,610**	9.55	1.29	-5.91	9.12	10.23	13.26
Gender	**2,610**	0.95	0.21	0	1	1	1
ROA	**2,610**	0.04	0.07	-0.12	0.01	0.08	0.16
ROE	**2,610**	0.02	0.07	-0.20	0.01	0.06	0.12
Leverage	**2,610**	0.95	0.98	0.00	0.25	1.24	3.80
Capital Intensity	**2,610**	0.03	0.04	0.00	0.01	0.05	0.44
Firm Size	**2,610**	9.35	1.67	2.35	8.22	10.45	14.93
Market to Book	**2,610**	2.25	18.99	-866.68	0.83	2.82	363.42
Tobin's Q	**2,610**	1.92	0.91	0.99	1.15	2.52	3.65
Investment	**2,610**	0.04	0.05	0.00	0.01	0.05	0.76
Tenure	**2,610**	12.64	7.94	5	7	16	53
Crisis Experience	**2,610**	0.39	0.49	0	0	1	1
Lagged ROA	**2,610**	0.05	0.06	-0.12	0.02	0.08	0.16
Lagged ROE	**2,610**	0.03	0.06	-0.20	0.02	0.06	0.12
Lagged Tobin's Q	**2,610**	1.95	0.89	0.99	1.19	2.55	3.65
Lagged Investment	**2,610**	0.04	0.06	0.00	0.01	0.05	0.83
Net Buyer	**2,610**	0.57	0.50	0	0	1	1

Table 2

Table 3: Distribution across Fama-French 12 Industry Groups (n = 2,610)

Group	Industry	% in Sample	Group	Industry	% in Sample
1	Consumer Nondurables	4.37	**7**	Telecom	2.07
2	Consumer Durables	2.80	**8**	Utilities	4.48
3	Manufacturing	11.34	**9**	Shops and Retail	9.23
4	Energy	4.10	**10**	Healthcare	9.77
5	Chemicals	4.06	**11**	Money	17.16
6	Business Equipment	16.55	**12**	Other	14.06

Table 3

Table 2 shows the summary statistics of the entire sample after winsorizing the variables of ROA, ROE, Tobin's Q and Investment at 5%. Table 3 shows the division of industries in my sample. Before winsorization the variables were tested for skewness and were respectively skewed -8.7, -61.8, 89.9, 19.6 and 34.6. These skewness values are all too distant from 0. To neutralize the effect of outliers, the variables were winsorized. Hereafter the skewness values were closer to 0 and acceptable to use: -0.38 (ROA), -1.86 (ROE), 0.98 (Tobin's Q) and 1.62 (Investment). The values for asymmetry and kurtosis between -2 and +2 are considered acceptable in order to prove normal univariate distribution (George & Mallery, 2010). Hair et al. (2010) and Bryne (2010) argued that data is considered to be normal if skewness is between -2 to +2.

57% of CEOs in the conducted sample are classified as a net buyer. For comparison, the study by Malmendier and Tate (2005) considers 97 out of 158 CEOs (61%) overconfident when using the Net Buyer technique. I believe this small difference can be attributed to different timeframes with different macro-economic conditions and does not give reason to investigate further. Looking at control variables, CEOs had an average age of 59 and 45% of them were also Chairman of the board. 95% of these CEOs were male. ROA, ROE, Tobin's Q and Investment have a mean of 0.04, 0.02, 1.92 and 0.04. lagged firm performance measures display a slightly lower mean in ROA, ROE and Tobin's Q. This could be a first indication that firm performance, regardless of CEO overconfidence, was affected by COVID-19. All variables also considered by Malmendier and Tate (2005) show similar statistics. The average percentage of shares owned by the CEO is 2.1%. The percentage of ownership is widely spread, since some CEOs own as much as 68% while others have no shares. Furthermore, the average tenure of CEOs is 12.64 years, this includes CEOs that are currently in their role. Note that this does not include CEOs with a tenure of less than 5 years, since these observations are not used for this study. The variable crisis experience has a mean of 0.39, meaning 39% of the CEOs in

the sample have experienced the financial crisis. To clearly see the difference between overconfident and other CEOs, table 4 presents separate summary statistics.

Table 4: Summary Statistics Stratified by Net Buyer
Significance: *** p<0.01, ** p<0.05, *p<0.1

	Non-overconfident			*Overconfident*			
Statistic	**N**	**Mean**	**St. Dev.**	**N**	**Mean**	**St. Dev.**	**Δ Mean**
Total Assets	**1,127**	22,388.92	83,456.54	**1,483**	17,152.16	45,408.84	5236.76*
Capital Expenditures	**1,127**	522.59	1,959.59	**1,483**	588.28	1,837.53	65.69
Duality	**1,127**	0.43	0.49	**1,483**	0.47	0.50	0.07**
Ownership Percentage	**1,127**	2.38	6.42	**1,483**	1.84	5.33	0.54**
Age	**1,127**	58.88	7.22	**1,483**	59.38	6.97	0.25*
Total Compensation	**1,127**	9.51	1.43	**1,483**	9.57	1.17	0.26
Gender	**1,127**	0.97	0.17	**1,483**	0.94	0.23	-0.03***
ROA	**1,127**	0.05	0.06	**1,483**	0.04	0.07	-0.01***
ROE	**1,127**	0.03	0.06	**1,483**	0.02	0.08	-0.01***
Leverage	**1,127**	0.88	0.97	**1,483**	1.00	0.98	0.12***
Capital Intensity	**1,127**	0.03	0.04	**1,483**	0.03	0.04	0.00
Firm Size	**1,127**	9.38	1.68	**1,483**	9.33	1.67	0.05
Market to Book ratio	**1,127**	2.57	3.53	**1,483**	2.01	25.00	0.56
Tobin's Q	**1,127**	2.03	0.93	**1,483**	1.83	0.88	0.2***
Investment	**1,127**	0.04	0.05	**1,483**	0.04	0.05	0.00
Tenure	**1,127**	12.68	8.44	**1,483**	12.62	7.53	0.06
Crisis Experience	**1,127**	0.42	0.49	**1,483**	0.37	0.48	0.05
Lagged ROA	**1,127**	0.06	0.06	**1,483**	0.04	0.06	0.02***
Lagged ROE	**1,127**	0.04	0.05	**1,483**	0.03	0.07	0.01***
Lagged Tobin's Q	**1,127**	2.07	0.91	**1,483**	1.86	0.87	0.21***
Lagged Investment	**1,127**	0.04	0.06	**1,483**	0.04	0.05	0.00

Table 4

Looking at the separate summary statistics, a couple of variables stand out. The firms of overconfident CEOs on average have a leverage ratio of 1.0 while firms of non-overconfident CEOs have a ratio of 0.88 on average. This is in line with Malmendier and Tate (2005) who acknowledge that overconfident CEOs tend to fund their firm with debt rather than raise additional equity. We also see that 42% of non-overconfident CEOs have experienced the financial crisis against 37% of the overconfident CEOs. In combination with an almost similar tenure average, it is logical to assume that some non-overconfident CEOs have been in their position for a long time. ROE, ROA and Tobin's Q means are slightly higher for non-overconfident CEOs. This could indicate that my proposed relationship of CEO overconfidence's negative effect on firm performance exists. Furthermore, firms with overconfident CEOs are on average somewhat smaller in asset size (again in line with Malmendier and Tate, 2005). The above description of Table 4 is only based on a visual

interpretation of the two separate summaries. To be confident that the observed non-overconfident and overconfident sample mean differences are significant, two-sided unpaired T-tests are conducted.

The last column of Table 4 displays the statistical differences in means between the overconfident and non-overconfident CEO groups. My dependent performance measures ROA, ROE and Tobin's Q all show significant mean differences with non-overconfident CEO's showing slightly higher firm performances. This is an indication that my proposed negative relationship between net buyer and firm performance exists. However, Investment does not show a significant difference in mean, which could indicate that there is no relationship between investment and CEO overconfidence. Furthermore, Duality, Age, Ownership Percentage and Leverage Ratio show a significant difference in means between the two groups. The T-tests of these variables are either significant at the 90%, 95% or 99% confidence level and therefore H_1 is accepted. As mentioned earlier, the significant difference in leverage is in line with Malmendier and Tate (2005) who acknowledge that overconfident CEOs tend to fund their firm with debt rather than external equity. There is no clear explanation in previous literature for the difference in the other variables. In my regressions, I will control for all these variables. I try to address further endogeneity concerns about these differences in the robustness section.

5. Results

Table 5: Regression of Net Buyer on Firm Performance and Investment

OLS regressions with CEO overconfidence as independent variable and various firm performance measures as dependent variables. Regression 1,2,3 and 4 do not contain industry fixed effects and control variables. Regressions 5 to 8 are controlled for several CEO and firm characteristics. Standard errors are in parentheses. *** p<0.01, ** p<0.05, *p<0.1

	Baseline Regressions: No Fixed Effects, No Control Variables				*Regressions with Fixed Effects and Control Variables*			
	ROA	ROE	Tobin's Q	Investment	ROA	ROE	Tobin's Q	Investment
Net_Buyer	-0.014***	-0.013***	-0.225***	-0.002	-0.005*	-0.008**	-0.026	-0.0005
	(0.003)	(0.003)	(0.054)	(0.002)	(0.003)	(0.004)	(0.006)	(0.001)
Crisis_2020	-0.021***	-0.024***	0.152**	-0.016***	-0.014***	-0.013**	-0.014	-0.002*
	(0.004)	(0.005)	(0.077)	(0.003)	(0.004)	(0.005)	(0.006)	(0.001)
Net_Buyer:Crisis_2020	0.002	-0.001	-0.051	0.006	-0.0001	-0.003	-0.077**	0.002
	(0.006)	(0.006)	(0.101)	(0.004)	(0.004)	(0.005)	(0.034)	(0.001)
Tenure					-0.022	-0.023	-0.056	0.006
					(0.013)	(0.018)	(0.119)	(0.004)
Firm_Size					0.034***	0.084***	-0.506***	0.025***
					(0.006)	(0.008)	(0.053)	(0.002)
Gender					-0.138*	-0.140	0.157	0.024
					(0.076)	(0.102)	(0.686)	(0.025)
Age					-0.005***	-0.012***	0.110***	-0.001*
					(0.002)	(0.003)	(0.018)	(0.001)
Total_Compensation					0.003**	0.002	0.034**	-0.0005
					(0.002)	(0.002)	(0.014)	(0.001)
Ownership_Percentage					0.002**	0.001	-0.003	0.0002
					(0.001)	(0.001)	(0.007)	(0.0002)
Leverage					-0.027***	-0.030***	-0.087***	0.002***
					(0.002)	(0.003)	(0.021)	(0.001)
Capital_Intensity					0.461***	0.642***	1.480***	1.308***
					(0.055)	(0.073)	(0.493)	(0.018)

Table 5 - Continued

					Regressions with Fixed Effects and Control Variables			
					ROA	ROE	Tobin's Q	Investment
Duality					0.003	-0.003	0.021	-0.001
					(0.007)	(0.009)	(0.059)	(0.002)
Market_Tobook					-0.00001	-0.00003	0.0004	-0.00000
					(0.00004)	(0.0001)	(0.0004)	(0.00001)
Lagged_ROA					-0.196***			
					(0.027)			
Lagged_ROE						-0.256***		
						(0.029)		
Tobin's Q_{t-1}							0.033	
							(0.023)	
$Investment_{t-1}$								0.032**
								(0.014)
Crisis Experience					0.337	0.372	0.240	-0.114
					(0.244)	(0.326)	(2.202)	(0.081)
Constant	0.056***	0.039***	2.115***	0.043***	0.297*	0.147	1.652	-0.245***
	(0.002)	(0.002)	(0.041)	(0.002)	(0.166)	(0.222)	(1.508)	(0.055)
Observations	2,610	2,610	2,610	2,610	2,601	2,601	2,601	2,601
R^2	0.031	0.035	0.012	0.014	0.818	0.733	0.953	0.962
Adjusted R^2	0.029	0.034	0.011	0.013	0.689	0.545	0.920	0.936
Residual Std. Error	0.065 (df = 2606)	0.071 (df = 2606)	1.158 (df = 2606)	0.047 (df = 2606)	0.037 (df = 1523)	0.049 (df = 1523)	0.329 (df = 1523)	0.012 (df = 1523)
F Statistic	27.374*** (df = 3; 2606)	31.436*** (df = 3; 2606)	10.925*** (df = 3; 2606)	12.296*** (df = 3; 2606)	6.354*** (df = 1077; 1523)	3.892*** (df = 1077; 1523)	28.696*** (df = 1077; 1523)	36.258*** (df = 1077; 1523)
Firm Fixed Effects	NO	NO	NO	NO	YES	YES	YES	YES
Controlled	NO	NO	NO	NO	YES	YES	YES	YES

Table 5

Table 5 shows the regression results of overconfident CEOs on ROA, ROE, Tobin's Q and Investment. The first four baseline regressions are not controlled by firm and CEO characteristics and do not have firm fixed effects, while the last four regressions do have firm fixed effects (ticker based) and are controlled by other variables The low (adjusted) R^2 in the first four regressions indicates that the crisis dummy variable and net buyer do not solely explain the effect on firm performance. All baseline regressions R-squared coefficients are below 0.1, indicating low explanatory power of the regressions. The R^2 of the latter four regressions show more promising figures: 0.818 (ROA), 0.733 (ROE), 0.953 (Tobin's Q) and 0.962 (investment) are all high, adjusted R-squared coefficients essential for drawing conclusions on our regressions.

In the controlled regressions, the Net Buyer effects (row 1) are negative and significant for ROA (column 4, -0.05) , ROE (column 5, -0.008)). For Tobin's Q (column 6, -0.026) and Investment (column 4, -0.0005) this effect is insignificantly negative. The crisis dummy shows a negative relationship for ROA, ROE, Tobin's Q and Investment. The ROA, ROE and Investment coefficients are all significantly negative in crisis year 2020 while Tobin's Q is insignificantly negative.

Lasty, we examine the interaction between net buyer and the crisis dummy which is the coefficient crucial for my hypotheses. Although ROA and ROE (column 5, 6) do show a negative coefficient, only ROE (column 7, -0.077) shows a significant negative relationship. The relationship between Investment and Net Buyer (column 8, 0.002) interacting with crisis years is very slightly positive and insignificant. Based on Tobin's Q (6 , -0.077), I can reject my first null hypothesis and accept my alternative hypothesis. This could indicate that CEO overconfidence indeed has a negative effect on firm performance during COVID-19. However, as ROA and ROE do not show significant relationships, I believe more tests are needed to confidently accept this alternative hypothesis. The regressions do not give evidence to accept the second hypothesis regarding increased investment during COVID-19 by overconfident CEOs. Investment does not show a significant relationship to net buyer in crisis years (column 8, 0.002). To further test if my proxy for overconfidence is correct, I attempt to use a different proxy for overconfidence first calculated by Malmendier and Tate (2005).

6. Robustness Tests

6.1 Holder67

To test the proxy for overconfidence used in the main regression, Net Buyer, I construct a different proxy. Holder67 is a proxy that looks at option packages at the end of their vesting period. The proxy assumes a CEO is overconfident if he or she persistently withholds from exercising options that are in-the-money. This namely means that the CEO is convinced that under his leadership, the stock price will keep rising and he wants to profit from this expected price increase by holding the options. To establish a minimum threshold after which options are considered "enough" in-the-money, Malmendier and Tate look at a theoretical framework constructed by Hall and Murphy (2002). The writers eventually settle on 67% in-the-money as a threshold, and I will use this threshold for consistency matters as well.

The proxy constructed follows the line of Malmendier and Tate (2005) as much as possible. Starting point is the initial dataset before deleting the years 2013-2017 and deleting financial services firms. This results in 9,843 initial firm-year observations. Note that this only includes CEOs with a tenure of more than 5 years, and firms with more than 5 consecutive year observations. To construct this proxy, an estimated value of the unexercised, exercisable options is required. In addition, the number of unexercised, exercisable options is needed. These are both variables available in Execucomp. I delete observations with missing values for one of these variables. I do this because if a CEO does not have any options, I am unable to calculate its overconfidence and keeping these CEOs in will therefore interfere with my results. This deletion reduces my dataset to 5,391 observations. The value per vested option is calculated as the estimated value of all unexercised options divided by the number of unexercised options. The strike price is calculated by the share price at fiscal year close minus the value per vested option. The value is made binary by assigning a 1 to every value higher than 0.67 and 0 otherwise. Lastly, in line with Malmendier and Tate (2005), I calculate the net Holder67 score of a CEO over 5 years. This means CEOs in the year 2018 receive a net Holder67 score calculated with the years 2013 to 2018, while for example 2020 net Holder67 scores are calculated by the years 2015 to 2020. If the net Holder67 score is higher than 1, meaning the CEO was a Holder67 at least two times in the sample period, the CEO is classified as overconfident. After finalizing the Holder67 construct, the years before 2018 are deleted. My final Holder67 dataset holds 914 observations of 444 unique firms.

Table 6: Summary Statistics of Holder67 Sample

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Total Assets	**914**	23,286.89	62,222.28	43	1,620.2	17,136.0	815,078
Capital Expenditures	**914**	527.05	1,544.34	0	23.7	336.5	21,251
Duality	**914**	0.50	0.50	0	0	1	1
Ownership Percentage	**914**	1.58	4.29	0.00	0.12	0.98	51.44
Age	**914**	59.39	6.53	42	55	63	86
# of Unexercised Options	**914**	822.59	1,524.76	1.24	176.07	907.65	20,562.50
Est. Value of Unexercised Options	**914**	38,344.63	116,195.50	0.57	2,498.76	27,593.52	1,770,497.00
Total Compensation	**914**	9.74	1.16	-5.91	9.35	10.36	12.82
Gender	**914**	0.96	0.19	0	1	1	1
ROA	**914**	0.06	0.06	-0.12	0.02	0.09	0.16
ROE	**914**	0.03	0.05	-0.20	0.02	0.06	0.12
Leverage	**914**	0.90	0.94	0.00	0.22	1.16	3.80
Capital Intensity	**914**	0.03	0.03	0.00	0.01	0.04	0.36
Firm Size	**914**	9.62	1.68	4.77	8.39	10.75	14.61
Market to Book	**914**	3.11	4.57	-28.88	1.15	3.75	69.55
Tobin's Q	**914**	2.21	0.96	0.99	1.35	3.18	3.65
Investment	**914**	0.03	0.03	0.00	0.01	0.05	0.49
Tenure	**914**	12.69	7.76	5	7	16	53
Crisis Experience	**914**	0.42	0.49	0	0	1	1
Lagged ROA	**914**	0.06	0.06	-0.12	0.03	0.10	0.16
Lagged ROE	**914**	0.04	0.04	-0.20	0.02	0.06	0.12
Lagged Tobin's Q	**914**	2.23	0.93	0.99	1.40	3.10	3.65
Lagged Investment	**914**	0.04	0.04	0.00	0.01	0.05	0.51
Net Buyer	**914**	0.56	0.50	0	0	1	1
Holder67	**914**	0.59	0.49	0	0	1	1

Table 6

In the summary statistics of my Holder67 sample we can see that 59% of the CEO-firm years are classified as Holder67 and thus overconfident. This is slightly higher than Malmendier and Tate (2005) with 52%. This is a small margin of difference which I account to macro-economic time difference and in my view there is no need of further examination. 56% of this dataset is classified as Net Buyer. To ensure the consistency of overconfidence proxies used a correlation test between Net Buyer and Holder67 variables in the Holder67 sample is performed. The correlation efficient is 0.058 which is equal to the 0.06 of earlier research (Malmendier and Tate, 2005).

Table 7: Regression of Holder67 on Firm Performance and Investment

OLS regressions with CEO overconfidence as independent variable and various firm performance measures as dependent variables. Regression 1,2,3 and 4 do not contain industry fixed effects and control variables. Regressions 5 to 8 are controlled for several CEO and firm characteristics. Standard errors are in parentheses. *** p<0.01, ** p<0.05, *p<0.1

	Baseline Regressions: No Fixed Effects, No Control Variables				*Regressions with Fixed Effects and Control Variables*			
	ROA	ROE	Tobin's Q	Investment	ROA	ROE	Tobin's Q	Investment
Holder67	0.020***	-0.004	0.731***	-0.001	-0.004	-0.003	-0.069	-0.0004
	(0.006)	(0.005)	(0.109)	(0.003)	(0.007)	(0.007)	(0.071)	(0.001)
Crisis_2020	-0.017**	-0.020***	-0.056	-0.008*	-0.025***	-0.015*	-0.133*	-0.0004
	(0.008)	(0.007)	(0.164)	(0.005)	(0.008)	(0.008)	(0.075)	(0.001)
Holder67: Crisis_2020	-0.004	0.00001	0.248	0.001	0.003	0.003	-0.148**	0.004**
	(0.010)	(0.008)	(0.192)	(0.005)	(0.007)	(0.007)	(0.070)	(0.001)
Tenure					0.021	-0.062	2.097***	-0.109***
					(0.043)	(0.045)	(0.428)	(0.008)
Firm_Size					0.003	0.040***	-0.627***	0.023***
					(0.010)	(0.010)	(0.096)	(0.002)
Gender					0.082	0.035	2.166***	-0.106***
					(0.070)	(0.072)	(0.694)	(0.013)
Age					0.002	-0.010***	0.150***	-0.001
					(0.004)	(0.004)	(0.036)	(0.001)
Total_Compensation					0.009**	0.005	0.046	-0.001*
					(0.004)	(0.004)	(0.037)	(0.001)
Ownership_Percentage					-0.004	0.003	-0.135***	-0.0002
					(0.005)	(0.005)	(0.047)	(0.001)
Leverage					-0.012***	-0.008**	-0.050	0.002***
					(0.004)	(0.004)	(0.039)	(0.001)
Capital_Intensity					0.570***	0.674***	3.498**	1.123***
					(0.154)	(0.159)	(1.523)	(0.028)

Table 7 - Continued

					Regressions with Fixed Effects and Control Variables			
					ROA	ROE	Tobin's Q	Investment
Duality					0.009	0.008	0.046	0.0001
					(0.012)	(0.012)	(0.120)	(0.002)
Market_Tobook					-0.001	-0.0005	0.009*	0.0003***
					(0.001)	(0.001)	(0.005)	(0.0001)
ROA_{t-1}					-0.216***			
					(0.046)			
ROE_{t-1}						-0.205***		
						(0.054)		
Tobin's Q_{t-1}							-0.114***	
							(0.041)	
$Investment_{t-1}$								-0.095***
								(0.022)
Crisis Experience					-0.012*	-0.007	-0.018	0.0003
					(0.007)	(0.006)	(0.052)	(0.001)
Constant	0.047***	0.044***	1.807***	0.035***	-0.344	0.491*	0.749**	0.574***
	(0.005)	(0.004)	(0.093)	(0.003)	(0.277)	(0.286)	(0.466)	(0.051)
Observations	914	914	914	914	914	914	914	914
R^2	0.040	0.034	0.086	0.009	0.845	0.755	0.962	0.983
Adjusted R^2	0.037	0.031	0.083	0.006	0.690	0.511	0.924	0.966
Residual Std. Error (df = 908; 702)	0.061 (df = 910)	0.051 (df = 910)	1.206 (df = 910)	0.034 (df = 910)	0.035 (df = 455)	0.036 (df = 455)	0.347 (df = 455)	0.006 (df = 455)
F Statistic (df = 5, 908; 205,702)	12.683*** (df = 3; 910)	10.619*** (df = 3; 910)	28.656*** (df = 3; 910)	2.737** (df = 3; 910)	5.475*** (df = 3; 910)	3.101*** (df = 3; 910)	25.344*** (df = 3; 910)	58.201*** (df = 3; 910)
Firm Fixed Effects	NO	NO	NO	NO	YES	YES	YES	YES
Controlled	NO	NO	NO	NO	YES	YES	YES	YES

Table 7

Table 7 shows the results of an OLS regression of the Holder67 dummy variable on firm performance measures and Investment. Similar to the Net Buyer regressions, the first four regressions do not control for firm fixed effects and do not take control variables into account. The R-squared coefficients for the controlled regressions show similar values to the net buyer regressions and again give us confidence that the regressions explain a lot in the total variance. In the controlled regressions in column 5 to 8, The Holder67 coefficient without interaction with the crisis variable shows negative relationships for all four independent variables. However, all are insignificant. The coefficients for the crisis dummy variable 2020 are significantly negative for ROA (column 5,-0.025***), ROE (column 6,-0.015*) and Tobin's Q (column 7,-0.133*) . Investment (column 8,-0.004) shows an insignificant negative relationships. The interaction coefficient of Net Buyer and Crisis 2020 is negative and significant for Tobin's Q (7, -0.148**). For ROA(5) and ROE (6), the relationship is insignificant. The results from this interaction variable further solidifies the results from the net buyer regression, where the negative Tobin's Q relationship was also visible (-0.077**). The regression on Investment (column 8) results in a positive relationship of 0.004 significant at the 95% confidence level. This relationship is positive and insignificant for the net buyer regression (0.002). The significance of the relationship with Holder67 could indicate that there is some relationship between the variables. Given that one of the two regressions shows a significant result but both are positive, the second null hypothesis is rejected.

In terms of control variables, lagged performance plays a significant role in these regressions as well as leverage. Differing from the previous regressions is the significance of crisis experience. I find it interesting that crisis experience is only slightly negative and significant for Holder67 on ROA (5, -0.012*). As the crisis experience relationship has not been significant in the net buyer regressions, it contradicts many articles (E.g., Malmendier, Tate and Yan,2011; Schoar and Zuo, 2017; Malmendier and Nagel,2011) that do indicate that these kinds of macro-economics play a role in future decision making.

6.2 Propensity Score Matching

One major challenge of every observational research is that sampling cannot be done randomly. Specific for this research is the fact that we cannot choose which CEO is linked to which firm. Of essence for my research is the fact that I should rule out reverse causality. This reverse causality infers that whether a firm has an overconfident CEO is not random. For example, in

section 3.5 we see that the mean of leverage ratio and ownership percentage differs significantly between net buyers and non- net buyers. Propensity scores matching aims to make this difference insignificant. Other examples of endogenous sampling include firms with a higher lagged performance, and thus higher prospects for performance in the future, that might opt for an overconfident CEO to take risks and stimulate growth. On the other hand, firms that are already highly levered might choose a non-overconfident CEO to lead the firm in a more risk-averse strategy. In short, it must be examined if my independent variables are affecting my dependent variables, and not vice-versa. To mitigate these endogeneity concerns, Rosenbaum and Rubin (1983) suggest using propensity score matching. Matched firms are assumed to be in similar conditions and equally likely to have an overconfident CEO. This is also known as the conditional independence assumption. There are several techniques to choose from when matching. The R-formula we use for matching, "MatchIt" has three classes of methods: distance matching, stratum matching and pure subset selection. Stratum matching creates strata based on unique values of the chosen matching variables and then assigning observations with these unique values to those strata. Observations that were not matched with an overconfident or non-overconfident CEO, would then be dropped. By stratifying the data in this way prior to randomization, the researchers can reduce the heterogeneity of their treatment and control groups, thereby reducing the variance of their estimate of the effect of their treatment. The pure subset selection matching selects a subset of observations from the original sample without considering distance between observations or different strata they might belong to. The idea behind pure subset selection is that the researcher can set a maximum imbalance that is allowed. The method than attempts to find the largest matched sample that satisfies those balance constraints (Greifer, 2021).

The method that will be used in this study is distance matching. Distance matching involves a treatment group (overconfident CEOs) and matching these observations to members of the control group (non-overconfident CEOs). The observations are paired based on the smallest distance between units. Eventually, members of either group that are not paired are dropped from the sample (Caliendo and Kopeinig, 2008). After trying different techniques, I chose the optimal pair method to perform my matching, which is one of the most straightforward matching estimators. It is very similar to nearest neighbour technique and matches observations based on similar characteristics, also known as the smallest "distance" between observations. However, nearest neighbour is greedy, meaning that once a match is made it is fixed. This is not the case for the Optimal matching technique. This algorithm reconsiders all previously

made matches before making the current match. Gu and Rosenbaum (1993) compared the greedy and optimal algorithms and found that "optimal matching is sometimes noticeably better than greedy matching in the sense of producing closely matched pairs, sometimes only marginally better, but it is no better than greedy matching in the sense of producing balanced matched samples." In my propensity score design, the treatment is firm-years with an overconfident CEO and the control group is the sample of firm-years without an overconfident CEO. To randomize the firm-CEO matches, I rematch my dataset based on firm and CEO characteristics. I thus aim to match the overconfident (and non-overconfident) CEOs to firms based on my firm-and-CEO-specific independent variables: Tenure, Firm Size, Gender, Age, Total Compensation, Ownership Percentage, Leverage, Capital Intensity, Duality, Industry fixed effects, Crisis Experience, Market to Book ratio, $Investment_{t-1}$, ROA_{t-1}, ROE_{t-1} and Tobin's Q_{t-1}.

Figure 2: Propensity Scores Before and After Matching

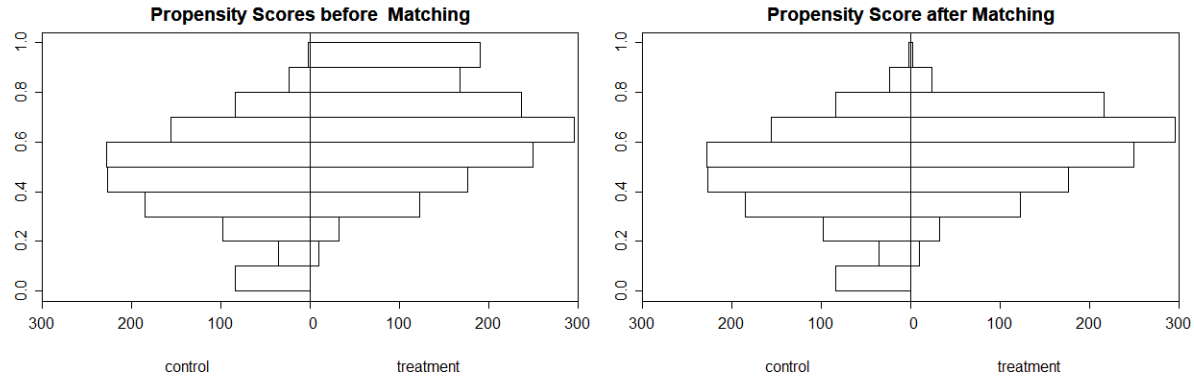

Figure I

I first perform a chi-squared test on my net buyer dataset (2610 observations) before propensity score matching. This results in a Chi-square value of 521 (df=290) and a p-value of 2.23e-15. This highly significant p-value indicates that at least one of the variables included in the model is creating an imbalance between the net buyer and non-net buyer group. We then start with our propensity score model by calculating the propensity scores with a generalized linear model in R. The results of this model are then used to predict propensity score (ps) values. After obtaining these ps values, I start matching the data based on all variables named in the previous alinea. I match with a ratio of 1, meaning only control unit can be matched to each treated unit. After matching, I perform another chi-squared test to examine if one of the tested variables is still creating a significant imbalance between the two groups. The test results in a chi-square

value of 254 with 244 degrees of freedom. This corresponds to a p-value of 0.309, meaning the imbalance between the groups is now insignificant.

Table 8: Summary Statistics Propensity Score Matched Net Buyer Sample
Significance: *** p<0.01, ** p<0.05, *p<0.1

	Non-overconfident			*Overconfident*			
Statistic	**N**	**Mean**	**St. Dev.**	**N**	**Mean**	**St. Dev.**	**Δ Mean**
Total Assets	**1,127**	22,427.57	83,563.09	**1,127**	17,377.93	47,122.89	5049.64
Capital Expenditures	**1,127**	523.81	1,962.06	**1,127**	554.56	1,673.44	-30.75
Duality	**1,127**	0.43	0.49	**1,127**	0.46	0.50	0.07
Ownership Percentage	**1,127**	2.37	6.43	**1,127**	1.79	4.76	0.58**
Age	**1,127**	58.89	7.22	**1,127**	59.19	7.02	-0.30
Total Compensation	**1,127**	9.51	1.43	**1,127**	9.58	1.24	-0.07
Gender	**1,127**	0.97	0.17	**1,127**	0.96	0.19	0.01
ROA	**1,127**	0.05	0.06	**1,127**	0.04	0.07	0.01***
ROE	**1,127**	0.03	0.06	**1,127**	0.02	0.07	0.01***
Leverage	**1,127**	0.88	0.97	**1,127**	0.96	0.94	-0.08*
Capital Intensity	**1,127**	0.03	0.04	**1,127**	0.03	0.04	0.00
Firm Size	**1,127**	9.38	1.68	**1,127**	9.36	1.65	0.02
Market to Book ratio	**1,127**	2.57	3.53	**1,127**	2.04	28.70	0.53
Tobin's Q	**1,127**	2.03	0.93	**1,127**	1.87	0.89	0.16***
Investment	**1,127**	0.04	0.05	**1,127**	0.04	0.05	0.00
Tenure	**1,127**	12.67	8.43	**1,127**	12.60	7.39	0.07
Crisis Experience	**1,127**	0.41	0.49	**1,127**	0.38	0.49	0.03
Lagged ROA	**1,127**	0.06	0.06	**1,127**	0.05	0.06	0.01***
Lagged ROE	**1,127**	0.04	0.05	**1,127**	0.03	0.06	0.01
Lagged Tobin's Q	**1,127**	2.07	0.91	**1,127**	1.91	0.88	0.16***
Lagged Investment	**1,127**	0.04	0.06	**1,127**	0.04	0.06	0.0

Table 8

Table 8 summarizes the covariates of the control and treatment group. All observations in the control group are matched with the treatment group, resulting in the removal of excess control observations without a treatment match. The final dataset holds 2,254 observations.

The last column shows the difference in means between the two groups. Although the propensity score matching technique has made most of the existing differences in means of the independent variables in Table 4 (original sample) insignificant , the propensity score sample still holds significant mean differences for Ownership percentage and lagged performance. This could indicate that these variables play a major part in explaining the overconfidence level of a CEO.

Table 9: Propensity Score Matching: Regression of Net Buyer on Firm Performance and Investment

OLS regressions with CEO overconfidence as independent variable and various firm performance measures as dependent variables. Regression 1,2,3 and 4 do not contain industry fixed effects and control variables. Regressions 5 to 8 are controlled for several CEO and firm characteristics. Standard errors are in parentheses. *** p<0.01, ** p<0.05, *p<0.1

	Baseline Regressions: No Fixed Effects, No Control Variables				*Regressions with Fixed Effects and Control Variables*			
	ROA	ROE	Tobin's Q	Investment	ROA	ROE	Tobin's Q	Investment
Net Buyer	-0.011***	-0.010***	-0.177***	-0.004	-0.004	-0.006*	0.053**	-0.0001
	(0.003)	(0.003)	(0.059)	(0.002)	(0.003)	(0.004)	(0.026)	(0.001)
Crisis_2020	-0.021***	-0.024***	0.144*	-0.016***	-0.013***	-0.010*	0.018	-0.002
	(0.004)	(0.005)	(0.078)	(0.003)	(0.004)	(0.005)	(0.036)	(0.001)
Net Buyer: Crisis_2020	0.003	-0.001	-0.051	0.007	-0.003	-0.008	-0.102***	0.001
	(0.006)	(0.006)	(0.108)	(0.005)	(0.004)	(0.005)	(0.036)	(0.001)
Tenure					-0.019	-0.020	-0.038	0.006
					(0.014)	(0.017)	(0.115)	(0.005)
Firm Size					0.030***	0.077***	-0.456***	0.027***
					(0.007)	(0.008)	(0.055)	(0.002)
Gender					-0.117	-0.109	0.303	0.027
					(0.078)	(0.100)	(0.665)	(0.026)
Age					-0.006***	-0.013***	0.100***	-0.001**
					(0.002)	(0.003)	(0.019)	(0.001)
Total Compensation					0.003*	0.002	0.033**	-0.0005
					(0.002)	(0.002)	(0.014)	(0.001)
Ownership Percentage					0.002**	0.001	-0.008	0.0003
					(0.001)	(0.001)	(0.006)	(0.0003)
Leverage					-0.025***	-0.027***	-0.073***	0.002**
					(0.003)	(0.003)	(0.022)	(0.001)
Capital Intensity					0.515***	0.718***	1.703***	1.351***
					(0.060)	(0.076)	(0.509)	(0.020)

Table 9 - Continued

					Regressions with Fixed Effects and Control Variables			
					ROA	ROE	Tobin's Q	Investment
Duality					0.007	0.002	0.033	0.0004
					(0.007)	(0.009)	(0.059)	(0.002)
Market to Book					(0.00005)	(0.0001)	(0.0004)	(0.00001)
					(0.00005)	(0.0001)	(0.0004)	(0.00001)
ROA_{t-1}					-0.173***			
					(0.030)			
ROE_{t-1}						-0.228***		
						(0.032)		
Tobin's Q_{t-1}							0.031	
							(0.024)	
$Investment_{t-1}$								0.044***
								(0.015)
Crisis Experience					0.292	0.305	-0.188	-0.118
					(0.249)	(0.319)	(2.120)	(0.085)
Constant	0.056***	0.039***	2.116***	0.043***	0.331*	0.212	1.508	-0.250***
	(0.002)	(0.002)	(0.041)	(0.002)	(0.172)	(0.220)	(1.473)	(0.058)
Observations	2,254	2,254	2,254	2,254	2,254	2,254	2,254	2,254
R^2	0.031	0.041	0.012	0.016	0.528	0.391	0.863	0.933
Adjusted R^2	0.029	0.039	0.010	0.014	0.469	0.316	0.846	0.924
Residual Std. Error (df = 2242; 2001)	0.063	0.067	0.911	0.049	0.047	0.056	0.359	0.014
F Statistic (df = 5, 2242; 246,2001)	14.189***	19.386***	5.423***	7.363***	9.082***	5.217***	51.104***	112.818***
Firm Fixed Effects	NO	NO	NO	NO	YES	YES	YES	YES
Controlled	NO	NO	NO	NO	YES	YES	YES	YES

Table 9

Table 9 shows the regression results of overconfident CEOs on ROA, ROE, Tobin's Q and Investment. The first four baseline regressions are not controlled by firm and CEO characteristics and do not have firm fixed effects, while the last four regressions do. The R-squared coefficients of all regressions are similar to those of the main regressions (Table 5, without propensity score matching). Net Buyer without interaction coefficients are significantly negative at the 90% confidence interval for ROE (column 6, -0.006*). In the main regressions of Table 5 this coefficient is -0.05*. The interaction variable between Net Buyer and Crisis 2020 shows negative relationships throughout the three performance measures and shows a positive relationship for Investment. Only the relationship with Tobin's Q is significant on the 99% confidence interval level with a coefficient of -0.121 (column 7). This negative significant relationship corresponds with earlier findings in the net buyer and holder67 regressions.

If we look at the regressions with control variables and firm fixed effects (column 5 to 8), we see firm size has a significant positive effect on ROA and ROE and Investment (0.030***,0.077***, 0.027***) while showing a negative relationship to Tobin's Q (-0.456***). Total compensation and ownership percentage show weak but sometimes significant positive relationships to the firm performance measures. Leverage however, has a negative relationship on all three firm performance measures on the 99% confidence level and a positive effect on Investment (column 8, 0.002**) . Furthermore, we see that lagged performance plays a large, significant role in every regression.

The regressions results of the propensity score matching data robust and even solidify the findings of the main regression. The interaction effect of Net Buyer and Crisis 2020 displayed a more significant, stronger negative relationship. This helps mitigate endogeneity concerns and further proves the existence of a negative relationship between an overconfident CEO and firm performance during COVID-19.

7. Conclusion & Limitations

This section presents the conclusions of this research on CEO overconfidence and its impact on firm performance and investment during COVID-19. Firstly, this thesis aims to identify whether overconfident CEOs have a negative effect on firm performance during COVID-19. Secondly, this thesis examines the effect of CEO overconfidence on investment level during the COVID-19 crisis. The established research question of this thesis is:

How did CEO overconfidence affect firms during the COVID-19 crisis?

In order to examine this research question, CEO-specific and firm-specific data from the Execucomp and Compustat databases are matched. With this data two proxies for overconfidence are constructed in line with Malmendier and Tate (2005). Furthermore, several obtained variables are used to control the regressions. The sample used in the main regressions of this thesis consists of 2,610 observations of the years 2018 to 2021.

Firstly, it is studied in Table 5 if CEOs who show irrational share acquisition behaviour over a period of five years, net buyers, affect firm performance and investment level. Ordinary least squares regressions are used with ROA, ROE, Tobin's Q and Investment as dependent variables. The results of this analysis prove that overconfident CEOs negatively affect Tobin's Q by -0.077 in a crisis. Other dependent variables showed insignificant negative relationships. Therefore, another proxy for CEO overconfidence is tested in Table 7. This proxy (Holder67) uses the option realization behaviour of CEOs as an indication for their overconfidence. The regression results on Holder67 showed that CEO overconfidence negatively affects Tobin's Q by -0.148. This second strong negative relationship means that two firm performance measures showed a negative relationship to the constructed overconfidence measures.

The fact that some coefficients of the interaction between the dummy crisis 2020 variable and firm performance are significantly negative in both regressions gives some comfort for my hypotheses. For the first hypothesis, I am comfortable to reject the null hypothesis and accept the alternative hypothesis. In other words, CEO overconfidence has a negative effect on firm

performance during the COVID-19 crisis. I base this conclusion on the significant negative coefficients for Tobin's Q in both regressions.

I also reject my second null hypothesis that states that CEO overconfidence has a positive effect on the amount of investment during the COVID-19 crisis. The relationships are positive for both Net Buyer and Holder67. However, the relationship is only significant on the 99% level in the Holder67 regression. Thus, further research should point out why this relationship is not significant in the net buyer regressions. Nevertheless, I believe it is safe to say that there is a positive relationship between CEO overconfidence and investment level during times of crisis. To eliminate endogeneity concerns, a propensity score model is constructed. With an optimal distance propensity matching technique statistical differences between firms from the control (non-net buyer) and treatment (net buyer) group are removed. The results of this propensity score model further underpinned the results and indicated a (significant) negative relationship to Tobin's Q of -0.102.

The contribution of this thesis is twofold. First, this thesis aims at expanding the results of Malmendier and Tate (2005), especially in a period of crisis. Since overconfidence is a behavioural bias, its implications could differ in a period of economic decline. As reported, the implication of the crisis is significant. Therefore, the results of Malmendier and Tate (2005) are expected to differ in a period of crisis. This research could have implications for further firm decisions. If firms want to hire a CEO, they have to take into account the possibility that another pandemic or crisis hits the financial markets. This research indicates that overconfident CEOs further deteriorate firm performance in these times. Bearing this in mind, the outcomes of this research might thus persuade firms to choose a non-overconfident CEO for challenging times.

Secondly, this thesis looks at the impact of CEO overconfidence on investment level in crisis times. The impact of the interaction between overconfidence CEOs and crisis years was not examined yet. No significant results are found, therefore there is no evidence that there is any impact of CEO overconfidence on investment level during a crisis. At first glance these insignificant results might look like results without implications, but I believe not showing a relationship has value as well. The research namely suggests that when firms are hiring a CEO and consider the risk of entering crisis years, they do not have to incorporate the risk of an

overconfident CEO increasing the level of (risky) investment significantly more than a non-overconfident CEO.

7.1 Limitations and Further Research

Just as many other research papers, this study is subject to some limitations. Some of these limitations arise due to the methodology and data used in this thesis. Others are merely research gaps that can potentially be filled by further research.

First, I point out that the overconfidence variables used are proxies. CEO overconfidence is a behavioural bias which is hard to quantify and can never be fully captured with data. With the use of broadly accepted papers like in the well-cited paper of Malmendier and Tate (2005), this research tries to relieve as much of the subjectivity as possible. Nevertheless, actual CEO overconfidence might still not be uniquely the proxy results, meaning that some overconfident CEOs can be incorrectly categorized.

Another limitation is the fact that this research pertains to at a time period that has not fully come to an end yet. At the time of writing, the COVID-19 pandemic is still far from over and new variants are still emerging across the globe. Although the financial markets apparently have recovered from the first shocks, it cannot be forecast with certainty that COVID-19 will not upset markets in the future again. Therefore, we may as yet not have seen the entire impact of this pandemic. This limitation is also an avenue for further research. I hope that research on this topic will be performed after the pandemic is fully eradicated to examine the full effect.

Future researchers might also consider a deep dive in the dependent variables and their specific effects. As not all performance measures showed significant results, it might be of interest to look at the reason behind this, and what specific factors that form the used performance measures are affected.

8. Appendix

APPENDIX 1: Variable Descriptions

Variable	Description	Variable	Description
Total Assets	Total reported balance sheet assets at the end of a fiscal year	**Firm Size**	Log of Total Assets
Capital Expenditures	Capital expenditures over fiscal year	**Market to Book Ratio**	Market Equity / (Total Assets − Long term Debt − Debt in Current Liabilities)
Duality	Official title of CEO holds: "Chairman"	**Tobin's Q**	(Total assets + Market Equity − Book Equity) / Total Assets
Ownership Percentage	Percentage of shares owned by CEO	**Investment**	$\text{Capital Expenditures/Total Assets}_{t-1}$
Age	Age of CEO in fiscal year	**Tenure**	Year left as CEO (current CEO marked as 2021) – Year became CEO
Total Compensation	Salary + Bonus + Other in fiscal year	**Crisis Experience**	Binary: 1 = Became CEO =< 2008; 0 = Became CEO > 2008
Gender	Gender of CEO	**Lagged ROA**	Net Income (loss) $_{t-1}$ / Total Assets $_{t-1}$
Market Equity	Common shares outstanding * price closed fiscal year	**Lagged ROE**	Net Income (loss) $_{t-1}$ / Market Equity $_{t-1}$
Book Equity	Stockholder's Equity – Preferred stock liquidating value – Post-retirement assets + Deferred tax + Investment tax credit	**Lagged Tobin's Q**	(Total Assets $_{t-1}$ + Market Equity $_{t-1}$ - Book Equity $_{t-1}$) / Total Assets $_{t-1}$
ROA	Net income (loss)/Total Assets	**Lagged Investment**	Capital Expenditures $_{t-1}$ / Total Assets $_{t-2}$
ROE	Net income (loss)/Market Equity	**Strike Price**	Share Price Fiscal Year Close – Value per Vested Options
Leverage	Longterm Debt + Debt in Current Liabilities/Stockholder's Equity	**Holder67**	Strike Price / Share Price Fiscal Year Close
Capital Intensity	Capital Expenditures/Total Assets		

Table 10

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