CEO Overconfidence and the Probability of Bankruptcy

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Abstract

This thesis examines the relation between CEO overconfidence and the probability of bankruptcy. In addition to the main research question, we develop two additional hypotheses. We evaluate the potential link or channel between CEO overconfidence and the probability of bankruptcy. In the relationship between CEO overconfidence and the probability of bankruptcy, we seek for any interaction effects of CEO dominance. It is not uncommon for CEOs to be overconfident about their firms' prospects. In our sample, we use data from the year 2000 to 2019 for US companies. We proxy the bankruptcy probability using Altman's Z Score. We use a stock option-driven measure of overconfidence, and this measure assumes that non-overconfident CEO will exercise their stock options if it is in the money, while overconfident CEOs will hold stock options beyond a rational threshold. We construct both continuous and indicator-based measures of overconfidence to test the hypotheses. The empirical findings reveal that CEO overconfidence increases the probability of bankruptcy. We do not find any evidence in favor of overinvestment which we consider as a channel through which overconfidence leads to increased bankruptcy risk. We also find that dominant and overconfident CEOs are suited for innovative firms, implying that giving an overconfident CEO a dominant position can minimize a firm's probability of bankruptcy. The implications of this study are that firms should be cautious in hiring overconfident CEO and they should take measures to reduce the negative effects of CEO overconfidence like the probability of bankruptcy. One way to reduce the probability of bankruptcy in innovative firms is to appoint overconfident CEO into a dominant position.

Keywords: CEO Overconfidence, Probability of bankruptcy, Altman Z-Score, Overinvestment, CEO dominance.

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Table of Contents

List of Tables

1. Introduction

In this thesis, we propose and test a new explanation of a negative outcome of managerial behavior on company performance. Instead of focusing on the impact of firm-level characteristics on bankruptcy probability (Campbell et al., 2008; Furfine & Rosen, 2011), we examine whether the probability of bankruptcy can be interpreted by CEOs' psychological traits or personal characteristics. In particular, we investigate the linkages between CEO overconfidence or over-optimism to the probability of bankruptcy. Increasing risks of bankruptcy or default hamper companies' productivity, customer satisfaction, employee retention and incur high administrative and legal costs. While many researchers relate bankruptcy with firm performance, others associate it with the attribute of board composition (Daily et al. 1994; Darrat et al., 2016). Furfine & Rosen (2011) find increased default risks of an acquiring firm after mergers. Nonetheless, the study of bankruptcy necessitates more research because investors and financial managers are continuously looking for information about a company's financial position.

Rational individuals, whether investors or executives, think, forecast, and evaluate a project's potential before embarking on it. While irrational individuals start working without much thought, sometimes even simply based on their own belief and capability. Simon (1993) categories decision making into three distinct tasks. Identifying the issues that seek attention and responding to them is the first step in making a decision. After identifying problems, we should look for solutions, i.e., what options will assist us in resolving those concerns. The last step is to assess the options and select one. A company's decision makers are its top executives and if they make irrational judgments, the company's performance will suffer.

Behavioral finance appears to link human behavior with financial outcomes. Investor and executive irrationality are two common topics in behavioral finance study. The focus of this thesis is on managerial irrationality, specifically manager's overconfidence. Overconfident people tend to be judgmental and optimistic even in uncertain situation. Overconfidence research has found that CEOs overestimate their abilities, overinvest, spend in projects with a negative net present value, and make poor mergers and acquisitions (Malmendier & Tate, 2005, 2008; Kim et al., 2016). As a result, it's fascinating to investigate one of CEOs behavior and assess whether it has any implications for organizational policies.

Research related to behavioral finance on corporate policies gets popularity since the introduction of Malmendier & Tate's (2005) paper on CEO overconfidence and corporate investment. They show that managerial overconfidence distort investment. When overconfident CEOs have plenty of cash on hand they overinvest, but they cut back when they need to borrow money. Kim et al., (2016) show that higher stock price crash risks exist in companies with overconfident CEOs. Overconfidence has long been considered the reason for corporate risk-taking, which reduces a firm's value. Adam et al., (2015) examine the effect of overconfidence on corporate risk management, and they conclude that overconfidence dominates several corporate and risk management decisions. An overconfident CEO overestimates the company's performance and thereby increases the risks. These overconfident CEOs think they have private information regarding the return of their companies and curtail investment if external funds require (Malmendier & Tate, 2005). Because of the risks taking tendency, the possibility of bankruptcy filing increases by a more significant percentage. By analyzing CEO behavior in exercising options, we tried to figure out the impact of CEO overconfidence on probability of bankruptcy. Previous research (Malmendier & Tate, 2008) shows that overconfident managers overinvest when

they have enough funds; in that context, we assume overinvestment[1] as a reason for increased probability of bankruptcy, and we use overinvestment as a channel to show the impact of overconfidence on the likelihood of probability of bankruptcy.

To test the relation between CEO overconfidence and the probability of bankruptcy, we measure CEO overconfidence using CEO personal portfolios and modify the stock option-based measure of Malmendier and Tate (2005) following Banerjee et al., (2020). We use both continuous and indicator measures of overconfidence. We measure the average percent moneyness of CEOs' option holdings each year and choose CEOs as overconfident who are in the top tercile for the continuous measure. We collect data on executives' stock and option holdings from ExecuComp, financial and accounting data from Compustat, and monthly stock prices from CRSP between 2000 and 2019.

Past literature shows that overconfident CEOs overestimate the performance of companies and overinvest when they have enough internal cash holdings (Malmendier & Tate, 2005, 2008). Overconfident CEOs increase stock price crash risks of a company (Kim et al., 2016), strong managerial discretion leads overconfident CEO to take risks which ultimately increase firm risks (Li & Tang, 2010). Consistent with the first hypothesis, we get a positive relation between overconfidence and the probability of bankruptcy. We get significant and robust results across continuous and indicator measures of overconfidence. Results from the difference in difference model and the two-stage least square model demonstrate that CEO overconfidence is positively associated with the probability of bankruptcy likelihood.

[1] There are also other issues like stock price crash risks and value-destroying mergers, which could increase the likelihood of probability of bankruptcy.

We also explore the role of overinvestment in the relationship between overconfidence and the bankruptcy probability. We considered overinvestment as a channel, but the evidence of our study suggests that overinvestment is not a true channel for which probability of bankruptcy increase. Apart from this, we also check for the interaction effect of CEO dominance and CEO overconfidence on the probability of bankruptcy likelihood. We find that dominant CEOs are suitable for innovative firms. A dominant and overconfident CEO reduces the risks of bankruptcy in innovative firms. We contribute to the body of probability of bankruptcy literature by including the impact of overconfidence on probability of bankruptcy and showing the evidence of the impact of personal managerial traits on probability of bankruptcy. This thesis is related to emerging behavioral finance research that examines CEOs personal managerial traits such as overconfidence in business performance and corporate policies.

The remainder of the thesis is organized as follows. Section 2 relates the managerial overconfidence and bankruptcy literature, and hypothesis development is in Section 3. Section 4 introduces the data and variable measurement, the methodology included in Section 5. Section 6 outlines the regression results and section 7 includes robustness check. And section 8 concludes the thesis.

2. Literature Review

The literature review section starts with the general idea and definition of overconfidence from literatures. The section then proceeds with the description of self-performance of overconfident CEO. We include the literatures of the impact of overconfident CEO on corporate performance and corporate policies.

2.1 CEO overconfidence

Overconfidence is one of the CEO personal characteristics that has a wide range of effects on firm's performance and in this thesis, we are focusing on that. So, what's exactly mean by CEO overconfidence? Before going into the definitions of overconfidence, we want to highlight some reasons or causes of overconfidence. Russo & Schoemaker (1992) divide the causes of overconfidence into three distinct areas: cognitive, physiological, and motivational causes. Availability bias, conformity bias, other biases are one type of cognitive reason, and they can be mitigated through fast and precise input, counter reasoning, or critical study of the topic. Confirmation bias, which has been studied extensively in the literature, is a partly perceptual and partly behavioral cause of overconfidence. Experiment participants' confirmation bias occurs when they overuse positive evidence (for a given hypothesis) while ignoring conflicting arguments (Skala, 2008). Personal or professional success leads to jubilations, a happy feeling, which may create overconfidence. The most significant thing in dealing with physiological or all kinds of overconfidence is individual awareness. Motivational causes induce us to believe in our ability, which sometimes become a distorting reality.

Overconfidence linked to some behavioral biases among them overoptimism and miscalibration are the most common[2]. Researchers commonly define miscalibration as the difference between actual outcome and assigned probability. Overconfidence is a type of miscalibration in which the assigned probability that the given responses are correct is greater than the genuine accuracy of the answers (Skala, 2008). In the analysis of clinical judgement of psychologists, Oskamp (1965) found complete discrepancy between accuracy rate and confidence. Although psychologists claimed 53% confidence, their accuracy rate was just 28%, which the

[2] Other biases include- illusion of control, unrealistic optimism, self-attribution biases, and positive illusion.

author describes as overconfidence. The illusion of control occurs when people believe they have control over the result of an event that is either skillful or depending on luck. Langer & Roth (1975) find that people think they have control over outcome even though the event determined by luck. A perfect example they mention; people believe in themselves and prefer to toss dice themselves rather than having someone else do it for them because they believe they have more control over it. Overestimation leads to a better-than-average effect, which is another key behavioral bias of executives. People seem themselves more capable and expert compared to their peers or competitors. Svenson (1981) experiment better than average effect within a sample of drivers and inquired about their driving skills in comparison to a group of drivers. In comparison to the typical drivers in each group, most participants in the experiment believed they were more skilled and safer.

Economists began incorporating psychological results into economic models in the mid-twentieth century, and overconfidence has since been a research topic for economists, mostly relating to financial market activity. Researchers define CEO optimism and CEO overconfidence to the extent that looks almost similar in many finances and economics literature (Malmendier & Tate, 2005, 2008; Campbell et al., 2011; Hayward & Hambrick, 1997). We can classify someone as overconfident if their confidence in the correctness of their prediction exceeds the actual extent (Klayman, Soll, Gonzalez-Vallerjo, & Barlas, 1999; Simon, & Houghton, 2003). People generally stay optimistic about their performance compared to their peers. Larwood and Whittaker (1977) point out that people believe themselves as more productive than they are capable of. They test the hypothesis and assert that executives tend to take overly optimistic plans for their companies when these biases occur at organizational levels. Russo & Schoemaker (1992) conclude that overconfidence distorts decision-making and exists as hidden defect in managerial decision-

making. People have an unrealistic optimistic assumption regarding future life events, and this hypothesis is investigated and supported by Weinstein (1980). He finds that people think about their own ability and qualities which may help them to achieve success, while they fail to recognize about the qualities of their peers or rivals. Overconfident managers overestimate the firm performance, and they think their venture will succeed because of their own knowledge and expertise (Hayward & Hambrick, 1997; Hayward et al., 2006).

Overconfidence remains an unresolve issue in finance. Many researchers strongly support the existence of overconfidence in investors, traders, and top executives. Maciejovsky and Kirchler (2002) discover that overconfidence is higher for risky asset when agents depend particularly on their experience gained from overly optimistic knowledge. Chuang and Lee (2006) demonstrate a variety of effects of overconfidence on financial markets using data from US listed businesses from 1963 to 2001. They discover evidence for private signal overreactions and public signal underreactions, as well as the existence of short-term momentum and long-term reversal. Friesen and Weller (2006) use earnings estimate to demonstrate financial analyst overconfidence, which is perceived as an overestimation of personal information value.

2.2 CEO overconfidence and firms' performance

The characteristics and behavior of CEOs have a significant impact on a firm's performance, and such literature has become popular among researchers. CEO is one of the most powerful actors in the company, and his methods reflect his personality (Hambrick & Mason, 1984). CEO qualities influence strategic decision-making and strategic actions, both of which have implications for business success. Miller & Toulouse (1986) investigate the relationship of three

aspects of CEO personality[3] to firm performance and find a strong influence of CEO personality to corporate policies and outcome. They conclude that executives with internal control and confidence have been involved more in product innovation and aggressive business strategies. In the case of CEO personality and firm performance, Nadkarni et al., (2010) argue that CEO personality has a role in evolving strategic flexibility, which influences firm performance by enhancing or stemming strategic flexibility.

Overconfident CEOs' behavior resembles that of a gambler, and an overconfident CEO gambles with the firm's return. There is a chance of making a huge profit, but the odds of losing money outnumber the chances of making a profit. Analyzing corporate debt maturity structure, Huang et al., (2016) find that firms with overconfident CEOs take short-term debt maturity structure, ignoring the liquidity risk of such strategy. Banks with overconfident CEOs make themselves more vulnerable to the crisis period, and there happens to be an increase in default of loans, a significant fall of firm performance, and soar in the probability of default in the crisis period compared to other banks (Ho et al., 2016).

In an experiment on business start-ups conducted by Camerer and Lovallo (1999), a noticeable and extremely substantial presence of overconfidence is established, primarily in terms of the better-than-average effect and unjustified optimism. Even though most of the business founders remain informed about the failure rate of start-up businesses, they stay optimistic about their own investment and predict a positive profit and success. This is due to the overconfidence of entrepreneurs, who are overconfident in their own competence.

2.3 CEO overconfidence and firm risk, M&A activities and bankruptcy

[3] Three aspects of CEO personality are CEO flexibility, CEO need for achievement, and locus of control.

Performance of a firm and its default risks considered as a core issue for investors. When investors become informed of a company's default risks, it works as a sanctuary for their investments. When evaluating default risks, these investors might learn about a company's liquidity, profitability, leverage, and a range of other accounting and financial information. Literature on default risks in terms of board composition, firm performance, corporate policies, mergers, and acquisition seems abundant. Daily & Dalton (1994) study board composition and bankruptcy and find that bankrupt firms have less CEO and chairperson on their board. They conclude that bankrupt firms have lower earnings, lower liquidity, and lower equity than non-bankrupt firms. They also show that in bankrupt firms', the proportion of CEOs working as board chairs is also higher. Dambolena & Shulman (1988) study the relation of cash holdings and probability of bankruptcy. They find that probability of bankruptcy decreases when a firm has higher net liquid assets. Uhrig-Homburg (2005) shows that insufficient cash flow leads firms to bankruptcy. Many researchers point out that bankruptcy occurs because of loose board structure and governance (Platt & Platt, 2012; Darrat et al., 2016; Fich & Slezak, 2008). Fich & Slezak (2018) investigate financially distressed firms and find a significant impact of the governance structure of the distressed firms on the probability of bankruptcy. Furfine & Rosen (2011) find that mergers and acquisitions add probability of bankruptcy to the acquiring firm.

Though there exists an abundance of studies on bankruptcy filing and the probability of bankruptcy, the impact of CEO behavior or CEO characteristics on probability of bankruptcy is not explored adequately. Overconfidence has been linked to a number of negative outcomes in the past, which prompted us to investigate the relationship between overconfidence and the risk of bankruptcy. Roll (1986) links executive hubris with corporate finance. He argues that a firm with a hubris executive pays an excessive amount to the target firm if it participates in bidding. Hayward

& Hambrick (1997) demonstrate that CEO hubris substantially impacts company performance and shareholder value. They found a substantial loss of shareholder's wealth following an acquisition, and this loss was more significant for higher hubris and acquisition premiums. It seems more probable that an overconfident entrepreneur will lead the company to failure (Hayward et al., 2006).

Overconfident CEOs overestimate the return, who in turn overestimate firm performance. Malmendier & Tait (2005) find that overconfident CEOs overestimate the return of future company projects. They overinvest if they have ample funds and have no obligation from corporate governance or the capital market. They do not issue new equity because they think the market will undervalue their company's equity, and thus, they curtail investment when they lack funds. CEO with overconfidence tends to acquire firms with overpayment because of overestimation, and the effects tend to be higher if the CEO has access to internal financing (Malmendier & Tate, 2008). They further show that overconfident CEOs overestimate their capability to generate future returns and make acquisitions that destroy their shareholders' value.

Overconfident CEOs also contribute to stock price crashes as they overestimate the projects' performance, and there is a possibility to run a project for a long time despite being a negative NPV project. Kim et al., (2016) demonstrate that higher stock price crash risks exist for firms with overconfident CEOs than its counterpart, and this risk becomes more evident when the CEO gets a dominant position in the management team. Benmelech et al., (2010) show the adverse impact of stock-based compensation on stock price crash risks. They conclude that stock-based compensation encourages executives to hide bad news regarding the future growth option to keep the firm's worth high. To keep stock price high, they overinvest, which creates overvaluation and a substantial crash in stock prices. Managers keep bad projects because of lousy incentive

packages, they benefit themselves at the expense of shareholders, and young CEOs are riskier than older ones (Serfling, 2014).

Firm risk-taking is also associated with the behavioral decision-making of executives. Scholars so far discuss three main instruments to discuss firm risk-taking with managerial decision-making (Li & Tang, 2010). First, overconfident executives tend to overestimate their performance over their peers (Hayward et al., 2006). This overestimation leads executives to pay a higher amount for acquisition, leading to shareholder wealth losses (Hayward & Hambrick, 1997). Because of overestimation, overconfident CEOs pay higher amounts for target firms and enter upon value-destroying mergers (Malmendier & Tait, 2008). Secondly, an overconfident CEO tends to overestimate the resource endowment in his or her company and avoid taking outside financing. Malmendier and Tait (2005) argue that overconfident CEO reluctant to take outside financing and prefer internal over external financing. Finally, overestimation leads CEOs to underestimate uncertainties in their business environment. They believe they possess more information than they have. They think their prediction regarding the firm performance is more accurate than the actual figure (Klaymann et al., 1999). The possibility of underestimating risks and uncertainty increases with an increased perception of control (Schwenk, 1986). This illusion of control increases forecast biases and the absolute value of errors (Durand, 2003). Ultimately, forecast biases and the illusion of control lead to poor outcomes (Li & Tang, 2010).

3. Hypothesis Development

CEOs are among the most powerful persons in a company, and their personal characteristics and behaviors will influence firm's performance. The upper echelons theory assumes that executives' managerial, psychological, and belief characteristics, as well as other

demographic factors, impact their actions and outcomes (Hambrick, 2007). Top executives play a critical role in the success of a corporation (Hambrick & Mason, 1984). Managers enjoy taking risks and do so. They are, however, unconcerned with the likely consequences of their choices (March & Shapira, 1987). Though the performance of top executives is crucial, it is not always in a positive way. Depending on the situation, their activities may result in success or failure.

According to Chen et al. (2014), there is a link between CEO overconfidence and a healthy growth in R&D spending. They find that long-run stock returns are good only for firms with non-overconfident CEOs after evaluating abnormal stock returns and firm performance following increasing R&D investment. They also discovered that increasing R&D spending for companies with overconfident CEOs is less worthwhile; it adds no value to the company. Overconfident executives provide poor long-term results and low announcement returns (Doukas & Petmezas, 2007). Over-optimistic entrepreneurs are more likely to drive businesses to bad performance and insolvency by extending a failing initiative (Lowe & Ziedonis, 2006). Risk-taking has a considerable impact on corporate performance and has critical implications for survival (Bromliley, 1991).

Managers that are overconfident overstate company's performance. As a result, they enhance the firm's risks by investing for a longer term in a project with a negative net present value (NPV) or stopping investment in the project for personal reasons. The risk of overestimation or underestimating puts a corporation in financial trouble, which may prompt it to declare for bankruptcy. Yilmaz et al., (2014) support this argument by stating that overconfident CEO creates a significant negative impact on a firm's stock price. Firms that take extensive capital investments and have growth in net operating assets are negatively associated with future returns on stock

(Titman et al., 2004). Abarbanell and Bushee (1997) show that capital expenditure larger than the industry average signals negative stock returns in one year ahead.

Overconfident CEOs overestimate the return on investment and, as a result, overestimate corporate performance. They overinvest because they overestimate their companies' performance. They also engage in value-diminishing mergers. These overconfident CEOs also have a proclivity for taking risks, which raises the chance of a stock price drop. Because of these negative consequences of overconfidence, an overconfident CEO will lead a company into a scenario where it will be unable to generate enough income to cover debt obligations, ultimately increasing the likelihood of bankruptcy. Therefore, we make the following hypothesis:

Hypothesis 1. *There is a positive relationship between overconfidence and the probability of bankruptcy.*

Excess investment and excess market entry or product innovation could lead an organization into failure. Barnet & Freeman (2001) find that entry of multiple products simultaneously into the market increase the hazard of organizational failure. Entrepreneurs' optimism negatively correlates with firm performance regarding revenue and employment growth (Hmieleski & Baron, 2009). According to Li (2004), there is a negative relation between overinvestment and future profitability and stock return when companies have extensive investment discretion, i.e., greater free cash flow and lower leverage. Further, he argues that this negative association occurs solely because of positive discretionary investment; in this case, overinvestment is more likely. Overinvestment is more critical for firms with fewer investment opportunities as it reduces the productivity of assets (Fu, 2010).

Goel & Thakor (2008) divide CEO overconfidence into three types: i) Risk-averse or less overconfident ii) Moderately overconfident iii) Highly overconfident. They propose that

moderately overconfident CEO reduce underinvestment and increase firm value while highly overconfident CEO do overinvestment and reduce firm value. CEOs invest excessive amounts because of stock options incentives, and these investments occur at an insecure level (Sanders & Hambrick, 2007). They also find that stock options incentives bring about extreme firm performance, and in most of the cases, significant losses compare to significant gains. Managers seem to be miscalibrated; they either underinvest or overinvest. Studying a broad sample of CFOs, their capabilities, and how this ability affects corporate policies, Ben-David et al., (2013) show that overconfident managers invest more and have more debt than less confident managers. To explore the high rate of business failure, Camerer & Lovallo (1999) conducted an in-depth study. They find that decision-makers overestimate their capabilities and relative success, and overconfidence is a reason for the high business failure rate. Hence, we have the following hypothesis:

Hypothesis 2. *Overinvestment is a channel through which overconfidence increases probability of bankruptcy.*

CEO dominance is different from CEO overconfidence: while overconfidence is intrinsic and personal characteristics of an individual, CEO dominance is a leadership role that relates to power and position. Dominance means the capability of oneself to impose rulings and will on others. Brown and Sarma (2007) argue that CEO dominance has almost similar significance as CEO overconfidence on corporate acquisitions, and they find the positive effect of CEO dominance. In our first hypothesis, we argue that CEO overconfidence increases probability of bankruptcy. When an overconfident CEO becomes a dominant CEO, it will be easier to exercise his or her decisions and willingness within the firm. Therefore, we hypothesize that the interaction of CEO dominance and CEO overconfidence will increase the probability of bankruptcy.

Hypothesis 3*. The interaction effect of CEO overconfidence and CEO dominance has positive effect on the probability of bankruptcy.*

4. Data and Variable Measurement

4.1. Sample selection and data sources

Our study comprises data from 2000 to 2019, and we use several datasets, including Compustat, Execucomp, CRSP. Stock options data and other CEO personality traits that might impact corporate performance, have been collected from the Execucomp database. This database comprises S& P 1500 index companies or companies that were once part of the S&P 1500. At first, we collect executive compensation data from the Execucomp dataset and began with closely 38,000 observations on CEO compensation from 2000 to 2019. Following past literature, we exclude financial (the SIC code between 6000 and 6799) and utility companies (the SIC code between 7000 and 8999) from the sample as they have different mechanisms and regulations compared to other industries. We exclude any missing values for required variables to compute CEO overconfidence. We classify different firms based on their Standard Industrial Classification Codes (SIC) and construct industry dummies to check industry effects on the regression model. From Compustat, we obtain financial and accounting data, while monthly stock return data have been collected from CRSP. To get the firm-level variables, we merge the Execucomp data with the Compustat and CRSP databases. The final sample comprises 15,038 CEO year observations, 1638 unique firms, and 3085 unique CEOs. More than half of the firm belongs to the manufacturing industry.

We compute important control variables largely following Campbell et al., (2008), including profitability, leverage, and liquidity as accounting variables and firm-related variables

include firm size (SIZE), market to book ratio (MTB), volatility of stock return (SIGMA), and excess return (EXRET). Based on the method used by Campbell et al., (2008), we calculate leverage as a ratio of total liabilities to the sum of market equity and book liabilities (TLMTA). Liquidity measure is defined as cash and short-term assets divided by the sum of market equity and book liabilities (CASHMTA). Profitability ratio calculated as net income to the sum of market equity and book liabilities (ROA). Market value of assets to book value of assets denotes market to book ratio (MTB). Market-based variables such as firm size, which we estimate as the natural log of market capitalization (SIZE). Where market capitalization is calculated by multiplying common shares outstanding with market price per share. SIGMA is the volatility of one year ahead of daily stock return. EXRET is the annualized daily log excess return calculated as the difference of daily return of each firm and S&P 500 index. To eliminate outliers in the data, we winsorize all the variables at 1st and 99th percentile. We replace observations below the first percentile with the first percentile and those above the 99th percentile with the 99th percentile.

Table 2 captures the summary statistics of the key variables we use in the regression model. The dependent variable, Z_Score, which we use to measure the probability of bankruptcy, has a mean of 4.910. We use three proxies for the overconfidence measure. The primary measure of overconfidence, OCCont, has a mean of around 0.91 and a standard deviation of 1.38. It is a continuous measure, and around 33% of the total sample classify as overconfident. The following two measures of overconfidence are indicator measures. The dummy variable for both OC67[4] and OC100[5] become one from the first time the CEO shows high overconfidence behavior, and both

[4] OC67 is an indicator measure, which equal 1 if a CEO exhibit the behavior twice within the sample period when stock options are above 67% cutoff. We assign 1 to the indicator measure OC67 when CEO shows the behavior for the first time.

[5] OC100 also an indicator variable and become 1 when a CEO exhibit the behavior to hold stock options twice within the sample period even though they are 100% in the money. We assign 1 to the indicator measure OC100 from first time CEO shows this behavior.

measures consider high or low confidence as persistent traits.[6] For measure OC67, around 53.4% of the total sample classifies as overconfident identical to other authors.[7] The third measure of overconfidence, OC100, has a mean of 0.38, almost identical to Campbell et al., (2011) 0.34. Table 3 provide the mean and median difference of the variables in the descriptive statistics. For overconfidence measure OCCont, we get low z_score for overconfident group compared to non-overconfident group. That mean bankruptcy probability is high for overconfident group. Firms with overconfident managers have higher volatility, lower size, low leverage, high profitability compared to non-overconfident group. For overconfidence measure OC100, we notice similar result as for OCCont, bankruptcy probability is high for overconfident group (OC100=1).

Table 4 panel A represents the correlation between the variables used in the regression analysis. Almost all the correlations are significant at the 1% level, which means a significant relationship exists between the variables. All three measures of overconfidence have a significant positive correlation with the probability of bankruptcy, which is consistent with our prediction. OCCont and Z_Score correlate with around 29 percent, significant at 1% level. The correlation of Z_Score with OC67 and OC100 are respectively 18% and 21% roughly. Measure OC67 and OC100 both have a strong correlation of around 74%. As both measures are indicator measures and estimate a similar effect, the multicollinearity problem should not be a concern here. Table 3 panel B represents the multicollinearity in the data. To ensure there is no multicollinearity, we must check the value of tolerance and variance inflation. The value of tolerance should not be below 0.1, and in our result table the lowest value of tolerance stands at 0.625. The result indicates that there is no multicollinearity among the variables. For variance inflation factor, the value

[6] Here, persistent trait of overconfidence means that an overconfident CEO always remains overconfident.
[7] Malmendier and Tate (2005) classify 51.3% of their sample as overconfident.

should not be above 10. Our result shows that the highest value of variance inflation sits at 1.6, which highlight lack of multicollinearity in the data. Multicollinearity is indicated when one or more of the eigenvalues are small and the related condition number is big. None of our eigenvalues or condition index correlations satisfy this description, as we can see from the result of our data, (ii) of panel B table 3.

4.2. Variable Definition

4.2.1. Proxies for bankruptcy

We calculate bankruptcy probability, Z-score, following Altman, 1968. We use the classic equation for all the publicly held firms:

$$Z = 1.2\frac{WC}{TA} + 1.4\frac{retEarnings}{TA} + 3.3\frac{EBIT}{TA} + 0.6\frac{MV}{TL} + 0.99\frac{SALE}{TA}$$

WC is working capital; TA is total asset; retEarnings is retained earnings; EBIT is short for earnings before interest and taxes; MV refers to market value of equity; TL stands for total liabilities; SALE is for sales. The five sub-ratios measure different accounting aspects; i) Liquidity of assets in terms of firm size, ii) Cumulative profitability, which denotes firms' earnings power, iii) Reflects firms operation efficiency, iv) Market dimension, v) Turnover measure. The higher the value of the Z-score, the lower the probability of bankruptcy. For the above equation, a company is considered bankrupt if Z-score stays below 1.81 and the non-bankrupt company scores more than 2.99.

4.2.2. Proxies for overconfidence

Measuring CEO overconfidence is a little complicated as indirect estimation is required. The literature on CEO overconfidence measures looks extent, and researchers use several ways to predict overconfidence. Malmendier and Tate (2005) propose option-based measures of

overconfidence, while Malmendier and Tate (2008) develop a media-based measure of overconfidence. Schrand and Zechman (2012) develop firm-specific scores to measure overconfidence. In our thesis, the overconfidence measure is based on option holding exercises.

Following Malmendier and Tate (2005, 2008), we construct an overconfidence sample based on the option grant. This measure applies the timing of option exercises to find overconfident CEOs. They define optimism if CEOs hold options that are more than 67 percent in the money (i.e., the stock price is 67 percent higher than the exercise price). The cut of threshold exercised by Malmendeir and Tate was developed by Hall and Murphy (2002). Throughout the working tenure of executives, they receive a large sum of option grants as incentives which create company-specific risks. Also, they are highly exposed to idiosyncratic risks as their human labor is tied up with companies. Thus, to mitigate the risk exposure, a rational, risk-averse, undiversified executive exercise option early, if it is in the money (Hall & Murphy, 2002). Malmendier and Tate (2005,2008) point out that CEOs those hold options beyond the rational threshold are overconfident. They argue that overconfident managers overestimate their investment's future return, which induces them to postpone option exercises or even buy more options. They also show that CEOs who hold excessive stock options do not earn any irregular return over the S&P 500.

For our first measure of overconfidence (*OCCont*), we estimate the percent moneyness of stock options as follows. At first, we gather the data of unexercised but exercisable options holding of CEOs in year t (from Execucomp database). Then we divide the total realizable value of the exercisable option (OPT_UNEX_EXER_EST_VAL) by the number of total exercisable options (OPT_UNEX_EXER_NUM) to estimate per option realizable value of unexercised but vested options. To obtain an estimate of the average exercise price of the option, we subtract per option's realizable value from the stock price at the fiscal year-end (PRCC_F). Later, the average percent

moneyness of the option or the confidence measure is calculated by dividing the per option realizable value by the estimated average exercise price. Instead of taking indicator measures as in Malmendier and Tate (2005), we use a continuous measure of overconfidence following Banerjee et al., (2020)[8]. This thesis's primary measure (*OCCont*) of overconfidence is continuous, and we divide all the observations in the sample into terciles. We termed those in the top tercile as overconfident CEO while the lowest tercile consists of non-overconfident CEO. The minimum value of the confidence level of overconfident CEO in my sample is 0.80, higher than the 67 percent threshold of Malmendier & Tate (2005).

For our second measure of overconfidence (OC67), we use option-based measure developed by Malmendier and Tate (2005). This measure is similar to the *OCCont* but instead of continuous it is an indicator variable. Though we follow Malmendier and Tait (2005) to construct OC67, our data has some differences. Malmendier and Tait (2005) construct Holder-67, which requires CEOs to hold their stock options for at least five years while the option raises 67% over that period. If the confidence level becomes at least 0.67 on two or more occasions within a sample period, it takes one. In our measure, there is a slight relaxation of a five-year holding period following Campbell et al., (2011). We assign 1 to the measure *OC67* if a CEO exhibit the behavior twice within the sample period when stock options are above 67% cutoff. We assign 1 to the indicator measure *OC67* when CEO shows the behavior for the first time.

We choose Campbell et al., (2011) high optimism measure *OC100* as our third measure of overconfidence in this thesis. In measuring indicator variable *OC100*, we consider 100% moneyness. *OC100* become 1 when a CEO exhibit the behavior to hold stock options twice within

[8] We choose continuous measure along with indicator measure as continuous measure fits with the notion of a continuum of confidence levels (Ben-David et al., 2013; Banerjee et al., 2020).

the sample period even though they are 100% in the money. We assign 1 to the indicator measure *OC100* from first time CEO shows this behavior.

4.2.3. Proxies for Overinvestment

To test the second hypothesis of this thesis, in which we are predicting that overinvestment is a channel for increasing bankruptcy probability of companies comprised of overconfident CEOs, we follow Richardson (2006) to measure overinvestment. First, we measure total investment, for which we add capital expenditure, acquisition, and research and development and subtract any sale of property, plant, and equipment.

$$I_{total_t} = CAPEX_t + Acquisition_t + RD_t - SalePPE_t$$

Then we calculate the investment expenditure of the new project as follows:

$$I_{new_t} = I_{total_t} - I_{maintenance_t}$$

Where, $I_{maintenance_t}$ is the required investment expenditure to maintain assets costs. We use depreciation and amortization as a proxy of $I_{maintenance_t}$. We use model (1) to select firms those overinvested.

$$I_{new_t} = \alpha + \beta_1 V_{P_{t-1}} + \beta_2\, TLMTA_{t-1} + \beta_3\, CashMTA_{t-1} + \beta_4\, ROA_{t-1} + \beta_5\, Size_{t-1} + \beta_6\, Age_{t-1} + \Sigma\, Industry + \Sigma\, Year \quad (1)$$

The residual of this model gives us overinvestment measure while fitted value is the expected new investment. $V_{P_{t-1}}$ is the growth opportunity which is the ratio of the value of the firm to market equity. The detail description of the control variables of above equation is attached to the appendix section.

4.3 Control Variables

We mostly follow Campbell et al., (2008) in constructing the bankruptcy-related control variables. We collect accounting-related variables from Compustat, while from CRSP, we gather market-related variables. Campbell et al., (2008) find more substantial explanatory power for market valued version of total assets (MTA), which we follow. We measure market valued version by adding market value of equity to book value of liabilities. Following Cohen, Polk, and Vuolteenaho (2003), we adjust the denominator MTA by adding 10% of the difference between the market value of equity and the book value of equity. Following Campbell et al., (2008), we make a similar adjustment to book value of equity to control outliers in the data.

Market to Book (MtB): We use Daniel and Titman's (JF 1997) Book of Equity Calculation. Where book value of equity is calculated as stockholder's equity plus deferred taxes plus investment tax credit and then subtract the value of the preferred stock. To get preferred stock, we use coalesce function to get the first non-missing value among preferred stock total (PSTK), preferred stock liquidating value (PSTKL), and preferred stock redemption value (PSTKRV). We multiply stock price at the fiscal year-end with total share outstanding to get the market value of equity. MtB is calculated as the ratio of the book value of equity to the market value of equity.

TLMTA: To measure leverage, we use the market valued version of assets as the denominator, the sum of market equity, and book liabilities. Leverage is the ratio of total liabilities to the sum of market equity and book liabilities. As high leverage increases risks, we expect a positive association with bankruptcy probability.

CASHMTA: We calculate the liquidity ratio by dividing cash and short-term investment by the sum of the market value of equity and book liabilities. We expect a negative association with default risks as liquidity ensures more stability.

NIMTA: This variable is calculated as the ratio of net income to market valued version of total assets (market value of equity plus book value of liabilities).

SIZE: Size is the logarithm of the market value of equity. We expect a negative association with probability of bankruptcy as companies with a larger market share has more stability.

SIGMA: We calculate firm specific daily return volatility over the fiscal year period.

EXRET: Annualized excess return which is the difference of daily return and S&P 500 return. We take the log difference of 1 plus the variables. We take EXRET as an indicator of firm performance, high value of EXRET should reduce default risks.

5. Methodology

To test our first hypothesis that CEO overconfidence positively correlated with the probability of bankruptcy, we use the following OLS (ordinary least square) regression model:

$$I(Z_{Score})_{i,t} = \beta_0 + \beta_1 OC_{i,t} + \sum_q^n \alpha_{q=2} \left(q^{th} ContrVar_{i,t}\right) + \varepsilon_{i,t} \qquad (2)$$

The dependent variable in equation (2) I(Z_Score) measured in year t stands for the proxy of the likelihood of bankruptcy: inverse of Altman (1968) Z_Score. β_0 is the intercept and β_1 measures the coefficient of overconfidence where OC denotes one of three proxies of overconfidence measure: *OCCont, OC67,* and *OC100*. While OCCont is a continuous variable, OC67 and OC100 are two dummy variables. All measures of overconfidence are expected to be positively correlated with the probability of bankruptcy. We include industry and year fixed effect to the above model

to partially address endogeneity issue. All the independent variables are calculated in year t. We employ a set of control variables in our regression analysis following prior research on probability of bankruptcy and overconfidence. Following Campbell et al., (2008), we use accounting-based control variables, which include profitability (NIMTA), leverage (TLMTA), and liquidity (CASHMTA), while market-based control variables are excess return (EXRET), volatility of past return (SIGMA), market to book ratio (MTB) and firm size (SIZE).

Our second hypothesis predicts that overinvestment is a mediator of increased probability of bankruptcy in firm, which have overconfident CEOs. Malmendier and Tate (2005) show that, in equity-dependent firms, overconfidence increases the sensitivity to investment to cash flow. Since overconfident CEOs overinvest,[9] we are assuming that overinvestment has a positive association with probability of bankruptcy.

To test our second hypothesis, we run a regression specification test as follows:

$$I(Z_{Score_t}) = \beta_0 + \beta_1\, Confidence + \beta_2\, Overinvestment + \beta_3 OC * Overinvestment + \beta_4\, MTB + \beta_5\, ROA + \beta_6\, TLMTA + \beta_7\, CASHMTA + \beta_8 SIZE + \beta_9\, SIGMA + \beta_{10}\, EXRET + + \varepsilon_t \quad (3)$$

Where, I(Z_Score) is the inverse of Atlman (1968) Z Score, proxy for Bankruptcy probability. Overinvestment is the residual term of Eq. (1), which we describe in the data and measurement section. All other variables are similar to equation (2). β_3 is the interaction variable between overconfidence and overinvestment and we expect a positive value of interaction term. We use all three measures of overconfidence to test hypothesis 2 in the above regression equation.

[9] We get positive correlation between overconfidence and overinvestment in our sample which is significant at 1% level. Malmendier & Tate (2005) also find that overconfident CEO overinvest.

CEO dominance or CEO power should have a significant impact on firm performance. A powerful CEO can generally make decisions with less accountability and be a central decision-maker than a less dominant CEO. Here, we argue that an overconfident CEO who becomes dominant will be highly overconfident because of decision making nature. Brown & Sarma (2007) find that CEO dominance and CEO overconfidence have a significant role in decision-making, and both have a similar impact on firm acquisitions. According to Bebchuk et al., (2011), CPS (CEO dominance) negatively relates to firm value, where industry-adjusted Tobin's Q measures firm value. In this section, we focus on CEO dominance, whether dominant overconfident CEO has more impact on Probability of bankruptcy. To figure out the impact of CEO dominance on CEO overconfidence and the likelihood of probability of bankruptcy, which is our hypothesis no 3, we use the following regression model:

$$I(Z_{Score_t}) = \beta_0 + \beta_1\, Confidence + \beta_2\, CPS + \beta_3 OC * CPS + \beta_4\, MTB + \beta_5\, ROA + \beta_6\, TLMTA + \beta_7\, CASHMTA + \beta_8 SIZE + \beta_9\, SIGMA + \beta_{10}\, EXRET + \varepsilon_t \quad (4)$$

We use CEO pay slices (CPS) to measure CEO dominance following Bebchuk et al., (2011). They define CEO dominance as the proportion of the total compensation of CEO and top five executives, where total compensation designates ExecuComp item TDC1. TDC1 is the sum of salary, bonus, other annual pay, the total value of restricted stock granted that year, the Black and Scholes value of stock options granted that year, long-term incentive payouts, and all other total compensation. β_3 is the interaction variable between CEO overconfidence and CPS, and we expect a positive value of the interaction term. We use all three measures of overconfidence to test hypothesis 3 in the above regression equation. All other variables are similar to our primary regression model Eq. 2.

6. Regression results

To check the impact of CEO overconfidence on probability of bankruptcy, we run a regression according to Eq. (2). Table 5 provides the OLS regression results between CEO overconfidence and probability of bankruptcy, which we use to test the primary hypothesis of this thesis: *There is a positive relationship between overconfidence and probability of bankruptcy*. The first three columns show the regression specifications of Eq. (2), where the dependent variable is the probability of bankruptcy measured as the inverse of Z_Score and three measures of the independent variable, overconfidence. The first three columns capture the result of baseline regression with no controls and no fixed effects. In columns 4-6, regression specification includes the control variables and no fixed effect; however, in columns 7-9, regression consists of control variables and year and industry fixed effect. Standard errors are clustered by firms in all the regression specifications. In column 1-3, the coefficient of overconfidence, all three measures are significant at 1% level, and they all are positive. The coefficient for measures *OCCont*, *OC67*, *OC100* are 0.972, 1.661, and 1.937 respectively and they are significant at 1% level. The results support our first hypothesis that overconfidence has a positive association with the likelihood of probability of bankruptcy. When we include control variables in the regression in column 4-6, the result does not change much, still they are significant at 1% and have positive coefficients. Though, the coefficients of all three measures are lower compared to the regression without control variables, still they comply with our expectations. The last three columns of Table 5 illustrate the regression results when control variables and fixed effects included. The association of OCCont with the likelihood of probability of bankruptcy (Z_Score) is positive and significant: in column 7, we see that 1 unit increase in overconfidence leads to 0.408 unit increase in probability of bankruptcy. The effect of OC67 on the bankruptcy likelihood is also positive and significant:

overconfidence leads to a 29.5% increase in probability of bankruptcy. For measure OC100, the result also robust and significant: overconfidence increases probability of bankruptcy by 58.5%.

Regarding control variables, most of them have predicted sign and level of significance. MTB and NIMTA have positive coefficients and are significant. We expect a positive coefficient for leverage (TLMTA), but it has a negative coefficient and is significant at 1%. Firm size has a negative coefficient and is highly significant. That means larger firms have fewer bankruptcy probability compared to smaller firms. CASHMTA has a negative coefficient and is significant at 5% level for overconfidence measure OC67 and OC100. EXRET has a negative coefficient while SIGMA has a positive coefficient, and both are significant at 10% and 1% levels, respectively. As expected, a more volatile firm has more bankruptcy probability. Therefore, we accept our first hypothesis that overconfidence positively affects the probability of bankruptcy.

Table 6 shows the regression results of the interaction effect of CEO overconfidence and overinvestment on bankruptcy probability. Using Eq. (3), we test the hypothesis: *Overinvestment is a channel through which overconfidence increases probability of bankruptcy*. The interaction of CEO overconfidence and overinvestment is our main interest in this regression equation. The independent variable overinvestment is being measured following equation (1), which is the residual from equation (1). There are total of 13,383 observations for which we can run regression specifications for interaction effect of overinvestment and CEO overconfidence. The mean of overinvestment is close to zero, minimum and maximum value are -0.43 and 1.28 respectively. The first three columns of table 6 present the regression results without any control variable but includes industry and year fixed effects. Columns 4-6 provide regression results using control variables and year and industry fixed effects.

We notice in columns 1 to 3 of table 6 that the coefficient of confidence is positive and strong enough for all three measures of overconfidence. Overinvestment is negatively related to probability of bankruptcy, and the result is significant at 1% level for all three measures. However, we do not get any significant interaction between CEO overconfidence and overinvestment on the probability of bankruptcy. Overinvestment has a negative association with bankruptcy probability, which means overinvestment reduces the probability of bankruptcy. However, the interaction term of overconfidence and overinvestment is not significant, which implies that we can not surely say that overinvestment of overconfident CEO will reduce probability of bankruptcy. We do not get much change in the results when we include control variables, which shown in columns 4 to 6. Still the interaction term of CEO overconfidence and overinvestment remains insignificant. Therefore, the result is not consistent with our prediction that overinvestment works as a mediator for increased probability of bankruptcy, and thus the second hypothesis has been rejected. Our findings suggest that overinvestment resulting from overconfidence does not affect probability of bankruptcy likelihood.

Panel A of Table 7 illustrates the interaction effect of CEO overconfidence and CEO dominance (CPS) on bankruptcy probability. The mean value of CPS is around 0.40 and minimum and maximum value are 0 and 0.97 respectively. We run a regression specification based on Eq. (3), and we use all three measures of overconfidence of this thesis interchangeably. For overconfidence measure OCCont: we get a negative coefficient of -0.87 for interaction term OCCont*CPS which is significant at 10% level. That means the interaction of CEO overconfidence and CPS is negatively associated with the bankruptcy probability. We get a similar result for the overconfidence measure OC67; the interaction effect of CEO overconfidence and CPS has a negative effect on the probability of bankruptcy. However, for the overconfidence

measure OC100, we do not get any significant results for the interaction term. We conclude that CEO overconfidence and CPS have a negative interaction effect on the probability of bankruptcy. Therefore, we reject our third hypothesis: *The interaction effect of CEO overconfidence and CEO dominance has a positive effect on the probability of bankruptcy.* The negative interaction effect suggests that when overconfident CEO becomes the dominant CEO, it decreases the likelihood of probability of bankruptcy. This scenario is consistent with some previous studies (Galasson & Simcoe, 2011; Sariol & Abebe, 2017). Dominant CEO do more exploratory innovation, which means powerful CEO venture more innovative projects than less dominant CEO (Sariol & Abebe). Galasso and Simcoe (2011) show that in the case of innovative companies, firm performance is higher if the CEO is overconfident. More than half of the firms in our sample are manufacturing firms, which largely depends on technology and innovation.

We do a subsample analysis based on high and low innovative firms to assess this situation further. We measure innovation following Hirshleifer et al., (2012), where innovation is the ratio of research and development expenditure to book value of assets[10]. We replace the missing R&D expenditure with 0. We divide our sample into three sub-sample, the highest tercile consists of high innovative firms while the lowest terciles consists of low innovative firms. The regression results are shown in Panel B, Table 7. For less innovative firms, there is no significant interaction effect of CPS and overconfidence[11] on Z Score, however for high innovative firms, there is a negative association between the interaction term and Z Score. Our result suggests that for

[10] We use market value version of total assets instead of book assets, that is the sum of market value of assets and book liabilities.
[11] We consider indicator measure OC67 as a measure of overconfidence in this case for its nature of persistent traits. We do not consider OC100 as in panel A, we do not get any significant result for this measure.

innovative firms, the interaction effect of CPS and overconfidence negatively impacts bankruptcy probability.

7. Robustness Tests

7.1 Endogeneity

We conduct robustness tests to deal with endogeneity issues. One concern in our study is the reverse causality issue; someone may point out that more probability of bankruptcy prone firms hire overconfident CEOs. Overconfidence could increase the probability of bankruptcy, but probability of bankruptcy also could affect overconfidence. Highly growth and high risks firms may self-select overconfident managers (Graham et al., 2013), and maybe high growth or high risks firm has more probability of bankruptcy than low growth firms. For this reason, we control for firm growths (MTB) and firm risks (SIGMA).

7.1.1 Difference in Difference

To deal with endogeneity issues further, we use a non-shock-based DID approach. This thesis's primary measure *OCCont* of overconfidence is continuous, and we use it in our difference in difference analysis. We use *OCCont* to measure overconfidence in the DID model as it is simpler and easier to find and segment designated control and treatment groups. We divide all the samples into terciles; those are in the top tercile, we consider them overconfident CEO while the lowest tercile consists of non-overconfident CEO. The mean value of overconfidence measure *OCCont*[12] for the non-overconfident group stands at 0.105, far lower than the overconfident group, whose score 2.168. Our grouping of overconfidence levels matches other

[12] It will be impossible to split the complete sample into treatment and control groups if we use indicator measures (OC67, OC100) that have a persistent nature (that is, an overconfident CEO will always be overconfident). Changes in confidence levels are required to form both the treatment and control groups.

authors; Malmendier and Tate (2005) consider 0.67 as a benchmark for overconfident CEOs whose confidence score exceeds this benchmark. In our calculation, overconfident CEOs minimum score is 0.81, higher than Malmendier and Tate (2005) 0.67 benchmark, which captures a similar figure of overconfident CEO.

The control group consists of observations that were not overconfident at time t-1, and their successive observations also remain not overconfident at time t. We divide the control group into two groups, pre-control, and post-control. The pre-control group consists of observations that were not overconfident at time t-1. In contrast, their successive observations that remain not overconfident at time t are included in the post-control group. The successive observations are selected by company id, which means successive observations are from the same company. We select a total of 4,991 observations for the control group; among them, 1,299 are in the pre-control group, and 3,692 are in the post-control group. The mean of *OCCont* for the pre-control and the post-control groups are 0.11 and 0.10, respectively. On the other hand, the treatment group consists of observations that were not overconfident at time t-1, but the successive observations become overconfident. We divide them into pre-treatment and post-treatment groups, just as the control group. We have 663 observations for the pre-treatment group and 2,057 for the post-treatment group in our sample. The means of OCCont in the pre-treatment and post-treatment groups are 0.12 and 1.80, respectively.

We then use Eq. (2) to regress both the control and treatment groups, and the results are reported in Table 8. We use *OCCont*, the primary measure in this thesis, as an overconfidence measure and independent variable while I(Z_Score) is the dependent variable, and control variables are the same as equation (2). We include industry and year fixed effects in the regression while standard errors are clustered by firms. Overconfidence is not significantly associated with

the probability of bankruptcy in columns (I) and (II) of Table 6; those columns are the regression results of the pre-control and the post-control groups, respectively. As expected, in column (III), which consists of the pre-treatment group, we do not get any significant relation between *OCCont* and I(Z_Score). However, for the post-treatment group, in column (IV), we notice that overconfidence is positive and significantly related to the probability of bankruptcy, where the coefficient of *OCCont* becomes 0.417 and statistically significant at 1% level. Overall, the result of Table 6 suggests overconfidence does matter and assume to be an important factor in increasing companies' probability of bankruptcy. Hence, our results from the difference in difference model are robust to an endogeneity bias.

7.1.2 Two Stage Least Square

In our study, there could be an endogenous issue due to some unobservable factors or characteristics driving both the probability of bankruptcy and CEO overconfidence, which leads to correlation in the error term. We estimate two-stage least square (2SLS) models to address this endogenous issue. To estimate 2SLS, first, we need to identify an exogenous variable related to CEO overconfidence but unrelated to the dependent variable, the probability of bankruptcy.

Following Ho et al., (2016), we consider CEO age as an exogenous variable related to CEO overconfidence (Ferris et al., 2013; Serfling, 2014; Yim, 2013). Ferris et al., (2013) find that older CEO are more considerate and cautious, and they find a negative relation between overconfidence and CEO age. Young CEOs are more aggressive and acquisitive than old CEOs (Levi et al., 2010). Serfling (2014) argues that older CEOs reduce firm risks by investing in a more stable project, and he finds a negative relation between CEO age and stock return volatility. Yim (2013) concludes that a firm's acquisition tendency reduces with decreasing CEO age. Thus, we argue that CEO overconfidence has negative relation with CEO age. It is hard to find any strong instrument which

does not relate to dependent variable but has relation to independent variable. Therefore, it appears that CEO age has no relation to likelihood of bankruptcy because CEO age has no economic impact in this case.

In our first stage of 2SLS model, we consider OC100 as endogenous variable[13] and CEO age as an instrument.

Stage 1. Regression of endogenous variable OC100 with instrument CEO age and other exogenous variables:

$$P\left(OC100_{i,t} = 1 \mid CEO\ Age_{it},\ \boldsymbol{X}_{i,t}\right) = L(\beta_0 + \beta_1 CEO\ Age_{i,t} + \beta_2 MTB_{i,t} + \beta_3 ROA_{i,t} + \beta_4 TLMTA_{i,t} + \beta_5 CASHMTA_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 SIGMA_{i,t} + \beta_8 EXRET_{i,t} + \varepsilon_{i,t}) \quad (5)$$

Stage 2. Now, we replace the fitted value of OC100 generated from first stage to our main equation Eq. (2):

$$I(Z_{Score})_{i,t} = \beta_0 + \beta_1 \widehat{OC100}_{i,t} + \beta_2 MTB_{i,t} + \beta_3 ROA_{i,t} + \beta_4 TLMTA_{i,t} + \beta_5 CASHMTA_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 SIGMA_{i,t} + \beta_8 EXRET_{i,t} + \varepsilon_{i,t} \quad (6)$$

where L is the logistic distribution, OC100 is the measure of overconfidence which is an indicator variable; value equal 1 if CEO is overconfident else it is 0; $\widehat{OC100}$is the fitted value estimated from first stage of 2SLS; CEO Age is the age of CEO; all other control variables similar as equation (2).

[13] We consider OC100 measure as it is an indicator measure which shows persistent traits of overconfidence that means an overconfident CEO is always overconfident. For measure OC67 and OCCont, we do not find significant association with instrument CEO age in the first stage.

Table 9 reports the regression results of the first stage of 2SLS, which includes industry and year fixed effect. The standard errors are clustered by firm. The logistic regression between CEO age, OC100, and other exogenous variables show a significant relationship between the instrument and CEO overconfidence. The coefficient of CEO age is negative and significant at 1% level, which assured that CEO age has negative relation with CEO overconfidence. The regression result of the 2nd stage of 2SLS is shown in Table 10. $\widehat{OC100}$ is the fitted value from first-stage regression, and we replace OC100 with the fitted value in equation (6); the regression results remain significant at 1%. The coefficient of OC100 is 1.74 and significant at 1% level, which supports our primary hypothesis that CEO overconfidence increases the likelihood of probability of bankruptcy. Therefore, we conclude that our results from 2SLS are robust to an endogeneity bias.

7.2 Overconfidence and Financial Constraints

Malmendier and Tate (2005) show that equity-dependent firms predominantly suffer the impact of overconfidence. They show that overconfidence impacts the investment cash flow sensitivity for firms that access the equity market for additional funds. When a firm has enough cash holding or access to debt financing, then cash flow has no impact on the desired investment projects of the CEO. Our second hypothesis predicted that overinvestment is a channel through which overconfidence increases probability of bankruptcy. However, we find that overinvestment is not a true channel, and we reject hypothesis 2. To further confirm the result of hypothesis 2, we do a subsample analysis on the financial constraint. Some may argue that, as financially constrained firms do not have enough funds to overinvest, there should not have a significant positive association in our regression model for their case. We use the SA index to capture financially constraint firms.

The SA index is calculated as follows:

$$SA = (-0.737 * Size) + (0.43 * Size^2) - (0.040 * Age) \quad (7)$$

We consider Headlock and Pierce (2010) SA index for this prediction. We construct Headlock and Pierce's (2010) SA index of financial constraints – used by Farre-Mensa and Ljungqvist (2016), Li (2011), for our sample firms. Here, size is the inflation-adjusted book value of assets, age is the total years the company included in the Compustat with a non-missing price. Size is winsorized at the log of 4.5 billion, and age is winsorized at 37 years. A higher value of the combinations of ratios used in equation (7) implies most constraint firms. The mean of SA index is -3.96, which consistent with other studies.[14] We divide the sample into terciles based on the SA index and run the regression of equation (2) separately for each tercile. To test the regression equation (2), we use all three measures of overconfidence in our thesis. We find that impact of overconfidence on bankruptcy likelihood is higher for top tercile, which consists of most financially constraint firms. The results shown in Table 11, in columns 4 to 6, which consists of most financially constrained firms, we notice that the coefficient of all three measures of overconfidence is positive and significant at 5% level. Therefore, our subsample analysis results confirm that overinvestment is not a true channel for which overconfidence increases the probability of bankruptcy.

8. Conclusion

This thesis examines the impact of overconfident CEO's decision on the probability of bankruptcy. Getting overconfident CEOs and their optimistic opinion about the company's future

[14] Li (2011); Farre-Mensa & Ljungqyist (2016)

performance is not unusual. Overconfident CEOs prefer to make decisions by believing in themselves. We examine the following research question:

What is the impact of CEO overconfidence on the probability of bankruptcy?

We also use two other hypotheses to complement our main research question. We try to find out the channel between CEO overconfidence and bankruptcy probability. In addition, we examine any interaction effect of CEO dominance in the relation of CEO overconfidence and probability of bankruptcy.

Our study focuses on US firms; we collected panel data from Execucomp, Compustat, and CRSP databases between the period 2000 and 2019. The data contains 15,038 CEO year observations, 1638 unique firms, and 3085 unique CEOs. We use an option-based measure of overconfidence, and this measure is based on the logic that non-overconfident CEO will sell their stock option if it is in the money, while overconfident CEOs will hold stock options beyond a rational threshold. Executives receive large sums of option grant during their working tenure which create company-specific risks. Also, they are highly exposed to idiosyncratic risks as their human labor is tied up with companies. Thus, to mitigate the risk exposure, a rational, risk-averse, undiversified executive exercise option early, if it is in the money (Hall & Murphy, 2002). We construct three overconfidence measures following the methodology of Malmendier & Tate (2005). Our first overconfidence measure OCCont is a continuous measure following Banerjee et al., (2020) which is a modification of Malmendier & Tate (2005) methodology. To construct OC67, which is an indicator measure, we followed Malmendier & Tate (2005) but there is a slight relaxation of fiver year vesting period following Campbell et al., (2011). OC67 classifies overconfident CEO who hold stock options that are at least 67% in the money. For constructing

our third measure OC100, we followed Campbell et al., (2011) and OC100 classifies CEO as overconfident who hold vested options that are at least 100% in the money.

All of our research questions are empirically tested to figure out the primary purpose of this thesis: CEO overconfidence has positive effect on the probability of bankruptcy. Our empirical findings indicate that overconfidence has a positive association with the probability of bankruptcy, and overconfidence is crucial for increased bankruptcy likelihood. The results are robust when we include industry and year fixed effects. Except leverage, all other control variables have predicted sign and level of significance. Leverage was expected to have positive effect on probability of bankruptcy likelihood, but we get the opposite, that means high level leverage reduce the bankruptcy likelihood. The effects of OCCont, OC67, and OC100 on bankruptcy probability are positive and significant: OCCont leads to 40.8% increase in probability of bankruptcy likelihood, while OC67 and OC100 leads to 29.5% and 58.5% increase in probability of bankruptcy respectively. Therefore, hypothesis 1 is accepted.

To find the channel between CEO overconfidence and probability of bankruptcy, we consider overinvestment. Past literature (Camerer & Lovallo, 1999; Malmendier & Tate, 2005; Sanders & Hambrick, 2007) show the negative aspect of overinvestment on corporate policies. However, we find that overinvestment is not responsible for increased probability of bankruptcy. Thus, we reject our second hypothesis that overinvestment work as a channel for increased bankruptcy likelihood. In hypothesis three, we check the interaction effect of CEO dominance on CEO overconfidence and bankruptcy likelihood. We find that in innovative firms a dominant and overconfident CEO reduces the probability of bankruptcy likelihood.

The results have some significant implications for corporate policies and hiring overconfident CEO's. From the regression results, we notice that overconfident CEOs increase the

bankruptcy probability. Therefore, a firm should be cautious on hiring CEOs those are overconfident. In the question: “Does overconfident CEO always bad?” Hirshleifer et al., (2012) state that in innovative industries, overconfident CEO ensure the growth opportunities and help firms to increase its value. We do find that in innovative firms, a dominant and overconfident CEO reduces the probability of bankruptcy likelihood. Therefore, an innovative firm can reduce its probability of bankruptcy if it gives overconfident CEO a dominant position.

There are some limitations in our study. We do not use any governance issues like accounting conservatism to check whether increased governance measures help to reduce the impact of overconfidence. This study shows that overconfidence increases bankruptcy likelihood, which does not mean that we never hire overconfident CEOs. Instead, we should be cautious, and the board should reduce the negative outcome of overconfidence by taking different measures. In this thesis, we assume that overinvestment is a channel through which overconfidence increases the probability of bankruptcy likelihood, but we do not get any relation between them. We can check other issues like stock price crash risks and value-destroying mergers to find an actual channel that increases the likelihood of probability of bankruptcy.

References:

Abarbanell, J. S., & Bushee, B. J. (1997). Fundamental analysis, future earnings, and stock prices. *Journal of accounting research*, *35*(1), 1-24.

Adam, T. R., Fernando, C. S., & Golubeva, E. (2015). Managerial overconfidence and corporate risk management. *Journal of Banking & Finance*, *60*(60), 195-208.

Banerjee, S., Dai, L., Humphery-Jenner, M., & Nanda, V. (2020). Governance, board inattention, and the appointment of overconfident CEOs. *Journal of Banking & Finance*, *113*, 1-26.

Barnett, W. P., & Freeman, J. (2001). Too much of a good thing? Product proliferation and organizational failure. *Organization Science*, *12*(5), 539-558.

Bebchuk, L. A., Cremers, K. M., & Peyer, U. C. (2011). The CEO pay slice. *Journal of financial Economics*, *102*(1), 199-221.

Ben-David, I., Graham, J. R., & Harvey, C. R. (2013). Managerial miscalibration. *The Quarterly journal of economics*, *128*(4), 1547-1584.

Benmelech, E., Kandel, E., & Veronesi, P. (2010). Stock-based compensation and CEO (dis) incentives. *The Quarterly Journal of Economics*, *125*(4), 1769-1820.

Brogaard, J., Li, D., & Xia, Y. (2017). Stock liquidity and default risk. *Journal of Financial Economics*, *124*(3), 486-502.

Bromiley, P. (1991). Testing a causal model of corporate risk taking and performance. *Academy of Management journal*, *34*(1), 37-59.

Brown, R., & Sarma, N. (2007). CEO overconfidence, CEO dominance and corporate acquisitions. *Journal of Economics and business*, *59*(5), 358-379.

Camerer, C., & Lovallo, D. (1999). Overconfidence and excess entry: An experimental approach. *American economic review*, *89*(1), 306-318.

Campbell, J. Y., Hilscher, J., & Szilagyi, J. (2008). In search of distress risk. *The Journal of Finance*, *63*(6), 2899-2939.

Campbell, T. C., Gallmeyer, M., Johnson, S. A., Rutherford, J., & Stanley, B. W. (2011). CEO optimism and forced turnover. *Journal of Financial Economics*, *101*(3), 695-712.

Chen, S. S., Ho, K. Y., & Ho, P. H. (2014). CEO overconfidence and long-term performance following R&D increases. *Financial Management*, *43*(2), 245-269.

Chen, I. J., & Lin, S. H. (2012). Will managerial optimism affect the investment efficiency of a firm? *Procedia Economics and Finance*, *2*, 73-80.

Chuang, W. I., & Lee, B. S. (2006). An empirical evaluation of the overconfidence hypothesis. *Journal of Banking & Finance*, *30*(9), 2489-2515.

Cohen, R. B., Polk, C., & Vuolteenaho, T. (2003). The value spread. *The Journal of Finance*, *58*(2), 609-641.

Daily, C. M., & Dalton, D. R. (1994). Bankruptcy and corporate governance: The impact of board composition and structure. *Academy of Management journal*, *37*(6), 1603-1617.

Dambolena, I. G., & Shulman, J. M. (1988). A primary rule for detecting bankruptcy: watch the cash. *Financial Analysts Journal*, *44*(5), 74-78.

Daniel, K., Grinblatt, M., Titman, S., & Wermers, R. (1997). Measuring mutual fund performance with characteristic-based benchmarks. *The Journal of finance*, *52*(3), 1035-1058.

Darrat, A. F., Gray, S., Park, J. C., & Wu, Y. (2016). Corporate governance and bankruptcy risk. *Journal of Accounting, Auditing & Finance*, *31*(2), 163-202.

Doukas, J. A., & Petmezas, D. (2007). Acquisitions, overconfident managers and self-attribution bias. *European Financial Management*, *13*(3), 531-577.

Durand, R. (2003). Predicting a firm's forecasting ability: The roles of organizational illusion of control and organizational attention. *Strategic Management Journal*, *24*(9), 821-838.

Farre-Mensa, J., & Ljungqvist, A. (2016). Do measures of financial constraints measure financial constraints? *The Review of Financial Studies*, *29*(2), 271-308.

Ferris, S. P., Jayaraman, N., & Sabherwal, S. (2013). CEO overconfidence and international merger and acquisition activity. *Journal of Financial and Quantitative Analysis*, *48*(1), 137-164.

Fich, E. M., & Slezak, S. L. (2008). Can corporate governance save distressed firms from bankruptcy? An empirical analysis. *Review of Quantitative Finance and Accounting*, *30*(2), 225-251.

Friesen, G., & Weller, P. A. (2006). Quantifying cognitive biases in analyst earnings forecasts. *Journal of financial Markets*, *9*(4), 333-365.

Fu, F. (2010). Overinvestment and the operating performance of SEO firms. *Financial Management*, *39*(1), 249-272.

Furfine, C. H., & Rosen, R. J. (2011). Mergers increase default risk. *Journal of Corporate Finance*, *17*(4), 832-849.

Galasso, A., & Simcoe, T. S. (2011). CEO overconfidence and innovation. *Management Science*, *57*(8), 1469-1484.

Goel, A. M., & Thakor, A. V. (2008). Overconfidence, CEO selection, and corporate governance. *The Journal of Finance*, *63*(6), 2737-2784.

Graham, J. R., Harvey, C. R., & Puri, M. (2013). Managerial attitudes and corporate actions. *Journal of financial economics*, *109*(1), 103-121.

Hambrick, D. 2007. Upper echelons theory: An update. *Academy of Management Review, 32*, 334-343.

Hambrick, D. C., & Mason, P. A. (1984). Upper echelons: The organization as a reflection of its top managers. *Academy of management review*, *9*(2), 193-206.

Hayward, M. L., & Hambrick, D. C. (1997). Explaining the premiums paid for large acquisitions: Evidence of CEO hubris. *Administrative science quarterly*, *42*, 103-127.

Hayward, M. L., Shepherd, D. A., & Griffin, D. (2006). A hubris theory of entrepreneurship. *Management science*, *52*(2), 160-172.

Hirshleifer, D., Low, A., & Teoh, S. H. (2012). Are overconfident CEOs better innovators? *The journal of finance*, *67*(4), 1457-1498.

Hmieleski, K. M., & Baron, R. A. (2009). Entrepreneurs' optimism and new venture performance: A social cognitive perspective. *Academy of management Journal*, *52*(3), 473-488.

Ho, P. H., Huang, C. W., Lin, C. Y., & Yen, J. F. (2016). CEO overconfidence and financial crisis: Evidence from bank lending and leverage. *Journal of Financial Economics*, *120*(1), 194-209.

Huang, R., Tan, K. J. K., & Faff, R. W. (2016). CEO overconfidence and corporate debt maturity. *Journal of Corporate Finance*, *36*, 93-110.

Kim, J. B., Wang, Z., & Zhang, L. (2016). CEO overconfidence and stock price crash risk. *Contemporary Accounting Research*, *33*(4), 1720-1749.

Kirchler, E., & Maciejovsky, B. (2002). Simultaneous over-and underconfidence: Evidence from experimental asset markets. *Journal of Risk and Uncertainty*, *25*(1), 65-85.

Klayman, J., Soll, J. B., Gonzalez-Vallejo, C., & Barlas, S. (1999). Overconfidence: It depends on how, what, and whom you ask. *Organizational behavior and human decision processes*, *79*(3), 216-247.

Langer, E. J., & Roth, J. (1975). Heads I win, tails it's chance: The illusion of control as a function of the sequence of outcomes in a purely chance task. *Journal of personality and social psychology*, *32*(6), 951.

Larwood, L., & Whittaker, W. (1977). Managerial myopia: Self-serving biases in organizational planning. *Journal of applied psychology*, *62*(2), 194.

Levi, M., Li, K., & Zhang, F. (2010). Deal or no deal: Hormones and the mergers and acquisitions game. *Management Science*, *56*(9), 1462-1483.

Li, D. (2004). The implications of capital investments for future profitability and stock returns—an overinvestment perspective. Working paper, University of California, Berkeley.

Li, D. (2011). Financial constraints, R&D investment, and stock returns. *The Review of Financial Studies*, *24*(9), 2974-3007.

Li, J., & Tang, Y. I. (2010). CEO hubris and firm risk taking in China: The moderating role of managerial discretion. *Academy of Management Journal*, *53*(1), 45-68.

Lowe, R. A., & Ziedonis, A. A. (2006). Overoptimism and the performance of entrepreneurial firms. *Management science*, *52*(2), 173-186.

Malmendier, U., & Tate, G. (2005). CEO overconfidence and corporate investment. *The journal of finance*, *60*(6), 2661-2700.

Malmendier, U., & Tate, G. (2008). Who makes acquisitions? CEO overconfidence and the market's reaction. *Journal of financial Economics*, *89*(1), 20-43.

March, J. G., & Shapira, Z. (1987). Managerial perspectives on risk and risk taking. *Management science*, *33*(11), 1404-1418.

Miller, D., & Toulouse, J. M. (1986). Chief executive personality and corporate strategy and structure in small firms. *Management science*, *32*(11), 1389-1409.

Oskamp, S. (1965). Overconfidence in case-study judgments. *Journal of consulting psychology*, *29*(3), 261.

Nadkarni, S., & Herrmann, P. O. L. (2010). CEO personality, strategic flexibility, and firm performance: The case of the Indian business process outsourcing industry. *Academy of Management Journal*, *53*(5), 1050-1073.

Platt, H., & Platt, M. (2012). Corporate board attributes and bankruptcy. *Journal of Business Research*, *65*(8), 1139-1143.

Richardson, S. (2006). Over-investment of free cash flow. *Review of accounting studies*, *11*(2), 159-189.

Roll, R. (1986). The hubris hypothesis of corporate takeovers. *Journal of business*, *59*, 197-216.

Russo, J. E., & Schoemaker, P. J. (1992). Managing overconfidence. *Sloan management review*, *33*(2), 7-17.

Sanders, W. G., & Hambrick, D. C. (2007). Swinging for the fences: The effects of CEO stock options on company risk taking and performance. *Academy of Management Journal*, *50*(5), 1055-1078.

Sariol, A. M., & Abebe, M. A. (2017). The influence of CEO power on explorative and exploitative organizational innovation. *Journal of Business Research*, *73*, 38-45.

Schwenk, C. H. (1986). Information, cognitive biases, and commitment to a course of action. *Academy of Management Review*, *11*(2), 298-310.

Serfling, M. A. (2014). CEO age and the riskiness of corporate policies. *Journal of Corporate Finance*, *25*, 251-273.

Simon, H. A. (1993). Decision making: Rational, nonrational, and irrational. *Educational Administration Quarterly*, *29*(3), 392-411.

Simon, M., & Houghton, S. M. (2003). The relationship between overconfidence and the introduction of risky products: Evidence from a field study. *Academy of Management Journal*, *46*(2), 139-149.

Skala, D. (2008). Overconfidence in psychology and finance-an interdisciplinary literature review. *Bank I kredyt*, (4), 33-50.

Svenson, O. (1981). Are we all less risky and more skillful than our fellow drivers? *Acta psychologica*, *47*(2), 143-148.

Uhrig-Homburg, M. (2005). Cash-flow shortage as an endogenous bankruptcy reason. *Journal of Banking & Finance*, *29*(6), 1509-1534.

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of personality and social psychology*, *39*(5), 806.

Yim, S. (2013). The acquisitiveness of youth: CEO age and acquisition behavior. *Journal of financial economics*, *108*(1), 250-273.

Tables

Table 1: Definitions of variables

This table provide the information on key variables and their sources. We collect the data between 2000 and 2019 from Compustat, Execucomp, and CRSP databases.

Variables	Description	Sources
Z_Score	Altman (1968) Z Score	Compustat
OCCont	Per option real value / Average exercised price Where, per option real value=(opt_unex_exer_est_val / opt_unex_exer_num) average exercised price= PRCC_F – per option real value	Execucomp, CRSP
OC67	It is an indicator measure, which is calculated as Per option real value / Average exercised price.	Execucomp, CRSP
OC100	It is an indicator measure, which is calculated as Per option real value / Average exercised price.	Execucomp, CRSP
NIMTA	This variable is calculated as the ratio of net income to market valued version of total assets.	Compustat
CASHMTA	Cash and Short-term Assets / (Market Equity + Book Liabilities).	Compustat
TLMTA	Total Liabilities / (Market Equity + Book Liabilities).	Compustat
EXRET	Difference between Daily Return of Each Firm and S&P 500 index Return (annualized).	CRSP
SIGMA	Annualized Daily Return Volatility.	CRSP
MTB	Market Value of Equity to Book Value of Equity.	Compustat
SIZE	Log of Market Value of Equity.	Compustat
Overinvestment	The residual from equation (1) of this thesis.	Compustat
CPS (CEO Pay Slice)	The proportion of the total compensation of CEO and top five executives, where total compensation designates ExecuComp item TDC1.	ExecuComp

V_p	Growth opportunity, which is the ratio of value of firm to market equity. Value of firm calculated as $V = (1 - \alpha r)BV + \alpha(1 + r)X - \alpha rd$ Where, α=ω/(1+r- ω), r=12%, X is operating income after depreciation, BV is the book value of common equity, and ω=0.62, ω is the abnormal earnings persistent parameter from Ohlson(1995).	Compustat

SA Index

Following Headlock and Pierce (2010), we calculate SA index as follows:

$$SA = (-0.737 * Size) + (0.43 * Size^2) - (0.040 * Age)$$

Where, size is the inflation adjusted (2004) book assets, and age is the total number of years the firm existed in Compustat with non-missing stock price. Size is winsorized at the log of $4.5 billion and age is winsorized at 37 years.

Table 2: Descriptive statistics of key variables

Variables	N	Mean	SD	Min	Max	Q1	Median	Q3
Z_Score	15038	4.910	4.560	-3.005	29.256	2.487	3.732	5.606
OCCont	14973	0.912	1.383	0.002	9.662	0.167	0.470	1.059
OC67	14996	0.534	0.499	0.000	1.000	0.000	1.000	1.000
OC100	14996	0.385	0.487	0.000	1.000	0.000	0.000	1.000
MTB	15038	2.345	1.289	0.300	7.227	1.436	2.310	2.891
NIMTA	15038	0.023	0.050	-0.411	0.126	0.017	0.032	0.044
TLMTA	15038	0.317	0.189	0.021	0.958	0.165	0.293	0.448
CASHMTA	15038	0.080	0.091	0.001	0.542	0.018	0.048	0.107
SIZE	15038	7.815	1.622	2.927	11.767	6.639	7.674	8.925
EXRET	15038	0.056	0.333	-1.006	1.054	-0.122	0.055	0.240
SIGMA	15038	0.411	0.202	0.140	1.190	0.270	0.364	0.498

The above table represents the descriptive statistics of the key variables. Z_Score is the Altman (1968) Z Score, denote the probability of bankruptcy; OCCont, OC67, and OC100 are three measures of overconfidence. OCCont is a continuous measure while OC67 and OC100 are two dummy variables. The dummy variable for both OC67 and OC100 become one from the first time CEO show overconfidence behavior. MTB is the market-to-book ratio of the firm; ROA is the ratio of EBIT and total assets; TLMTA is measured as total liabilities to market value of equity plus book liabilities; CASHMTA is the ratio of cash and short-term assets to market value of equity plus book liabilities; Size is the natural logarithm of market capitalization; EXRET is the annualized difference of daily return and S&P 500 return; SIGMA is the annualized daily return volatility. To control the outliers, all the variables winsorized at 1st and 99th percentile level. The data ranges from 2000 to 2019 fiscal year for all the variables.

Table 3: Differences in descriptive statistics

Table 3 presents the differences in descriptive statistics between overconfident and non-overconfident groups for two measure of overconfidence OCCont and OC100 in two different tables. OC100 is a dummy variable measuring overconfidence, which becomes 0 for non-overconfident group and 1 for overconfident group. MTB is the market-to-book ratio of the firm; ROA is the ratio of EBIT and total assets; TLMTA is measured as total liabilities to market value of equity plus book liabilities; CASHMTA is the ratio of cash and short-term assets to market value of equity plus book liabilities; Size is the natural logarithm of market capitalization; EXRET is the annualized difference of daily return and S&P 500 return; SIGMA is the annualized daily return volatility.

Table 2.1 Overconfidence measure: OCCont

	Non-overconfident		Overconfident		Difference	
Variable	Mean	Median	Mean	Median	Mean	Median
Z_Score	6.4293	4.4998	3.771	3.153	-2.6583	-1.3468
MTB	1.9063	1.594	2.8714	2.5945	0.9651	1.0005
NIMTA	0.0124	0.0276	0.031	0.0333	0.0186	0.0057
TLMTA	0.3793	0.3637	0.2484	0.2227	-0.1309	-0.141
CASHMTA	0.0972	0.02	0.0667	0.0446	-0.0305	0.0246
SIZE	7.9773	7.8219	7.5531	7.3578	-0.4242	-0.4641
EXRET	0.0462	0.0433	0.0663	0.0684	0.0201	0.0251
SIGMA	0.4151	0.3703	0.4274	0.3803	0.0123	0.01

Table 2.2 Overconfidence measure: OC100

	OC100=0		OC100=1		Difference	
Variable	Mean	Median	Mean	Median	Mean	Median
Z_Score	6.1035	4.3441	4.1667	3.4198	-1.9368	-0.9243
MTB	2.1518	1.3305	2.6573	2.3719	0.5055	1.0414
NIMTA	0.0215	0.0152	0.0269	0.0329	0.0054	0.0177
TLMTA	0.3499	0.2016	0.2641	0.2336	-0.0858	0.032
CASHMTA	0.0805	0.0181	0.0789	0.0504	-0.0016	0.0323
SIZE	7.8649	7.7294	7.7891	6.5679	0.0758	1.1615
EXRET	0.0505	0.0477	0.0671	0.0714	0.0166	0.0237
SIGMA	0.4048	0.3557	0.4211	0.3749	0.0163	0.0192

Table 4: Sample correlations and multicollinearity of key variables of multivariate analysis of Probability of bankruptcy

Panel A: Correlations

		A	B	C	D	E	F	G	H	I	J	K
I(Z_Score)	A	1.00										
OCCont	B	**0.29**	1.00									
OC67	C	**0.18**	**0.38**	1.00								
OC100	D	**0.21**	**0.44**	**0.74**	1.00							
MTB	E	**0.35**	**0.32**	**0.19**	**0.19**	1.00						
NIMTA	F	**0.12**	**0.08**	**0.07**	**0.05**	**0.02**	1.00					
TLMTA	G	**-0.63**	**-0.24**	**-0.23**	**-0.22**	**-0.45**	**-0.10**	1.00				
CASHMTA	H	**0.11**	**-0.09**	**-0.02**	-0.01	**-0.14**	**-0.21**	**-0.23**	1.00			
SIZE	I	**-0.02**	**0.05**	**0.04**	**0.02**	**0.31**	**0.22**	**-0.03**	**-0.32**	1.00		
EXRET	J	**0.08**	**0.18**	**0.03**	**0.02**	**0.17**	**0.12**	**-0.08**	**-0.14**	**0.03**	1.00	
SIGMA	K	**0.11**	**0.08**	**0.01**	**0.04**	**-0.04**	**-0.29**	**-0.08**	**0.32**	**-0.46**	**0.08**	1.00

This table provides the Pearson correlations between the key variables of the regression analysis. I(Z_Score) is the inverse of proxy for the probability of bankruptcy and dependent variable; OCCont, OC67, and OC100 are three measures of overconfidence. OCCont is a continuous measure while OC67 and OC100 are two dummy variables. The dummy variable for both OC67 and OC100 become one from the first time CEO show overconfidence behavior. MTB is the market-to-book ratio of the firm; ROA is the ratio of EBIT and total assets; TLMTA is measured as total liabilities to market value of equity plus book liabilities; CASHMTA is the ratio of cash and short-term assets to market value of equity plus book liabilities; Size is the natural logarithm of market capitalization; EXRET is the annualized difference of daily return and S&P 500 return; SIGMA is the annualized daily return volatility. The data sample contains 15,038 CEO year observations from the 2000-2019 fiscal year. Boldface portion of table indicates significance level better than 5% level.

Panel B: Multicollinearity of Key Independent Variables

The below tables show the multicollinearity among independent variables. We check for the value of tolerance, variance inflation, Eigenvalue, and Condition index to figure out multicollinearity among the variables. All the variables are same as in the descriptive statistics.

(i)

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > | t |	Tolerance	Variance Inflation
Intercept	1	8.677	0.219	39.62	<.0001	.	0
OCCont	1	0.409	0.022	18.64	<.0001	0.851	1.175
MTB	1	0.291	0.027	10.60	<.0001	0.625	1.600
NIMTA	1	7.988	0.617	12.95	<.0001	0.837	1.194
TLMTA	1	-13.500	0.181	-74.54	<.0001	0.667	1.499
CASHMTA	1	-1.01	0.360	-3.05	0.0023	0.733	1.365
SIZE	1	-0.167	0.021	-8.10	<.0001	0.682	1.467
EXRET	1	-0.294	0.088	-3.33	0.0009	0.909	1.100
SIGMA	1	1.699	0.167	10.19	<.0001	0.697	1.435

(ii)

Variable	Intercept	OCCont	MTB	NIMTA	TLMTA	CASHMTA	SIZE	EXRET	SIGMA
Eigenvalue	5.391	1.135	0.819	0.644	0.514	0.279	0.150	0.056	0.011
Condition Index	1.000	2.180	2.566	2.892	3.238	4.398	5.898	9.824	22.00

Table 5: The impact of CEO overconfidence on probability of bankruptcy

Dependent variable	$I(Z_{Score_t})$								
	Overconfidence with no fixed effects, no controls			Overconfidence with no fixed effects, controls			Overconfidence with fixed effects, controls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$OCCont$	0.972***			0.409***			0.408***		
	(12.61)			(6.96)			(6.94)		
$OC67$		1.661***			0.229***			0.295***	
		(10.80)			(2.32)			(2.96)	
$OC100$			1.937***			0.508***			0.585***
			(10.74)			(4.20)			(4.72)
MTB				0.291***	0.388***	0.374***	0.252***	0.340***	0.326***
				(4.72)	(5.99)	(5.79)	(4.09)	(5.27)	(5.05)
$NIMTA$				7.987***	8.615***	8.498***	7.667***	8.311***	8.202***
				(8.07)	(8.68)	(8.68)	(7.60)	(8.22)	(8.24)
$TLMTA$				-13.50***	-13.796***	-13.686***	-13.949***	-14.255***	-14.126***
				(-27.70)	(-28.60)	(-28.72)	(-27.89)	(-28.98)	(-29.09)
$CASHMTA$				-1.099	-1.668**	-1.604**	-1.015	-1.552*	-1.469**
				(-1.51)	(-2.28)	(-2.19)	(-1.34)	(-2.04)	(-1.92)
$SIZE$				-0.169***	-0.178***	-0.176***	-0.110***	-0.113***	-0.111***
				(-4.04)	(-4.21)	(-4.17)	(-2.44)	(-2.48)	(-2.46)
$EXRET$				-0.294***	-0.121	-0.107***	-0.381***	-0.201*	-0.196*
				(-2.99)	(-1.19)	(-1.06)	(-3.62)	(-1.87)	(-1.82)
$SIGMA$				1.698***	1.983***	1.934***	1.888***	2.369***	2.250***
				(5.46)	(6.61)	(6.04)	(4.87)	(5.97)	(5.70)
Constant	4.025***	4.025***	4.166***	8.677***	8.769***	8.692***	8.402***	8.430***	8.365***
	(41.67)	(42.44)	(46.03)	(19.34)	(19.93)	(19.74)	(14.65)	(14.79)	(14.74)
Industry fixed effect	no	no	no	no	no	no	yes	yes	yes
Year fixed effect	no	no	no	no	no	no	yes	yes	yes
Observations	14,973	14,996	14,996	14,973	14,979	14,996	14,973	14,996	14,996
Adjusted R^2	0.09	0.033	0.043	0.437	0.427	0.427	0.454	0.442	0.445

This table presents the regression coefficients and respective t statistics for the regression results of the impact of CEO overconfidence on probability of bankruptcy. I(Z_Score) is the dependent variable of above regression results and the sample period extend from 2000 to 2019. OCCont, OC67, and OC100 are three measures of overconfidence. OCCont is a continuous measure while OC67 and OC100 are two dummy variables. The dummy variable for both OC67 and OC100 become one from the first time CEO shows overconfidence behavior. The description of the variables is given in table 1. The t-statistics reported in the parenthesis are based on standard errors clustered by firms. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.

Table 6: Interaction effect of CEO Overconfidence and Overinvestment

	Dependent variable: I(Z_Score)					
Independent & Control variables	(1)	(2)	(3)	(4)	(5)	(6)
OCCont	0.879***			0.342***		
	(10.33)			(5.30)		
OC67		1.564***			0.299***	
		(10.48)			(3.07)	
OC100			1.857***			0.566***
			(10.43)			(4.63)
Overinvestment	-4.492***	-4.876***	-4.475***	-1.117*	-0.968*	-1.096*
	(-6.57)	(-6.81)	(-7.01)	(-1.81)	(-1.63)	(-1.74)
OCCont*Overinvestment	0.044			-0.189		
	(0.08)			(-0.38)		
OC67*Overinvestment		1.299			-0.276	
		(1.18)			(-0.30)	
OC100*Overinvestment			0.648			-0.269
			(0.58)			(-0.28)
MTB				0.235***	0.292***	0.280***
				(3.63)	(4.31)	(4.13)
TLMTA				-13.79***	-13.99***	-13.861***
				(-26.40)	(-27.11)	(-27.17)
CASHMTA				-0.933	-1.317*	-1.242
				(-1.21)	(-1.70)	(-1.60)
NIMTA				7.698***	8.382***	8.268***
				(7.763)	(8.35)	(8.35)
SIZE				-0.128***	-0.131***	-0.129***
				(-2.73)	(-2.77)	(-2.76)
EXRET				-0.395***	-0.242**	-0.233**
				(-3.56)	(-2.15)	(2.07)
SIGMA				1.464***	1.771***	1.644***
				(3.52)	(4.18)	(3.89)
Intercept	1.538***	1.580***	1.674***	8.788***	8.840***	8.780***
	(6.38)	(6.61)	(7.15)	(14.83)	(15.08)	(15.04)
Industry fixed effect	yes	yes	yes	yes	yes	yes
Year fixed effect	yes	yes	yes	yes	yes	yes
Observations	13,331	13,345	13,345	13,331	13,345	13,345
R^2	13.74%	10.65%	11.79%	44.83%	44.17%	44.43%

The above table represents the regression results of overinvestment and probability of bankruptcy. I(Z_Score) used as a dependent variable while overconfidence is an independent variable. We use interaction term of overconfidence and overinvestment to see impact of overinvestment on bankruptcy likelihood. Using regression equation (1), we measure the residual for each firm which is a proxy for overinvestment. Standard error is clustered by firms and the sample contains data from compustat between year 2000 and 2019. Description of all other control variables is given in table 1. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.

Table 7: Interaction effect of CEO Overconfidence and CPS

Panel A:

Dependent variable	I(Z_Score)		
	(1)	(2)	(3)
OCCont	0.756***		
	(3.84)		
OC67		1.239***	
		(3.29)	
OC100			1.286***
			(2.85)
CPS	0.364	0.516	-0.021
	(0.66)	(1.09)	(-0.05)
OCCont*CPS	-0.877*		
	(-1.84)		
OC67*CPS		-2.209***	
		(2.45)	
OC100*CPS			-1.636
			(-1.54)
MTB	0.264***	0.339***	0.327***
	(4.52)	(5.51)	(5.30)
NIMTA	7.074***	7.694***	7.594***
	(6.77)	(7.30)	(7.36)
TLMTA	-13.392***	-13.664***	-13.544***
	(-26.41)	(-27.81)	(-27.86)
CASHMTA	-0.033	-0.620	-0.501
	(-0.02)	(-0.73)	(-0.60)
SIZE	-0.118***	-0.119***	-0.118***
	(-2.63)	(-2.56)	(-2.57)
EXRET	-0.454***	-0.277***	-0.275***
	(-4.26)	(-2.51)	(-2.50)
SIGMA	1.612***	2.069***	1.935***
	(4.45)	(5.35)	(5.03)
Constant	8.247***	8.204***	8.382***
	(9.24)	(13.05)	(13.38)
Industry fixed effect	yes	yes	yes
Year fixed effect	yes	yes	yes
Observations	13,677	13,698	13,698
R^2	46.27%	45.08%	45.33%

The above table presents the results of interaction effect of CEO overconfidence and CEO dominance on probability of bankruptcy likelihood. CPS is the proxy of CEO dominance. I(Z_Score) is the proxy of probability of bankruptcy likelihood and dependent variable. OCCont, OC67, and OC100 are three measures of overconfidence. OCCont is a continuous measure while OC67 and OC100 are two dummy variables. The dummy variable for both OC67 and OC100 become one from the first time CEO shows overconfidence behavior. Description of all other control variables is given in table 1. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.

Panel B:

Dependent Variable: I(Z_Score)		
Independent Variables:	Less Innovative Firm	High Innovative Firm
OC67	0.48*	1.75***
	(1.68)	(2.87)
CPS	-0.27	2.15**
	(-0.67)	(2.12)
OC67*CPS	-0.88	-3.41**
	(-1.33)	(-2.28)
MTB	0.45	0.21
	(4.88)	(1.63)
TLMTA	-8.63***	-18.63***
	(-18.21)	(-17.50)
NIMTA	3.25***	12.65***
	(4.18)	(8.05)
CASHMTA	2.79***	-2.65**
	(3.69)	(-2.05)
SIZE	-0.11***	-0.12
	(-2.88)	(-1.63)
EXRET	-0.17*	-0.30
	(-1.67)	(-1.59)
SIGMA	0.87**	1.29**
	(2.32)	(2.15)
Intercept	5.98***	8.60***
	(10.21)	(7.82)
Industry fixed effect	yes	yes
Year fixed effect	yes	yes
Observations	5,694	4,495
R^2	58%	44%

Panel B of table 7 represents a subsample analysis based on high and low innovative firms to assess the impact of interaction between overconfidence and CPS on high and low innovative firms. Description of all other control variables is given in table 1. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.

Table 8: Difference in difference analysis of the impact of overconfidence on Probability of bankruptcy

Standard errors clustered by firms				
	Pre_Control (I)	Post_Control (II)	Pre_Treatment (III)	Post_Treatment (IV)
OCCont	0.160	0.013	-1.962	0.417
	(0.16)	(0.02)	(-1.50)	(3.34)***
MTB	0.007	-0.063	-0.077	0.285
	(0.07)	(-0.93)	(-0.47)	(2.03)**
NIMTA	7.781	8.616	8.141	6.105
	(6.93)***	(6.75)***	(4.63)***	(1.29)
TLMTA	-10.536	-9.687	-11.132	-17.852
	(-19.82)***	(-16.91)***	(-14.00)***	(-13.79)***
CASHMTA	-0.591	0.368	-0.730	1.761
	(-0.57)	(0.38)	(0.44)	(0.91)
SIZE	-0.034	-0.076	0.029	-0.139
	(-0.61)	(-1.63)	(0.40)	(-1.33)
EXRET	-0.199	-0.245	-0.301	-0.673
	(-1.06)	(-1.34)	(-0.99)	(2.12)**
SIGMA	0.909	-0.181	0.599	2.961
	(1.69)	(-0.32)	(0.81)	(2.48)***
CEO_AGE	0.002	0.005	0.002	0.013
	(0.19)	(0.49)	(0.11)	(0.55)
Intercept	7.287	7.480	8.510	8.185
	(7.13)***	(8.55)***	(3.66)***	(4.12)***
Industry fixed effect	yes	yes	yes	yes
Year fixed effect	yes	yes	yes	yes
Observations	1299	3692	663	2057
Adjusted R^2	44.79%	42.31%	45.90%	47.99%

The table above shows the regression results of difference in difference analysis. The pre_treatment group includes the observations those were not overconfident at time t-1 while post_treatment group consist of observations those become overconfident at time t (in the successive years of that company). On the other hand, pre_control group have observations those were not overconfident at time t-1 while post_control group remain not overconfident at time t (in the successive years). The dependent variable of this regression is the inverse of probability of bankruptcy, I(Z_Scores). We use continuous measure of overconfidence OCCont as overconfidence measure in our DID model. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.

Table 9: Two Stage Least Square Estimation: First Stage

	Standard Errors Clustered by Firm
CEO_AGE	-0.035***
	(-5.64)
MTB	-0.202***
	(-5.33)
TLMTA	2.486***
	(9.36)
NIMTA	-2.105***
	(-3.36)
CASHMTA	1.631
	(2.97)***
SIZE	0.006
	(0.18)
EXRET	0.046
	(0.81)
SIGMA	-1.797***
	(-7.81)
Intercept	2.60***
	(5.15)
Industry fixed effect	yes
Year fixed effect	yes
Observations	14,996
R^2	12.26%

The above table provides the regression results of first stage of Two Stage Least Square Model. OC100 is the dependent variable. OC100 is a dummy variable, proxy of overconfidence, and become one from the first time CEO shows overconfidence behavior. CEO_AGE is the instrument, which is the total age of the CEO at fiscal year-end. Description of other exogenous variables given in table 1. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.

Table 10: Two Stage Least Square Estimation: Second Stage

	Standard Errors Clustered by Firm
$\widehat{OC100}$	1.744***
	(9.84)
MTB	0.165***
	(2.62)
TLMTA	-12.997***
	(-29.09)
NIMTA	7.487***
	(7.31)
CASHMTA	-0.470
	(-0.63)
SIZE	-0.077*
	(-1.75)
EXRET	-0.175
	(-1.64)
SIGMA	1.394***
	(3.49)
Intercept	8.069***
	(14.80)
Industry fixed effect	yes
Year fixed effect	yes
Observations	15,038
R^2	45.58%

The table above presents the results of second stage regression of 2SLS. OCCont, OC100 is a dummy variable, proxy of overconfidence, it becomes one from the first time CEO shows overconfidence behavior. Here, $\widehat{OC100}$ is the predicted value of OC100 from the first stage regression. Description of other exogenous variables given in table 1. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.

Table 11: Overconfidence and Financial Constraints

	Least Constrained			Most Constrained		
	(1)	(2)	(3)	(4)	(5)	(6)
OCCont	0.06*			0.47***		
	(1.80)			(5.41)		
OC67		0.02			0.52**	
		(0.26)			(2.39)	
OC100			0.16			0.62***
			(1.33)			(2.56)
MTB	0.16***	0.17***	0.17***	0.18	0.31***	0.31**
	(4.11)	(4.28)	(4.21)	(1.48)	(2.42)	(2.35)
NIMTA	3.86***	4.01***	3.88***	9.78***	10.26***	10.21***
	(3.88)	(3.96)	(3.85)	(6.70)	(6.93)	(7.05)
TLMTA	-8.20***	-8.23***	-8.17***	-18.74***	-19.07***	-18.99***
	(-14.94)	(-15.15)	(-15.56)	(-22.55)	(-23.31)	(-23.10)
CASHMTA	3.00***	2.93***	3.01***	-3.56***	-4.08***	-4.05***
	(3.39)	(3.31)	(3.40)	(-3.37)	(-3.87)	(-3.85)
SIZE	-0.05	-0.05	-0.05	-0.03	0.00	-0.00
	(-1.56)	(-1.54)	(-1.52)	(-0.33)	(0.01)	(0.01)
EXRET	-0.41***	-0.38***	-0.38***	-0.15	0.02	0.04
	(-3.39)	(-3.30)	(-3.34)	(-0.88)	(0.12)	(0.22)
SIGMA	0.74*	0.81**	0.73*	1.90***	2.35***	2.32***
	(1.81)	(1.99)	(1.88)	(2.97)	(3.68)	(3.64)
Intercept	5.84***	5.85***	5.81***	9.22***	8.83***	8.84***
	(13.46)	(13.13)	(13.27)	(7.93)	(7.72)	(7.73)
Industry fixed effect	yes	yes	yes	yes	yes	yes
Year fixed effect	yes	yes	yes	yes	yes	yes
Observations	5017	5019	5019	4,978	4,987	4,987
Adjusted R^2	59%	59%	59%	45%	44%	44%

The above table provides the regression results of subsample analysis on financially constraint firms. Subsample of financially constraint firms is drawn based on SA index. The data then sampled into tercile and highest tercile contains the most constraint firms while the least constraint firms are in lowest terciles. Sample contains data from Compustat and period extends from 2000 to 2019 and standard errors is clustered by firms. Description of all exogenous variables given in table 1. Here, the sign, ***, **, and * indicates the statistical significance level at 1%, 5%, and 10% level respectively.