Are bonds blind? Board-CEO social networks and firm risk

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Abstract

We examine the impact of social networks between independent directors and the CEO on firm risk. Employing the deaths and retirements of socially connected independent directors and the passage of the 2002 Sarbanes-Oxley Act for two identifications, we find that board-CEO social networks have a positive impact on firm risk. Specifically, CEOs who are socially connected to their independent directors are motivated to adopt riskier investment, operating and financing strategies. This positive influence is more pronounced for prior under-performing firms and for CEOs with low power or overconfidence, indicating that board-CEO social networks act as career insurance and a power-enhancing mechanism to encourage managerial risk-taking.

Keywords: Board-CEO social networks; Internal governance mechanism; Firm risk; Deaths and retirements of directors.

JEL Classification: G30; G32

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1. Introduction

Over the past two decades, the importance of CEO and board characteristics in explaining firm risk-taking behaviors has been documented by scholars in corporate finance from two standpoints. One line of research stresses that the CEO's ability, age, managerial incentives, overconfidence, political preference, religion, sensation-seeking and social capital have implications for firm risk-taking decisions (Coles, Damial, and Naveen, 2006; Hilary and Hui, 2009; Hirshleifer, Low, and Teoh, 2012; Hutton, Jiang, and Kumar, 2014; Serfling, 2014; Cain and McKeon, 2016; Ferris, Javakhadze, and Rajkovic, 2017). Another body of research emphasizes the potential impact of board size, women on the board, board diversity, board knowledge and skills on firm risk-taking behaviors (Cheng, 2008; Levi, Li and Zhang, 2014; Berger, Kick and Schaeck, 2014; Minton, Tailard, and Williamson, 2014; Sila, Gonzalez, and Hagendorff, 2016; Adams and Ragunathan, 2017). However, whether certain shared characteristics between the board and the CEO play a vital role in firm risk-taking behaviors has received little research attention in the corporate finance literature. Thus, to fill this research gap, our study attempts to investigate how social network ties between the board, particularly independent directors, and the CEO impact firm risk.

In recent years, both practitioners and academics have centered on social networks between the board and the CEO (board-CEO social networks below) as the key factor in influencing firm activities (Westphal, 1999; Hwang and Kim, 2009; Hoitash, 2011; Krishnan, Raman, Yang, and Yu, 2011; Fracassi and Tate, 2012; Nguyen, 2012; Khanna, Kim, and Lu, 2015). This is due to the inadequacy of the 2002 Sarbanes-Oxley Act in improving corporate governance (Bargeron, Lehn, and Zutter, 2010; Kang, Liu, and Qi, 2010; Cohen, Dey, and Lys, 2013), which heavily regulates board-CEO economic and familial networks but gives board-CEO social networks free rein. Following the logic of Granovetter (1973) and McAdam and Paulsen (1993), board-CEO networks, whether built through families or social organizations, such as firms, universities, charities and clubs, directly influence communications and actions between the board and the CEO, which could further affect firm risk-taking decisions. Thus, it is meaningful to provide an insight into the specific impact of board-CEO social networks on firm risk-taking activities.

We assume that board-CEO social networks boost firm risk via two channels: diminishing the CEO's career risk and enhancing the CEO's power over the board and within the firm. First, based on the sociological literature, social networks foster mutual caring, trust and positive impression, as well as increasing tolerance for failure among actors (Silver, 1990; Tsui, Egan,

and O'Reilly, 1992). With their friendly directors' trust in and positive impressions of them, socially connected CEOs are less likely to have their pay cut and have a lower chance of dismissal, even when their performance is poor, which is supported by several finance studies (Larcker, Richardson, Seary, and Tuna, 2005; Hwang and Kim, 2009; Hoitach, 2011; Nguyen, 2012; Balsam, Kwack, and Lee, 2017). Further, a large body of empirical studies shows that lower likelihood of pay reduction and job loss, reflecting a more secure career, could encourage managerial risk-taking (Smith and Stulz, 1985; Aggarwal and Samwick, 1999; Kempf, Ruenzi, and Thiele, 2009). As a result, board-CEO social networks could promote firm risk by mitigating the CEO's career risk.

Second, based on managerial power theory, a manager who can exercise control over the board can gain power within a firm (Freeman, 1984; Finkelstein, 1992). Board-CEO social networks could increase the CEO's control (or power) over the board and within the firm by minimizing board discipline and increasing directors' support and assistance for his/her initiatives and decisions (Westphal and Zajac, 1995; Westphal, 1999; Adams and Ferreira, 2007; Hwang and Kim, 2009; Schmidt, 2015). Further, the literature holds the view that CEOs with more power promote optimism in perceiving risk, which results in riskier behaviors (Anderson and Galinsky, 2006; Maner, Gailliot, Butz, and Peruche, 2007; Carney, Cuddy, and Yap, 2010). As a result, socially connected CEOs, possessing more power, are likely to take more risks.

To examine this research question, we employ a merged dataset containing 1,660 US firms for the period 2000 to 2014. Following Hayes, Lemmon, and Qiu (2012), Choy, Lin, and Officer (2014), Bartram, Brown, and Stulz (2016) and Savaser and Şişli-Ciamarra (2017), we employ both firm idiosyncratic risk and firm total risk as our measures of firm risk. We define firm idiosyncratic risk as the log of the annualized standard deviation of daily abnormal returns over a fiscal year, which are the residuals from a CAPM model. We define firm total risk as the log of the annualized standard deviation of daily stock returns over a fiscal year. In terms of risk-related strategies, we use capital expenditures and R&D expenditures to proxy for firm investment strategy, No. of business segments and segment Herfindahl index to proxy for firm operating strategy, and leverage ratio and liquidity ratio to proxy for firm financing strategy.

Since independent directors play a major role in evaluating and disciplining the CEO, we focus on social networks between independent directors and the CEO. Following Fracassi and Tate (2012) and Khanna, Kim, and Lu (2015), we assume that board-CEO social networks are established through past and present employment outside the firm, education and membership

of social organisations during overlapping years. We measure board-CEO social networks from two dimensions: social network breadth and social network depth. Social network breadth is the percentage of independent directors that are socially connected to the CEO. Social network depth is the number of social network ties that the CEO has with independent directors divided by the number of independent directors on the board. We observe that the phenomenon of board-CEO network ties is not random but prevalent. On average, about 20% of independent directors are socially connected with the CEO, and each CEO has at least one social network tie with one out of every two independent directors.

Empirically, we start by investigating how board-CEO social networks are associated with firm risk. We find that both social network breadth and depth have a significant and positive impact on firm idiosyncratic risk and total risk. This impact has economic magnitude, i.e., one more independent director socially connected with the CEO results in an increase in firm idiosyncratic risk by 11.38% and an increase in firm total risk by 22.76%. These findings support our hypothesis that board-CEO social networks are positively linked to firm risk. Then, we attempt to identify potential channels through which board-CEO social networks enhance firm risk. We find that board-CEO social networks improve firm risk by encouraging the CEO to make riskier investment, operating and financing strategies. Our mediation analysis further confirms the significant channel effect of these strategies.

Potential endogeneity issues might bias our baseline results. According to Adams and Ferreira (2007), Harris and Raviv (2006) and Linck, Netter, and Yang (2008), director/executive characteristics and firm risk are not exogenous random variables, and their causal relation suffers from simultaneity and reverse causality issues. In our case, board-CEO social networks may be correlated with other variables that are also mechanically related to firm risk. For instance, there is a possibility that smaller firms are in favor of recruiting more socially connected independent directors and prefer to take more risks. Alternatively, board-CEO social networks could be a function of past firm risk. For example, riskier firms may prefer to appoint socially connected independent directors, who may be more willing to support their CEOs' risk-taking behaviors (Fracassi and Tate, 2012; Kang, Liu, Low, and Zhang, 2018).

To address these potential endogeneity concerns, we first employ the deaths and retirements of socially connected independent directors as two instruments and estimate the two-stage regressions. This strategy draws upon the assumption that independent directors' departure due to their death or retirement provides a relatively exogenous shock for identifying within-firm changes of board-CEO social networks that are not plausibly driven by changes in

firm economic outcomes (Fracassi and Tate, 2012; Falato, Kadyrzhanova, and Lel, 2014). Second, we employ a difference-in-difference approach to test the difference in firm risk changes around two types of quasi-natural events: unconnected independent director departures or connected independent director departures due to deaths and retirements. Third, we use the 2002 Sarbanes-Oxley Act, which requires that listed firms have independent directors as a majority on the board, as another identification strategy. Such a requirement creates a relatively exogenous change in board structure and then board-CEO social networks for non-compliant firms, which enables us to isolate the effect of socially connected independent directors on firm risk. Fourth, we use two alternative firm risk measures: earnings volatility and insolvency risk. Our main findings still hold with all of these specifications.

Then, we examine cross-sectional differences in board-CEO social networks to increase firm risk by considering prior firm performance, CEO power and CEO overconfidence to further support our main results. We find that the positive relation between board-CEO social networks and firm risk is moderated (or weaker) when the firm prior performance is good. This evidence supports our conjecture that if board-CEO social networks alleviate the CEO's career pressure or risk, and subsequently enable the CEO to take more risks, then this effect should be stronger for the firm with low prior performance. We further find that the positive impact of board-CEO social networks is moderated (or weaker) when the CEO is powerful or overconfident. This finding supports our conjecture that if board-CEO social networks boost the CEO's power or confidence, and subsequently incentive the CEO to take more risks, then the effect should be stronger for the firm with less powerful CEO or less overconfident CEO.

Our study provides two main contributions to the extant literature. First, our research adds to and extends the emerging literature on the relationship between director/executive characteristics and firm risk. Prior studies tend to separately investigate the impact of certain director characteristics or executive characteristics on firm risk-taking actions. Our study proposes a new perspective to shed light on this topic, which is shared characteristics (or connections) between directors and executives. Thus, our evidence of a significant and positive impact of social network ties between independent directors and the CEO on firm risk provides a novel understanding of this topic. Our study is close to that of Ferris, Javakhadze, and Rajkovic (2017), which identifies a positive impact of CEO social capital, proxied by the CEO's social networks to directors outside the firm, on firm risk. Acting as an external governance mechanism, their CEO's social capital captures the general labor market (or reemployment) insurance effect and social status reinforcement effect. By contrast, acting as

an internal governance mechanism, our board-CEO social networks capture the current pay and job (or employment) insurance effect and firm status reinforcement effect.

Second, our research complements limited but increasingly popular literature on the link between board-CEO social networks and firm economic outcomes. Major studies identify and emphasize the dark side of board-CEO social networks. For instance, most scholars hold the view that the board having social networks with the CEO may facilitate wrongdoing by not 'blowing the whistle' or even by providing the necessary support, which reduces board monitoring and encourages managerial self-seeking behaviors (Hwang and Kim, 2009; Nguyen, 2012). Therefore, they find a negative relationship between board-CEO social networks and firm earnings quality, firm M&A performance and firm valuation (Krishnan, Raman, Yang, and Yu, 2011; Fracassi and Tate, 2012; Bruynseels and Cardinaels, 2013; Rose, Rose, Norman, and Mazza, 2014; Schmidt, 2015). By contrast, our study reveals the bright side of board-CEO social networks in acting as a risk-sharing mechanism to encourage managerial risk-taking behaviors, in line with Schmidt (2015) and Kang, Liu, Low, and Zhang (2018). Our research calls for more regulations on firm disclosure of board-CEO social networks and suggests that investors take both the dark and bright sides of board-CEO social networks into account when evaluating the quality of corporate governance.

Our paper is organized as follows. The next section presents our hypothesis development. Section 3 discusses data, empirical methods, variables and summary statistics. Section 4 presents the main results, resolves the potential endogeneity concerns and reports the cross-sectional findings. Section 5 draws conclusions.

2. Hypothesis development

In this section, we hypothesize that board-CEO social networks encourage firm risk by reducing the CEO's career risk and boosting the CEO's power over the board and within the firm.

2.1. Board-CEO social networks, CEO career risk and firm risk

Board-CEO social networks, acting as a risk-sharing mechanism between these two parties (Ferris, Javakhadze, and Rajkovic, 2017), could effectively reduce the CEO's pay-cut and dismissal risk (Hwang and Kim, 2009; Nguyen, 2012). Not only financial ties, but also

social ties could influence individuals' actions. Two actors with no social bond are governed by exchange-based norms, which lead to dispassionate reciprocation (Mills and Clark, 1982; Silver, 1990). In contrast, two actors sharing a social bond are governed by communal norms, which boost mutual caring, trust and loyalty. Moreover, a social bond fosters an actor to view another's intentions and actions positively, which encourages mutual tolerance of failure (Tajfel, 1978; Turner, Hogg, Oakes, and Reicher, 1987; Tsui, Egan, and O'Reilly, 1992). Thus, a social tie might change an independent director's attitude towards a CEO or his/her motivation to side with shareholders when shareholders' interests oppose those of the CEO, which eventually has an impact on the firm's economic outcomes (Francassi and Tate, 2012; Bruynseels and Cardinaels, 2013; Rose, Rose, Norman, and Mazza, 2014).

Specifically, when a CEO shares a social tie with a director, he/she might face lower pay-cut and dismissal risk, even if he/she is an underperforming CEO. The reason is that, with feelings of trust towards and a positive impression of the friend, the director might attribute good performance to the CEO's strategic wisdom, while attributing poor performance to environmental issues beyond the CEO's control (Westphal and Zajac, 1995). Finance scholars empirically support this assertion. Hwang and Kim (2009) find that CEOs who are socially connected to directors receive higher pay in both periods of good and poor performance. Similarly, Larcker, Richardson, Seary, and Tuna (2005) and Hoitach (2011) demonstrate that social ties between directors sitting on compensation committees and the CEO (or top management team) are associated with higher managerial compensation. Hwang and Kim (2009), Nguyen (2012) and Balsam, Kwack, and Lee (2017) find that socially connected CEOs are less likely to be fired, regardless of whether their performance is good or poor.

According to agency-based theoretical models, if the CEO's firm-specific wealth could be diversified or his/her career risk (including pay-cut and dismissal risk) could be mitigated, the CEO will become less risk-averse (Holmstrom, 1979; Amihud and Lev, 1981; Holmstrom and Costa, 1986; Hirshleifer and Thakor, 1992). This is because the success of investments in risky projects could increase (or maximize) the CEO's variable compensation conditional on firm performance and also enhance his/her human capital, while the failure will barely lead to his/her pay-cut or dismissal. Namely, when facing unlimited benefits but limited losses, the CEO is encouraged to take more risks. A large body of research provides consistent evidence that a lower risk of pay reduction and dismissal could motivate managerial risk-taking (Smith and Stulz, 1985; Aggarwal and Samwick, 1999; Kempf, Ruenzi, and Thiele, 2009).

Chakraborty, Sheikh, and Subramanian (2007) find that a lower probability of being fired in the event of poor performance encourages the CEO to take more risks. Cziraki and Groen-Xu (2019) use the length of employment contracts as a proxy of the protection against dismissal and find that CEOs with longer fixed-term employment agreements pursue riskier projects. Coles, Daniel and Naveen (2006) provide the evidence that lower pay-performance sensitivity, reflecting less pay-cut during poor performance, is associated with higher risky investment and financial policies. Gande and Kalpathy (2012) find that CEOs of financial firms with lower pay-performance sensitivity receive higher Federal loan assistance. Brick, Palmon, and Wald (2012) find that managers increase firm risk in response to a reduction in pay-performance sensitivity.

Thus, based on the above arguments, we expect that board-CEO social networks could induce firm risk by acting as insurance for the CEO's pay and job security.

2.2. Board-CEO social networks, CEO power and firm risk

Board-CEO social networks could boost the CEO's power over the board and in the firm. Power refers to "the capacity of individual actors to exert their will" (Finkelstein, 1992). Freeman (1984) posits that power for top executives is the ability to deal with internal and external sources of uncertainty. As representatives of a firm's shareholders, the board of directors is one of the key internal sources of uncertainty for top managers. Although executive directors might have little influence, independent directors have the power to limit managerial discretion. There is evidence that firms with a majority of independent directors on their boards may follow different strategies compared to firms with few independent directors (Bhagat and Bolton, 2013; Armstrong, Core, and Guay, 2014). Thus, a manager who can control board activities and reduce the uncertainty that the board engenders can gain power over the board and within the firm (Finkelstein, 1992).

Board-CEO social networks could increase the CEO's control (or power) over the board and within the firm by diminishing board monitoring and promoting board advising. First, embedded in social networks, mutual trust enables CEOs to receive less strict monitoring or discipline from socially connected directors, which provides them with more empire-building opportunities (Adams and Ferreira, 2007; Hwang and Kim, 2009; Nguyen, 2012; Sandvik, 2020). Second, socially connected CEOs could improve boards' support for their initiatives and decisions or minimize the risk of criticism and dissension (Westphal and Zajac, 1995).

This is because a friend feels socially obligated to come to one's aid or defence when needed (Shah and Jehn, 1993). Further, board-CEO social networks could facilitate information flow and communication between these two parties, so CEOs could obtain more timely and useful advice and help from connected directors (Westphal, 1999; Carpenter and Westphal, 2001; Schmidt, 2015).

Sociology literature indicates that the CEO's power could have an impact on managerial risk-taking behaviors. Applying the approach-inhibition theory of power (Keltner, Gruenfeld, and Anderson, 2003; Magee and Galinsky, 2008), CEOs with more power tend to focus more on the potential rewards of risky projects, while focusing less on the accompanying threats. The reason is that more power enables individuals to obtain more financial resources, higher esteem and more positive social attention, and to experience less interference or control from others when pursing potential rewards (Anderson and Berdahl, 2002). As a result, CEOs with enhanced power promotes optimism in perceiving risk, which results in riskier behaviors (Anderson and Galinsky, 2006; Maner, Gailliot, Butz, and Peruche, 2007; Carney, Cuddy, and Yap, 2010).

Empirical findings from finance research corroborate this sociological framework. Adams, Almeida, and Ferreira (2005) show that firm risk increases with CEO power. They demonstrate that powerful CEOs, who have more discretion to impact decisions, could make more idiosyncratic choices that lead to more extreme outcomes and eventually higher risk. Lewellyn and Muller-Kahle (2012) find that CEO power is positively linked to excessive risk-taking of financial firms, and Sheikh (2019) finds the same evidence for non-financial firms. Sariol and Abebe (2017) reveal that powerful CEOs tend to purse more exploratory innovations. Chikh and Filbien (2011) find powerful CEOs are more likely to complete acquisitions although the market reacts negatively to the event announcements. Onali, Galiakhmetova, Molyneux, and Torluccio (2016) find that firms with powerful CEOs have lower dividend payout ratios, which signal more aggressive investments.

Thus, based on the above arguments, we expect that board-CEO social networks could promote firm risk by intensifying the CEO's power over the board and in the firm.

3. Data and empirical specification

3.1. Data

We collect biographical information of directors and CEOs for US listed firms from BoardEx and ExecuComp databases. For each fiscal year during the sample period, we obtain demographic information, such as age, gender and nationality; historical activities, such as employment record, social charities and leisure clubs; and education background, including degree, graduation year and institution attended, on each board director and CEO. We also obtain firm financial and market data from Compustat and CRSP databases respectively. We exclude financial and public utility firms from our sample. Our final sample contains 2,775 CEOs and 20,429 directors of 1,660 US firms over the period 2000-2014. We do not consider the time period before 2000, due to incomplete biographical information of directors and CEOs. The final unbalanced dataset includes 12,470 firm-year observations.

3.2. Empirical methods and variables

We investigate the impact of social networks between independent directors and the CEO on firm risk. Our baseline specification is presented below:

$$Firm\ Risk_{i,t} = \alpha + \beta_1 Social\ Network\ Measures_{i,t} + \beta_2 Controls_{i,t} + \beta_3 Firm_i + \beta_4 Year_t + \varepsilon_{i,t} \quad (1)$$

Where our dependent variable *Firm Risk* is *Idiosyncratic Risk* or *Total Risk*. As our primary variables of interest, board-CEO social networks are captured by two measures: *Social Network Breadth* and *Social Network Depth*. We also include three vectors of variables that control for CEO characteristics, board characteristics and firm characteristics. *Firm* and *Year* control for firm and year fixed effects.

Following Gul, Srinidhi, and Ng (2011), Hayes, Lemmon, and Qiu (2012), Choy, Lin, and Officer (2014), Bartram, Brown, and Stulz (2016) and Savaser and Şişli-Ciamarra (2017), we define *Idiosyncratic Risk* as the log of the annualized standard deviation of daily abnormal returns over a fiscal year, which are the residuals from a CAPM model. We define *Total Risk*

as the log of the annualized standard deviation of daily stock returns. The CAPM model is presented below:

$$R_{i,t} = \alpha + \beta_1 Rmt_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where $R_{i,t}$ is the stock return on day *t* for firm *i*, and $Rmt_{i,t}$ is the value-weighted market index return on day *t*. In each calendar year, we estimate the market model individually for all firms with at least 100 daily return observations available.

Since independent directors play a key role in evaluating and disciplining the CEO, we focus on social networks between independent directors and the CEO. We employ two social network measures: *Social Network Breadth* and *Social Network Depth*. According to Fracassi and Tate (2012) and Khanna, Kim, and Lu (2015), we assume that board-CEO social networks are established through past and present employment outside the firm, education and membership of social organizations during overlapping years. *Social Network Breadth* is the percentage of independent directors that are socially connected to the CEO. The value of this measure ranges from zero to one, where zero means that no independent directors have social network ties with the CEO, and one means that all independent directors have social network ties with the CEO.

Social Network Depth is the number of social network ties that the CEO has with independent directors divided by the number of independent directors on the board. The value of this measure can exceed one, since one particular independent director may have multiple social network ties with the CEO. For example, if an independent director works with the CEO in an outside firm and also attends the same golf club as the CEO, then we count two network ties between this independent director and the CEO. For each firm-year observation, we calculate the total number of social network ties between each independent director and the CEO, and then aggregate them together to capture social network depth between all independent directors and the CEO.

We control for three groups of variables related to CEO characteristics, board characteristics and firm characteristics, respectively. For CEO characteristics, we include *CEO Duality*, a dummy variable that equals one if the CEO is the chairman of the board; *CEO Outside*, a dummy variable that equals one if the CEO comes from outside the firm; *CEO Age*; *CEO Stock Option*, the value of in-the-money stock options (in billions of dollars) owned by

the CEO, including exercisable and unexercisable stock options; *CEO Share Ratio*, the percentage of outstanding common shares held by the CEO; *CEO Social Network Centrality*, the log of the total number of outside individuals with whom the CEO is linked via past and present employment outside the firm, education and membership of social organizations; and *CEO Overconfidence*, a dummy variable that equals one if the CEO holds exercisable stock options that are over 67% in the money at least twice over our sample period, and the CEO is classified as overconfident beginning with the first time he/she exhibits such behavior; and *CEO Human Capital Index* (Adams, Almeida, and Ferreira, 2005; Fracassi and Tate, 2012; Ali and Zhang, 2015; Khanna, Kim, and Lu, 2015; Ferris, Javakhadze, and Rajkovic, 2017).

For board characteristics, we include *Board Size*, the total number of directors on the board, and *Board Independence %*, the number of total independent directors divided by the number of board members (Fracassi and Tate, 2012; Schmidt, 2015; Khanna, Kim, and Lu, 2015). Finally, for firm characteristics, we include *Return on Assets (ROA)*; *Tobin's Q*, market to book ratio; *Total Assets*; *Sales Growth*; *Cash Surplus*, net cash flow from operations minus depreciation expenses plus R&D expenditures, divided by total assets; and *Debt to Equity Ratio*, total debt divided by the book value of firm equity (Burgstahler, Hail, and Leuz, 2006; Cornett, McNutt, and Tehranian, 2009; Jiang, Petroni, and Wang, 2010; Fracassi and Tate, 2012; Gopalan and Jayaraman, 2012; Ahmed, Neel, and Wang, 2013; Sila, Gonzalez, and Hagendorff, 2016). Appendix A details definitions of all these variables.

3.3. Descriptive statistics

Table 1 reports descriptive statistics for our variables based on subsamples with and without board-CEO social networks. We winsorize all continuous variables at the one percent level to control for potential outliers. It is notable that over half of the total observations contain independent directors who are socially connected with the CEO, indicating that the phenomenon of board-CEO network ties is not random but relatively prevalent in recent decades. The mean value of *Social Network Breadth* is slightly less than 20%, suggesting that around one-fifth of independent directors have social network ties with the CEO. The average value of *Social Network Depth* is 0.5942, indicating that on average each CEO has at least one social network tie with one out of every two independent directors. These figures reflect the importance and potential effect of independent directors that are socially connected to the CEO on both CEOs' and directors' behaviors, which are directly related to firm risk.

The last column presents the mean differences between these two subsamples. The means of both *Idiosyncratic Risk* and *Total Risk* for firms with board-CEO social networks are higher than those for firms without such networks. This evidence might suggest that firms whose CEOs have social networks with independent directors are riskier than those whose CEOs do not have such networks, in line with our expectation. We also observe the same result for the means of alternative firm risk measures. Further, the presence of board-CEO social networks is associated with higher R&D expenditures, lower capital expenditures, fewer business segments, higher business concentration, higher leverage and lower liquidity, which reflect an increase in the riskiness of firm investment, operating and financing strategies.

CEOs with social networks to independent directors are more likely to be board chairs, less likely to come from outside the firm, have more stock options in value, have higher share percentages, have more social network ties outside the firm, and have higher human capital than CEOs without such networks. This suggests that firms with more powerful CEOs are more likely to recruit independent directors that are socially tied to their CEOs, in line with the evidence of Fracassi and Tate (2012). Additionally, firms with board-CEO social networks tend to have larger board size, larger firm size, higher sales growth, lower firm value, lower cash surplus and higher debt-to-equity ratio. In Appendix B, we report the correlation matrix for all independent variables. Coefficients between each pair of independent variables are small or insignificant on average, suggesting that multicollinearity is unlikely to be a significant concern in our multivariate analysis.

[Insert Table 1 here]

[Insert Appendix B here]

4. Empirical Results

4.1. Do board-CEO social networks influence firm risk?

We start by examining how board-CEO social networks affect firm risk. Table 2 reports estimates from the baseline regressions[1]. The table shows that both *Social Network Breadth* and *Social Network Depth* are positively and significantly related to *Idiosyncratic Risk* and *Total Risk* at the 5% level or above. The economic impact is also significant. The coefficients of *Social Network Breadth* on *Idiosyncratic Risk* (0.0083) and *Total Risk* (0.0166) indicate that

[1] In Appendix C, we also re-estimate our baseline regressions not controlling for firm fixed effects and controlling for industry fixed effects respectively and generate consistent statistical inferences.

one more independent director socially connected with the CEO leads to an increase of firm idiosyncratic risk by 11.38%[2] and an increase of firm total risk by 22.76%[3] respectively. The coefficients of *Social Network Depth* on *Idiosyncratic Risk* (0.0113) and *Total Risk* (0.0107) indicate that a one percent increase in *Social Network Depth* results in an increase of *Idiosyncratic Risk* and *Total Risk* by 1.13% and 1.07% respectively. Overall, this evidence supports our hypothesis that board-CEO social networks are positively related to firm risk[4]. Specifically, board-CEO social networks could reduce the board's motivation to reduce the CEO's salary or dismiss the CEO under poor performance, and also boost the CEO's power within the firm, which in turn stimulate managerial risk-taking behaviors[5].

In terms of control variables, we find that outside CEOs increase firm risk, due to the possibility that they normally bring greater changes to firm strategy and culture, leading to higher uncertainty and greater firm risk. CEO stock options stimulate firm risk probably by aligning CEOs' interests with those of shareholders. Both CEOs with more social networks outside, reflecting higher social capital, and CEOs with higher human capital prefer riskier projects. Overconfident CEOs are also in favour of riskier strategies. These findings are similar to those of Malmendier and Tate (2008), Duchin, Matsusaka, and Ozbas (2010), Berger, Kick, and Schaeck (2014), Kim, Mauldin, and Patro (2014), Otto (2014) and Ferris, Javakhadze, and Rajkovic (2017). In addition, larger boards tend to make fewer extreme decisions, thereby reducing firm risk, in line with Cheng (2008). Larger firms tend to have lower firm risk. ROA is negatively linked to firm risk, indicating that better-operated firms tend to take fewer risks, while Tobin's Q has a positive impact on firm risk, indicating that firms with more growth

[2] One more independent director socially connected with the CEO results in an increase of social network breadth ratio by 13.71% [1/(9.5781*0.7613)], which then leads to an increase of firm idiosyncratic risk by 11.38% (13.71*0.0083*100%).

[3] One more independent director socially connected with the CEO results in an increase of social network depth ratio by 13.71% [1/(9.5781*0.7613)], which then leads to an increase of firm total risk by 22.76% (13.71*0.0166*100%).

[4] While not tabulated, we also use the number of independent directors with social networks to the CEO (or the total number of social networks between independent directors and the CEO) as our alternative explanatory variable in the baseline regressions and generate consistent statistical inferences.

[5] While not tabulated, we also examine the impact of each type of board-CEO social networks on firm risk. We find that board-CEO social networks built through three ways, including employment, education and social activities, have a positive impact on firm risk individually, although those built through social activities have the most pronounced impact. Following Fracassi and Tate (2012), we do not set a restriction on the timing of social activities. Through this way, we can mitigate a significant loss of data because a large number of starting and ending dates are missing for social activities in the database. The error caused by this method tends to be small. Since most social activities, like club memberships and charity, are long-term activities, it is highly likely that two individuals have overlapping years even though we do not observe the accurate starting and ending dates for them.

opportunities tend to take more risks. Firms with less cash and more debt are more likely to have higher risk.

[Insert Table 2 here]

4.2. Board-CEO social networks and firm risk-related strategies

The above results indicate that there is an increase in firm risk if the CEO is socially connected with independent directors. In this section, we attempt to identify potential channels through which board-CEO social networks increase firm risk. Specifically, we investigate whether board-CEO social networks encourage the CEO to implement more aggressive or risky investment, operating and financing strategies that might expose the firm to greater risk. First, we examine the relation between board-CEO social networks and firm investment strategy, captured by capital expenditures and R&D expenditures. According to Kothari, Laguerre, and Leone (2002) and Eberhart, Maxwell, and Siffique (2004), R&D expenditures are investments in soft, intangible assets, such as technology, while capital expenditures are investments in hard, tangible assets, such as equipment. Thus, carrying more uncertainties, R&D expenditures are perceived as riskier investments than capital expenditures. If board-CEO social networks lead to a more aggressive or risky investment strategy, then we expect these networks to be positively related to R&D expenditures and negatively related to capital expenditures.

Second, we examine the relation between board-CEO social networks and firm operating strategy, reflected by firm business diversification. Based on Kini and Williams (2012) and Choy, Lin, and Officer (2014), conducting business in more industry segments, with no priority, is an effective way to reduce firm risk. If board-CEO social networks lead to a more aggressive operating strategy, then we expect these networks to be negatively related to No. of business segments and positively related to the segment Herfindahl index, a concentration ratio of assets across business segments. Third, we examine the relation between board-CEO social networks and firm financing strategy, captured by leverage and liquidity. In light of Coles, Daniel, and Naveen (2006), Cassell, Huang, Sanchez, and Stuart (2012) and Cai and Shefrin (2018), greater debt burden and liquidity constraints increase firm risk. If board-CEO social networks lead to a more aggressive financing strategy, then we expect these networks to be positively related to leverage ratio and negatively related to liquidity ratio.

To test these three potential channels, we rerun our baseline model (Equation (1)) using investment, operating and financing variables as dependent variables. *R&D Expenditures* is the

ratio of R&D expenses to total assets and *Capital Expenditures* is the ratio of capital expenditures to total assets. *No. of Business Segments* is the log of the number of business segments. *Segment Herfindahl Index* is calculated as the sum of the squares of the ratio of segment assets divided by firm total assets. It equals one if the firm operates solely in one business segment and reduces as the firm diversifies. *Leverage Ratio* is the ratio of total debt to total assets and *Liquidity Ratio* is the difference between current assets and current liabilities scaled by total assets at the beginning of the period.

Table 3 presents the regression results regarding the impact of board-CEO social networks on firm investment, operating and financing strategies. Panel A shows that board-CEO social networks have a negative impact on capital expenditures and a positive impact on R&D expenditures. This indicates that CEOs who are socially tied to independent directors spend more on R&D activities but spend less cash, reflecting socially networked CEOs prefer riskier investment strategy. Panel B shows that firms with board-CEO social networks have fewer business segments and higher business concentration, suggesting that board-CEO social networks lead to a decrease in firm business diversification. Panel C shows that firms whose CEOs are socially tied to independent directors have higher leverage ratios and lower liquidity ratios, showing riskier financing strategy. Overall, these findings reveal that CEOs who are socially connected to their independent directors improve firm risk by adopting riskier investment, operating and financing strategies.

We then conduct a mediation analysis to further confirm that board-CEO social networks promote firm risk through changing risk-related strategies. Specifically, we argue that board-CEO social networks lead to an increase in the riskiness of investment, operating and financing strategies, which in turn makes firm stock returns more volatile. To quantify this indirect effect, following Semrau and Sigmund (2012), Rungtusanatham, Miller, and Boyer (2014), Ferris, Javakhadze, and Rajkovic (2017) and Fedaseyeu, Linck, and Wagner (2018), we include all firm strategies as additionally independent variables in our baseline model (Equation (1)) and rerun it. If this indirect effect exists, we would expect that the positive impact of board-CEO social networks on firm risk reduces (becomes smaller) compared with that derived from our baseline regressions.

Table 4 presents the regression results using the mediation analysis. This table shows that the coefficients on *Social Network Breadth* and *Social Network Depth* remain positive and significant at the 5% level or above, reflecting that the positive impact of board-CEO social networks on firm risk still exists. Importantly, these coefficients are all smaller in magnitude

than those obtained from the baseline regressions, indicating a significant channel (indirect) effect of these firm strategies. For instance, the impact of *Social Network Breadth* on *Idiosyncratic Risk* reduces by around 24% after including all firm strategies in the model. Thus, this mediation analysis further provides evidence that the positive impact of board-CEO social networks on firm risk is channelled by firm risk-related strategies.

[Insert Table 3 here]

[Insert Table 4 here]

4.3. Are these results driven by potential endogeneity issues?

Our results thus far document a positive impact of board-CEO social networks on firm idiosyncratic risk and total risk. However, potential endogeneity issues might confound our baseline results. It is commonly recognized in the literature that director/executive characteristics and firm risk are not exogenous random variables, and their causal relation suffers from simultaneity and reverse causality issues (Adams and Ferreira, 2007; Harris and Raviv, 2006; Linck, Netter, and Yang, 2008; Sila, Gonzalez, and Hagendorff, 2016). In our case, board-CEO social networks may be correlated with other variables that are also mechanically related to firm risk. This possibility is supported by our evidence in Table 2 that firm risk is negatively related to firm size. Thus, smaller firms may prefer to hire independent directors that are tied to their CEOs and tend to take on riskier projects at the same time. Alternatively, board-CEO social networks may be a function of past firm risk. For instance, riskier firms may tend to appoint socially connected independent directors, who are more willing to support their CEOs' risk-taking behaviors (Fracassi and Tate, 2012; Kang, Liu, Low, and Zhang, 2018).

We take several steps to plausibly address potential endogeneity issues in our study. First, in the previous section, we employ firm and year fixed effects in our main specification to address the simultaneity issue caused by unobserved firm-specific and time-invariant variables. Second, in this section, following Fracassi and Tate (2012) and Falato, Kadyrzhanova, and Lel (2014), we employ the deaths and retirements of independent directors as an arguably natural experiment to generate a relatively exogenous variation in board-CEO social networks to address the simultaneity issue caused by unobserved not-firm-specific and time-varying variables and the reverse causality issue. Third, following Coles, Daniel, and Naveen (2014) and Chang and Wu (2020), we employ the Sarbanes-Oxley Act (SOX) as another arguably

natural experiment to create a relatively exogenous variation in board structure and then in board-CEO social networks to further address the associated endogeneity issues.

4.3.1. The deaths and retirements of socially connected directors: IVs

To address these endogeneity issues in our study, we first construct instrumental variables (IVs) that are directly related to board-CEO social networks but are unlikely to be directly related to firm risk and estimate the two-stage regressions. Our IVs are the deaths and retirements of independent directors that are socially tied to the CEO. We treat directors' departures as their retirements if they are at or beyond firms' mandatory retirement ages. This strategy draws upon the assumption that a director's departure due to their deaths or retirements could impact board-CEO social ties but are not plausibly driven by changes in firm economic outcomes (Fracassi and Tate, 2012; Hwang and Kim, 2012; Falato, Kadyrzhanova, and Lel, 2014). Thus, as relatively exogenous shocks, the deaths and retirements of independent directors would allow us to estimate how within-firm changes of board-CEO social networks could impact firm risk.

To construct these two instrumental variables, we identify all the death and retirement events of independent directors who were socially connected with the CEO[6]. It is vital to note that independent directors are still on boards in the years of their deaths or retirements or one year before their deaths (indicating at least some surprises in their passing). We define *Deaths of Directors* as a dummy variable that equals one if an independent director with social networks to the CEO dies, and *Retirements of Directors* as a dummy variable that equals one if a departing independent director with social networks to the CEO is at, or above, a firm's mandatory retirement age. We expect that these two instruments would reduce both *Social Network Breadth* and *Social Network Depth* significantly, because it is difficult for the CEO to immediately replace connected independent directors with equally connected new independent directors. In our sample, there are 386 deaths of independent directors and 2,093 retirements of independent directors. Of the independent directors who died during our sample period, 77

[6] The data on directors' deaths and the data on directors' social networks are collected from two different and independent profiles in BoardEx database. Because a director's death event does not impact the record of this director's social networks across our sample period in the database, the death of a director would not cause a survivorship bias of our social network measures or an irrelevance of the death instrument.

were socially connected with the CEO. Of the independent directors who retired during our sample period, 376 were socially connected with the CEO.

In Table 5, we report the regression results of the 2SLS estimator. Columns (1) and (4) display the first-stage regression results, while the remaining columns display the second-stage regression results. In the first stage, we regress *Social Network Breadth* (or *Depth*) on *Deaths of Directors* and *Retirements of Directors*. The coefficients on *Deaths of Directors* and *Retirements of Directors* are negative and significant, indicating that the relatively unexpected departure of independent directors due to their death or retirement reduces social network ties between independent directors and the CEO. In the second stage, we regress firm risk variables on fitted values of *Social Network Breadth* (or *Depth*) from the first-stage regressions. All the columns show a positive and significant impact of board-CEO social networks on firm risk at the 5% level or above[7]. Thus, our results still hold when employing the IV estimate.

We should also note that the possible anticipation of some directors' retirements could violate the assumption of our instruments. The reason is that directors' final retirement decisions would possibly be impacted not only by age and personal considerations, but also by firm economic outcomes. For example, directors might be more likely to retire if firms perform poorly, such as being extremely volatile. The study of Fracassi and Tate (2012) has mitigated this likelihood by providing evidence that independent directors that are socially tied to the CEO prefer to retire when the firm performs well, while retirements of those not tied to the CEO are not linked to firm performance. Further, our evidence on the *F*-test and the Sargan-Hansen test suggests the validity of our instruments to some extent[8]. Specifically, we reject the hypothesis that the instruments are unlinked to each of our explanatory variables, because values for the *F*-test are over 10. And we cannot reject the over-identifying restrictions of our model because *p*-values of the Sargan-Hansen test are statistically insignificant, which indicates that our instruments are distributed independently of each of our dependent variables.

[7] We observe that the IV estimates of the coefficients of *Social Network Breadth* (or *Depth*) are approximately twice as much as the baseline estimates. This is consistent with Jiang (2017) that the OLS estimate could underestimate the true effect between the outcome and treatment variables because of its weakness to address the endogeneity issue, and also that on the other hand, the IV estimate could produce an effect that is larger than the true effect due to the associated "local average treatment effect deviation" issue.

[8] Nevertheless, we also find that our explanatory variables *Social Network Breadth* (or *Depth*) are exogenous, i.e., statistically uncorrelated with error terms because *p*-values for the Durbin-Wu-Hausman test are statistically insignificant. Thus, we cannot say that this IV analysis is more efficient that the baseline OLS analysis.

[Insert Table 5 here]

4.3.2. The deaths and retirements of socially connected directors: DID

We second use a difference-in-difference approach as an alternative attempt to mitigate potential endogeneity issues. Specifically, we test the difference in firm risk changes around two types of quasi-natural events: unconnected independent director departures or connected independent director departures due to deaths and retirements. Thus, events of deaths and retirements of independent directors having at least one social network with the CEO are considered as treated events, while events of deaths and retirements of independent directors having no social network with the CEO are regarded as control events. The specifical formula is presented below:

$$Firm\ Risk_{i,t} = \alpha + \beta_1 Connected * After + \beta_2 After + \beta_3 Controls_{i,t} + \beta_4\ Firm_i + \varepsilon_{i,t} \quad (3)$$

Where *Connected* is a dummy variable that equals to one if the independent director deceased or retired had at least one social network with the CEO, and zero otherwise. *After* is a dummy variable that equals to one for years after the year of death or retirement, and zero otherwise. The coefficient β_2 on *After* captures the average within-firm effect of departures of unconnected independent directors on firm risk. As our primary interest, the coefficient $\beta_1$on the interaction term *Connected*After* captures the incremental impact of board-CEO social networks on firm risk. *Connected* is not included in the model as it is subsumed by firm fixed effects. In all DID regressions, we only include firms for which there is at least one observation both before and after the event year.

The regression results of the DID specification for the two-year window are presented in the first two columns of Table 6, while those for the three-year window are presented in the last two columns. In all columns, the coefficients on *After* are negative and significant indicating that firm risk decreases after the departures of unconnected independent directors. More importantly, the coefficients on the interaction term *Connected*After* are negative and significant at the 10% level or above. It suggests that independent director deaths or retirements causing the loss of board-CEO social networks experience a more obviously drop in firm risk

than those not causing such loss. Thus, this evidence further supports our baseline and IV results that higher (or lower) board-CEO social networks lead to higher (or lower) firm risk.

[Insert Table 6 here]

4.3.3. The Sarbanes-Oxley Act (the SOX)

To further mitigate endogeneity issues in our study, we third employ the Sarbanes-Oxley Act (the SOX) in 2002 as a relative exogenous shock of board-CEO social networks to perform a modified difference-in-difference (DID) analysis. The SOX requires that the majority of directors on the boards of listed firms are independent (Cohen, Dey, and Lys, 2008; Linck, Netter, and Yang, 2008; Bargeron, Lehn, and Zutter, 2010; Kang, Liu, and Qi, 2010). Thus, this act imposes a relatively exogenous change in board structure. Specifically, non-compliant firms are required to add new independent directors to their boards. In order to comply with the act and retain management control, non-compliant firms are compelled to recruit independent directors that are socially connected to the CEO (Westphal and Graebner, 2010). This results in a relatively exogenous increase (change) in board-CEO social networks, which enables us to identify the arguably causal effect of board-CEO social networks on firm risk.

Following Coles, Daniel, and Naveen (2014) and Chang and Wu (2020), we employ a modified DID specification to isolate the clean effect of board-CEO social networks. The key difference from the normal DID is that we allow for the likelihood that the SOX and related exchange provisions have a direct impact on firm risk, as well as an impact through board-CEO social network ties. This is because other regulations and political pressures brought by the SOX are likely to have affected board functioning, which is directly related to the CEO's risk-taking behaviors, through numerous channels. For instance, the NYSE also requires its listed firms to have audit, nominating and compensation committees consisting entirely of independent directors, and the Nasdaq requires its listed firms to have audit committees consisting entirely of independent directors. Further, the SOX imposes greater liability for both the board and the CEO. The board is required to meet with management, and the CEO is required to disclose internal control statements. Thus, we estimate the modified regression, which is presented as follows:

$$
\begin{aligned}
Firm\ Risk_{i,t} \;=\; & \alpha + \beta_1 Social\ Network\ Meausres_{i,t} + \beta_2 Social\ Network\ Meausures_{i,t} \\
& * \ Post\ SOX + \ \beta_3 Non-compliant\ Firms * Social\ Network\ Meausres_{i,t} \\
& + \ \beta_4 Non-compliant\ Firms * Social\ Network\ Meausres_{i,t} * Post\ SOX \\
& + \beta_5 Controls_{i,t} + \beta_6\ Firm_i + \beta_7\ Year_t + \varepsilon_{i,t} \qquad (3)
\end{aligned}
$$

Where *Non-compliant Firms* is a dummy variable that equals one for firms that had an independent board ratio below 50% before the year 2002. *Post SOX* is a dummy variable that equals one if the year is after 2002. In this model, β_1 is the constant component that captures the impact of board-CEO social networks on firm risk for compliant firms in the pre-SOX period, while $\beta_1+\beta_3$ captures the impact of board-CEO social network ties for non-compliant firms in the pre-SOX period. Both effects include the bias due to endogeneity. $\beta_1+\beta_2$ captures the effect of board-CEO social networks for compliant firms in the post-SOX period, which includes not only the effect of bias, but also the direct effect of the SOX. *Non-compliant Firms* and *Post SOX* are not included in the model as they are subsumed by firm fixed and year fixed effects.

Since the SOX imposes an exogenous shock on the board composition of non-compliant firms, $\beta_1+\beta_2+\beta_3+\beta_4$ captures both the clean effect of board-CEO social networks on firm risk and the direct impact from the SOX. Thus, we obtain the clean effect of board-CEO social networks ($\beta_1+\beta_3+\beta_4$) by subtracting the direct effect of the SOX (β_2) from the combined effect ($\beta_1+\beta_2+\beta_3+\beta_4$). Specifically, given that non-compliant firms are forced to enhance board independence, $\beta_1+\beta_3+\beta_4$ offers us the clean estimate of board-CEO social networks on firm risk from the resulted relatively exogenous change in board-CEO social networks. In this specification, we also include other control variables as well as firm and year fixed effects. And *Non-compliant Fir*ms and *Post SOX* are subsumed due to the use of these two fixed effects.

Table 7 reports estimation results by considering the SOX as a relatively exogenous shock. For brevity, we present only the clean estimates for the total impact of board-CEO social networks on two measures of firm risk at the bottom of the table. We find that the clean estimates of the impact of board-CEO social networks, based on the relatively exogenous variation in board structure via the SOX, on firm risk are significant and positive. The clean impact of *Social Network Breadth* and *Social Network Depth* on firm risk becomes statistically stronger than the estimated impact from the baseline regressions. This consistent evidence mitigates our concerns that endogeneity might drive our baseline results.

[Insert Table 7 here]

4.3.4. Alternative measures of firm risk

In addition to the changes in firm idiosyncratic and total risk, a variation in firm risk may also be reflected in changes in its earnings volatility and insolvency risk (Choy, Lin, and Officer, 2014; Cai and Shefrin, 2018). Thus, in this part, we use earnings volatility and insolvency risk as alternative measures of firm risk to check the robustness of our main findings. Based on Kini and Williams (2012), Sila, Gonzalez, and Hagendorff (2016) and Wruck and Wu (2017), earnings volatility is captured by *Sd (ROA)* or *Sd (Cash Flow)*, the standard deviation of annual ROA (or annual EBITDA) in the three fiscal years from t to t+2. Higher values mean higher volatility or risk. Following Boyd, Graha and Hewitt (1993), Esty and Megginson (2003), Laeven and Levin (2009) and Bai and Elyasiani (2013), insolvency risk is captured by *Z-score* calculated as (ROA+CAR)/ Sd (ROA), where CAR is the capital-asset ratio. A higher Z-score means a higher ability to cover firm debt and, hence, a lower default risk.

To test the robustness, we rerun our baseline model (Equation (1)) using these three variables as dependent variables. Table 8 shows the regression results of the robustness checks. The coefficients of *Sd (ROA)* and *Sd (Cash Flow)* are all positive and significant, indicating that firms with board-CEO social networks have more volatile earnings. The coefficients of *Z-Score* are negative and significant, indicating that firms with board-CEO social networks have a higher probability of default. Hence, the use of alternative measures of firm risk further confirms our baseline results that board-CEO social networks are positively related to firm risk.

[Insert Table 8 here]

4.4. Heterogeneity in board-CEO social networks and firm risk

We previously identify the average positive effect of social networks between independent directors and the CEO on firm risk. However, the specific effect of social networks between these two parties on firm risk might vary in different circumstances. In this section, we examine the variation in the effect of board-CEO social networks on firm risk by considering firm prior performance, CEO power and CEO overconfidence respectively.

4.4.1. Board-CEO social networks, prior performance and firm risk

We firstly examine whether the relation between board-CEO social networks and firm risk varies by prior firm performance. If board-CEO social networks alleviates the CEO's career pressure or risk, and subsequently enable the CEO to take more risks, then this effect should be stronger for the firm with low prior performance. On the other hand, for the firm with high prior performance, the CEO's threat of dismissal is much smaller, and thus the relation between board-CEO social networks and firm risk should be weaker.

To test this expectation, we, following Chakraborty, Sheikh, and Subramanian (2007) and Nguyen (2012), employ one-year lagged and industry-adjusted stock returns to proxy for prior firm performance. Then, we insert the interaction term *Social Network Breadth (or Depth)*Prior Performance* in our baseline regressions and rerun the regressions. The empirical results are shown in Table 9. The coefficients of the interaction term *Social Network Breadth*Prior Performance* (or *Social Network Depth*Prior Performance*) are negative and significant at the 5% level. It indicates that the positive relation between board-CEO social networks and firm risk is moderated (or weaker) when the firm prior performance is good. This evidence supports our argument that the effect of board-CEO social networks on firm risk should be stronger for the firm with low prior performance.

[Insert Table 9 here]

4.4.2. Board-CEO social networks, CEO power (or CEO overconfidence) and firm risk

We then examine whether the relation between board-CEO social networks and firm risk varies by CEO power or CEO overconfidence. If board-CEO social networks boost the CEO's power or confidence, and subsequently incentive the CEO to take more risks, then the effect should be stronger for firms with low CEO power or low CEO overconfidence. The reason is that the presence of socially connected independent directors could add incremental power or confidence to the CEO if he/she is relatively not powerful or overconfident, and then greatly promotes managerial risk-taking behaviors.

To test this expectation, we, following the conventional literature, employ the principal analysis method to constitute a composite measure of *CEO Power* based on five variables, *CEO Duality*, *CEO Outside*, *CEO Share Ratio*, *Board Independence* and *Board Size* (Cheng, 2008; Laux, 2008; Pathan, 2009; Minton, Tailard, and Williamson, 2014; Abernethy, Kuang,

and Qin, 2015; Khanna, Kim, and Lu, 2015). The CEO chairing the board tends to be more powerful; the CEO recruited from outside the firm tends to be less knowledgeable about the firm and have less influence (or power); larger share ownership (ratio) gives the CEO more voting rights, increasing his/her ownership-related power; the CEO under monitoring by more independent directors tends to have less discretions or power; larger board size, reflecting less efficiency in monitoring, provides more opportunities (or power) to the CEO to extract rents. Then, we insert the interaction term *Social Network Breadth (or Depth)*CEO Power* or *Social Network Breadth (or Depth)*CEO Overconfidence* in our baseline regressions respectively and rerun the regressions.

The empirical results on CEO power are shown in Table 9 and those on CEO overconfidence are shown in Table 10. Panel A of Table 9 shows factor solution for our measure of *CEO Power* and these five factors capture 69.57% of the variance. In Panel B of Table 10, the coefficients of the interaction term *Social Network Breadth (or Depth)*CEO Power* are negative and significant at the 5% level or above. It indicates that the positive relation between board-CEO social networks and firm risk is moderated (or weaker) when the CEO is powerful. Similarly, in Table 11, the coefficients of the interaction term *Social Network Breadth (or Depth)*CEO Overconfidence* are negative and significant at the 5% level. This indicates that the positive relation between board-CEO social networks and firm risk is moderated (or weaker) when the CEO is relatively overconfident. In summary, these results support our expectation that the effect of board-CEO social networks on firm risk should be stronger for the firm with less powerful CEO or less overconfident CEO.

[Insert Table 10 here]

[Insert Table 11 here]

5. Conclusions

Our study investigates how social networks between independent directors and the CEO impact firm risk. We hypothesize that board-CEO social networks increase firm risk through two channels: lessening the CEO's career risk and increasing the CEO's power over the board and within the firm. This is because social networks foster mutual caring, trust, positive impression and tolerance of failure among actors (Silver, 1990; Tsui, Egan, and O'Reilly, 1992). Based on a merged dataset comprising 1,660 US firms for the period 2000 to 2014, we observe that social network ties between independent directors and the CEO are a relatively

prevalent phenomenon. Our main regression results support our hypothesis that board-CEO social networks increase firm risk. Findings also show the economic importance of this result. Additionally, we find that board-CEO social networks increase firm risk by encouraging the CEO to embark on riskier investment, operating and financing strategies.

Our results still hold when we use deaths and retirements of socially connected independent directors as instrumental variables or using DID approach; the 2002 SOX, which creates a relatively exogenous change in board structure as another identification; and alternative firm risk measures. Our cross-sectional analyses show that the positive relation between board-CEO social networks and firm risk is moderated (or weaker) when the firm prior performance is good, the CEO is powerful or the CEO is overconfident. Our study provides a new insight into the relation between director/executive characteristics and firm risk. Previous studies mainly focus on the dark side of board-CEO social networks, while our study reveals the bright side of these networks. Our study calls for mandatory disclosure of board-CEO social networks.

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Table 1
Summary statistics

This table reports descriptive statistics for the variables of 1,660 US firms during the period 2000-2014 used in our models. Measures of firm risk and board-CEO social network ties are defined in Section 3.2. Definitions of all variables are presented in Appendix A.

	Total sample (12,470 observations)		**Subsample with board-CEO social networks** (7,358 observations)		**Subsample without board-CEO social networks** (5,112 observations)		
Variables	Mean	SD	Mean	SD	Mean	SD	Mean Difference
Independent Variables							
Social Network Breadth	0.1875	0.1684	0.3178	0.1763	0.0000	0.0000	0.3178***
Social Network Depth	0.5942	0.4732	1.0070	0.4592	0.0000	0.0000	1.0070**
Dependent Variables							
Idiosyncratic Risk	-1.4217	1.4733	-1.3685	1.4953	-1.4983	1.4682	0.1298***
Total Risk	-1.3874	1.4257	-1.3457	1.4511	-1.4474	1.4157	0.1017**
Sd (ROA)	0.0446	0.0416	0.0483	0.0454	0.0393	0.0398	0.0090**
Sd (Cash Flow)	0.0235	0.0193	0.0265	0.0232	0.0192	0.0185	0.0073**
Z-score	1.3657	3.8461	1.2578	3.6757	1.5210	4.0872	-0.2632***
R&D Expenditures	0.0462	0.0649	0.0502	0.0704	0.0404	0.0591	0.0098**
Capital Expenditures	0.0843	0.0872	0.0735	0.0753	0.0998	0.1042	-0.0263**
No. of Business Segments	1.0431	1.3761	0.9751	1.2857	1.1410	1.3859	-0.1659***
Segment Herfindahl Index	0.7135	0.6361	0.7693	0.7553	0.6332	0.6158	0.1361***
Leverage Ratio	0.4624	0.4019	0.4914	0.4552	0.4207	0.3572	0.0707***
Liquidity Ratio	0.2191	0.2053	0.2074	0.1996	0.2359	0.2098	-0.0285**
Control Variables							
CEO Duality	0.4855	0.5636	0.5079	0.5935	0.4533	0.5426	0.0546**
CEO Outside	0.1980	0.3990	0.1837	0.3695	0.2186	0.4641	-0.0349*
CEO Age	55.9987	7.2544	56.3846	7.5428	55.4433	7.0736	0.9413
CEO Stock Option	0.0260	0.1620	0.0294	0.1796	0.0211	0.1575	0.0083**
CEO Share Ratio	0.0300	0.1040	0.0335	0.1245	0.0250	0.0985	0.0085**
CEO Social Network Centrality	2.3261	2.6474	2.5322	2.7961	2.0294	2.5632	0.5028***
CEO Overconfidence	0.6348	0.7637	0.6631	0.8078	0.5941	0.7284	0.0690
CEO Human Capital Index	1.2583	1.4753	1.3753	1.6953	1.0899	1.4089	0.2854**
Board Size	9.5781	2.6414	10.1057	2.8535	8.8187	2.5348	1.2870***

Board Independence %	0.7613	0.1401	0.7541	0.1389	0.7717	0.1412	-0.0176
ROA	0.0528	0.0774	0.0501	0.0762	0.0567	0.7942	-0.0066
Tobin's Q	1.4092	1.2935	1.2982	1.2185	1.5690	1.4524	-0.2708**
Total Assets	7.9014	1.7079	8.5317	2.1572	6.9942	1.5758	1.5375**
Sales Growth	0.1003	1.0716	0.1021	1.0834	0.0977	1.0638	0.0044**
Cash Surplus	0.0563	0.0946	0.0521	0.0936	0.0623	0.0953	-0.0111**
Debt to Equity Ratio	0.8601	0.8147	0.9342	0.8736	0.7535	0.7062	0.1807***

Table 2
Board-CEO social networks and firm risk

This table reports panel regression results of firm risk on board-CEO social networks during the sample period 2000 to 2014. *Social Network Breadth* is the percentage of independent directors that are socially connected to the CEO. *Social Network Depth* is the number of social network ties that the CEO has with independent directors divided by the number of independent directors on the board. As to our dependent variables, *Idiosyncratic Risk* is the log of the annualized standard deviation of daily abnormal returns over a fiscal year, which are the residuals from a CAPM model, and *Total Risk* is the log the annualized standard deviation of daily stock returns. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	**Idiosyncratic Risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breadth	0.0083***	0.0166**		
	(3.219)	(2.214)		
Social Network Depth			0.0113***	0.0107**
			(2.615)	(2.342)
CEO Duality	0.0043	-0.0024	0.0028	-0.0051
	(0.568)	(-0.278)	(0.233)	(-0.599)
CEO Outside	0.0187*	0.0242**	0.0210*	0.0296**
	(1.718)	(2.132)	(1.737)	(2.549)
CEO Age	-0.0008	-0.0005	-0.0009	-0.0007
	(-0.728)	(-0.572)	(-1.229)	(-0.725)
CEO Stock Option	0.0023**	0.0045**	0.0034***	0.0067***
	(2.256)	(2.428)	(2.584)	(2.793)
CEO Share Ratio	-0.0015	-0.0029	-0.0003	-0.0010
	(-0.837)	(-1.594)	(-0.033)	(-0.362)
CEO Social Network Centrality	0.0026*	0.0061**	0.0027*	0.0063**
	(1.763)	(2.378)	(1.773)	(2.395)
CEO Overconfidence	0.0071*	0.0172**	0.0072*	0.0129**
	(1.795)	(2.327)	(1.784)	(2.365)
CEO Human Capital Index	0.0038*	0.0042*	0.0026*	0.0035
	(1.898)	(1.873)	(1.728)	(1.647)
Board Size	-0.0066***	-0.0058**	-0.0064**	-0.0048**
	(-2.621)	(-2.537)	(-2.535)	(-2.159)
Board Independence %	-0.1024	-0.0917	-0.0925	-0.0873
	(-0.716)	(-0.386)	(-0.479)	(-0.317)
Total Assets	-0.0536***	-0.0790***	-0.0714***	-0.0942***
	(-4.856)	(-6.694)	(-6.368)	(-8.834)
ROA	-0.6083***	-0.5683***	-0.6013***	-0.5485***
	(-11.275)	(-10.133)	(-11.362)	(-9.864)
Tobin's Q	0.0396***	0.0322***	0.0339***	0.0247***
	(8.638)	(7.364)	(7.542)	(5.853)
Sales Growth	0.0023	0.0037*	0.0026	0.0047
	(0.915)	(1.794)	(0.385)	(1.537)
Cash Surplus	-0.0032**	-0.0045**	-0.0036**	-0.0048**
	(-2.216)	(-2.357)	(-2.175)	(-2.296)
Debt to Equity Ratio	0.0253**	0.0286***	0.0254**	0.0288***
	(2.356)	(2.752)	(2.360)	(2.785)
Constant	-2.9623***	-2.8573***	-2.5734***	-2.4757***
	(-4.269)	(-3.185)	(-2.783)	(-3.159)

Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.6648	0.6049	0.6463	0.6185

Table 3
Board-CEO social networks and firm risk-related strategies

This table reports panel regression results of firm strategies on board-CEO social networks. In Panel A, as our proxies for investment strategy, *R&D Expenditures* is the ratio of R&D expenses to total assets and *Capital Expenditures* is the ratio of capital expenditures to total assets. In Panel B, as our proxies for operating strategy, *No. of Business Segments* is the log of the number of business segments and *Segment Herfindahl Index* is calculated as the sum of the squares of the ratio of segment assets divided by total assets. In Panel C, as our proxies for financing strategy, *Leverage Ratio* is the ratio of total debt to total assets and *Liquidity Ratio* is the difference between current assets and current liabilities scaled by total assets at the beginning of the period. *Debt to Equity Ratio* is not included in control variables in Panel C. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Panel A: firm investment strategy

Dependent Variables	**R&D Expenditures**	**Capital Expenditures**	**R&D Expenditures**	**Capital Expenditures**
	(1)	(2)	(3)	(4)
Social Network Breadth	0.0051**	-0.0038**		
	(2.167)	(-1.984)		
Social Network Depth			0.0012**	-0.0014**
			(2.263)	(-2.475)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.2873	0.1868	0.2933	0.1874

Panel B: firm operating strategy

Dependent Variables	**No. of Business Segments**	**Segment Herfindahl Index**	**No. of Business Segments**	**Segment Herfindahl Index**
	(1)	(2)	(3)	(4)
Social Network Breadth	-0.0336***	0.0041**		
	(-3.268)	(2.573)		
Social Network Depth			-0.0147***	0.0034**
			(-2.864)	(2.523)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.4628	0.3274	0.4689	0.3517

Panel C: firm financing strategy

Dependent Variables	**Leverage Ratio**	**Liquidity Ratio**	**Leverage Ratio**	**Liquidity Ratio**
	(1)	(2)	(3)	(4)
Social Network Breadth	0.0105**	-0.0039**		
	(2.436)	(-2.031)		
Social Network Depth			0.0117***	-0.0038**
			(2.693)	(-2.086)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

N	12,470	12,470	12,470	12,470
adj. R-sq	0.5775	0.4854	0.5436	0.4574

Table 4
Board-CEO social networks, firm risk and firm strategies

This table reports panel regression results of firm risk on board-CEO social networks after controlling for firm strategies during the sample period 2000 to 2014. Definitions of all variables are presented in Appendix A. *Debt to Equity Ratio* is not included in control variables in all regressions. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	**Idiosyncratic Risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breadth	0.0063***	0.0122**		
	(3.204)	(2.317)		
Social Network Depth			0.0091***	0.0079***
			(2.623)	(2.587)
R&D Expenditures	0.0336**	0.0462**	0.0285**	0.0476**
	(2.015)	(2.128)	(2.021)	(2.195)
Capital Expenditures	-0.0638***	-0.0850***	-0.0694***	-0.0829***
	(-3.117)	(-3.179)	(-3.253)	(-3.248)
No. of Business Segments	-0.0358**	-0.0574**	-0.0385*	-0.0548**
	(-2.116)	(-2.505)	(-1.952)	(-2.574)
Segment Herfindahl Index	0.0669**	0.0885**	0.0691**	0.0879**
	(2.183)	(2.368)	(2.267)	(2.366)
Leverage Ratio	0.1361***	0.1445***	0.1369***	0.1468***
	(2.642)	(2.764)	(2.643)	(2.786)
Liquidity Ratio	-0.1272**	-0.0352**	-0.1278**	-0.1465***
	(-2.421)	(-2.518)	(-2.346)	(-2.853)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.6854	0.6205	0.6623	0.6338

Table 5

Board-CEO social networks and firm risk: deaths and retirements of socially connected independent directors as IVs

This table reports panel regression results of firm risk on board-CEO social networks employing two instrumental variables: deaths and retirements of socially connected independent directors, which are defined in Section 4.3.1. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables		**Idiosyncratic Risk**	**Total Risk**		**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)	(5)	(6)
First Stage						
Deaths of Directors	-0.0581*			-0.1153***		
	(-1.874)			(-2.836)		
Retirements of Directors	-0.0263**			-0.0897***		
	(-2.128)			(-3.103)		
Second Stage						
Social Network Breath		0.0176**	0.0358**			
		(2.258)	(2.405)			
Social Network Depth					0.0217**	0.0196***
					(2.335)	(2.683)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap Wald *F*-statistics	10.513			12.658		
Durbin-Wu-Hausman test	0.362			0.523		
Sargan-Hansen statistic of over-identification		2.317	2.180		2.297	1.905
N	12,470	12,470	12,470	12,470	12,470	12,470

Table 6
Board-CEO social networks and firm risk: deaths and retirements of socially connected independent directors in DID

This table reports panel regression results of firm risk on the dynamics of board-CEO social networks and deaths and retirements of independent directors during the sample period 2000 to 2014. *Connected* is a dummy variable that equals to one if the independent director deceased or retired had at least one social network with the CEO, and zero otherwise. *After* is a dummy variable that equals to one for years after the year of death or retirement, and zero otherwise. The interaction term *Connected*After* captures the effect of the dynamics of board-CEO social networks and deaths and retirements of independent directors on firm risk. The first two columns report the results using a two-year window period centered on the event, while the last two columns report the results using a three-year window period. Definitions of all variables are presented in Appendix A. In all columns, firm fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

	Two-year window [-2, 2]		Three-year window [-3, 3]	
Dependent Variables	**Idiosyncratic risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Connected*After	-0.0968**	-0.1442*	-0.0892***	-0.1305**
	(-2.478)	(-1.937)	(-2.685)	(-2.201)
After	-0.0575**	-0.0812**	-0.0553**	-0.0753**
	(-2.556)	(-2.364)	(-2.551)	(-2.436)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
N	5,951	5,951	7,742	7,742
adj. R-sq	0.8387	0.8124	0.8176	0.7942

Table 7

Board-CEO social networks and firm risk: the Sarbanes-Oxley Act of 2002

This table reports panel regression results of firm risk on the dynamics of board-CEO social networks and the Sarbanes-Oxley Act of 2002 during the sample period 2000 to 2014. *Post SOX* is a dummy variable that equals one if the year is after 2002. *Non-compliant Firms* is a dummy variable that equals one for those firms that had independent board ratio below 50% before the year 2002. The interaction term *Social Network Breadth* (or *Depth*)***Post SOX* represents the effect of the dynamics of board-CEO social networks and the SOX on firm risk. The interaction term *Social Networks Breadth* (or *Depth*)**Non-compliant Firm*Post SOX* represents the effect of the dynamics of board-CEO social networks, non-compliant firms and the SOX on firm risk. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	**Idiosyncratic risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breath	0.0181***	0.0186***		
	(9.843)	(11.657)		
Social Network Breath*Post SOX	-0.0053***	-0.0051***		
	(-10.741)	(-13.565)		
Social Network Breath*Non-compliant Firm	0.0179***	0.0160***		
	(7.498)	(7.311)		
Social Network Breadth*Non-compliant Firm*Post SOX	-0.0259***	-0.0173***		
	(-7.586)	(-7.426)		
Social Network Depth			0.0095***	0.0104***
			(4.131)	(8.338)
Social Network Depth*Post SOX			-0.0101***	-0.0103***
			(-12.563)	(-15.953)
Social Network Depth*Non-compliant Firm			0.0062***	0.0055***
			(7.348)	(7.046)
Social Network Depth*Non-compliant Firm*Post SOX			-0.0031***	-0.0034***
			(-7.291)	(-7.365)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.6832	0.6214	0.6635	0.6295
Clean estimate $(\beta_1 + \beta_3 + \beta_4)$	0.0101***	0.0173***	0.0126***	0.0125***
	(7.454)	(9.236)	(5.788)	(6.380)

Table 8

Board-CEO social networks and firm risk: alternative measures of firm risk

This table reports panel regression results of firm risk on board-CEO social networks during the sample period 2000 to 2014 using alternative measures of firm risk. *Sd (ROA)* is calculated as the standard deviation of annual ROA in the three fiscal years from t to t+2. *Sd (Cash Flow)* is calculated as the standard deviation of annual EBITDA in the three fiscal years from t to t+2. *Z-Score* is calculated as (ROA+CAR)/ Sd (ROA), where CAR is the capital-asset ratio. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	**Sd (ROA)**	**Sd (Cash Flow)**	**Z-score**	**Sd (ROA)**	**Sd (Cash Flow)**	**Z-score**
	(1)	(2)	(3)	(4)	(5)	(6)
Social Network Breath	0.0053***	1.1482***	-0.2390**			
	(3.842)	(3.279)	(-1.982)			
Social Network Depth				0.0025***	0.3937***	-0.0946**
				(5.217)	(3.375)	(-2.286)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	10,908	10,908	12,470	10,908	10,908	12,470
adj. R-sq	0.5437	0.5516	0.1176	0.5429	0.5483	0.1127

Table 9

Board-CEO social networks, firm prior performance and firm risk

This table reports panel regression results of firm risk on the dynamics of board-CEO social networks and firm prior performance during the sample period of 2000 to 2014. We employ one-year lagged and industry-adjusted stock returns to proxy for prior firm performance. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	**Idiosyncratic Risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breadth	0.0114***	0.0218**		
	(2.835)	(2.237)		
Social Network Breadth*Prior Performance	-0.0035**	-0.0052**		
	(-2.371)	(-2.468)		
Social Network Depth			0.0146**	0.0149*
			(2.274)	(1.942)
Social Network Depth*Prior Performance			-0.0043**	-0.0048**
			(-2.275)	(-2.386)
Prior Performance	-0.0632**	-0.0471**	-0.0624**	-0.0485***
	(-2.136)	(-2.346)	(-2.125)	(-2.692)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.6698	0.6096	0.6513	0.6259

Table 10
Board-CEO social networks, CEO power and firm risk

This table reports panel regression results of firm risk on the dynamics of board-CEO social networks and CEO power during the sample period of 2000 to 2014. Panel A of this table presents factor loadings on *CEO Power* factors derived from principal components analysis, including *CEO Duality*, *CEO Outside*, *CEO Share Ratio, Board Independence* and *Board Size*. Panel B of this table presents multivariate analyses using the interaction term *Social Network Breadth* (or *Social Network Depth*) * *CEO Power*, which represents the effect of the dynamics of board-CEO social networks and CEO power on firm risk. The five factors of CEO power are not included as controls. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Panel A: factor loadings

	CEO Power
CEO Duality	0.6342
CEO Outside	-0.5158
CEO Share Ratio	0.3692
Board Independence	-0.5818
Board Size	0.6156
Model Statistics:	
Eigenvalue	1.4719
% Variance Explained	0.6957

Panel B: regression results

Dependent Variables	**Idiosyncratic risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breath	0.0132**	0.0239**		
	(2.547)	(2.226)		
Social Network Breadth*CEO Power	-0.0042**	-0.0065***		
	(-2.251)	(-2.672)		
Social Network Depth			0.0167**	0.0166**
			(2.438)	(2.093)
Social Network Depth*CEO Power			-0.0046**	-0.0051**
			(-2.453)	(-2.478)
CEO Power	0.0082**	0.0115**	0.0135*	0.148*
	(2.138)	(2.295)	(1.925)	(1.938)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.6538	0.5954	0.6375	0.6096

Table 11

Board-CEO social networks, CEO overconfidence and firm risk

This table reports panel regression results of firm risk on the dynamics of board-CEO social networks and CEO overconfidence during the sample period of 2000 to 2014. Definitions of all variables are presented in Appendix A. In all columns, firm and year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	**Idiosyncratic risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breath	0.0138**	0.0243**		
	(2.363)	(2.218)		
Social Network Breadth*CEO Overconfidence	-0.0053**	-0.0078**		
	(-2.183)	(-2.258)		
Social Network Depth			0.0172**	0.0189**
			(2.185)	(2.318)
Social Network Depth*CEO Overconfidence			-0.0059**	-0.0080**
			(-2.279)	(-2.452)
CEO Overconfidence	0.0132*	0.0269**	0.0145*	0.235**
	(1.836)	(2.158)	(1.856)	(1.993)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.6785	0.6186	0.6604	0.6317

Appendix A
Definitions of variables

Variable Names	Definitions
Firm Risk Measures	
Firm Idiosyncratic Risk	The log of the annualized standard deviation of daily abnormal returns over a fiscal year, where abnormal returns are the residuals from a CAPM model.
Firm Total Risk	The log of the annualized standard deviation of daily stock returns over a fiscal year.
Sd (ROA)	The standard deviation of annual ROA in the three fiscal years from t to t+2.
Sd (Cash Flow)	The standard deviation of annual EBITDA in the three fiscal years from t to t+2.
Z-score	The sum of ROA and CAR scaled by Sd (ROA), where CAR is the capital-asset ratio.
R&D Expenditures	The ratio of R&D expenses to total assets.
Capital Expenditures	The ratio of capital expenditures to total assets.
No. of Business Segments	The log of the number of business segments.
Segment Herfindahl Index	The sum of the squares of the ratio of segment assets divided by firm total assets.
Leverage Ratio	The ratio of total debt to total assets.
Liquidity Ratio	The difference between current assets and current liabilities scaled by total assets at the beginning of the period.
Board-CEO Social Network Measures	
Social Network Breadth	According to Fracassi and Tate (2012) and Khanna, Kim, and Lu (2015), we assume that board-CEO social networks are established through past and present employment outside the firm, education and membership of social organizations during overlapping years. Thus, social network breadth is the percentage of independent directors that are socially connected to the CEO.
Social Network Depth	The number of social network ties that the CEO has with independent directors divided by the number of independent directors on the board.
Control Variables	
CEO Duality	A dummy variable that equals one if the CEO is the chair of the board.
CEO Outside	A dummy variable that equals one if the CEO comes from outside the firm.
CEO Age	CEO age.
CEO Stock Option	The value of in-the-money stock options (in billion dollars) owned by the CEO including exercisable and unexercisable stock options.
CEO Share Ratio	The percentage of outstanding common shares held by the CEO.
CEO Social Network Centrality	The log of the total number of outside individuals with whom the CEO is linked via past and present employment outside the firm, education and membership of social organizations.
CEO Overconfidence	A dummy variable that equals one if the CEO holds exercisable stock options that are over 67% in the money at least twice over our sample period, and zero otherwise. And the CEO is classified as overconfident beginning with the first time the CEO exhibits such behavior.
CEO Human Capital Index	The sum of the dummy variables below: a dummy variable that equals one if the CEO holds an academic degree from an 'elite' university; a dummy variable that equals one if the CEO has a Ph.D.; a dummy variable that equals one if the CEO has financial experience; a dummy variable that equals one if the CEO has legal experience; a dummy variable that equals one if the CEO has political experience and a dummy variable that equals one if the CEO has military experience.
Board Size	The total number of directors on the board.
Board Independent %	The number of independent directors divided by the number of board members.
ROA	Return on assets.

Tobin's Q	Market to book ratio.
Total Assets	The log of total assets.
Sales Growth	Annual growth rate of sales.
Cash Surplus	Net cash flow from operations minus depreciation expenses plus R&D expenditures, divided by total assets.
Debt to Equity Ratio	Total debt divided by the book value of firm equity.

Appendix B
Correlation Matrix

This table reports the Person Correlation Matrix for all independent variables over the period 2000-2014. * denotes statistical significance at the 10% or above.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Social Network Breadth	1																	
2	Social Network Depth	0.463*	1																
3	CEO Duality	0.031*	0.027*	1															
4	CEO Outside	-0.050*	-0.022*	-0.043*	1														
5	CEO Age	0.062*	0.045*	0.217*	-0.038*	1													
6	CEO Stock Option	-0.032*	-0.034*	0.021*	0.008	0.001	1												
7	CEO Share Ratio	0.034*	0.024*	-0.003	0.005	-0.001	-0.005	1											
8	CEO Social Network Centrality	0.178*	0.156*	-0.081*	0.083	0.057*	0.129*	0.164*	1										
9	CEO Overconfidence	0.083*	0.016*	0.074*	0.075	0.174	0.094*	0.157*	0.046*	1									
10	CEO Human Capital Index	0.201*	0.160*	0.095	0.084	0.071*	0.067*	0.104*	0.052*	0.158*	1								
11	Board Size	0.191*	0.132*	0.068*	-0.081*	0.073*	0.002	-0.008	0.134*	-0.075*	0.074*	1							
12	Board Independence %	0.212*	0.162*	-0.082*	-0.034*	0.005	-0.036*	0.062*	-0.052	-0.015	-0.047	0.089*	1						
13	ROA	0.012	-0.002	-0.033*	-0.051*	-0.028*	0.005	0.006	0.033	-0.018	0.045*	0.054*	0.054*	1					
14	Tobin's Q	-0.308*	-0.102*	0.062*	-0.038	0.014	-0.001*	-0.011	0.026	0.061	0.047	-0.012	0.019	0.408*	1				
15	Total Assets	0.373*	0.307*	0.067*	-0.098*	0.098*	-0.015*	0.014*	0.223*	-0.151	0.121	0.587*	0.193*	0.083*	-0.243*	1			
16	Sales Growth	0.052*	0.046*	-0.023*	0.032*	0.017*	-0.027*	0.037*	-0.016	0.035*	-0.113	-0.036*	0.091*	-0.010*	0.017*	0.036*	1		
17	Cash Surplus	-0.012*	-0.007*	-0.057	-0.064	0.016*	-0.015*	0.023	-0.053*	-0.064*	-0.025	0.018*	0.032	0.084*	-0.023*	0.052*	-0.042*	1	
18	Debt to Equity Ratio	0.053*	0.036*	0.046*	0.032*	-0.024*	0.032*	-0.031	0.068*	0.082*	0.016	-0.019*	-0.045	-0.125*	0.054*	-0.054*	0.065*	-0.107*	1

Appendix C

Board-CEO social networks and firm risk with alternative fixed effects

This table reports panel regression results of firm risk on board-CEO social networks not controlling for firm fixed effects (Panel A) and controlling for industry fixed effects (Panel B) during the sample period 2000 to 2014. Definitions of all variables are presented in Appendix A. In all columns, year fixed effects are controlled. The standard errors are clustered at the firm level and *t*-statistics are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Panel A: no firm fixed effects

Dependent Variables	**Idiosyncratic Risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breadth	0.0102***	0.0195***		
	(3.674)	(2.744)		
Social Network Depth			0.0137***	0.0136***
			(2.964)	(2.769)
Controls	Yes	Yes	Yes	Yes
Firm FE	No	No	No	No
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.5457	0.4835	0.5364	0.4892

Panel B: industry fixed effects

Dependent Variables	**Idiosyncratic Risk**	**Total Risk**	**Idiosyncratic Risk**	**Total Risk**
	(1)	(2)	(3)	(4)
Social Network Breadth	0.0092***	0.0176***		
	(3.463)	(2.626)		
Social Network Depth			0.0126***	0.0119**
			(2.784)	(2.533)
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	12,470	12,470	12,470	12,470
adj. R-sq	0.5746	0.5347	0.5974	0.5632