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Abstract

This paper examines through various channels the effects of CEO social network heterogeneity on firm value. We construct four measures of heterogeneity based on demographic attributes, intellectual backgrounds, professional experience, and geographical exposures of individuals in the CEO social network. We find that CEO social network heterogeneity leads to higher Tobin's Q of firms. Greater CEO social network heterogeneity also leads to: (i) more innovation, (ii) more foreign sales growth, (iii) higher investment sensitivity to Tobin's Q, and (iv) better M&A performance. Overall, our results indicate that CEO social network heterogeneity is an aspect of CEO social capital and soft skills that deserves the attention of shareholders.

1. Introduction

The issue of human diversity has been front and center in both academic research and policy debates. One important insight in economic studies emphasizes that variety within human populations gives rise to knowledge heterogeneity, which is crucial to the production of innovation and the accumulation of universally applicable human capital (Hargadon and Sutton, 1997; Galunic and Rodan, 1998; Lazear, 1999a, 1999b; Hong and Page, 2001). Such an observation has an evidential basis in human biology, as genetic variations are associated with different modes of cognitive functioning, approaches, and ideologies. Hence, access to a more diverse group of people could obtain a wider range of options, reduce groupthink, and enable one to make better decisions (Asch, 1951; Janis, 1982). The conflicting effects of diversity, however, suggest that a high degree of diversity might hinder cooperation and trust between individuals, which is detrimental to the value creation of a society (Fukuyama, 1995; Ashraf and Galor, 2011).

In taking views offered by these arguments, this paper empirically studies the diversity of CEO social networks and the impact of these networks on the value creation of U.S. corporations. Specifically, we ask the following question: is it value-added to shareholders' wealth if a CEO has access to a more heterogeneous group of people, who themselves have different demographic attributes, intellectual backgrounds, occupational experiences, and international experiences?

Recent years have witnessed an increasing trend toward more significant labor force diversity in U.S. corporations. Such a diversity increase occurs not only among ordinary employees, but also in the corporate hierarchies of top management and boards of directors.[1] This phenomenon has provoked considerable research in the finance field that examines the value implications of boardroom diversity (e.g., Anderson et al., 2011; Brochet and Welch, 2011). However, few studies have looked into the diversity of social contexts faced by the managers. Our study attempts to fill in this gap, because social network is an important form of social capital: social networks are not available from inside firms, and yet CEOs can draw upon these networks and derive valuable resources (Granovetter, 1973, 1985; Coleman, 1988; Bourdieu, 1986; McDonald and Westphal,

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[1] For example, minority and female executives of S&P1500 firms have increased from 4.1% in 1992 to 10% in 2010.

2003). Social networks also serve as a kind of social media, whereby managers may obtain business opportunities by word-of-mouth communications and learn key market information that is not easily accessed by public sources (Granovetter, 1995).

The role of CEO social networks has been studied in various finance contexts, yet the diversity characteristics of social networks are overlooked. Important studies include Cohen et al. (2008), who find that social connections of mutual fund managers provide information advantages that result in significantly higher performance on connected holdings relative to non-connected holdings. In a following research, Butler and Gurun (2012) show that corporate CEOs also benefit from network connections with mutual fund managers in terms of obtaining higher compensation. Cai and Sevilir (2012) examine board connections between the target and acquirer firms, showing that social ties improve information flow between the two firms, and therefore benefit acquirers with lower takeover premiums and greater value creation. Engelberg et al. (2012a) look at whether personal connections with bankers reduce the cost of bank loans and find supportive evidence. In another paper, Engelberg et al. (2012b) argue that CEO social connections are valuable assets to firms because they increase CEOs' abilities to draw resources and learn the best business practices from their social peers.

Our paper demonstrates that the value of social network also comes from the heterogeneity of social ties. We obtain biographic information of CEOs of 2879 U.S. public firms over the period 2000-2010, and identify their social connections through education tie, work tie, and other social activities such as charities and club memberships. We measure diversity of social ties by examining social contacts' demographic attributes (e.g., gender, nationality), intellectual backgrounds (e.g., school, degree, and major), professional experience (e.g., industry and managerial positions), and geographical exposures (e.g., international working experience).

We first find that CEO social network heterogeneity (CEO SNH hereafter) is not randomly distributed across firms, but that high tech-, multinational firms, and firms with diverse board of directors are significantly associated with higher degree of CEO SNH. Given that these firm characteristics may also have significant impacts on firm value, we run a simultaneous equations model to correct for the spurious relationships. The results show that after controlling for the simultaneous effects, there is a strong and positive

relationship between CEO SNH and firm value. A comparison among different types of heterogeneity further suggests that profession heterogeneity has the largest impact on firm value, followed by demographic heterogeneity and intellectual heterogeneity. Geographical exposure has the smallest impact.

Though suggestive, the evidence so far is difficult to interpret as causal relationship due to the endogeneity of CEO social networks. In particular, better firms may have the advantage of selecting CEOs who have good connections. It is also possible that high growth firms provide more opportunities for CEOs to meet and associate with different people, and thus obtain diverse social networks. To deal with this endogeneity concern, our main identification strategy is to use death and retirement of heterogeneous network ties as an instrumental variable (Fracassi and Tate, 2012). In the first stage we find that CEO SNH decreases significantly with the death or retirement of heterogeneous network ties. And in the second stage, we find that the predicted value of CEO SNH significantly increases firm value. We further address the endogeneity problem in an event-study framework to analyze market reactions to new CEO appointments. In particular, we form two groups of CEOs, with the benchmark group consisting of CEOs whose SNH scores are higher than the previous CEOs', and the matching group consisting of CEOs whose SNH scores are lower than the previous CEOs'. We employ the nearest-neighbor matching technique to make sure two groups of firms are similar in firm characteristics and CEO personal attributes, but different in social networks. The results show that benchmark firms on average experience significantly positive cumulative abnormal returns around the CEO appointment. In contrast, matching firms have insignificant market reactions to the CEO appointment. Results are robust to using a different event window. Overall, the results support the previous finding that CEO SNH is a value-added resource that increases shareholder wealth.

Next, we explore possible economic explanations for the value-added effects of CEO SNH. Rodan and Galunic (2004) find that access to heterogeneous knowledge positively affects managerial performance. In particular, it is beneficial for managers to think creatively and become more supportive for innovations (Hargadon and Sutton, 1997; Galunic and Rodan, 1998). Given that innovation can create higher firm value (Hall et al., 2005), we believe that CEO SNH enhances firm value through its impact on

innovation. Secondly, we consider the channel of foreign sales. As prior literature emphasizes, exposures to different cultures could largely increase managers' abilities to reach a network of foreign contacts, identify good business opportunities, and solve complex problems faced by multinational firms (Prahalad, 1990; Reuber and Fischer, 1997; Carpenter and Sanders, 1998). If this is the case, it is plausible that higher CEO SNH leads to higher foreign sales, and that by acting on foreign sales CEO SNH enhances firm value. Our tests confirm the channels of innovation and foreign sales.

As a third channel, we investigate whether CEOs' access to a heterogeneous social network leads to better investment decisions. Team theory establishes that heterogeneity enhances team productivity especially when the team members are complementary to one another (Prat, 2002). Interactions with a diverse group of people also widen one's information sources and skill sets, which helps stimulate debates about the appropriateness of a business strategy and prompts the CEO to make better decisions (Wiersema and Bantel, 1992; Watson et al., 1993). We test the impact of CEO SHN on investment firstly by examining investment-Q sensitivity, a proxy for investment efficiency (e.g., Dittmar and Shivdasani, 2003; Xuan, 2007). Results suggest that investment is more sensitive to Tobin's Q when the CEOs have more heterogeneous social ties, thus lending support to our argument. We perform a second test on M&A investment performance and find a positive relationship between CEO SNH and 3-day cumulative abnormal returns (CAR). In terms of long-run performance, we find that CEO SNH is associated with better long run post M&A performance for diversified deals. Overall, the findings indicate that CEO SNH is beneficial for CEOs to make better investment decisions.

This paper contributes to a growing CEO social network literature. Existing studies have investigated the impact of CEO/director social network on corporate investment decisions (Fracassi, 2012), mutual fund performance and trading behavior (Cohen et al., 2008; Hong et al., 2005), cost of capital (Engelberg et al., 2012a), M&A (Cai and Sevilir, 2012), CEO compensation (Barnea and Guedj, 2007; Horton et al., 2012; Engelberg et al., 2012b; Butler and Gurun, 2012), analyst performance (Cohen et al., 2010; Horton and Serafeim, 2009), and corporate governance (Hwang and Kim, 2009; Fracassi and Tate, 2012). While these studies provide important economic

underpinnings of social networks in various corporate finance issues, they have mainly focused on overall connectedness of CEO social networks or social ties with resource holders (e.g., banks). Our paper moves beyond by looking at the heterogeneity characteristics of social ties. Controlling for the size of social network and potential endogeneity problem, we document a significant and positive relationship between CEO social network heterogeneity and firm value.

Moreover, we identify multiple channels through which the heterogeneity feature of CEO social network increases firm value. Our findings reveal that heterogeneous social networks make CEOs more supportive and successful in spurring product innovations. Social networks enable CEOs to achieve higher foreign sales and make better investment decisions. To the best of our knowledge, our paper is the first study that builds a direct link between CEO social network heterogeneity and firm value. Our findings suggest that with more heterogeneous social connections, CEOs could obtain a broader set of knowledge, consider a larger range of options, and learn more business opportunities. These benefits also enable CEOs to make better investment decisions and respond more quickly to product innovation and foreign market competition. Given the changing face of demographic characteristics of corporate hierarchy, and given the increasing pressure on U.S. companies from global market competition and increased product innovation, this study provides important policy implications.

In addition to social network literature, our paper also sheds light on literature on CEO talent. Seminal work in this area has indicated that a CEO's personal characteristics can play an important role in determining corporate policy and firm performance (e.g., Bertrand and Shoar, 2003). It is also emphasized that CEOs would benefit from a broader field of knowledge in response to innovations in market conditions, competitive threats, and macroeconomic factors (e.g., Rajan and Wulf, 2006; Murphy and Zabojnik, 2007). These analyses so far are mostly focused on directly observable characteristics, such as CEOs' education qualification, professional experience, and demographics. What has been less explored in the literature are CEOs' social capital and network skills. Our paper offers an examination of the micro-sociology perspective in order to understand CEO talent. We analyze social network heterogeneity at different dimensions and show that profession heterogeneity has the largest impact on firm value, followed by demographic

heterogeneity and intellectual heterogeneity. Our findings suggest that heterogeneity is another important characteristic of social network. Given the increasing importance of internationalization, CEOs need to think about not only having more connections, but also heterogeneity of connections.

The rest of this paper is organized as follows. Section 2 introduces related literature and our hypotheses. Section 3 discusses the data and the construction of the variables. Section 4 presents our empirical results. Section 5 summarizes and concludes.

2. Literature Review and Hypotheses

2.1 Social network and finance

Social network, broadly understood as a group of people linked by a set of relationships, is a well-established area in the fields of socioeconomics. There have been relatively few examinations of social networks in corporate finance. But recently, as more data becomes available that can identify CEOs' social connections (e.g., school ties, professional ties, memberships), there is a growing interest in understanding the role of CEOs' social networks as it relates to various corporate finance issues. In this section we briefly review social network theories and their applications in the corporate finance literature (for a review of networks and financial markets, please see Allen and Babus (2009)).

Social network theories emphasize that social network is an important channel to gather and diffuse information that is not easily accessible from other sources.[2] In support of this theory, Cohen et al. (2008) find that portfolio managers place larger bets and obtain higher returns on firms with which they have social connections, suggesting that social networks transfer key information in the security market. Butler and Gurun (2012) show that education connections between CEOs and mutual fund managers lead to higher CEO compensation, as connected funds are more likely to vote against shareholder-initiated proposals to reduce executive compensation than unconnected. Cohen et al. (2010) and Horton and Serafeim (2009) document that analysts perform better forecasts and recommendations when they have an educational link to the company. Cai and

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[2] Early research has extensively examined the role of social networks in the labor market, with focus on areas such as job search and pay. It is demonstrated that social networks can overcome the information asymmetry that is largely existent in the labor market by transmitting crucial information, such as news about job vacancies or accounts of workers' abilities (Granovetter, 1973; Holzer, 1987; Burt, 1992; Granovetter, 1995; Calvo-Armengol and Jackson, 2004).

Sevilir (2012) show that board connections between the target and acquirer firms improve information flow and communication between the two firms, and therefore benefit acquirers with lower takeover premiums and greater value creation. Engelberg et al. (2012a) report that firms that have social connections with bankers obtain lower cost of bank loans, which suggests that interpersonal connections help reduce information asymmetry.

Moreover, social ties can also generate decision externalities (Ellison and Fudenberg, 1993, 1995; Watts, 2003). In particular, it is argued that economic agents do not know all the information and alternative choices when making decisions. In this context, agents are more likely to rely on whatever information they can acquire via word-of-mouth communication. They may also change preferences and beliefs due to the actions of their social peers. In finance, Hong et al. (2005) display the word-of-mouth effects between mutual fund managers by showing that trades of mutual funds that are located in the same city are correlated. Fracassi (2012) find that CEOs who are well connected in the corporate elite network make financial decisions that are similar to those of their social peers.

Finally, social network theories also examine issues related to the mutual trust and exchange of social support (Powell, 1990; McPherson, Smith-Lovin, and Cook, 2001). The enhanced trust between socially connected individuals leads them to interpret the behavior of one another favorably, and thus assume that each will take actions that are predictable and mutually acceptable (Uzzi, 1996, 1999). But such trust may also create inefficient favoritism and raise concern of collusion (Asch, 1951; Janis, 1982). There is significant evidence in the corporate finance research supporting the darker side of the CEO social network. For example, Nguyen (2012) and Hwang and Kim (2009) report that when the CEO and other board members share common connections, underperforming CEOs are less likely to be fired. And pre-existing social ties between CEOs and their boards of directors may also undermine independent corporate governance, which is detrimental to shareholder wealth (Fracassi and Tate, 2012). Ishii and Xuan (2010) look at social ties between managers and board of directors of acquirer and target firms. They find a negative social network effect on acquirer announcement

returns, and interpret the result as evidence of flawed decision-making and a lack of due-diligence due to the familiarity between two connected firms.

2.2 Economics of Heterogeneity and Hypotheses

The issue of diversity has been at the forefront of many fields, including economics, management, and social psychology. In the corporate finance field, our understanding has been mainly focused on corporate leaders such as boards of directors and top management teams. In this section, we bring views from different fields to illustrate the pros and cons of corporate diversity. We also develop hypotheses relating CEO social network heterogeneity to innovation, foreign business, investment, and firm value.

2.2.1 Social network heterogeneity and innovation

Considerable evidence in innovation research suggests that knowledge heterogeneity is a wellspring for creativity and innovation (Hargadon and Sutton, 1997). Taken from social psychology, researchers emphasize that a team consisted of individuals with different psychological attributes and personal characteristics achieve higher levels of creativity (Amabile, 1988; Barron and Harrington, 1981; Martindale, 1989). For managers, access to a heterogeneous social and contextual environment is crucial for them to develop novel ideas about organizational products, practices, services, or procedures (Shalley and Gilson, 2004; Shalley and Perry-Smith, 2008).

Social network literature has also documented the role of social networks in knowledge diffusion and innovation (Goyal and Moraga-Gonzales, 2001). For example, Gomes-Gasseres et al. (2006) find that inter-organizational linkages can speed up a firm's ability to learn and utilize new technology and innovation (Gomes-Gasseres et al., 2006). Rodan and Galunic (2004) consider the social networks of managers, finding that access to heterogeneous knowledge through social contacts is useful in the generation and implementation of new ideas, and also in improving innovation performance. Oldham and Cummings (1996) argue that a heterogeneous social network could contribute to managerial innovation, as well as the availability of complex and challenging jobs. Aligning with this literature, we argue that firms with CEOs who have more

heterogeneous social connections are more innovative. Given that there is a positive link between innovation and firm value (Hall et al., 2005), we hypothesize that

H1: Heterogeneity of CEO social network has a positive impact on a firm's innovative capability, and by acting on innovation, it adds value to the firm.

2.2.2 Social network heterogeneity and foreign business growth

During the past decades, U.S. corporations have substantially expanded their operations to the foreign markets. Foreign earnings are found to have higher associations with market valuations than domestic earnings for U.S. multinational firms (Bodnar and Weintrop, 1997). Considering the possible explanations, the authors argue that foreign sale income changes more permanently than do domestic earnings. Moreover, foreign operations create more growth opportunities for firms. Literature also highlights that culture sensitivity of corporate leaders can be critical in the process of internationalization (Reuber and Fischer, 1997). Carter et al. (2003) find that ethnicity diversity of boards of directors could make CEOs more sensitive to cultures that are not located in the U.S. (Carter et al., 2003). As more and more firms want to penetrate foreign markets, there is increasing need to match the diversity of a company hierarchy to the diversity of the company's potential customers (Robinson and Dechant, 1997). Masulis et al. (2012) show that foreign directors can enhance the advisory capability of boards to the extent that living or working in foreign countries gives them first-hand knowledge of foreign markets and enables them to develop and tap a network of foreign contacts. These resources can enable foreign directors to provide valuable advice and assistance to U.S. corporations, especially those with major foreign operations or aspirations to expand internationally (Adams et al., 2010). These considerations suggest that social network heterogeneity, particularly ethnicity diversity and foreign exposure, can promote the generation of foreign business, push sales, and improve firm performance.

Examining CEO social networks, Engelberg et al. (2012b) indicate that social networks provide an informal media for managers to share each other's valuable experiences, gather key market information, exchange resources, and identify business opportunities. Taken together with the diversity literature, we expect that CEOs who have

exposure to demographically and intellectually diverse groups of people are likely to understand more about foreign culture, receive and acquire more foreign market information, push sales, and generate more foreign business. Hence, our second hypothesis is that

H2: Heterogeneity of CEO social network has a positive impact on a firm's foreign sale generation, and by acting on foreign sale, it adds value to the firm.

2.2.3 Cognitive differences, diverse opinions, and impacts on decision-making

The social psychology literature emphasizes that attitudes, cognitive functioning, and beliefs are not randomly distributed in the population, but tend to vary systematically with demographic characteristics such as age, race, and gender (Robinson and Dechant, 1997). Similarly, different educational backgrounds and professional experiences are also associated with different thinking processes and opinions. Focusing on boards of directors and top executives, corporate finance literature provides significant evidence that gender differences reflect differences in cognitive paradigms that affect one's attitudes and decisions. For example, Francis et al. (2010) find that female CFOs are more risk-averse and tend to make conservative financial decisions. Adams and Ferreira (2009) show that female board members attend board meetings and interact with management to a greater degree than male board members. Because of their work ethic and professionalism, the presence of women on boards has a positive influence on corporate governance. Gul et al. (2011) find that gender-diverse boards improve informativeness by providing more transparent public disclosure in large firms and by encouraging private information collection in small firms. Francis et al. (2011) examine professional backgrounds of boards of directors, and their findings suggest that directors who have academic backgrounds can bring to bear their advising and monitoring expertise, which leads to higher firm performance.

Taking the perspectives of social network theories, it is argued that heterogeneous social ties provide access to other groups so that one can gain superior information and resources that are beyond one's own group (Burt, 1992). Although it is possible that a heterogeneous environment may initially produce more conflicts in the decision making process, the variety of perspectives would enable decision makers to consider more

alternatives and take a broader view. In contrast, team members with similar attitudes and personal characteristics can lead to group thinking and flawed decision-making as a result of ignorance and a lack of challenging views (Asch, 1951). Such a context may also result in missed opportunities due to the limited range of options (Janis, 1982).

Following these arguments, we believe that access to heterogeneous social networks offers managers a broader knowledge base, adds information richness, and provides alternative problem-solving insights. Hence, diverse social ties are beneficial for managerial decision-making in terms of selecting value-enhancing investment projects. To empirically test the impacts of CEO SNH on investment performance, we first examine investment efficiency by studying the sensitivity of investment to Tobin's Q. Higher investment-Q sensitivity suggests more efficient allocation of capital. If CEOs with heterogeneous social networks make better investment decisions compared with those who have homogeneous social networks, then we expect that investment-Q sensitivity will be higher as CEO SNH increases. This leads to our third hypothesis.

H3: Heterogeneity of CEO social network has a positive impact on a firm's investment performance.

In addition to investment-Q sensitivity, we also examine M&A performance. M&A is an important type of corporate investment, as it is usually involved with a large amount of capital, faces significant challenges, and requires manager capability in selecting good targets. Theoretically, M&A should create economic synergies among merging firms and increase the value of the acquirers. However, evidence often indicates value-decreasing effects of M&A on acquirers' shareholders' wealth due to incorrect decisions in conducting M&A investment and agency problems. We argue that if a heterogeneous social network helps managers make better decisions, then, holding all else equal, managers with greater diversity of social networks should perform better in M&A investment as opposed to managers who have more homogenous social networks. This leads to our fourth hypothesis, that CEOs with a greater diversity of networks make better M&A decisions.

H4: Heterogeneity of CEO social network has a positive impact on a firm's M&A performance.

2.2.4 Overall effect of CEO social network heterogeneity on firm value

We construct four measures of CEO SNH based on demographic attributes, intellectual backgrounds, professional experience, and geographical exposures of individuals in the CEO social network. Taking H1-H4 together, we believe that CEOs with diverse social connections could benefit from a broader set of knowledge and have exposure to new perspectives and different problem-solving options. The access to heterogeneous knowledge and diverse opinions would widen managers' mindsets and enable them to perform better in responding to product innovation, enhancing market share in foreign markets, and making better investment decisions. Hence, higher heterogeneity of CEO social network should lead to higher firm value.

>   *H5: Overall, CEO social network heterogeneity enhances firm value.*

3. Data and Variables

3.1 CEO social network

CEO social network data is obtained from BoardEx database provided by Management Diagnostics Limited. This database contains comprehensive biographic information of senior management and board of directors of US and European public companies. Biographic information includes demographic attributes (e.g., date of birth, date of death, gender, nationality), employment history (e.g., workplaces and job title), educational background (e.g., school, degree, and major), and other social activities such as club membership, professional associations, and charity. BoardEx dataset also provide relational links among these individuals. Links are constructed if two individuals were once employed by the same company (work ties), graduated from the same university (school ties), or maintained memberships with the same country clubs and nonprofit organizations, such as charities, government organizations, and branches of the military (other social ties).

Recent studies that have used this dataset have tended to focus on one or all three types of social links (Cohen et al., 2008; Liu, 2010; Engelberg et al., 2012a, 2012b; Fracassi, 2012; Fracassi and Tate, 2012). In this paper we consider all types of social links. Specifically, we identify a school tie between two individuals if they went to the same school and graduated within three year of each other with the same master's or

doctoral degree. The restriction on graduation year and degree is to maximize the probability that the individuals actually met as a result of shared education (Fracassi, 2012). Work ties are built if two individuals have worked in the same company. Other social ties are identified if two individuals maintain membership in the same country clubs, or served the same charity, university, government, army, or other non-profit association. To make sure people have active roles in these organizations, we consider a qualified tie to be one in which a person was more than merely a member and instead maintained an important role in the organization (with the exception of club membership, for which membership alone is considered qualified) (Fracassi, 2012). For example, important roles can be "Trustee," "President," "Advisor," and "Board Member."

We further refine our criteria in examining CEO social networks by checking the starting and ending date of the social relationships. We drop work ties and other social ties that terminate five years before our testing year. As for school ties, we do not use a time window; although many CEOs may have graduated decades ago, they often maintain connections to their schoolmates through alumni events. As regards work ties and other social ties, however, this is less likely to be the case. Moreover, we also examine the job titles of the individuals who are in a CEO's social network. To maximize the probability that two individuals actually have met and have had informative conversations, we require that the two individuals must have held a relatively high level of positions, e.g., top management team, board of directors, advising council, etc. (Fracassi, 2012).

3.2 The Measure of CEO SNH

To measure the heterogeneity of a CEO's social network, we gather personal information on individuals in the CEO's network from BoardEx. Four categories of heterogeneity are calculated in the following ways:

A. *Demographic heterogeneity*: is the average of gender heterogeneity and ethnicity heterogeneity. We measure gender heterogeneity by calculating inverse Herfindahl index (HHI) based on the percentage of female versus male in the network and then taking the inverse. Specifically, *Het_gender =1/(female_ratio^2 + male_ratio^2)*. The smaller the value, the more gender-diverse one's social network is. We measure the

ethnic heterogeneity of a CEO's social network by using inverse Herfindal index based on the percentage of people from different geographical regions. Specifically, *Het_enthnicity = 1/(North_America_ratio^2 + Latin_America_ratio^2 + Europe_ratio^2 + Asia_ratio^2 + Africa_ratio^2).* Finally, demographic heterogeneity is measured by the mean of gender heterogeneity and ethnicity heterogeneity. Overall, *Het_demo = (Het_gender + Het_ethnicity) /2.*

B. *Intellectual heterogeneity*: calculated as the average of three heterogeneity indices, namely, degree heterogeneity, major heterogeneity, and school heterogeneity. Degree heterogeneity is calculated by the inverse Herfindahl index based on percentage of people with different educational degrees. In particular, *Het_degree = PhD_ratio^2+ Master_ratio^2+ Bachelor_ratio^2.* Major heterogeneity is calculated based on percentage of people with different majors. In particular, *Het_degree = Business_Finance_ratio^2 + Engineering_ratio^2+ Liberal_Arts_ratio^2 + Law_ratio)^2.* School heterogeneity is calculated based on percentage of people graduated from the same school as the CEO. *Het_school = Same_school_ratio^2+Different_school_ratio^2.* Averaging three indices, *intellectual heterogeneity = (Het_degree + Het_major + Het_school)/3.*

C. *Profession heterogeneity*: is calculated as the average of two heterogeneity indices, namely, occupation heterogeneity and industry heterogeneity. Occupation heterogeneity is calculated by the inverse Herfindahl index based on the percentage of people with different occupations. We assume that different job title reflects different expertise and management skills. In particular, *Het_occupation = (CEO ratio)^2 +(CFO ratio)^2+ (Other executives ratio)^2+(board of directors ratio)^2.* Industry heterogeneity is calculated by the inverse Herfindahl index based on percentage of people working in the same industry according to 2-digit SIC code. *Het_industry =(same industry ratio)^2+(different industry ratio)^2.* Overall profession heterogeneity index is the average of occupational heterogeneity and industry heterogeneity. That is, *Het_prof = (Het_occupation + Het_industry) / 2.*

D. *Geographical heterogeneity*: We measure geography heterogeneity of a CEO's social network by the inverse Herfindahl index based on the percentage of people working

in different regions. Specifically, *Het_geography = 1/ (North_America_ratio^2 + Latin_America_ratio^2 + Europe_ratio^2 + Asia_ratio^2 + Africa_ratio^2).*

E. *Overall heterogeneity:* the average of above four heterogeneity indices.

3.3 Other Data and Variables

A. *Firm characteristics:* we match BoardEx with Compustat using ticker and CIK number to obtain firm characteristics.[3] Financial institutions, the utility industry, and nonprofit organizations are excluded from the sample. Firm value is measured by Tobin's Q.[4] Our analysis also requires many other firm characteristics as specified in Table 1.

B. *Boardroom heterogeneity:* we construct two measures of board heterogeneity. One is the percentage of female board members over total number of board members. The second one is the percentage of minority board members over the total number of board members. These variables are constructed using board characteristics data from BoardEx.

C. *CEO characteristics:* we obtain the following CEO characteristics from BoardEx: age, gender, nationality, rank of school graduated from (e.g., Ivy League or not), and highest degree achieved. In addition, we gather information on past employment history and construct two proxies for working experience: one is the number of companies worked at as top management, and the other is the number of countries worked in other than the U.S.

D. *CEO turnover:* we extract CEO turnover data from ExecuComp and then match with BoardEx to obtain social network information of the CEOs. We only keep turnover cases, where social network heterogeneity information is available for both departing CEOs and new CEOs, thus allowing us to calculate differences in social network heterogeneity. To measure the market reaction to the appointment of a new CEO, we

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[3] The matching needs to be done with care. In some cases, the same firm can be assigned with different Board IDs as its name can be referenced with slight variations in different sources (Ishii and Xuan, 2010). We therefore drop all firms with the same CIK/ticker but different names to minimize the matching problem.

[4] This is calculated as the book value of assets plus the market value of equity (price times number of shares outstanding) less the sum of the book value of common equity and balance sheet deferred taxes all over assets.

examine cumulative abnormal returns over three windows of [-1,1], [-2,2], and [-5,5]. Abnormal returns are measured as the firms' stock returns minus expected returns, which is estimated from a market model with parameters estimated using daily stock returns over a period of [-255, -20] and using the CRSP value-weighted index to measure market returns. Following the CEO turnover literature, two CEO characteristics are important in affecting market reaction: whether the CEO is promoted from inside of the firm or hired from outside; and whether he or she has had CEO experiences in the past. We construct these two variables as controls. Our subsample on CEO turnovers consists of 114 turnover events between 2000 and 2010.

E. *Innovation variables:* To test the hypotheses relating innovation, we further match our sample with NBER Patent database (Hall et al., 2001). There are 524 firms in our sample that have patent applications in NBER. In addition to these firms, we also include firms that have zero patent applications but also have non-zero R&D expenditure. Overall, our subsample for the innovation channel test has 1754 firms. Our measure for innovation is log number of patents applied by a firm in a given year. Notice that patents are not granted immediately after applying, and that there is generally a two to three year lag between applying and granting patents, sometimes even more. To avoid the truncation problems that may arise from a lag between applying and granting patents, our sampling criteria for patent count is during application year and not when patents are granted (Francis et al., 2012).

F. *M&A characteristics and performance measures:* For the analysis on M&A investment, we extract merger and acquisition deal data from Securities Data Corporation (SDC) and match with our main sample. Deals are selected based on the following criteria: (1) announcement dates are between 2000 and 2010; (2) the deal is complete; (3) the acquirer's initial stake in the target firm is less than 50%, and the final stake is more than 50% after merger and acquisition; (4) deal value is more than $1 million; (5) acquirers have no multiple mergers in the testing year; (6) acquirers have stock return data in CRSP. Finally, our M&A subsample contain 4598 deals. To measure M&A performance, we examine market performance in both the short-run and the long-run. Short-run performance is measured by the 3-day cumulative abnormal return (CAR) during the event window of [-1,1] experienced by the

18

acquiring firms. Event day 0 is the acquisition announcement date provided by SDC. Expected returns are estimated from a standard market model over the period from event day -210 to event day -11 with the CRSP value-weighted return as the market return. Long-run performance is measured by buy and hold abnormal returns (BHAR) over the 1 year period after M&A announcement. In particular, BHAR=$\Pi(1+R_i)$-$\Pi(1+R_m)$, where R_i is daily stock returns of the acquirers and R_m is the daily market value-weighted return.

<TABLE 1: Variable Definitions >

3.4 Sample Descriptive Statistics

Table 2 reports the descriptive statistics of HHI measures of CEO social network. We report here by HHI instead of inverse HHI because HHI measure has a range of 0 to 1. The minimum value of HHI can be 0, which means that the network is very heterogeneous, and a maximum of HHI can be 1, which means that the network is very homogeneous. But in the regression analysis we use the inverse HHI, which is labeled as Het. In our sample the range is between 0.6 to 0.9, indicating that CEOs' social networks are, on average, not very heterogeneous. We report CEO SNH by firms' industry, high tech type, and R&D intensity. High tech is an indicator which is equal to 1 if firms belong to pharmaceutical industry, and high tech industry as classified by SIC2=48, SIC2=73, SIC3=283. The indicator of R&D is defined as 1 if a firm has non-zero R&D expenditures, and 0 otherwise. Comparing CEO SNH across industries, we do not find significant differences. It is interesting to note that high tech firms and R&D intensive firms have higher CEO SNH. This could indicate that CEOs with heterogeneous social networks are responsible for more innovations, or it could also mean that innovative firms allow CEOs to meet people with more diverse exposure.

< TABLE 2: Summary Statistics of CEO SNH >

Table 3 reports the summary statistics of all other variables used in our analysis. The main sample consists of 2090 CEOs and 2879 US public firms over the 2000-2010

period. Panel A reports the heterogeneity measures in terms of demographic, intellectual, professional, and geographic attributes of CEO social networks. Average network size is 20, meaning that the average CEO in our sample has 20 social ties. Note that our identification strategy for social ties requires that the connected person be at a senior managerial position or on the board of directors at other firms. Internal connections are excluded.

Panel B reports summary statistics for firm characteristics as well as board characteristics. We describe the variable definitions in Appendix A. The average firm value is relatively high, with Tobin's Q of 2. The average firm size is about 3.4 billion. This is because BoardEx provide CEO information not only for S&P1500, but also broad cross-sections of firms of smaller sizes. 20% of our sample firms are high tech, and 60% are multinational firms. Examining board characteristics of our sample firms, we find that these firms have significant boardroom diversity; roughly 9% of board members are females and 7% have minority directors.

Panel C focuses on the characteristics of CEOs. We describe the variable definitions in Appendix A. In our sample, 3% are female CEOs and 0.6% are minority CEOs. Roughly 36.6% of CEOs have MBA degrees and 15.4% have PhD degrees. 16% graduated from Ivy League universities. We also examine work experience by tracing past employment history. Our measures indicate that the average CEO in our sample has changed jobs in 4 companies where he or she serve as a member of the top management team or on the board of directors. Foreign experience, on average, is very minimal. Foreign experience is measured by taking the number of non-U.S. countries CEOs have worked in as either a member of the top management team or on the board of directors. Our data indicate that more than half of the CEOs have no such experience.

Panel D reports variables used in CEO turnover analysis. We describe the variable definitions in Appendix A. We identify 114 cases of CEO turnover in which we have social network information for both the new incoming CEO and the previous CEO. To measure market reactions to the new CEO appointment announcement, we obtain cumulative abnormal returns over three windows of [-1,1], [-2,2] and [-5,5]. Our measure indicates that 96% of the new CEOs are internal candidates, and only 4% are hired from outside of the firm. 60% have been CEO in the past.

Panel E reports descriptive statistics of variables used in the analysis for M&A investment. We describe the variable definitions in Appendix A. Our subsample for M&A analysis contains 4598 deals. The average of acquirers' 3-day CAR [-1,1] is -0.4%, and the average of long-run performance, as measured by one year BHAR, is about -8.3%. We measure the return-based run-up as the CRA of the acquirer's stock for trading days [-210, -11] relative to the M&A announcement date. The average run-up is -0.7%. Moreover, in our M&A sample there are 32.3% diversified deals, 4% stock deals, and 25.1% cash deals. 56.6% target firms are private firms. Finally, 2/3 of acquirers in our sample are multiple M&A acquirers. We measure the frequency of multiple mergers by taking the number of M&As an acquirer makes in one year as a proxy for their M&A experience.

<TABLE 3: Summary Statistics of All Other Variables>

4. Empirical Results

4.1 Endogeneity Concern

The relationships between CEO SNH and firm value can be spurious due to the possibility that (1) better performing firms can select CEOs who have strong social connections (reverse causality), and (2) certain firm characteristics can simultaneously affect CEOs' choices of social network and firm value (simultaneity bias). This means that firm value and CEO social network can be determined in equilibrium so that it is difficult to interpret which is causing which. In our case, the endogeneity problem, if not corrected, could cause our results be overestimated, meaning that we are more likely to find CEO SNH to be positively associated with higher Tobin's Q. Hence, it is important to address this issue carefully. In this section we first estimate the effects of CEO SNH on firm value, using several econometric techniques, including simultaneous equations estimation, instrumental variable approach, and event study. We then explore the channels through which CEO SNH affects firm value.

4.2 CEO SNH and Firm Value: Simultaneous Equations Approach

We begin estimating the effects of CEO social network heterogeneity on firm value using simultaneous equations approach. A simultaneous model is appropriate because evidence based on our analysis suggests that a CEO's preference of social network is likely to be correlated with firm type and financial conditions. Clearly these firm characteristics also affect firm value. To control for the intertwined relationships, we first regress CEO SNH on a set of potential determinants. Potential determinants include firm characteristics and CEOs' personal characteristics, such as demographic attributes, education, and professional experience. Specifically, we consider the following determinants at firm level: firm size, leverage, Tobin's Q, capital expenditure, cash flow, R&D expenditure, high tech type, multinational type, and board diversity. Notice that these firm-level determinants are measured at one year prior to the measurement of CEO SNH. At the CEO level we include age, gender, nationality, Ivy League graduate, highest degree achieved, work mobility, and international experience as potential determinants. In our view, these CEO characteristics likely affect the preference of social network, but do not directly affect firm performance. Hence, we use them as a set of exogenous variables in the first stage. In the second stage we regress CEO SNH measures on firm value. CEN SHN is measured for demographic, intellectual, professional, geographic, and overall heterogeneity. The estimation uses two stage least square techniques following a system of two equations as below. Year dummies and industry indicators at 1-digit SIC code are also included (but not written in the equations due to space constraints). Robust standard errors are clustered at firm level.

$$CEO\ SNH_{i,t} = \alpha_0 + \sum \alpha \bullet (Firm\ char.)_{i,t-1} + \sum \gamma \bullet (CEO\ char.)_{i,t} + \varepsilon_{i,t} \qquad (1\text{-}1)$$

$$Q_{i,t} = \beta_0 + \sum \beta \bullet (Predicted\ SNH)_{i,t} + \sum \delta \bullet (Firm\ char.)_{i,t} + \varepsilon_{i,t} \qquad (1\text{-}2)$$

Results of two stages of regressions are reported separately in Table 4 and Table 5. In Table 4, we find that some firm characteristics and CEO personal characteristics could explain between 20% and 30% of variations in CEO SNH. While the significance of coefficients varies across different measures of CEO SNH, some variables show

22

consistent impacts. For example, larger firms, less levered firms, R&D intensive firms, high tech firms, and firms with greater minority participation on boards of directors are significantly associated with greater CEO SNH. Interestingly, we do not find firm value affects CEO SNH in a significant way. Notice that these firm variables are measured at one year before CEO network. Hence, the reverse causality from Q to CEO SNH is less of concern. Regarding CEO personal characteristics, our results network size has a significant and positive impact on CEO SNH. In addition, minority CEOs and CEOs with PhD degree tend to have more heterogeneous social networks. Interestingly, CEO age has a negative impact on CEN SHN. Other characteristics like past work experience, university, and gender have impacts on CEO SNH, but the impacts are not consistent for different heterogeneity measures.

Table 5 presents results from the second stage regression (eq. (1-2)). Specifically, we regress the predicted value of CEO SNH, which is estimated from the first stage on Tobin's Q. Columns (1)-(5) report the regressions results for demographic, intellectual, professional, geographic, and overall heterogeneity, respectively. Overall findings exhibit significant and positive relations between firm value and all types of CEO SNH, suggesting that as CEO SNH increases, firm value increases. As demographic heterogeneity increases by 1, Q increases by 1.141, which is statistically significant at 5% level. To better interpret this result, this means that if a CEO could increase his or her network demographic heterogeneity by 10%, Tobin's Q could increase by 0.064%.[5] Taking our sample mean as an example, a firm with total assets of 3.4 billion could increase market value by about 2.38 million if the CEO increases his or her networks by 10%. This effect is economically significant. Using the same method, we report the interpretations of our results in Table 6. All the coefficient estimates are statistically significant and economically meaningful, which supports our hypotheses that social ties with people who have different demographic attributes, intellectual backgrounds, professional experiences, and geographic exposure enhance firm value. A comparison among different types of heterogeneity suggests that profession heterogeneity has the

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[5] We calculate this percentage change as: 10% * Mean (Het-demo) * β (Het-demo) / Mean (Q) = 0.1*1.126*1.141/2.012=0.064%

largest impact on firm value, followed by demographic heterogeneity and intellectual heterogeneity. Geographic exposure has the smallest impact.

< TABE 4: Determinants of CEO SNH: 1st Stage Estimations>

< TABE 5: CEO SNH and Firm value: 2nd Stage Estimation>

< TABE 6: Economic Interpretations of Results in Table 5>

4.3 CEO SNH and Firm Value: Instrumental Variables Approach

An ideal way to deal with the endogeneity issue in our case is to find an exogenous shock to CEO social network, which is plausibly unrelated to firm performance. Our main identification strategy is to look at CEOs' network contacts who have either died or retired during the testing year of firm value. Based on Fracassi and Tate (2012), death of network ties provide an ideal shock to the network, as it is less likely to be anticipated and is unrelated to firm performance. Retired ties, however, may be anticipated, and are less likely to be replaced immediately. Hence, it can also be considered as an exogenous shock that changes network ties directly but not firm value directly. To construct the instrument, we first count, for each CEO each year, the number of deaths and retirements of individuals who belong to the CEO's social network. Additionally, to be taken into consideration, we also require that the deceased and retired individuals have different backgrounds in at least one of the categories of our heterogeneity measures (e.g., demographic, intellectual, profession, or foreign exposure). This is to ensure that death or retirement is a valid shock not only to the network ties but also to the heterogeneity of ties. Finally, we divide the number of qualified deaths or retirements by total number of social ties of the CEO to obtain a standardized measure, as larger network can give rise to more death and retirement. The model specification of 2-SLS IV estimations is as follows:

CEO SNH$_{i,t}$ =α_0 +$\sum \alpha$• (Deceased or retired network ties)$_{i,t}$+$\sum \gamma$•(Firm char)$_{I, t}$+$\varepsilon_{i,t}$ (2-1)

Q $_{i,t}$ = β_0 +$\sum \beta$ • (Predicted SNH)$_{i,t}$ +$\sum \delta$• (Firm char.)$_{i, t-1}$ +$\varepsilon_{i,t}$ (2-2)

Table 7 reports our results of 2-SLS IV estimations. 1st stage regressions results are reported in Columns (1) (3) (5) (7) (9) for different types of CEO SHN, respectively. We find that coefficients of the instrument on CEO SHN are significant and negative, which means that the death and retirement of network contacts with different backgrounds than the CEO reduces the heterogeneity of CEO social networks. To show if our instrument can successfully predict the variations of CEO social network heterogeneity measures, we report F-statistics of the 1st stage regressions. F-statistics across all 1st stage regressions are greater than the cut-off value of 10, which suggests that our instrument is relevant and does not suffer from weak instrument concern (Staiger and Stock, 1997). We also report endogeneity test using Durbin Wu-Hausmann Chi-sq test. The null hypothesis is that CEO SNH is exogenous. Rejection of null implies it is endogenous. As reported in Table 7, CEO SNH is indeed endogenous. In the second stage regressions, we regress predicted value of CEO SHN on firm value. The coefficients of CEO SNH measures are all positive related to firm value and significant at 10%. Overall, we confirm the results from the simultaneous equation analysis in the previous section. The instrumental variables approach again suggests that having a CEO who has more heterogeneous social connections is value-added to shareholder wealth.

<Table 7: Effect of CEO Network Heterogeneity on Firm Value: IV Approach>

4.4 Event Study on the Market Reaction to CEO appointment

We further address the endogeneity problem more generally by examining the market reaction to the new CEO appointment. In particular, we compute the social network heterogeneity for the new CEO and compared the score with the previous CEO. Two groups of firms are then formed: the first group includes incoming CEOs with higher heterogeneity scores than their predecessors (the heterogeneity-increasing group); the second group includes incoming CEOs with lower heterogeneity scores than their predecessors (the heterogeneity-decreasing group). Our aim in this section is to investigate whether market reactions to CEO appointment can be explained by the social network heterogeneity differences between the new CEO and the old CEO. If our

previous findings are robust, we expect that the market reaction will be higher when the new CEO has greater social network heterogeneity.

While reverse causality is not a concern in the event study framework (as it is hard to argue that higher market reaction leads to more heterogeneous CEO social network), another issue cannot be ignored: the omitted variable problem. That is, some underlying firm characteristics, such as size, firm type, R&D, and foreign business strategies, can affect both CEO social network and market reaction to the new CEO appointment. In addition, personal characteristics of the new CEOs can explain market reactions, as well as social networks. To correct for any endogenous selection on observables, we adopt the propensity score matching techniques to match firms with similar firm characteristics and CEO characteristics based on the following parameters: logarithm of total assets, leverage, capital expenditure, cash flow, R&D intensity, indicator of high tech type, and indicator of multinational firm. According to the previous literature, whether the new CEO is promoted from inside of the firm and whether he or she has experience as a CEO are two key factors in influencing the market's perception of future firm performance. To remove the potential market reaction differences that are driven by these CEO characteristics, we also include these two CEO characteristics as matching criteria. As Panel A of Table 8 reports, we compare the mean difference of the matched pairs and find that matched firms have no differences in selected firm characteristics, and that the newly hired CEOs are also similar to each other in terms of key experience variables. The only difference between the matched firms is that one firm belongs to the heterogeneity-increasing group while the other belongs to the heterogeneity-decreasing group.

Panel B of Table 8 reports the results of the event study on CEO appointment. We report cumulative abnormal returns (CAR) over the 3-day window [-1, +1], where day 0 is the date on which the firm announces the new CEO appointment. As an alternative, we also compute a 5-day window of [-2,2], and 10-day window of [-5,5]. Our results for different event windows consistently show that firms in which the old CEO is replaced with a new CEO with greater social network heterogeneity experience a positive market reaction, which is statistically significant at 10% level for the 3-day and 5-day event windows, and become more significant for the 10-day event window. In contrast, the

firms where the new CEO has less heterogeneous social networks turn out to have insignificant market reactions. Comparing the two groups, the heterogeneity-increasing group has higher CAR than the heterogeneity-decreasing group. The differences of CAR between the two groups are statistically significant at 5% level for 3-day and 5-day event window and 10% level for the 10-day event window. Thus, CEOs with more heterogeneous social ties appear to increase shareholder wealth.

<Table 8: Investor Response to CEO Appointment Announcement>

4.5 Exploring the Channels: Innovation and Foreign Sale Growth

In order to better understand how CEO SNH enhances firm value, we further explore potential channels. We first investigate whether heterogeneity of social network enhances innovation. Social network theorists have documented the role of social networks in knowledge diffusion (Goyal and Moraga-Gonzales, 2001). Innovation literature emphasizes knowledge heterogeneity as a wellspring for creativity and innovation (Hargadon and Sutton, 1997; Galunic and Rodan, 1998). In addition, Hall et al. (2005) demonstrate a positive link between innovation and firm value. In particular, in using patent as a proxy for knowledge assets, the paper shows that market valuation is higher for firms that have more patents. In exploring the determinants of innovation, researchers further show that an environment that promotes inter-firm knowledge learning and technology sharing is crucial for innovation. For example, Gomes-Gasseres et al. (2006) document that alliance partners tend to have greater knowledge flow and innovation. Rodan and Gulunic (2004) argue that managers' access to diverse knowledge is equally important for innovation performance. Taking the insights offered by these papers, we hypothesize that CEO SNH leads to more firm innovation, and that acting on innovation increases firm value. To test this hypothesis, we run simultaneous equations on CEO social network heterogeneity, innovation, and firm value. The model is specified as (3-1)-(3-3). In the first stage we use death and retirement of network ties as instruments and receive a predicted value of network heterogeneity. The reason to do so is that there could be endogeneity problems associated with CEO social network and innovation (e.g., reverse causality). That is, more innovative firms tend to hire CEOs who have

heterogeneous social ties. In the second stage, we run simultaneous equations model for (3-2) and (3-3) using seemingly unrelated regressions.

CEO SNH$_{i,t}$ =α_0 +$\sum \alpha \bullet$ (Deceased or retired network ties)$_{i,t}$+$\sum \gamma \bullet$(Firm char)$_{i, t}$+$\varepsilon_{i,t}$ (3-1)

Innovation $_{i,t}$ =α_0 +$\alpha \bullet$ (Predicted SNH)$_{i,t}$ +$\sum \gamma \bullet$ (Firm char)$_{i, t}$ + $\varepsilon_{i,t}$ (3-2)

Q $_{i,t}$ = β_0+$\sum \beta \bullet$(Innovation)$_{i,t-1}$+ $\alpha \bullet$(Predicted SNH)$_{i,t}$+$\sum \delta \bullet$(Firm char.)$_{i\ t}$ +$\varepsilon_{i,t}$ (3-3)

Columns (1) – (2) in Table 9 report the results on innovation channel. We find that CEO social network heterogeneity has a positive impact on innovation, as measured by logarithm of patents. And innovation has a positive impact on firm value, as indicated by the results in Column (2). Moreover, in Column (2) we also find that the effect of CEO social network heterogeneity on firm value becomes less significant. This means that CEO social network heterogeneity has a direct impact on firm value through the channel of its impact on innovation. Once we run the simultaneous equation model to control for the channel of innovation, CEO social network heterogeneity no longer significantly affects firm value.

<Table 9: Regression results relating innovation channel and foreign sale channel >

Next, we investigate whether CEO SNH contributes to firm value through its impact on foreign business generation. Entering a foreign market is a process that compounds the complexity of all managerial tasks, especially cultural know-how (Prahalad, 1990; Carpenter and Sanders, 1998). Since social networks serve as an important medium for managers to exchange knowledge and experience, we believe that CEOs who have exposure to diverse groups of people are likely to know more about foreign market information, reach a network of foreign contacts, identify good opportunities, and push sales. We test this hypothesis by examining the impact of CEO SNH on foreign sale growth. Similar to the analysis of innovation channel, the model for analyzing foreign sale channel is specified as follows:

CEO SNH$_{i,t}$ =α_0 +$\sum \alpha \bullet$ (Deceased or retired network ties)$_{i,t}$+$\sum \gamma \bullet$(Firm char)$_{i, t}$+$\varepsilon_{i,t}$ (4-1)

Foreign sale growth $_{i,t}$ $=\alpha_0 + \alpha \cdot$ *(Predicted SNH)*$_{i,t}$ $+\sum \gamma \cdot$ *(Firm char)*$_{i,\,t}$ $+ \varepsilon_{i,t}$ $\qquad$ *(4-2)*

$Q_{i,t}$ $=\beta_0 + \sum \beta \cdot$ *(Foreign sale growth)*$_{i,t-1}$ $+\alpha \cdot$ *(Predicted SNH)*$_{i,t}$ $+\sum \delta \cdot$ *(Firm char.)*$_{it,}$ $+\varepsilon_{i,t}$ *(4-3)*

Columns (3) and (4) of Table 9 reports the regression results for (4-1) – (4-3). Our findings show that CEO social network heterogeneity has a positive and significant impact on foreign sale growth. Once we control for foreign sale growth channel in the regression, CEO social network heterogeneity loses significance on its own. This result suggests that CEOs with heterogeneous social ties promote foreign sale, and by acting on foreign sales, firm value is increased.

4.6 Exploring the Channel: Investment Performance

Finally, we test whether CEO SNH affects firm value through its impact on corporate investment. We argue that a heterogeneous social network is beneficial for a CEO to make better decisions because such diversity is likely to provide the CEO with a wider breadth of information sources and skill sets. Moreover, a heterogeneous social network could simulate debate about the appropriateness of a business strategy, which allows the CEO to gain multiple perspectives and alternative solutions (Wiersema and Bantel, 1992; Watson et al., 1993). Hence, we expect that CEOs with greater diversity of networks make better investment decisions that create value for the firms.

We test the CEO SNH on investment through two means. First, we examine investment-Q sensitivity, a variable used as a proxy for measuring the efficiency of investment (e.g., Dittmar and Shivdasani, 2003; Xuan, 2007). Based on the typical Fazzari et al. (1988) investment equation, we estimate investment-Q sensitivity following equation (5),

$$I_{i,t}/TA_{i,t-1} = \beta_0 + \beta_1 Q_{i,t-1} + \beta_2(CF_{i,t}/TA_{i,t-1}) + \sum \gamma \cdot (Firm\ fixed\ effects)_{i,\,t} + \varepsilon_{i,t} \quad (5),$$

where investment (I) scaled by the lagged book value of assets (TA) is estimated as a function of Tobin's Q and cash flows (CF) scaled by the lagged book value of assets (TA). β_1 is the investment-Q sensitivity. Tobin (1969) shows that there is a positive relationship between the stock prices and the level of investment, which means that the β_1

coefficient in the above equation is positive and significant. We test whether CEOs with greater SNH make more efficient investment by interacting CEO SNH with Q and CF and using IV estimation to get predicted value of CEO SNH. The equations are specified as (6-1)-(6-2):

$$CEO\ SNH_{i,t} = \alpha_0 + \sum \alpha \bullet (Deceased\ or\ retired\ network\ ties)_{i,t} + \sum \gamma \bullet (Firm\ char)_{i,\ t} + \varepsilon_{i,t} \quad (6\text{-}1)$$

$$I_{i,t}/TA_{i,t-1} = \beta_0 + \beta_1 Q_{i,t-1} + \beta_2(CF_{i,t}/TA_{i,t-1}) + \beta_3 Q_{i,t-1} *CEO\ SNH + \beta_4 CF_{i,t-1} *CEO\ SNH$$

$$+\beta_5 CEO\ SNH + \sum \gamma \bullet (Firm\ char)_{i,\ t} + \beta_6\ (Firm\ fixed\ effects) + \varepsilon_{i,t} \qquad (6\text{-}2)$$

Table 10 shows the results relating CEO SNH and investment efficiency. Column (1) shows the estimation of investment sensitivities to Tobin's Q and cash flow. Dependent variable is investment, measured by capital expenditure scaled by total assets. Column (2) adds the interaction terms of CEO social network heterogeneity with Tobin's Q and Cash flow. The coefficients of the interaction terms capture how investment sensitivity to Q and to cash flow changes as CEO social network heterogeneity increases. A positive coefficient indicates an increase in sensitivity. Het-overall-hat is the predicted value of CEO overall social network heterogeneity from first stage of IV estimation using percentage of deceased or retired social ties as an instrument. Column (3) adds more firm characteristics as controls. For all three regressions, firm fixed effects are included. And robust standard errors are clustered by firm. We find that the coefficient of Tobin's Q is positive and significant, which is consistent with the argument that investment enhances firm value. In Column (2) we include the interaction terms and estimate eq. (6-1). Our results on the interaction term between CEO SNH and Q is positive and significant at 10% level. This means that CEOs with greater diversity of networks can translate investment into higher firm value. This finding supports our hypothesis that CEOs with heterogeneous social networks make better decisions.

<Table 10: CEO SNH, Investment Efficiency, and Firm Value >

Our second test is to examine how CEO social network heterogeneity affects M&A performance. As argued before, we expect that CEOs with greater diversity of networks make better M&A decisions. To test this claim, we compute both short-run

market reaction to the M&A announcement and long-run post-merger performance. And then we relate M&A performance measures to acquiring firms' CEO social network heterogeneity. Specifically, short-run market reaction is computed for 3-day cumulative abnormal return in the event window of [-1,1], and long-run performance is captured by the buy and hold abnormal return during 1-year time period post M&A.

Table 11 reports the regressions results relating CEO SNH and M&A performance. Columns (1) and (2) examine M&A short-run performance as dependent variable. It is measured by the 3-day cumulative abnormal return during the event window of [-1,1] experienced by the acquiring firms. Event day 0 is the acquisition announcement date provided by SDC. Abnormal returns are residuals from a standard market model, whose parameters are estimated over the period from event day−210 to event day−11 with the CRSP value -weighted return as the market return. As shown in the first columns of Table 12, the acquirer's 3-day CAR is significantly and positively associated with acquiring firms' CEO social network heterogeneity. In the regression, we control for a wide array of acquirer- and deal-specific characteristics, including acquiring firm size, leverage, operating performance, method of payment, and market run-up. The sign of coefficients for the control variables are consistent with prior literature on M&A. In Column (2), we interact network heterogeneity with an indicator of diversifying M&A, and we do not find the interaction term to be significant. This suggests that in terms of short-run market reactions, investors value CEO social network heterogeneity positively no matter whether the M&A deal is diversified or focused. Columns (3) and (4) report the regression results on post-merger long-term performance. The dependent variable is BHAR, which is computed by compounded stock returns in excess to market compound return over 1 year window. We find that CEO social network heterogeneity only appears to be significantly associated with long-run post-merger performance for diversified deals. The coefficient for CEO social network heterogeneity on BHAR is not significant. But when we include the interaction term with diversified deal, it shows that the interaction term is significant at 10% level. Overall evidence indicates that CEOs with heterogeneous social network make better M&A decisions.

<Table 11: Regressions on CEO SNH and M&A Performance >

5. Conclusion

While existing literature has documented various benefits and costs of CEO social network, little attention is paid to the composition and heterogeneity aspect of CEO social network. This is a bit surprising, given that the content of a CEO's social network clearly has an impact on what information and resources he or she can obtain. For example, joining a heterogeneous group of people could offer diverse knowledge, new perspectives, and multiple problem-solving options that enrich the CEO's knowledge set and improves decision-making. In contrast, the benefit from a homogeneous social network can be marginal.

We test this argument by examining the impacts of CEO social network heterogeneity on innovation creation, new revenue generation from foreign markets, and corporate investment decisions. Our study measures different aspects of heterogeneity such as demographic, intellectual, profession, and geographic exposure of CEO social networks. We find that CEO social network heterogeneity is positively associated with firm innovation, foreign sale growth, investment efficiency, and M&A performance. Overall, CEO social network heterogeneity significantly enhances firm value. We apply different approaches to deal with the endogeneity problem and results remain robust. These results overall are consistent with the notion that greater heterogeneity allows for transfer of different knowledge, expertise, and problem-solving skills between connected people and companies, which is value-added to the firm. To the best of our knowledge, this paper is the first to manifest a positive link between social network heterogeneity and firm value.

Our findings have a number of broad implications. The fields of economics and finance have come to focus too much on quantitative skills, and not enough on social capital. Literature on CEO characteristics has also largely emphasized hard skills, such as education and professional qualification, as key factors for managerial performance, but has overlooked CEOs' social network skills. Contemporary CEOs require a broader set of knowledge to response to product innovation and increased competitive business pressure in the market. Yet acquiring knowledge can be costly. Our findings suggest that a diverse social network provides a CEO with exposure to different information and resources,

which ultimately improves managerial performance. Our results hopefully get corporate shareholders' to think about how, given the changing face of the workforce and increasing competition from international markets, social networks of upper management and board members can be value-added for the company.

Moreover, policy makers are concerned about the increased diversity in the workplace. Some claim that firms are pressured to hire minority workers due to ethical reasons rather than profitability, while some argue that firms do not want to lose talented employees with varied experience, knowledge, and cultural backgrounds because they can assist the firm to be more successful in the global competition. Through the lens of CEOs' connections in the overall labor market, our findings offer academic evidence that diversity and heterogeneity are tangible assets that contribute to corporate profit. As pressure from global market competition and product innovation increases, the heterogeneity of CEO social network will become more important.

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Table 1.
Definitions of Variables Used in the Analyses

Variable	Definition
	CEO social network characteristics
Het-demographic	Average index of gender and ethnicity heterogeneity of a CEO's social network
Het-intellectual	Average index of education degree, major and school heterogeneity of a CEO's social network
Het-profession	Average index of occupation and industry heterogeneity of a CEO's social network
Het-geography	An index of
Het-overall	Average of four heterogeneity indices above
Network size	Log of total number of social ties
	Firm characteristics
Q	Total assets (#6) + market value of equity (#25*#199) - book value of common equity (#60)- deferred taxes (#74) / Total assets (#6).
Size	Log of total assets (#6)
Leverage	Long term debt (#9) + debt in current liabilities (#) / total assets (#6)
Capex	Capital expenditure (#128) / total assets (#6)
Cashflow	Operating income before depreciation (#13) / Lag of total assets (#6).
R&D intensity	R&D expenditure (#46) / total assets (#6)
HiTecPharma	Indicator equal to 1 if SIC2 is 48 or 73, or SIC3 is 283
Multinational	Indicator if a firm has non-zero foreign revenue (#273), 0 otherwise
Patent	Number of patents applied by a firm
Foreign sales growth	Percentage increase of foreign revenue (#273) from last year
Board female ratio	Percentage of female board of directors
Board minority ratio	Percentage of minority board of directors
	CEO personal characteristics
Age	CEO age
Female CEO	Indicator equal to 1 if a CEO is female, 0 otherwise
Minority	Indicator equal to 1 if a CEO's nationality is not US, 0 otherwise
MBA	Indicator equal to 1 if a CEO has a MBA degree, 0 otherwise
PhD	Indicator equal to 1 if a CEO has a doctor degree, 0 otherwise
Ivy school graduate	Indicator equal to 1 if a CEO is graduate from an Ivy League school, 0 otherwise
Work mobility	Number of companies a CEO has worked at as a top executive
International experience	Number of countries other than U.S. a CEO has worked at as a top executive
	CEO turnover characteristics
CAR [-1,1]	Cumulative abnormal returns of [-1, 1], where 0 is the announcement date of new CEO appointment
CAR [-2,2]	Cumulative abnormal returns of [-2, 2], where 0 is the announcement date of new CEO appointment
CAR [-5,5]	Cumulative abnormal returns of [-5, 5], where 0 is the announcement date of new CEO appointment
Outside hire	Indicator equal to 1 if the new CEO is hired from outside the firm, 0 otherwise
Experience as CEO	Indicator equal to 1 if a CEO has a doctor degree, 0 otherwise
	M&A characteristics

Run-up	Cumulative abnormal returns for the acquirer over [-210, -11], where 0 is the M&A announcement date
CAR [-1,1]	Cumulative abnormal returns for the acquirer over [-1, 1], where 0 is the M&A announcement date
BHAR- 1year	Buy and hold abnormal returns for the acquirer over 1 year after the M&A
Diversify M&A	Indicator equal to 1 if the acquirer is in different industry than target, based on 1-digit SIC.
FCF	Free cash flow / total assets (#6), where free cash flow = Operating income before depreciation (#13) - Interest expense (#15) - Income taxes (#16) +Deferred taxes and investment tax credit (#35 - #35 from previous year) - Preferred dividends (#19) - Common dividends (#21).
P/E ratio	Price to earning ratio of acquirers
Stock deal	Indicator equal to 1 if the deal is 100% paid by stock, 0 otherwise
Cash deal	Indicator equal to 1 if the deal is 100% paid by cash, 0 otherwise
Private target	Indicator equal to 1 if the target firm is private, 0 otherwise
Repeated mergers	Number of M&A deals an acquirer has conducted in a year

Table 2.
CEO SNH (HHI measures) by Firm Industry and R&D type

This table reports the summary statistics of CEO social network heterogeneity, measured by using Herfindahl Index. Higher Herfindahl Index indicates greater homogeneity and less heterogeneity. We report here by HHI instead of inverse HHI because HHI measure has a range of 0 to 1. The minimum value of HHI can be 0, which means that the network is very heterogeneous, and a maximum of HHI can be 1, which means that the network is very homogeneous. We report CEO SNH HHI by firms' industry, high tech type, and R&D intensity. High tech is a indictor, which is equal to 1 if firms belong to pharmaceutical industry and high tech industry as classified by SIC2=48, SIC2=73, SIC3=283. The indicator of R&D is defined as 1 if a firm has non-zero R&D expenditure, and 0 otherwise.

Panel A: By Industry 1-digit SIC					
SIC1	HHI-demographic	HHI-intellectual	HHI-profession	HHI-geography	HHI-overall
0	0.880	0.821	0.688	0.846	0.721
1	0.934	0.760	0.608	0.910	0.742
2	0.898	0.727	0.609	0.885	0.722
3	0.915	0.753	0.620	0.894	0.732
5	0.922	0.771	0.655	0.922	0.750
7	0.918	0.753	0.609	0.907	0.724
8	0.908	0.749	0.633	0.914	0.748
Panel B: By High tech (High tech=1 if SIC2=48, SIC2=73, SIC3==283)					
High Tech	HHI-demographic	HHI-intellectual	HHI-profession	HHI-geography	HHI-overall
0	0.915	0.752	0.627	0.903	0.737
1	0.907	0.745	0.600	0.889	0.715
Panel C: By R&D (R&D=1 if R&D expenditure>0)					
R&D	HHI-demographic	HHI-intellectual	HHI-profession	HHI-geography	HHI-overall
0	0.922	0.765	0.636	0.918	0.747
1	0.908	0.741	0.611	0.888	0.723

Table 3.
Descriptive Statistics of All Variables Used in the Analyses

This table reports the summary statistics of CEO social network heterogeneity measures, firm and board characteristics, CEO characteristics, variables used in the CEO turnover sample and M&A sample. Variable definitions are described in Table 1.

Variable	N	Mean	S.D	Min	Median	Max
Panel A. CEO social network measures						
Het-demographic	14221	1.120	0.154	1.000	1.048	2.000
Het-intellectual	14221	1.438	0.277	1.000	1.461	2.419
Het-profession	14221	1.761	0.398	1.000	1.641	2.978
Het-geography	14221	1.188	0.303	1.000	1.000	3.630
Het-overall	14221	1.377	0.184	1.000	1.375	2.242
Network size	14221	19.034	33.018	1.000	8.000	355.000
Panel B. Firm and board characteristics						
Q	14221	2.042	1.330	0.603	1.612	10.739
Size (million)	14221	3034.970	5823.918	5.951	859.588	40877.000
Leverage	14221	0.203	0.188	0.000	0.178	0.987
Capex	14221	0.047	0.044	0.001	0.033	0.305
Cashflow	14221	0.132	0.165	-0.996	0.156	0.516
R&D intensity	14221	0.054	0.094	0.000	0.013	0.737
HiTecPharma	14221	0.214	0.410	0.000	0.000	1.000
Multinational	14221	0.566	0.496	0.000	1.000	1.000
Patent	8935	19.573	89.727	0.000	0.000	1843.000
Foreign sales growth	7464	-0.046	2.390	-20.569	0.030	17.915
Board female ratio	14221	0.092	0.095	0.000	0.100	0.800
Board minority ratio	14221	0.067	0.140	0.000	0.000	0.800
Panel C. CEO characteristics						
Age	9147	55.754	7.261	31.000	56.000	91.000
Female CEO	9147	0.031	0.174	0.000	0.000	1.000
Minority	9147	0.006	0.079	0.000	0.000	1.000
MBA	9147	0.361	0.480	0.000	0.000	1.000
PhD	9147	0.153	0.360	0.000	0.000	1.000
Ivy school graduate	9147	0.156	0.363	0.000	0.000	1.000
Work mobility	9147	4.858	2.798	1.000	4.000	26.000
Oversea experience	9147	0.043	0.220	0.000	0.000	2.000
Panel D. CEO turnover sample						
CAR [-1,1]	114	0.004	0.060	-0.081	0.004	0.077
CAR [-2,2]	114	0.004	0.069	-0.114	0.002	0.129
CAR [-5,5]	114	0.016	0.094	-0.111	-0.003	0.212
Outside hire	114	0.035	0.185	0.000	0.000	0.000
Experience as CEO	114	0.596	0.493	0.000	1.000	1.000
Panel E. M&A sample						
Runup	3863	-0.005	0.218	-0.909	-0.008	0.846
CAR [-1,1]	3830	0.004	0.050	-0.187	0.002	0.309
BHAR- 1year	3855	-0.080	0.502	-2.486	-0.055	1.919
Diversify M&A	3863	0.316	0.465	0.000	0.000	1.000
FCF	3863	0.084	0.074	-0.778	0.087	0.510

P/E ratio	3858	20.521	44.358	-161.400	18.664	270.455
Sale growth	3863	0.150	0.262	-0.650	0.108	3.070
Stock deal	3863	0.040	0.195	0.000	0.000	1.000
Cash deal	3863	0.243	0.429	0.000	0.000	1.000
Private target	3863	0.558	0.497	0.000	1.000	1.000
Repeated mergers	3863	2.132	1.221	1.000	2.000	5.000

Table 4.
Determinants of CEO Social Network Heterogeneity—First Stage of the Simultaneous Equations

This table reports the results of estimating regression equation (1) as given in the text. The dependent variables are five measures of CEO social network heterogeneity, including demographic, intellectual, profession, and geographical heterogeneity from Columns (1)-(5). Independent variables include a set of firm characteristics and CEO characteristics. Firm characteristics include firm size, leverage, Tobin's Q, cash flow, R&D intensity, capital expenditure, indicator of high tech, indicator of multinational firms, and board diversity (female ratio and minority ratio). All firm characteristics are taken from one year before the measuring year of CEO social network. As for CEO characteristics, we include overall network size, CEO age, gender, minority, indicator of Ivy League school graduate, number of companies a CEO has worked in the past, and number of foreign countries he has worked at before. Detailed variable definitions are available in Table 1. Year dummies and industry indicators at 1-digit SIC code are included. Robust standard errors are clustered by firm. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

VARIABLES	(1) Het- demographic	(2) Het- intellectual	(3) Het- profession	(4) Het- geography	(5) Het-overall
Firm characteristics (t-1)					
Size	0.001	0.037***	0.015***	0.001	0.013***
	(0.478)	(17.530)	(4.786)	(0.056)	(10.235)
Leverage	-0.005	-0.042***	-0.033	-0.035*	-0.029***
	(-0.529)	(-2.698)	(-1.406)	(-1.914)	(-3.004)
Q	0.001	0.004	0.005	0.001	0.002
	(0.064)	(1.440)	(1.362)	(-0.031)	(1.429)
Capex	-0.025	-0.11	0.163	-0.160**	-0.033
	(-0.631)	(-1.587)	-1.54	(-1.968)	(-0.777)
Cashflow	-0.009	-0.028	0.011	0.006	-0.005
	(-0.606)	(-1.134)	-0.299	-0.222	(-0.313)
R&D intensity	0.047*	0.237***	0.336***	0.194***	0.204***
	(1.722)	(5.068)	(4.735)	(3.557)	(7.092)
HiTecPharma	0.016**	-0.001	0.124***	0.036***	0.044***
	(2.395)	(-0.065)	(7.113)	(2.655)	(6.206)
Multinational	-0.002	-0.009	0.034***	-0.012*	0.003
	(-0.485)	(-1.448)	(3.742)	(-1.654)	(0.826)
Board female ratio	0.021	0.057*	-0.140***	-0.069*	-0.033*
	(1.128)	(1.804)	(-2.930)	(-1.873)	(-1.703)
Board minority ratio	0.110***	0.001	-0.028	0.148***	0.058***
	(9.618)	(-0.003)	(-0.943)	(6.466)	(4.766)
CEO characteristics					
Female	0.029***	0.079***	0.006	-0.031*	0.021**
	(3.119)	(4.957)	(0.237)	(-1.647)	(2.118)
Minority	0.029	0.007	0.128**	0.201***	0.091***
	(1.485)	(0.197)	(2.509)	(5.112)	(4.416)
Log (Age)	-0.001***	0.001	-0.003***	-0.003***	-0.002***
	(-6.172)	(0.187)	(-4.812)	(-6.630)	(-7.516)
MBA	-0.005	0.010*	-0.002	0.020***	0.006
	(-1.400)	(1.705)	(-0.203)	(2.756)	(1.547)
PhD	0.008*	0.116***	0.013	0.038***	0.044***
	(1.724)	(14.766)	(1.121)	(4.103)	(9.061)
Ivy school graduate	0.043***	-0.123***	-0.058***	0.102***	-0.009*
	(9.719)	(-16.116)	(-5.038)	(11.439)	(-1.936)
Work mobility	-0.003***	0.012***	0.021***	-0.006***	0.006***
	(-4.991)	(11.619)	(13.361)	(-5.138)	(9.375)
International experience	0.052***	-0.023*	-0.029	0.176***	0.044***
	(7.366)	(-1.902)	(-1.562)	(12.324)	(5.863)
Network size	0.059***	0.084***	0.100***	0.095***	0.084***
	(32.614)	(26.847)	(21.040)	(26.004)	(44.033)
Constant	1.095***	0.921***	1.334***	1.222***	1.143***
	(35.631)	(17.422)	(16.584)	(19.773)	(35.190)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Observations	8486	8486	8486	8486	8486
Adjusted R-squared	0.216	0.247	0.143	0.179	0.346

Table 5.
CEO Social Network Heterogeneity and Firm Value: Second Stage of the Simultaneous Equations

This table reports the results of estimating regression equation (2) as given in the text. The dependent variable is Tobin's Q. Independent variables of main interest are five measures of CEO social network heterogeneity, including demographic, intellectual, profession, and geographical heterogeneity from Columns (1)-(5). Control variables include a set of firm characteristics and CEO characteristics. Firm characteristics include firm size, leverage, Tobin's Q, cash flow, R&D intensity, capital expenditure, indicator of high tech, indicator of multinational firms, and board diversity (female ratio and minority ratio). All firm characteristics are measured at the previous year. We also control for CEO social network size, as it is correlated with heterogeneity. Detailed variable definitions are available in Table 1. Year dummies and industry indicators at 1-digit SIC code are included. Robust standard errors are clustered by firm. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Q	Q	Q	Q	Q
CEO network heterogeneity					
Het-demographic	1.141**				
	(2.447)				
Het-intellectual		0.562***			
		(3.574)			
Het-profession			1.281***		
			(6.616)		
Het-geography				0.332*	
				(1.878)	
Het-overall					3.150***
					(7.255)
Controls					
Size	-0.067***	-0.089***	-0.087***	-0.067***	-0.107***
	(-7.796)	(-8.524)	(-8.905)	(-7.851)	(-9.933)
Leverage	-0.650***	-0.653***	-0.638***	-0.647***	-0.586***
	(-9.983)	(-10.117)	(-9.087)	(-9.986)	(-8.264)
Capex	0.861***	0.910***	0.641**	0.893***	0.902***
	(2.956)	(3.136)	(2.025)	(3.089)	(2.862)
Cashflow	2.078***	2.096***	2.085***	2.067***	2.117***
	(20.732)	(20.985)	(19.248)	(20.846)	(19.515)
R&D intensity	5.344***	5.257***	4.935***	5.345***	4.640***
	(28.567)	(27.813)	(23.231)	(28.552)	(20.480)
HiTecPharma	0.418***	0.420***	0.259***	0.423***	0.274***
	(8.680)	(8.810)	(4.474)	(8.896)	(4.878)
Multinational	-0.081***	-0.076***	-0.126***	-0.079***	-0.096***
	(-3.224)	(-3.019)	(-4.470)	(-3.173)	(-3.498)
Board female ratio	0.608***	0.596***	0.821***	0.680***	0.717***
	(4.775)	(4.712)	(5.914)	(5.406)	(5.248)
Board minority ratio	0.096	0.224***	0.247***	0.167*	-0.025
	(0.974)	(2.803)	(2.850)	(1.913)	(-0.266)
Network size	-0.018	0.006	-0.086***	0.017	-0.227***
	(-0.603)	(0.341)	(-3.569)	(0.768)	(-5.637)
Constant	1.223**	1.877***	0.836***	2.032***	-0.959*
	(2.356)	(7.595)	(2.609)	(7.330)	(-1.878)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Observations	8,486	8,486	8,486	8,486	8,486
Adjusted R-squared	0.215	0.224	0.082	0.231	0.083

Table 6.
Effects of CEO Social Network Heterogeneity on Firm Value: Economic Interpretation

Variable Name	Marginal effects (dy/dx)	Elasticity d(lny)/d(lnx)	Economic interpretation using sample mean
Het-demographic	1.141**	0.061**	Female ratio increases 5% or minority ratio increases by 5% could lead to 0.61% increase in Q
Het-intellectual	0.562***	0.038*	Intellectual heterogeneity increases 1 % --> 0.38% increase in Q
Het-profession	1.281***	0.100***	Profession heterogeneity increases 1% --> 0.1% increase in Q
Het-geography	0.332*	0.070***	Geographic heterogeneity increases 1% --> 0.07% increase in Q
Het-overall	3.150***	0.270***	Overall heterogeneity increases 1% --> 0.27% increase in Q

Table 7.
Instrumental Variable Estimation of the effect of CEO network heterogeneity on firm value

This table reports the results of equations (3) and (4) as given in the text. Columns (1) and (2) report results of 2SLS estimations relating the effect of CEO demographic heterogeneity on firm value. Instrumental variable is percentage of individuals who have network ties with the testing CEO and have either died or retired during the testing year. The detailed construction of our instrumental variable is described in Appendix A. Columns (3) and (4) report results of 2SLS estimations relating the effect of intellectual heterogeneity on firm value using the same instrument. Columns (5) and (6) report results for profession heterogeneity. Columns (7) and (8) report results for geography heterogeneity. Columns (9) and (10) report results for overall heterogeneity. Control variables include a set of firm characteristics and CEO characteristics. Firm characteristics include firm size, leverage, Tobin's Q, cash flow, R&D intensity, capital expenditure, indicator of high tech, indicator of multinational firms, and board diversity (female ratio and minority ratio). All firm characteristics are measured at the previous year. We also control for CEO social network size, as it is correlated with heterogeneity. Detailed variable definitions are available in Table 1. Year dummies and industry indicators at 1-digit SIC code are included. Robust standard errors are clustered by firm. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

VARIABLES	(1) Het - demographic	(2) Q	(3) Het- intellectual	(4) Q	(5) Het- profession	(6) Q	(7) Het- geography	(8) Q	(9) Het- overall	(10) Q
Num_retire_death	-0.022***		-0.079***		-0.158***		-0.07**		-0.063***	
	(-2.975)		(-4.480)		(-7.258)		-2.106		(-6.616)	
Het-demographic		5.746*								
		(1.719)								
Het-intellectual				1.598*						
				(1.830)						
Het-profession						0.794*				
						(1.902)				
Het-geography								1.292*		
								(1.72)		
Het-overall										1.996*
										(1.933)
Controls										
Size	-0.002	-0.040**	0.037***	-0.108***	0.011**	-0.057***	-0.004	-0.124	0.010***	-0.070***
	(-0.783)	(-2.085)	(9.459)	(-3.065)	(2.128)	(-3.839)	(-0.978)	(-0.581)	(4.937)	(-3.920)

Leverage	-0.011	-0.705***	-0.020	-0.739***	-0.003	-0.768***	-0.035	-1.404	-0.017	-0.736***
	(-0.835)	(-5.344)	(-0.783)	(-7.145)	(-0.100)	(-7.763)	(-1.197)	(-0.820)	(-1.166)	(-7.296)
Capex	0.038	0.679	-0.075	1.017**	0.208	0.732	-0.071	-0.405	0.025	0.847*
	(0.756)	(1.322)	(-0.734)	(2.151)	(1.435)	(1.606)	(-0.720)	(-0.105)	(0.417)	(1.902)
Cashflow	-0.011	2.185***	-0.040	2.188***	-0.018	2.139***	-0.023	1.703	-0.023	2.170***
	(-0.545)	(8.723)	(-1.164)	(9.709)	(-0.388)	(9.805)	(-0.653)	(1.355)	(-1.202)	(9.802)
R&D intensity	0.061	5.308***	0.310***	5.161***	0.321***	5.402***	0.167**	8.715	0.215***	5.228***
	(1.554)	(11.490)	(4.734)	(11.169)	(3.031)	(14.450)	(2.122)	(1.106)	(4.919)	(12.496)
HiTecPharma	0.018	0.418***	0.025	0.481***	0.137***	0.412***	0.046*	1.365	0.057***	0.408***
	(1.371)	(3.141)	(1.097)	(4.725)	(4.622)	(3.888)	(1.650)	(0.617)	(4.028)	(3.721)
Multinational	0.006	-0.116**	-0.009	-0.069*	0.029**	-0.108***	0.005	0.010	0.008	-0.100**
	(1.019)	(-2.273)	(-0.877)	(-1.669)	(2.079)	(-2.700)	(0.455)	(0.033)	(1.297)	(-2.563)
Board female ratio	0.062***	-0.293	0.094***	-0.085	0.130***	-0.039	0.101***	1.906	0.097***	-0.129
	(24.963)	(-1.443)	(13.070)	(-1.070)	(16.476)	(-0.730)	(16.744)	(0.402)	(26.402)	(-1.317)
Board minority ratio	0.031	0.264	0.084	0.307	-0.062	0.491**	-0.061	-0.678	-0.002	0.446*
	(1.092)	(0.873)	(1.625)	(1.207)	(-0.876)	(2.072)	(-1.046)	(-0.219)	(-0.067)	(1.902)
Network size	0.110***	-0.400	0.021	0.197	0.047	0.192	0.195***	3.803	0.093***	0.044
	(5.549)	(-0.980)	(0.601)	(1.320)	(0.933)	(1.289)	(4.236)	(0.415)	(4.267)	(0.243)
Constant	1.015***	-3.565	0.933***	0.778	1.200***	1.315**	1.063***	21.712	1.053***	0.167
	(15.895)	(-1.045)	(13.585)	(0.902)	(21.261)	(2.457)	(6.027)	(0.433)	(20.688)	(0.152)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Durbin Wu-Hausmann Chi-sq P-value	0.0458		0.0523		0.0675		0.0477		0.0586	
1st stage F statistic	21.98		30.6		33.32		20.03		32.49	
Observations	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144

Table 8.
Investor Response to CEO Appointment Announcement

This table presents the results of comparisons between two groups of firms that experience CEO turnover events. Group 1 consists of firms where the new hire has greater social network heterogeneity than the old hire. And Group 2 consists of firms where the new hire has less social network heterogeneity than the old hire. The two groups are formed using propensity score matching techniques to make sure two groups of firms have similar firm characteristics including size, leverage, capital expenditure, cash flow, R&D intensity, firm type. We also require the new CEOs between two groups are similar in terms of experience as CEO and whether they are internal candidate or hired from outside. Panel A reports the differences and associated t-statistics of firm and CEO characteristics between the two groups. Panel B reports the results of the event study on new CEO appointment. We report cumulative abnormal returns (CAR) over the 3-day window [-1, +1], where day 0 is the date on which the firm announces the new CEO appointment. As alternative, we also compute 5-day window of [-2,2], and 10-day window of [-5,5].

	Panel A. Matching on firm characteristics and CEO characteristics			
Variable Name	Group 1: New CEO has more heterogeneous network than the old CEO	Group 2: New CEO has less heterogeneous network than the old CEO	Diff.	T-stat
Firm characteristics				
Size	7.369	7.609	-0.240	0.910
Leverage	0.166	0.201	-0.035	1.099
Capex	0.036	0.038	-0.003	0.498
Cashflow	0.165	0.174	-0.170	0.474
R&D intensity	0.048	0.040	0.007	0.754
HiTecPharma	0.246	0.211	0.035	0.443
Multinational	0.807	0.807	0.000	0.000
CEO characteristics				
Experience as CEO	0.053	0.018	0.035	1.014
Outside hire	0.596	0.596	0.000	0.000
	Panel B: Comparison of cumulative announcement return			
CAR (-1,1)	0.016*	-0.008	0.023**	1.742
CAR (-2,2)	0.018*	-0.009	0.027**	2.086
CAR (-5,5)	0.032**	0.001	0.031*	1.754

Table 9.
Regression results relating innovation channel and foreign sale channel

This table reports the results of equations (5)- (8) as given in the text. Columns (1) and (2) report results of simultaneous equations estimations relating CEO social network heterogeneity, innovation, and firm value. Innovation is measured by logarithm of patent applications. Het-overall-hat is the predicted value of CEO overall social network heterogeneity from first stage of IV estimation using percentage of deceased or retired social ties as instrument. Columns (3) and (4) report results of simultaneous equations estimations relating CEO social network heterogeneity, foreign sale growth, and firm value. The detailed construction of our instrumental variable is described in Appendix A. All the regressions control for a set of firm characteristics and CEO characteristics. Firm characteristics include firm size, leverage, Tobin's Q, cash flow, R&D intensity, capital expenditure, indicator of high tech, indicator of multinational firms, and board diversity (female ratio and minority ratio). We also control for CEO social network size, as it is correlated with heterogeneity. Detailed variable definitions are available in Table 1. Year dummies and industry indicators at 1-digit SIC code are included. Robust standard errors are clustered by firm. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

VARIABLES	(1) Log (patent)	(2) Q	(3) Foreign sale growth	(4) Q
Het-overall-hat	5.563***	1.910	5.033**	1.287
	(5.722)	(1.566)	(2.342)	(1.286)
Log (Patent)		0.024**		
		(2.232)		
Foreign sale growth				0.025***
				(4.339)
Controls				
Log (assets)	0.429***	-0.130***	-0.059	-0.053**
	(19.946)	(-5.036)	(-1.327)	(-2.556)
Leverage	-0.452***	-0.477***	-0.208	-0.787***
	(-3.991)	(-4.332)	(-1.256)	(-10.223)
Capex	-0.828	2.712***	0.203	-1.351***
	(-1.406)	(5.740)	(0.251)	(-3.601)
Cash flow	0.526***	1.512***	0.984***	4.144***
	(3.690)	(12.844)	(3.316)	(29.971)
R&D intensity	2.754***	3.683***	-3.579***	4.325***
	(9.155)	(10.604)	(-2.936)	(7.613)
HiTecPharma	-0.698***	0.486***	-0.040	0.551***
	(-7.422)	(5.321)	(-0.299)	(8.959)
Board female ratio	0.277	1.058***	0.038	0.505***
	(1.370)	(6.099)	(0.126)	(3.545)
Board minority ratio	0.297**	-0.208	-0.454*	0.170
	(2.136)	(-1.475)	(-1.898)	(1.521)
Network size	-0.364***	-0.134	-0.390**	-0.062
	(-4.174)	(-1.237)	(-2.237)	(-0.765)
Constant	0.000	0.000	-4.918**	0.670
	(.)	(.)	(-2.347)	(0.686)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	6,220	6,220	6,348	6,348
Adjusted R-squared	0.389	0.212	0.015	0.272

Table 10.
CEO Social Network Heterogeneity and Investment Sensitivities to Firm Value and Cash Flow

This table reports regression results relating equation (9) as given in the text. Column (1) shows the estimation of investment sensitivities to Tobin's Q and cash flow. Dependent variable is investment, measured by capital expenditure scaled by total assets. Column (2) adds the interaction terms of CEO social network heterogeneity with Tobin's Q and Cash flow. The coefficients of the interaction terms capture how investment sensitivity to Q and to cash flow changes as CEO social network heterogeneity increases. A positive coefficient indicates an increase in sensitivity. Het-overall-hat is the predicted value of CEO overall social network heterogeneity from first stage of IV estimation using percentage of deceased or retired social ties as instrument. Column (3) adds more firm characteristics as controls. Detailed variable definitions are available in Table 1. Firm fixed effects are included. Robust standard errors are clustered by firm. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

VARIABLES	(1) Capex	(2) Capex	(3) Capex
Het-overall-hat *Q		0.029*	0.038**
		(1.707)	(2.326)
Het-overall-hat *Cash flow		-0.294**	-0.240*
		(-2.308)	(-1.832)
Het-overall-hat		-0.085	-0.087
		(-1.415)	(-1.458)
Cash flow	0.031***	0.032***	0.034***
	(7.248)	(5.930)	(6.175)
Q (t-1)	0.004***	0.004***	0.004***
	(9.719)	(7.080)	(7.209)
Size			-0.003**
			(-2.065)
Leverage			-0.010**
			(-2.300)
R&D intensity			0.045***
			(4.119)
Constant	0.043***	0.038***	0.057***
	(24.926)	(21.026)	(5.837)
Observations	13,821	11,105	11,105
Firm fixed effects	Yes	Yes	Yes
Number of firms	2,478	2,478	2,478
Adjusted R-squared	0.095	0.089	0.096

Table 11

CEO Social Network Heterogeneity and M&A performance

This table reports the OLS regressions results relating CEO social network heterogeneity and M&A performance. Dependent variable in Columns (1) and (2) is short run performance, measured by cumulative abnormal returns around [-1,1] of the announcement date. Dependent variable in Columns (3) and (4) are long run performance, measured by buy and hold abnormal return during 1-year time period post M&A. We control firm and deal characteristics. Independent variables of main interest are overall CEO social heterogeneity and its interaction with diversified M&A. Detailed definitions are provided in Table 1. Robust standard errors are clustered by firm. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

VARIABLES	(1) CAR[-1,1]	(2) CAR[-1,1]	(3) BHAR-1year	(4) BHAR-1year
Het_overall1	0.012**	0.015***	0.064	0.104
	(2.289)	(2.621)	(1.110)	(1.559)
Het_overall* Diversifing M&A		0.010		0.122*
		(1.063)		(1.818)
Acquirer characteristics				
Size	-0.004***	-0.004***	0.005	0.006
	(-4.609)	(-4.595)	(0.712)	(0.725)
Leverage	0.011	0.011*	-0.019	-0.017
	(1.642)	(1.666)	(-0.282)	(-0.254)
Cash flow	-0.010	-0.010	0.300	0.304
	(-0.562)	(-0.546)	(1.412)	(1.427)
FCF	0.003	0.003	-0.545**	-0.552**
	(0.144)	(0.116)	(-2.109)	(-2.135)
P/E ratio	0.003	0.003	0.005	0.005
	(1.382)	(1.398)	(0.709)	(0.737)
Sale growth	-0.004	-0.004	-0.345***	-0.344***
	(-0.877)	(-0.858)	(-6.382)	(-6.338)
Board female ratio	0.008	0.008	0.068	0.067
	(0.710)	(0.703)	(0.635)	(0.622)
Board minority ratio	0.001	0.001	-0.068	-0.069
	(0.123)	(0.115)	(-1.060)	(-1.071)
Network size	0.001	0.001	0.010	0.010
	(0.846)	(0.898)	(1.037)	(1.100)
Deal characteristics				
Stock deal	-0.021***	-0.021***	-0.228***	-0.229***
	(-3.718)	(-3.734)	(-3.276)	(-3.299)
Cash deal	0.007***	0.007***	0.015	0.015
	(3.605)	(3.585)	(0.816)	(0.803)
Private target	0.003**	0.003**	-0.038**	-0.038**
	(2.076)	(2.056)	(-2.104)	(-2.120)
Diversify M&A	-0.003	-0.017	-0.002	-0.174
	(-1.436)	(-1.224)	(-0.124)	(-1.304)
Run-up	-0.002	-0.002	0.312***	0.313***
	(-0.430)	(-0.416)	(6.174)	(6.186)
Multiple mergers	0.001	0.001	-0.012	-0.013
	(0.886)	(0.860)	(-1.577)	(-1.608)
				-0.109

Constant	0.030**	0.035**	-0.159	
	(2.078)	(2.330)	(-1.180)	(-0.767)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	3,757	3,781	3,757	3,781
Adjusted R-squared	0.023	0.059	0.023	0.060

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