

More than Connectedness—Heterogeneity of CEO Social Network and Firm Value

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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 international 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,

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, education degree, and major), professional experience (e.g., industry and managerial positions), and international exposures (e.g., connections with foreign companies).

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. This means that CEO SNH could be capturing the effect of different firm types that are correlated with firm value. To address this concern, 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 heterogeneity of international exposure has the largest impact on firm value, followed by professional heterogeneity and demographic heterogeneity. Intellectual heterogeneity has the smallest impact on firm value.

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 more information and hence better investment decisions-making. The rationale is that interactions with a diverse group of people could widen a CEO's information sources and skill sets, which helps stimulate debates about the appropriateness of a business strategy and prompts the CEO to make better investment decisions (Wiersema and Bantel, 1992; Watson et al., 1993). We test this hypothesis by examining the relation between CEO SNH and the sensitivity of corporate investment to stock price, a measure to proxy for efficiency of corporate investment (e.g., Dittmar and Shivdasani, 2003; Chen et al., 2007; Xuan, 2009). 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 5-day cumulative abnormal returns (CAR). The relationship is more pronounced for diversified deals. In terms of long-run performance, we find that CEO SNH is associated with better long run post M&A performance and it is more pronounced 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 Zabojsnik, 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.

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).

(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 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 international 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 Measuring 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 Measuring 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 two components— 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, $HHI_{gender} = (female_ratio^2 + male_ratio^2)$. $Het_gender = 1 / HHI_{gender}$. The

smaller the *Het_gender*, 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 international regions. Specifically, $HHI_ethnicity = (North_America_ratio^2 + Latin_America_ratio^2 + Europe_ratio^2 + Asia_ratio^2 + Africa_ratio^2)$. $Het_ethnicity = 1/HHI_ethnicity$. Finally, demographic heterogeneity is measured by the mean of gender heterogeneity and ethnicity heterogeneity. That is, $Het_demographic = (Het_gender + Het_ethnicity) / 2$.

B. *Intellectual heterogeneity*: it is the average of three components—educational 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, $HHI_degree = PhD_ratio^2 + Master_ratio^2 + Bachelor_ratio^2$. $Het_degree = 1/HHI_degree$. Major heterogeneity is calculated based on percentage of people with different majors. In particular, $HHI_major = (Business_Finance_ratio^2 + Engineering_ratio^2 + Liberal_Arts_ratio^2 + Law_ratio^2)$. $Het_major = 1/HHI_major$. School heterogeneity is calculated based on percentage of people graduated from the same school as the CEO. $HHI_school = Same_school_ratio^2 + Different_school_ratio^2$. $Het_school = 1/HHI_school$. Averaging three indices, we get $intellectual_heterogeneity = (Het_degree + Het_major + Het_school) / 3$.

C. *Profession heterogeneity*: it is the average of two components—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, $HHI_occupation = (CEO_ratio)^2 + (CFO_ratio)^2 + (Other_executives_ratio)^2 + (board_of_directors_ratio)^2$. $Het_occupation = 1/HHI_occupation$. 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. $HHI_industry = (same_industry_ratio)^2 + (different_industry_ratio)^2$. $Het_industry = 1/HHI_industry$. Averaging these two, we get $Het_prof = (Het_occupation + Het_industry) / 2$.

D. *International heterogeneity*: this measure attempts to capture the diversity of CEO social networks with international companies. We examine the headquarter location of companies where CEOs' friends work at. Based on World Bank category of countries of income level, we group headquarter countries in to four groups: high income, upper middle income, lower middle income, and lower income countries. Using Herfindahl index, $HHI_international = (HighIncome_ratio^2 + UpperMidIncome_ratio^2 + LowerMidIncome_ratio^2 + LowIncome_ratio^2)$. $Het_international=1/HHI_international$.

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

Table 1 reports the summary statistics of CEO SNH by industries and firm types using HHI measures (inverse of Heterogeneity). The reason we report HHI instead of Heterogeneity is that HHI measure provides better intuitions to understand the degree of diversity in a CEO's social network. For example, HHI measure has a range of 0 to 1. 0 means that everyone in the network has different backgrounds than others, and hence the network is completely heterogeneous. On the other extreme, the maximum value of HHI is 1, which means that everyone in the network is the same, and hence the network is completely homogeneous.

In Table 1 we report CEO network HHI measures by firms' industry, high tech type, whether they have R&D investment, and whether they are multinational firms. On average, CEOs have lower network HHI for professional networks and international networks. Since HHI is a reverse measure of heterogeneity, this means that these two types of networks have higher diversity than other types. In Panel A of Table 1, we report CEO network HHI by firm industries. We include all industries except for finance (SIC1=6) and utility industry (SIC1=4). Results suggest that network diversity does not have significant differences across industries. Panel B shows CEO network HHI for high tech versus non-high tech firms. Following literature, we define "high tech" as 1 if the firm belongs to high tech and pharmaceutical industry (as classified by SIC2=48, SIC2=73, SIC3=283) (Bodnaruk et al., 2012). We find that CEOs of high tech firms have lower network HHI than non-high tech firms in terms of all types of networks. This indicates that high tech CEOs tend to have more heterogeneous social networks than non-

high tech firms. Panel C examines CEO network HHI by firm R&D investment. We define “R&D” as 1 if a firm has non-zero R&D expenditures and 0 otherwise. Results suggest that firms with R&D investment are associated with lower network HHI, which means higher CEO network heterogeneity. Finally, Panel D reports CEO network HHI by foreign business. “Multinational” is defined as 1 if a firm has foreign revenue in the testing year, and 0 otherwise. As it is reported, it is clear that multinational firms are associated with lower CEO network HHI for all types of networks. We will test the determinants of CEO SNH in the regression analysis. For now, the statistics in Table 1 suggests that CEOs of high tech firms, R&D intensive firms, and multinational firms tend to have more diversified networks than other firms.

< TABLE 1: Summary Statistics of HHI measure of CEO SNH >

3.3 Other 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 2.
- B. Boardroom heterogeneity:* we use 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

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.

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 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). Our measure for innovation is logarithm 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). We identify 525 firms in our sample that have patent applications recorded in NBER Patent database. 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 1759 firms.

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) transaction form is categorized as “Merger”, “Acquisition”, “Acquisition of Assets”, or “Acquisition of Majority Interest”; (3) the deal is complete; (4) 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; (5) deal value is more than \$1 million; (5) acquirers have no multiple mergers in the same year; (6) acquirers have stock return data available in CRSP. Finally, our M&A subsample contain 1300 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 5-day cumulative abnormal return (CAR) during the event window of [-2, 2] experienced by the 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 [-210, -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 3 year period after M&A announcement. In particular, $BHAR = \Pi(1+R_i) - \Pi(1+R_m)$, where R_i is monthly stock returns of the acquirers and R_m is the monthly value-weighted market return.

<TABLE 2: Variable Definitions >

3.4 Sample descriptive statistics

Table 3 reports the summary statistics of all other variables used in our analysis. The main sample consists of 2969 CEOs and 2151 US public firms over the 2000-2010 period. Panel A reports the heterogeneity measures in terms of demographic, intellectual, professional, and international 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 Table 2. The average firm value is relatively high, with Tobin's Q of 2.043. The average firm size is about 3.028 billion spanning from the smallest firm of 5.9 million and largest firm of 40.9 billion. The large range of firm size in our sample is due to the fact that BoardEx provide CEO information not only for S&P1500, but also broad cross-sections of firms of smaller sizes. When looking at different firm types in our sample, 21.4% sample firms are high tech, and 56.7% are multinational firms. Among multinational firms, foreign sale growth rate on average is 11.2%. This is consistent with the recent increasing trend of foreign business generation of U.S. firms. As for board characteristics of our sample firms, on average, there are roughly 9% of board members are females and 7% have minority directors. The patent measure is number of patents applied by a firm in a given year. The mean patent application number in our sample is 59.4 with the minimum value of 1 and maximum value of 1843.

Panel C focuses on the characteristics of CEOs. We describe the variable definitions in Table 2. In our sample, 3% of CEOs are female CEOs, and 0.6% are minorities (non U.S. nationality). On average, 36.1% of CEOs have MBA degrees and 15.3% have PhD degrees. And 16% graduated from Ivy League universities. Regarding past working experiences, we construct two measures: work mobility and oversea experience. Work mobility measures number of companies the CEO has worked at as senior managers and executives. As statistics shows, CEOs in our sample have held senior managerial positions at 4.8 companies on average. The other work experience measure is oversea experience. It measures number of countries a CEO has worked at as senior managers and executives in a non-US country. In our sample, the oversea experience variable has a mean of 0.043, which indicates that CEOs do not have much top management oversea working experience. This highlights the need to gain foreign business experience via social networks.

Panel D reports variables used in CEO turnover analysis. We describe the variable definitions in Table 2. 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 Table 2. Our subsample for M&A analysis contains 1370 deals. The average of acquirers' 5-day CAR $[-2, 2]$ is 0.2%, which is consistent with prior studies (e.g. Masulis et al., 2007). The average of long-run performance, as measured by one year BHAR, is about -7.2%. 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 28.9% diversified deals, 5.4% tender offer, 11% all stock deals, and 29.6% mixed payment deals. As for target type, 48.7% target firms are private firms, 23.9% are publicly traded firms, and the rest are subsidiaries.

<TABLE 2: Summary Statistics of Analysis 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. CEO SNH is measured for demographic, intellectual, professional, international, 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.

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

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

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

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, international, 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 1.236, which is statistically significant at 1% 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 0.068%.⁵ Taking our sample mean as an example, a firm with total assets of 3 billion could increase market value by about 205 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 international exposure enhance firm value. A comparison among different types of heterogeneity suggests that international heterogeneity has the

⁵ We calculate this percentage change as: $10\% * \text{Mean (Het-demo)} * \beta \text{ (Het-demo)} / \text{Mean (Q)} = 0.1 * 1.120 * 1.236 / 2.043 = 0.068\%$

largest impact on firm value, followed by professional heterogeneity and demographic heterogeneity. Intellectual heterogeneity has the smallest impact.

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

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

< TABLE 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:

$$CEO\ SNH_{i,t} = \alpha_0 + \sum \alpha \cdot (Deceased\ or\ retired\ network\ ties)_{i,t} + \sum \gamma \cdot (Firm\ char)_{i,t} + \varepsilon_{i,t} \quad (2-1)$$

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

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 positively and significantly related to firm value. 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: CEO SNH and Innovation

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.

$$CEO\ SNH_{i,t} = \alpha_0 + \sum \alpha \cdot (Deceased\ or\ retired\ network\ ties)_{i,t} + \sum \gamma \cdot (Firm\ char)_{i,t} + \varepsilon_{i,t} \quad (3-1)$$

$$Innovation_{i,t} = \alpha_0 + \alpha \cdot (Predicted\ SNH)_{i,t} + \sum \gamma \cdot (Firm\ char)_{i,t} + \varepsilon_{i,t} \quad (3-2)$$

$$Q_{i,t} = \beta_0 + \sum \beta \cdot (Innovation)_{i,t-1} + \alpha \cdot (Predicted\ SNH)_{i,t} + \sum \delta \cdot (Firm\ char.)_{i,t} + \varepsilon_{i,t} \quad (3-3)$$

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. In Column (3) and (4) we repeat the same analysis for intellectual heterogeneity and in Column (5) and (6) we repeat the analysis for professional heterogeneity. Interestingly we find that these two types of heterogeneity play a significant role in enhancing innovation and firm value through innovation.

<Table 9: Regression results relating innovation channel >

4.5 Exploring the Channels: CEO SNH and Foreign Sale Growth

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:

$$CEO\ SNH_{i,t} = \alpha_0 + \sum \alpha \cdot (Deceased\ or\ retired\ network\ ties)_{i,t} + \sum \gamma \cdot (Firm\ char)_{i,t} + \varepsilon_{i,t} \quad (4-1)$$

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

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

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. We repeat the same analysis for demographic heterogeneity and international heterogeneity in Column (3) and (4) for demographic heterogeneity and Column (5) and (6) for international heterogeneity. The findings suggest that two types of heterogeneity play a significant role in pushing foreign sale growth and enhancing firm value through foreign sale channel.

<Table 10: Regression results relating foreign sale channel >

4.6 Exploring the Channel: CEO SNH and Investment Efficiency

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 are more likely to choose positive NPV projects and make better investment that add value for the firms.

We start our analysis focusing on investment efficiency. We follow the literature to measure investment efficiency. Researchers have used the change in investment sensitivity to Q as a measure of investment efficiency. A positive change in the Q-sensitivity is interpreted as an increase in investment efficiency. For example, Gertner et al. (2002) examine the investment behavior of firms before and after spin-off from their parent companies. Dittmar and Shivdasani (2003) investigate corporate divestiture and its impact on efficiency of segment investment. Xuan (2009) examines how specialist CEO affects internal capital allocation within a multi-segment firm. His empirical approach is to first estimate investment efficiency using investment-Q sensitivity, and then to interact Q with specialist CEO. The coefficient of the interaction term captures the changes of investment efficiency conditional on CEO type. Chen et al. (2007) examine whether information content of stock prices and its impact on investment price sensitivity. Using the same approach of interacting Q with information content, they demonstrate that stocks with higher information content could provide managers more information and improve their investment decisions.

Our empirical models follow above literature. In the first step, we estimate investment-Q sensitivity based on the typical Fazzari et al. (1988) investment equation as shown in equation (5),

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

where investment ($I_{i,t}$) scaled by the lagged book value of assets ($TA_{i,t-1}$) is regressed on lagged Tobin's Q ($Q_{i,t-1}$) and cash flows ($CF_{i,t}$) scaled by the lagged book value of assets ($TA_{i,t-1}$). When we calculate our measures of investment, we consider overall capital expenditure, which includes capital expenditures, R&D expenditures, and acquisition expenditures. Moreover, we also investigate acquisition expenditure as a separate measure because merger and acquisition is often the largest capital expenditure in a firm if it happens. Both investment measures are scaled by lagged total assets. Firm fixed effects and year fixed effects are included in order to control for omitted variables over time that affect investment level. The coefficient β_1 captures the investment-Q

sensitivity. However, β_1 is not the focus of our paper. Our goal is to examine whether the level of investment efficiency (measured by the investment-Q sensitivity) depends on CEO social network heterogeneity (CEO SNH).

To do so, we adopt a second step, where we interact CEO SNH with Tobin's Q. The coefficient of CEO SNH*Q_{t-1} will capture the effect of CEO network heterogeneity on the sensitivity of investment to Q. This approach is similar to Xuan (2009) when he examines the effect of specialist CEO on internal capital allocation efficiency, and Chen et al. (2007) where they analyze the effect of private information private information in price on the sensitivity of investment to price. The model specifications are expressed in equation (6-1) and (6-2). In equation (6-1), we use IV approach to the exogenous measure of overall CEO SHN. Using the predicted value of CEO SNH in the equation (6-2), we examine the interaction between CEO SNH and Q. And the coefficient β_3 is our main focus.

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

$$I_{i,t} / TA_{i,t-1} = \beta_0 + \beta_1 Q_{i,t-1} + \beta_2 (CF_{i,t} / TA_{i,t-1}) + \beta_3 Q_{i,t-1} * CEO\ SNH + \beta_4 CEO\ SNH + \sum \psi (Firm\ and\ year\ fixed\ effects) + \sum \gamma \cdot (Firm\ char)_{i,t} + \varepsilon_{i,t} \quad (6-2)$$

The results are reported in Table 11. Column (1) reports the basic investment equation for the overall capital expenditure. Tobin (1969) shows that Q, a proxy for investment opportunity, is a predictor of investment. Hence, there should be a positive relationship between the stock prices and the level of investment, which means that the β_1 coefficient in equation (5) should be positive and significant. We find consistent result that Q_{i,t-1} is positively associated with total capital expenditure ratio, with the coefficient for Q_{i,t-1} is 0.021 significant at 1% level. To further test our hypothesis on CEO SNH, we focus on Column (2), which includes additional interaction term Het-overall-hat* Tobin's Q_{i,t-1}. Note that Het-overall-hat is the predicted value of CEO SNH from first stage of IV estimation using percentage of deceased or retired social ties as an instrument (equation 6-1). The coefficient of the interaction term is estimated at 0,299 with t-statistic of 2.739, which is statistically significant at 1% level. This suggests that the investment-Q sensitivity is higher when CEOs have more heterogeneous social connections. This supports our hypothesis. Based on prior literature, our regressions include the following

set of control variables: Inverse total asset, measured by 1/logarithm of total assets, leverage, and cash flow. We use inverse total asset based on Chen et al (2007)'s argument that both dependent variable (investment) and the regressor Q are scaled by last year's book assets. Therefore, using reverse asset can isolate the correlation between investment and Q induced by the common scaling variable. For all regressions, firm year fixed effect and firm fixed effects are included to control for omitted time invariant firm characteristics and economic changes over time.

Column (3) and (4) repeat the same analysis but focus on acquisition expenditure ratio instead of total capital expenditure. The purpose is to examine whether CEO SNH plays a stronger/weaker role in the efficiency of M&A investment. We can see that in Column (3), the coefficient of $Q_{i,t-1}$ on acquisition investment ratio is positive, meaning that growth opportunity increases acquisition related investment. This is consistent with the general view that investment opportunity is a predictor of investment (Tobin, 1969). In Column (4), we find that the interaction term $\text{Het-overall-hat} * \text{Tobin's } Q_{i,t-1}$ has a coefficient of 1.043, which is strongly significant at 1% level. This suggests that the acquisition investment efficiency improves significantly when CEOs have more heterogeneous social connections. Again, this supports our hypothesis.

<Table 11: CEO SNH, Investment Efficiency, and Firm Value >

4.7 Exploring the Channel: CEO SNH and M&A performance

Acquisitions are one of the largest forms of corporate investment. These investments also tend to be inefficient due to the inherent agency problems between managers and shareholders in large public operations (Jensen and Meckling, 1976). For example, it is well documented that managers prefer M&A investment not because they are positive NPV projects but bring significant personal benefits from empire building (Jensen 1986; Lang et al., 1991). And in this case, M&A is inefficient investment and is value destroying to shareholder wealth. Morck et al (1990) identify that diversifying M&A is one of the types of acquisition that especially hurts shareholder wealth.

Our hypothesis regarding CEO SNH and investment argues that access to a heterogeneous social network provides CEOs with a wider range of information and resources, which is crucial for them to identify good investment opportunities. As we have found in the previous test, CEO SNH is positively associated with acquisition related investment efficiency. In the following test, we go a step further to examine how CEO SNH affects value effect of M&A. To measure wealth effect, we compute both short-run market reaction to the M&A announcement and long-run post-merger performance. Specifically, we measure acquirer by computing 5-day cumulative abnormal return in the event window of $[-2, 2]$. We estimate expected returns from a standard market model over the period from $[-210, -11]$ with the CRSP value-weighted return as the market return. As Panel E of Table 3 shows, the average 5-day CAR in the M&A sample is 0.2%. The magnitude is comparable with Masulis et al. (2007). Long-run performance is measured by buy and hold abnormal returns (BHAR) over the 3 year period after M&A announcement. In particular, $BHAR = \Pi(1+R_i) - \Pi(1+R_m)$, where R_i is monthly stock returns of the acquirers and R_m is the monthly value-weighted market return. After a series sample selection and matching procedure, our M&A sample includes 1300 deals from 2000 to 2010.

In the regression analysis, we relate M&A performance measures to acquiring firms' CEO SNH. Table 12 reports the regressions results relating CEO SNH and M&A performance. In Column (1) we show that CEO SNH is significantly and positively associated with abnormal returns of the acquirer in the 5-day window around announcement. Note that CEO SNH measure we use here is the predicted value from the IV regression using number of death and retirement of connections as instrument. Hence, it is less concern of endogeneity problem. In Column (2) we include diversified M&A and its interaction with CEO SNH. The purpose is to examine whether CEOs with more heterogeneous networks make better M&A investment decisions especially for diversified deal. Our hypothesis says that heterogeneous social connections bring different perspectives and market information from different areas of expertise and industries. Hence it might be especially beneficial for making the right decisions on diversified M&A deals. Our findings as reported in Column (2) support this hypothesis. The indicator of diversifying M&A has a significant and negative coefficient on

abnormal returns. However, the interaction between CEO SNH and diversifying M&A is significantly and positively associated with CAR [-2, 2]. In Column (3) and (4) we analyze the effect of CEO SNH on long-run performance of M&A, measured by 3-year BHAR of acquirers. The findings are consistent with short-run market reaction. In particular, Column (3) shows that CEO SNH has a significant and positive relationship with BHAR. Column (4) further reports that the beneficial role of CEO SNH on long run performance is more pronounced for diversifying deal.

In the regression, we include a wide array of acquirer- and deal-specific characteristics. For acquirer characteristics, we control for firm, leverage, market-to-book ratio, profitability, sale growth, and pre-merger stock price run-up as measured by cumulative stock returns over the [-210, -11] window (Masulis et al., 2007). For these control variables, our estimates are consistent with prior studies (e.g. Moeller et al., 2004; Masulis et al., 2007). In particular, we observe that acquirer firm size has a significant and negative relationship with CAR. Acquirer leverage has a positive and significant effect on CAR, which supports the argument that leverage serves as an important governance mechanism as higher debt ratio reduces managers' incentive to make inefficient investment. We find that market to book ratio has a negative, albeit insignificant, effect on bidder returns. We do not find pre-merger acquirer stock run-up to be significantly associated with bidder returns. However, prior operating profitability has a significant effect on bidder returns in the short run.

Deal characteristics that we control for include payment method, public status of target firms, relative deal size, tender off, and whether it is a diversified M&A, measured at 1-SIC level. Prior literature has well documented that acquirers experience significantly negative abnormal returns when they are buying publicly traded firms as opposed to private targets (Fuller et al., 2002). As shown in Table 12, we find strong evidence supporting prior literature. Public target variable is significantly and negatively associated with market reaction to the M&A announcement. It is also negatively associated with long run performance of M&A. Consistent with Moeller et al. (2004), our results also imply that subsidiary target (the omitted group because we create three groups based on target type: public, private, and subsidiary) should be associated with the highest abnormal bidder returns both in short run and long run. Our findings in Table 12

also support existing evidence that payment method plays an important role in affecting abnormal returns of the short run (Chang 1998; Fuller et al., 2002). For example, we find stock deal M&As are associated with significantly negative announcement abnormal returns, mix payment method has no significant coefficient. And the omitted group—cash payment—should be positively associated with abnormal returns. These are consistent with the adverse selection problem in equity issuance analyzed by Myers and Majluf (1984). We control for relative deal size, but only find it significantly and positively associated with long run performance of M&A. This is consistent with Asquith et al. (1983) and Moeller et al (2004). We also control for tender offer, which is a dummy variable equal to 1 if the deal is categorized as tender offer in SDC. We do not find it to have a strong effect on abnormal return, except for Column (2) when we control diversified M&A. Lastly in Column (2) and (4) we test the differential effects of CEO SNH on diversified M&A deals versus focused M&A deals. Diversified M&A is defined as 1 if the acquirer and target are in the same industry as measured by 1-SIC code. We find strong evidence that diversified M&A is significantly associated with negative abnormal returns both in the short run and in the long run. Overall, the coefficients on the deal characteristics are consistent with existing literature.

<Table 12: 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 international 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 respond 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
Descriptive statistics of CEO SHN by industry and firm type (HHI measures)

This table reports the descriptive statistics of the inverse measure of CEO social network heterogeneity, namely HHI measures. We report here HHI measures for the purpose of easy interpretation. But in the regression analysis we use the inverse HHI, which is labeled as Het. Theoretically, the minimum value of HHI can be 0, which means that the network is very heterogeneous and everyone in the network has different attributes, while a maximum of HHI is 1, which means that the network is very homogeneous and everyone has the same attributes. In our sample the range is between 0.6 to 0.9, indicating that on average CEOs' social networks are not very heterogeneous. We report CEO SNH by firms' industry, high tech type, whether the firm has R&D activities, and the firm has foreign revenue. High tech is a 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 expenditure, and 0 otherwise. Multinational is defined as 1 if the firm has non-zero revenue from foreign countries, and 0 otherwise.

Panel A: By Industry 1-digit SIC					
SIC1	HHI-demographic	HHI-intellectual	HHI-profession	HHI-international	HHI-overall
0	0.880	0.825	0.695	0.669	0.704
1	0.935	0.761	0.611	0.675	0.697
2	0.898	0.732	0.611	0.666	0.682
3	0.916	0.757	0.622	0.670	0.691
5	0.923	0.777	0.659	0.670	0.704
7	0.919	0.761	0.614	0.672	0.684
8	0.909	0.754	0.639	0.671	0.702
Panel B: By High tech (High tech=1 if SIC2=48, SIC2=73, SIC3==283)					
High Tech	HHI-demographic	HHI-intellectual	HHI-profession	HHI-international	HHI-overall
0	0.916	0.756	0.629	0.670	0.694
1	0.908	0.753	0.604	0.668	0.678
Panel C: By R&D (R&D=1 if R&D expenditure>0)					
R&D	HHI-demographic	HHI-intellectual	HHI-profession	HHI-international	HHI-overall
0	0.923	0.770	0.639	0.673	0.701
1	0.908	0.745	0.613	0.668	0.684
Panel D: By foreign business (Multinational=1 if foreign revenue>0)					
Multinational	HHI-demographic	HHI-intellectual	HHI-profession	HHI-international	HHI-overall
0	0.927	0.782	0.645	0.676	0.703
1	0.905	0.734	0.607	0.666	0.682

Table 2
Definitions of Variables Used in the Analyses

Variable	Definition	Data source
	<i><u>CEO social network characteristics</u></i>	BoardEx
Het-demographic	Average index of gender and ethnicity heterogeneity of a CEO's social network	BoardEx
Het-intellectual	Average index of education degree, major and school heterogeneity of a CEO's social network	BoardEx
Het-profession	Average index of occupation and industry heterogeneity of a CEO's social network	BoardEx
Het-international	Average index of heterogeneity with foreign companies from different income and economic development group	BoardEx
Het-overall	Average of four heterogeneity indices above	BoardEx
Network size	Log of total number of social ties	BoardEx
	<i><u>Firm characteristics</u></i>	
Q	Total assets (#6) + market value of equity (#25*#199) - book value of common equity (#60)- deferred taxes (#74) / Total assets (#6).	Compustat
Size	Log of total assets (#6)	Compustat
Leverage	Long term debt (#9) + debt in current liabilities (#) / total assets (#6)	Compustat
Capex	Capital expenditure (#128) / total assets (#6)	Compustat
Cashflow	Operating income before depreciation (#13) / Lag of total assets (#6).	Compustat
R&D intensity	R&D expenditure (#46) / total assets (#6)	Compustat
Total capital expenditure ratio	Capital expenditure (#128) + R&D expenditure (#46) + acquisition expenditure (#129) - cash receipts from sale of property, plant, and equipment (# 107) / total assets of last year (#6)	Compustat
Acquisition expenditure ratio	Acquisition expenditure (#129) /total assets of last year (#6)	Compustat
HiTecPharma	Indicator equal to 1 if SIC2 is 48 or 73, or SIC3 is 283	Compustat
Multinational	Indicator if a firm has non-zero foreign revenue (#273), 0 otherwise	Compustat
Patent	Number of patents applied by a firm	NBER
Foreign sales growth	Percentage increase of foreign revenue (#273) from last year	Compustat
Board female ratio	Percentage of female board of directors	BoardEx
Board minority ratio	Percentage of minority board of directors	BoardEx
	<i><u>CEO personal characteristics</u></i>	
Age	CEO age	BoardEx
Female CEO	Indicator equal to 1 if a CEO is female, 0 otherwise	BoardEx
Minority	Indicator equal to 1 if a CEO's nationality is not US, 0 otherwise	BoardEx
MBA	Indicator equal to 1 if a CEO has a MBA degree, 0 otherwise	BoardEx
PhD	Indicator equal to 1 if a CEO has a doctor degree, 0 otherwise	BoardEx
Ivy school graduate	Indicator equal to 1 if a CEO is graduate from a Ivy League school, 0 otherwise	BoardEx
Work mobility	Number of companies a CEO has worked at as a top executive	BoardEx
Oversea experience	Number of countries other than U.S. a CEO has worked at as a top	BoardEx

executive

CEO turnover characteristics

CAR [-1,1]	Cumulative abnormal returns of [-1, 1], where 0 is the announcement date of new CEO appointment	CRSP, ExecuComp
CAR [-2,2]	Cumulative abnormal returns of [-2, 2], where 0 is the announcement date of new CEO appointment	CRSP, ExecuComp
CAR [-5,5]	Cumulative abnormal returns of [-5, 5], where 0 is the announcement date of new CEO appointment	CRSP, ExecuComp
Outside hire	Indicator equal to 1 if the new CEO is hired from outside the firm, 0 otherwise	ExecuComp
Experience as CEO	Indicator equal to 1 if a CEO has a doctor degree, 0 otherwise	ExecuComp

M&A characteristics

CAR [-2,2]	Cumulative abnormal returns for the acquirer over [-2, 2], where 0 is the M&A announcement date	CRSP, SDC
BHAR- 3year	Buy and hold abnormal returns of the acquirer over 3 year after the M&A	CRSP, SDC
Run-up	Cumulative abnormal returns for the acquirer over [-210, -11], where 0 is the M&A announcement date	CRSP, SDC
Diversify M&A	Indicator equal to 1 if the acquirer is in different industry than target, based on 1-digit SIC.	SDC
Tender off	indicator equal to 1 if the deal is recorded as a tender off in SDC, 0 otherwise	SDC
Relative size	Deal value over market value of the acquirer	SDC, CRSP
All stock payment	Indicator equal to 1 if the deal is 100% paid by stock, 0 otherwise	SDC
Mix stock and cash payment	Indicator equal to 1 if the deal is paid by combination of cash and stock, 0 otherwise	SDC
Private target	Indicator equal to 1 if the target firm is private, 0 otherwise	SDC
Public target	Indicator equal to 1 if the target firm is publicly traded, 0 otherwise	SDC
Relative size	Number of M&A deals an acquirer has conducted in a year	SDC

Table 3-1
Descriptive Statistics of Analysis Variables

Table 3-1 reports the summary statistics of CEO social network measures, firm and board characteristics, CEO characteristics, and all other variables used in the analyses. Variable definitions are described in Table 2.

Variable	N	Mean	S.D	Min	Median	Max
<i>Panel A. CEO social network measures</i>						
Het-demographic	14242	1.120	0.154	1.000	1.043	2.000
Het-intellectual	14242	1.438	0.276	1.000	1.462	2.419
Het-profession	14242	1.760	0.398	1.000	1.641	2.978
Het-international	14242	1.511	0.139	1.000	1.473	2.228
Het-overall	14242	1.457	0.167	1.100	1.459	2.130
Network size	14242	19.007	33.014	1.000	8.000	355.000
<i>Panel B. Firm and board characteristics</i>						
Q	14242	2.043	1.331	0.603	1.611	10.739
Size (million)	14242	3028.557	5814.025	5.951	859.071	40877.000
Leverage	14242	0.203	0.188	0.000	0.177	0.987
Capex	14242	0.047	0.044	0.001	0.033	0.305
Total capital expenditure ratio	16856	0.155	0.147	0.004	0.111	0.979
Acquisition expenditure ratio	10108	0.102	0.244	0.000	0.030	8.338
Cashflow	14242	0.133	0.164	-0.996	0.156	0.516
R&D intensity	14242	0.054	0.094	0.000	0.013	0.737
HiTecPharma	14242	0.214	0.410	0.000	0.000	1.000
Multinational	14242	0.567	0.496	0.000	1.000	1.000
Patent	2944	59.404	148.570	1.000	13.000	1843.000
Foreign sales growth	8471	0.112	1.381	-7.319	0.081	7.696
Board female ratio	14242	0.091	0.094	0.000	0.100	0.800
Board minority ratio	14242	0.067	0.140	0.000	0.000	0.800
<i>Panel C. CEO characteristics</i>						
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
<i>Panel D. CEO turnover sample</i>						
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
<i>Panel E. M&A sample</i>						
CAR [-2,2]	1370	0.002	0.078	-0.404	0.001	0.488
BHAR- 3year	1370	-0.072	0.616	-2.767	-0.153	3.599

Runup	1370	-0.007	0.169	-0.858	-0.012	0.809
Diversify M&A	1370	0.289	0.453	0.000	0.000	1.000
Tender offer	1370	0.054	0.226	0.000	0.000	1.000
All stock payment	1370	0.110	0.313	0.000	0.000	1.000
Stock and cash mix payment	1370	0.296	0.456	0.000	0.000	1.000
Private target	1370	0.487	0.500	0.000	0.000	1.000
Public target	1370	0.239	0.426	0.000	0.000	1.000

Table 3-2
Correlation matrix

Table 3-2 reports correlation matrix among main variables.

	1	2	3	4	5	6	7	8
1 Het-demographic	1							
2 Het-intellectual	0.2080*	1						
3 Het-profession	0.1597*	0.4028*	1					
4 Het-international	0.3635*	0.3738*	0.1371*	1				
5 Het-overall	0.4671*	0.7141*	0.7968*	0.5153*	1			
6 Network size	0.3067*	0.0952*	0.0540*	0.2771*	0.2493*	1		
7 Q	0.0258*	0.0059	0.0630*	0.0299*	0.0548*	-0.0027	1	
8 Size (million)	0.1266*	0.2523*	0.0608*	0.0886*	0.1928*	0.1970*	-0.0538*	1
9 Leverage	0.0032	0.0575*	-0.011	-0.0312*	0.003	0.0370*	-0.1966*	0.1446*
10 Capex	-0.0312*	-0.0352*	0.0003	-0.0393*	-0.0365*	-0.0001	0.0348*	0.0392*
11 Cashflow	-0.0045	0.0213*	-0.0121	-0.0241*	-0.0098	0.0913*	-0.0320*	0.1534*
12 R&D intensity	0.0252*	0.012	0.0760*	0.0592*	0.0764*	-0.0967*	0.3484*	-0.1579*
13 HiTecPharma	0.0394*	0.0351*	0.1259*	0.0363*	0.1056*	-0.0551*	0.2361*	-0.0971*
14 Multinational	0.0707*	0.1027*	0.0917*	0.0509*	0.1253*	0.0842*	-0.0728*	0.1994*
15 Foreign sales growth	0.0065	-0.0053	0.0199	0	0.0102	0.005	0.0503*	0.0226*
16 Board female ratio	0.1015*	0.1341*	0.0059	0.0076	0.0787*	0.1132*	-0.0012	0.2418*
17 Board minority ratio	0.1316*	0.0847*	0.0547*	0.1130*	0.1380*	0.0351*	0.0231*	0.2108*
18 Age	-0.0454*	0.0663*	-0.0204*	-0.0615*	-0.0220*	0.0412*	-0.1253*	0.0847*
19 Female CEO	0.0640*	0.0647*	0.0104	-0.0052	0.0415*	0.0473*	0.0139	0.0191*
20 Minority	0.0233*	0.0065	0.0342*	0.0624*	0.0526*	-0.0164	0.0189*	0.0112
21 MBA	0.1065*	0.0352*	0.0489*	0.1138*	0.1112*	0.2904*	-0.0089	0.0534*
22 PhD	0.0263*	0.1509*	0.0365*	0.0413*	0.0998*	-0.0710*	0.0724*	-0.0018
23 Ivy school graduate	0.2044*	-0.0585*	0.0239*	0.2152*	0.1268*	0.3829*	0.0083	-0.004
24 Work mobility	0.0597*	0.2256*	0.2080*	0.0317*	0.2241*	0.1404*	-0.0252*	0.0880*
25 Oversea experience	0.0888*	0.0283*	0.0199*	0.1357*	0.0982*	0.0117	-0.0181*	0.0557*
	9	10	11	12	13	14	15	16
10 Capex	0.0651*	1						
11 Cashflow	0.0772*	0.3004*	1					

12	R&D intensity	-0.1792*	-0.1598*	-0.6258*	1				
13	HiTecPharma	-0.1550*	-0.1665*	-0.2548*	0.3686*	1			
14	Multinational	-0.0222*	-0.1033*	0.1818*	-0.0805*	-0.0610*	1		
15	Foreign sales growth	-0.0149	0.0099	0.0783*	-0.0314*	-0.0116	*	1	
16	Board female ratio	0.0735*	0.006	0.1302*	-0.1264*	-0.0488*	0.1040*	-0.0009	1
17	Board minority ratio	0.016	-0.0251*	0.0146	0.011	0.0382*	0.1312*	0.0061	0.0385*
18	Age	0.0933*	0.0103	0.0856*	-0.1151*	-0.1437*	0.0182*	-0.0071	0.0065
19	Female CEO	-0.0165	0.0071	0.0012	-0.0043	0.0193*	-0.008	-0.005	0.3052*
20	Minority	-0.0375*	0.0013	0.0200*	0.0149	0.0422*	0.0296*	0.0031	-0.0043
21	MBA	0.0221*	0.0044	0.0668*	-0.1011*	-0.0222*	0.0549*	-0.0049	0.0609*
22	PhD	0.0106	0.003	-0.1269*	0.1814*	0.0567*	-0.0187*	0.0051	-0.0433*
23	Ivy school graduate	-0.0114	-0.0127	0.0173*	-0.0061	-0.0383*	0.0502*	-0.0116	0.0018
24	Work mobility	0.0811*	-0.0219*	-0.0395*	0.0001	0.0606*	0.0250*	-0.0281*	0.0390*
25	Oversea experience	0.0076	0.0011	-0.0086	-0.0041	-0.0066	0.0487*	0.0033	0.0052
		17	18	19	20	21	22	23	24
18	Age	0.0127	1						
19	Female CEO	-0.009	-0.0515*	1					
20	Minority	0.1898*	0.0008	0.0521*	1				
21	MBA	0.0124	-0.0237*	-0.0333*	-0.0493*	1			
22	PhD	0.0428*	0.0346*	-0.0051	0.0201*	-0.3245*	1		
23	Ivy school graduate	-0.0143	-0.0139	-0.0043	-0.0196*	0.2044*	-0.0188*	1	
24	Work mobility	0.0255*	0.2164*	0.0449*	0.0168*	-0.0118	0.0266*	0.014	1
25	Oversea experience	0.1277*	0.0409*	-0.0280*	0.0204*	-0.0529*	0.0051	-0.0495*	0.1496*

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 international heterogeneity from Column (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 - international	(5) Het - overall
<u>Firm characteristics (t-1)</u>					
Log(assets)	0.001 (0.536)	0.037*** (17.441)	0.015*** (4.742)	0.004*** (3.850)	0.014*** (12.004)
Leverage	-0.005 (-0.519)	-0.042*** (-2.685)	-0.032 (-1.356)	-0.015* (-1.823)	-0.023*** (-2.673)
Tobin's Q	0.000 (0.127)	0.003 (1.387)	0.005 (1.372)	0.005*** (3.686)	0.003** (2.444)
Capextoasset	-0.022 (-0.536)	-0.113 (-1.634)	0.161 (1.531)	-0.054 (-1.486)	-0.007 (-0.179)
Cashflow	-0.009 (-0.636)	-0.026 (-1.053)	0.009 (0.243)	0.030** (2.261)	0.001 (0.063)
RDtoasset	0.046* (1.687)	0.238*** (5.092)	0.336*** (4.722)	0.002 (0.065)	0.155*** (5.908)
High tech	0.016** (2.415)	-0.001 (-0.094)	0.124*** (7.101)	0.011* (1.751)	0.037*** (5.797)
Multinational	-0.002 (-0.466)	-0.009 (-1.545)	0.034*** (3.742)	-0.001 (-0.415)	0.006 (1.626)
Board female ratio	0.020 (1.080)	0.063** (1.993)	-0.141*** (-2.943)	0.039** (2.342)	-0.005 (-0.275)
Board minority ratio	0.108*** (9.436)	0.007 (0.378)	-0.019 (-0.645)	0.013 (1.272)	0.027** (2.470)
<u>CEO characteristics</u>					
Networksize	0.059*** (32.556)	0.084*** (26.873)	0.100*** (21.045)	0.032*** (19.568)	0.069*** (39.198)
Female	0.029*** (3.136)	0.078*** (4.901)	0.006 (0.248)	0.018** (2.170)	0.033*** (3.668)
Minority	0.030 (1.545)	0.004 (0.130)	0.125** (2.450)	0.045** (2.521)	0.051*** (2.707)
Log (age)	-0.001*** (-6.217)	0.000 (0.164)	-0.003*** (-4.771)	-0.000* (-1.906)	-0.001*** (-5.209)

MBA	-0.005 (-1.414)	0.010* (1.690)	-0.002 (-0.218)	0.064*** (19.815)	0.017*** (4.898)
PhD	0.008* (1.702)	0.116*** (14.748)	0.013 (1.084)	0.091*** (21.778)	0.057*** (12.851)
Ivy school graduate	0.043*** (9.738)	-0.123*** (-16.106)	-0.058*** (-5.019)	-0.008** (-2.077)	-0.036*** (-8.525)
Work mobility	-0.003*** (-4.953)	0.012*** (11.673)	0.021*** (13.311)	-0.001 (-1.370)	0.007*** (12.589)
Oversea experience	0.052*** (7.360)	-0.024* (-1.952)	-0.029 (-1.588)	0.014** (2.097)	0.003 (0.454)
Constant	1.094*** (35.608)	0.921*** (17.436)	1.333*** (16.582)	1.360*** (48.633)	1.177*** (39.609)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Observations	8,490	8,490	8,490	8,490	8,490
Adjusted R-squared	0.215	0.248	0.142	0.177	0.322

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 international heterogeneity from Column (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 same year as the measuring year of Tobin's Q. 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) Tobin's Q	(2) Tobin's Q	(3) Tobin's Q	(4) Tobin's Q	(5) Tobin's Q
<u>Heterogeneity index</u>					
Het_demographic	1.236*** (2.648)				
Het_intellectual		0.567*** (3.601)			
Het_profession			1.317*** (6.731)		
Het_international				2.976*** (9.441)	
Het_overall					3.168*** (8.422)
<u>Firm characteristics (t-1)</u>					
Log(assets)	-0.067*** (-7.808)	-0.089*** (-8.561)	-0.088*** (-8.919)	-0.076*** (-8.434)	-0.111*** (-10.568)
Leverage	-0.651*** (-9.973)	-0.656*** (-10.142)	-0.641*** (-9.078)	-0.629*** (-9.288)	-0.618*** (-8.918)
Capextoasset	0.880*** (3.013)	0.933*** (3.216)	0.657** (2.065)	0.951*** (3.136)	0.848*** (2.734)
Cashflow	2.099*** (20.860)	2.116*** (21.140)	2.107*** (19.318)	1.981*** (18.850)	2.114*** (19.789)
RDtoasset	5.354*** (28.532)	5.272*** (27.855)	4.938*** (23.094)	5.304*** (27.569)	4.808*** (22.890)
High tech	0.417*** (8.636)	0.421*** (8.820)	0.255*** (4.377)	0.362*** (7.200)	0.278*** (5.147)
Multinational	-0.082*** (-3.237)	-0.076*** (-3.021)	-0.127*** (-4.505)	-0.082*** (-3.124)	-0.101*** (-3.745)
Board female ratio	0.588*** (4.606)	0.576*** (4.547)	0.810*** (5.794)	0.470*** (3.547)	0.586*** (4.355)
Board minority ratio	0.085 (0.865)	0.218*** (2.717)	0.235*** (2.688)	0.145* (1.721)	0.097 (1.115)

Networksize	-0.023 (-0.763)	0.006 (0.362)	-0.089*** (-3.662)	-0.069*** (-3.961)	-0.177*** (-5.951)
Constant	1.129** (2.173)	1.874*** (7.581)	0.794** (2.456)	-1.650*** (-3.458)	-1.186** (-2.491)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Observations	8,490	8,490	8,490	8,490	8,490
Adjusted R-squared	0.212	0.224	0.074	0.150	0.112

Table 6
Effects of CEO SNH on Firm Value: Economic Interpretation

This table reports the economic interpretations of the results in Table 5. Column (2) reports the coefficients of estimates of CEO SNH on firm value. Column (3) reports the increase of market value if a CEO could increase his/her network heterogeneity by 10%. Column (4) reports the calculation procedures.

CEO SNH	Coefficients	Dollar amount (mil) increase as a result of 10% increase in CEO SHN	Calculation
Het-demographic	1.236***	205	$[10\% * \text{Mean (Het-demographic)} * \beta (\text{Het-demographic}) / \text{Mean (Q)}] * \text{Assets} = (0.1 * 1.120 * 1.236 / 2.043) * 3028.557 = 205$
Het-intellectual	0.567***	121	$[10\% * \text{Mean (Het-intellectual)} * \beta (\text{Het-intellectual}) / \text{Mean (Q)}] * \text{Assets} = (0.1 * 1.438 * 0.567 / 2.043) * 3028.557 = 121$
Het-profession	1.317***	344	$[10\% * \text{Mean (Het-profession)} * \beta (\text{Het-profession}) / \text{Mean (Q)}] * \text{Assets} = (0.1 * 1.760 * 1.317 / 2.043) * 3028.557 = 388$
Het-international	2.976***	667	$[10\% * \text{Mean (Het-international)} * \beta (\text{Het-international}) / \text{Mean (Q)}] * \text{Assets} = (0.1 * 1.511 * 2.976 / 2.043) * 3028.557 = 667$

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

This table reports the results of equation (3) and (4) as given in the text. Column (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. Column (3) and (4) report results of 2SLS estimations relating the effect of intellectual heterogeneity on firm value using the same instrument. Column (5) and (6) report results for profession heterogeneity. Column (7) and (8) report results for geography heterogeneity. Column (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 same year as the measuring year of Tobin's Q. 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) TobinQ	(3) Het - intellectual	(4) TobinQ	(5) Het - profession	(6) TobinQ	(7) Het - international	(8) TobinQ	(9) Het - overall	(10) TobinQ
Num_retire_death	-0.021*** (-3.396)		-0.086*** (-5.055)		-0.166*** (-7.828)		-0.019*** (-2.611)		-0.070*** (-7.756)	
Het_demographic		7.334** (2.157)								
Het_intellectual				1.213* (1.649)						
Het_profession						0.690* (1.869)				
Het_international								7.983** (2.026)		
Het_overall										1.740* (1.828)
<i>Firm characteristics (t-1)</i>										
Log(assets)	-0.001	-0.047**	0.035***	-0.095***	0.016***	-0.054***	0.002	-0.070***	0.013***	-0.069***

	(-0.460)	(-2.446)	(10.374)	(-3.339)	(3.506)	(-3.751)	(1.226)	(-3.364)	(6.487)	(-3.718)
Leverage	-0.011	-0.727***	-0.018	-0.779***	0.020	-0.827***	-0.017	-0.679***	-0.015	-0.748***
	(-0.942)	(-5.370)	(-0.837)	(-8.715)	(0.674)	(-9.075)	(-1.345)	(-4.618)	(-1.099)	(-7.624)
Capextoasset	0.023	0.964*	-0.091	1.181***	0.145	1.209***	0.015	1.013*	0.032	0.995**
	(0.533)	(1.930)	(-1.086)	(3.039)	(1.121)	(2.935)	(0.277)	(1.759)	(0.546)	(2.191)
Cashflow	-0.001	2.080***	-0.070**	1.964***	-0.058	1.931***	0.012	1.975***	-0.012	2.204***
	(-0.083)	(8.969)	(-2.511)	(10.423)	(-1.365)	(10.193)	(0.791)	(8.354)	(-0.613)	(10.031)
RDtoasset	0.037	5.080***	0.219***	4.779***	0.185**	5.164***	0.024	5.178***	0.187***	5.388***
	(1.185)	(12.531)	(4.006)	(14.079)	(2.105)	(16.551)	(0.775)	(13.397)	(4.753)	(13.777)
High tech	0.023**	0.396***	0.023	0.507***	0.134***	0.479***	0.027***	0.345**	0.050***	0.432***
	(2.024)	(2.760)	(1.150)	(5.845)	(5.125)	(4.974)	(3.009)	(2.242)	(3.978)	(4.200)
Multinational	0.004	-0.116**	-0.002	-0.096***	0.018	-0.099***	0.004	-0.118**	0.005	-0.103***
	(0.806)	(-2.310)	(-0.265)	(-2.795)	(1.475)	(-2.744)	(0.735)	(-2.222)	(0.889)	(-2.713)
Networksize	0.064***	-0.414*	0.136***	-0.093	0.186***	-0.068	0.046***	-0.307*	0.082***	-0.077
	(29.941)	(-1.912)	(20.992)	(-0.946)	(24.242)	(-0.991)	(21.714)	(-1.728)	(21.865)	(-0.998)
Board female ratio	0.034	0.223	0.062	0.488**	-0.092	0.604***	0.039	0.163	0.025	0.370
	(1.403)	(0.717)	(1.418)	(2.279)	(-1.433)	(2.807)	(1.556)	(0.486)	(0.875)	(1.547)
Board minority ratio	0.096***	-0.491	0.032	0.268*	0.043	0.152	0.029	-0.022	0.059***	0.124
	(5.191)	(-1.303)	(1.066)	(1.889)	(0.915)	(1.083)	(1.605)	(-0.102)	(2.927)	(0.756)
Constant	0.992***	-4.946	0.784***	1.334**	0.989***	1.475***	1.376***	-8.652	1.113***	0.223
	(19.163)	(-1.459)	(20.510)	(2.195)	(13.330)	(3.627)	(52.867)	(-1.594)	(39.917)	(0.207)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,429	14,429	16,191	16,191	15,404	15,404	14,389	14,389	12,157	12,157
Adjusted R-squared	0.233	-0.395	0.342	0.166	0.242	0.188	0.137	-0.417	0.310	0.199

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
<i><u>Firm characteristics</u></i>				
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
<i><u>CEO characteristics</u></i>				
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 CEO SNH, innovation, and firm value

This table reports the results of simultaneous equations estimations relating CEO social network heterogeneity, innovation, and firm value. Innovation is measured by logarithm of patent applications. Column (1) and (2) examine overall heterogeneity. To obtain an exogenous measure of overall heterogeneity, we use Het-overall-hat, which is the predicted value of CEO overall social network heterogeneity from first stage of IV estimation using percentage of diseased or retired social ties as instrument. Column (3) and (4) examine intellectual heterogeneity. We obtain Het-intellectual-hat from IV estimation using the same instrumental variable approach. Column (5) and (6) examine professional heterogeneity. We obtain Het-professional-hat from IV estimation using the same instrumental variable approach. 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). 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.

MODEL	Simultaneous equations on overall heterogeneity, innovation, and Tobin's Q		Simultaneous equations on intellectual heterogeneity, innovation, and Tobin's Q		Simultaneous equations on professional heterogeneity, innovation, and Tobin's Q	
	(1) Log (patent)	(2) Tobin's Q	(3) Log (patent)	(4) Tobin's Q	(5) Log (patent)	(6) Tobin's Q
Het-overall-hat	5.183*** (5.063)	1.636 (1.556)				
Het-intellectual-hat			4.414*** (5.508)	1.430 (1.555)		
Het-profession-hat					1.229*** (2.663)	0.667 (1.585)
Log (patent)		0.025** (2.279)		0.025** (2.360)		0.028*** (2.623)
<u>Firm characteristics (t-1)</u>						
Log(assets)	0.434*** (19.224)	-0.125*** (-5.393)	0.354*** (10.383)	-0.153*** (-3.891)	0.502*** (31.079)	-0.111*** (-7.177)
Leverage	-0.569*** (-5.267)	-0.529*** (-5.580)	-0.647*** (-6.122)	-0.556*** (-6.138)	-0.698*** (-6.602)	-0.578*** (-6.451)
Capextoasset	-0.901 (-1.530)	2.685*** (5.708)	-0.284 (-0.468)	2.960*** (5.741)	-0.998* (-1.692)	2.677*** (5.698)
Cashflow	0.477*** (3.356)	1.491*** (12.720)	0.719*** (4.821)	1.581*** (12.228)	0.521*** (3.633)	1.527*** (12.825)
RDtoasset	3.012*** (10.566)	3.816*** (13.471)	3.104*** (11.545)	3.856*** (14.503)	3.614*** (14.471)	3.967*** (17.802)
High tech	-0.632*** (-6.963)	0.512*** (6.351)	-0.547*** (-6.701)	0.535*** (7.349)	-0.463*** (-5.634)	0.546*** (7.860)
Networksize	-0.248*** (-3.276)	-0.084 (-1.086)	-0.375*** (-4.059)	-0.127 (-1.216)	-0.075 (-0.975)	-0.075 (-1.072)
Board female ratio	0.091	0.986***	0.046	0.972***	0.343	1.111***

	(0.450)	(5.690)	(0.227)	(5.562)	(1.644)	(6.137)
Board minority ratio	0.490***	-0.127	0.568***	-0.097	0.708***	-0.052
	(3.859)	(-1.136)	(4.649)	(-0.923)	(5.915)	(-0.516)
Constant	-6.896***	0.946	0.000	0.000	-2.584***	1.588**
	(-5.504)	(0.752)	(.)	(.)	(-3.656)	(2.542)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies (SIC1)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,220	6,220	6,220	6,220	6,220	6,220
Adjusted R-squared	0.388	0.212	0.388	0.212	0.386	0.212

Table 10
Regression results relating CEO SNH, foreign sale growth, and firm value

This table reports the results of simultaneous equations estimations relating CEO social network heterogeneity, foreign sale growth, and firm value. Foreign sale growth is measured by percentage change of foreign revenue from last year. Column (1) and (2) examine overall heterogeneity. To obtain an exogenous measure of overall heterogeneity, we use Het-overall-hat, which is the predicted value of CEO overall social network heterogeneity from first stage of IV estimation using percentage of diseased or retired social ties as instrument. Column (3) and (4) examine demographic heterogeneity. We obtain Het-demographic-hat from IV estimation using the same instrumental variable approach. Column (5) and (6) examine international heterogeneity. We obtain Het-international-hat from IV estimation using the same instrumental variable approach. 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). 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.

MODEL	Simultaneous equations on overall heterogeneity , foreign sale growth, and Tobin's Q		Simultaneous equations on demographic heterogeneity , foreign sale growth, and Tobin's Q		Simultaneous equations on international heterogeneity , foreign sale growth, and Tobin's Q	
	(1) Foreign sale growth	(2) Tobin's Q	(3) Foreign sale growth	(4) Tobin's Q	(5) Foreign sale growth	(6) Tobin's Q
Het-overall-hat	2.061* (1.822)	0.974 (0.991)				
Het-demographic-hat			6.769* (1.822)	3.200 (0.991)		
Het-international-hat					4.091* (1.822)	1.934 (0.991)
Foreign sale growth (t-1)		0.080*** (6.581)		0.080*** (6.581)		0.080*** (6.581)
<u>Firm characteristics (t-1)</u>						
Log(assets)	-0.062*** (-2.577)	-0.016 (-0.754)	-0.038*** (-2.703)	-0.005 (-0.371)	-0.044*** (-2.723)	-0.008 (-0.532)
Leverage	-0.100 (-1.034)	-0.877*** (-10.437)	-0.066 (-0.683)	-0.861*** (-10.228)	-0.079 (-0.819)	-0.867*** (-10.352)
Capextoasset	-0.019 (-0.042)	-2.308*** (-5.729)	-0.087 (-0.189)	-2.340*** (-5.829)	0.044 (0.094)	-2.278*** (-5.603)
Cashflow	-0.896*** (-4.959)	5.446*** (34.638)	-1.272*** (-4.891)	5.268*** (23.273)	-1.165*** (-5.263)	5.319*** (27.592)
RDtoasset	-1.224* (-1.885)	5.044*** (8.943)	-1.421* (-1.900)	4.951*** (7.618)	-0.759* (-1.743)	5.263*** (13.907)
High tech	-0.005 (-0.063)	0.486*** (7.357)	0.168* (1.674)	0.568*** (6.511)	-0.016 (-0.206)	0.481*** (7.066)

Networksize	-0.130*	-0.019	-0.404*	-0.149	-0.173*	-0.040
	(-1.818)	(-0.309)	(-1.828)	(-0.774)	(-1.825)	(-0.481)
Board female ratio	-0.401**	0.550***	-0.646***	0.434**	-0.617***	0.447**
	(-2.411)	(3.804)	(-3.077)	(2.375)	(-3.076)	(2.565)
Board minority ratio	0.062	0.239**	-0.772	-0.156	0.049	0.233**
	(0.572)	(2.531)	(-1.498)	(-0.348)	(0.443)	(2.396)
Constant	-1.183	0.483	-5.371	-1.497	-4.128	-0.909
	(-0.962)	(0.452)	(-1.531)	(-0.491)	(-1.460)	(-0.370)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies (SIC1)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,091	5,091	5,091	5,091	5,091	5,091
Adjusted R-squared	0.038	0.330	0.038	0.330	0.038	0.330

Table 11**Regression results relating CEO SNH, Investment Efficiency, and Firm Value**

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 using total capital expenditure ratio as the dependent variable. Column (2) adds the interaction terms of CEO social network heterogeneity with Tobin's Q. The coefficients of the interaction terms capture how investment sensitivity to Q changes as CEO social network heterogeneity increases. A positive coefficient of the interaction term means that investment-Q sensitivity increases as CEO network heterogeneity increases, and an increase in investment-Q sensitivity indicates improved investment efficiency. To obtain an exogenous measure overall heterogeneity, we use Het-overall-hat, which is the predicted value of CEO overall social network heterogeneity from first stage of IV estimation using percentage of diseased or retired social ties as instrument. Column (3) and (4) repeat the same analysis using acquisition expenditure to asset as dependent variable to capture the efficiency of acquisition related investment. Detailed variable definitions are available in Table 1. All models include firm fixed effects. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

VARIABLES	(1) total capital expenditure ratio	(2) total capital expenditure ratio	(3) acquisition expenditure ratio	(4) acquisition expenditure ratio
Het-overall-hat		1.088 (1.410)		2.231 (1.534)
Het-overall-hat *Tobin's Q (t-1)		0.299*** (2.739)		1.043*** (3.529)
Tobin's Q (t-1)	0.021*** (11.368)	0.022*** (8.769)	0.026*** (3.693)	0.042*** (4.731)
Inverse logasset (t-1)	1.884*** (6.733)	1.863*** (4.022)	5.490** (2.083)	2.481 (0.861)
Leverage (t-1)	-0.166*** (-10.258)	-0.188*** (-8.640)	-0.385*** (-9.178)	-0.438*** (-7.967)
Cash flow (t-1)	0.017 (0.873)	0.001 (0.031)	0.274*** (3.529)	0.174* (1.928)
Constant	0.137*** (15.976)	0.131*** (9.575)	0.064** (2.243)	0.089*** (2.848)
Firm fixed effect	Yes	Yes	Yes	Yes
Observations	9,788	7,820	6,386	5,265
Number of firms	2,375	2,099	1,814	1,612
Adjusted R-squared	0.086	0.078	0.098	0.098

Table 12
CEO SNH and M&A performance

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

VARIABLES	(1) CAR[-2,2]	(2) CAR[-2,2]	(3) BHAR- 3year	(4) BHAR- 3year
Het-overall-hat	0.298** (1.960)	0.266** (1.964)	4.461* (1.735)	5.205* (1.766)
Het-overall-hat* Diversifying M&A		0.009** (2.401)		1.963** (2.197)
<u>Deal characteristics</u>				
All stock payment	-0.020** (-2.041)	-0.019** (-2.103)	0.003 (0.026)	0.008 (0.071)
Mix cash and stock payment	0.003 (0.445)	0.003 (0.521)	-0.023 (-0.362)	-0.026 (-0.383)
Private target	-0.006 (-0.986)	-0.004 (-0.743)	-0.062 (-0.979)	-0.074 (-1.045)
Public target	-0.030*** (-3.432)	-0.028*** (-3.657)	-0.215** (-2.152)	-0.238** (-2.122)
Tender offer	0.019 (1.533)	0.018* (1.768)	0.142 (1.145)	0.169 (1.236)
Relative size	-0.476 (-0.036)	-2.586 (-0.219)	331.354** (2.402)	345.398** (2.266)
Diversifying M&A		-0.018*** (-3.040)		-3.021** (-2.266)
<u>Acquirer characteristics</u>				
Log (assets)	-0.013** (-2.362)	-0.012** (-2.373)	-0.063 (-1.276)	-0.096 (-1.516)
Leverage	0.063*** (3.013)	0.062*** (3.489)	0.506** (2.115)	0.586** (2.134)
Market to book	-0.003 (-1.011)	-0.003 (-0.939)	-0.048 (-1.466)	-0.062* (-1.645)
Run-up	0.018 (1.008)	0.018 (1.070)	0.007 (0.041)	-0.031 (-0.173)
Sale growth	-0.008 (-0.850)	-0.009 (-1.029)	-0.100 (-1.280)	-0.064 (-0.739)
ROA	0.104*** (2.591)	0.092** (2.536)	0.790 (1.509)	0.992 (1.626)

Board female ratio	0.041 (1.245)	0.042 (1.381)	-0.739** (-2.059)	-0.788* (-1.935)
Board minority ratio	0.003 (0.147)	0.007 (0.342)	-0.123 (-0.467)	-0.217 (-0.723)
Constant	-0.393** (-2.030)	-0.353** (-2.194)	-5.720* (-1.920)	-6.299* (-1.891)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	3,757	3,781	3,781	3,757
Adjusted R-squared	0.023	0.059	0.060	0.023

