Heterogeneity of CEO Social Networks and Firm Value

Yiwei Fang
Stuart School of Business
Illinois Institute of Technology
565 W. Adams Street, 4th Floor
Chicago, IL 60661
Telephone: 312 906 6559
E-mail: yfang15@stuart.iit.edu

Bill Francis
Lally School of Management
Rensselaer Polytechnic Institute
110 8th Street, Pittsburgh Building
Troy, New York 12180-3590
Telephone: 518 276 3908
E-mail: **francb@rpi.edu**

Iftekhar Hasan
Fordham University and Bank of Finland
5 Columbus Circle, 11th Floor
New York, New York 10019
Telephone: 646 312 8278
E-mail: ihasan@fordham.edu

Heterogeneity of CEO Social Networks and Firm Value

Abstract

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

Keywords: Social Networks, Heterogeneity, Intellectual Background, Professional Experience, International Exposure and Firm Value.

JEL code: L14; J15; J24; G30;

1. Introduction

The United States is a melting pot of different races and cultures. Since the 1970s, the percentage of the population that is foreign-born has increased significantly due to higher fertility rates and higher labor-based immigration rates (Shrestha, 2011). The projected demographic characteristics of the U.S. workforce suggest that immigration trends will continue to bring more diversity to the American workforce. By 2050, minorities are projected to rise from one in every four Americans to almost one in every two. The gender gap in the workforce will also narrow (Toossi, 2002).

The increasing diversity of the workforce necessitates a better understanding of the economic influence of individual differences (Pfeffer, 1983; Ashraf and Galor, 2013; Fryer and Loury, 2013). In turn, one important insight from economic studies is 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). 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 create a wider range of options, reduce groupthink, and make one knowledgeable of and adaptable to a rapidly changing environment (Asch, 1951; Janis, 1982). However, a high degree of diversity might also hinder cooperation and trust between individuals, lead to higher turnover rates among group members, and therefore be detrimental to value creation (Wagner et al., 1984; Pelled, 1996; Ashraf and Galor, 2013).

In this paper, we build upon this line of research and study the impacts of social-environmental diversity on firm value through the lens of CEO social networks. In particular, we ask the following questions: Does shareholder wealth rise if a CEO is connected with a more heterogeneous group of people who have diverse experience and backgrounds? And if so, through which channel(s) does this heterogeneity make manifest itself?

We focus on social networks because they can influence decision-making in significant ways. First of all, they facilitate information diffusion and transmission within the group (Holzer, 1987; Granovetter, 1995; Calvo-Armengol and Jackson, 2004), and therefore managers often draw on their social networks to obtain valuable experiences, gather key market information, exchange resources, and identify business opportunities (Engelberg et al., 2013). Second, when individuals do not have all the required information, they tend to rely on whatever information they can acquire via word-of-mouth communication (Ellison and Fudenberg, 1993, 1995; Watts, 2003). Managers likely have similar preferences regarding financial decisions due to the actions of their social peers (Fracassi, 2012).

Although the role of CEO social networks has been studied in various finance contexts (e.g., Cohen et al., 2008; Engelberg et al., 2012), the diversity characteristics of social networks are overlooked. To measure the heterogeneity in CEO social networks (CEO SNH hereafter), we obtain biographical information for 3,506 CEOs from 2,484 U.S. public firms over the period 2000–2010. We identify their education ties, previous work ties, and other social ties through activities in charities and country clubs. The generally accepted definition of diversity refers to differences between individuals on any attributes that could lead to an individual's perception that another person is different from himself/herself (Williams and O'Reilly, 1998). In this regard, our paper addresses more than age, ethnic, and gender diversity; it considers differences in skills, competencies, and international experiences as well.

Our baseline estimations examine the effect of CEO SNH on firm value using OLS regressions. Controlling for social-network size, centrality (measure of connectedness), and various firm and CEO characteristics, we find that greater diversity in terms of intellectual background, professional experience, and international exposure is significantly associated with higher firm value. Among these diversity measures, international exposure has the largest impact on firm value (a $96 million increase in market value following a 10% increase in international exposure), followed by professional heterogeneity (a $30 million increase in market value following a 10% increase in professional diversity), and intellectual heterogeneity (a $28 million increase following a 10% increase in intellectual diversity). Finally, a 10% increase in the overall

heterogeneity index (the average of the four individual heterogeneity indices) could increase a firm's market value by $106 million. Demographic diversity, however, does not appear to have a significant impact on firm value.

Though suggestive, the evidence so far is difficult to interpret as a causal relationship between CEO SNH and firm value. Firms with better performance may have the advantage of hiring managers who have diverse networks of connections. Moreover, managers of growth firms have more opportunities to meet people from different backgrounds and thus form diverse social networks. To deal with the endogeneity of connections, we use death and retirements of network-member CEOs as the instrument for network ties following Fracassi and Tate (2012). We find robust results with the instrumental-variable approach. Noticeably, the effect of demographic diversity on firm value also becomes statistically significant.

We further address the endogeneity problem in an event-study framework to analyze market reactions to new CEO appointments. We form two groups of CEOs, with the benchmark group consisting of CEOs whose SNH scores are higher than those of the previous CEOs, and the matching group consisting of CEOs whose SNH scores are the same or lower than those of the previous CEOs. We employ the nearest-neighbor matching technique to ensure the two groups of firms have similar characteristics and CEO personal attributes but different social networks. The results show that the benchmark firms on average experience significantly positive cumulative abnormal returns around the time of the CEO appointment. In contrast, matching firms have insignificant market reactions to the CEO appointment. The results are robust to using different event windows.

Our analyses further suggest that CEO SNH increases firm value through several channels. First, we find that innovation activities increase with CEO SNH. When we simultaneously control for this channel, we find that CEO SNH has less impact on firm value. This suggests that CEO SNH has a positive impact on innovative capability, and that by acting on innovation, it adds value to the firm.

Second, we find that firms experience greater foreign-sale growth rates when their CEOs' networks are more heterogeneous. After simultaneously controlling for the effect of CEO SNH

on foreign sales growth, the impact of CEO SNH on firm value becomes less significant. The results indicate that heterogeneity of CEO social networks has a positive impact on a foreign sales generation, and that by acting on foreign sales, these CEO social networks add value to firms.

Finally, we explore the potential channel through investment based on two types of analysis. We first examine the relationship between CEO SNH and a corporate investment's sensitivity to stock price, which becomes a proxy for the efficiency of the corporate investment (e.g., Dittmar and Shivdasani, 2003; Chen et al., 2007; Xuan, 2009). The results show that investments are indeed more sensitive to Tobin's Q when CEOs have more heterogeneous social ties. Second, we look at M&A investment performance and find a positive relationship between CEO SNH and five-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 is more pronounced for diversified deals.

These findings suggest that diverse CEO social networks provide different knowledge bases and varieties of opinions that are crucial for helping CEOs make better investment decisions and achieve more innovation. Moreover, exposures to different cultures also largely increase CEOs' ability to establish a network of foreign contacts, identify good business opportunities, and enjoy more success in foreign business (Prahalad and Hamel, 1990; Reuber and Fischer, 1997; Carpenter and Sanders, 1998).

Our paper contributes to several different research streams. First, a growing line of research in behavioral finance tries to understand to the role of CEOs in value creation. For example, using manager fixed effects as proxies for CEO management style, Bertrand and Schoar (2003) demonstrate that managers' personal attributes explain a wide range of corporate behavior, such as investment, leverage, and cash holdings. Kaplan, Klebanov, and Sorensen (2012) find that general ability and execution skills are more crucial to firm performance. Exploring a unique data set, Bennedsen et al. (2011) find that firms whose CEOs are hospitalized underperform compared to similar firms, but the hospitalization of other senior executives does

not have similar effects on firm performance. Along these lines, our paper provides a microsociology perspective of CEO characteristics. Our results suggest that heterogeneous social ties should be a key consideration in evaluating CEO quality. CEOs can benefit from diverse social connections because they provide a broader field of knowledge in response to innovations in market conditions, international business opportunities, and mergers and acquisitions.

Second, a strand of social-network studies investigate the impact of CEO social networks on investment style (Fracassi, 2012), R&D (Faleye et al., 2013), M&A (Cai and Sevilir, 2012), CEO compensation (Barnea and Guedj, 2007; Engelberg et al., 2013; Butler and Gurun, 2012), mutual fund performance and trading behavior (Cohen et al., 2008; Hong et al., 2005), cost of capital (Engelberg et al., 2012), analyst performance (Cohen et al., 2010; Horton and Serafeim, 2009), and corporate governance (Hwang and Kim, 2009; Fracassi and Tate, 2012). Though these studies establish the important economic underpinnings of social networks in various corporate finance issues, researchers focus primarily on the overall connectedness of CEO social networks or social ties with resource holders (e.g., banks). Our paper extends the literature by looking at the heterogeneity characteristics of social ties. By controlling for the size of social network and potential endogeneity problems, we demonstrate that the value of social networks also comes from the heterogeneity of their ties.

Last but not least, we identify multiple areas where heterogeneity of CEO social networks is crucial to add value. The results on innovation suggest that heterogeneous social networks make CEOs more supportive and successful in spurring product innovations. The findings on foreign business channels and investment channels show that diversity of social ties enables CEOs to achieve higher foreign sales and make better investment decisions.

To the best of our knowledge, our paper is the first to establish a direct link between CEO social-network heterogeneity and firm value. Our findings suggest that with more heterogeneous social connections, CEOs could obtain broader knowledge, consider a larger range of options, and learn about 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 demographic characteristics of corporate hierarchies, and given

the increasing pressure on U.S. companies from global market competition and product innovation, this study offers important policy implications.

The rest of the 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 networks and firm value

Fundamentally, social networks affect economic outcomes by offering a way to exchange resources and information that are not easily accessible elsewhere. Early work on social networks extensively examines their role in information dissemination in the labor market (e.g., spreading news about job vacancies or accounts of workers' abilities) (Holzer, 1987; Granovetter, 1995; Calvo-Armengol and Jackson, 2004).

Recent research in finance suggests that social networks also play an influential role in affecting prices in the financial markets. For example, Cohen et al. (2008) find that portfolio managers place larger bets and obtain higher returns on firms with which they have social connections. Similarly, Cohen et al. (2010) and Horton and Serafeim (2009) provide evidence that analysts provide better forecasts and recommendations when they have educational links to the company. Cai and Sevilir (2012) show that board connections between targets and acquirers improve information flow and communication between the two firms, and therefore they benefit acquirers via lower takeover premiums and greater value creation. Engelberg et al. (2012) report that interpersonal connections also reduce information asymmetry in the bank loan market. As a result, firms that have social connections with bankers obtain cheaper bank loans. These findings support the information role of social networks.

A second way social networks affect economic outcomes is by influencing individual behavior and strategies. That is, when individuals do not have all the required information, they tend to rely on whatever information they can acquire via word-of-mouth communication

(Ellison and Fudenberg, 1993, 1995; Watts, 2003). Individuals are also likely to have similar preferences and beliefs due to the actions of their social peers.

Supporting this theory, Fracassi (2012) finds that CEOs who are well connected make financial decisions similar to those of their social peers. Hong et al. (2005) show that trades of mutual funds that are in the same city are correlated due to word-of-mouth communication. Finally, social networks provide social support for connected individuals (Powell, 1990; McPherson et al., 2001). That is, socially interconnected individuals have more trust in one another, they tend to interpret one another's behavior favorably, and they assume that each party will take predictable and mutually acceptable action (Uzzi, 1996, 1999).

In addition to overall connectedness, the heterogeneity characteristics of social networks are also crucial determinants of economic outcomes. For example, diverse social networks can offer a depth and breadth of insight, perspectives, philosophies, and life experiences. This argument has a root in human biology, which says that genetic variations are associated with different modes of cognitive functioning, approaches, and ideologies. Therefore, CEOs who are exposed to people with diverse demographic backgrounds are able to consult with a variety of authorities, obtain divergent ideas to tackle the same problem, and thus make their companies more adaptable to market competition. Moreover, different educational backgrounds and professional experiences help enrich managers' information sets and provide more approaches to solve problems (Robinson and Dechant, 1997).

We construct four measures of CEO SNH based on demographic attributes, intellectual backgrounds, professional experience, and international exposure for individuals in CEO social networks. We hypothesize that managers derive valuable knowledge from social peers, which enables them to perform better. Hence, higher heterogeneity of a CEO social network should lead to higher firm value.

H1: CEO social-network heterogeneity enhances firm value.

2.2. CEO SNH and firm value–innovation channel

The literature extensively examines the role of informal networks on innovation. Goyal and Moraga-Gonzales (2001) demonstrate that R&D networks among firms play an important role in the knowledge diffusion that promotes innovation. Gomes-Gasseres et al. (2006) find that inter-organizational linkages, such as alliances, speed up a firm's ability to learn and utilize new technology and innovation (Gomes-Gasseres et al., 2006).

The social psychology approach emphasizes that differences in psychological attributes and personal characteristics, such as attitudes, cognitive functioning, and beliefs, are also crucial to achieving a higher level of creativity within a team (Barron and Harrington, 1981; Hong and Page, 2001; De Dreu and West, 2001). The reason is that diverse individuals bring diverse opinions and combine ideas that may stimulate innovative solutions to work-related problems. Hence, knowledge heterogeneity is a wellspring for creativity and innovation (Hargadon and Sutton, 1997; Galunic and Rodan, 1998).

Supporting this view, Rodan and Galunic (2004) find that managers with access to heterogeneous knowledge through their social contacts perform better in generating and implementing new ideas for their firms. Similarly, managers working with a heterogeneous contextual environment have advantages in developing novel ideas about organizational products, practices, services, or procedures (Shalley and Gilson, 2004; Shalley and Perry-Smith, 2008). In aligning with these arguments, we propose that innovation is a channel through which CEO SNH increases firm value.

H2: Heterogeneous CEO social networks have a positive impact on a firm's innovative capability, and by acting on innovation, heterogeneity adds value to the firm.

2.3. CEO SNH and firm value–foreign sale channel

The international business literature highlights that cultural sensitivity among corporate leaders can be critical in the process of internationalization (Reuber and Fischer, 1997). As more and more firms attempt to penetrate foreign markets, there is an increasing need to match the diversity of a company's hierarchy to the diversity of the company's potential customers (Robinson and Dechant, 1997). In the finance literature, Carter et al. (2003) find that the

ethnicity diversity of boards of directors could make CEOs more sensitive to cultures outside the U.S. (Carter et al., 2003). 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 firsthand knowledge of foreign markets and enables them to develop and tap into a network of foreign contacts. Foreign directors and their connections can provide valuable assistance to U.S. corporations, especially those with major foreign operations or aspirations to expand internationally (Adams et al., 2010).

Hence, we expect that CEOs who have exposure to demographically and intellectually diverse groups of people are likely to understand different institutional environments and acquire key foreign-market information. Their connections with foreign companies could also enhance their managerial capabilities to push sales and generate more foreign business. Given that more U.S. corporations rely on foreign businesses and that foreign earnings have higher associations with market valuations than domestic earnings (Bodnar and Weintrop, 1997), we argue that social network heterogeneity promotes foreign business, pushes sales, and improves firm performance. This leads to our third hypothesis:

H3: Heterogeneity of CEO social networks has a positive impact on a firm's foreign sales generation, and by acting on foreign sales, heterogeneity adds value to the firm.

2.4. CEO SNH and firm value–investment channel

Engelberg et al. (2013) indicate that social networks serve as an informal medium through which managers share valuable experiences, gather key market information, exchange resources, and identify business opportunities. It suggests that manager social networks are crucial for investment performance. Burt (1992) argues people who can build a bridge between two distinct groups of people will obtain superior information and resources beyond their own groups. It emphasizes that heterogeneous social connections are also important for decision-makers in order to consider more alternatives and to take a broader view.

The finance literature examines diversity mainly in the context of boards of directors. For example, Anderson et al. (2011) investigate the economic value of having a heterogeneous board

of directors in a firm. They find that investors value heterogeneous boards in complex firms but do not value them in less complex firms. 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. Additionally, 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 in turn has a positive influence on corporate governance. Francis et al. (2014) find that female CFOs are more risk-averse and tend to make conservative financial decisions. Francis et al. (2013) 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. Following these arguments, one of the major benefits of having diverse team members is that doing so generates healthy debate, adds information richness, and improves corporate governance. These are important features for decision-making. We therefore expect that diverse social ties are beneficial for CEOs to make investment decisions.

We examine two investment performance measures: (1) investment-Q sensitivity and (2) M&A market valuation effect in both short and long run. If a heterogeneous social network helps managers make better decisions, then, holding all else equal, we expect that:

H4: Heterogeneous CEO social networks lead to more efficient allocation of capital, as measured by higher investment-Q sensitivity.

H5: Heterogeneity of CEO social networks has a positive impact on a firm's M&A performance.

3. Data and Variables

3.1. Measuring CEO social network

CEO social network data is obtained from the BoardEx database provided by Management Diagnostics Limited. This database contains comprehensive biographic information of senior

management and boards of directors of U.S. and European public companies. Biographical 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 charities. The BoardEx dataset also provide relational links between 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 use this dataset tend to focus on one or all three types of social links (Cohen et al., 2008; Liu, 2010; Engelberg et al., 2012, 2013; 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 dates 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 graduated several years ago, they often maintain connections with their former classmates through alumni events. As regard to work 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 have actually met and have had informative conversations, we require that the two individuals must have held relatively high level positions, such as serving on the top level management team, the board of directors, an advising council, and so on (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 as follows:

A. *Demographic heterogeneity*: it is the average of two components—gender heterogeneity and ethnicity heterogeneity. We measure gender heterogeneity by calculating an 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 is one's social network. 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 the 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 the percentage of people with different majors. Specifically, $HHI\_major = (Business\_Finance\_ratio^2 + Engineering\_ratio^2 + Liberal\_Arts\_ratio^2 + Law\_ratio^{2)}$.

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 locations of companies at which the CEOs' friends work. Based on the World Bank category of countries of income level, we group headquarter countries into 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 the HHI measure provides a better intuition to understanding the degree of diversity in a CEO's social network. For example, the HHI measure has a range of 0 to 1 and a value of 0 means that everyone in the network has different backgrounds and hence the network is completely

heterogeneous. In contrast a value 1 means that everyone in the network has the same background 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. 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 the 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., 2013). 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 the results indicate, it is apparent 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 suggest 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 and CEO characteristics:* we match BoardEx with Compustat using ticker and CIK number to obtain firm characteristics.[1] Financial institutions, the utility industry, and nonprofit organizations are excluded from the sample. Firm value is measured by Tobin's Q.[2] Our analysis also requires many other firm characteristics as specified in Table 2. 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. We obtain the following CEO characteristics from BoardEx: age, gender, nationality, chairman position, and tenure. We construct a minority indicator, which is 1 if the CEO's nationality is U.S., 0 otherwise. For those CEOs with missing information on the nationality, we create an indicator called minority missing. The detailed variable definitions can be found in Table 2.

B. *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, we gather information regarding CEOs' past employment history and construct an indicator of whether the CEO is hired from outside the firm or not. Our subsample on CEO turnovers consists of 114 turnover events between 2000 and 2010.

[1] 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.

[2] 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.

C. *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.

D. *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 3506 CEOs from 2484 U.S. public firms over the 2000-2010 period. Panel A reports the measures for demographic, intellectual, professional, and international heterogeneity. Two other social network measures are network size and network centrality. Network size is small, which reflects the sample screening limitation. We require that the person connected with the CEO be at a senior position at other firms to maximize the probability that two individuals actually have had informative conversations (Fracassi, 2012). Hence, the results will not overestimate the effect of social networks. Panel B reports summary statistics for firm characteristics in addition to board characteristics. We describe the variable definitions in Table 2. The average firm value is relatively high, with Tobin's Q of 1.961. The average firm size is about 2665 million spanning from 40.3 million for the 5 percentile to 13 billion for the 95 percentile. The large range of firm size in our sample is due to the fact that BoardEx provides CEO information not only for S&P1500, but also broad cross-sections of firms of smaller sizes. As for board characteristics of our sample firms, on average there are 9% of board members are females and 6% have minority directors. The patent measure is number of patents applied for by a firm in a given year. We assume that firms with positive R&D investment but no recorded patent in the NBER database have zero patents. The mean patent application number in our sample is 26.3.

Panel C focuses on the characteristics of CEOs. The average CEO age is 55.5 and tenure is 10.5 years. Among our sample CEOs, 3% of CEOs are female CEOs and 0.6% are minority CEOs. 32.2% of CEOs do not have nationality information and we treat them as non-minorities, and we create a dummy variable of minority missing in the regression as control. . On average, 54.8% of CEOs are also chairman of the board. To study the CEO appointment announcement

effects, we identify 114 cases of CEO turnover in which we have social network information for both the new incoming CEO and the previous CEO. Among the new incoming CEOs, 60% are hired from outside of the firm. 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].

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 offers, 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 3: Summary statistics >

4. Empirical Results

4.1. CEO SNH and firm value: baseline regressions

We begin estimating the effects of CEO social network heterogeneity on firm value using OLS regressions. The dependent variable is firm value, as measured by Tobin's Q, and independent variables of interests include five CEO SNH indices. We control for firm characteristics including size, leverage, capital expenditure, cash flow, R&D, and the diversity of board of directors. In addition, we also control for network size and centrality to tease out their potential effects on firm value. CEO SHN is measured for demographic, intellectual, professional, international, and overall heterogeneity. 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. The estimation equation is as follows:

$$Q_{i,t} = \alpha_0 + \sum \alpha \bullet (\text{CEO SNH})_{i,t} + \sum b \bullet (\text{Network measures}) + \sum \delta \bullet (\text{Firm and CEO char.})_{i,t} + \varepsilon_{i,t}$$

Table 5 reports the baseline OLS results. We find that intellectual, profession, and international diversity are significantly and positively related to Tobin's Q. However, the effect of demographic diversity on firm value is not statistically significant. These results suggest that CEOs with more diverse social connections create more firm value compared with CEOs with less diverse social ties. And the benefits of diversity mainly come from knowing people with different education backgrounds, diverse professional skills set, and multiple international exposures. The role of demographic diversity does not seem to be as significant as other aspects of diversity. In the last column, we regress overall heterogeneity index on firm value. Overall index is the average of the four individual heterogeneity indices. The finding suggests that average heterogeneity index is strongly associated with higher firm value. The coefficient is 0.532, which is statistically significant at 1% level. It indicates that if a CEO could increase his or her social network heterogeneity by 10%, Tobin's Q could increase by 4%.[3] For an average firm of our sample with total assets of 2665 million, 4% increase in Q indicates about 106 million increases in market value. This effect is strongly significant in the economic sense. Using the same calculation approach, we report the economic interpretations other coefficients in Table 6.

Among these diversity measures, international exposure has the largest impact on firm value ($96 million increase in market value following a 10% increase in international exposure), followed by professional heterogeneity ($30 million increase in market value following a 10% increase in professional diversity) and intellectual heterogeneity ($28 million increase following a 10% increase in intellectual diversity). Besides the demographic diversity, all the other diversity measures play a nontrivial economic impact on firm value. We also compute the economic impact of social network centrality on firm value using the coefficient from Column (5). It shows that as centrality increases by 10%, firm value increases by 16 million for an average firm in the sample. Compared with this magnitude, overall heterogeneity has much

[3] We calculate this percentage change as: 10% * Mean (Het-overall) * β (Het-overall) / Mean (Q) = 0.1*1.467*0.532/1.961=4%

bigger economic impacts on firm value. These results highlight our argument that although being in a central network position is important, knowing different people with diverse education backgrounds and working experiences can be more crucial to create firm value.

< TABE 5: CEO SNH and firm value: baseline results>

< TABE 6: Economic interpretations of results in Table 5>

4.2. CEO SNH and firm value: instrumental variables approach

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.

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 that 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, retired ties 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 international experience). 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 a larger network can give rise to more death and retirement. The model specification of 2-SLS IV estimations is as follows:

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

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

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 the level of CEO SNH significantly reduces following the death and retirement of network connections that have different attributes than the CEO. To test if the instrumental variable has a good predictability of CEO SNH, we report the 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). The results of the second stage regressions show that

CEO SNH for demographic, intellectual, professional, and international exposure are all positively and significantly related to firm value. Comparing with the baseline results, demographic diversity appears to have a significant effect on firm value in the IV estimation. This means that after correcting for the endogeneity issue, demographic diversity of CEO social ties can increase firm value. The overall heterogeneity measure, in both baseline and IV estimation show a strong and significant coefficient with Tobin's Q. Hence, we conclude 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>

4.3. 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 the same or 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 networks), another issue cannot be ignored: the omitted variable problem. That is, some underlying firm characteristics, such as size, capital structure, capital expenditure, cash flow and R&D investment can affect both CEO social network and market reaction to the new CEO appointment. In addition, personal characteristics of the new CEOs, including age, tenure, chairman position, 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, and R&D intensity. According to the previous literature, whether the new CEO is promoted from inside of the firm isa key factor 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 at which the firm announces the new CEO appointment. As an alternative, we also compute a 5-day

window of [-2,2] and a 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 [-2, 2] event window, and become more significant for the [-5, 5]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 10% level for 3-day and 10-day event windows and 5% 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>

4.4. Exploring the channel through 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.

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

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

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

Columns (1) and (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 Columns (3) and (4) we repeat the same analysis for intellectual heterogeneity, and in Columns (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 >

4.6. Exploring the channel through 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:

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

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

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

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 sales, and by acting on foreign sales, firm value is increased. We repeat the same analysis for demographic heterogeneity and international heterogeneity in Columns (3) and (4) for demographic heterogeneity and Columns (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 >

4.7. Exploring the channel through 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 CEOs affect 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 the 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),

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

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 the 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, in which 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), who examines the effect of specialist CEOs on internal capital allocation efficiency, and Chen et al. (2007), who analyze the effect of private information private information in price on the sensitivity of investment to price. The model specifications are expressed in equations (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 equation (6-2), we examine the interaction between CEO SNH and Q. And the coefficient β_3 is our main focus.

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

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

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 a consistent result that $Q_{i,t-1}$ is positively associated with total capital expenditure ratio, with the coefficient for $Q_{i,t-1}$ is 0.021signifciant 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 the 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 the argument by Chen et al. (2007) that both the 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 effects and firm fixed effects are included to control for omitted time invariant firm characteristics and economic changes over time.

Columns (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 Het-overall-hat* 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 >

4.8. Exploring the channel through M&A

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 because they 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 to 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 the announcement. Note that the 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, there is less concern of an 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 Columns (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 deals.

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' incentives 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 offer, 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. The 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 the short run and the long run. Our findings in Table 12 also support the existing evidence that payment method plays an important role in affecting abnormal returns in 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 and that mixed 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 Columns (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, since who is in a CEO's social network clearly has an impact on what information and resources he or she can obtain. 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 improve decision-making. In contrast, the benefit from a homogeneous social network can be marginal.

We examine this issue by empirically testing 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 the 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. The literature on CEO characteristics has also largely emphasized hard skills—such as education and professional qualification—as key factors for managerial performance, but has overlooked CEOs' social network skills. Contemporary CEOs require a broader set of knowledge to response to product innovation and increased competitive business pressure in the market. Yet acquiring knowledge can be costly. Our findings suggest that a diverse social network provides a CEO with exposure to different information and resources, which ultimately improves managerial performance. Our results can hopefully encourage 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 in becoming more successful in global marketplace. 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.

References:

Adams, R., Ferreira, D. 2009, Women in the boardroom and their impact on governance and performance. Journal of Financial Economics, 94: 291-309.

Adams, R.B., Hermalin, B.E., and Weisbach, M.S., 2010. The role of boards of directors in corporate governance: A conceptual framework and survey. Journal of Economic Literature, 48(1): 58-107

Anderson, D. C., Reeb, D. B., Upadhyay, A., Zhao, W. 2011. The economics of director heterogeneity. Financial Management, 40(1): 5-38.

Asch, S., 1951, Effects of Group Pressure upon the Modification and Distortion of Judgment, in H. Guetzkow (ed.) Groups, Leadership, and Men. Pittsburgh: Carnegie Press.

Ashraf, Q., Galor, O. 2013. The out of Africa hypothesis, human genetic diversity, and comparative economic development. The American Economic Review, 103(1): 1-46.

Barnea, A., Guedj, I. 2007, CEO compensation and director networks, Working paper.

Barron, F. B., Harrington, D. M. 1981. Creativity, intelligence, and personality. Annual Review of Psychology 32: 439–476.

Bennedsen, M., Perez-Gonzales, F., Wolfenzon, D. 2012. Evaluating the Impact of The Boss: Evidence from CEO Hospitalization Events. Working Paper.

Bertrand, M., Schoar, A. 2003. Managing with Style: The Effect of Managers on Firm Policies, Quarterly Journal of Economics 118(4), 1169-1208.

Bodnar, G. M., Weintrop, J. 1997. The valuation of the foreign income of US multinational firms: a growth opportunities perspective. Journal of Accounting and Economics, 24: 69-97.

Bodnaruk, A., Massa, M., Simonov, A. 2013. Alliances and corporate governance. Journal of Financial Economics 107 (3): 671-693.

Burt, R.S. 1992. Structural Holes. New York: Cambridge University Press.

Butler, A.W., Gurun, U.G. 2012. Educational Networks, Mutual Fund Voting Patterns, and CEO Compensation. Review of Financial Studies.

Cai, Y., Sevilir, M. 2012. Board Connections and M&A Transactions. Journal of Financial Economics, 103: 327-349.

Calvo-Armengol, A., Jackson, M. 2004 .The Effects of Social Networks on Employment and Inequality. American Economic Review, 94, 426.454.

Carter, D. A., Simkins, B. J., Simpson, W. G. 2003. Corporate Governance, Board Diversity, and Firm Value. Financial Review, 38 (1): 33-53.

Carpenter, M. A., Sanders, WM. G.,1998, Internationalization and firm governance: The roles of CEO compensation, top team composition, and board structure, Academy of Management Journal, 41, 158:178.

Chen, Q., Goldstein, I., Jiang, W. 2007. Price informativeness and investment sensitivity to stock price. Review of Financial Studies, 20(3): 619-650.

Cohen, L., Frazzini, A., Malloy, C. 2008. The small world of investing: Board connections and mutual fund returns. Journal of Political Economy, 116(5): 951–979.

Cohen, L., Frazzini, A., Malloy, C., 2010. Sell side school ties, Journal of Finance 65(4), 1409-1437.

De Dreu, C. K., West, M. A. 2001. Minority dissent and team innovation: The importance of participation in decision making. Journal of Applied Psychology, 86, 1191−1201.

Dittmar, A., Shivdasani, A. 2003. Divestitures and Divisional Investment Policies. Journal of Finance, 58:2711–43.

Ellison, G., Fudenberg., D. 1993. Rules of thumbs for social learning. The Journal of Political Economy 101(4), 612–643.

Ellison, G. Fudenberg., D. 1995. Word-of-mouth communication and social learning. The Quarterly Journal of Economics 110 (1), 93–125.

Engelberg, J., Gao, P., Parsons, C. 2012. Friends with Money, Journal of Financial Economics, 103(1): 169-188.

Engelberg, J., Gao, P., Parsons, C. 2013. The Value of a Rolodex: CEO Personal Network and Compensation. Review of Financial Studies 26(1): 79-114.

Faleye, O., Kovacs, T., Venkateswaran, A. 2013. Do Better-Connected CEOs Innovate More? Journal of Financial and Quantitative Analysis, forthcoming.

Fazzari, S., Hubbard, R. G., Petersen, B. C. 1988, Finance constraints and corporate investment, Brookings Papers on Economic Activity 1, 141–195.

Fracassi, C. 2012. Corporate finance policies and social networks. AFA 2011 Denver Meetings Paper.

Fracassi, C., Tate, G. 2012. External networking and internal firm governance. Journal of Finance, 67 (1): 153-194.

Francis, B., Hasan, I., Wu, Q. 2014. Gender differences in financial reporting decision-making: Evidence from accounting conservatism. Contemporary Accounting Research, forthcoming.

Francis, B., Hasan, I., Wu, Q. 2013. Professors in the Boardroom and their Impact on Corporate Governance and Firm Performance. Working paper.

Fryer R, Loury G. 2013. Valuing Diversity. Journal of Political Economy. 121(4):747-774

Galunic, D. C., Rodan, S. A. 1998. Resource recombinations in the firm: knowledge structures and the potential for Schumpeterian innovation. Strategic Management Journal 19(12): 1193–1201.

Goyal, S., Moraga-Gonzales, J. L. 2001. R&D Networks. RAND Journal of Economics, 32, 686-707.

Gomes-Casseres, B., Hagedoorn, J., Jaffe, A. B. 2006. Do alliances promote knowledge flows? Journal of Financial Economics. 80(1): 5-33.

Granovetter, M. 1995. Getting a job: a study of contacts and careers, 2nd edition, Harvard University Press, Cambridge.

Gul, F., Srinidhi, B., Ng, A. 2011. Does board gender diversity improve the informativeness of stock prices? Journal of Accounting and Economics, 51 (3): 314-338.

Hargadon, A., Sutton, R. I., 1997. Technology brokering and innovation in a product development firm. Administrative Science Quarterly 42: 716–749.

Hall, B., Jaffe, A., Trajtenberg, M. 2001. The NBER patent citations data file: Lessons, insights and methodological tools. Working Paper 8498, NBER.

Hall, B., Jaffe, A., Trajtenberg, M. 2005. Market value and patent citations. The Rand Journal of Economics 36, 16-38.

Holzer, H., 1987. Hiring procedures in the firms: their economic determinants and outcomes. In: M. Kleiner, ed., Human Resources and the Performance of the Firm, Wis.: Industrial Relation Research Association, 243-274.

Horton, J., Serafeim, G. 2009. Security Analyst Networks, Performance and Career Outcomes. Working paper available at SSRN: http://ssrn.com/abstract=1522313

Hong, H., Kubik, J. D., Stein, J. C. 2005. Thy Neighbor's Portfolio: Word-of-Mouth Effects in the Holdings and Trades of Money Managers. Journal of Finance, 60 (6), 2801-2824.

Hong, L., Page, S. E. 2001. Problem Solving by Heterogeneous Agents. Journal of Economic Theory, 97 (1), 123-163.

Hwang, B., Kim, S. 2009. It pays to have friends. Journal of Financial Economics, 93(1):138–158.

Janis, I. L., 1982, Groupthink: Psychological Studies of Policy Decisions, 2nd ed., Houghton Mifflin Company.

Kaplan, S. N., Klebanov, M. M., Sorensen, M. 2012. Which CEO characteristics and abilities matter?. The Journal of Finance, 67(3), 973-1007.

Liu, Y. 2010. The Impact of Networks on CEO Turnover, Appointment, and Compensation. Available at SSRN: http://ssrn.com/abstract=1573244.

Masulis, R. W., Wang, C., Xie, F. 2012. Globalizing the boardroom—The effects of foreign directors on corporate governance and firm performance. Journal of Accounting and Economics, 53 (3): 527-554.

McPherson, M., Smith-Lovin, L. Cook, J. 2001. Birds of a Feather: Homophily in Social Networks, Annual Review of Sociology 27, 415-44.

Pelled, L. 1996. Demographic diversity, conflict, and work group outcomes: An intervening process theory. Organization Science, 7, 615−631.

Pfeffer, Jeffrey. 1983. “Organizational Demography.” pp. 299-357 in L.L. Cummings and Barry M. Staw (eds.), Research in Organizational Behavior (Volume 5).Greenwich, CT: JAI Press.

Powell, W. W. 1990. Neither market nor hierarchy: Network forms of organization.

Prahalad, C. K., Hamel, G. 1990. The core competence of the corporation. Harvard Business Review, 68(3): 79–90.

Reuber, A. R., Fischer, E. 1997. The influence of the management team’s international experience on the internationalization behaviors of SMES. Journal of International Business Studies, 28, 807-825.

Robinson, G., Dechant, K. 1997. Building a business case for diversity. Academy of Management Executive, 11(3): 21-30.

Rodan, S., Galunic, C. 2004. More than network structure: How knowledge heterogeneity influences managerial performance and innovativeness. Strategic Management Journal, 25: 541-562.

Shalley, C.E., Gilson, L.L. 2004. What leaders need to know: A review of social and contextual factors that can foster or hinder creativity. Leadership Quarterly, 15: 33-53.

Shalley, C. E., Perry-Smith, J. E., 2008. The emergence of team creative cognition: The role of diverse outside ties, socio-cognitive network centrality, and team evolution. Strategic Entrepreneurship Journal, 1, 2, 23-41.

Shrestha, L. B. 2011. Changing Demographic Profile of the United States. DIANE Publishing.

Staiger, D., Stock, J. 1997. Instrumental Varaiables Regression with Weak Instruments, Econometrica, 557-586.

Tobin, J., 1969, A general equilibrium approach to monetary theory, Journal of Money, Credit and Banking 1, 15–29.

Toossi, M. 2002. Century of Change: The US Labor Force, 1950-2050, A. Monthly Lab. Rev., 125, 15.

Uzzi, B. 1996. The sources and consequences of embeddedness for the economic performance of organizations: The network effect. American Sociological Review, 61(4): 674–698.

Uzzi, B. 1999. Embeddedness in the making of financial capital: How social relations and networks benefit firms seeking financing. American Sociological Review, 64(4): 481–505.

Wagner, W. G., Pfeffer, J., O'Reilly III, C. A. 1984. Organizational demography and turnover in top-management group. Administrative Science Quarterly, 74-92

Watson, W. E., Kumar, K., Michaelsen, L. K. 1993. Cultural diversity’s impact on interaction process and performance: comparing homogeneous and diverse task groups. Academy of Management Journal, 36:3, 590-602.

Watts, D. J. 2003. Six degrees - the science of a connected age. W. W. Norton & Company.

Wiersema, M. F., Bantel. L. 1992. Top management demography and corporate strategic change. Academy of Management Journal, 35:1, 91-121.

Williams, K. Y., O'Reilly, C. A. 1998. Demography and diversity in organizations: A review of 40 years of research. Research in Organizational Behavior, 20, 77−140.

Xuan, Y. 2009. Empire-building or bridge-building? Evidence from new CEOs' internal capital allocation decisions. Review of Financial Studies, 22(12), 4919-4948.

Table 1
Descriptive statistics of CEO SHN by industry and firm type (HHI measures)

This table reports the descriptive statistics of the Herfindahl index (HHI) of CEO social networks. HHI-demographic measures how focused CEO social networks are in terms of their demographical attributes. HHI-intellectual measures how focused CEO social networks are in terms of their education achievement. HHI-profession measures how focused CEO social networks are in terms of their working experience. HHI-international measures how focused CEO social networks are in terms of their international exposure. Lastly, HHI-overall is average of all. Note that HHI are the inverse measures of heterogeneity (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. We report descriptive statistics of HHI measures for the purpose of easy interpretation, but in the regression analysis we use Het, which is 1 divided by HHI. We report HHI measures by firms' industry, high tech type, whether the firm has R&D activities, and whether the firm is multinational. High tech is a indictor, which is equal to 1 if firms belong to pharmaceutical industry and high tech industry as classified by SIC2=48, SIC2=73, SIC3==283. The indicator of R&D is defined as 1 if a firm has non-zero R&D expenditure and 0 otherwise. 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: Variable Definitions

Variable	Definition	Data source
	CEO social network characteristics	
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
Centrality	A measure of network position of the CEO, calculated by the degree centrality of CEO's professional network	BoardEx
	Firm characteristics	
Tobin's Q	Total assets (#6) + market value of equity (#25*#199) - book value of common equity (#60)- deferred taxes (#74) / Total assets (#6).	Compustat
Log(assets)	Log of total assets (#6)	Compustat
Leverage	Long term debt (#9) + debt in current liabilities (#) / total assets (#6)	Compustat
Capextoasset	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 sales (#12)	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
High tech	Indicator equal to 1 if SIC2 is 48 or 73, or SIC3 is 283	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
	CEO personal characteristics	
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
Minority missing	Indicator equal to 1 if the information on CEO nationality is missing	BoardEx
Tenure	Indicator equal to 1 if a CEO has a doctor degree, 0 otherwise	BoardEx

Chairman	Indicator equal to 1 if a CEO is graduate from a Ivy League school, 0 otherwise	BoardEx
Outside hire	Indicator equal to 1 if the new CEO is hired from outside the firm, 0 otherwise	BoardEx
	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
	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 to1 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: Summary Statistics

This table 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 1.

Variable	N	Mean	S.D	P5	Median	P95
Panel A. CEO social network measures						
Het-demographic	10272	1.112	0.153	1.000	1.000	2.000
Het-intellectual	11336	1.394	0.292	1.000	1.421	2.419
Het-profession	10919	1.706	0.413	1.000	1.619	2.978
Het-international	10248	1.505	0.138	1.000	1.456	2.300
Het-overall	8846	1.467	0.162	1.100	1.468	2.130
Network size	12366	2.061	1.082	0.693	1.946	5.875
Centrality	12366	0.0004	0.0003	0.0000	0.0003	0.0049
Panel B. Firm characteristics						
Tobin's Q	12366	1.961	1.170	0.604	1.596	10.720
Total assets (million)	12366	2665.4	5206.8	6.1	741.4	40877.0
Leverage	12366	0.197	0.185	0.000	0.171	0.985
Capextoasset	12366	0.046	0.043	0.001	0.032	0.305
Cashflow	12366	0.134	0.153	-0.996	0.154	0.518
R&D intensity	12366	0.285	3.291	0.000	0.012	271.385
Board female ratio	12366	0.091	0.095	0.000	0.100	0.800
Board minority ratio	12366	0.062	0.135	0.000	0.000	0.800
High tech	6211	0.277	0.448	0.000	0.000	1.000
Patent	6211	26.256	105.829	0.000	0.000	124.000
Foreign sales growth	8471	0.112	1.381	-1.764	0.081	2.212
Total capital expenditure ratio	14046	0.147	0.140	0.004	0.105	0.979
Acquisition expenditure ratio	8752	0.094	0.216	0.000	0.029	8.338
Panel C. CEO characteristics						
Age	9079	55.760	7.266	31.000	56.000	91.000
Female CEO	9079	0.031	0.173	0.000	0.000	1.000
Minority	12366	0.006	0.074	0.000	0.000	0.000
Minority missing	12366	0.322	0.467	0.000	0.000	1.000
Chairman	12366	0.548	0.498	0.000	1.000	1.000
Tenure	12366	10.497	6.819	0.000	10.400	22.500
Outside hire	114	0.596	0.493	0.000	1.000	1.000
Panel D. CEO announcement returns						
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
Panel E. M&A sample						
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
Relative size	1370	0.000	0.000	0.000	0.000	0.003
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 4: Correlation Matrix

This table reports correlation matrix among main variables.

		1	2	3	4	5	6	7
1	Tobin's Q	1						
2	Het-demographic	0.0116	1					
3	Het-intellectual	0.0076	0.2065*	1				
4	Het-profession	0.0408*	0.1661*	0.3812*	1			
5	Het-international	0.0507*	0.3920*	0.3833*	0.1387*	1		
6	Het-overall	0.0621*	0.4745*	0.7176*	0.7862*	0.5241*	1	
7	Network size	-0.0096	0.4547*	0.5175*	0.4237*	0.3500*	0.4912*	1
8	Centrality	0.0043	0.1242*	0.3603*	0.2175*	0.1211*	0.2562*	0.4421*
9	Total assets	-0.0537*	0.1532*	0.2866*	0.1092*	0.1387*	0.2110*	0.3116*
10	Leverage	-0.2119*	0.0092	0.0747*	0.0186*	0.0064	0.0117	0.0919*
11	Capextoasset	0.0149*	-0.0321*	-0.0375*	-0.0168*	-0.0197*	-0.0315*	-0.0063
12	Cashflow	-0.0596*	0.0054	0.0280*	-0.0031	0.0328*	0.0037	0.0981*
13	R&D intensity	0.0864*	0.0409*	0.0032	0.0024	0.0097	0.0350*	-0.0136
14	Board female ratio	0.0098	0.1189*	0.1527*	0.0362*	0.1052*	0.1111*	0.1848*
15	Board minority ratio	0.0167*	0.1287*	0.1019*	0.0647*	0.0496*	0.1081*	0.1003*
16	CEO age	-0.1140*	-0.0317*	0.0525*	-0.0106	0.0005	0.0045	0.0733*
17	CEO female	0.0172*	0.0549*	0.0534*	0.0147	0.0357*	0.0598*	0.0504*
18	Minority	0.0353*	0.0228*	0.0041	0.0370*	0.0199*	0.0452*	-0.0087
19	Minority missing	-0.0206*	-0.0227*	-0.0692*	-0.0333*	-0.0403*	-0.0286*	-0.0837*
20	Chairman	-0.0530*	0.0443*	0.1071*	0.0250*	0.0501*	0.0523*	0.1520*
21	Tenure	0.1142*	0.0232*	-0.0596*	-0.0035	-0.01	-0.0179*	-0.0917*

		8	9	10	11	12	13	14
8	Centrality	1						
9	Total assets	0.4499*	1					
10	Leverage	0.1227*	0.1549*	1				
11	Capextoasset	0.0159*	0.0267*	0.0518*	1			
12	Cashflow	0.1320*	0.1417*	0.0819*	0.2954*	1		
13	R&D intensity	-0.0262*	-0.0354*	-0.0253*	-0.0276*	-0.2451*	1	
14	Board female ratio	0.2094*	0.2394*	0.0650*	0.0344*	0.1206*	-0.0044	1
15	Board minority ratio	0.1274*	0.2221*	0.0167*	-0.0205*	0.0129	0.0064	0.0478*
16	CEO age	0.1152*	0.0714*	0.0910*	0.0168*	0.0926*	-0.0213*	-0.0067
17	CEO female	0.0633*	0.0252*	-0.0193*	0.0146	-0.0072	-0.0026	0.2878*
18	Minority	-0.0111	0.0103	-0.0272*	-0.0039	0.0221*	-0.0041	-0.0071
19	Minority missing	-0.1314*	-0.1562*	-0.0460*	-0.0484*	-0.0897*	0.0193*	-0.0873*
20	Chairman	0.1914*	0.1619*	0.1081*	0.0166*	0.1516*	-0.0319*	0.1011*
21	Tenure	-0.1355*	-0.0891*	-0.1038*	-0.0209*	-0.0986*	0.0195*	-0.0052

		15	16	17	18	19	20	21

15	Board minority ratio	1						
16	CEO age	0.0055	1					
17	CEO female	-0.0086	-0.0567*	1				
18	Minority	0.1897*	-0.0062	0.0442*	1			
19	Minority missing	-0.0496*	-0.0664*	-0.0154*	-0.0516*	1		
20	Chairman	0.0302*	0.2799*	-0.0485*	0.0135	-0.1148*	1	
21	Tenure	-0.0156*	-0.9747*	0.0559*	0.0023	0.0649*	-0.2793*	1

Table 5: CEO SNH and Firm Value —OLS Regressions

This table reports the OLS regression results relating CEO social network heterogeneity and firm value. The dependent variable is Tobin's Q. Independent variables of main interest are five measures of CEO social network heterogeneity, including demographic, intellectual, profession, international, and overall heterogeneity. Control variables include CEO social network size and centrality, key firm financial variables, board diversity, and CEO characteristics. Firm financial variables are measured at the previous year before the testing year. Detailed variable definitions are available in Table 2. 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) TobinQ	(2) TobinQ	(3) TobinQ	(4) TobinQ	(5) TobinQ
Network measures					
Het_demographic	0.023				
	(0.184)				
Het_intellectual		0.149**			
		(2.187)			
Het_profession			0.128***		
			(2.880)		
Het_international				0.467***	
				(3.364)	
Het_overall					0.532***
					(3.942)
Centrality	337.041***	292.105***	307.231***	344.239***	297.094***
	(4.512)	(3.910)	(4.112)	(4.634)	(3.851)
Network size	0.021	0.024	0.003	0.001	-0.005
	(0.983)	(1.146)	(0.163)	(0.024)	(-0.190)
Firm and CEO characteristics					
Log(assets)	-0.140***	-0.140***	-0.132***	-0.141***	-0.146***
	(-8.814)	(-9.155)	(-8.262)	(-8.847)	(-8.624)
Leverage	-1.029***	-0.988***	-1.037***	-1.025***	-0.939***
	(-8.721)	(-9.162)	(-9.211)	(-8.711)	(-7.889)
Capextoasset	1.579***	1.529***	1.877***	1.611***	1.632***
	(3.206)	(3.482)	(3.890)	(3.272)	(3.099)
Cashflow	0.524**	0.260	0.176	0.518**	0.588**
	(2.404)	(1.348)	(0.844)	(2.378)	(2.530)
R&D intensity	0.051***	0.020**	0.023**	0.051***	0.049***
	(3.648)	(1.973)	(2.017)	(3.653)	(3.207)
Board female ratio	0.638***	0.725***	0.686***	0.614***	0.630***
	(2.826)	(3.314)	(2.996)	(2.717)	(2.607)
Board minority ratio	0.238*	0.304**	0.216	0.228	0.276*
	(1.656)	(2.162)	(1.497)	(1.590)	(1.813)
Tenure	0.006	-0.002	-0.000	0.006	-0.003
	(0.448)	(-0.193)	(-0.007)	(0.469)	(-0.260)
Chairman	-0.031	-0.059*	-0.041	-0.030	-0.046
	(-0.799)	(-1.677)	(-1.117)	(-0.785)	(-1.162)

CEO Female	-0.143	-0.133	-0.120	-0.140	-0.136
	(-1.005)	(-0.935)	(-0.863)	(-0.978)	(-0.843)
CEO_age	-0.008	-0.015	-0.013	-0.008	-0.017
	(-0.684)	(-1.396)	(-1.031)	(-0.634)	(-1.401)
Minority	0.450	0.371	0.114	0.434	0.136
	(1.187)	(1.003)	(0.412)	(1.137)	(0.442)
Minority_missing	-0.108**	-0.109***	-0.104**	-0.105**	-0.095**
	(-2.539)	(-2.755)	(-2.502)	(-2.463)	(-2.100)
Constant	3.783***	4.010***	3.850***	3.124***	3.736***
	(4.362)	(5.233)	(4.270)	(3.484)	(4.183)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Observations	10,272	11,336	10,919	10,248	8,846
Adjusted R-squared	0.136	0.135	0.140	0.139	0.140

Table 6: **Effects of CEO SNH on Firm Value: Economic Interpretations**

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. We also include the coefficient of centrality to compare with the heterogeneity measures. The coefficient of centrality is taken from the regression on overall heterogeneity (Column 5 of Table 5). 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	0.023	3.476	[10% * Mean (Het-demographic) * β (Het-demographic) / Mean (Q)]*Assets = (0.1*1.112*0.023/1.961)*2665.4=3.476
Het-intellectual	0.149**	28.231	[10% * Mean (Het-intellectual) * β (Het-intellectual) / Mean (Q)]*Assets = (0.1*1.394*0.149/1.961)*2665.4=28.231
Het-profession	0.128***	29.681	[10% * Mean (Het-profession) * β (Het-professional) / Mean (Q)]*Assets = (0.1*1.706*0.128/1.961)*2665.4=29.681
Het-international	0.467***	95.53	[10% * Mean (Het-international) * β (Het-international) / Mean (Q)]*Assets = (0.1*1.505*0.467/1.961)*2665.4=95.53
Het-overall	0.532***	106.078	[10% * Mean (Het-overall) * β (Het-overall) / Mean (Q)]*Assets = (0.1*1.467* 0.532/1.961)*2665.4=106.078
Centrality	297.094***	16.152	[10% * Mean (Centrality) * β (Centrality) / Mean (Q)]*Assets = (0.1*0.0004*297.094/1.961)*2665.4=16.152

Table 7: CEO SNH and Firm Value: IV Approach

This table reports the results of instrumental variable regressions of CEO SNH on firm value (equation (3) and (4) as given in the text). Instrumental variable is percentage of individuals who have network ties with the testing CEO and have either died or retired during the testing year. Column (1) and (2) report results of the estimations relating the effect of CEO demographic heterogeneity on firm value. 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 CEO social network size and centrality, key firm financial variables, board diversity, and CEO characteristics. Firm financial variables are measured at the previous year before the testing year. Detailed variable definitions are available in Table 2. Year dummies and industry indicators at 1-digit SIC code are included. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Het - demo	TobinQ	Het - intell	TobinQ	Het - prof	TobinQ	Het - inter	TobinQ	Het - overall	TobinQ
Instrumental variable										
Num_retire_death	-0.012**		-0.094***		-0.174***		-0.016**		-0.069***	
	(-1.986)		(-7.625)		(-10.208)		(-2.468)		(-9.422)	
Network measuares										
Het_demographic		10.767*								
		(1.650)								
Het_intellectual				0.968*						
				(1.827)						
Het_profession						0.590**				
						(2.139)				
Het_international								7.744*		
								(1.912)		
Het_overall										1.298*
										(1.736)
Centrality	-36.441***	731.509***	123.075***	193.002**	68.442***	277.444***	-20.070***	492.951***	35.727***	270.679***
	(-7.556)	(2.860)	(11.710)	(2.341)	(5.062)	(4.865)	(-4.537)	(4.549)	(6.882)	(4.377)
Network size	0.068***	-0.703	0.115***	-0.066	0.167***	-0.069	0.047***	-0.336*	0.075***	-0.059
	(52.610)	(-1.599)	(36.084)	(-1.118)	(42.423)	(-1.543)	(39.309)	(-1.792)	(38.966)	(-1.088)

Firm and CEO characteristics										
Log(assets)	0.001	-0.152***	0.028***	-0.163***	0.015***	-0.139***	0.003**	-0.160***	0.011***	-0.155***
	(0.995)	(-8.878)	(14.763)	(-9.276)	(5.193)	(-13.702)	(2.451)	(-9.728)	(9.038)	(-11.691)
Leverage	-0.014*	-0.883***	-0.028**	-0.966***	-0.047**	-1.017***	-0.019**	-0.888***	-0.036***	-0.912***
	(-1.762)	(-6.279)	(-2.091)	(-14.282)	(-2.292)	(-14.750)	(-2.498)	(-7.697)	(-4.242)	(-11.650)
Capextoasset	-0.037	1.982***	-0.095*	1.606***	0.045	1.854***	-0.058*	2.033***	0.004	1.628***
	(-1.216)	(3.907)	(-1.654)	(5.633)	(0.498)	(6.059)	(-1.822)	(4.614)	(0.107)	(4.966)
Cashflow	-0.012	0.653***	-0.152***	0.386**	-0.148***	0.246*	0.001	0.510***	-0.071***	0.643***
	(-1.055)	(3.267)	(-8.989)	(2.491)	(-5.441)	(1.710)	(0.146)	(3.235)	(-5.907)	(3.992)
R&D intensity	0.003**	0.024	0.000	0.020**	-0.000	0.023**	0.001*	0.043***	0.002**	0.047***
	(2.044)	(1.037)	(0.334)	(1.986)	(-0.146)	(2.096)	(1.695)	(3.509)	(2.572)	(3.404)
Board female ratio	0.051***	0.087	0.024	0.703***	-0.158***	0.757***	0.053***	0.222	-0.008	0.634***
	(2.992)	(0.217)	(0.874)	(5.206)	(-3.832)	(5.300)	(3.378)	(0.791)	(-0.445)	(4.372)
Board minority ratio	0.101***	-0.843	0.020	0.287***	-0.016	0.223***	0.011	0.152	0.032***	0.251***
	(8.555)	(-1.256)	(1.192)	(3.530)	(-0.560)	(2.753)	(1.101)	(1.358)	(2.893)	(2.853)
Tenure	0.001	-0.007	0.004**	-0.006	-0.006***	0.003	-0.001	0.011	-0.002***	-0.002
	(1.455)	(-0.521)	(2.536)	(-0.783)	(-3.413)	(0.414)	(-0.847)	(1.212)	(-2.591)	(-0.268)
Chairman	0.001	-0.038	0.008	-0.065***	-0.026***	-0.030	-0.001	-0.022	-0.004	-0.043*
	(0.221)	(-0.953)	(1.527)	(-2.838)	(-3.328)	(-1.257)	(-0.408)	(-0.693)	(-1.252)	(-1.730)
CEO Female	0.019**	-0.351*	0.037**	-0.164*	0.007	-0.124	0.006	-0.185*	0.024***	-0.155*
	(2.174)	(-1.956)	(2.374)	(-1.956)	(0.312)	(-1.568)	(0.714)	(-1.735)	(2.735)	(-1.706)
CEO_age	-0.000	-0.006	0.003**	-0.017***	-0.007***	-0.010*	-0.001	-0.001	-0.002***	-0.015**
	(-0.287)	(-0.653)	(2.457)	(-2.772)	(-4.276)	(-1.692)	(-1.372)	(-0.091)	(-3.571)	(-2.257)
Minority	0.023	0.206	0.033	0.343	0.203***	0.020	0.037**	0.163	0.085***	0.071
	(1.059)	(0.545)	(1.169)	(1.530)	(3.333)	(0.119)	(2.179)	(0.519)	(3.513)	(0.375)
Minority_missing	-0.006*	-0.045	0.006	-0.114***	0.011	-0.109***	-0.006**	-0.060	0.005*	-0.099***
	(-1.928)	(-0.796)	(1.273)	(-4.932)	(1.370)	(-4.590)	(-2.126)	(-1.435)	(1.651)	(-3.796)
Constant	1.005***	-7.034	0.605***	3.511***	1.526***	3.137***	1.445***	-7.408	1.325***	2.714**
	(17.214)	(-1.064)	(6.265)	(6.605)	(12.788)	(5.363)	(28.180)	(-1.259)	(23.384)	(2.486)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-stat from 1st stage	136.91		148.14		90.49		69.06		95.95	
Observations	10,272	10,272	11,336	11,336	10,919	10,919	10,248	10,248	8,846	8,846
Adjusted R-squared	0.232	-1.402	0.319	0.105	0.208	0.119	0.129	-0.516	0.281	0.132

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 the same or 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, and R&D intensity. We also require the new CEOs between two groups are similar in terms of age, tenure, chairman position, 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's network heterogeneity is greater than the old CEO	Group 2: New CEO's network heterogeneity is equal or less than the old CEO	Differences	P-value
Firm characteristics				
Log(total assets)	7.392	7.558	-0.166	-0.522
Book leverage	0.167	0.184	-0.018	-0.565
Capex to assets	0.036	0.043	-0.007	-0.261
Cash flow	0.171	0.176	-0.003	-0.762
R&D intensity	0.068	0.055	0.013	0.415
CEO characteristics				
CEO age	52.145	53.236	-1.091	-0.398
Tenure	13.524	12.433	1.091	0.399
Chairman	0.400	0.364	0.036	0.698
Hiring from outside	0.582	0.582	0.000	1.000
Panel B: Comparison of cumulative announcement return				
CAR (-1,1)	0.014	-0.005	0.019*	0.093
CAR (-2,2)	0.018*	-0.011	0.029**	0.034
CAR (-5,5)	0.031**	0.0005	0.031*	0.092

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 IV estimation using percentage of diseased or retired social ties as instrument (results for the first stage estimation is available upon request). Column (3) and (4) examine intellectual heterogeneity. We obtain Het-intellectual-hat from IV estimation using the same instrumental variable. Column (5) and (6) examine professional heterogeneity. We obtain Het-professional-hat from IV estimation using the same instrumental variable. Firm characteristics include firm size, leverage, cash flow, R&D intensity, capital expenditure, indicator of high tech, indicator of multinational firms, and board diversity (female ratio and minority ratio). We also control for network size and network centrality to tease out their potential effects on innovation and firm value. Detailed variable definitions are available in Table 2. 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)	(2)	(3)	(4)	(5)	(6)
	Log (patent)	Tobin's Q	Log (patent)	Tobin's Q	Log (patent)	Tobin's Q
Het-overall-hat	5.172***	1.778*				
	(5.052)	(1.702)				
Het-intellectual-hat			3.988***	1.445*		
			(5.011)	(1.699)		
Het-profession-hat					1.283***	0.718*
					(2.821)	(1.727)
Lag (patent)		0.022**		0.023**		0.025**
		(2.012)		(2.157)		(2.342)
Controls						
Networksize	-0.281***	-0.107	-0.330***	-0.131	-0.124*	-0.097
	(-3.817)	(-1.437)	(-3.943)	(-1.483)	(-1.670)	(-1.436)
Centrality	396.542***	132.613**	64.478	9.513	461.202***	141.167**
	(5.549)	(2.137)	(0.577)	(0.086)	(6.580)	(2.351)
Log(assets)	0.411***	-0.134***	0.368***	-0.153***	0.474***	-0.119***
	(18.740)	(-6.041)	(12.615)	(-4.879)	(29.446)	(-7.827)
Leverage	-0.595***	-0.515***	-0.668***	-0.542***	-0.730***	-0.572***
	(-5.489)	(-5.389)	(-6.298)	(-5.935)	(-6.906)	(-6.338)
Capextoasset	-0.874	2.690***	-0.305	2.990***	-0.973*	2.683***
	(-1.488)	(5.688)	(-0.501)	(5.742)	(-1.652)	(5.681)
Cashflow	0.498***	1.505***	0.679***	1.578***	0.543***	1.540***
	(3.500)	(12.766)	(4.631)	(12.733)	(3.797)	(12.945)
R&D intensity	2.917***	3.801***	3.129***	3.879***	3.501***	3.965***
	(10.252)	(13.466)	(11.884)	(15.419)	(14.045)	(17.756)
High tech	-0.564***	0.510***	-0.500***	0.527***	-0.401***	0.546***

	(-6.198)	(6.307)	(-5.891)	(6.971)	(-4.861)	(7.783)
Board female ratio	0.084	0.969***	0.163	1.003***	0.320	1.101***
	(0.412)	(5.560)	(0.805)	(5.763)	(1.513)	(5.938)
Board minority ratio	0.440***	-0.174	0.504***	-0.150	0.635***	-0.102
	(3.457)	(-1.557)	(4.067)	(-1.398)	(5.234)	(-0.980)
Constant	-6.800***	0.000	-4.324***	0.000	0.000	1.544**
	(-5.384)	(.)	(-5.243)	(.)	(.)	(2.471)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,160	6,160	6,160	6,160	6,160	6,160
Adjusted R-squared	0.395	0.214	0.395	0.214	0.393	0.214

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 IV estimation using percentage of diseased or retired social ties as instrument (results for the first stage estimation is available upon request). Column (3) and (4) examine demographic heterogeneity. We obtain Het-demographic-hat from IV estimation using the same instrumental variable. Column (5) and (6) examine international heterogeneity. We obtain Het-international-hat from IV estimation using the same instrumental variable. Firm characteristics include firm size, leverage, cash flow, R&D intensity, capital expenditure, indicator of high tech, indicator of multinational firms, and board diversity (female ratio and minority ratio). We also control for network size and network centrality to tease out their potential effects on foreign sale and firm value. Detailed variable definitions are available in Table 2. 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 intellectual heterogeneity, foreign sale growth, and Tobin's Q		Simultaneous equations on professional heterogeneity, foreign sale growth, and Tobin's Q	
VARIABLES	(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	2.013*	1.195				
	(1.826)	(1.242)				
Het-intellectual-hat			8.718*	5.176		
			(1.826)	(1.242)		
Het-profession-hat					4.544*	2.698
					(1.826)	(1.242)
Lag(Foreign sale growth)		0.082***		0.082***		0.082***
		(6.662)		(6.662)		(6.662)
Controls						
Networksize	-0.115*	-0.045	-0.531*	-0.292	-0.195*	-0.093
	(-1.723)	(-0.780)	(-1.810)	(-1.142)	(-1.774)	(-0.969)
Centrality	-107.589*	126.092**	189.802	302.666**	53.054	221.471***
	(-1.778)	(2.387)	(1.362)	(2.488)	(0.710)	(3.395)
Log(assets)	-0.054**	-0.030	-0.062**	-0.035	-0.054**	-0.030
	(-2.512)	(-1.600)	(-2.456)	(-1.579)	(-2.512)	(-1.601)
Leverage	-0.091	-0.882***	-0.047	-0.856***	-0.073	-0.871***
	(-0.941)	(-10.461)	(-0.480)	(-10.022)	(-0.756)	(-10.356)
Capextoasset	-0.045	-2.262***	-0.049	-2.264***	0.087	-2.184***
	(-0.097)	(-5.606)	(-0.105)	(-5.613)	(0.185)	(-5.296)
Cashflow	-0.871***	5.469***	-1.329***	5.197***	-1.163***	5.296***
	(-4.828)	(34.648)	(-4.531)	(20.261)	(-5.096)	(26.534)
R&D intensity	-1.175*	4.920***	-1.900*	4.490***	-0.862*	5.106***

	(-1.837)	(8.811)	(-1.881)	(5.094)	(-1.750)	(11.878)
High tech	0.001	0.477***	0.287*	0.647***	0.002	0.478***
	(0.016)	(7.175)	(1.888)	(4.873)	(0.031)	(7.203)
Board female ratio	-0.353**	0.540***	-0.830***	0.256	-0.629***	0.376**
	(-2.097)	(3.679)	(-2.814)	(0.994)	(-2.946)	(2.016)
Board minority ratio	0.103	0.201**	-0.886	-0.386	0.092	0.195**
	(0.963)	(2.149)	(-1.497)	(-0.747)	(0.838)	(2.030)
Constant	-1.185	0.287	-7.116	-3.235	-4.678	-1.787
	(-0.975)	(0.270)	(-1.602)	(-0.835)	(-1.505)	(-0.659)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies (SIC1)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,037	5,037	5,037	5,037	5,037	5,037
Adjusted R-squared	0.037	0.332	0.037	0.332	0.037	0.332

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.

	(1)	(2)	(3)	(4)
VARIABLES	total capital expenditure ratio	total capital expenditure ratio	acquisition expenditure ratio	acquisition expenditure ratio
Het-overall-hat		1.088	`	2.231
		(1.410)		(1.534)
Het-overall-hat *Tobin's Q (t-1)		0.299***		1.043***
		(2.739)		(3.529)
Tobin's Q (t-1)	0.021***	0.022***	0.026***	0.042***
	(11.368)	(8.769)	(3.693)	(4.731)
Inverse logasset (t-1)	1.884***	1.863***	5.490**	2.481
	(6.733)	(4.022)	(2.083)	(0.861)
Leverage (t-1)	-0.166***	-0.188***	-0.385***	-0.438***
	(-10.258)	(-8.640)	(-9.178)	(-7.967)
Cash flow (t-1)	0.017	0.001	0.274***	0.174*
	(0.873)	(0.031)	(3.529)	(1.928)
Constant	0.137***	0.131***	0.064**	0.089***
	(15.976)	(9.575)	(2.243)	(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.

	(1)	(2)	(3)	(4)
VARIABLES	CAR[-2,2]	CAR[-2,2]	BHAR- 3year	BHAR- 3year
Het-overall-hat	0.298**	0.266**	4.461*	5.205*
	(1.960)	(1.964)	(1.735)	(1.766)
Het-overall-hat* Diversifying M&A		0.009**		1.963**
		(2.401)		(2.197)
Deal characteristics				
All stock payment	-0.020**	-0.019**	0.003	0.008
	(-2.041)	(-2.103)	(0.026)	(0.071)
Mix cash and stock payment	0.003	0.003	-0.023	-0.026
	(0.445)	(0.521)	(-0.362)	(-0.383)
Private target	-0.006	-0.004	-0.062	-0.074
	(-0.986)	(-0.743)	(-0.979)	(-1.045)
Public target	-0.030***	-0.028***	-0.215**	-0.238**
	(-3.432)	(-3.657)	(-2.152)	(-2.122)
Tender offer	0.019	0.018*	0.142	0.169
	(1.533)	(1.768)	(1.145)	(1.236)
Relative size	-0.476	-2.586	331.354**	345.398**
	(-0.036)	(-0.219)	(2.402)	(2.266)
Diversifying M&A		-0.018***		-3.021**
		(-3.040)		(-2.266)
Acquirer characteristics				
Log (assets)	-0.013**	-0.012**	-0.063	-0.096
	(-2.362)	(-2.373)	(-1.276)	(-1.516)
Leverage	0.063***	0.062***	0.506**	0.586**
	(3.013)	(3.489)	(2.115)	(2.134)
Market to book	-0.003	-0.003	-0.048	-0.062*
	(-1.011)	(-0.939)	(-1.466)	(-1.645)
Run-up	0.018	0.018	0.007	-0.031
	(1.008)	(1.070)	(0.041)	(-0.173)
Sale growth	-0.008	-0.009	-0.100	-0.064
	(-0.850)	(-1.029)	(-1.280)	(-0.739)
ROA	0.104***	0.092**	0.790	0.992
	(2.591)	(2.536)	(1.509)	(1.626)
Board female ratio	0.041	0.042	-0.739**	-0.788*
	(1.245)	(1.381)	(-2.059)	(-1.935)
Board minority ratio	0.003	0.007	-0.123	-0.217

	(0.147)	(0.342)	(-0.467)	(-0.723)
Constant	-0.393**	-0.353**	-5.720*	-6.299*
	(-2.030)	(-2.194)	(-1.920)	(-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