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Differences make a difference: Diversity in social learning and value creation

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ABSTRACT

Prior research has demonstrated that CEOs learn privileged information from their social connections. Going beyond the importance of the number of social ties in a CEO's social network, this paper studies the value generated from a diverse social environment. We construct an index of social-network heterogeneity (SNH) that captures the extent to which CEOs are connected to people of different demographic attributes and skill sets. We find that higher CEO SNH leads to greater firm value through the channels of better corporate innovation and diversified M&As. Overall, the evidence suggests that CEOs' exposure to human diversity enhances social learning and creates greater growth opportunities for firms.

1. Introduction

Social learning theory suggests that human behavior is a learning process that often takes place in a social context through observation and imitation (Bandura, 1977; Ellison and Fudenberg, 1993, 1995). Some recent financial studies have applied social context to the case of corporate executives, finding that whom they know significantly affects managers' behavior and corporate performance (Larcker et al., 2013; Kedia et al., 2015; Fracassi, 2016). Following this theme in the literature, we focus on a different, but related, aspect of a CEO's social environment—human diversity. Specifically, we construct an index of social-network heterogeneity (SNH) that captures the extent to which CEOs are connected to people of different demographic attributes and skill sets. Our study attempts to understand (1) whether shareholders gain higher firm value when the CEO is connected to a heterogeneous group of people who themselves have diverse attributes and backgrounds, and (2) in what ways does human diversity in CEO social interactions affect firm value?

Understanding the nature and importance of human diversity in CEOs' social contexts is worthwhile for several reasons. First, diversity provides access to different types of knowledge and opportunities (Williams and O'Reilly, 1998; Eagle et al., 2010; Gompers et al., 2016). As Granovetter's (1973) famous principle of "the strength of weak ties" implies, members of the same social circle form strong ties, but cannot provide a variety of information because they are alike. By contrast, although persons from

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different social backgrounds form weak ties, they play an important role in promoting information flow concerning external opportunities. Burt (1992, 2005) also argues that connections that cut across boundaries also bring diverse perspectives and exposures, which are important for conceiving novel approaches and seeking alternative solutions. Consistent with this argument, studies in organizational psychology emphasize the value of diversity in creating new knowledge and find that genetic variation is associated with different modes of cognitive functioning, approaches, and ideologies, which are crucial to the process of innovation and the accumulation of universally applicable human capital (Mumford and Gustafson, 1988; Galunic and Rodan, 1998; Rodan and Galunic, 2004). Under the diffusion mechanism of social networks, a high degree of diversity of culture, gender, and race can effectively weaken social barriers so that new knowledge can be created more efficiently (Blau, 1960, 1977; Coleman et al., 1957; Jackson, 2010). By contrast, homophily in a social environment may foster "groupthink" and cause less than optimal economic outcomes (Asch, 1951; Janis, 1982; Gompers et al., 2016).

Secondly, the United States is a melting pot of different races and cultures. Dramatic demographic changes resulting from higher immigrant fertility rates and higher labor-based immigration rates have made the modern workforce far more diverse than in the past (Shrestha, 2011).[1] At the same time, the business environment has also become more global and hence more ethnically and culturally diverse (Hunt et al., 2015; Masulis et al., 2012). Firms that engage with consumers around the world must cope with various cultural differences and needs. Although people naturally tend to affiliate with similar others (McPherson et al., 2001), attitudes toward human diversity are changing rapidly both in social life and in the workplace, and being knowledgeable about different cultural interests and institutional differences is increasingly seen as critical to success in the modern global business environment. Considering these social and economic trends, we believe that it is necessary to have a better understanding of the implications for firm value of executive social network diversity.

Notwithstanding all the benefits of social network diversity, we cannot ignore potential for dark side effects. For instance, diversity might hinder cooperation and trust between individuals, leading to high turnover rates for group members (Wagner et al., 1984; Pelled, 1996; Alesina and La Ferrara, 2000). Conflicts driven by diversity among groups may also negatively affect firm performance (Van Peteghem et al., 2017). Moreover, CEOs with diverse social ties may be distracted from acting in shareholders' best interests because they are too concerned with social interactions. Whether beneficial or detrimental effects of social diversity eventually dominate remains an open question.

Two key challenges exist to demonstrating that the diversity of a CEO's social interactions affects firm performance. The first challenge is to construct a measure that can capture different aspects of the characteristics of network members' heterogeneity. The generally accepted definition of human diversity refers to differences between individuals in any attribute that could lead to an individual's perception that another person is different from him/herself (Williams and O'Reilly, 1998). We construct an index of CEO social-network heterogeneity by defining the network boundary as a focal CEO's connections with top executives and members of boards of directors of other companies. As shown in prior studies, these connections are formed through former employment connections, past schools attended, and affiliations with charitable or volunteer organizations (Fracassi, 2016; Akbas et al., 2016). For each member of a focal CEO's network, we collect six dimensions of personal attributes: gender, ethnicity, academic degree, academic major, professional expertise, and international exposure. Finally, to overcome the hurdle that diversity measures are multidimensional and each aspect can only partially capture overall diversity, we use common factor analysis to create an aggregated measure from the six individual components. This aggregated index is further regressed on firm size, CEO gender and ethnicity, and year and industry dummies to remove confounding effects. The residuals of the regressions are used as our final measure and are labeled as social-network heterogeneity (SNH).

The second challenge concerns endogeneity. The performance effect can derive from both network diversity and network size. To tease out the network-size effect, we control for network size and network centrality throughout all tests. In addition, we use network-size fixed effects, firm fixed effects, and CEO fixed effects to rule out other potential omitted variables. We find that all six dimensions of network heterogeneity are positively and significantly associated with firm value. The aggregated measure, SNH, also has economically and statistically significant impacts on firm value. Our baseline regression estimate links a one-standard-deviation increase in SNH to a 0.64% increase in Tobin's Q, which is equivalent to a $30 million increase in market capitalization for the median-sized firm in our sample. Given that median CEO total compensation for S&P1500 firms was about $5 million during the sample period (e.g., Albuquerque et al., 2013), hiring a diversely networked CEO seems a worthwhile decision, since it generates approximately a six-fold firm market value increase relative to his/her compensation.

Another issue related to endogeneity is that CEO networks are not static, but evolve dynamically. Hence, it is plausible that better performing firms allow CEOs to expand their networks to a larger and more diverse group of people. To address this reverse-causality concern, we use two instrumental variables that capture the genetic diversity of CEOs' countries of origin and the demographic diversity of their undergraduate institutions. These two variables reflect the deep-rooted social, cultural, psychological, physiological, and institutional characteristics that shape CEOs' mindsets toward diversity and, hence, they are good predictors for CEO SNH, but are not influenced by firm characteristics. Using the 2SLS IV approach, we can identify a clean effect of CEO SNH on firm value, and the results confirm its value-enhancing effect. Finally, through a difference-in-differences analysis

[1] A similar trend has also occurred at higher levels of the corporate ladder. For example, there has been a decreasing gender gap and an increasing percentage of minorities in top management positions and in the boardroom (Wolfers, 2006; Anderson et al., 2011).

using incidences of death/retirement of network members whose disappearance from the network exogenously changes its degree of heterogeneity (Fracassi and Tate, 2012), we alleviate concerns about the endogenous CEO-firm pairing bias. All findings collectively suggest a positive and significant impact of CEO SNH on firm value.

To provide further evidence on the value creation of SNH, we perform an event-study analysis to examine whether the market is more (less) favorable toward a new CEO who possesses more (less) SNH than the departing CEO. Using a propensity-score matching procedure to form a control group that shares similar firm and CEO characteristics, we find that firms with new CEOs who possess greater SNH than their predecessors experience a positive and significant announcement cumulative abnormal return (CAR). By contrast, firms in which new CEOs possess less SNH experience significantly lower announcement CAR.

A final set of results explores the mechanisms through which CEO SNH enhances firm value. If accessibility to diverse knowledge derived from heterogeneity of network ties is the driving force behind better CEO performance, as we have argued, then we would expect innovation to be a significant channel. We find strong evidence that CEOs with more diverse connections make more and better-cited innovations, and engage more in exploratory than in exploitative strategies. Furthermore, using 2SLS regressions, the level of innovation predicted by SNH is associated with higher firm value. The results support our conjecture that CEO SNH has a positive impact on a firm's innovative capability and that, by acting on such innovation, it adds value to the firm.

We also expect that cross-cultural knowledge and foreign-market information obtained from diverse social networks help CEOs make better decisions on diversifying and engaging in cross-border M&As. To test this expectation, we examine market reactions around the announcement of M&A deals. We find that the level of CEO SNH of the acquirer CEO is positively associated with announcement CARs when they take over a target in a different industry or in a different country. These results support the argument that diverse social connections increase a CEO's ability to obtain knowledge and resources across industries, to establish a network of foreign contacts, and to identify good business opportunities in other fields (Prahalad and Hamel, 1990; Reuber and Fischer, 1997; Masulis et al., 2012). Taken together with the channel tests, our results suggest that the breadth of knowledge provided by diversity in the social network context is the key reason why SNH drives better firm performance.

The paper contributes to a growing literature on social learning. Many studies have indicated the importance of social ties in the transfer of privileged information. For instance, it allows firms to leverage social relationships and reduce asymmetric information in the capital market (Engelberg et al., 2012); it promotes new ideas and encourages CEOs to tackle innovative projects (Faleye et al., 2014). It propagates management expertise and experience, and hence enhances managerial performance (Larcker et al., 2013; Engelberg et al., 2013). The existing literature also highlights several reasons why interconnectedness may facilitate the contagion of value-decreasing management practices, such as the spread of options backdating (Bizjak et al., 2009), tax avoidance strategies (Brown and Drake, 2014), and earnings management (Kedia et al., 2015). The presence of social reciprocity is also found to reduce monitoring efforts of boards of directors or auditors (Hwang and Kim, 2009; Fracassi and Tate, 2012; Guan et al., 2016; Khanna et al., 2015). Such different implications of social ties for management practice have led to a somewhat narrow and cynical view of social connections and firm valuation. This paper brings a different perspective to the discussion by examining human diversity in CEO social networks. Our findings suggest subtle nuances in relationships between network diversity, information, and economic performance, opening a new line of inquiry into the micro-sociological view of CEO networks. The implication is that the benefit or cost of social networks comes not only from the number of a CEO's social ties, but also from the level of diversity within the network.

Secondly, our research also relates to a stream of literature focusing on CEO traits, leadership and corporate performance (Bertrand and Schoar, 2003; Adams et al., 2016; Kaplan et al., 2012; Custodio et al., 2013, 2015). Going beyond individual traits, we shed further light on the social capital aspects of CEO skills. Our findings suggest that the diversity of CEO social ties should be given consideration as a crucial component of management quality. Consistent with the social contextual view of creativity (Amabile, 1988), our results imply that CEOs who connect with diverse groups of individuals are more successful in performing innovative activities and seeking opportunities outside existing boundaries. Given the changing demographics of corporate hierarchies and the increasing pressure on U.S. companies to expand abroad, manager network diversity can benefit the firm in the long run.

This paper also extends studies on organizational diversity (e.g., Pfeffer, 1983; Hong and Page, 2001). While prior research has emphasized the value-added role of females, minorities, and diverse professions in the boardroom (e.g., Anderson et al., 2011; Gul et al., 2011; Adams and Ferreira, 2009; Francis et al., 2015), the financial consequence of the contextual diversity of CEOs' social capital has not yet been explored. Our study is the first to compile a comprehensive measure of CEO social network diversity that captures multidimensional aspects, including demographical, cultural, intellectual, and occupational attributes of network members. Our results support the bright side of social network diversity by establishing a robust causal linkage between CEO SNH and higher corporate performance. To provide additional insights, we also show that higher diversity in social networks is associated with better-cited patents and more emphasis on exploratory rather than exploitative strategies. We also show that SNH has a positive impact on diversified and cross-border M&As. Taken together, our findings suggest that human diversity in social networks enhances firm value by providing CEOs with novel information and broader knowledge of unfamiliar markets.

The rest of the paper is organized as follows. Section 2 presents the data and sample summary statistics. Section 3 discusses the empirical results, and Section 4 summarizes and concludes the paper.

2. Data description and heterogeneity measures

2.1. Sample construction

We construct our sample for empirical investigation by matching BoardEx with Compustat firms using tickers and CIK number.[2] BoardEx provides comprehensive biographical information for members of senior management and boards of directors of U.S. and European public companies,[3] and provides relational links among these individuals. Compustat provides firms' financial characteristics. Our dependent variable is Tobin's Q and our independent variable of main interest is CEO SNH. For control variables, we include a set of firm characteristics, boardroom diversity, governance index, and other characteristics of social networks. To minimize the effect of outliers, we winsorize all firm characteristics at the 1st and 99th percentiles. Our final sample yields 934 U.S. firms (1212 CEOs) from 2000 to 2010.[4] We exclude financial institutions, utilities, and nonprofit organizations from the sample. Detailed variable definitions are reported in Appendix A. Descriptive statistics are presented in Table 1.

The average firm size in our sample is $4.7 billion, spanning from $220.7 million in the 5th percentile to $21.6 billion in the 95th percentile. The average Tobin's Q is 1.96, which ranges from 0.93 at the 5th percentile to 4.3 at the 95th percentile. On average, book leverage ratio is 22.0%, the capital investment-to-assets ratio is 4.8%, and R&D expenditure to sales is 8.1%. A characteristic board of directors in our sample contains, on average, 10% female and 7.5% non-American members; the average CEO age is 56; 3% of CEOs are female and 0.6% are non-American; 63.7% of CEOs sit on the board as Chairman; and the G-index has a mean of 9.3. These summary statistics reflect those cited in the existing literature (e.g., Custodio et al., 2013). We consider network size and centrality as other characteristics of CEO social networks. Measured by the number of total CEO social ties, network size ranges from 1 at the 5th percentile to 116 at the 95th percentile. Note that these network ties are screened based on several criteria, as illustrated in the next section, and therefore the number is relatively small. Network centrality captures the dominant position in the network. Degree of centrality is small because it is scaled by the total number of connections in the network.

2.2. CEO social networks

To identify CEO social networks, we consider three types of social link, namely school, work, and other social ties. Following the recent literature (Akbas et al., 2016; Fracassi, 2016), we identify a school tie between two individuals if they went to the same school and graduated within three years 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 met as a result of shared education (Fracassi, 2016). Work ties exist if two individuals worked in the same company. Other social ties are identified if two individuals maintain membership in the same country club or serve the same charity, university, government, military, or other nonprofit association. To make sure people have active roles in these organizations, we consider a qualified tie to be one in which a person maintains an important role (such as trustee, president, advisor, or board member) in the organization (with the exception of club membership, for which membership alone is considered as qualification).

We further refine our criteria for examining CEO social networks by checking the starting and ending dates of the social relationships. We drop work and other social ties that terminated five years before our testing year. As for school ties, we do not use a time window, since CEOs often maintain connections with their former classmates through alumni events. Such continuity is less likely to be the case with work and other social ties, however. We also examine the job titles of the individuals in a CEO's social network. To maximize the probability that two individuals have met and have had informative conversations, we require that the two individuals must hold or have held relatively high-level positions, including, but not limited to, serving at the top level of a management team, on a board of directors, or on an advisory council (Fracassi, 2016).

2.3. Individual heterogeneity measures

We first construct six categories of heterogeneity measures based on network contacts' gender, nationality, academic degrees, majors, professional expertise, and international exposure. The individual measures are then aggregated using common factor analysis to extract a single index of SNH. The six individual heterogeneity measures are specified below.

Gender heterogeneity: The number of females in CEO social networks divided by total ties of the CEOs.

Ethnicity heterogeneity: The number of non-American in CEO social networks divided by total ties of the CEOs.

Academic degree heterogeneity: This measure captures the diversity of the academic degree of individuals in CEO social networks. We use a Herfindahl index based on the percentage of individuals in one of three academic degree categories: a bachelor's, master's, or doctoral degree. And then we take one minus the Herfindahl index to obtain the measure for academic degree heterogeneity. Specifically, $Academic\ degree\ heterogeneity = 1 - [(PhD\_ratio^{2} + Master's\_ratio^{2} + Bachelor's\_ratio^{2})]$, where the

[2] The matching needs to be done with care. In some cases, the same firm can have different board IDs as its name can be referenced with slight variations in different sources (Ishii and Xuan, 2014). To minimize the matching problem, we therefore drop all firms with the same CIK/ticker but different names.

[3] Biographical information includes demographic attributes (e.g., date of birth, date of death, gender, nationality), employment history (e.g., workplaces and job titles), educational background (e.g., schools, degrees, and majors), and other social activities, such as club memberships, professional associations, and charities.

[4] Our sample started with 1914 firms with CEO information and firm characteristics from BoardEx. After matching corporate governance G-index, it reduces to 1129 firms. Finally, it decreases to 934 firms after we require heterogeneity measure of the social networks for the CEOs.

Table 1
Summary statistics.
This table reports the summary statistics. The sample consists of firms matched between BoardEx and Compustat over 2000–2010. Financial and utility firms are omitted. Variable definitions are reported in Appendix A.

Variable	N	Mean	Std. Dev.	p5	p50	p95
Firm characteristics						
TobinQ	6270	1.956	1.147	0.931	1.605	4.288
Log (assets)	6270	7.534	1.397	5.397	7.492	9.982
Total assets	6270	4738	7548	221	1794	21,633
Leverage	6270	0.220	0.172	0.000	0.211	0.524
Capex/assets	6270	0.048	0.041	0.009	0.036	0.133
Cash flow/assets	6270	0.173	0.104	0.024	0.173	0.335
R&D/sales	6270	0.081	0.466	0.000	0.011	0.249
Chairman	6270	0.632	0.482	0.000	1.000	1.000
G index	6270	9.276	2.568	5.000	9.000	13.000
Board female	6270	0.108	0.091	0.000	0.111	0.250
Board minority	6270	0.076	0.137	0.000	0.000	0.400
CEO characteristics						
CEO female	6270	0.029	0.167	0.000	0.000	0.000
CEO minority	6270	0.007	0.084	0.000	0.000	0.000
CEO age	6270	55.933	7.055	44.000	56.000	67.000
Network measures						
Gender diversity	6270	0.064	0.121	0.000	0.000	0.250
Ethnicity diversity	6270	0.012	0.056	0.000	0.000	0.067
Education degree diversity	6270	0.387	0.223	0.000	0.449	0.645
Education major diversity	6270	0.347	0.234	0.000	0.444	0.660
Professional diversity	6270	0.637	0.200	0.000	0.702	0.799
International diversity	6270	0.115	0.161	0.000	0.000	0.460
SNH	6270	−0.026	0.848	−1.842	0.166	1.046
Network size	6270	19.925	32.962	1.000	8.000	116.000
Centrality (%)	6270	0.049	0.039	0.015	0.038	0.123
Other variables						
Patents	2648	14.791	31.922	0.232	3.488	69.582
Citations	2648	86.193	254.776	0.000	13.781	380.470
Exploratory ratio	2648	0.305	0.263	0.000	0.271	0.780
General ability	4643	0.284	0.979	−1.042	0.173	2.139
Log (population)	5136	13.655	1.057	11.828	13.726	15.151

ratios represent the percentages of connections with doctoral, master's, or bachelor's degrees as the highest educational achievement.

Academic major heterogeneity: This measure captures the diversity of academic majors of the individuals in CEO social networks. We categorize majors into four categories: 1) business, 2) engineering, 3) liberal arts and sciences, and 4) law. Similarly, we use 1 minus a Herfindahl index to capture the heterogeneity. Specifically, $Academic\ major\ heterogeneity = 1 - [(Business\_ratio^2 + Engineering\_ratio^2 + Liberal\_Arts\_ratio^2 + Law\_ratio^2)]$, where the ratios represent the percentage of connections with majors related to business, engineering, liberal arts and sciences, and law, respectively.

Professional heterogeneity: This measure captures the diversity of managerial expertise of individuals in CEO social networks. We categorize managerial expertise into four areas: 1) CEO, 2) CFO, 3) other top executives, and 4) board of directors. $Professional\ heterogeneity = 1 - [(CEO\_ratio)^2 + (CFO\_ratio)^2 + (Other\_executives\_ratio)^2 + (Board\_of\_directors\_ratio)^2]$, where the ratios reflect the percentage of ties that represent persons holding such positions as CEO, CFO, other top executives, and members of board of directors, respectively.

International experience heterogeneity: This measure captures the diversity of international experience of the individuals in CEO social networks. We identify the headquarter countries of companies where the individuals in CEO social networks work. Then based on those countries' World Bank income-level category, we group them into four categories: high, upper middle, lower middle, and low income. $International\ experience\ heterogeneity = 1 - [(HighIncome\_ratio^2 + UpperMidIncome\_ratio^2 + LowerMidIncome\_ratio^2 + LowIncome\_ratio^2)]$, where the ratios refer to the percentage of connections who work in different income-level categories of countries.

Table 1 (Network Measures Panel) provides the descriptive statistics of the six heterogeneity measures as illustrated above. For a median CEO in our sample, the gender heterogeneity is 0.064, indicating that, among all the connections, 6.4% are female. The ethnicity heterogeneity is 0.012, meaning that 1.2% of the connections are non-Americans based on nationality. The rest of the four heterogeneity measures are calculated as 1 minus a Herfindahl index. A value of 0 means no diversity, in which case the network is completely homogeneous in terms of that attribute. In contrast, a value of 1 means the highest level of diversity, where

the network is completely heterogeneous for that attribute. The median for academic degree heterogeneity is 0.387, and is 0.347 for academic major diversity. Professional diversity has a median value of 0.637, and international diversity has a median value of 0.115. Overall, we find that social networks are more heterogeneous in terms of educational and professional attributes; however, gender, ethnicity and international experience heterogeneity are relatively low.

The types of connection a CEO forms reflect that individual's personal characteristics, such as gender, age, and nationality. For example, female CEOs tend to have higher gender diversity, and foreign CEOs are likely to have more international connections. Moreover, large firms may also provide wider networks and higher diversity of social ties to their CEOs. Because of these considerations, we use residuals of heterogeneity measures to reduce the confounding effect of firm size and CEO attributes on the raw heterogeneity measures. Specifically, we estimate the following regressions for each of the six measures of heterogeneity:

$$Heterogeneitymeasures_{i,t} = f\left(firmsize_{i,t}, CEOage_{i,t}, CEOgender_{i,t}, CEOminority_{i,t}, industrydummies, yeardummies\right) \quad (1)$$

where i indexes the firm and t indexes the year of the observation. *Firm size* is logarithm of total assets, *CEO_female* is a dummy variable, which equals 1 if the CEO is female, and 0 otherwise. *CEO_minority* is a dummy variable, which equals 1 if the CEO's nationality is non-American, and 0 otherwise. *CEO_age* is the age of the CEO. Industry dummies and year dummies capture industry (defined at the 2-digit SIC code level) and year fixed effects, respectively. We use the residuals from the above regressions as the adjusted measures of heterogeneity.

2.4. Aggregated heterogeneity measure: SNH

Individual heterogeneity measures are observable measures of CEO network diversity, but since they are limited to capturing only one dimension, they are unlikely to be comprehensive. Common factor analysis is a commonly used statistical approach to extract the minimum number of factors from observed and correlated variables (Chemmanur et al., 2011). We believe common factor analysis is more appropriate than principal component analysis because the latter breaks down the covariance matrix into a set of orthogonal components equal to the number of individual proxies. We use common factor analysis in our study to obtain an aggregated index that can capture the maximum amount of common variations of the six different individual heterogeneity measures. To ensure that our heterogeneity measures are independent of firm size, CEO age, gender, and foreign status, we use six residuals from the six regressions, as specified in eq. (1), as inputs to conduct common factor analysis. Table 2 presents the results of the common factor analysis.

Table 2
Common factor analysis.
This table reports the results of common factor analysis. We have six individual social-network heterogeneity measures (see Appendix A for detail definitions). We obtain residuals of the six individual measures using the following six regressions: *Heterogeneity measures* $_{i,t}$ = *f*(*firm size* $_{i,t}$, *CEO age*$_{i,t}$, *CEO gender*$_{i,t}$, *CEO minority* $_{i,t}$, *industry dummies*, *year dummies*), where the dependent variables are the six individual heterogeneity measures, respectively. The residuals are used as inputs for the common factor analysis. Panel A reports the eigenvalues of the common factor analysis. Factor 1 has the largest eigenvalue and it is larger than 1. We take Factor 1 as our aggregated social-network heterogeneity measure (SNH). Panel B reports the loadings and correlations with Factor 1. Panel C reports sample distribution by industry and descriptive statistics of SNH for each industry.

Panel A: eigenvalues of common factor analysis

Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
1.43275	0.22006	0.00303	−0.007851	−0.13803	−0.22596

Panel B: summary of factor analysis

Input variables	Loadings on Factor 1	Correlations with Factor 1
Gender diversity residual	0.0758	0.0929
Ethnicity diversity residual	0.0074	0.0077
Degree diversity residual	0.7378	0.8791
Major diversity residual	0.7106	0.8563
Professional diversity residual	0.6089	0.7221
International diversity residual	0.0837	0.0992

Panel C: summary of SNH (Factor 1)

SIC1	N	Std. Dev.	p5	p50	p95
0	16	1.004	−1.454	−0.080	1.113
1	289	0.980	−2.063	0.093	0.997
2	1471	0.810	−1.915	0.106	0.901
3	2482	0.838	−1.842	0.168	1.019
5	820	0.841	−1.461	0.221	1.284
7	954	0.880	−1.838	0.258	1.122
8	238	0.836	−1.919	0.065	1.030
All	6270	0.848	−1.842	0.166	1.046

Panel A of Table 2 provides the eigenvalues of the six factors obtained from common factor analysis. Factor 1 has the highest eigenvalues, which are >1, and accounts for the largest proportion of the variance of the six residual heterogeneity measures. Hence, we take factor 1 as our common factor to represent the aggregated measure of SNH. Panel B reports factor loadings on factor 1 for each individual heterogeneity measure. The loadings all suggest that individual heterogeneity measures have positive loadings on the first factor. Educational and professional heterogeneity have the larger factor loadings on the common factor than the other three measures. The second column of Panel B examines the correlations of individual heterogeneity measures with the common factor, and finds positive correlations between the first factor and each of the six individual heterogeneity measures. Overall, common factor analysis successfully extracts the first factor that can be used as the aggregated measure for the six individual heterogeneity measures. We term this factor SNH. Panel C reports summary statistics of SNH and distribution by industry. The value of SNH ranges from −1.842 at the 5th percentile to 0.166 at the 95th percentile. Lower values indicate less diversity. Table 3 reports the correlation matrix for the key variables.

3. Empirical analysis

3.1. Baseline regressions

3.1.1. Regressions on individual heterogeneity measures

We begin with the OLS regression estimations to test whether individual heterogeneity measures affect firm value. The dependent variable is Tobin's Q (Tobin, 1969) and independent variables of interest are the six individual heterogeneity measures. The model specifications follow eq. (2) as below:

$$Q_{it} = \alpha + \beta Heterogeneity_{i,t-1} + \delta X_{i,t-1} + IndustryFE + YearFE + \varepsilon_{i,t} \quad (2)$$

where i indexes firms and t indexes time. *Heterogeneity* represents the six individual heterogeneity measures (gender, ethnicity, academic degree, major, profession, and international heterogeneity), and are residual-based measures obtained from Eq. (1). Control variables X include various firm financial characteristics, corporate governance, boardroom diversity, and network characteristics. We lag all explanatory variables on the right-hand side by one year to alleviate potential endogeneity concerns (Faleye et al., 2014). We also include year dummies and industry indicators at the two-digit SIC-code level. Standard errors are clustered at the firm level for all regressions.

Table 4 presents the regression results relating Tobin's Q to individual heterogeneity measures. We find that all six heterogeneity measures have positive and significant effects on Tobin's Q. To interpret the economic effects of individual heterogeneity on firm value, we calculate the dollar amount of increase in market value should a CEO increase his/her network heterogeneity by one standard deviation (SD). Among the six individual dimensions of heterogeneity, gender heterogeneity has the largest

Table 3
Correlation matrix.
This table reports correlation matrix among main variables. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	1	2	3	4	5	6	7	8
1. Tobin Q	1							
2. Log assets	−0.0512*	1						
3. Leverage	−0.2511*	0.2601*	1					
4. Capex/assets	0.0951*	0.0315*	0.0026	1				
5. Cash flow/assets	0.3194*	0.1680*	−0.0242	0.3951*	1			
6. R&D/sales	0.0724*	−0.1129*	−0.0132	−0.0582*	−0.2939*	1		
7. CEO female	0.0067	−0.0159	−0.0294*	−0.0109	−0.0272*	0.0183	1	
8. CEO minority	0.0313*	−0.0119	−0.0425*	0.0207	0.0041	0.0075	0.0418*	1
9. CEO age	−0.0912*	0.1070*	0.0778*	0.0255*	0.0565*	−0.0490*	−0.0772*	−0.008
10. Board female	0.0156	0.3147*	0.0812*	0.0037	0.1033*	−0.0285*	0.2689*	−0.02
11. Board minority	0.0550*	0.2406*	0.0236	−0.0202	0.013	0.0263*	0.0093	0.2125*
12. Chairman	−0.0271*	0.1911*	0.1035*	0.0151	0.1013*	−0.0429*	−0.0541*	−0.0135
13. G index	−0.1292*	0.1978*	0.1439*	−0.0309*	0.0435*	−0.0653*	−0.0404*	0.0365*
14. SNH	0.0086	0.017	−0.0315*	−0.0158	−0.0614*	0.0107	−0.0309*	0.0326*
15. Network size	0.0396*	0.2048*	0.0235	−0.0023	0.0549*	−0.0248*	0.0561*	−0.0179
16. Centrality	0.0981*	0.4331*	0.0929*	0.0187	0.0774*	−0.0320*	0.0619*	−0.0103

	9	10	11	12	13	14	15	16
9. CEO age	1							
10. Board female	−0.0164	1						
11. Board minority	−0.0037	0.0612*	1					
12. Chairman	0.3039*	0.1002*	0.0279*	1				
13. G index	0.0490*	0.1492*	0.0716*	0.1197*	1			
14. SNH	0.0286*	0.0417*	0.0117	0.0750*	0.0302*	1		
15. Network size	0.0285*	0.1282*	0.0553*	0.0493*	0.0568*	0.0204	1	
16. Centrality	0.1314*	0.1915*	0.1249*	0.1585*	0.1047*	0.1748*	0.2288*	1

Table 4
Network diversity and firm value—individual heterogeneity.
This table reports the results of OLS regressions, relating six CEO social-network heterogeneity measures to Tobin's Q. The dependent variable across all models is Tobin's Q. Independent variables of interest are individual heterogeneity measures, including gender, ethnicity, education degree, major, profession, and international heterogeneity. They are obtained as residuals from the following regressions: *Heterogeneity measures* $_{i,t}$ = *f*(*firm size* $_{i,t}$, *CEO age*$_{i,t}$, *CEO gender*$_{i,t}$, *CEO minority* $_{i,t}$, *industry dummies*, *year dummies*), where the dependent variables are the six raw heterogeneity measures, respectively. Our control variables include various firm characteristics, corporate governance proxies, boardroom diversity, and CEO network characteristics. All of our right-hand-side variables are lagged by one year. Year dummies and industry indicators at 2-digit SIC code are included across all the models. Standard errors are adjusted for heteroskedasticity. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Dependent variable	Tobin's Q					
	(1)	(2)	(3)	(4)	(5)	(6)
Heterogeneity measures						
Gender	0.646*					
	[1.816]					
Ethnicity		0.088**				
		[2.069]				
Academic degree			0.108*			
			[1.774]			
Academic major				0.284***		
				[4.751]		
Professional					0.184***	
					[2.587]	
International						0.286***
						[3.459]
Controls						
Log assets	−0.057***	−0.052***	−0.057***	−0.050***	−0.053***	−0.054***
	[−4.512]	[−4.576]	[−4.828]	[−4.152]	[−4.369]	[−4.655]
Leverage	−0.911***	−1.198***	−0.985***	−0.909***	−0.967***	−0.957***
	[−10.354]	[−15.621]	[−11.702]	[−10.747]	[−11.792]	[−11.688]
Capex/assets	−0.219	−1.585***	−0.289	−0.309	−0.247	−0.240
	[−0.458]	[−4.316]	[−0.665]	[−0.699]	[−0.581]	[−0.562]
Cash flow/assets	3.267***	3.678***	3.347***	3.267***	3.333***	3.340***
	[11.570]	[15.033]	[13.232]	[12.313]	[13.344]	[13.362]
R&D/sales	0.284**	0.552***	0.291***	0.302**	0.291***	0.289***
	[2.234]	[4.722]	[2.675]	[2.470]	[2.660]	[2.638]
Chairman	−0.072***	−0.033	−0.043*	−0.058**	−0.040*	−0.033
	[−2.846]	[−1.411]	[−1.832]	[−2.428]	[−1.740]	[−1.439]
G-index	−0.036***	−0.036***	−0.038***	−0.036***	−0.037***	−0.037***
	[−7.778]	[−9.368]	[−9.190]	[−8.546]	[−9.238]	[−9.183]
Board female	0.171	0.182	0.210	0.112	0.208	0.205
	[1.205]	[1.384]	[1.602]	[0.865]	[1.625]	[1.603]
Board minority	0.315***	0.314***	0.230***	0.248***	0.223***	0.200**
	[3.397]	[3.856]	[2.745]	[2.888]	[2.697]	[2.406]
Network size	−0.132***	−0.007	−0.147***	−0.179***	−0.194***	−0.110***
	[−2.893]	[−0.164]	[−2.940]	[−3.752]	[−3.279]	[−2.822]
Network size_sq	0.025***	0.005	0.027***	0.032***	0.034***	0.018**
	[3.058]	[0.664]	[3.067]	[3.896]	[3.414]	[2.457]
Centrality	327.440***	298.971***	357.942***	320.802***	360.849***	370.973***
	[5.069]	[4.786]	[5.887]	[5.178]	[5.988]	[6.133]
Constant	2.863***	2.417***	2.794***	2.825***	2.747***	2.675***
	[9.993]	[14.375]	[9.888]	[9.693]	[9.923]	[10.077]
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6270	7178	7640	7118	7848	7818
Adjusted R-squared	0.281	0.236	0.268	0.271	0.270	0.272

economic impact. For an average firm with total assets of $4738 million (according to sample average), one SD increase *gender heterogeneity* leads to about $189 million increase in market value.[5] This finding adds new evidence to a stream of literature that emphasizes the value of female directors and top executives (Adams and Ferreira, 2009; Gul et al., 2011; Francis et al., 2015). Following the same calculation procedure, the increase of market value is $12 million for one SD increase in *ethnicity heterogeneity*; $58 million for one SD increase in *academic degree heterogeneity*; $161 million for one SD increase in *academic major heterogeneity*; $89 million for one SD increase in *professional heterogeneity*; $112 million for one SD increase in *international experience heterogeneity*. These results suggest that the benefits from diverse social connections are economically meaningful.

Regarding the control variables, the signs of the coefficients are generally consistent with the existing literature. For example, firm size and leverage are associated with lower growth opportunity and firm value; operating profitability and R&D intensity result in higher firm value; a CEO's dual role as chairman of the board reduces firm value, and G-index is also associated with lower

[5] [SD (Gender) ∗ β (Gender) / Mean (Q)] ∗ Assets = (0.121 ∗ 0.646 / 1.956) ∗ 4738 = 189.34.

value (Faleye et al., 2014). Boardroom ethnicity diversity increases firm value (Anderson et al., 2011). Several studies have pointed out that CEO networks affect firm policies and therefore have different implications for firm value. To control for the network-size effect, we include network size, the squared term of network size, and network degree of centrality. We find that network size has a non-linear relationship with firm value, i.e., network size increases firm value only after reaching a point where the network consists of many connections. Network centrality also has a positive and strong impact on firm value, consistent with Larcker et al. (2013).

3.1.2. Regressions on aggregated measure—SNH

In this section, we use the aggregated heterogeneity index, SNH, as the main variable of interest to explain firm performance. Table 5 reports the results for an OLS regression and alternative model specifications for robustness tests. The baseline model (Column 1) has the same empirical specification as Eq. (2), except we use SNH as the heterogeneity measure instead of individual measures. The coefficient of SNH is 0.076, which is statistically significant at the $p < 5\%$ level. Taking the sample median, for

Table 5
Network diversity and firm value — SNH.
This table reports the regression results of Tobin's Q to SNH. SNH is our aggregated measure of network heterogeneity obtained from common factor analysis using six individual heterogeneity measures. Column (1) presents OLS baseline model, where we control for the same set of variables as in Table 4. Column (2) adds population of the county where company headquarters are located to examine whether it affects our testing variable SNH. Column (3) adds managerial general ability index as additional control to examine whether it affects our testing variable SNH. Column (4) and (5) report the results of instrumental variable regressions (2SLS IV). Two instrumental variables are firstly genetic diversity of the country of the CEO's nationality (Ashraf and Galor, 2013), and secondly the diversity score of CEOs' undergraduate institutions. Column (4) reports the 1st stage of the 2SLS estimations of SNH on the two instrumental variables as well as the whole set of controls in the 2nd stage. Column (5) reports the 2nd stage regression results of Tobin's Q on the predicted value of SNH, which is obtained from the 1st stage. Consistent with baseline regressions, firm financial variables are measured at the previous fiscal year end. Year dummies and industry indicators at 2-digit SIC code are included. Standard errors are adjusted for heteroskedasticity. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Dependent variable	Tobin's Q				
	(1)	(2)	(3)	(4)	(5)
	Baseline	Population	General ability	IV-1st	IV-2nd
SNH	0.076**	0.081**	0.064***	0.068**	0.440*
	[2.291]	[2.131]	[2.712]	[2.220]	[1.780]
Population		0.055**			
		[2.254]			
General ability			0.038**		
			[2.298]		
School diversity index				0.452***	
				[5.100]	
Genetic diversity index				6.827**	
				[2.463]	
Log assets	−0.049**	−0.045*	−0.011	−0.119***	−0.010
	[−2.237]	[−1.764]	[−0.772]	[−9.537]	[−0.263]
Leverage	−0.894***	−0.980***	−1.099***	−0.240***	−0.746***
	[−6.135]	[−5.936]	[−11.228]	[−2.833]	[−4.598]
Capex/assets	−0.203	−0.058	−1.795***	−0.030	−0.275
	[−0.286]	[−0.067]	[−3.579]	[−0.078]	[−0.363]
Cash flow/assets	3.279***	3.220***	5.067***	−0.636***	3.119***
	[7.841]	[6.924]	[15.402]	[−4.198]	[6.065]
R&D/sales	0.286**	0.263*	0.823***	−0.080***	0.524**
	[2.016]	[1.884]	[3.673]	[−3.045]	[2.120]
Chairman	−0.072*	−0.094*	−0.051*	−0.250	0.651***
	[−1.659]	[−1.908]	[−1.745]	[−1.637]	[2.580]
G-index	−0.036***	−0.036***	−0.038***	0.100	−0.063
	[−4.020]	[−3.452]	[−6.750]	[0.918]	[−0.442]
Board female	0.179	0.063	0.087	−0.016	−0.091**
	[0.696]	[0.212]	[0.529]	[−0.571]	[−2.049]
Board minority	0.318*	0.486**	0.225**	0.000	−0.028***
	[1.794]	[2.288]	[2.089]	[0.008]	[−3.528]
Network size	−0.303***	−0.319**	−0.386***	1.986***	−1.142**
	[−2.659]	[−2.431]	[−5.200]	[30.664]	[−2.280]
Network size_sq	0.052***	0.057**	0.061***	−0.294***	0.177**
	[2.668]	[2.509]	[4.897]	[−21.962]	[2.288]
Centrality	319.725***	329.229***	334.806***	118.437***	372.605***
	[2.861]	[2.714]	[4.628]	[3.882]	[2.665]
Constant	2.998***	2.434***	2.598***	−4.517***	Partial out
	[6.167]	[4.123]	[9.050]	[−3.974]	Partial out
Industry-year FE	Yes	Yes	Yes	Yes	Yes
Observations	6270	5136	4643	2036	2036
Adjusted R-squared	0.282	0.288	0.377	0.548	0.081

example, one SD increase in SNH could increase Tobin's Q by 0.64%,[6] which is equivalent to a $30 million increase in market capitalization for the median firm with total assets of $4.7 billion. Given that the measure itself is residual-based, the economic impact of SNH is relatively strong. The partial effect of SNH is statistically significant, which supports our argument that, although it is important for a CEO to hold a position of network centrality, being acquainted with many different people with diverse educational backgrounds and work experience adds firm value in a significant way.

Columns (2) and (3) add two additional control variables, *population* and CEO *general ability*, to ensure that our baseline results are robust to the inclusion of these factors. Specifically, *population* measures the logarithm of total population of the county where the firm headquarters are located. Several studies have found that firm location has important implications for firm value (e.g., Francis et al., 2010). Meanwhile, large cities and other dense population areas also are likely to be associated with greater societal demographic diversity. Hence, area population can affect both firm value and social-network heterogeneity. We thus include this factor to rule it out as an omitted variable. Results in Column (2) show that area population has a positive effect on firm value. However, after controlling for it, CEO SNH has a larger impact on firm value, compared with Column (1). The second additional control we add is CEO *general ability* (Custodio et al., 2013). Custodio et al. (2015) document that prior career experience provides some CEOs with a broader set of skills than others. They construct an index of general ability and find that it significantly affects innovation policies.[7] It is plausible that diverse work experience gives rise to a diverse social network. Hence, CEO general ability might be another omitted variable that could bias our result if not controlled. In Column (3), we control for the general ability index constructed by Custodio et al. (2013). Despite the reduction in sample size, the coefficient on SNH remains positive and statistically significant at the $p < 5\%$ level, and the magnitude of the estimate is comparable to those reported in baseline model.

3.2. Endogeneity issues and other robustness tests

While we address some omitted variables in Section 3.1, the relationship between *CEO SNH* and firm value can still be spurious due to reverse causality driven by endogenous pairings between firms and CEOs. For example, better-performing firms can select CEOs who have heterogeneous social connections (reverse causality), or certain firm characteristics can simultaneously affect CEOs' choices of social networks and firm value (simultaneity bias). To address these concerns, we adopt several identification strategies.

3.2.1. Instrumental variable approach

Based on insights on human diversity from the economics literature, our first instrument is genetic diversity of the country where the CEO was born. Ashraf and Galor (2013)'s "out-of-Africa" hypothesis demonstrates that migratory distance from East Africa gave rise to the genetic diversity of different settlements around the world. Genetic diversity captures deep-rooted differences in social, cultural, psychological, physiological, and institutional characteristics that were shaped in the distant past. Hence, we believe that genetic diversity is a good predictor for a CEO's natural preference for social network diversity. Moreover, it is unlikely that the genetic diversity of a CEO's country of origin can be reversely affected by firm performance or other firm characteristics. The data used to construct genetic diversity are taken from Ashraf and Galor (2013) and Delis et al. (2016). We expect country genetic diversity to be positively associated with CEO social network diversity.

For the second instrumental variable, we use campus ethnic diversity of CEOs' undergraduate institutions as a salient predictor for CEO social-network heterogeneity. People are attracted to different types of school and, thus, the greater (lesser) the demographic diversity of CEOs' universities might reflect their personalities and preferences for (against) social networking. However, it is hard to believe that the diversity of a school attended by a CEO can directly affect the firm value of the CEO's future workplace. We obtain the campus ethnic diversity index of US universities from the website of US News and World Report (Meyer and McIntosh, 1992) and then match it with CEOs' undergraduate institutions. We expect that university diversity is positively associated with CEO social network diversity. Please note the reduced sample size, since we need sufficient available information for the two instrumental variables.

The results of 2SLS IV estimations are reported in the last two columns of Table 5. In the first stage, the dependent variable is *SNH*, and the independent variables include the two instrumental variables and all control variables, as specified in the baseline model with year and industry fixed effects. Coefficients on both instrumental variables are statistically significant at the $p < 1\%$ level. Consistent with our expectations, both estimates on university diversity and country genetic diversity are positive. F-statistics of the first-stage regression is 20.1 (larger than the cut-off value of 10), which suggests that our instrument is relevant and does not suffer from the weak-instrument concern (Staiger and Stock, 1997). The Cragg-Donald F-statistic is 16.4, which rejects the null hypothesis that the instruments are weak (Cragg and Donald, 1993). Furthermore, the Hansen's J overidentification test has a *p*-value of 0.633, indicating that the two instruments are valid, or uncorrelated with the error term (Hansen, 1982). Another criterion for a valid instrumental variable is that it should have no direct effect on firm value. To examine this condition, we include them as additional control variables in the baseline model and find that they are not correlated with Tobin's Q. Results from this additional analysis are not tabulated but are available from the authors upon request. Column 5 reports the second-stage results using the exogenous component of SNH to explain Tobin's Q. We find that the coefficient estimate for the fitted

[6] We calculate this percentage change as: S.D. $*\beta$ (SNH) / Median (Q) $= 0.166 * 0.076/1.956 = 0.64\%$.

[7] The general ability index captures three aspects of a CEO's professional career: (1) past number of positions, firms, and industries in which a CEO worked; (2) whether the executive held a CEO position at a different company; and (3) whether the CEO worked for a conglomerate firm.

SNH is significantly positive at the $p < 10\%$ level, which confirms that our baseline result remains robust under the 2SLS IV approach.

3.2.2. Fixed effects

To alleviate the concern that network diversity is positively associated with firm size and network size, which can affect firm value and bias our results, we estimate the baseline model with firm-size fixed effect and network-size fixed effects. The results are presented in Table 6. Column (1) reports the firm-size fixed effect, where we sort firms into size-decile groups and add dummy variables for each group to absorb the effect of firm size. Column (2) reports the network-size fixed effect, where we sort by number of network ties of CEOs and add dummy variables for each group to absorb the network size effect. The coefficients of SNH remain positive and significant at the $p < 5\%$ level. The magnitude reflects that of the baseline model. Overall, our results are not affected by network size and firm size. Unobserved firm characteristics may still be driving both CEO social network and firm value. Therefore, we account for unobserved factors that are time-invariant using firm fixed-effects in Column (3) of Table 6. The result of SNH remains robust. Finally, researchers have examined whether corporate outcomes are affected by CEO characteristics. Bertrand and Schoar (2003) show that individual manager fixed effects matter for firms' investment and financial policies. To control for unobservable CEO characteristics, we estimate the baseline model with a CEO fixed effect in Column (4). The coefficient for SNH remains positive and is significant at the 10% level, suggesting a within-CEO improvement in firm performance owing to social-network heterogeneity.

3.2.3. Difference-in-differences analysis

In this section, we provide a further analysis to address the endogenous matching between CEOs and firms. An ideal way to deal with this type of endogeneity issue is to find an exogenous shock to a CEO social network that is plausibly unrelated to firm performance. We use incidences of death and retirement of individuals in a CEO's network as an exogenous shock to network

Table 6
Network diversity and firm value — fixed effect models.
This table reports our robustness results using fixed effect models. Column (1) uses firm size-decile fixed effect, where we sort firms into size-decile groups and add dummy variables for each group to absorb firm size effect. Column (2) uses network size-decile fixed effect, where we sort by network size of CEOs and add dummy variables for each group to absorb network size effect. Column (3) uses firm fixed effect to absorb omitted firm-level variables that might potentially affect Tobin's Q. Column (4) uses CEO fixed effect to absorb CEO characteristics that do not change over time. Year dummies and industry indicators at 2-digit SIC code are included across all the models. All independent variables are lagged by one year. Standard errors are adjusted for heteroskedasticity. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Dependent variable	Tobin's Q			
	(1)	(2)	(3)	(4)
	Firm size-decile FE	Network size-decile FE	Firm FE	CEO FE
SNH	0.068**	0.071**	0.064*	0.055*
	[2.107]	[2.051]	[1.927]	[1.842]
Controls				
Log assets	−0.551***	−0.425***	−0.426***	−0.497***
	[−6.286]	[−8.891]	[−8.928]	[−7.942]
Leverage	−0.280**	−0.247*	−0.250*	−0.095
	[−2.109]	[−1.858]	[−1.891]	[−0.799]
Capex/assets	0.135	0.175	0.193	−0.608
	[0.238]	[0.310]	[0.342]	[−1.248]
Cash flow/assets	1.544***	1.453***	1.459***	1.267***
	[5.422]	[5.164]	[5.218]	[5.249]
R&D/sales	0.148	0.140	0.139	0.116
	[1.145]	[1.130]	[1.127]	[1.235]
Chairman	0.060	0.062	0.064	0.038
	[1.288]	[1.308]	[1.341]	[0.848]
G-index	0.001	0.006	0.006	−0.024
	[0.043]	[0.229]	[0.209]	[−1.483]
Board female	−0.179	−0.131	−0.149	−0.127
	[−0.598]	[−0.437]	[−0.500]	[−0.547]
Board minority	−0.246	−0.240	−0.232	−0.166
	[−1.211]	[−1.164]	[−1.117]	[−0.891]
Network size	−0.296**	−0.020	−0.293**	0.199
	[−2.494]	[−0.065]	[−2.413]	[0.744]
Network size_sq	0.045**	0.016	0.044**	−0.021
	[2.140]	[0.354]	[2.054]	[−0.559]
Centrality	89.183	83.615	88.224	63.366
	[1.608]	[1.515]	[1.588]	[1.625]
Constant	6.423***	5.166***	5.307***	6.037***
	[11.847]	[10.768]	[12.596]	[11.571]
Industry-year FE	Yes	Yes	Yes	Yes
Observations	6270	6270	6270	6270
Adjusted R-squared	0.200	0.195	0.195	0.714

composition. Based on Fracassi and Tate (2012), the death of network members is an ideal shock to network composition, as it is unlikely to be anticipated and is unrelated to firm performance. Retirement, however, may be anticipated, though the contact is less likely to be replaced immediately. Hence, both death and retirement of network contacts can be considered as exogenous shocks to network ties that do not directly affect firm value. From an intuitive point of view, the change of network composition should be most unexpected and evident due to such shocks. Therefore, this intuition motivates us to design a difference in differences (DiD) test to analyze how firm value changes before and after a CEO is affected by such shocks. To correct for any endogenous selection on observables, we use propensity score matching to compare treatment firms (those run by CEOs who are affected by these shocks) with a control group that share similar firm and CEO characteristics in the year prior to the shocks. We then compare the difference in the before and after changes in firm value across the treatment and control groups to identify the causal effect of SNH on firm value.

Table 7 reports the DiD test results. We identify 441 firms in the treatment group that experience such shocks and their CEOs' SNH increases after the shocks. The control group consists of 441 matching firms that do not experience such shocks, but have closest comparative characteristics at the beginning of the year of the shock occurrence. The criteria for matching are reported in Table 7 Panel A.1, which reports the variables we use to do the matching and the mean comparison (*t*-tests) across the two groups. The results suggest that the treated and control firms are comparable in these observables prior to the treatment, and

Table 7
Difference-in-differences analysis.
This table reports the difference-in-differences analysis that examines how firm value changes after a shock to CEOs' network composition. The shock is defined as death and retirement of managers/directors in CEOs' social networks. Panel A.1. reports 441 firms (treatment group) that experience such shocks and their CEOs' SNH increases after the shock. The control group consists of firms that do not experience such shocks, but are similar to the treatment group in many aspects, including firm characteristics, board diversity, and network size. We also require the control firm to be of the same industry and to have the same years. Propensity-score matching method is used to form the control group, and *p*-value is reported for the mean differences of all the matching variables. Panel A.2. reports the changes of Tobin's Q (from T to T + 1, and T to T + 2) for the treatment and control groups. We also report the *p*-value of the *t*-test. *, **, and *** denote significance at 10%, 5%, and 1%, respectively. Panel B.1. reports 444 firms (treatment group) that experience such shocks and their CEOs' SNH decreases after the shock. The control group consists of firms that do not experience such shocks but are similar to the treatment group in many aspects, including firm characteristics, board diversity, and network size. We also require the control firm to be of the same industry and to have the same years. Propensity-score matching method is used to form the control group, and *p*-value is reported for the mean differences of all the matching variables. Panel B.2. reports the changes of Tobin's Q (from T to T + 1, and T to T + 2) for the treatment and control groups. We also report the *p*-value of the *t*-test. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Panel A. SNH increases after shock				
Panel A1. Matching criteria based on firm characteristics at T-1 ($N = 441$)				
Variable name	Treatment	Control	Differences	*p*-Value
Log (assets)	8.055	8.090	−0.035	0.710
Leverage	0.249	0.244	0.006	0.590
Capex/assets	0.052	0.048	0.004	0.134
Cash flow/assets	0.187	0.186	0.001	0.844
R&D/sales	0.044	0.045	−0.001	0.866
Tobin's Q	1.963	1.934	0.029	0.675
Chairman	0.698	0.710	−0.011	0.713
G-index	9.454	9.701	−0.247	0.171
Board female	0.113	0.113	0.001	0.911
Board minority	0.098	0.100	−0.003	0.785
Network size	3.159	3.150	0.009	0.909
Centrality	0.001	0.001	0.000	0.821
Panel A2. Change of Tobin's Q ($N = 441$)				
Q (T + 1)–Q(T)	0.043	−0.136	0.179	0.017
Q (T + 2)–Q(T)	0.024	−0.136	0.160	0.021
Panel B. SNH decreases after shock				
Panel B1. Matching criteria based on firm characteristics at T-1 ($N = 444$)				
Variable name	Treatment	Control	Differences	*p*-Value
Log (assets)	7.993	7.894	0.099	0.280
Leverage	0.220	0.211	0.010	0.350
Capex/assets	0.051	0.050	0.001	0.756
Cash flow/assets	0.185	0.180	0.005	0.414
R&D/sales	0.056	0.089	−0.033	0.172
Tobin's Q	1.936	1.880	0.056	0.425
Chairman	0.685	0.662	0.023	0.475
G-index	9.640	9.484	0.155	0.367
Board female	0.121	0.113	0.008	0.176
Board minority	0.091	0.099	−0.008	0.447
Network size	3.255	3.268	−0.013	0.868
Centrality	0.001	0.001	0.000	0.740
Panel B2: Change of Tobin's Q ($N = 444$)				
Q (T + 1)–Q(T)	−0.025	0.028	−0.053	0.182
Q (T + 2)–Q(T)	−0.104	−0.001	−0.102	0.049

that the parallel trend assumption is satisfied (Roberts and Whited, 2012). These selection variables are the same set as the control variables in our baseline model. In addition, to difference out any potential confounding effects of industry and economic shocks, we require the control firm to be of the same industry (at 2-digit SIC code) and to have the same year as the treatment firm.

Panel A.2 reports the DiD estimators for change of Tobin's Q from T to $T + 1$ and from T to $T + 2$, which are the first and second years following the shocks. Examining the differences between the two groups, we find that the treatment group has a significantly greater improvement in firm value over the two time windows. Compared with the control group, the mean differences are positive and statistically significant at the $p < 5\%$ level. We include pre-treatment Tobin's Q as an additional matching variable and ensure that the treatment and control groups are indistinguishable in firm value prior to the shock. Overall, our findings confirm a significant within-firm improvement in firm value after the CEO's network is shocked and becomes more diverse.

In Panel B we identify 444 firms in the treatment group that experience such shocks, but with a subsequent decrease in CEOs SNH. The control group consists of a group of matching firms that do not experience such shocks but share similar firm characteristics. The matching procedure is the propensity score-based approach, and the results for the matching variables are reported in Panel B1. The parallel trend assumption is satisfied (Roberts and Whited, 2012). Panel B2 reports the DiD comparisons for change of Tobin's Q from T to $T + 1$ and from T to $T + 2$. Examining the differences between the two groups, we find that the treatment group has progressively worse firm performance relative to the control group. The mean difference is negative and is statistically significant at the $p < 5\%$ level over two years. These findings suggest that firm performance deteriorates after the CEO's network becomes less diverse.

3.3. Market reactions to CEO appointment announcement

In this section provide additional evidence regarding value creation by a diversely networked CEO. Specifically, we investigate how the stock market reacts to a new CEO appointment announcement when he/she has a more (less) diverse social network than the departing CEO. We divide the sample into two groups: (1) CEOs who have higher SNH than their predecessors (the heterogeneity-increasing group); (2) CEOs who have lower SNH than their predecessors (the heterogeneity-decreasing group). The announcement returns are forward-looking and capture the new CEO's ability to create value.

Although reverse causality is not a concern in the event-study framework (as it is hard to argue that bigger market reactions lead to more heterogeneous social networks among CEOs), another issue cannot be ignored, i.e., the omitted-variable problem. Some underlying firm characteristics, such as size, capital structure, capital expenditures, cash flow, or R&D investment, can affect both CEO social networks and the market reaction to new CEO appointments. To correct for any endogenous selection on observables, we adopt propensity-score-matching techniques to match firms with similar firm characteristics. According to the literature, promoting a new CEO from inside the firm is a factor that affects future firm performance (Hayes and Schaefer, 1999; Huson et al., 2004). To remove market appreciation driven by these CEO characteristics, we include the following CEO characteristics as matching criteria: CEO age, chairman, and hiring from outside. As Panel A of Table 8 reports, we compare the mean difference

Table 8
Market reactions 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 ensure the two groups of firms have similar characteristics, including size, leverage, capital expenditure, cash flow, and R&D intensity. We also require that the new CEOs between the two groups are similar in terms of age, tenure, chairman position, and whether they are internal candidates 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 appointments. We report cumulative abnormal returns (CARs) over the 3-day window [−1, +1], where day 0 is the date on which the firm announces the new CEO appointment. As an alternative, we also compute the 5-day window of [−2.2].

Panel A. Matching on firm characteristics and CEO characteristics

Variable name	SNH-increasing group	SNH-decreasing group	Differences	*p*-Value
Firm characteristics				
Log assets	8.062	7.718	0.344	0.352
Leverage	0.187	0.183	0.004	0.897
Capex/assets	0.036	0.040	−0.004	0.615
Cash flow/assets	0.172	0.191	−0.019	0.448
R&D/sales	0.050	0.061	−0.011	0.588
G-index	9.375	9.469	−0.094	0.875
Board female	0.130	0.106	0.024	0.286
Board minority	0.084	0.063	0.022	0.493
CEO characteristics				
CEO age	53.844	53.656	0.188	0.909
Chairman	0.375	0.313	0.063	0.606
Hiring from outside	0.531	0.438	0.094	0.461

Panel B: comparison of cumulative announcement return

Variable name	SNH-increasing group	SNH-decreasing group	Differences	*p*-Value
CAR (−1.1)	0.019*	−0.010	0.030**	0.030
CAR (−2.2)	0.020	−0.020**	0.040**	0.012

of the matched pairs and find that matched firms show no differences in selected firm characteristics. We also find that the newly hired CEOs are similar to each other in terms of individual characteristics. The only difference between the matched firms is that one belongs to the heterogeneity-increasing group and the other to the heterogeneity-decreasing group.

Panel B of Table 8 reports the results of the event study on CEO appointments. We report cumulative abnormal returns (CARs) over a three-day window [−1, 1], where day 0 is the date on which the firm announces the new CEO appointment. As an alternative, we also compute a five-day window of [−2, 2]. Our results for different event windows consistently show that firms that replace old CEOs with new chief executives who possess more heterogeneous social networks experience positive CARs, which is statistically significant at the 10% level for the [−1, 1] event window. In contrast, firms in which the new CEOs have less heterogeneous social networks show significantly worse CARs over the [−2, 2] window. Comparing the two groups, the heterogeneity-increasing group has higher CARs than the heterogeneity-decreasing group measured by both windows. The differences in CARs between the two groups are statistically significant at the $p < 5\%$ level. Thus, CEOs' heterogeneous social networks appear to increase shareholder wealth.

3.4. SNH and corporate innovation

This section investigates the potential innovation channel through which SNH affects firm value. We run 2SLS regressions to test the direct impact of SNH on innovation, and then examine whether the level of innovation predicted by SNH is significantly and positively associated with firm value. The 2SLS model specifications are shown as below:

$$\text{Innovation}_{it} = \alpha + \beta SNH_{i,t-1} + \delta X_{i,t-1} + Industry\text{FE} + Year\text{FE} + \varepsilon_{i,t} \tag{3}$$

$$Tobin's Q_{it} = \alpha + \beta Predicted\text{innovation}_{it} + \delta X_{i,t-1} + Industry\text{FE} + Year\text{FE} + \varepsilon_{i,t} \tag{4}$$

where i indexes firms and t indexes time. We propose three measures for innovation performance. The first measure is the logarithm of patent applications granted in a given year (*Patents*). Patent applications filed near the end of a year in the sample period may not be granted immediately and, as a result, such applications are not shown in our sample. Therefore, we use adjusted patent applications to address a potential truncation bias (Hall et al., 2005). Moreover, we exclude firms in our sample that have not received patents to ensure that our results are not driven by those firms. Our second measure of innovation is the logarithm of citations of the patents for which a firm applied in a given year (*Citations*). Complementary to patents received, the citation count captures the relevance of a patent and is positively related to firm value (Hall et al., 2005). As with patent applications, the citation count also has a truncation bias due to the finite length of the patent database. We thus use adjusted citations in our analysis. The third measure of innovation consists of the number of exploratory patents filed in a given year divided by the total number of patents filed in the same year. A patent is classified exploratory if at least 60% of its citations are based on new knowledge (Custodio et al., 2015). Manso (2011) classifies innovative strategies into exploitative (i.e., strategies that refine existing technologies) and exploratory (i.e., strategies that search for new technologies that can transform a business). The set of control variables is the same for both equations and includes R&D intensity as a measure of innovation input, as well as firm characteristics, corporate governance, and network characteristics. We lag all right-hand-side variables one year to alleviate potential endogeneity concerns (Faleye et al., 2014). Dependent variables of innovation and Tobin's Q are measured at the current year. Year and industry fixed effects are applied across all regression models.

Table 9 reports the estimation results for the 2SLS regressions. Column (1) shows that SNH is significantly associated with a higher level of patents in the first stage, with p-value smaller than 1%. Because our patent and citation regressions control for R&D intensity, the results imply that CEOs with higher SNH receive more patents, given the same level of R&D investment. In Column (2), the predicted patents have a positive and significant impact on firm value. The results suggest that CEO SNH leads to greater innovation outputs, through which higher firm value is created. Similarly, as shown in Columns (3)–(6), we find consistent results using citations and exploratory innovation as alternative measures for innovation outputs. Overall, Table 9 suggests that firms run by CEOs with diverse social connections achieve more and better-cited innovations, and engage more in exploratory than exploitative strategies. Such innovation activities in turn promote firm value.

3.5. SNH and M&As

M&As represent one of the largest forms of corporate investment. These investments tend to be inefficient, especially for diversified and cross-border M&As, because of the high information asymmetry in a new industry or market (Jensen, 1986; Morck et al., 1990). Our expectation is that heterogeneous social connections bring different perspectives and greater overseas market information. Hence, SNH can help CEOs make more enlightened decisions on M&As that diversify into other industries and foreign countries. After conducting a series sample selection and matching procedure, our M&A sample includes 1671 domestic deals (US acquirers and US targets) and 716 foreign deals (US acquirers and foreign targets) from 2000 to 2010. To assess M&A performance, we compute three-day cumulative abnormal returns of acquirers' stocks in the event window of [−1, 1] around announcement dates. We estimate expected returns from a standard market model over the period [−210, −11] with the CRSP value-weighted return as the market return.

Table 10 reports the regression results relating *CEO SNH* to acquirers' CARs. In Column (1) we show, that for all domestic deals, *CEO SNH* does not affect announcement CARs in a significant way. However, when we look separately at diversified deals, which

Table 9
CEO SNH and corporate innovation.
This table presents results of 2SLS regressions relating SNH, innovation and firm value. In the first stage, SNH is used to predict three innovation output measures, including logarithm of patents, logarithm of non-self-citations, and a ratio of exploratory patents to total patents. In the second stage, the dependent variable is Tobin's Q, and independent variables are predicted innovation output measures from the first stage. Consistent with baseline regressions, all independent variables are measured at the previous fiscal year end. Innovation measures and Tobin's Q are measured at the current year. Year dummies and industry indicators at 2-digit SIC code are included. Standard errors are adjusted for heteroskedasticity. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Dependent variables	Patents	Tobin's Q	Citations	Tobin's Q	Exploratory ratio	Tobin's Q
	IV 1st stage	IV 2st stage	IV 1st stage	IV 2st stage	IV 1st stage	IV 2st stage
SNH	0.056***		0.139***		0.028***	
	[3.146]		[2.975]		[3.029]	
Predicted patent		1.987**				
		[2.332]				
Predicted citation				1.002***		
				[2.597]		
Predicted explore ratio						3.844**
						[2.060]
Log assets	0.337***	−0.645**	0.628***	−0.607***	−0.023***	0.091
	[26.320]	[−2.324]	[23.148]	[−2.590]	[−4.325]	[1.489]
Leverage	−0.667***	−0.047	−1.705***	0.276	0.106***	−1.984***
	[−9.013]	[−0.074]	[−9.098]	[0.377]	[2.616]	[−7.297]
Capex/assets	2.860***	−8.896***	4.624***	−7.994***	0.171	−4.768***
	[6.081]	[−3.372]	[4.356]	[−3.657]	[0.813]	[−3.917]
Cash flow/assets	0.384**	4.680***	0.592	5.149***	0.207***	5.416***
	[2.403]	[8.910]	[1.544]	[10.408]	[2.756]	[8.443]
R&D/sales	0.179**	0.201	0.367**	0.139	−0.050**	0.631**
	[2.446]	[1.096]	[2.218]	[0.790]	[−2.121]	[2.133]
Board female	0.881***	−1.625*	1.613***	−1.349*	0.111	−0.134
	[5.191]	[−1.935]	[3.756]	[−1.726]	[1.232]	[−0.247]
Board minority	0.257***	−0.202	0.755***	−0.424	0.001	0.365*
	[2.871]	[−0.610]	[3.559]	[−1.048]	[0.032]	[1.679]
Chairman	−0.027	−0.038	0.031	−0.143**	−0.008	−0.113
	[−1.144]	[−0.599]	[0.509]	[−2.006]	[−0.703]	[−1.568]
G-index	−0.041***	0.029	−0.083***	0.027	0.005**	−0.080***
	[−9.497]	[0.822]	[−7.912]	[0.822]	[2.370]	[−4.767]
Network size	−0.098*	−0.238**	−0.149	−0.352**	−0.124***	−0.059
	[−1.735]	[−2.270]	[−0.984]	[−2.523]	[−4.152]	[−0.380]
Network size_sq	0.017*	0.040**	0.030	0.055**	0.021***	0.008
	[1.852]	[2.253]	[1.206]	[2.471]	[4.366]	[0.290]
Centrality	122.805***	114.071	206.286***	158.555	−6.789	461.652***
	[3.925]	[0.714]	[3.191]	[1.082]	[−0.674]	[3.731]
Constant	−2.962***		−2.540***		0.942***	
	[−20.800]		[−9.475]		[18.931]	
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2277	2277	2046	2046	1710	1710
Adjusted R-squared	0.576	−0.465	0.515	−0.697	0.228	−0.235

are defined as 1 when acquirers are not in the same industry (2-SIC code) as the targets, SNH is significantly and positively associated with CARs. As shown in Column (2), the coefficient of SNH is significant at the $p < 5\%$ level. This result supports our hypothesis that CEOs with more heterogeneous networks make better M&As in diversified deals. Column (3) examines foreign deals, where US companies conduct cross-border M&As to acquire target companies in foreign countries. We find that SNH enters in a positive and significant sign, with a p-value <10%. In Column (4), we focus on a subsample of foreign and diversified deals, finding that SNH is also positively associated with CARs. Overall these results suggest that a diverse social network is helpful for managers to make investment decisions that require diverse knowledge and cross-cultural knowhow. Again, Table 10 provides additional evidence of the channel through which CEO SNH enhances firm value. 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, operating performance, and corporate governance quality. For these control variables, our estimates are in general consistent with prior studies (e.g., Moeller et al., 2004; Masulis et al., 2007). Deal characteristics that we control for include payment method, public status of target firms, relative deal size, and tender offer. Finally, we control for network centrality and find that CEOs with larger social networks perform better in domestic deals, which is consistent with the findings of Cai and Sevilir (2012).

4. Conclusion

Although the existing literature documents various benefits and costs of CEO social networks, researchers have paid scant attention to the composition and heterogeneity aspects of CEO social networks. This is somewhat surprising, since the composition of a CEO's social network clearly has an impact on the information and resources the CEO can access. Networking with a

Table 10
CEO SNH and M&A performance.
This table reports the OLS regressions results relating CEO SNH to acquirers' 3-day cumulative abnormal returns around M&As announcement. The dependent variable is the cumulative abnormal returns during the window of [−1, 1] around the announcement date. Testing variable is SNH of acquirers' CEOs. Column (1) includes all domestic targets (U.S. firms). Column (2) includes domestic and diversifying mergers. A diversifying merger is defined as 1 if the acquirer and the target are not in the same industry based on 2-digit SIC. Column (3) includes all foreign targets. Column (4) includes foreign diversifying mergers. Control variables include deal characteristics and acquirer financial variables. All cash is an indicator equal to 1 if the deal is 100% paid by cash, 0 otherwise. All stock equals 1 if the deal is 100% paid by stock, 0 otherwise. Tender offer is an indicator equal to1 if the deal is recorded as a tender off in SDC, and 0 otherwise, Relative size is measured by transaction value divided by market value of the acquirer. PublicTgt is an indicator which equals 1 if the target firm is publicly traded, and 0 otherwise. Market/Book is measured by the market value of equity divided by book value of equity of the acquirer as of the fiscal year end prior to the M&A announcement. All other financial characteristics of the acquirers are computed in the same way as in previous tables. Detailed definitions are given in Appendix A. Numbers in the parentheses are robust t-statistics. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Dependent variable	Acquirer [−1.1] cumulative abnormal returns			
	(1)	(2)	(3)	(4)
	All domestic	Domestic & diversify	All foreign	Foreign & diversify
SNH	0.002	0.007**	0.006*	0.012*
	[0.849]	[2.520]	[1.708]	[1.840]
All cash	0.009*	0.010	0.019*	0.023
	[1.950]	[1.442]	[1.829]	[1.199]
All stock	−0.008	−0.020*	0.002	0.026
	[−0.985]	[−1.907]	[0.074]	[0.584]
Tender offer	−0.006	−0.018	−0.007	0.003
	[−0.776]	[−1.568]	[−0.708]	[0.161]
Relative size	−0.029***	−0.037***	−0.049*	−0.097
	[−3.220]	[−2.725]	[−1.739]	[−1.595]
PublicTgt	−0.001	0.002	0.002	−0.003
	[−0.313]	[0.275]	[0.250]	[−0.217]
Log assets	−0.006***	−0.004**	−0.003	−0.005
	[−4.568]	[−1.971]	[−1.046]	[−0.988]
Leverage	0.010	0.021	0.004	−0.007
	[0.912]	[1.222]	[0.184]	[−0.178]
Market/book	0.000	0.000	−0.000	−0.001
	[0.321]	[1.635]	[−0.292]	[−0.678]
Cash flow/assets	0.012	0.030	−0.040	−0.037
	[0.624]	[0.949]	[−1.469]	[−0.382]
Capex/assets	−0.100**	−0.087	−0.030	0.018
	[−1.975]	[−0.907]	[−0.272]	[0.066]
Chairman	−0.001	0.002	−0.007	0.006
	[−0.413]	[0.308]	[−1.022]	[0.493]
G-index	−0.000	−0.001	0.000	0.001
	[−0.534]	[−1.155]	[0.206]	[0.400]
Centrality	6.805*	2.013	−11.641	−7.517
	[1.943]	[0.492]	[−1.527]	[−0.545]
Constant	−0.006	0.039	0.016	−0.019
	[−0.419]	[1.294]	[0.360]	[−0.352]
Year-industry FE	Yes	Yes	Yes	Yes
Target country FE	No	No	Yes	Yes
Observations	1671	716	496	223
Adjusted R-squared	0.042	0.051	−0.006	−0.087

heterogeneous group of people offers more diverse knowledge, new perspectives, and multiple problem-solving options that can enrich a CEO's knowledge set and improve his/her decision-making. By contrast, the benefits of a homogeneous social network can be marginal.

Our analyses show that 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 the transfer of different knowledge, expertise, and problem-solving skills between connected people and companies, which increases shareholder value. To the best of our knowledge, this paper is the first to find a positive link between social-network heterogeneity and firm value. We examine the mechanisms by empirically testing the impacts of heterogeneous CEO social networks on innovation creation and corporate investment decisions. Our study measures different aspects of heterogeneity, such as demographic, intellectual, professional, and international exposure in social networks. We find that CEO social-network heterogeneity is positively associated with firm innovation and M&A performance.

Our findings have broad implications. Contemporary CEOs require expansive knowledge sets to respond in a timely manner to product innovation and increased competitive pressure. Although acquiring knowledge can be costly, our findings suggest that the more diverse the social networks of the CEO, the greater the growth opportunities for the firm through exposure to different types of information and knowledge, which eventually benefits shareholders. Our results should encourage shareholders to consider how diversity of the social capital of upper management and board members can add value to the firm, given the changing face of the workforce and increasing global competition.

Increased diversity in the workplace can be an issue of concern for policymakers, however. Some claim firms are pressured to hire minorities for ethical rather than profitability reasons, while some argue that firms should strive not to lose talented employees with a variety of experience, knowledge, and cultural backgrounds because they help firms become more successful in the global marketplace. As global competitive pressure on product innovation increases, the heterogeneity of CEO social networks will become more important. Through the lens of CEOs' connections in the overall labor market, our findings offer academic evidence that diversity and heterogeneity are indeed tangible assets that increase profits.

Appendix A. Variable definitions

Variables	Definitions
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).
Log (assets)	Log of total assets (#6)
Leverage	Long-term debt (#9) + debt in current liabilities (#) / total assets (#6)
Capex/assets	Capital expenditure (#128) / total assets (#6)
Cash flow/assets	Operating income before depreciation (#13) / lag of total assets (#6).
R&D/sales	R&D expenditure (#46) / total sales (#12)
Chairman	Indicator equal to 1 if a CEO is a graduate of an Ivy League school, 0 otherwise
G-index	Governance index of Gompers et al. (2003)
Board female ratio	Percentage of female members of boards of directors
Board minority ratio	Percentage of minority members of boards of directors
CEO characteristics	
CEO age	CEO age
CEO female	Indicator equal to 1 if a CEO is female, 0 otherwise
CEO minority	Indicator equal to 1 if a CEO is non-American, 0 otherwise
Network measures	
Gender diversity	Percentage of females in the network
Ethnicity diversity	Percentage of non-Americans in the network
Academic degree diversity	Average index to capture the diversity of academic degree (bachelor's, master's, and doctoral) in the network.
Academic major diversity	Average index to capture the diversity of academic major (Business, Engineering, Liberal Arts and Sciences, and Law) in the network.
Professional diversity	Average index to capture the diversity of managerial expertise (CEO, CFO, Board of directors, Other executives) in the network.
International diversity	Average index to capture the diversity of geographical reach of the connections.
Network size	Log of total number of social ties
SNH	Aggregated measure of CEO social-network heterogeneity, which is the first factor extracted from common factor analysis
Centrality	Degree centrality is computed to capture the degree of interconnectedness of the CEO. It counts the number of direct ties with which a CEO has connections, and then normalize by dividing the maximum possible degrees in an N-actor network in our sample (Scott, 2017).
Other variables	
Patents	Truncation-adjusted number of patents filed by a firm in a given year
Citations	Truncation-adjusted number of citations received by the firm's patents filed in a year
Exploratory ratio	Number of exploratory patents filed divided by the number of all patents filed by the firm in a given year; a patent is classified as exploratory if at least 60% of its citations are based on new knowledge.
General ability	An index, capturing generality of a CEO's human capital based on lifetime work experience in publicly traded firms prior to the current CEO position
Log (population)	Log of total population of the country where the firm's headquarters are located

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