

The Economics of Director Heterogeneity

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Abstract

Government agencies, shareholder groups, and social activists frequently advocate and call for greater heterogeneity amongst directors on corporate boards. Board heterogeneity can arise from differences in director education, experience, profession, gender, ethnicity, and age. We investigate the potential costs and benefits of firms constituting a heterogeneous pool of directors relative to more homogeneous boards. The costs of board heterogeneity stem from difficulties in communication and coordination while the benefits arise from multiple heuristics, greater problem-solving capabilities, and improved mutual monitoring amongst directors. Using the Russell 1000 industrial firms for 2003 and 2005, our empirical analysis suggests that corporate complexity and managerial power affect board heterogeneity. In particular, firms facing greater operational complexity appear to constitute boards with greater heterogeneity while influential CEOs appear to limit or curb board heterogeneity. Controlling for endogeneity concerns, our results indicate that investors place valuation premiums on heterogeneous boards. Decomposing board heterogeneity into *occupational* and *social* heterogeneity components, we find that both components exhibit a positive relation to firm performance. Firm performance however, appears to be substantially more sensitive to occupational heterogeneity (based on director education, experience, and profession) than social heterogeneity (based on director gender, ethnicity, and age). Overall, our analysis indicates heterogeneity amongst directors brings costs and benefits to the firm; suggesting universal calls for greater heterogeneity may not necessarily improve board efficacy or firm performance.

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1. Introduction

The collapse of the dot-com bubble in 2001 and the subsequent failures of Enron and WorldCom lead many industry and legal analysts, as well as investors, to the collective belief that a governance crisis was occurring in corporate America (Gordon, 2003). In response to these high profile events, the U.S. Congress passed the Sarbanes-Oxley Act while major stock exchanges modified their listing requirements with the stated goal of improving board monitoring. Firms responded to these legislative and regulatory changes by placing more independent directors on their boards. Many of these new directors, although independent, came from similar demographic, financial and business backgrounds as those they are charged to monitor and oversee (Finkelstein and Hambrick, 1996). Business critics argue that director similarity or homogeneity leads to “clubby” boards with only nominal differences from management.¹ Westphal and Zajac (1997) find that executives often choose new directors with similar perspectives and values as themselves; suggesting uniformity of thought and practice amongst the firm’s directors.

Proponents of greater board heterogeneity argue that managers and firms benefit from directors bringing diverse social and occupational viewpoints to the boardroom. Large international firms such as PepsiCo and Aon Corp indicate social heterogeneity amongst directors proves helpful in developing new products and strategies.² A 1995 Catalyst survey found that Fortune 500 CEOs considered director heterogeneity an important “bottom-line” or profitability consideration. Activist investor groups such as Catalyst, ICCR and TIAA-CREF argue that homogeneous boards comprised of the CEO’s own peers may be less effective advisors and monitors. In early 2009, the California Public

¹ See for example, Wall Street Journal (March, 30th 2006) which notes that “Board members tend to recruit other board members from their network,... That's either their social network or from other boards they've been on. It's kind of comfortable to have people they know and trust, like-thinking people.”

² Business Week (Feb 27, 2006) quotes Aon Corp.’ executive chairman “A diverse board translates into a more profitable business.” Also see Wall Street Journal Asia, Nov. 29, 2005.

Employees Retirement System issued a report indicating that board diversity leads to greater shareholder returns and firm profitability.

Yet, the drive for less uniformity in the boardroom may be driven by social or ethical reasons rather than firm profitability (Agrawal and Knoeber, 2001; Adams and Ferreira, 2004). Farrell and Hersch (2005) for instance, examine gender heterogeneity and find women board members have no influence on firm performance. They argue that firms simply include members of minority groups to build a public image of inclusiveness, or tokenism. Adams and Ferreira (2009) in contrast, report that gender diversity has a positive and significant impact on board effectiveness. In a general analysis using a large survey of 30,000 interviews from the U.S., Putnam (2007) reports that heterogeneity amongst individuals decreases cooperation, impedes communication, and can lead to social loafing. Board heterogeneity can arise from differences in many areas, such as director education, experience, profession, gender, ethnicity, and age. Beyond gender diversity however, little academic research or evidence indicates that director heterogeneity influences board efficacy or firm performance.

In this study, we explore the potential financial costs and benefits that firms derive from a heterogeneous board of directors. We argue that the benefits of board heterogeneity arise from the varied perspectives and talents that a diverse group of directors brings to the boardroom. More specifically, we argue that director heterogeneity brings a variety of backgrounds, experiences, and skills to the boardroom that strengthens the managerial advisory role. Board heterogeneity in addition, potentially increases mutual monitoring amongst board members; resulting in fewer directors free-riding and improving managerial monitoring. Firms however, can incur costs from heterogeneity because of greater communication and coordination problems that arise amongst a group of directors with dissimilar or disparate backgrounds. In particular, directors bringing varied perspectives to board deliberations can increase conflict amongst board members and protract decision-making processes. Consequently, we compare and contrast firms with a heterogeneous pool of directors to those with

more homogeneous boards. We further classify these variations in board heterogeneity into occupational heterogeneity (education, experience, and profession) and social heterogeneity (gender, ethnicity, and age).

Our central premise suggests that board heterogeneity affects the actions of managers and directors, and ultimately firm performance. On the one hand, greater board heterogeneity potentially increases the skill complementarities of directors, thereby strengthening the board's advisory and monitoring capabilities. Yet, greater heterogeneity can lead to coordination and communication problems that hinder board efficacy. We explore the dominant effect between these competing hypotheses by examining board heterogeneity for the Russell 1000 industrial firms for 2003 and 2005. Additional testing considers the distinct influence of occupational and social heterogeneity on firm performance.

The results indicate that firms with complex operational environments – arguably those in need of greater advising – maintain significantly more diverse boards than firms with simpler operations. Board heterogeneity also appears to play an important role in managerial monitoring. Our evidence suggests that proxies for managerial influence (CEO stock ownership, CEO tenure, and free-cash flow) exhibit a significantly negative relation to board heterogeneity. Influential CEOs appear to face or work with boards comprising directors of similar characteristics to one another.

Our investigation also indicates that board heterogeneity affects firm performance. Using a two-stage framework to control for endogeneity concerns and accounting for firm and industry characteristics, we find a positive association between board heterogeneity and firm performance.³ Specifically, our analysis indicates that our proxy for industry-adjusted Tobin's Q increases by 5.17 percent as board heterogeneity increases by 10 percent, consistent with the notion that investors view

³ Our principal concern with endogeneity rests with reverse causality, whereby greater firm performance gives rise to greater director heterogeneity. We use a 2SLS-IV framework for our primary empirical analysis and also present ordinary-least square results for comparison. In additional testing, we use GMM estimation and non-contemporaneous, difference-on-difference regressions.

board heterogeneity as protecting or benefiting their interests. Our results further suggest that director heterogeneity plays a particularly important role in firms with complex operations. Specifically, the analysis indicates that in firms with complex operating environments, performance improves as boards become increasingly heterogeneous. However, in firms with less complex operating environments, board heterogeneity exhibits a negative relation to firm performance. We interpret this to suggest that greater heterogeneity amongst corporate directors brings both costs and benefits to the firm and thus universal calls for greater heterogeneity may not necessarily improve board efficacy and firm performance.

Separating board heterogeneity into occupational and social components, we find that both types of director heterogeneity exhibit a positive relation to firm performance. Occupational heterogeneity however, appears to have a significantly larger influence on performance than social heterogeneity. Shareholders appear to place greater value on heterogeneity arising from directors' education, experience, and profession than heterogeneity based on directors' gender, ethnicity, and age.

Our results provide evidence that firm and managerial characteristics affect board heterogeneity, and that greater heterogeneity influences performance. An alternative explanation however, suggests that better performing firms choose to maintain more heterogeneous boards to satisfy internal and external political demands. Although our primary empirical analysis uses a two-stage framework to control for this and other endogeneity concerns, we also examine a non-contemporaneous model that assesses the effect of current changes in director heterogeneity on future firm performance. We find that current changes in board heterogeneity are positively related to changes in future firm performance. Coupled with our primary tests, these non-contemporaneous, difference-on-difference results suggest that director heterogeneity can be an important aspect of board oversight. The results provide evidence consistent with the notion that board heterogeneity improves firm performance. Still, we cannot completely eliminate the possibility that better financial

performance leads firms to constitute more heterogeneous boards. However, our testing provides compelling evidence that board heterogeneity appears to be an important factor in corporate governance, providing both financial benefits and costs to firms.

2. *Board Heterogeneity*

The Securities and Exchange Commission, the U.S. Congress (Sarbanes-Oxley), and the major stock exchanges regularly emphasize the role of the board of directors in advising, overseeing, and controlling top management. Prior research examining board composition primarily focuses on director independence from the firm's senior executives. Fama and Jensen (1983) and Dahya, Dimitrov, and McConnell (2008) for instance, suggest that independent directors are more willing to provide effective oversight and disclosure due to reputation concerns. Bebchuk and Cohen (2005) and Linck, Netter, and Yang (2008) indicate that independent directors contribute expertise and objectivity that minimize managerial entrenchment and expropriation of firm resources. Although an abundance of literature investigates board independence (Anderson et al, 2004; Srinivasan, 2005; Boone et al, 2007; Coles, Daniel and Naveen, 2008), little work examines whether differences in directors' experiences and make-ups affect board efficacy and firm performance.

Social scientists devote substantial attention to the study of heterogeneity amongst and across various community settings. Organizational behavior research for instance, focuses on the function and productivity of heterogeneous teams; emphasizing that greater heterogeneity brings greater resources to problem-solving and increases the competitiveness of organizations (Williams and O'Reilly, 1998). Reagans and Zuckerman (2001) emphasize the importance of social ties in encouraging cooperation in teams. Studying the productivity of R&D teams, they find that homogeneity or similarity of demographic and ethnic make-up amongst team members appears to mitigate free-riding problems. Others note moreover, that heterogeneity can increase the costs of communication (Lang,

1986; Arrow, 1998; Putnam, 2007) and escalate team member turnover. Diverse teams tend to suffer from intra-group conflicts, leading to isolation of members not belonging to the majority group. O'Reilly, Caldwell and Barnett (1989) find that group heterogeneity leads to more conflict and less communication, but controlling for the latter it also leads to higher productivity.

Heterogeneity in the context of corporate boards attracts substantial interest from the popular press but only limited research consideration. Pfeffer and Salancik (1978) argue that heterogeneity increases environmental linkages of the board. Westphal and Zajac (1997) study the recruitment process of directors and conclude that CEOs systematically choose directors with similar demographic characteristics as themselves and often these nominees serve as CEOs in other firms. Westphal and Milton (2000) indicate that greater outside director representation on boards does not produce the desired results because most outsiders belong to the same demographic, social, and occupational group and thus fail to infuse fresh ideas into the decision-making process. Anecdotal accounts from companies and business executives indicate that greater board heterogeneity arises, not from an ethical or moral imperative, but from the idea that a heterogeneous workforce provides a competitive advantage by allowing the firm to more effectively communicate with a broad customer base.⁴

Boards of directors have a responsibility to represent the best interests of the firm's shareholders. In doing so, directors carry-out multiple functions including; voting on major proposals, hiring and evaluating managers, monitoring managerial activities, and offering expert advice to top managers. We focus on the potential effects of board heterogeneity on two of these important activities; managerial monitoring and managerial advising. Our framework suggests that heterogeneous boards bring multiple and different perspectives to oversight and advising duties that potentially yield benefits to firm shareholders through improved resource utilization, problem-solving, and strategy formulation (Jensen, 1993). Yet, heterogeneous board may suffer from greater communication

⁴ See for instance the Wall Street Journal, June 21st, 2004.

difficulties and coordination problems than homogeneous boards. Heterogeneity, in our context, includes occupational heterogeneity that incorporates directors' education, work experience, and profession, as well as social heterogeneity that incorporates directors' gender, ethnicity and age.

2.1. Determinants of Board Heterogeneity

2.1.1 Managerial Monitoring and Board Heterogeneity

Managers can waste or expropriate firm resources by using corporate assets to their private benefit and entrenching themselves to the detriment of firm shareholders (Jensen, 1986). Executives can misappropriate firm resources through high levels of executive compensation, excessive perquisites, or investing in negative NPV projects (Dittmar and Mahrt-Smith, 2005). To enable the pursuit of their private interests over outside shareholders' interests, managers can use their power and position to affect board composition (Shleifer and Vishny, 1997). Boone et al (2007) and Shivdasani and Yermack (1997) find that influential managers constitute boards comprising fewer independent directors; suggesting that as CEOs become powerful, they experience less oversight and control from their boards (Hermalin and Weisbach, 1998). Westphal and Zajac (1997) note that CEOs often choose directors that tend to be sympathetic to the demands and requirements of the top management team.

Based on the notion that an occupationally and socially diverse director pool brings multiple perspectives and varied talents to board oversight, we posit that shareholders derive greater monitoring benefits from a heterogeneous board than from a homogeneous board. Greater director heterogeneity arguably provides a greater number of viewpoints on executive actions and indicates that managers are likely to confront more knowledgeable and thus, less compliant monitors. Further, Kandel and Lazear (1992) argue that greater heterogeneity amongst team members increases mutual monitoring. Director mutual-monitoring suggests less free-riding on the board and ultimately, greater board monitoring effectiveness on the behalf of shareholders. If board heterogeneity improves oversight, then consistent

with prior literature, we expect managers to promote greater homogeneity (less heterogeneity) on corporate boards.

2.1.2 Managerial Advising and Board Heterogeneity

Beyond managerial monitoring, boards hold an additional role of providing top managers with advice and counsel to promote shareholder interests. We examine whether operationally complex firms, those potentially in greater need of board advising, maintain more heterogeneous boards than operationally simple firms.⁵ Operational complexity can manifest itself in different forms. Firms for instance, may operate in several different industries that require managers to maintain technical and business expertise in diverse and unrelated product lines (Denis, Denis, and Sarin, 1997; Rose and Sheppard, 1997; Duru and Reeb, 2002). Top managers in such firms, may arise from operating subsidiaries but may have limited knowledge and expertise in the firm's other business lines. Similarly, firms face many different customer bases. Customers vary depending on gender, ethnicity, age, income, geography (amongst other factors); suggesting that managers can confront complex environments in understanding consumer orientation and demands (Carpenter and Sanders, 1998).

To deal with the breadth and depth of operational complexity, managers can turn to their boards for insights and advice (Fama, 1980). Firms coping with multiple contingencies arguably benefit from the perspectives and insights of a heterogeneous board. Directors coming from different business, socio-economic, technical, and professional backgrounds potentially provide managers with a broader and deeper knowledge base than board members from more uniform backgrounds (Klein,

⁵ Industrial organization literature provides an alternate framework for examining the board advisory role. In particular, managers relying on the combined judgment and knowledge of their directors are potentially more likely to reject bad or marginal projects than managers acting upon their sole discretion (Sah and Stiglitz, 1986). Adams, Almeida, and Ferreira (2005) empirically find that powerful CEOs – those acting on little collective input – are associated with greater variability in firm performance than less powerful CEOs that rely on group decision-making. As opposed to an agency framework, this I/O structure suggests that boards potentially improve managerial decision-making, indicating managers promote board heterogeneity.

1998). Overall, we argue that greater firm complexity increases the demand for varying talents, perspectives, and problem-solving skills of corporate board members. Our framework thus suggests a positive relation between operational complexity and board heterogeneity.

2.2. Board Heterogeneity and Firm Performance

Our prior arguments suggest that firm operational complexity and managerial power influence the degree or level of board heterogeneity. The importance of board heterogeneity however, arguably depends on its effect on firm performance. Shareholders potentially benefit from a heterogeneous board because directors with diverse perspectives and talents promote problem-solving. Heterogeneity can also improve mutual monitoring amongst board members, suggesting less director free-riding and better managerial oversight (Kandel and Lazear, 1992). Yet, greater board heterogeneity can increase communication and coordination costs that detract from firm performance.

We argue that the benefits of board heterogeneity play a role in protecting and promoting shareholders' interests in two important cases; operationally complex firms and firms with powerful managers. In the first case, as firms become increasingly more complex, the skill complementarities arising from a heterogeneous board yield greater monitoring benefits to shareholders and also provide stronger advisory committees to managers than less heterogeneous boards. If so, we expect to observe a positive relation between board heterogeneity and firm performance as corporate complexity increases. In less complex firms however, we expect that heterogeneity will provide fewer benefits and its costs will become increasingly more pronounced. Consequently, we posit weaker performance for firms with less complex operations as board heterogeneity increases.

In the second case, although powerful managers may seek to limit the input and oversight of a heterogeneous board, the counsel and monitoring of such a board potentially provides benefits to firm shareholders. We argue that as managers become increasingly more powerful, shareholders derive

greater benefits from the monitoring and oversight of a heterogeneous board than from a homogeneous board. We thus, expect to observe a positive relation between board heterogeneity and firm performance as managerial power increases.

In summary, persuasive arguments exist for greater director heterogeneity creating both costs and benefits to firms. If greater board heterogeneity improves advising and monitoring effectiveness, then we expect shareholders to directly benefit through better firm performance. However, if greater heterogeneity increases conflict levels and communication costs, then firms potentially experience poor performance.

3. Data Description and Definition of Variables

For our empirical investigation, we start with the Russell 1000 firms of 2003 and 2005. Public utilities, banks, and other financial firms are excluded from the sample due to the difficulty in calculating a proxy for Tobin's Q and because government regulation potentially affects firm performance. To be included in the sample, firm proxy statements must also be available for 2003 and 2005 to collect director characteristics and attributes. We further restrict the sample to those firms with data on COMPUSTAT, CRSP, and ExecuComp. The final sample comprises 615 industrial firms (6,160 directors), yielding 1,230 firm-year observations. Data on director age, gender, and ethnic heterogeneity comes from the Investor Responsibility Research Center (IRRC) database.

Because corporate proxy statements often do not provide complete information on directors' educational and work-experience backgrounds, we manually collect this data from other sources. Data comes from *LexisNexis*, *google.com*, *The Dun and Bradstreet Reference Book of Corporate Management*, *Who's Who in Finance and Industry* and *MergentOnline*. In this process, we compare data from multiple sources to ensure accuracy and consistency.

3.1. Measuring Corporate Board Heterogeneity

Our primary concern rests with the effect of board heterogeneity on managerial advising, managerial oversight, and firm performance. For our analysis, we develop an index that ranks the relative board heterogeneity of each firm in the sample. To develop the index, we categorize each director across six individual categories: education, professional experience, board experience, age, gender, and ethnicity. The individual director categories are then aggregated across the entire board. The six aggregated board-characteristics are subsequently ranked and divided into quartiles with the most diverse boards taking a value of 4.0 and the least diverse boards assuming a value of 1.0. Finally, the six quartile rankings for each board are summed and again broken into quartiles that provide an index that ranges from 0.25 to 1.0; lower values denote less heterogeneous boards and higher values denote more heterogeneous boards. In the appendix (Panel A), we provide a detailed example, using the board data from General Dynamics, on the process we follow in developing the heterogeneity index. Sections 3.1.1 through 3.1.6 describe the individual inputs into the index.

3.1.1 Professional Heterogeneity

Our first measure for board heterogeneity centers on director work experience. Professional experience potentially bears a strong relation to a director's identification and perception of corporate problems, and the solutions to these issues. For instance, directors with accounting/finance expertise may be more sensitive to financial issues and can readily communicate their opinions to directors with similar work experience. Heterogeneity of director work-experience likely provides managers with a broader and deeper perspective in monitoring and advising senior management. Yet, greater heterogeneity along this dimension, potentially increases communication and coordination costs and thus hampers decision-making and detracts from firm performance.

Prior literature provides little guidance on measuring or classifying directors' work experiences; consequently, we use an aggregate of four distinct measures of experience. First, we use the variation in the percent of directors that are CEOs of other firms. CEOs serving as directors potentially share many of the same viewpoints and perspectives as the CEO they are charged to monitor and counsel. Second, we examine the functional background of the director. Klein (1998) suggests that a combination of director expertise, rather than a single type, bears a relation to board efficacy. To measure functional background, we assign a value of one if the board has at least one director with experience in a law firm, an accounting firm, a consulting firm, or an investment banking firm. We sum across the four experiential categories and use the total as a proxy for board functional heterogeneity.⁶

Our third proxy for experience heterogeneity focuses on director career development. Directors having worked in different positions and different firms arguably gain more experiences than a director serving in a single functional area for a single firm. Greater exposure to a variety of industries, products, corporate cultures, and corporate hierarchies potentially allows the director to bring greater knowledge and insight to board deliberations. We measure the heterogeneity of director career development as the coefficient of variation (across the entire board) of the number of firms that the director has worked with. In a similar manner, our final proxy for experience centers on the number of senior managerial positions that a director has held during his/her career. Defining senior management as a job title of vice-president or above, we count the number of senior positions that each director has held during their career and calculate its coefficient of variation across the entire board. To capture overall professional heterogeneity, we rank the four proxies for professional diversity into quartiles, sum the quartile rankings, and then rank again into quartiles. The final measure ranges from 0.25 to 1.00 with higher values denoting greater professional heterogeneity.

⁶ So that the maximum score for functional heterogeneity is 4 and minimum 0.

3.1.2 Educational Heterogeneity

Our second measure of heterogeneity focuses on director education. Social science studies suggest that different educational backgrounds are associated with different social status, networking and professional development paths (Useem and Karabel, 1986). Heterogeneous educational backgrounds arguably provide directors with different perspectives and cognitive paradigms that affect career development and social contacts. We measure board educational-heterogeneity by classifying directors into one of three education categories: no college degree, a bachelor degree only, a master degree or beyond. Based on the percentage of directors in each category, we calculate a Herfindahl index of board educational heterogeneity. Because we use a Herfindahl index, education is an inverse measure, i.e., higher values denote less educational heterogeneity.

3.1.3 Board Experience Heterogeneity

We argue that director decision-making and deliberations are not only influenced by prior work experience but also by the time spent serving as director on the firm's board and serving as a director on other corporate boards. The attributes and characteristics associated with being a successful executive are potentially different from the attributes associated with being an effective director. Prior board experience provides directors with an understanding of group dynamics, corporate culture, trust and collaboration with corporate insiders and with other outside directors. Further, board experience acts as a gauge of a director's reputation in the director labor-market. We use two proxies to capture director corporate board-experience heterogeneity. First, we measure the heterogeneity of director tenure as the coefficient of variation of time on the firm's board. Second, to capture the marketability of directors, we use the coefficient of variation of the number of corporate boards that directors serve upon. To measure overall directors' corporate board-experience heterogeneity, we rank the two proxies

into quartiles, sum the quartile rankings, and then rank again to quartiles. The final measure ranges from 0.25 to 1.00 with higher values denoting greater board-experience heterogeneity.

3.1.4 Age Heterogeneity

The next input into the heterogeneity index is director age. Greater heterogeneity amongst directors' ages potentially brings a broader range of ideas to the boardroom. Older directors for instance, may lend greater stability and experiential wisdom to deliberations while younger directors bring greater energy and less risk-aversion to decision-making. We measure the heterogeneity of directors' ages as the coefficient of variation of director age across the entire board. Specifically, we calculate the standard deviation of directors' ages across the entire board and divide by the mean board age.

3.1.5 Gender Heterogeneity

Gender heterogeneity can also bring different perspectives and problem solving attributes to board deliberations and board oversight. Cox et al (1991) and Adams and Ferreira (2009) suggest that gender proxies for heterogeneity of perspectives that individuals bring to their work situations or environments. Hillman et al (2002) indicate that female directors often obtain their board seats after attaining success in their professional field and that these directors provide informational richness to board deliberations. We measure gender heterogeneity as the number of female directors serving on the board divided by total board size.

3.1.6 Ethnic Heterogeneity

Ethnic heterogeneity represents our final measure of board heterogeneity. Similar to our argument on gender heterogeneity, we posit that directors coming from different social and cultural

backgrounds likely introduce new perspectives, ideas, and problem-solving skills to board discussions. Ethnic heterogeneity is calculated as the number of Asian, African American, Hispanics, and Native American directors serving on the board divided by total board size.

3.2. Dependent Variables

Industry-adjusted Tobin's Q is our primary performance measure. We estimate Tobin's Q as the sum of the market value of equity, book value of debt, and the book value of preferred stock, all divided by the book value of total assets. Industry-adjusted Q is calculated as the log of raw Tobin's Q less the log of median Tobin's Q for each 2-digit SIC code. In robustness testing, we use industry-adjusted economic value added (EVA) from Stern Stewart & Company that is measured as net operating profit less the book value of capital multiplied by the firm's cost of capital. EVA provides an annual measure of the firm's economic profit or return to shareholders, scaled by capital investment.

Our hypotheses indicate that firm complexity and managerial power effect board heterogeneity (Fama and Jensen, 1983; Yermack, 1996; Klein, 1998). We proxy for operational complexity using a factor score that incorporates firm size (natural log of total assets), number of 4-digit SIC codes that the firm operates within (business segments), firm leverage (long-term debt divided by total assets) and tangibility of assets (PP&E divided by total assets). CEO Power is measured using a factor score based on the number of years the CEO held his/her post (tenure), the fractional equity ownership of the CEO, and the ratio of free cash flow to total assets (Morck, et. al, 1988; McConnell and Servaes, 1990; Coles et al, 2008).

3.3. Control Variables

We introduce several variables into our analysis to control for industry and firm characteristics. To capture the extent to which larger boards are inherently more diverse, we include the natural log of

board size. Further, because greater director independence from senior management potentially improves the boards' monitoring and control activities and because independent boards may be more heterogeneous, we incorporate board independence into our analysis. Specifically, we use the number of independent directors divided by total board size. Our classification of independent directors follows that of Ferris, Jagannathan and Pritchard (2003), which is a non-employee director with no other relationship with the firm except their directorship.

Firm risk is the standard deviation of monthly stock returns for the past 60 months. To control for the effects of past performance on current performance and board structure, we use prior year return on assets calculated as income before interest, tax, depreciation, and amortization (EBITDA) divided by book value of total assets. We also include the equity ownership stake of the firm's officers and directors to capture the monitoring incentives of firm insiders. Finally, we include sales growth to proxy for firms' growth opportunities.

3.4. Descriptive Statistics and Univariate Results

Table 1 presents three panels of descriptive information for our sample of firms. Panel A provides means, medians, standard deviations, minimum and maximum values for the key variables in the analysis. Panel B shows the results of difference of means tests between firms with heterogeneous boards relative to firms with homogeneous boards. Panel C provides a simple correlation matrix for our primary variables of interest.

Average firm size is about \$12.4 billion of total assets. We note however, that the minimum and maximum values for total assets are \$163.9 million and \$647 billion respectively; suggesting that a broad cross-section of firms populate the sample. The average board comprises 10 directors. Minority directors serve on boards in about 1 out of 2 firms while the typical firm reports one female director. Minority and female board representation varies widely across the sample with a minimum of zero and

a maximum of nearly 54% of director seats held by females or minorities. Our director experience-heterogeneity measure indicates that, on average, 29.8% of board directors currently serve as CEOs of other firms. The average board also has 2.3 members from a law firm, accounting firm, consulting firm, or an investment bank. The average director also serves on one additional (external) corporate board.

Our composite measure of board heterogeneity ranges from a minimum value of 0.25 to a maximum of 1.00. Higher values of the index indicate greater heterogeneity while lower values suggest greater homogeneity amongst directors. Board heterogeneity exhibits a mean value of 0.571 with minimum and maximum values falling at each end of the index.

Panel B presents difference of mean tests for our key variables between firms with heterogeneous boards and homogeneous boards. For these univariate tests, boards with an index value above the median are classified as heterogeneous while boards with a value less than the median are deemed homogeneous. Our results indicate that firms with complex operational environments tend to constitute more diverse boards than firms in simpler operating settings (t statistic=3.46 for equal mean test); consistent with the notion that firm complexity increases the demand for varying talents, perspectives, and problem-solving skills of board members.

The univariate results further indicate a relation between CEO power and board heterogeneity. Specifically, we note that firms with powerful CEOs tend to face homogeneous boards while less powerful CEOs encounter more heterogeneous boards (t-statistic=4.58 for equal mean test); suggesting that powerful managers potentially may face less oversight and monitoring from their boards. The univariate analysis provides mixed findings on the relation between board heterogeneity and firm performance. When using ROA or economic value added (EVA) as a performance metric, we note that firms with heterogeneous boards perform significantly better than firms with homogeneous

boards. Industry-adjusted Tobin's Q however, suggests no performance differentials between firms with diverse directors and firms with similar board members.

Panel C provides a correlation matrix for some of the key variables in the analysis. Board heterogeneity bears a positive association to firm complexity and a negative relation to CEO power. In addition, we find a weak positive relation between board heterogeneity and our primary measure of firm performance, industry-adjusted Tobin's Q. Because board heterogeneity and firm performance are affected by other firm and industry characteristics, we examine our primary hypotheses on board heterogeneity in the following section using a multivariate framework.

4. Multivariate Analysis

4.1. Firm Complexity, Managerial Power and Board Heterogeneity

Our multivariate analysis begins by examining the effects of firm and managerial characteristics on board heterogeneity. Specifically, we posit that the greater the operational complexity of the firm, the greater the level of board heterogeneity. Our arguments also maintain that the greater the influence or power of management, the lower the level of board heterogeneity. To examine these propositions, we estimate the following regression model:

$$\text{Board Heterogeneity} = \beta_0 + \beta_1(\text{Firm Complexity}) + \beta_2(\text{CEO Power}) + \beta_{3-8}(\text{Control Variables}) + \beta_9(\text{Industry Dummies}) + \beta_{10}(\text{Year Dummies}) + \varepsilon \quad (1)$$

Where:

Board Heterogeneity = heterogeneity index comprising six measures of director heterogeneity.

Firm Complexity = factor score based on firm size, number of different 4-digit SIC industries codes that the firm operates within, firm leverage, and tangibility of assets.

CEO Power = factor score based on the number of years CEO held his/her post (tenure), fractional equity ownership of the CEO, and the ratio of free cash flow to total assets.

Control Variables = natural log of board size, board independence, performance_{t-1} (return on assets), growth opportunities, insider holdings and risk (stock return volatility).

Industry Dummies = one for each two-digit SIC code in our sample.

Year Dummies = one for each year of our sample.

We control for serial correlation and heteroskedasticity using the Huber White Sandwich Estimator (clustered on firm level identifier) for variance.⁷

Table 2 presents the results on the relation between board heterogeneity, firm complexity, and CEO power. Column 1 shows the results of regressing board heterogeneity on firm complexity. Consistent with the hypothesis that firms with greater complexity increase the demand for directors with varying talents, perspectives, and problem-solving skills, we find a significant and positive relation between board heterogeneity and firm complexity. The analysis suggests that a one-standard deviation increase in firm complexity ($\sigma = 0.630$) increases board heterogeneity by 2.9%.⁸

Column 2 of Table 2 examines the relation between CEO power and board heterogeneity. Our hypothesis suggests that the greater the influence of management, the lower the level of board heterogeneity. Our results provide fairly strong support to the notion that board heterogeneity decreases as CEO influence increases. We find that a one-standard deviation increase in CEO power ($\sigma = 0.636$) is associated with a decrease in board heterogeneity of 2.0%.⁹ Column 3 incorporates both firm complexity and CEO power into the same regression model. Our results continue to hold and indicate, overall, that firm complexity increases the demand for the talents of a heterogeneous board while the influence of a powerful CEO tends to limit director heterogeneity.

4.2. Board Heterogeneity and Firm Value

The results thus far indicate that firm complexity increases the demand for board heterogeneity and CEO power appears to limit board heterogeneity. Greater heterogeneity on boards however, potentially provides both costs and benefits to the firm and the firm's shareholders. Although a diverse

⁷ Additionally, we examined median regressions rather than mean regressions to investigate the possibility that outliers were driving our results. Both regression techniques provided similar results.

⁸ We compute this percent change as: (coefficient estimate on complexity * one-standard deviation change in complexity)/average board heterogeneity for the sample = $(0.026*0.630)/0.571 = 2.87\%$.

⁹ We compute this percent change as: (coefficient estimate on CEO Power * one-standard deviation change in CEO Power)/average board heterogeneity for the sample = $(-0.018*0.636)/0.571 = 1.99\%$.

pool of directors can bring multiple and varying insights to board deliberations, these same attributes arguably increase communication costs and protract decision-making processes. If board heterogeneity enhances (detracts from) monitoring/advising efficacy, then investors will place valuation premiums (discounts) on those firms with greater board heterogeneity.

Two endogeneity concerns arise when examining the relation between board heterogeneity and firm performance. First, our findings may simply reflect some underlying missing variable which influences board heterogeneity and firm performance. Second, our hypotheses imply that firm performance flows from board heterogeneity (Hermalin and Weisbach, 1998). Board heterogeneity however, could be a function of firm performance, i.e., better performing companies increase board heterogeneity to address public concerns of greater diversity within boardrooms. To mitigate concerns of an omitted variable bias and/or reverse causality, we use instrumental variable, two-stage least square (IV-2SLS) techniques to examine the relation between board heterogeneity and firm performance.¹⁰ In our analysis, we also present ordinary least squares (OLS) regressions for comparative purposes.

Our IV-2SLS procedure takes the form;

$$\text{Stage 1:} \quad \text{Board Heterogeneity} = \beta_0 + \beta_1 (\text{County Heterogeneity}) + \beta_{2,9} (\text{Control Variables}) + \beta_{10} (\text{Industry Dummies}) + \beta_{11} (\text{Year Dummies}) + \varepsilon \quad (2)$$

$$\text{Stage 2:} \quad \text{Firm Performance} = \gamma_0 + \gamma_1 (\text{Predicted Value of Board Heterogeneity}) + \gamma_{2,9} (\text{Control Variables}) + \gamma_{10} (\text{Industry Dummies}) + \gamma_{11} (\text{Year Dummies}) + \varepsilon \quad (3)$$

In the first stage regression, we model board heterogeneity using an instrumental variable that is unlikely to bear a conceptual relation to firm performance and prone to managerial influence. For our instrument, we use the heterogeneity of the county of the firm's corporate headquarters. Intuitively,

¹⁰ We find similar results to our IV-2SLS using an instrumental variable, generalized method of moments (IV-GMM) econometric technique. GMM potentially provides more efficient estimates than those available from 2SLS when regression errors are heteroskedastic and/or auto-correlated. Further, because we use our predicted value (endogenous variable) from the first-stage regression equation as an input to interaction terms (exogenous variable) in the second stage equation, GMM potentially yields more consistent estimates than 2SLS. However, as both approaches provide similar inferences, we present the IV-2SLS because of their greater familiarity. The IV-GMM results are available from the authors.

because corporate headquarters are the center of information exchange between the firm and outside stakeholders (Davis and Henderson, 2004; Pirinsky and Wang, 2006), directors from the local area with greater financial sophistication arguably better understand firm actions than directors with less sophistication.

Data on the location of each firm's headquarters county (and state) comes from COMPUSTAT. Data on county heterogeneity for 2003 and 2005 comes from the U.S. Census Bureau. We measure the county heterogeneity using data on the age, race, gender, and employment characteristics of the county population. In the appendix (Panel B), we discuss our process to aggregate county-population characteristics into the county-heterogeneity measure.

We conduct two preliminary tests to evaluate our IV-2SLS procedure. First, we conduct an endogeneity test which investigates whether OLS and IV-2SLS provide similar estimates. A rejection of the null indicates an endogenous regressor (board heterogeneity) and thus the need for the use of instrumental variable techniques (Hausman, 1978; Hayashi, 2000). The results of the test provide a χ^2 -statistic of 10.67; we reject the null hypothesis and conclude the board heterogeneity is endogenous and proceed with IV-2SLS. Second, we perform a partial F-test that examines the power of our instruments to predict board heterogeneity in the first-stage regression. The test examines whether the instrument variable differs from zero in predicting board heterogeneity. The partial F-statistic ($F=19.45$) indicates rejection of the null and we thus conclude that our instruments exhibit sufficient power in explaining board heterogeneity (Stock, Wright and Yogo, 2002).¹¹

¹¹ We also compute our instrument using various combinations of the county characteristics and arrive at similar results. In our analysis, we find that age, gender and employment heterogeneity are significantly related to board heterogeneity, while race heterogeneity does not bear a significant relation. The following combinations of our county characteristics are significantly related to board heterogeneity: (age, race), (age, race, gender), (age, gender), (gender, race), (age, race, employment), (race, gender, employment), (race, employment), (gender, employment) and (age, employment).

We also compile the local population data based on MSA (Metropolitan Statistical Area). We find very similar results. Because the MSA data is only available for the year 2000, we adopt the annual county data for 2003 and 2005 for our primary specification.

Table 3 presents the regression analyses. The IV-2SLS results are shown in columns 1, 2, and 3 and the reduced-form OLS results are shown in column 4. The econometric techniques yield similar results. As a stand-alone term, the results from column 1 indicate that board heterogeneity exhibits a significant and positive relation to industry-adjusted Q ; suggesting that as board heterogeneity increases, firm value increases. Economically, we note that as board heterogeneity increases by 10%, industry-adjusted Q increases by 4.24%.¹²

Column 2 shows the results between board heterogeneity and firm performance as corporate complexity increases. Previously, we proposed that firms with complex operations garner greater benefits from the competencies of a heterogeneous board than from a homogeneous board. To investigate this proposition, we introduce an interaction term into equation 2 between board heterogeneity and firm complexity. As a stand-alone term, the results from column 2 indicate that complexity exhibits a significant and negative relation to industry-adjusted Q ; suggesting that as operating complexity increases, firm value decreases. Similar to our earlier result, we again find that board heterogeneity as a stand-alone term also bears a positive and significant relation to firm value. Notably, the coefficient estimate on the interaction term between board heterogeneity and firm complexity is positive and significant. Economically, holding complexity constant, we note that as board heterogeneity increases by 10%, industry-adjusted Q increases by 4.11%.¹³ Our results provide fairly strong support to the hypothesis that investors of firms with complex operations value the perspectives and talents of a diverse director pool.

¹² Our economic estimates are based on the 2SLS results which tend to be larger than those noted in the reduced-form OLS model; however, we continue to draw similar inferences with either econometric technique. We calculate this percent change in industry-adjusted Q as: $0.10 * \text{Mean Board Heterogeneity} * \text{Exp}(\beta_1, \text{Coefficient of Board Heterogeneity}) / \text{Exp}(\text{Mean Ind. Adj. Ln } Q)$. Mean Ind. Adj. Ln Q is 0.73. Thus, the increase in ind.adj. Tobin's $Q = 0.10 * 0.571 * \exp(0.433) / \exp(0.73)$ or 4.24% approximately.

¹³ We calculate the increase in industry-adjusted Tobin's Q using the coefficient estimates in Table 3, column 2 as: $0.10 * \text{Mean Board Heterogeneity} * \text{Exp}(\beta_3, \text{Coefficient of Board Heterogeneity} * \text{Complexity}) / \text{Exp}(\text{Mean Ind. Adj. Ln } Q)$. Mean Ind. Adj. Ln Q is 0.73. Therefore increase in ind.adj. Tobin's $Q = 0.10 * 0.571 * \exp(0.402) / \exp(0.73)$ or 4.11% approximately.

Column 3 shows the results of examining board heterogeneity when using dummy variables to proxy for corporate complexity. Specifically, we create two dummy variables for complexity. Complexity-High Dummy equals one if the firm is in the top quartile of complexity and zero otherwise. Likewise, Complexity-Low Dummy is equal to one if the firm is in the bottom quartile of complexity and zero otherwise. Similar to our continuous complexity measure, we again find that complexity appears to detract from firm performance. The coefficient estimates on the complexity dummies show significant but opposite signs, suggesting that more complex firms exhibit worse performance than less complex firms. Interestingly, the interaction terms indicate that investors view greater board heterogeneity as beneficial in complex firms but costly in simpler firms. Specifically, we note that in less complex firms, as board heterogeneity increases, firm performance deteriorates (β_7). For complex firms however, we note that as board heterogeneity increases, firm performance improves (β_5). In an F-test examining the joint probability that board heterogeneity and the interaction of board heterogeneity and Complexity-High differs from zero ($\beta_1 + \beta_5 = 0$), we reject the null hypothesis (F=11.23, p<0.00) and conclude that board heterogeneity appears to improve performance in complex firms. In an F-test examining the joint probability that board heterogeneity and the interaction of board heterogeneity and Complexity-low differs from zero ($\beta_1 + \beta_7 = 0$), we reject the null hypothesis (F=9.45, p<0.00) and conclude that board heterogeneity detracts from performance in less complex firms. In summary, board heterogeneity appears to be value-adding in complex firms. Yet, heterogeneity appears to detract from performance in less complex firms.

4.3 Board Heterogeneity, CEO Power and Firm Performance

Although our earlier analysis indicated that powerful managers seek to limit board heterogeneity, the monitoring of a heterogeneous board over such managers potentially provides greater benefits to shareholders than a homogeneous board. To examine this notion, similar to our

prior regression specification with firm complexity, we develop an interaction term between board heterogeneity and CEO power. Table 4 presents the results. Columns 1 and 2 show the estimates from the IV-2SLS specification and column 3 shows the OLS estimates.

CEO power, as a stand-alone term, exhibits a marginally positive relation to firm performance, suggesting that powerful managers – those with longer tenures, greater shareholdings, and access to greater free cash-flows – exert a positive effect on the firm. We, again, note a positive relation between board heterogeneity (stand-alone term) and firm performance. The interaction term between CEO power and board heterogeneity bears a positive and significant relation to firm performance; suggesting that in the presence of powerful managers, shareholders derive greater benefits from a heterogeneous board than from a homogeneous board. Although our earlier results indicate that powerful managers limit board heterogeneity, these results suggest that shareholders – in the presence of powerful CEOs – appear to place a premium on the oversight and monitoring abilities of heterogeneous boards.

4.3. Occupational and Social Heterogeneity

In this section, we split our heterogeneity measures into two conceptually distinct categories, social heterogeneity and occupational heterogeneity. Social heterogeneity includes our measures for directors' age, gender, and ethnicity. Occupational heterogeneity consists of the heterogeneity measures for director education, work experience, and board experience. Social heterogeneity may be more directly observable by outsiders and more relevant to a political view on board heterogeneity, i.e., boards reflective of the general population. Occupational heterogeneity potentially plays a more relevant role in board advising and monitoring because varying director experiences may provide greater knowledge and understanding in handling corporate issues. We posit that both types of heterogeneity may be relevant and beneficial to the board decision-making process. Yet, differences

potentially arise because social heterogeneity may be politically driven while occupational heterogeneity may be an important consideration in advising and monitoring management.

Table 5 presents IV-2SLS results of regressing firm performance on social and occupational heterogeneity. Similar to our earlier specification, we use predicted values for social and occupational heterogeneity derived from equation (2). For brevity, we do not report the coefficient estimates on the control variables but note that all controls were included in the regression model. The evidence suggests that both forms of heterogeneity affect firm performance. Social heterogeneity and occupational heterogeneity bear significant and positive relations to industry-adjusted Q , indicating that greater heterogeneity along social and occupational lines improves firm performance. We note however, that occupational heterogeneity appears to have a greater influence, almost 32% more, on performance than social heterogeneity. Specifically, the results from column 1 indicate that a 10% increase in mean occupational heterogeneity (.571) is associated with an increase in industry-adjusted Q of $(.10*.571*\exp(0.555))/\exp(0.73)= 4.79\%$ while a 10% increase in mean social heterogeneity (0.570) results in an increase in Q of $(.10*.570*\exp(0.276))/\exp(0.73)= 3.63\%$. In an F-test for $(\beta_1 - \beta_2 = 0)$ examining the equality of the coefficient estimates on social heterogeneity and occupational heterogeneity, we reject the null hypothesis ($p\text{-value}<0.00$) and conclude that occupational heterogeneity exerts a larger influence on firm performance than social heterogeneity.

Column 2 shows a specification examining the effect of social/occupational heterogeneity on firm performance as corporate complexity increases. As noted earlier, we expect firms with more complex operating environments (compared to less complex) to garner greater benefits from more heterogeneous boards. The results indicate that holding corporate complexity constant, greater occupational and social board-heterogeneity enhances firm performance. In particular, the interaction terms between complexity and social heterogeneity, and complexity and occupational heterogeneity exhibit significantly, positive coefficient estimates. Occupational heterogeneity however, again appears

to have a significantly greater influence on firm performance than social heterogeneity. In an F-test examining the equality of coefficient estimates attached to social and occupational heterogeneity ($\beta_1 + \beta_4 = \beta_2 + \beta_3$; $p < 0.00$), we reject the null and conclude that occupational heterogeneity has a larger influence on performance than social heterogeneity.

In column (3), we present results examining the relation between CEO power, board heterogeneity and firm performance. The results, similar to firm complexity, indicate that occupational heterogeneity exerts a larger effect on firm performance than social heterogeneity. Overall, we interpret our results to suggest that shareholders place significantly larger valuations on occupational heterogeneity (based on directors' education, experience, and profession) than on social heterogeneity (based on directors' gender, ethnicity, and age).

4.4. Additional Tests on Causality, and Other Robustness Checks

The results thus far from our IV-2SLS and OLS framework provide evidence consistent with the notion that greater board heterogeneity improves managerial monitoring and advising capabilities that ultimately enhance firm value. In this section, we use a non-contemporaneous, difference-on-difference regression specification to examine the robustness of our economic inferences. Specifically, the model takes the following specification,

$$\Delta(\text{Firm Performance}_{t+2-t}) = \Delta(\text{Board Heterogeneity}_{t-t-2}) + \Delta(\text{Complexity}_{t-t-2}) + \Delta(\text{Control Variables}_{t-t-2}) + \varepsilon \quad (4)$$

Where:

$\Delta(\text{Firm Performance}_{t+2-t})$ = the change in Tobin's Q or economic value added (EVA) from 2005 to 2007.

$\Delta(\text{Board Heterogeneity}_{t-t-2})$ = the change in board heterogeneity from 2003 to 2005.

$\Delta(\text{Complexity}_{t-t-2})$ = the change in corporate complexity from 2003 to 2005.

$\Delta(\text{Control Variables}_{t-t-2})$ = change in control variables (ROA_{t-1}, board size, board independence, growth opportunities, insiders holdings, and risk) from 2003 to 2005. In addition, the regressions include 2-digit SIC dummy variables.

With this regression specification, we examine whether changes in current board heterogeneity (from 2003 to 2005) affect future firm performance (from 2005 to 2007). Beyond mitigating concerns

of firm performance determining board heterogeneity (reverse causality), this specification also controls for firm characteristics not included in our prior regression models (omitted variable bias).

Table 6 presents the non-contemporaneous, difference-on-difference OLS regression results. Column 1 shows the results when using industry-adjusted Tobin's Q as the dependent variable and column 2 provides the results with industry-adjusted economic value added (EVA) as the dependent variable. The results indicate that current changes in board heterogeneity affect future firm performance. Specifically, the analysis indicates that increasing board heterogeneity from 2003 to 2005 is associated with an increase in either Tobin's Q or EVA for the period from 2005 to 2007. Overall, the specification supports the notion that a positive, causal relation exists between board heterogeneity and firm performance.¹⁴

An alternative approach to investigate if better performing firms increase board heterogeneity due to external, political pressures is to examine whether prior performance bears a relation to changes in director heterogeneity. Specifically, we examine whether changes in performance from 2001 to 2003 affect changes in board heterogeneity from 2003 to 2005. The results (not reported) suggest that prior performance does not bear a significant relation to future changes in board heterogeneity; suggesting that prior performance appears to have little effect on board heterogeneity.

Finally, to test the sensitivity of our analysis to econometric techniques, we used fixed-effect models, year-by-year regressions, and 3SLS regressions. All three approaches provide similar results. We also repeat the analysis by winsorizing all variables at the 1% and 5% level to assess the effect of outliers on our results. The results remain quantitatively and qualitatively similar to those reported in the tables.

¹⁴ We also investigate the causality issue by including one-year lags of industry-adjusted Tobin's Q in our regression specifications (Klein, 1998; Anderson et al, 2004). The results (not reported) remain quantitatively and qualitatively similar.

5. Conclusion

Corporate boards of directors represent one of the most important governance devices available to shareholders in monitoring and controlling managerial actions. Recent regulatory changes by the major stock exchanges and U.S. Congress have resulted in firms placing more independent directors on their boards, however, many of these directors come from similar backgrounds as those they are charged to oversee (Finkelstein and Hambrick, 1996). Director like-ness or homogeneity can lead to “clubby” boards and group-think that potentially diminishes board oversight efficacy.

We explore the potential financial costs and benefits that firms derive by constituting boards with directors from various backgrounds and characteristics. Firms can benefit from board heterogeneity because directors of differing backgrounds can bring varied perspectives, talents, and problem-solving skills to corporate deliberations. High levels of board heterogeneity however, arguably increase communication costs and create coordination problems that impede firm performance.

Developing an index that includes six individual director attributes (education, experience, profession, age, gender, and ethnicity), our analysis indicates that board heterogeneity bears a positive relation to firm performance; providing evidence consistent with the notion that a diverse director pool enhances firm value. The results further indicate that as the firm’s operating environment becomes increasingly more complex, the demand for the varying talents and capabilities of a heterogeneous board increase. Specifically, we note a significant and positive association between firm complexity and board heterogeneity. Powerful managers however, appear to limit or mitigate board heterogeneity. Decomposing board heterogeneity into an occupational component based on directors’ education, profession and experience and a social component based on directors’ age, gender, and ethnicity, we find that shareholders place different valuations on each component. Occupational heterogeneity however, appears to yield a significantly larger, positive economic effect on firm performance than social heterogeneity.

Our analysis generally indicates that greater board heterogeneity improves firm performance. Yet, concerns of endogeneity and causality suggest that better performing firms structure more heterogeneous boards than poorly performing firms. To investigate this possibility, in our primary analysis, we use a two-stage least squares (IV-2SLS) approach to examine the relation between board heterogeneity and firm performance. Further testing that uses a non-contemporaneous, difference-on-difference econometric technique also suggests that changes in current board heterogeneity affect future firm performance. Although our results provide fairly compelling evidence that board heterogeneity improves firm performance, we still cannot unambiguously eliminate the possibility that firm performance influences board heterogeneity.

Overall, our results indicate that firm and managerial characteristics influence board heterogeneity, and that greater heterogeneity appears to positively influence firm performance. We note however, that ever-increasing board heterogeneity does not provide benefits to all firms, that is, uniformly prescribing greater board heterogeneity may not be an appropriate governance practice for all firms. Rather, greater heterogeneity appears to be most beneficial to firms with complex operations; indicative of the demand for varying talents, perspectives, and problem-solving skills that a diverse director pool brings to boardroom deliberations.

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Table 1

Descriptive Statistics: Firm, CEO Characteristics and Board Characteristics (n=1,230)

Tobin's Q is the ratio of (Market value of equity + book value of debt) to book value of assets. Leverage is the ratio of book value of long term and short-term debts to book value of total assets. Economic Value Added (EVA) is calculated as (Net Operating Profit after taxes)-(Capital * Cost of Capital) and divide by total assets. Firm Age is the number of years since the firm's inception. Growth opportunities are defined as sales growth of the last five years. ROA is operating income scaled by book value of total assets. Volatility of stock returns is standard deviation of stock returns of last 60 months. CEO stock holding is percent of a firm's outstanding stocks held by CEO. Insider holding is percent of outstanding stocks held by the directors and officers of the firm. Equity-based compensation is the ratio of stock-based compensation to total annual compensation of the CEO. CEO Tenure is tenure of incumbent CEO in number of years. Board size is the number of directors on board. Board independence is the percentage of unrelated outside directors. Board heterogeneity is based on director heterogeneity in six areas, director Age, director Ethnicity, Women directors on Board, director Education, director Working Experience and director board experience. Each of these six heterogeneity measures were divided into quartiles. The sum of six quartiles is then divided by 24 to get a continuous measure of heterogeneity ranging from 0.25 to 1.00.

<i>Panel A: Summary Statistics for the Full Sample</i>					
<i>Variables</i>	<i>Median</i>	<i>Mean</i>	<i>S.D.</i>	<i>Maximum</i>	<i>Minimum</i>
<i>Tobin's Q</i>	1.885	2.343	1.333	10.596	0.930
<i>Ind. Adj. ln(Tobin's Q)</i>	0.633	0.730	0.467	2.360	-0.073
<i>Sales growth (%)</i>	8.703	11.902	16.463	145.081	-41.009
<i>Firm Age (year)</i>	21.000	27.333	10.568	55.000	1.000
<i>Economic Value Added (EVA)</i>	-0.001	-0.011	0.050	0.540	-1.775
<i>Ind. Adj. EVA</i>	-0.000	-0.003	0.044	0.576	-1.714
<i>Volatility of Stock Returns</i>	0.395	0.446	0.178	1.154	0.180
<i>Insider Holding (%)</i>	5.800	8.776	12.488	81.100	0.000
<i>Board Size</i>	10.000	9.722	2.321	17.000	5.000
<i>Board Independence (%)</i>	72.700	69.795	0.157	93.800	0.000
<i>Firm Complexity</i>	1.846	1.863	0.630	4.673	0.523
<i>Assets (\$mill.)</i>	3,388.9	12,396.4	42,078.4	647,483.0	163.9
<i>Leverage</i>	0.216	0.215	0.164	1.442	0.000
<i>Asset tangibility (tangible assets/total assets %)</i>	21.335	27.263	21.366	93.104	2.984
<i>Business Segments (#)</i>	2.000	2.579	1.628	16.000	1.000
<i>CEO Power</i>	1.129	1.277	0.636	3.584	0.003
<i>Free Cash Flow/Assets</i>	0.100	0.095	0.228	0.469	-4.622
<i>CEO Tenure</i>	5.000	7.680	6.767	42.000	1.000
<i>CEO's Equity Holding (%)</i>	0.080	1.137	3.173	33.630	0.000
<i>Board heterogeneity</i>	0.555	0.571	0.112	1.000	0.250
<i>Social heterogeneity</i>	0.566	0.570	0.143	1.000	0.250
<i>Women on Board (%)</i>	11.111	11.919	8.909	54.545	0.000
<i>Minorities on Board (%)</i>	0.000	6.538	8.310	58.333	0.000
<i>CoV of Director Age</i>	0.118	0.124	0.040	0.335	0.010
<i>Occupational Heterogeneity</i>	0.542	0.571	0.122	1.000	0.250
<i>Educational Herfindahl Index</i>	0.273	0.298	0.276	0.840	0.035
<i>Professional Heterogeneity</i>	0.625	0.593	0.303	1.000	0.250
<i>CEO directors (%)</i>	28.500	29.823	25.704	88.900	0.000
<i>Functional heterogeneity</i>	2.000	2.310	1.141	4.000	0.000
<i>CoV of Firms worked with</i>	0.722	0.773	0.373	2.645	0.000
<i>CoV of Higher posts</i>	0.490	0.513	0.256	2.645	0.086

<i>Panel A- continued: Summary Statistics for the Full Sample</i>					
	<i>Median</i>	<i>Mean</i>	<i>S.D.</i>	<i>Maximum</i>	<i>Minimum</i>
<i>Board Experience Heterogeneity</i>	0.625	0.625	0.279	1.000	0.250
<i>CoV of number of external board seats</i>	0.931	1.034	0.465	3.605	0.203
<i>CoV of director tenure</i>	0.613	0.620	0.227	1.531	0.000

<i>Panel B: Difference of Mean Tests</i>			
<i>Variable</i>	<i>Heterogeneous Board</i>	<i>Homogeneous Board</i>	<i>Difference of Mean</i>
<i>Firm Complexity</i>	1.939	1.760	0.179***
<i>CEO Power</i>	1.274	1.405	-0.131***
<i>Ln (Ind. Adj. Q)</i>	0.735	0.725	0.001
<i>EVA (Ind. Adj.)</i>	0.021	-0.001	0.022***
<i>ROA (Ind. Adj.)</i>	0.068	0.044	0.023***

<i>Panel C: Correlation Data</i>			
	<i>Board</i>		<i>CEO</i>
	<i>Heterogeneity</i>	<i>Firm Complexity</i>	<i>Power</i>
<i>Board Heterogeneity</i>	1.000		
<i>Firm Complexity</i>	0.237	1.000	
<i>CEO Power</i>	-0.107	-0.183	1.000
<i>Ln (Ind. Adj. Q)</i>	0.028	-0.250	0.099

Table 2
Determinants of Board Heterogeneity

This table presents results from regression of equation (1). Dependent Variable is Board Heterogeneity. Board heterogeneity is a composite index constructed from six board heterogeneity measures. Complexity is a factor score variable created from Natural log of Assets, Number of Business Segments, Leverage and Assets Tangibility. Board Size is natural log of number of directors on board. Board independence is ratio of number of outsider directors to number of directors and is expressed in percent. ROA_{t-1} is operating income scaled by book value of assets of the previous year. Growth opportunities are defined as sales growth of the last five years. Insider holding is proportion of equity held by managers and directors of a firm. Risk is the volatility of monthly stock returns of last 60 months. All the regressions include intercept and dummies for 2-Digit SIC and year. The standard errors are corrected using Huber-White-sandwich estimator. 2-tail t-statistics are reported in parenthesis. *, **, *** - denotes significance at the 10%, 5%, and 1% level, respectively.

	<i>Dependent Variable: Board Heterogeneity Index</i>		
	(1)	(2)	(3)
β_1 (Complexity)	0.026*** (3.56)	-	0.027*** (4.43)
β_2 (CEO Power)	-	-0.018*** (-3.05)	-0.011*** (-3.00)
β_3 (Board Size)	0.160*** (5.29)	0.177*** (4.00)	0.171*** (5.20)
β_4 (Board Independence)	0.101*** (3.37)	0.090*** (3.14)	0.087*** (4.52)
β_5 (ROA_{t-1})	0.040** (2.13)	0.029 (1.54)	0.039** (2.03)
β_6 (Growth Opportunities)	-0.028** (-2.19)	-0.031** (-2.18)	-0.029** (-2.19)
β_7 (Insider Holdings)	0.001*** (3.25)	0.001*** (2.61)	0.001*** (2.93)
β_8 (Risk)	-0.065* (-1.68)	-0.055 (-1.42)	-0.045* (-1.85)
Intercept, Industry and Year Dummies	Yes	Yes	Yes
Observations	1,230	1,230	1,230
Adj R-squared =	0.288	0.267	0.294

Table 3
Board Heterogeneity, Firm Complexity, and Firm Performance

This table presents results from 2SLS regression in column (1), (2), and (3). Column (4) shows the OLS results. In the first stage of 2SLS, we run the regression of following equation.

$$\text{Board Heterogeneity} = \beta_0 + \beta_1 (\text{Firm Complexity}) + \beta_2 (\text{CEO Power}) + \beta_3 (\text{County Heterogeneity}) + \beta_{4-9} (\text{Control Variables}) + \beta_{10} (\text{Industry Dummies}) + \beta_{11} (\text{Year Dummies}) + \varepsilon$$

County Heterogeneity is a composite heterogeneity index based on the age, race, gender and employment heterogeneity of the county's population. Other variables see Section 4.1. We only show here the second stage results in the table. Dependent variable is natural log of Tobin's q, which is adjusted for the median value of firms in 2-digit SIC group. Complexity dummy denotes one if the firm is in the top quintile in terms of complexity ranking, zero if in the bottom quintile. All other variables are defined in Tables 1 and 2. All the regressions include intercept, industry and year dummies. The standard errors are corrected using Huber-White-sandwich estimator. 2-tail t-statistics are reported in parenthesis. *, **, *** - denotes significance at the 10%, 5%, and 1% level, respectively.

	<i>Dependent Variable: Firm Performance</i>			
	2SLS			OLS
	(1)	(2)	(3)	(4)
β_1 (Heterogeneity)	0.433** (2.24)	0.574** (2.26)	0.585** (2.22)	0.254** (1.99)
β_2 (Complexity)	-0.512*** (-4.32)	-0.902*** (-5.34)	-	-0.347*** (-3.55)
β_3 (Heterogeneity * Complexity)	-	0.402*** (3.67)	-	0.274*** (2.78)
β_4 (Complexity High Dummy)	-	-	-0.211** (-2.36)	-
β_5 (Heterogeneity * Complexity High Dummy)	-	-	0.079*** (2.89)	-
β_6 (Complexity Low Dummy)	-	-	0.633** (2.44)	-
β_7 (Heterogeneity * Complexity Low Dummy)	-	-	-0.963** (-2.32)	-
β_8 (Board Size)	-0.032** (-2.02)	-0.030** (-2.11)	-0.028** (-2.44)	-0.022* (-1.90)
β_9 (Board Independence)	0.135 (0.87)	0.127 (0.99)	0.131 (0.73)	0.120 (0.89)
β_{10} (ROA _{t-1})	0.266** (2.11)	0.256** (2.42)	0.189** (2.12)	0.245** (2.01)
β_{11} (Growth Opportunities)	0.054* (1.78)	0.046* (1.89)	0.049** (2.13)	0.040* (1.67)
β_{12} (Insider Holdings)	-0.000 (-0.54)	-0.000 (-0.74)	-0.001 (-1.03)	-0.000 (-0.34)
β_{13} (Risk)	-0.177* (-1.88)	-0.180** (-2.05)	-0.435** (-2.35)	-0.155** (-2.50)
β_{14} (CEO Power)	0.146 (1.55)	0.099 (1.47)	0.090 (1.37)	0.156 (1.33)
Intercept, Industry and Year Dummies	Yes	Yes	Yes	Yes
Observations	1,230	1,230	1,230	1,230
Adjusted R ²	0.316	0.325	0.389	0.242
F-test	-	$\beta_1 + \beta_3 = 0$	$\beta_1 + \beta_5 + \beta_7 = 0$	$\beta_1 + \beta_3 = 0$
p-value of F-test	-	<0.00	<0.00	<0.00

Table 4
Board Heterogeneity, CEO Power, and Firm Performance

This table presents results from 2SLS regression in column (1) and (2). Column (3) shows the OLS results. In the first stage of 2SLS, we run the regression of following equation.

$$\text{Board Heterogeneity} = \beta_0 + \beta_1 (\text{Firm Complexity}) + \beta_2 (\text{CEO Power}) + \beta_3 (\text{County Heterogeneity}) + \beta_{4-9} (\text{Control Variables}) + \beta_{10} (\text{Industry Dummies}) + \beta_{11} (\text{Year Dummies}) + \varepsilon$$

County Heterogeneity is a composite heterogeneity index based on the age, race, gender and employment heterogeneity of the county's population. Other variables see Section 4.1. We only show here the second stage results in the table. Dependent variable is natural log of Tobin's q, which is adjusted for the median value of firms in 2-digit SIC group. Complexity dummy denotes one if the firm is in the top quintile in terms of complexity ranking, zero if in the bottom quintile. All other variables are defined in Tables 1 and 2. All the regressions include an intercept, industry and year dummies. The standard errors are corrected using Huber-White-sandwich estimator. 2-tail t-statistics are reported in parenthesis. *, **, *** - denotes significance at the 10%, 5%, and 1% level, respectively.

	<i>Dependent Variable: Firm Performance</i>		
	2SLS		OLS
	(1)	(2)	(3)
β_1 (Heterogeneity)	0.545** (2.20)	0.520** (2.22)	0.335** (2.10)
β_2 (CEO Power)	0.030* (1.92)	-	0.047* (1.90)
β_3 (Heterogeneity * CEO Power)	0.574** (2.45)	-	0.426** (2.34)
β_4 (CEO Power High Dummy)	-	0.018* (1.93)	-
β_5 (Heterogeneity * CEO Power High Dummy)	-	0.231** (2.40)	-
β_6 (CEO Power Low Dummy)	-	0.032 (1.39)	-
β_7 (Heterogeneity * CEO Power Low Dummy)	-	-0.242 (-1.63)	-
β_8 (Board Size)	-0.030*** (-2.59)	-0.032*** (-2.68)	-0.034*** (-2.66)
β_9 (Board Independence)	0.111 (1.21)	0.125 (1.25)	0.154 (0.78)
β_{10} (ROA _{t-1})	0.220*** (2.78)	0.278*** (2.84)	0.326*** (2.87)
β_{11} (Growth Opportunities)	0.050** (2.13)	0.055** (2.42)	0.059*** (2.72)
β_{12} (Insider Holdings)	-0.000 (-0.99)	-0.001 (-1.02)	-0.000 (-0.55)
β_{13} (Risk)	-0.233** (-2.26)	-0.489*** (-2.57)	-0.284*** (-2.57)
β_{14} (Complexity)	-0.663*** (-4.94)	-0.643*** (-4.23)	-0.774*** (-3.75)
Intercept, Industry and Year Dummies	Yes	Yes	Yes
Observations	1,230	1,230	1,230
Adjusted R ²	0.355	0.362	0.377
F-test	$\beta_1 + \beta_3 = 0$	$\beta_1 + \beta_5 + \beta_7 = 0$	$\beta_1 + \beta_3 = 0$
p-value of F-test	<0.00	<0.00	<0.00

Table 5

Social Heterogeneity, Occupational Heterogeneity, Firm Complexity, CEO Power and Firm Performance

This table presents the second stage results from 2SLS regressions, examining the firm performance implication of social and occupational heterogeneity of the board. Social heterogeneity comprises gender, age and ethnicity heterogeneity. Occupational heterogeneity consists of education and experience heterogeneity. Dependent variable is industry-adjusted natural log of Tobin's q. All other variables are defined in Tables 1 and 2. All the regressions include intercept, industry and year dummies. The standard errors are corrected using Huber-White-sandwich estimator. 2-tail t-statistics are reported in parenthesis. *, **, *** - denotes significance at the 10%, 5%, and 1% level, respectively.

	<i>Dependent Variable: Firm Performance</i>		
	(1)	(2)	(3)
β_1 (<i>Social Heterogeneity</i>)	0.276** (2.22)	0.211 (1.55)	0.100 (1.55)
β_2 (<i>Occupational Heterogeneity</i>)	0.555*** (3.00)	0.230** (2.35)	0.123** (2.23)
β_3 (<i>Complexity</i>)	-0.699*** (-4.33)	-0.908*** (-5.77)	-0.803*** (-5.34)
β_4 (<i>Social Heterogeneity * Complexity</i>)	-	0.200* (1.75)	-
β_5 (<i>Occupational heterogeneity * Complexity</i>)	-	0.453** (2.45)	-
β_6 (<i>CEO Power</i>)	-	-	0.040* (1.76)
β_7 (<i>Social Heterogeneity * CEO Power</i>)	-	-	0.105 (1.57)
β_8 (<i>Occupational heterogeneity * CEO Power</i>)	-	-	0.160** (2.11)
<i>Other Controls (Board size, Board independence, ROA_{t-1}, Insider holdings, Growth opportunities, Risk_t)</i>	Yes	Yes	Yes
<i>Intercept, Industry and Year Dummies</i>	Yes	Yes	Yes
<i>Observations</i>	1,230	1,230	1,230
<i>Adjusted R²</i>	0.304	0.350	0.314
<i>F-test</i>	$\beta_1 + \beta_2 = 0$	$\beta_1 + \beta_4 = 0$	$\beta_1 + \beta_7 = 0$
<i>P-value of F-test</i>	<0.00	0.03	0.04
<i>F-test</i>	$\beta_1 - \beta_2 = 0$	$\beta_2 + \beta_5 = 0$	$\beta_2 + \beta_8 = 0$
<i>P-value of F-test</i>	<0.00	<0.00	<0.00
<i>F-test</i>	-	$\beta_1 + \beta_2 + \beta_4 + \beta_5 = 0$	$\beta_1 + \beta_2 + \beta_7 + \beta_8 = 0$
<i>P-value of F-test</i>	-	<0.00	<0.00
<i>F-test</i>	-	$\beta_1 + \beta_4 = \beta_2 + \beta_5$	$\beta_1 + \beta_7 = \beta_2 + \beta_8$
<i>P-value of F-test</i>	-	<0.00	<0.00

Table 6
Non-Contemporaneous, Difference-on-Difference Regressions

This table presents results from Difference-on-Difference regressions. Δ denotes difference of the variable, calculated by subtracting value of 2003 from value of 2005. The dependent variables are calculated by subtracting 2005 value from 2007 value. Economic Value Added (EVA) is calculated as (Net Operating Profit after taxes)-(Capital * Cost of Capital) and divide by total assets. Both Tobin's q and EVA are industry-adjusted. All other variables are defined in Tables 1 and 2. All the regressions include intercept. The standard errors are corrected using Huber-White-sandwich estimator. 2-tail t-statistic are reported in parenthesis. * denotes significant at 10%; ** significant at 5%; *** significant at 1%.

<i>Dependent Variable: Change in Firm Performance</i>		
	<i>Ln(Tobin's Q)₂₀₀₇ - Ln(Tobin's Q)₂₀₀₅</i>	<i>EVA₂₀₀₇ - EVA₂₀₀₅</i>
	(1)	(2)
<i>ΔBoard Heterogeneity</i>	0.235** (2.12)	0.212** (2.15)
<i>ΔComplexity</i>	-0.484** (-2.30)	-0.351** (-1.99)
<i>ΔROA_{t-1}</i>	0.184** (2.43)	0.330** (2.10)
<i>ΔBoard Size</i>	-0.004 (-1.45)	-0.002 (1.59)
<i>ΔBoard Independence</i>	0.100 (1.36)	0.023 (1.38)
<i>ΔGrowth Opportunities</i>	0.044** (2.45)	0.014** (2.37)
<i>ΔInsider Holdings</i>	0.000 (0.04)	0.000 (0.04)
<i>ΔRisk</i>	-1.800*** (-3.99)	-0.306*** (-4.50)
<i>Intercept and Industry Dummies</i>	Yes	Yes
<i>Observations</i>	613	613
<i>Adjusted R²</i>	0.304	0.222

Appendix (Panel A)

Example Given On How We Derive Board Heterogeneity Index: General Dynamics in 2003.

Director	Age	Gender	Ethnic Minority	Tenure	BoardSeats	CEO Firms worked	Highpost	Law	Consulting	Accounting	IB/venture	Bachelor	Master or higher	
1	59	m	No	2003	0	Yes	1	5	No	No	No	No	Yes	No
2	80	m	No	1974	2	No	2	5	No	No	No	Yes	Yes	Yes
3	72	m	No	1991	2	No	2	4	No	No	No	No	Yes	Yes
4	63	m	No	2004	2	No	2	4	No	Yes	No	No	Yes	Yes
5	59	m	Yes	2003	2	No	0	0	No	No	No	No	Yes	Yes
6	63	m	No	1994	1	No	2	5	Yes	No	No	No	Yes	Yes
7	61	m	No	2003	0	Yes	3	5	No	No	No	No	Yes	Yes
8	52	m	No	1987	2	No	2	4	No	No	No	Yes	Yes	Yes
9	65	m	No	2004	4	No	0	0	No	No	No	No	No	No
10	63	m	No	1997	1	Yes	1	5	No	Yes	No	Yes	Yes	Yes
11	66	m	No	1998	0	No	2	4	No	Yes	No	No	Yes	Yes
12	70	m	No	1998	2	No	1	5	No	No	No	No	Yes	No

Educational Heterogeneity:

General Dynamics had 12 directors in 2005. Among them, 1 director has no college degree. 2 of them have bachelor’s degree only and 9 of them have master’s or higher degree (Column 14 & 15). As such, the educational heterogeneity of General Dynamics is calculated by the Herfindahl index based on the percentage of the three categories of directors. More specifically, the index is $(1/12)^2 + (2/12)^2 + (9/12)^2 = 0.5972$. The smaller the value the more heterogeneous of the board members in terms of their education.

Professional Heterogeneity:

This index has four proxies, namely percentage of outside CEOs, function area expertise, coefficient of variation based on number of firms of directors’ experience, coefficient of variation of high positions of the directors’ experience.

Among the 12 directors of General Dynamics, 3 directors were current CEOs of other firms and thus we calculate the percentage as $3/12 = 25\%$ (Column 7).

1 director has experience in law firm, 3 in consulting, and 3 in IB/venture capital firm and none in accounting firm. As such, the functional heterogeneity for General Dynamics is 3, as we count the number of directors with experience in the same area only once (Column 10-13).

The coefficients of variation of the firms worked with of the directors and of the high positions are calculated directly based on the information collected (Column 8 & 9). For General Dynamics, they are 0.603 and 0.483, respectively.

Board Experience Heterogeneity

The first proxy is the coefficient of variation of the directors’ tenure on General Dynamics’ board, which is calculated as 1.03 (Column 5). The second proxy is based on the external board seats of the directors and the coefficient of variation of that is 0.778 (Column 6).

Age Heterogeneity

We calculate the coefficient of variation of directors’ age for General Dynamics as 0.111 (Column 2).

Gender Heterogeneity

This proxy is calculated as the percentage of female directors. For General Dynamics, it is 0 (Column 3).

Ethnic Heterogeneity

It is measured by the percentage of ethnic minority (Asian, African American, Hispanic, and Native American) directors. For General Dynamics, it is $1/12=0.083$ (Column 4).

Compiling Board Heterogeneity Index

We rank the entire samples firm into quartiles according to our heterogeneity proxies. Higher quartile means greater heterogeneity. For instance, age heterogeneity is measured by coefficient of variation of director’s age and the larger the number the greater the heterogeneity. As such, General Dynamics rank in terms of age heterogeneity is 2. The following Table summarizes the quartile rank of General Dynamics in terms of the proxy:

<i>Age</i>	<i>Gender</i>	<i>Ethnicity</i>	<i>Education</i>	<i>Professional</i>	<i>Board Experience</i>
2	1	3	4	3	3

Finally, we add up the heterogeneity ranking of each category and rank the total value into quartile again. We standardize our final board heterogeneity value to range from 0.25 to 1 (divided the quartile ranking by 4).

Appendix (Panel B) – Development of County Heterogeneity

1. Age Heterogeneity of County Population

We calculate the Herfindahl Index based on the county population information based on US Census Bureau annual estimate data, which is organized by 5-year bracket. There are 18 brackets, from under 5, 5 to 9, until 85 years old and over. We calculate the percentage of population in each age bracket first and then the Herfindahl Index on the age distribution. Note that the Herfindahl index is an inverse measure of age heterogeneity of the county population.

2. Gender Heterogeneity

We measure gender heterogeneity by the percentage of female population of the county.

3. Race Heterogeneity

We measure Race Heterogeneity of the county by calculating a Herfindahl index based on the percentage of ethnic population distribution. More specifically, we obtain the percentage population of the county based on US Census Bureau annual estimate data, which categorize the population into 6 ethnic groups, namely, white, black, American Indian/Alaska Native, Asian, Native Hawaiian/Other Pacific Islander, and two or more races. We then calculate the Herfindahl index based on the percentage of each ethnic group among the total county population. The lower the Herfindahl index, the more ethnic heterogeneous the county population.

4. Employment Heterogeneity

US Census Bureau publishes data on private nonfarm employment in 19 2-digit NAICS industries (see the table below). We calculate the Herfindahl index based on the percentage of employees in the 19 industries amongst the total county employment. The lower the index, the greater employment Heterogeneity of the county population.

Industry Name	2-digit NAICS Code
<i>Forestry, fishing, hunting, and agriculture support</i>	11
<i>Mining</i>	21
<i>Utilities</i>	22
<i>Construction</i>	23
<i>Manufacturing</i>	31
<i>Wholesale trade</i>	42
<i>Retail trade</i>	44
<i>Transportation and warehousing</i>	48 & 49
<i>Information</i>	51
<i>Finance and insurance</i>	52
<i>Real estate, rental and leasing</i>	53
<i>Professional, scientific, and tech. services</i>	54
<i>Management of companies</i>	55
<i>Administration, support, waste management & remediation services</i>	56
<i>Educational services</i>	61
<i>Health care and social assistance</i>	62
<i>Arts, entertainment and recreation</i>	71
<i>Accommodation and food services</i>	72
<i>Other services (except public administration)</i>	81

Composite County Heterogeneity

We aggregate the aforementioned four county heterogeneity measures into a single County Heterogeneity Index. More specifically, we rank all the counties into quartiles by each heterogeneity measure, with higher quartile indicating greater heterogeneity. Finally, we add up the four rankings of each heterogeneity measure and divided the total by 16, so that the County Heterogeneity ranges from 0.25 to 1. In the table below, we show the numerical examples of two counties in 2003. For instance, Ocean county of New Jersey has an age Herfindahl index of 0.053 and it ranks in the top quartile, while Bland, VA has an age Herfindahl index of 0.061 and ranks in the bottom quartile. Likewise, the Herfindahl indexes of employment heterogeneity of the two counties are 0.138 and 0.376, respectively. The quartile rankings of the two counties are 4 and 1, respectively. The total composite County Heterogeneity index is the sum of the four rankings for each county and divide by 16. For Ocean, NJ, the composite index is 0.875 and for Bland, VA, the index is 0.3125.

<i>County</i>		<i>Heterogeneity Measure</i>			
		<i>Age</i>	<i>Race</i>	<i>Gender</i>	<i>Employment</i>
Ocean, NJ <i>(Composite: 0.875)</i>	Raw	0.053	0.887	52.3%	0.138
	Quartile Rank	4	2	4	4
Bland, VA <i>(Composite: 0.3125)</i>	Raw	0.061	0.900	44.6%	0.376
	Quartile Rank	1	2	1	1