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Director Human Capital, Information Processing Demands, and Board Effectiveness

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Research on human capital as a source of competitive advantage has focused largely on firm employees. In this article, we argue that outside directors' general human capital can also be a source of competitive advantage. Firm performance is likely to benefit from directors' human capital—that is, their prior experience and education—because such human capital is likely to make them more effective at monitoring management and providing advice. Drawing on insights from research on individuals' cognitive limitations, we further argue that the extent to which the firm is able to benefit from this human capital can be severely limited by the demands for information processing that directors face from their other board positions. Consequently, we find that the benefit of directors' human capital is contingent upon the information processing load placed upon them from their other board appointments. We find support for our hypotheses using data on over 5,700 directors from 650 firms sampled from the Fortune 1000. This study extends the nascent literature on board human capital by showing that in addition to specific expertise in relevant areas, directors' general human capital can also help firms create competitive advantage. The theory developed in this article also contributes to the literature on strategic human capital by incorporating the concept of information processing demands, suggesting that not only do such demands leave limited cognitive capacity for directors to focus on the focal firm but also that they can severely diminish the beneficial effects of directors' general human capital.

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Prior research on board effectiveness has focused almost exclusively on structural characteristics of the board, such as board size and the level of independence, and attempted to link those characteristics to firm performance. Moreover, reviews of the literature on board structural independence have concluded that there is little evidence that increased independence actually improves board functioning and subsequent firm performance (Dalton, Daily, Ellstrand, & Johnson, 1998; Westphal, 1998). More recently, scholars have begun to argue that we must consider the directors' human capital—that is, their knowledge, skills, and abilities—when examining board effectiveness and its link with firm outcomes (Carpenter & Westphal, 2001; Hillman & Dalziel, 2003; McDonald, Westphal, & Graebner, 2008).

While this recent research is a significant step forward, these studies have a number of limitations. First, although this research has begun to consider the effect of director human capital on firm outcomes, the focus has been on linking very specific types of experience with specific firm outcomes (such as the relationship between directors' acquisition experience and the focal firm's subsequent acquisition performance, or between directors' international experience and the proportion of international sales) (Carpenter, Sanders, & Gregersen, 2001; McDonald et al., 2008). Although these findings are instructive, what they have not considered is whether a more general form of human capital may have an influence on board effectiveness. Furthermore, this research has focused on intermediate outcomes and has not found a link between the human capital of the board and overall firm performance.

Second, very few studies have considered directors' limitations in conjunction with their human capital. Most of the literature on human and social capital posits a "more is better" approach, assuming that the possession of incremental levels of skill, experience, and access to information flow is always beneficial to the individual and ultimately the firm (Burt, 1992, 1997; Ployhart & Moliterno, 2011). Kor and Sundaramurthy (2009) develop the only study that we are aware of that considers the drawbacks of having too much human capital. The authors found (although at a weak level of support) "overboarding"—that is, one individual being on too many boards at the same time—to be a problem that diminishes the benefit of having directors with human capital. Tian, Haleblian, and Rajagopalan (2011) note the difficulty of capturing the processes used to unlock director human capital and call for future research to examine the direct benefits of human capital to the firm.

Given the development of the literature on board effectiveness, the primary research questions of this study are: What factors add to or detract from directors' abilities to contribute effectively to the firm, and how do these factors influence ultimate board effectiveness? In order to answer these questions, we draw on theory and research on human capital and information processing to develop a more comprehensive model of board effectiveness. Information processing theory posits that the boundary conditions of information overload occur when individuals reach a point at which they are unable to process any additional information (O'Reilly, 1980; Tushman & Nadler, 1978). Additional information received once an individual reaches overload, or is overcommitted, becomes a liability and may harm performance (Eppler & Mengis, 2004). Not recognizing an individual's limitations to absorb and process new information can limit firms in their ability to benefit from the available human and social capital (Oldroyd & Morris, 2012). We combine these insights with research on

human capital to argue that board effectiveness can be predicted more accurately if directors' human capital and the information processing demands they face from the other boards they are associated with are taken into consideration simultaneously. More specifically, we argue that directors' general human capital, defined as the skills or experience embedded within individuals (Becker, 1962; Harris & Helfat, 1997), is likely to be a useful proxy for their ability to perform their monitoring and advice-giving functions. We further argue that the limitations that firms face in leveraging the board's human capital may not be connected only to the directors' firm-specific or industry-specific knowledge, but also to the information processing demands they face from their other board appointments. These information processing demands are likely to directly inhibit their ability to interpret and process the large volumes of information they need to in order to effectively monitor or provide useful advice to management.

This study contributes to the nascent literature on board human capital as well as more generally to the corporate governance literature, and the strategy literature on human capital. First, in contrast to previous research that has linked specific indicators of human capital with specific outcomes (Carpenter, Pollock, & Leary, 2003; Carpenter & Westphal, 2001; Hillman, 2005; Jensen & Zajac, 2004), this study extends the growing research on the value of board human capital by arguing and empirically testing the effects of general indicators of the board's level of human capital on overall firm performance.

Second, this study goes beyond prior research by developing a unique model of board effectiveness that includes the construct of information processing demands that has not previously been considered in research on boards. Although previous research has discussed the inability of directors to devote time to firms on whose boards they hold seats due to being "overboarded," it has not conducted a systematic examination of the effect of high levels of information processing demands. In contrast, we argue, and demonstrate empirically, that models of board effectiveness need to attend to the negative spillovers produced by serving on other boards that may limit directors' ability to contribute to firm performance. Even the most skilled and qualified directors may be overwhelmed if they face excessive information processing demands from their other board appointments, which may reduce their ability to apply their knowledge and skill effectively to the focal firm. This study suggests that research on strategic human capital should consider not just how to attract or retain human capital but also how excessive information processing loads can prevent the available human capital from being leveraged to benefit the firm. Furthermore, by expanding understanding of determinants of board effectiveness to include the directors' limitations in addition to their capabilities, this study takes a first step in building a framework that will help governance researchers find more consistent relationships between corporate governance characteristics and firm performance.

Theory Development and Hypotheses

The theory presented in this article argues that the human capital of directors on corporate boards can have a positive effect on the performance of the firm but that this potential benefit may not materialize fully to the extent that the directors face excessive information processing demands from their other board appointments. Specifically, we argue that boards filled with directors who have high levels of human capital in the form of general knowledge and management experience will enhance firm performance, while boards with directors who

face high levels of information processing demands will harm the performance of the firm. The overall premise is that directors' human capital contributes to their ability to perform the primary functions of monitoring and providing advice to the management and that the overall information processing demands directors face hinders their ability to perform these functions effectively (Hillman & Dalziel, 2003). Monitoring involves exercising oversight over choices made by the firm's management (Jensen & Meckling, 1976). Boards usually exercise such oversight through the alignment of executive interests, direct ratification of decisions, and executive dismissal (Mizruchi, 1983). In contrast, advice and counsel on strategic issues is provided by participating in strategic decision making as well as in the decision-making process about how to effectively manage the firm. Both monitoring and advice-giving have been shown to improve firm performance (Westphal, 1999).

However, the quality of the monitoring and advice-giving is likely to vary according to the level of general human capital directors possess as well as with the extent to which they are able to process and assimilate information about the focal firm (Certo, 2003; Hillman & Dalziel, 2003). In turn, their ability to effectively process information relating to the focal firm is likely to be affected by the extent to which their limited cognitive resources are strained by the information processing demands placed on them by the other firms on whose boards they serve as outside directors. It follows then that the greater the cognitive resources directors are required to devote to processing information about other firms, the lower the cognitive resources available for the focal firm and therefore the lower the focal board's effectiveness. Our arguments here may seem to contradict the well-established finding in the networks literature that access to greater amounts of information such as that provided by holding seats on other boards is beneficial (Beckman & Haunschild, 2002; Coleman, Katz, & Menzel, 1966; Haunschild, 1994; Powell, Koput, & Smith-Doerr, 1996; Rogers, 1995). To resolve this contradiction, it is useful to consider the difference in the two contexts. Access to large amounts of information is beneficial when the board is making specific decisions such as choosing an acquisition target. However, as network research recognizes (Reagans & Zuckerman, 2001, 2008), the same access to information also imposes an ongoing cognitive cost on the directors that is likely to interfere with their ability to effectively process information about the focal firm during periods of regular board activity and deliberation.

General Human Capital of Directors

Human capital has been defined as the resources that are embedded within people (Becker, 1962). The term *human capital* has occasionally been used interchangeably with the terms *knowledge, skill*, and *experience* (Harris & Helfat, 1997). Becker (1962) viewed human capital as the result of human-specific investments. Individuals make choices about which productivity-enhancing activities to pursue in order to maximize future income and other benefits (Gimeno, Folta, Cooper, & Woo, 1997). These choices and time-investments result in a stock of human capital that can then be used in subsequent situations (Carpenter et al., 2001; Hitt, Bierman, Shimizu, & Kochar, 2001; Kor & Leblebici, 2005). Research on human capital originated in the economics literature and has been primarily used to predict an individual's wages or job mobility (Antel, 1986; Brown, 1976; Eriksson, 1991; Mincer, 1997). The argument is that measurable differences in human capital (such as experience and education) are visible to employers *a priori*, and result in higher productivity *ex post*, and that

therefore employees with these stocks of resources should be able to extract higher wages and have greater job mobility. The concept has also been used within the management literature to predict higher compensation for individuals, especially CEOs and other top executives (Gerhart & Milkovich, 1990; Harris & Helfat, 1997; Weiss, 1995).

In addition, there has also been extensive use of human capital explanations to predict firm-level outcomes in the management literature, primarily in the top management and upper echelons literatures (e.g., Carpenter & Westphal, 2001; Certo, Daily, & Dalton, 2001; Westphal & Milton, 2000). For example, researchers have argued that high levels of human capital within top management teams (TMTs) lead to a number of positive firm outcomes such as greater success of entrepreneurial ventures (Bruderl, Preisendorfer, & Ziegler, 1992), and better performance in service-oriented firms (Hitt et al., 2001). In addition, executive characteristics such as education, experience, and other skills have also been shown to predict higher firm performance in a number of settings (Bantel & Jackson, 1989; Finkelstein & Hambrick, 1996; Huselid, 1995). The reasoning used in these studies is generally consistent with human capital arguments, claiming that firms benefit from executives who possess pools of individual resources such as knowledge or experience that they can apply towards the firm. This line of research provides support for the idea that human capital may have important effects on firm-level outcomes such as performance.

Human capital theory has also recently begun to receive attention in the literature on boards of directors (e.g., Johnson, Schnatterly, & Hill, 2013). Some of the prior work has been conceptual in nature and has argued, much as we do here, that human capital of the board should be valuable to the firm (Certo, 2003; Hillman & Dalziel, 2003). Although, as discussed above, the human capital of executives has received considerable empirical attention, there have been only a few studies that have attempted to directly link the human capital of the board with important firm outcomes. In one of the first applications of the effects of director experience, Carpenter and Westphal (2001) found that strategically related board ties affected directors' perceived ability to contribute to both monitoring and advice-giving at the firm (although the nature of this effect was contingent on the stability of the firm's environment). In another article, Carpenter et al. (2003) found that the international experience of the firm's directors affected the firm's international sales. Jensen and Zajac (2004) found that having outside directors with a background in finance resulted in a lower level of acquisition activity. In the first empirical study of boards that explicitly draws on human capital theory, Hillman (2005) argued that in highly regulated industries, the political experience of directors would be a form of human capital that would be valuable to the firm. Also, very recent work has demonstrated that directors' industry experience can help young firms (Kor & Misangyi, 2008) and that their acquisition experience may improve firms' acquisition performance (McDonald et al., 2008).

What this prior research demonstrates is that specific firm outcomes are positively affected if directors have relevant experience. Our study differs from this prior research in that we argue that in addition to the specific situations examined previously, the board's general human capital is also beneficial for more general firm outcomes such as firm performance. We argue that while specific knowledge improves context-specific decisions, firms are generally not able to look for new directors each time they face a specific decision and, therefore, directors who are generally more intelligent, skilled, or qualified are useful during the regular activities of the firm. Thus, we theorize about and test for the effects of general human capital

on a broader outcome, the overall performance of the firm. Higher levels of human capital of the board should result in higher quality monitoring and advice-giving, leading firm managers to make better decisions, which in turn results in higher firm performance.

Sources of general human capital. General human capital is a kind of skill or experience that is valuable across settings (Campbell, Coff, & Kryscynski, 2012). Education is often used as an attribute associated with general human capital (Bruderl et al., 1992) because it is assumed that education reflects not only the information learned, but also an individual's intelligence (Becker, 1993). The positive effect of education on organizational outcomes has been demonstrated by several scholars (Bantel & Jackson, 1989; Carpenter & Westphal, 2001), which anchors the idea that directors with higher education have greater cognitive ability to contribute to the organization. Thus, a bachelor's degree is seen as more valuable than a high school diploma not just for the specific information learned but because it reflects the individual's level of intelligence.

Another way a director can develop their general human capital is through prior experience. The role of a director is more than just reading financial statements or setting compensation contracts. A director is expected to understand and evaluate the actions of top managers and how those actions will impact the firm. Executive and managerial jobs are very complex (Finkelstein & Hambrick, 1996; Lorsch & MacIver, 1989; Mintzberg, 1975), typically involving high amounts of often incomplete information and a lot of uncertainty. In addition, managerial skill is rare and difficult to acquire (Castanias & Helfat, 1991; Pennings, Lee, & van Witteloostuijn, 1998). Directors are involved with the firm at a high level, and therefore, the human capital developed based on their prior experience at top levels of management of other firms should be valuable.

The impact of human capital on performance. General human capital, such as the type developed by way of higher levels of formal education, or more extensive prior experience at top management levels or boards of other firms may be valuable to the board for a number of reasons including that it indicates greater intelligence and more direct experience. Furthermore, individuals with more human capital may be better able to generate abstract principles from specific situations (Dalziel, Gentry, & Bowerman, 2011). This ability often indicates that an individual has expertise in a given area (Chi, Glaser, & Rees, 1982; Singley & Anderson, 1989). For instance, research has shown that experience with making certain types of decisions leads to better decision-making performance in the future, in similar situations (Taylor, 1975).

Consequently, directors who possess greater amounts of general human capital should be valuable to the extent that they are more intelligent, have more relevant skills, and are able to generate abstract principles from specific situations (Dalziel et al., 2011). The types of learning and knowledge structures indicated by greater levels of general human capital will be more valuable because directors are required to understand large amounts of complex information quickly, and having knowledge structures that promote this will help them do their job more effectively (Carpenter & Westphal, 2001). Directors who invest in activities that develop their general human capital should be better able to interpret and group the information presented to them (Dalziel et al., 2011). For example, one of the jobs of a board of directors is to choose new CEOs. Understanding the job of a CEO and who would make a good

CEO will be difficult without top management experience. Therefore, boards filled with more experienced directors should be more effective at selecting CEOs, evaluating their actions, and providing strategic advice.

Taken together, the arguments presented above suggest that general human capital should improve the ability of the board to contribute to the firm. Therefore, we predict the following:

Hypothesis 1: The greater the aggregate level of human capital of the outside directors of a focal firm, the higher the firm's subsequent performance.

The Influence of Information Processing Demands on Directors

Next, we consider how the demand for information processing (Galbraith, 1974) placed on directors by their other board appointments may detract from their ability to provide useful advice to or engage in effective monitoring of a focal firm's management. A well-established body of literature deals with individuals' cognitive limitations, and the rather axiomatic conclusion that follows from these works that individuals are bounded in their ability to handle and process information (Cyert & March, 1963). In order to reduce the amount of information they need to process when making decisions, people frequently make use of heuristics or simplifying strategies (Tversky & Kahneman, 1974). Although using heuristics is useful, it also leads to a variety of cognitive biases that can in turn create errors in decision making (Schwenk, 1984; Staw, Sandelands, & Dutton, 1981).

Like all human beings, managers are also boundedly rational in their ability to process large amounts of complex information. Researchers have long recognized that the process of strategic decision making suffers from cognitive biases because, on the one hand, managers are boundedly rational and, on the other hand, strategic decision making is characterized by ambiguities, uncertainty, and lack of structure (March, 1999; Schwenk, 1984; Walsh, 1995). A number of empirical studies have provided support for the notion that strategic decision making is subject to cognitive biases (e.g., Barnes, 1984; Bateman & Zeithaml, 1989; Bukszar & Connolly, 1988; Golden, 1992; Lant, Milliken, & Batra, 1992).

Researchers have noted that corporate boards routinely confront tasks that are highly complex (Forbes & Milliken, 1999; Zajac & Westphal, 1996). Board members need to make informed judgments about highly complex issues that require them to have a high degree of understanding of the focal firm as well as its environment (Makri, Lane, & Gomez-Mejia, 2006). According to the information processing perspective, mechanisms for organizational control are most effective when available information processing capacity equals or exceeds information processing demands (Galbraith, 1974; Tushman & Nadler, 1978).

Drawing on the above research, we argue that the effectiveness with which outside directors are able to perform their duties of monitoring and advice-giving is also likely to be determined by their bounded rationality and the complexity of the information processing demands they face from their other responsibilities. More specifically, we argue that in order to be effective at monitoring decisions made by a focal firm's management, and providing advice for which directors need to have a fairly high degree of understanding of the focal firm's business and its environment, they are required to process a large amount of information pertaining to the focal firm. However, prior research has argued that the ability to process large volumes of information varies across individuals (Dollinger, 1984; Henderson & Fredrickson,

1996). In the context of the present study, one factor that may influence directors' abilities to process information pertaining to the focal firm is the level of information processing demands or cognitive commitment they face from their other board appointments.

The level of information processing demands placed on directors by their other board appointments may be a function of the number of directorships held. Qualitative interviews of directors conducted at the outset of this study suggest that the idea that directors who are very busy might not be as effective is widely held by directors. However, to date, research support for this idea has been mixed (Ferris, Jagannathan, & Pritchard, 2003; Perry & Peyer, 2005). Moreover, most of these studies have used simple counts of the number of directorships, and therefore, one reason for the mixed findings could be that all directorships are not equal in the level of information processing required. Firms entail different levels of information complexity (Henderson & Fredrickson, 1996). Therefore, rather than simply considering the number of firms with which a director is associated, we also consider the effect of the complexity of those firms.

It has been argued that the level of complexity of a firm and its consequent information processing demands are a function of both firm size and its level of diversification (Henderson & Fredrickson, 1996). As a firm increases in size, so does the scope and variety of its customers and suppliers, which in turn results in a need for more strategic initiatives (Michel & Hambrick, 1992). Also, larger firms are likely to have a larger range and heterogeneity of factors that need to be considered when making strategic decisions (Baysinger & Hoskisson, 1990). This requires not only more information processing by management as well as directors but also a wider range of information to be processed.

At the same time, the information load placed on executives and directors should increase as a focal firm becomes involved in more businesses (Henderson & Fredrickson, 1996). Although it may be argued that only unrelated diversification would add to information load, the number of businesses a firm participates in is important to separate from whether they are related or unrelated (Henderson & Fredrickson, 1996). Increases in the number of related businesses add to complexity because of the need to understand these businesses and manage interdependencies between them (Hill & Hoskisson, 1987; Jones & Hill, 1988). At the same time, increases in the number of unrelated businesses adds to the information processing load because of the need to maintain efficient internal capital markets (Henderson & Fredrickson, 1996; Jones & Hill, 1988). Consequently, the number of unique businesses should directly relate to the overall information processing load of top managers as well as directors. Therefore, the larger the other firms with which a director is associated through board appointments, and the more businesses those firms participate in, the lower the capacity the director will have for his or her monitoring and advice-providing duties in the focal firm.

We note here that, because the number of board seats held by a focal firm's outside directors is closely related to the number of other firms the focal firm is connected to by way of director interlocks, our arguments may appear to contradict the well-accepted network argument that access to greater amounts of diverse information is beneficial to actors (Coleman et al., 1966; Powell et al., 1996; Rogers, 1995), particularly since board interlocks have been shown to be an important source of information (Beckman & Haunschild, 2002; Haunschild, 1994; Haunschild & Beckman, 1998). On the surface, this suggests a potential paradox whereby a focal firm benefits, on the one hand, from having access to greater amounts of information through its directors' networks, but suffers, on the other hand, because of the high cognitive commitment this places on the directors, which limits their ability to

effectively monitor and participate in the strategic decision-making process. However, this paradox may at least be partially resolved by considering the difference in the two contexts. Access to large and diverse information networks is undoubtedly beneficial with respect to deliberations about specific decisions, such as the choice of an acquisition target (Beckman & Haunschild, 2002). However, although having access to large and diverse information networks may be valuable during times of deliberation about individual decisions, it also imposes a continual cognitive cost on directors. Consequently, during periods of regular board activity and deliberation, the ongoing cognitive cost of a director's multiple appointments to large, diversified firms will likely outweigh the benefits.[1] Thus, holding a large number of board seats produces both positive spillovers in the form of access to information and negative spillovers in the form of ongoing cognitive cost. In fact, even within the literature on networks, the costs of network maintenance in terms of time and effort are well established (Burt, 1992). Network theorists indicate that although diverse network structures may be valuable, they are also costly because maintaining the network ties and the overall network structure requires ongoing expenditures of time and effort (Reagans & Zuckerman, 2001, 2008).

In sum, we argue that as the number and complexity of organizations that a director is associated with through his or her board appointments increases, so do the information processing demands on that director. Given their limited cognitive capacity, when directors are overloaded with information processing demands from their other board appointments, they will not be able to effectively monitor executive action or contribute meaningfully to strategic decision making at the focal firm. This leads to the following hypothesis:

Hypothesis 2: The greater the level of information processing demands on directors, the lower the focal firm's subsequent performance.

Interaction Between Director Human Capital and Information Processing Demands

It is important to consider how human capital will interact with information processing demands to affect the performance of the firm. We consider the interactive effect of human capital and information processing demands in an attempt to understand the limitations that directors face. Although some scholars consider a "more is better" approach and support the notion that individuals' knowledge and skills automatically achieve greater benefit for the firm, we attempt to identify the boundary conditions (limitations) of individual human capital. Thus, although we expect information processing demands to have a negative main effect on firm performance as argued above, we also expect that effect to mitigate the benefits of having high levels of human capital on the board. According to information processing theory (due to cognitive limitations), individuals' ability to effectively process information declines sharply once their cognitive limits are reached (O'Reilly, 1980; Tushman & Nadler, 1978). Not only are individuals unable to process additional information beyond a threshold, the availability of too much information also interferes with their ability to process the remaining information, thereby leveraging their knowledge or skills. Studies have shown that information overload has a number of negative effects on individuals' performance. For example, the availability of excessive amounts of information has been shown to lead to a decline in decision-making accuracy among managers (Connolly, 1977). Thus, high levels of information processing

demands outside the focal firm may overwhelm even the most experienced and skilled directors and render them less able to provide quality monitoring and meaningful advice. Some of the benefits of human capital described above are related to having more efficient knowledge structures and a greater ability to effectively make decisions. However, even individuals who are more efficient, on average, at processing information are not likely to be able to effectively process additional information beyond a certain threshold. Therefore, we expect the positive effect of human capital to be weakened or absent when information processing demands are high. These arguments lead to the following hypothesis:

Hypothesis 3: Information processing demands on directors from other firms that they are associated with will negatively moderate the positive relationship between their human capital and focal firm performance.

Research Methodology

Sample and Data Collection

This study uses archival data on 650 firms that were randomly selected from the Fortune 1000. We chose an "intertypical" sample—that is, a sample of firms across multiple industries rather than a sample of firms from within one industry—because this allows our results to be more generalizable (Kimberly, 1976). In order to allow for the time it takes for the influence of the board to be manifested in firm performance, we incorporated a 2-year lag between the independent variables and the dependent variable. Our independent variables were measured from 2001 to 2003, and our dependent variables were measured from 2003 to 2005.[2]

The archival data were collected from a number of sources. Data on firm sales, performance, and diversification were collected from COMPUSTAT and the COMPUSTAT segment database. Information on executive compensation was collected from the EXECUCOMP database, firm proxy statements, and the Corporate Library. Information on director attributes was collected from the Corporate Library, the *Who's Who Directory of Corporate America*, the Standard and Poor's *Register of Corporations, Directors and Executives*, and company proxy statements.

Measurement of Variables

Dependent variable. The dependent variable of this study is *firm performance*. The theory developed in this study argues that directors with high levels of human capital will be better able to monitor and provide advice to the executives of the focal firm, which should in turn improve the performance of the focal firm. This improved performance is more likely to be represented in accounting-based measures of performance than in market-based measures. In general, institutional investors use indicators such as the outsider ratio as proxies for the effectiveness of the governance of the firm. Market valuations are based on investors' perceptions of the firm, and because the concept of director capabilities is relatively new, it is less likely that the market is cognizant of the board's capabilities or incorporates those capabilities into its valuation. Consequently, we measure *firm performance* using *return on equity (ROE)*, which is an accounting measure of performance. We chose *ROE* as our performance

measure because it reflects the operating efficiency of the firm as well as its financing choices. Given that the board is concerned with total firm performance, a performance measure that incorporates both operating efficiency and financing is appropriate when measuring firm performance as affected by the board. However, *ROE* may seem to present a biased measure of overall firm performance because two firms with equal operating performance may have different *ROEs* based on their level of debt. Therefore, in all models we control for the level of firm *debt*. Furthermore, in order to ensure the robustness of our results, we also ran models using *return on assets (ROA)* as the dependent variable, and obtained results on our hypothesized variables that were all in the same direction, but were less significant. We discuss the implications of these slightly different results in the Discussion section.

Independent variables. For all of our independent variables, we aggregate individual-level measures to create a board-level measures. It is theoretically and empirically appropriate to aggregate these measures to the board level because of the functions and nature of the board. The board represents stockholders (Fama & Jensen, 1983) and is considered the key internal control mechanism to align the interests of top management and shareholders (Boyd, 1994; Mizruchi, 1983; Walsh & Seward, 1990). The boards' responsibilities are viewed as a collective responsibility. In fact, this idea is so strong that most boards will not even proceed with a vote unless there is a consensus about the voting (Gillespie & Zweig, 2010; Mace, 1986). Furthermore, the board is a social entity that is recognized as such by both its members and outsiders (Adams, Hermalin, & Weisbach 2010; Andersen, Mansi, & Reeb, 2004; Hillman & Dalziel, 2003). For example, individual directors identify with the boards with which they are associated (Hillman, Nicholson, & Shropshire, 2008). In fact, even legally, boards are recognized as distinct entities (Lan & Heracleous, 2010). According to Forbes and Milliken (1999), "boards of directors can be characterized as large, elite, and episodic decision-making groups that face complex tasks pertaining to strategic-issue processing" (Forbes & Milliken, 1999: 492). The claim that boards are seen as distinct entities is also borne out by numerous corporate governance studies that have examined various aspects of these entities such as their composition, structure, behavior, vigilance, decision-making processes, and power (e.g., Baysinger & Hoskisson 1990; Garg & Eisenhardt, 2013; Golden & Zajac, 2001; Westphal & Bednar, 2005; Westphal & Milton, 2000; also see Zahra & Pearce, 1989 and Finkelstein, Hambrick, & Cannella, 2009 for extensive reviews of research on boards of directors). Therefore, for our analysis, we aggregate individual director characteristics to the board level. We discuss the specifics of how we aggregate our variables for information processing demands and human capital below.

Information processing demand measures. We measured information processing demands faced by directors at the other firms where they held board seats in three ways: the *size of directors' other board appointments,* the *number of businesses of directors' other board appointments,* and *the number of board appointments*. To calculate the first two measures, first the value for each individual director was arrived at by averaging across all his or her board appointments, and then the value for the focal board was arrived at by averaging across all directors. The third measure was simply the average number of board seats held by all outside directors on the focal board.

The *size of directors' other board appointments* was measured as the average of the log of sales for each company on whose board each individual director held a seat, averaged across all directors on the focal board. The *number of businesses of directors' other board appointments* was measured by taking the average number of unique North American Industry Classification System (NAICS) codes in which the firm participated, and then calculating the average across all directors on the board. We used simple counts of NAICS codes because research suggests that when studying the primary effects of diversification, simple counts of NAICS codes can be just as valid as more complex measures of diversification (Henderson & Fredrickson, 1996; Lubatkin, Merchant, & Srinivasan, 1993). The *number of board appointments* was arrived at by counting the number of board appointments for each director and then averaging across all directors on the focal board (Finkelstein, 1992; Haunschild, 1994).

We also created a composite of our information processing demand measures as a data reduction technique in order to simplify the interaction models. Without a composite measure we would need to include six interaction terms that are highly related, and potentially subject to multicollinearity. Instead, we used a formative composite measure. Jarvis, Mackenzie, and Podsakoff (2003) outline a set of criteria that can be used to determine whether the use of formative or causal indicators is appropriate in creating composite measures. According to them, in formative models, (i) the direction of causality is from the measure to the construct, (ii) the indicators do not need to be interchangeable in the measurement models, (iii) covaration is neither necessary nor implied, and (iv) the indicators do not necessarily capture the same aspect of the content's domain and do not need to have similar causes or consequences (Bollen & Lennox, 1991; Diamantopoulos & Winklhofer, 2001; Jarvis et al., 2003). Together, this set of criteria suggests that indicators in these models do not necessarily capture similar content or share a similar theme. In fact, dropping an indicator from the measurement model may even alter the meaning of the construct. Formative indicators are better viewed as composite variables because these constructs are simply linear composites of their indicators (Diamantopoulos & Winklhofer, 2001; MacCallum & Browne, 1993). On the other hand, for reflective indicators, correlation between indicators is necessary (Cook & Campbell, 1979).

Although the construct information processing demands is composed of multiple factors, it is not a latent variable, like personality or motivation, which are measured by using indirect (or reflective) indicators and then assuming the presence of an unmeasured but real factor. Instead, information processing demands are accumulative, can be measured using formative (or causal) rather than reflective indicators (Bollen & Lennox, 1991; Diamantopoulos & Winklhofer, 2001; Jarvis et al., 2003; MacCallum & Browne, 1993), and to fully test their impact, should be considered jointly. Therefore, we run models using the indicators separately to test the main effects, and in our interaction analyses, we model the construct of information processing demands by creating a formative or causal indicator by summing their z-scores and using the total scores in our regression equations (Bollen & Lennox, 1991).

One limitation of using summed z-scores is that the process uses equal weighting for each indicator. Although we do not believe that each measure of information processing demands necessarily has an equal impact on an individual's overall level of information processing demands, extant theory does not suggest an alternative weighting scheme *a priori*. Furthermore, research has shown that equal weighting of indicators often produces

regression results that are nearly identical to more sophisticated weightings (Lawshe & Schucker, 1959; Schmidt & Kaplan, 1971; Stanley & Wang, 1970). In fact, in some instances simple unit weighting provides superior estimates than does a regression weighting of composite measures (Schmidt, 1971). So, as noted above, to ensure that this aggregation technique is not unduly impacting our findings, for Hypotheses 1 and 2, we run a model (Model 2) where we use the raw indicators of information processing demands as our independent variables, and we also run a model (Model 3) where we use the composite index. In order to test Hypothesis 3, we use the interaction of the composite index of information processing demands with each human capital measure.

Human capital measures. Prior empirical research that has examined the effects of board human capital has used context-specific measures such as the relatedness of directors' board appointments (Carpenter & Westphal, 2001), and directors' international, functional, or political background (Carpenter et al., 2003; Hillman, 2005; Jensen & Zajac, 2004). In this study, we operationalize board human capital using two indicators that are more general in nature. We chose these general measures because they are a good conceptual match between the construct of human capital and the specific requirements of corporate directorships.

Specifically, we measured human capital in the following ways: *board education level* and *board TMT experience*. Both measures were first calculated for each outside director and then summed to arrive at the total for the board. Prior work on TMTs that has measured executives' skills and abilities has often aggregated these measures using averages. However, conceptually, human capital is similar to other types of capital in that the overall level is important (Becker, 1962). Supporting this logic, more recently scholars using human capital of directors have viewed it as the stock of resources available to the firm (Certo, 2003; Hillman & Dalziel, 2003). Consequently, recent research in both human and social capital has often used sums or totals to aggregate these measures (Carpenter et al., 2003; Carpenter et al., 2001; Chen, Hambrick, & Pollock, 2008; Coleman, 1988; Hillman, 2005; Jensen & Zajac, 2004; McDonald et al., 2008). This approach to aggregating board member experience is consistent with prior research on how the expertise of group members affects group performance (for reviews, see Kerr & Tindale, 2004; McGrath, 1984), which has usually aggregated group members' experience by summing the characteristics of the individual members of the group (McDonald et al., 2008). In separate analyses we tried other aggregation methods (like the mean level of education and experience). The alternative approaches to aggregation reduced the fit of our empirical models.[3]

Because the levels of human capital could be overinflated due to the size of the board, we control for *board size* in all models. One potential concern that occurs when aggregating individual characteristics to create a group construct is that the diversity of those attributes may affect how the group functions (Knight et al., 1999; Pelled, Eisenhardt, & Xin, 1999; Smith et al., 1994). Consequently, in all models we control for the diversity of the board on the human capital measures (described in detail below). We also control for a number of other factors (such as the outsider ratio and CEO duality) that have been argued to influence how the board functions.

Board education level was measured as the total (across all directors) of each individual director's number of years of schooling, with the lowest value of 12 representing a high school education (Kosnik, 1987; Wiersema & Bantel, 1992).[4] Education level is a very

common indicator of general human capital (Bantel & Jackson, 1989; Hambrick & Mason, 1984; Pennings et al., 1998; Wiersema & Bantel, 1992). Formal education shapes individuals' mental models and teaches them cognitive shortcuts (Hitt & Tyler, 1991). TMT researchers have reasoned that individuals with high levels of education "are likely to engage in boundary spanning, tolerate ambiguity, and show an ability for 'integrative complexity'" (Wiersema & Bantel, 1992: 99). Organizational researchers have also proposed that high levels of education will give TMT members a better ability to distinguish among different stimuli (Wiersema & Bantel, 1992). Higher levels of TMT education have been associated with both greater firm innovation (Bantel & Jackson, 1989; Kimberly & Evanisko, 1981) and greater organizational change (Wiersema & Bantel, 1992).

Board TMT experience was measured as the number of years each individual director had served as a top executive (Carpenter & Westphal, 2001), summed across all directors. As mentioned above, human capital theory specifically argues that experience within a given context should increase an individual's human capital (Harris & Helfat, 1997). As with education, the level of managerial experience has been examined in the context of top executives (Bruderl et al., 1992; Harris & Helfat, 1997; Hitt et al., 2001), but its effect has not been demonstrated with directors.

Control variables. We want to highlight the fact that this study uses an extensive set of control variables. Although this makes our models more complicated, we did so in order to control for a wide variety of potential alternative explanations, including variables used in prior research. In addition, we believe that the controls we include are necessary because they are likely to be correlated with both board effectiveness and focal firm performance. Fortunately, because of our large sample, we still have sufficient power to fully test our hypotheses.

A firms' current level of performance is highly influenced by its prior performance. In order to control for that effect, we included *prior performance*, measured as the firm's *ROE* in the previous year, using an instrumental variable to control for the problem of autoregression (Haveman, 1993). One of the problems with intertypical sampling is that it can often be difficult to compare firms across industries (Kimberly, 1976). Therefore, we controlled for industry differences in all our models by including *change in industry concentration ratio,* a measure of the turbulence within the firm's primary industry, and a strong predictor of firm performance (Carpenter & Westphal, 2001). In unreported models, we replaced *change in industry concentration ratio* with over 200 industry dummies at the three-digit NAICS level. The results of our hypothesized variables were exactly the same. For robustness, we also ran our models with industry dummies at varying levels of specificity (that is, at the four-digit, five-digit, and six-digit NAICS levels), with equivalent results. Because the results of all of our hypothesized variables were identical, we report only the models using the *change in industry concentration ratio* due to their much greater simplicity.

Firm size may affect firm performance as well as the board's ability to influence firm outcomes (Kimberly, 1976). Because firm sales are usually highly skewed, *firm size* was measured as the log of sales. We controlled for *firm debt* in all models because *ROE* includes the financing choices of the firm. *Firm diversification* may affect the performance of the firm as well as the amount of information the directors are required to process, and thus, we controlled for the focal firm's level of diversification using an entropy-based measure (Palepu, 1985). *Proportion of outsiders* on the board was measured as the ratio of the number of outside

directors to the total number of directors on the board, which is one of the most commonly used measures of board independence (Dalton et al., 1998; Kosnik, 1987). *Blockholder ownership* was measured as the percentage of company stock owned by parties with at least a 5% stake in the company, who are not officers or directors and who have no business ties to the firm (Bethel & Liebeskind, 1993). We also controlled for *institutional ownership*, which was measured as the total percentage of company stock owned by institutional investors like pension or mutual funds (Bethel & Liebeskind, 1993). The size of the board may affect how well the board functions as a group (Ancona & Caldwell, 1992), and as noted above, it also influences the total human capital of the board. Thus, we control for *board size*, which is simply the total number of directors on the focal firm's board of directors. *CEO contingent compensation* may affect the level of monitoring necessary by the board by affecting the extent of agency conflict that exists (Westphal, 1999). Therefore, we controlled for the level of a CEO's pay that is paid in long-term forms. It is important to account for the power of the board relative to the CEO's power when studying the board's effectiveness at influencing firm performance. Therefore, we have attempted to control for two aspects of power. Being appointed after the CEO can reduce directors' power and their ability to contribute to board meetings (Westphal & Zajac, 1995). Therefore, we included the variable *appointments after the CEO* to control for the number of directors that were appointed after the current CEO took office. Leadership structure can also affect the distribution of power between the CEO and the board (Westphal & Zajac, 1995), and therefore, we controlled for whether the CEO was also the chairman of the board. *CEO is chair* was coded as a dummy variable, where a 1 indicates the positions are held by the same individual. As discussed above, the level of diversity among board members may affect the functioning of the team (Hambrick, Cho, & Chen, 1996; Knight et al., 1999; Pelled et al., 1999). In order to control for this, we included heterogeneity measures for both of our human capital measures, namely the *diversity of directors' education level* and the *diversity of directors' top management experience.*

Estimation Methods

In this study, both our dependent and independent variables are continuous in nature and are measured over time. This results in a cross-sectional panel data set, which can be tested using pooled time-series analyses. These analyses allow use of the full sample and reflect the average effect of the independent variables over the full study. We analyzed the data using generalized least squares (GLS) regression with firm-specific controls. GLS is appropriate for analyzing continuous longitudinal data because it generates a coefficient to correct for the inherent autocorrelation across panels. Moreover, GLS models with panel-specific (that is, firm-specific) autocorrelation coefficients control for firm-specific heterogeneity over time. The effect of panel-specific autocorrelation coefficients is very similar to that of fixed effects regression models. To ensure robustness, in unreported models we simulated fixed effects models by mean-deviating each variable in the model. The results from these models were unchanged.

Results

Table 1 provides descriptive statistics and bivariate correlations for the variables in this study, and Table 2 presents the results of the GLS analyses. As Table 1 shows, the bivariate

Table 1
Means, Standard Deviations, and Correlations[a]

Variable	*M*	*SD*	1	2a	2b	2c	3a	3b	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Performance	0.15	1.55	1.00																		
2. Board information processing demands:																					
a. Size of dir. other board appointments	3.55	2.21	–0.00	1.00																	
b. No. of bus. of dir. other board appointments	1.13	0.77	–0.02	0.87	1.00																
c. Number of board appointments	0.73	0.51	–0.02	0.85	0.75	1.00															
3. Board human capital characteristics:																					
a. Education level	140.01	49.65	0.01	0.36	0.32	0.39	1.00														
b. TMT experience	84.22	45.60	0.01	0.33	0.30	0.40	0.74	1.00													
4. Firm size	8.47	1.08	–0.03	0.50	0.41	0.49	0.48	0.37	1.00												
5. Firm diversification	0.37	0.46	0.00	0.09	0.10	0.08	0.11	0.07	0.08	1.00											
6. Firm debt	22.65	84.17	–0.00	0.20	0.19	0.18	0.32	0.25	0.42	–0.02	1.00										
7. Change in industry concentration ratio	0.01	0.03	–0.01	0.04	0.02	0.03	–0.07	–0.07	–0.02	0.04	0.02	1.00									
8. Proportion of outsiders on board	0.80	0.13	0.01	0.22	0.21	0.34	0.58	0.44	0.20	0.09	0.09	–0.05	1.00								
9. Blockholder ownership %	0.17	0.14	–0.01	–0.02	–0.02	–0.00	–0.18	–0.16	–0.19	–0.03	–0.15	0.03	–0.03	1.00							
10. Institutional ownership %	0.64	0.17	0.00	0.11	0.09	0.11	–0.10	–0.11	0.00	–0.01	–0.03	0.04	0.06	0.28	1.00						
11. Board size	10.55	2.82	0.00	0.24	0.21	0.23	0.85	0.66	0.44	0.07	0.31	–0.08	0.20	–0.20	–0.19	1.00					
12. CEO contingent pay	0.55	0.27	–0.04	0.23	0.18	0.23	0.22	0.21	0.22	–0.01	0.08	–0.01	0.16	–0.04	0.17	0.15	1.00				
13. Number of appointments after CEO	3.88	3.66	0.02	–0.07	–0.07	–0.08	0.20	0.14	0.05	–0.01	0.05	–0.01	–0.04	–0.04	–0.10	0.30	–0.04	1.00			
14. CEO is chair	0.72	0.45	0.02	0.17	0.14	0.18	0.16	0.11	0.10	0.11	0.08	–0.04	0.18	–0.02	0.04	0.03	0.02	0.23	1.00		
15. Director education diversity	2.67	0.77	–0.01	–0.19	–0.22	–0.19	–0.06	–0.13	–0.07	–0.05	–0.05	–0.01	–0.05	–0.06	–0.02	0.03	–0.08	0.06	–0.02	1.00	
16. Director TMT experience diversity	2.64	0.42	–0.04	0.02	0.02	0.02	0.15	0.28	0.15	0.05	0.07	–0.02	0.03	–0.12	–0.15	0.20	–0.00	0.08	–0.01	0.11	1.00

Note: TMT = top management team.
[a]*N* = 1,772 firm-years.

Table 2
Generalized Least Squares Analysis[a]

Variable	Predicted Effect	Dependent Variable = Return on Equity			
		Model (1)	Model (2)	Model (3)	Model (4)
Board human capital:	H1 (+)				
Board education level			0.005*	0.25*	0.005**
			(0.002)	(0.10)	(0.002)
Board TMT experience			0.003***	0.10*	0.001
			(0.001)	(0.05)	(0.001)
Dummy for estimated data			–0.05	–0.11†	–0.06
			(0.07)	(0.06)	(0.06)
Board information processing demands:	H2 (–)				
Size of directors' other board appointments			0.09*		
			(0.04)		
No. of businesses of directors' other board appointments			–0.20*		
			(0.09)		
Number of board appointments			–0.28*		
			(0.12)		
Board information processing demands composite				–0.03*	–0.04**
				(0.01)	(0.01)
Board Education × Board Information Processing Demands Composite	H3 (–)				–0.06***
					(0.02)
Board TMT Experience × Board Information Processing Demands Composite					0.06**
					(0.02)
Controls:					
Prior performance		1.23***	1.50***	1.27***	1.16***
		(0.12)	(0.16)	(0.12)	(0.12)
Firm size		–0.05	–0.06†	–0.01	0.01
		(0.03)	(0.04)	(0.03)	(0.03)
Firm diversification		0.13†	0.10	0.13†	0.11
		(0.07)	(0.07)	(0.07)	(0.07)
Firm debt		0.00	0.00	0.00	0.00
		(0.00)	(0.00)	(0.00)	(0.00)
Change in industry concentration ratio		–1.10	–1.20	–0.76	–0.28
		(0.72)	(0.87)	(0.68)	(0.74)
Proportion of outsiders on board		–0.17	–0.67†	–0.85*	–0.89**
		(0.22)	(0.40)	(0.34)	(0.34)
Blockholder ownership %		0.53**	0.94***	0.97***	0.88***
		(0.20)	(0.25)	(0.19)	(0.19)
Institutional ownership %		–0.05	–0.46*	–0.41*	–0.27†
		(0.15)	(0.19)	(0.17)	(0.14)
Board size		0.02	–0.08*	–0.08*	–0.07*
		(0.01)	(0.03)	(0.03)	(0.03)
CEO contingent pay		–0.31***	–0.31*	–0.38***	–0.33**
		(0.09)	(0.13)	(0.11)	(0.11)

(continued)

Table 2 (continued)

Variable	Predicted Effect	Dependent Variable = Return on Equity			
		Model (1)	Model (2)	Model (3)	Model (4)
Number of appointments after CEO		–0.005	0.005	–0.003	–0.01
		(0.01)	(0.01)	(0.01)	(0.01)
CEO is chair		–0.08	–0.18*	–0.14*	–0.16**
		(0.05)	(0.07)	(0.06)	(0.06)
Director education diversity		–0.05	–0.04	–0.03	–0.08*
		(0.04)	(0.04)	(0.04)	(0.04)
Director TMT experience diversity		–0.29***	–0.43***	–0.34***	–0.20*
		(0.08)	(0.09)	(0.09)	(0.08)
Intercept		1.50***	2.71***	3.08***	1.63***
		(0.37)	(0.50)	(0.64)	(0.46)
Wald chi[2]		162.19***	135.63***	196.51***	191.91***

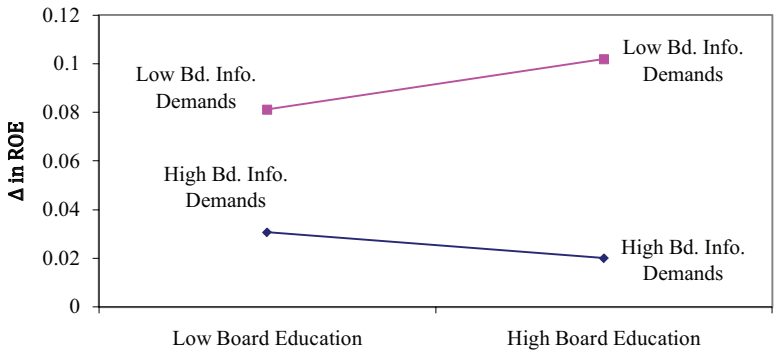
Note: TMT = top management team.
[a]N = 1,754 firm-years for 602 firms; standard errors are in parentheses.
†$p < .10$.
*$p < .05$.
**$p < .01$.
***$p < .001$; two-tailed tests.

correlations between a few variables were relatively high. However, given our large sample size, our results are unlikely to be biased due to multicollinearity. Nevertheless, we assessed our models using matrix decomposition techniques (Judge, Hill, Griffiths, Lutke-pohl, & Lee, 1988: 870). None of the condition indices exceeded the upper limit of 30 recommended by Belsley (1991). Finally, we also ran models in which we randomly dropped 10% of the observations. Again, our reported results were unchanged. In Table 2, Model 1 consists of only the control variables, whereas Models 2 and 3 add the hypothesized main effects, and Model 4 adds the hypothesized interactions between the human capital measures and the composite of the information processing demands variables. More specifically, Model 2 adds the different indicators of the hypothesized main effects of information processing demands, whereas Model 3 uses the composite measure. The overall Wald chi-squares for these models (reported in Table 2) indicate significant explanatory power.

Hypothesis 1 predicted a positive association between the human capital characteristics of directors on the focal firm's board and the firm's subsequent performance, arguing that the extent of human capital possessed by directors would enhance their ability to monitor and provide advice to the focal firm's management. As Models 2 and 3 in Table 2 show, this hypothesis was strongly supported. Both the human capital measures are significant in Model 2 (*education level* $\beta = 0.005$, $p < .05$; *TMT experience* $\beta = 0.003$, $p < .001$) and Model 3 (*education level* $\beta = 0.25$, $p < .05$; *TMT experience* $\beta = 0.10$, $p < .05$).

Next, Hypothesis 2 predicted that directors would be less effective at monitoring and providing advice to the focal firm's management to the extent that they faced high levels of information processing demands at their other board appointments. We argued that, given individuals' cognitive limitations, such information processing demands would interfere with their ability to effectively process information about the focal firm. Again, as Models 2

Figure 1
Interactive Effects of Board Education Level and Board Information Processing Demands on Firm Performance



and 3 show, this hypothesis was generally supported. The effects of the *number of businesses of directors' other board appointments* and the *number of board appointments* were both negative and significant ($\beta = -0.20$, $p < .05$, and $\beta = -0.28$, $p < .05$, respectively), as was the composite measure in Model 3 ($\beta = -0.032$, $p < .05$). However, as Model 2 shows, contrary to our prediction, the coefficient on the *size of directors' other board appointments* was *positive* and significant ($\beta = 0.09$, $p < .05$).

Finally, Hypothesis 3 argued that, in addition to their negative main effects on focal firm performance, information processing demands faced by directors would also mitigate the positive effects of their human capital. Model 4 includes interactions between the individual human capital variables and the *board information processing demands composite*. As predicted, the interaction of *board education level* and the *board information processing demands composite* was negative and significant ($\beta = -0.06$, $p < .001$). However, the interaction of *board TMT experience* and the *board information processing demands composite* was *positive* and significant ($\beta = 0.06$, $p < .01$). Thus, Hypothesis 3 was partially supported. Model 4 also suggests that, according to our estimates of the main effects of education, a 10% increase in *board education* is associated with a 7% increase in *firm performance*.

Figure 1 uses the coefficients from Model 4 to graph the interactive effect size of *board education level* and the *board information processing demands composite* on *firm performance* as measured by how changes in the interaction terms affect the level of *ROE*. The *y*-axis on the figure indicates the change in the focal firm's performance associated with changes in the predictor variables, and the *x*-axis indicates the *board's education level*. The low and high values for changes in *board education level* and *board information processing demands* are 1 standard deviation below and above the mean of the respective variable. The slopes of both lines are significant, as are the differences in the points on the graph. This graph highlights that, consistent with our hypothesis, information processing demands do tend to mitigate the positive effects of human capital. More specifically, the graph suggests that high levels of director education become less valuable under conditions of high information processing demands.

Discussion

The findings of this study extend prior research on board human capital and corporate governance in three important ways. First, we extend the literature on board human capital and corporate governance that has primarily focused on linking very specific indicators of human capital with specific outcomes (Carpenter et al., 2003; Carpenter & Westphal, 2001; Hillman, 2005; Jensen & Zajac, 2004). We theorized and found support for the idea that the capabilities of directors as measured by indicators of general human capital can affect overall firm performance. This finding also provides additional insight into why some studies of board effectiveness that have examined only board structure may have failed to find significant results (Dalton et al., 1998). Next, we argued and demonstrated that increases in information processing demands on directors from outside the focal firm may lower the performance of the focal firm by limiting the cognitive capacity they can devote to processing information about the focal firm, thereby reducing their effectiveness at monitoring and providing advice to the focal firm's management. This extends theory on corporate governance by suggesting that cognitive limitations of directors must be considered in order for models of board effectiveness to have more predictive value. Our study opens the discussion regarding the pull of positive and negative spillovers linked to board commitments that may influence director effectiveness at the focal firm. Our final and most important contribution focuses on board effectiveness. Typically, studies of board effectiveness have largely focused on board characteristics, and the empirical results have been mixed (Dalton et al., 1998). We developed and tested a unique model of board effectiveness that includes the construct of information processing demands. Our results show that excessive information processing demands may decrease the extent to which directors are able to utilize their human capital to gain a competitive advantage for the firm.

By examining director capabilities, this study also extends the growing literature on board human capital and its link to important firm-level outcomes (Carpenter et al., 2003; Carpenter & Westphal, 2001; Hillman, 2005; Jensen & Zajac, 2004; Jones, Makri, & Gomez-Mejia, 2008). This line of recent research implicitly questions one of the core assumptions of most governance research: the notion that, barring situations when a board appoints directors with specific expertise or resources for inputs relating to specific upcoming strategies or decisions (such as appointing a director with acquisition experience when the firm plans to launch an acquisition strategy), all directors are equally capable. This assumption, while unstated, is a part of corporate governance research from a broad range of perspectives including agency theory, power, and resource dependence perspectives. Most of the work to date in this area questions the extent to which directors actually monitor executive behavior (Lorsch & MacIver, 1989; Mace, 1986; Westphal, 1998; Westphal & Zajac, 1995), rather than questioning their ability to do so. The ideas presented here serve to further confirm the notion that all boards are not created equal (Carpenter et al., 2003; Certo, 2003; Hillman & Dalziel, 2003). Thus, structurally similar boards may vary considerably in their ability to both monitor executive action and to provide advice and counsel. Consistent with this assertion, we find that firms that had higher levels of general board human capital exhibited superior performance, after controlling for the ratio of outsiders on the board. What this suggests is that current research on agency theory and corporate governance focusing primarily on board structure does not provide a complete or accurate picture and that understanding differences in the abilities of boards with similar

structures should help explain some of the inconsistencies in prior research findings on the relationship between board structure and firm performance. By demonstrating that some general indicators of human capital also have positive effects on firm performance, this study extends the recent line of inquiry that suggests that the relatedness of directors' other board appointments (Carpenter & Westphal, 2001), their international experience (Carpenter et al., 2003), their functional background (Jensen & Zajac, 2004), and their political connections (Hillman, 2005) all affect their ability to function effectively.

As mentioned above, one of the interesting findings of this study was that when we tested our models using ROA instead of ROE as the dependent variable, we got results that were the same in direction, but were less significant. The main difference between ROA and ROE is that ROE is more strongly influenced by the financing choices of the firm. What our results may indicate is that a large part of the effect of directors on firm performance may come from their influence on a firm's financing choices. Intuitively, financing options seem like an area where outside directors would be able to contribute and make useful suggestions based on their own prior experience. Although this has not been considered by prior research, this seems like a potentially interesting and fruitful area of future inquiry. Future research should explore whether boards have a stronger influence on firm financing choices.

As noted, perhaps the most important contribution of this study is that it incorporates the concept of information processing demands into current thinking on board effectiveness. Most work on board effectiveness focuses solely on factors that purportedly improve firm performance. The findings of this study provide support for the notion that excessive information processing demands faced by directors lower firm performance by reducing their available cognitive capacity to process information relating to the focal firm. Moreover, it appears that the negative effect of information processing demands actually weakens the impact of having directors with high levels of education. High levels of information processing demands outside the focal firm may overwhelm even the most highly educated directors and render them less able to provide quality monitoring and meaningful advice. These findings also have implications for the broader literature on strategic human capital. Our study suggests that the level of information processing demands must be considered when studying human capital at any level in the organization. Neglecting to consider this aspect will provide a less than complete picture of how human capital can be a source of competitive advantage.

We note that, contrary to our prediction, the size of directors' other board appointments actually had a positive effect when run separately from the other information processing demand measures. What this possibly suggests is that when considered separately, it is the complexity of an individual's information load that matters more than the amount. Thus, having board appointments at multiple firms, and at firms involved in many different businesses, requires greater cognitive attention than merely having board appointments at firms that are large, but all else equal, not significantly complex. The positive sign indicates that the size of directors' other board appointments may convey benefits that are greater than their costs.

We also note that Figure 1 indicates that when information processing demands are high, higher levels of board education are actually worse for firm performance. One speculation for this unusual result is that perhaps for individuals with low levels of education, access to more information serves as a substitute for better knowledge and experience. Moreover, it is possible that, although directors provide relatively lower quality advice

when they are faced with high information processing demands, their advice is given more weight by the firm when they are highly educated than when they have lower levels of education. Our analysis reveals an interesting distinction between the influence of directors' education and experience. Although both education and experience are indicators of human capital, they yield contrasting influences in the context of high information processing demands. Fundamentally, director education benefits the firm; however, in the context of high information processing demands, our results suggest that general education may not be sufficient to support a positive influence on firm outcomes. In contrast, director experience could potentially provide a stronger resource for directors to rely on in the presence of high information processing demands (Barney & Wright, 1998; Hatch & Dyer, 2004). These results suggest that all types of human capital are not the same. Future research should further explore how human capital stemming from education may be different from that stemming from experience.

One interesting result of this study is that the significance of some of the governance controls (the outsider ratio, institutional ownership, board size, and CEO duality) changes once the limitations and capabilities of the board are added into the model. In Model 1, these variables are not significant. However, when the capabilities of the board are added in Model 2, they become significant. Because we did not generate any hypotheses about these effects, it is impossible to interpret them with great confidence. However, one possible reason for this effect is that without measuring the capabilities and limitations of the board, these characteristics may be less indicative of the overall governance quality of the firm. For instance, in today's corporate governance climate, most boards have a majority of independent directors, but many boards are still not effective. This finding highlights that the ratio of outsiders on the board may provide very little information about the quality or effectiveness of the board and indicates that additional study regarding these variables may be needed.

Implications for Management Practice

This article has possible implications for management practice. If directors vary in their abilities to monitor and provide advice to management, then firms seeking to fill vacancies on their boards would be better served by considering potential candidates' level of human capital acquired through education and previous experience, as well as the information processing demands they face from their other board appointments. Moreover, firms may even contractually restrict the number of other boards with which a director can be associated. Our study may also suggest that executives with less TMT experience may struggle to add value to a board. As such, experienced TMT members may be more sought after due to the experience and insights they have gained. This study also demonstrates that shareholders may need to examine boards more closely than just examining the ratio of outsiders to insiders, in order to determine their ability to adequately protect their interests. Recently, there has been a large public outcry for increased board independence. However, the model developed here suggests that increased independence may not be enough to truly bring about effective corporate governance reform. In fact, based on the results of this study, after controlling for human capital, increased independence may actually hurt firm performance. What this suggests is

that investors and governance reformers need to consider the capabilities as well as the structure of the board.

This study also has implications for the management of strategic human capital at other levels in organizations. Our findings suggest that taking only human capital into consideration may offer an incomplete picture of strategic human capital as a source of competitive advantage at any level in the organization. Therefore, in order to obtain a more complete understanding of strategic human capital, managers must consider the corresponding level of information processing demands faced by individuals, as this may interfere with their abilities to actually utilize their human capital.

Limitations

Despite our contributions to the literature, our study also contains limitations. As mentioned above, one of our measures of information processing demands, the size of directors' other board appointments, is positively related to focal firm performance. This positive association may indicate that measures of information processing demands are also related to human capital. For example, individuals with greater human capital may be sought out by larger firms. Future research should explore the relationship between information processing demands and human capital more fully. Next, we recognize that directors with more human capital may be more valued by firms and hence be in a position to pick and choose firms that are expected to perform better in the future. In fact, there is evidence that better firm performance makes directors less likely to leave the board of a particular firm (Boivie, Graffin, & Pollock, 2012). This would suggest that the relationship between board composition and firm performance may be more recursive than what we argue for in this article. Consequently, although we believe that the increased human capital may be partially causing the observed increases in firm performance, we cannot fully prove this aspect of our claim. Nevertheless, in our study, concerns regarding direct reverse causality are mitigated considerably due to a number of reasons. First, our data are longitudinal, and there is a 2-year lag between our independent and dependent variables. Therefore, our dependent variable (i.e., performance in time t+2) cannot cause our independent variables (i.e., the board's human capital in time t). Second, if the direction of causality was from firm performance to director human capital, the relationship would likely be stronger for recently appointed directors than for directors who have been on the board for a long time. However, there was no evidence of this in our data. In fact, director tenure was highly nonsignificant whenever we entered it in the model. However, the idea that there is a recursive relationship between firm performance and board composition is interesting and could prompt additional study. Future research should explore whether there is a complicated causal pathway whereby high-performing firms attract the best directors, who are then able to help the firms continue with their high performance.

Finally, in this study we focused on the effects of general human capital and information processing demands on firm performance. However, research on boards has also indicated that social capital may be beneficial to firms (Hillman & Dalziel, 2003) because directors with social capital may provide access to unique information and have influence with stakeholders (Adler & Kwon, 2002). Our study found that one source of social capital—namely, other board appointments—had a negative effect because of the increased information processing demands it imposes on directors. Future research should explore whether other forms

of social capital have effects similar to those of human capital and also whether they contribute to increased information processing demands.

Conclusion

In this study, we developed a model of board effectiveness that incorporates director capabilities and limitations. We proposed and found that structurally similar boards may have very different impacts on the performance of the firm based on directors' capabilities and the cognitive demands they face from their other board appointments. Boards comprised of directors with high levels of human capital can improve the performance of the firm. This model helps us understand why some boards of directors seem better than others at monitoring and at resource provision, even though they are similar in structure. Research on boards of directors can be improved by using a more accurate picture of director capabilities as well as their limitations.

Notes

1. Although we believe that in our context the effect of information processing demands on directors is negative and linear in shape, the positive benefits found in prior research may indicate that the value of increased levels of information may be initially positive, and then become negative at high levels (an inverted U-shape). Therefore, we test for this in our analysis. However, we do not find evidence of an inverted U-shaped relationship.

2. In order to test the robustness of using this time lag, we also ran all our models using a 1-year lag. The results from these models were qualitatively similar to the models reported here for our hypothesized variables.

3. Because the effect of general human capital has received little testing in the context of the board, we wanted to explore multiple possibilities regarding how human capital might affect the firm. One of the first alternatives we considered was that it is possible that the effect of human capital is nonlinear in nature. Therefore, we ran models where we tested squared terms for each of our human capital indicators. We also ran models using logged versions of our independent variables. None of these alternative models were significant. Additionally, because prior research shows that the effect of related board appointments is contingent on the context of the firm (Carpenter & Westphal, 2001), we also ran models where we interacted our human capital variables with the relatedness variables used by Carpenter and Westphal (2001) in order to determine whether the value of the directors' human capital was contingent on how related their prior experience was to the focal firm. None of the interactions were significant, suggesting that the value of our human capital measures was not contingent upon having contextually related experience. Taken together, this additional analysis suggests that the effect of human capital is most appropriately modeled in the way described.

4. In some cases, because of missing data, aspects of an individual director's education were estimated. To ensure that this did not bias our analysis, we included a dummy variable (coded as 1 when education data regarding one or more director(s) on a focal board was estimated, 0 otherwise) in all models.

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