When Do Independent Directors Improve Firms' Information Environments?

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Abstract: Recent research finds that a greater proportion of independent directors are observed on boards of firms characterized by high corporate transparency. The causality of this relation, however, is unclear. One branch of the governance literature takes firms' information environments as fixed and shows that board independence is dictated by exogenous variation in corporate transparency. Another branch, mainly in accounting, argues that independent directors can effect changes in the information environment. We examine a regulatory shock that substantially increased board independence for some firms, and find that information asymmetry, and to some extent disclosure, financial intermediation, and the shareholder base, changed at firms affected by this shock. These results are muted to some extent when management is more entrenched or when information processing costs are relatively high. Our results suggest that the corporate information environment is an endogenous function of board structure.

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1. Introduction

We explore whether and how firms' information environments adjust in response to a required increase in the proportion of independent directors. Independent directors, as outsiders to the firm, must acquire and process substantial firm-specific information to effectively perform their advising and monitoring duties. When the corporate information environment is opaque, and there are significant costs to acquire detailed knowledge of the firm's operating, financing, and investing activities, independent directors are less effective. We document that the corporate information environment, as measured by proxies for information asymmetry, disclosure, and information intermediation, generally improves in response to a required increase in the proportion of independent directors. This improvement is muted to some extent for firms with high information processing costs and firms where management is relatively more entrenched. When interpreted in the context of existing literature, our results highlight the simultaneity in the evolution of board structure and the corporate information environment.

Prior research finds an association between the proportion of independent directors and various aspects of the corporate information environment. In the accounting literature, for example, a number of studies examine the relation between independent directors and the quality of financial reporting. These studies report mixed findings. Specifically, Bushman et al. (2004) and Vafeas (2000) fail to find a significant relation between earnings timeliness and the proportion of independent directors, whereas Petra (2007) and Ferreira et al. (2009) document positive relations between accounting quality and the proportion of independent directors and earnings informativeness, respectively. Beekes, Pope, and Young (2004) and Ahmed and Duellman (2007) find that the degree of conservatism in accounting earnings is greater for firms with a higher proportion of independent directors. In a related vein, Klein (2002) and Krishnan

(2005) find that the proportion of independent audit committee directors is negatively related to the magnitude of discretionary accruals and the incidence of internal control weaknesses, respectively. However, Farber (2005) and Karamanou and Vafeas (2005) fail to find a relation between the proportion of independent audit committee directors and either SEC enforcement actions or the frequency and accuracy of managements' earnings forecasts, respectively.

Beyond the difficulty of interpreting the mixed findings of this literature, there is the challenge of identifying the direction of causality of any associations between board structure and properties of firms' financial reporting. For example, consider the Ahmed and Duellman (2007) finding that firms with a greater proportion of independent directors have more timely recognition of bad news in their financial reports. As the authors note, one interpretation of this finding is that independent directors work to institute greater conservatism because conservative reporting can aid independent directors in reducing agency conflicts that arise from information asymmetries with managers.[1] An alternative interpretation, also alluded to by the authors, is that causality runs in the opposite direction. That is, firms with conservative financial reporting may invite a larger fraction of independent directors to sit on their boards because their financial reporting allows directors to monitor managers more effectively. Thus, this result leaves open the question of whether independent directors actively increase the timely recognition of news, or instead whether firms that have made a commitment to recognize news in a timely fashion choose to appoint more independent directors.

The question of causality applies broadly to the accounting literature cited above.[2] This

[1] Specifically, Ahmed and Duellman (2007, pp.414-415) state, "Second, directors need verifiable information in order to effectively monitor and advise managers. The accounting and financial reporting system is a critical source of verifiable information that is useful in monitoring and evaluating managers as well their decisions and strategies (Watts and Zimmerman, 1986; Bushman and Smith, 2001)." The accounting literature addressing board structure largely follows this line of reasoning.

[2] A recent exception is Goh, Ng, and Yong (2011). They examine the cross-sectional association between board independence, accruals quality, management forecasts, analyst coverage, and information asymmetry. They address

interpretation issue becomes even more complicated when considered together with the ample empirical evidence in finance documenting that information asymmetry and transparency influences board independence. This literature argues that independent directors have difficulty performing their advising and monitoring roles when information processing costs are high, and therefore that firms with information processing costs choose to have relatively few independent directors (e.g., Linck et al., 2008; Lehn et al., 2008). Consistent with this prediction, several recent papers find a negative relation between board independence and information acquisition and processing costs.[3] These papers, however, generally assume that the information environment is exogenous with respect to independent directors. In other words, in contrast to much of the literature in accounting, these studies do not consider the possibility that managers and directors can influence the information environment by committing to various financial reporting and disclosure policies.

To explore whether firms' information environments adapt to fit the informational needs of a given board structure, we examine a shock to the proportion of independent directors, and then observe whether and how the information environment responds. Similar to Duchin, Matsusaka, and Ozbas (2010), we use regulations promulgated in 2003 by the NYSE and Nasdaq exchanges as an exogenous event that altered the independence of some firms' boards.[4] These exchange regulations require most listed corporations to have a majority (more than 50%) of independent outside directors on their boards. In general, firms were required to comply with these regulations by the earlier of: (1) the listed firm's first annual shareholders meeting after January 15, 2004; or (2) October 31, 2004. Some firms already had a majority of independent

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the endogeneity of board independence by a board connections instrumental variable, which they define as: "the fraction of dependent directors with board connections to boards with a majority of independent directors."

[3] See, for example, Boone et al. (2007); Coles, Daniel and Naveen (2007); Linck et al. (2008); Lehn et al. (2008); Cai, Liu, and Qian (2009); and Ferreira, Ferreira, and Raposo (2011).

[4] Duchin et al. (2010) use the 2002 Sarbanes-Oxley (SOX) regulation related to audit committee independence.

directors on their boards and therefore complied with these new regulations at the time they were adopted; other firms did not. In our sample, the firms that were not in compliance with the majority board independence rule (as of 2000) have a 43% increase in the mean proportion of independent directors, whereas firms that were already in compliance do not increase the proportion of independent directors. We use a model of board structure to identify the expected change in proportion of independent directors based on whether firms initially met the exchange requirements. We then use the predicted change in the proportion of independent directors (over a four-year period from roughly 2000-2004) to identify the effect of changes in board structure on changes in a variety of information-related variables.

Using board structure data for a broad sample of 1,892 firms, we document that information asymmetry, measured as the information asymmetry component of the bid-ask spread, generally decreases in response to an exogenous increase in the proportion of independent directors. Moreover, the economic magnitude of this effect is often large. We also explore some of the potential channels through which the information environment may be altered to satisfy the informational demands of the board. Specifically, we examine variables related to management forecast frequency and precision, accrual quality, analyst following and consensus, and shareholder base. Our evidence suggests that an increase in the proportion of independent directors leads to increases in the frequency and precision of management forecasts and institutional ownership (with some marginally significant results related to analyst following and consensus).

Although a board with a majority of independent directors likely requires a more transparent information environment than an insider-dominated board to govern effectively, management may not willingly relinquish their control over the board. One way for management

to limit the monitoring effectiveness of new independent directors is to withhold information or to otherwise resist efforts by directors to elicit increased transparency. We explore this possibility by testing whether the improvements in corporate transparency are muted for firms where managers are likely to be entrenched. We find that when management is likely to be entrenched, management forecasts become less frequent and less precise following an increase in board independence. We find no significant mediating effects of management entrenchment on the relations between the change in board independence and the change in our other measures of corporate transparency.

Finally, we consider whether information processing costs impede the changes in transparency dictated by an increase in independent directors. Similar to Duchin et al. (2010), we predict that making improvements in corporate transparency is more difficult for some firms than others. To capture cross-sectional variation in information transfer difficulties, we use principal components analysis to develop an information cost factor that is a function of various firm characteristics, such as firm size, age, growth, investment, and risk. We find only modest evidence in support of this hypothesis. In particular, only two of our eight proxies for corporate transparency show an attenuated relation with the change in independent directors when information processing costs are relatively large.

Collectively, our results suggest that firms can and do alter certain aspects of their information environments to facilitate the informational demands of independent directors. Specifically, we find that a required increase in the proportion of independent directors induces improvements in corporate transparency, such as a decrease in information asymmetry, an increase in the frequency and precision of management forecasts, and an increase in institutional holdings. Further, we find that some of these results are muted when management is more

entrenched, and when information processing costs are large. These results generally support the inferences in a large body of accounting literature arguing that the corporate information environment is endogenous with respect to management and/or board actions. At the same time, our findings also highlight the importance of considering the simultaneity of the relation between board structure and corporate transparency, and we suggest that caution be exercised when interpreting results that take either board structure or corporate transparency as exogenous rather than jointly determined.

2. Background and predictions

As noted above, many authors predict and find a positive relation between corporate transparency and the proportion of independent directors.[5] This relation is interpreted as evidence that firms populate their boards with a high proportion of outsiders only when the information environment is sufficiently transparent to allow independent directors to effectively perform their monitoring and advising duties.[6] A consistent maintained assumption across this literature is that the information environment is exogenous with respect to the choice of board structure; that is, board structure reacts to the information environment but is not able to alter it. In contrast, much of the accounting literature on governance assumes that boards and managers can and do use financial reporting and disclosure choices to alter corporate transparency. In these papers, the board is often viewed as a mechanism to effect change in the information environment.

[5] E.g., Boone et al. (2007); Coles, Daniel and Naveen (2007); Linck et al. (2008); Lehn et al. (2008); Cai, Liu, and Qian (2009); and Ferreira, Ferreira, and Raposo (2011).

[6] As noted by Bushman et al. (2004), one might alternatively predict a negative relation between transparency and the proportion of independent directors if the monitoring activities of independent directors are more valuable in settings where substantial information asymmetries exist between managers and investors. This negative relation, however, does not appear to be borne out in the data examined in prior studies.

Our objective is to explore whether and how the corporate information environment adapts to the informational demands of a given board structure. As we discuss in more detail below, our research design uses a regulatory shock that required substantial increases in the proportion of independent directors for some firms but not others. Specifically, the regulation requires that most boards have a majority of independent directors. Therefore, boards with a majority of inside or non-independent directors were required to add more independent directors, to remove some inside directors, or some combination of the two. Boards with a majority of independent directors prior to the regulation were not required to make changes to their board structure. In our sample, firms that were not in compliance with the majority board independence rule experience significant increases in the proportion of independent directors (43% increase in mean proportion of independent directors), whereas firms that were already in compliance do not increase the proportion of independent directors. In untabulated analysis, we find that for most firms this change in board structure is achieved by replacing inside directors with independent directors, rather than simply adding more independent directors to the board until a majority is achieved.

Our main hypothesis is that if independent directors can influence corporate transparency to meet their informational demands, then an exogenous increase in the proportion of independent directors will be followed by increased transparency. Independent directors require a transparent information environment to effectively monitor and advise management. When new independent directors come on the board, they will take action to ensure transparency. Alternatively, managers may increase transparency in order to attract independent directors. If corporate transparency cannot be altered to fit the information demands of an independent board, then there will be no association between an increase in the proportion of independent directors

and changes in transparency.

However, some economic forces could complicate our prediction of a positive relation between changes in board independence and changes in transparency. One issue is that as decision rights are taken away from management directors (because the previous majority of inside directors is required to be reduced to a minority), managers may respond by actively decreasing transparency. As noted by Holmstrom (2005), Adams and Ferreira (2007), and others, if management believes that a more independent board will monitor more intensively, they may be reluctant to disclose information that can be used for disciplining purposes. Further, management may not only withhold information from independent directors, but may also seek to entrench themselves by investing in manager-specific projects that increase information asymmetries and limit the board's ability to impose discipline (see Shleifer and Vishny, 1989; Edlin and Stiglitz, 1995). We expect that managements' ability to resist the informational demands of independent directors increases with the degree to which management is entrenched. In our tests below, we explore this prediction using inside ownership and the proportion of independent directors that have been appointed during the current CEO's tenure as proxies for entrenchment.

Further, managers' ability to withhold information, and the difficulty with which independent directors can elicit information, is expected to be greater when information processing costs are large. The influence of information processing costs on board structure is discussed in detail by Duchin et al. (2010) who emphasize, "when an outsider's cost of acquiring information about the firm is high, outside directors are less effective at monitoring and providing advice, than when the cost of information is low." Duchin et al. (2010) further note that because some firms optimally maintain a low proportion of independent directors (e.g., due

to high information processing costs), a mandate that all boards be governed by a majority of independent directors is unlikely to be equally beneficial for all firms. And, if the required increase in independent directors does not result in a more effective board structure, then any improvement in corporate transparency following the regulation may be muted. Further, it seems possible that transparency could even decrease in this latter setting if independent directors make worse project selection decisions due to a lack of necessary information, and uncertainty about the outcome of these decisions leads to greater information asymmetry. This prediction of a muted improvement in transparency when information processing costs are high complements our previous prediction that when control is relinquished to independent directors, high information processing costs may afford managers an increased ability to withhold information and maintain effective control of decision making.

In summary, the discussion above suggests that the effect of a required increase in the proportion of independent directors on corporate transparency and information asymmetry is an empirical issue: independent directors require greater transparency to govern effectively, but managers have incentives to decrease transparency when they are stripped of their control rights. The discussion also predicts that the relation between a required increase in the proportion of independent directors and corporate transparency will be less positive for firms characterized by greater information processing costs. In our tests below, we explore whether the relation between a required increase in the proportion of independent directors and corporate transparency varies with proxies for managerial entrenchment and information processing costs.

3. Research Design

We wish to test whether a firm's proportion of independent directors causally determines characteristics of its information environment. Therefore, we would ideally estimate the following specification:

$$\textit{Information Variable} = a_0 + a_1\%\ \textit{Ind. Directors} + \sum a_2 * \textit{Controls} + \textit{error} \qquad (1)$$

However, as discussed in the previous section, the literature on the relation between firms' governance structures and information environments suggests that board structure and information are jointly determined. If firms' *% Ind. Directors* is endogenously related to their information environments, the estimated effect of board structure will be biased. Credible identification of an effect of firms' board structure on their information environment therefore requires an instrument that produces exogenous variation in board structure, but that has no *direct* effect on firms' information environments.

Similar to Duchin et al. (2010), we use recent regulatory requirements that imposed changes to board structure as a source of exogenous variation in board structure. Specifically, we use 2003 NYSE and Nasdaq regulations that require listed corporations to have a majority (more than 50%) of independent directors on their boards.[7] About 30% of our sample did not initially comply with this regulation, so our sample contains firms that had to change their board structure and other firms for which no change was required. In general, firms were required to adopt these policies by the earlier of: (1) the listed issuer's first annual shareholder meeting after January 15, 2004; or (2) October 31, 2004.[8] It is important to note that exchange regulations produced

[7] As discussed in Chhaochharia and Grinstein (2009, p. 235-6), in February 2002, the SEC asked the exchanges to improve their governance listing standards. The NYSE and the Nasdaq proposed the changes requiring majority independence in August 2002 (NYSE) and October 2002 (Nasdaq). The SEC approved the proposals with minor changes in November 2003.

[8] Firms with classified boards had until their first annual meeting after January 15, 2005, but no later than December 31, 2005 (Securities and Exchange Commission press release 34–48745, November 4, 2003).

variation in the *change* in the proportion of independent directors, rather than in the proportion of independent directors *per se*.

To use this instrument in our research design, we take first-differences of Eq. (1), which yields the following model of changes in information variables as a function of changes in board structure and changes in controls:

$$\textit{Change in Information Variable} = a_0 + a_1 * \textit{Change in \% Ind. Directors} + \sum a_2 * \textit{Change in Controls} + \textit{error} \qquad (2)$$

Change in %Independent Directors remains endogenous, and we instrument for it with its predicted value from the following regression:

$$\textit{Change in \%Independent Directors}_{2000\text{-}2004} = b_0 + b_1 * \textit{Min \% Change ID}_{2000} + \sum b_2 * \textit{Change in Controls} + \textit{industry indicators} + \textit{error} \qquad (3)$$

This regression models the change in the proportion of independent directors at each firm between 2000 and 2004, and identifies it with the instrument, the minimum required percentage change in independent directors, *Min % Change ID*. We calculate this variable as follows:

Min % Change ID = 0 if % independent directors in 2000 > 50%

Min % Change ID = (Minimum number of independent directors required for majority independence)/board size if % independent directors in 2000 ≤ 50%

This variable measures the percentage by which firms as of 2000 had to increase their independent directors to comply with the 2003 NYSE and Nasdaq regulations that require more than 50% independent directors. The regulations affect firms with small boards more than large boards, and the construction of our variable captures this effect. For example, consider two firms, one with five directors and the other with twenty. If both firms have 40% independent directors, the firm with five directors needs to add one independent director (an increase from two to three independent directors, or 20% of the board) to comply, while the firm with twenty directors

needs to add three independent directors (an increase from eight to eleven independent directors, or 15% of the board) to comply. We then use fitted values from this regression as the predicted changes in the proportion of independent directors between 2000 and 2004 with which we identify the effect of changes in board structure on changes in firms' information environments in the second stage.

As we discuss in more detail below, we measure changes in the proportion of independent directors and other variables over the period 2000 and 2004, where 2004 is the first year that firms were required to comply with the regulations, and 2000 is the latest year in which the new regulations could not have been reasonably anticipated.

Our second stage empirical specification is as follows:

$$\begin{aligned} \textit{Change in Information Variable}_{2000\text{-}2004} = a_0 \\ + a_1 * \textit{Change in \% Ind. Directors}_{2000\text{-}2004}\textit{(predicted)} \\ + \sum a_2 * \textit{Change in Controls}_{2000\text{-}2004} + \sum a_3 * \textit{Controls}_{2000} \\ + \textit{industry indicators} + \textit{error} \end{aligned} \quad (4)$$

As dependent variables, we examine three categories of information environment variables: 1) a comprehensive measure of information asymmetry between informed and uninformed shareholders, as measured by changes in the information asymmetry component of the bid-ask spread; 2) disclosure choices by management that can influence the information environment, as measured by changes in the frequency and precision of management forecasts, and accruals quality; and 3) information intermediation that may have changed as a consequence of the changed information environment, as measured by changes in analyst following and consensus, institutional holdings, and the number of shareholders. We describe measurement of these information variables in more detail below.

In both the first- and second-stage regressions, we control for contemporaneous changes in (1) the natural logarithm of total assets, (2) research and development expenditures, (3)

leverage, (4) the natural logarithm of the number of business segments, (5) the natural logarithm of firm age, (6) return volatility, (7) the natural logarithm of share price, and (8) the book-to-market ratio. For completeness, although the specification in (2) does not require them, we also include the initial value (i.e., as of 2000) of each control variable, and industry fixed effects.

The research design described thus far is designed to estimate the unconditional effect of changes in board structure on changes in firms' information environments. However, there are certain firms for which the required changes in board structure either may not have an effect, or may have an effect that is moderated by some other variable.

Any effect of a change in board structure on firms' information environments may also depend on their initial information environment and other features of their initial governance structure. First, similar to Duchin et al. (2010), we expect the initial level of information asymmetry to affect the efficacy of independent directors who are put in place to satisfy the exchange regulations. Second, there could be variation in the extent to which firms' directors who, although technically independent, are actually independent of the CEO. We follow prior literature (e.g., Core, Holthausen, and Larcker, 1999) and measure the proportion of firms' independent directors who were appointed during the CEO's tenure to isolate directors that were likely selected by the CEO. Third, we predict that there will be variation according to the fraction of shares owned by insiders (i.e., officers and directors). We use inside ownership data gathered by Fahlenbrach and Stulz (2008). This ownership data is measured about one month before the proxy date, and is scaled by the total number of shares outstanding at that time.

To estimate whether any of these conditional effects exists, we estimate a modified version of Eq. (4) in which we interact a proxy for relatively high and low values for each of the three characteristics with both the (predicted) change in the proportion of independent directors

and all of the control variables. The advantage of this "fully-interacted" specification is that it allows the relation between changes in the information variables and both changes in board structure and the controls to vary across the partitions. Any differential effect of changes in board structure across these partitions should manifest in differences in the estimated effect of changes in board structure on our measures of firms' information environments.

We note the following caveats about our use of NYSE and Nasdaq regulations as an instrument for changes in board composition. First, there was a trend in regulations aimed at increasing board independence during this period. As Duchin et al. (2010) discuss, NYSE and Nasdaq regulations adopted in 1999 require audit committees to be comprised entirely of independent directors. This requirement was subsequently reiterated by the Sarbanes-Oxley (SOX) Act of 2002. Further, in addition to the board independence rules adopted in 2003, at the same time the NYSE and Nasdaq adopted additional rules requiring that the compensation committee and nominating committee consist entirely of independent directors. Thus, while we concentrate on regulatory changes affecting the independence of the entire board, other changes at about the same time affected the independence of certain board committees. Our research design implicitly assumes that changes in board independence have more of an effect on firms' information environments than changes in the independence of any of its separate committees. This assumption is consistent with results in Chhaochharia and Grinstein (2009, p. 244), who find that "that the requirement for a majority of independent directors, rather than that of compensation committee independence or nominating committee independence, is important to compensation decisions."

Second, in addition to the independence rules, the NYSE and Nasdaq adopted rules requiring: (1) a written charter for the compensation committee and the nomination committee,

(2) committees should also have self-evaluation procedures, (3) all audit committee members should be financially literate, and (4) non-management directors of a company must have regularly scheduled executive sessions without management. Likewise, in addition to requiring independent audit committees, SOX enacted three additional corporate governance requirements into the federal securities laws: (1) auditors were restricted in providing non-audit services, (2) corporate loans to directors and corporate executives were prohibited, and (3) the CEO and CFO were required to certify the firm's financial statements. Our research design does not explicitly control for these changes, which may lower our power in the event the changes are not correlated with changes to board structure. Although these governance changes may have also affected firms' information environments, these changes should not bias our inferences unless they also happen to be correlated with our instrument. While we cannot entirely dismiss this concern, we believe that our difference-in-difference research design that tests for differential effects of changes in the proportion of independent directors across partitions of firms (e.g., low vs. high information costs) helps to address this issue. However, we cannot entirely rule out that some other governance change, such as the initiation of executive sessions, is correlated with changes in independent directors in such a way as to partially explain our results.

Finally, many of these regulatory changes were in response to frauds and other accounting irregularities that were thought to have occurred in part because of deficient board structures and lax oversight. Although these governance changes may be considered endogenous for certain firms such as Enron, whose fraud may have prompted certain regulations, we follow prior literature and consider the regulatory changes to be largely exogenous from the perspective of most firms.[9]

[9] Larcker et al. (2011, p. 4) argue that "so long as the regulatory shift is not the result of actions on the part of every individual firm, the regulatory shift can be treated as largely exogenous. For example, many argue that the Enron

4. Sample and Variable Measurement

4.1. Sample

We begin our sample selection by specifying a sample period that starts just before the exchange regulations would have been anticipated and ends just after the first time firms were required to comply with the regulations. As noted above, firms that were not initially compliant with the regulations were required to change their boards by the earlier of (1) the firm's first annual shareholders meeting after January 15, 2004; or (2) October 31, 2004. For example, a December fiscal-year-end firm needed to comply with the regulations by its Spring 2004 annual meeting. As another example, a firm that typically holds its annual meeting in November would need to comply either at its November 2003 annual meeting or at a special meeting held before November 2004. These examples illustrate that most firms were required to comply by their annual meetings between November 1, 2003 and October 31, 2004, and we use this period as the ending point for our sample. Because the annual meeting generally occurs between four and six months following a firm's fiscal year-end, at the ending point, the sample firms have fiscal years ending between May 2004 and June 2005.

To determine the starting point for the sample, we match the ending point sample firms to the same firms four years earlier. The starting point then consists of firm-years with fiscal years that end between May 2000 and June 2001, and with annual meetings between October, 1999 and December, 2000.[10] We note that this starting period is before the Enron collapse in 2001,

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scandal was the impetus for new regulation. While the resulting regulation might be considered endogenous to Enron, the Enron scandal and ensuing regulations were beyond the control of most firms. Thus, the resulting regulation is largely exogenous." Similarly, although the exchange regulations for board independence represented an endogenous response to perceived governance deficiencies, they were largely exogenous from the perspective of any particular firm.

[10] The months of the annual meetings for the starting period and ending period are not necessarily the same because firms do not always have their annual meetings in exactly the same month each year.

SOX in 2002, and the NYSE and Nasdaq regulations in 2003. For convenience, we refer to the starting period as the "2000 starting period" and the ending period as the "2004 ending period." See Figure 1 for a summary of timing.[11]

To be included in our sample, we require that a firm have non-missing data on board independence at both the starting point and ending point of the sample period (as defined above). We begin with a sample of firms for which we have board independence data in 2004. We eliminate foreign private issuers following Berger, Li, and Wong (2011). Specifically, we eliminate publicly-traded ADRs (share codes between 30 and 39) and eliminate all Canadian and Israeli firms that are directly listed in the U.S. (Compustat country codes 9 and 49). We also exclude "controlled companies," which we define as those with dual class shares, or for which more than 50% of the company's voting power in electing directors is held by an individual, a group, or another company.[12] Controlled firms are exempt from a number of the exchanges' governance rules, including the requirement of having a majority of independent directors.[13,14]

This leaves a sample of 1,892 firms with board independence data in 2004. We obtain board data primarily from RiskMetrics, and supplement these data with additional observations

[11] Our sample period begins about the same time, but ends roughly a year earlier than that in Duchin et al. (2010), whose sample period runs "from the end of fiscal year 2000 to the end of fiscal year 2005" (p. 200). The advantage of our earlier ending date is that we pick up the firm the first time it complies, whereas with a later ending date, some firms likely are complying for the second time (December firms with June meeting dates) whereas others likely are complying for the first time (March firms with September meeting dates). As we note below, our information asymmetry test do not appear to suffer from low power due to this timing difference. We can replicate the Duchin et al. results on our larger and slightly earlier sample. Further, our results are virtually unchanged if we use an ending date one year after the first year in which compliance was required.

[12] We identify firms with dual class shares using the data set described in, and provided by, Gompers, Ishii, and Metrick (2010).

[13] The NYSE Listed Company Manual specifies that "A listed company of which more than 50% of the voting power for the election of directors is held by an individual, a group or another company is not required to comply…" The NASDAQ-AMEX listing requirements are similar and specify that "a controlled company is exempt from the majority independent board requirement…" where a "controlled company" is defined similar to the NYSE listing requirements.

[14] In untabulated analysis, we find no evidence that controlled firms experience significant increases in transparency, and that with respect to some of the transparency variables, we find significantly greater increases in transparency for the non-controlled firms.

available from the Corporate Library and Equilar. RiskMetrics provides data on board independence for 1,301 of these firms in 2000; the remaining board independence data for 2000 we collect by hand. Consistent with prior research (e.g., Linck et al., 2008; Duchin et al., 2010) and with NYSE/Nasdaq regulations, we define a director to be independent if he or she is an outsider with no material relationship with the firm.[15]

All our tests require the board data, data from Compustat and CRSP to estimate the controls in Eqs. (3) and (4), and data to estimate the information asymmetry component of the bid-asked spread (*IAC_spread*). Our sample size varies between 1,459 and 1,892 firm-observations depending upon the specific test. This variation occurs because we only require data for the necessary variables for a firm to be included in a given test.

4.2. Information environment variables

As noted above, our information environment variables are grouped into three categories: 1) the information asymmetry component of the bid-ask spread as a broad measure of transparency; 2) the frequency and precision of management forecasts, and accruals quality, as measures of management's disclosure and accounting choices, and 3) analyst following and consensus, institutional holdings, and number of shareholders as measures of information intermediaries.

4.2.1. IAC_spread

[15] Pursuant to Item 470(a) of Regulation S–K, firms must disclose whether each director is ''independent'' within the definition prescribed by the exchange on which the firm's shares are traded. Directors are typically classified as insiders, outsiders, and affiliates (or gray directors). Insiders are those the firm currently employs, such as the CEO, CFO, president, and vice presidents. Outsiders have no affiliation with the firm beyond their membership on its board of directors. Affiliates are former employees, relatives of the CEO, or those who engage in significant transactions and business relationships with the firm as defined by Items 404(a) and (b) of Regulation S–K. Directors on interlocking boards are also considered to be affiliated, where interlocking boards are defined by Item 402(j)(3)(ii) of Regulation S–K as "those situations in which an inside director serves on a non-inside director's board."

IAC_spread measures the extent to which unexpected order flow affects prices and is increasing in information asymmetry. This variable measures the effect of information asymmetry on a firm's stock price (i.e., the price impact or adverse selection that results from information asymmetry between informed and uninformed shareholders). We measure *IAC_spread* following Madhavan, Richardson, and Roomans (1997) as modified by (and described in) Armstrong et al. (2011). To estimate *IAC_spread*, we gather trade-by-trade and quote data from the Institute for the Study of Security Markets (ISSM) and the Trades and Automated Quotes (TAQ) database provided by the NYSE. We match trades and quotes using the Lee and Ready (1991) algorithm with a five-second lag to determine the direction of the trade (i.e., buy or sell). We clean trades and quotes using the algorithm described in Appendix B of Ng, Rusticus, and Verdi (2008). Once trades are classified as either buyer- or seller-initiated, we estimate the following firm-specific regression using all transactions available during the month:

$$\Delta p_t/p_{t-1} = \psi\, \Delta D_t + \lambda\, (D_t - \rho D_{t-1}) + u_t \quad , \tag{5}$$

where p_t is the transaction price, D_t is the sign of trade (+1 if buy and -1 if sell), and ρ is the AR(1) coefficient for D_t. We measure *IAC_Spread* each month using all intra-day data for that month to estimate Eq. (5) for each firm in the sample. Note that we have deflated the dependent variable by lagged price to allow for cross-sectional comparability. This gives us an estimate of the *IAC_spread* as a percentage of price. We then average the monthly estimate of *IAC_spread* over the six months centered on each firm's fiscal year end (i.e., from three months before to three months following) to derive the measure that we use in our tests.

4.2.2. Management disclosure variables

We define the number of management forecasts, *log(1+Management Forecasts)*, as the natural logarithm of one plus the number of annual earnings per share forecasts issued by

management during the six months centered on the fiscal year end. We also measure the precision of these management forecasts, *Avg. Mgt. Forecast Precision*, using the five category approach of Rogers and Van Buskirk (2009): We assign forecast precision of 4 for point estimates, 3 for range estimates, 2 for open-ended estimates, 1 for qualitative estimates, and 0 for no forecast. Management forecast data are obtained from the First Call Company Issued Guidelines (CIG) database.

We use the accruals quality measure proposed by Dechow and Dichev (2002) and modified by Francis et al. (2005) as a measure of firms' accounting quality. We estimate accruals quality using residuals from cross-sectional regressions of total current accruals on lagged, current, and one-year-ahead cash flows and the change in revenue and property, plant, and equipment. Thus, accruals quality is higher when accruals are more highly correlated with the current and adjacent years' cash flows. Prior research (e.g., Aboody et al., 2005; Francis et al., 2005) suggests that when the variance of the residuals from this regression is higher, earnings quality is lower, and information asymmetry is higher. We estimate the accruals regressions at the Fama-French 48 industry level, with the requirement that there are no fewer than ten observations in the industry regression. Much research estimates accruals quality as the standard deviation of five years of residuals, but because we measure changes over a four-year period, this convention is not appropriate in our setting. Instead, as a proxy for changes in the standard deviation, we compare the absolute value of the residual in 2000 with its counterpart in 2004 (*MDD Absolute Accruals*).[16]

[16] An alternative proxy for accruals quality is the absolute value of discretionary accruals estimated using the modified Jones Model. Absolute accruals from this model can be considered as a proxy for earnings management, which independent directors might seek to limit as argued by Chen et al. (2011). However, it is also plausible that these accruals proxy for managers' conveying information (e.g., Watts and Zimmerman, 1986, and empirical papers by Guay, Kothari and Watts, 1996; Tucker and Zarowin, 2006; Bowen et al., 2008), which independent directors might seek to enhance. Given these opposing predictions, we do not examine discretionary accruals.

4.2.3. Information intermediary variables

We construct four variables to proxy for changes in intermediaries that are expected to be related to changes in the information environment. The number of analysts, *log(1+Number Analysts)*, is the natural logarithm of one plus the number of analysts on IBES that issued a one-year ahead earnings per share forecast during the six month period centered on the fiscal year end. Prior research documents that analysts tend to cover firms with more transparent information environments (e.g., Bhushan, 1989; Lang and Lundholm, 1996; Healy, Hutton, and Palepu, 1999; Bushman, Piotroski, and Smith, 2005). *Analyst Consensus*, is the natural logarithm of one plus the standard deviation of the most recent IBES consensus earnings per share forecast (prior to the earnings announcement date) scaled by total assets per share averaged over the six months centered on the fiscal year end. Institutional holdings, *log(Inst. Holdings %)*, is the natural logarithm of the percentage of the firm's shares held by institutional investors either on, or as of the end of the most recent quarter after the fiscal year end. Institutional ownership data are obtained from the Thomson-Reuters Institutional Holdings (13F) Database. Healy, Hutton, and Palepu (1999) and Bushee and Noe (2000) find higher institutional ownership at firms with greater disclosure. Finally, we measure *log(Number Shareholders)* as the natural logarithm of the number of shareholders as of the fiscal year end. Grullon et al. (2004) find that measures of firm size and investor recognition (e.g., advertising expense, market value, and firm age) are positively associated with the number of shareholders.

We note that although our intermediation variables are expected to proxy for the richness of the information environment, we are agnostic as to the direction of causality. That is, it may be that independent directors improve the information environment, and this attracts more analysts, institutions, and shareholder, or instead that more of these intermediaries improve

information transparency. For example, independent directors may encourage greater analyst following or more institutional investors, which could, in turn, improve the information environment. Consistent with this simultaneity, Brennan and Subrahmanyam (1995) show that a reduction in information asymmetry increases the number of analysts, but that that causality also runs in the opposite direction in that an increase in the number of analysts reduces information asymmetry. Likewise, Grullon et al. (2004) and Armstrong et al. (2011) suggest that one consequence of more shareholders is an improved information environment.

5. Results

5.1. Descriptive statistics

Table 1 provides descriptive statistics for our sample firms partitioned into "compliant" and "non-compliant" groups based on whether the firm complied with the new exchange board structure requirement at the start of our sample. Our sample contains 1,322 compliant firms and 570 non-compliant firms as of 2000. By construction, the compliant firms have a substantially greater fraction of independent directors than the non-compliant firms in 2000 (mean of 72% versus 40%).

Most importantly for our analysis, however, is the increase in the proportion of independent directors for the non-compliant firms during the sample period from 2000 to 2004 to comply with the listing regulations. In Figure 2, we plot the mean fraction of independent directors by year. For the non-compliant firms, the fraction of independent directors increases significantly from 40% to 57% in 2004, which represents roughly a 43% increase. The proportion of independent directors at the compliant firms, in contrast, remains relatively constant, with a mean of 72% in 2000 and 74% in 2004. This suggests that these firms had a

relatively stable board structure during the sample period and represent an appropriate benchmark against which to compare the effects of an increase in independent directors at the non-compliant firms. Thus, the regulations appear to be a powerful instrument for required board structure changes that are sufficiently large to produce detectable changes in firms' information environments.

Figure 2 also illustrates that the increase in independent directors for the non-compliant firms occurs steadily during the sample period. This relatively constant growth over our sample period suggests that the non-compliant firms gradually altered their board independence to comply with the regulation by the effective date. Thus, one might also expect to observe gradual changes in the information environments over this four-year period rather than a large change around the effective date of the exchange regulations. Our tests accommodate this multi-year window when measuring changes in transparency.

Table 1 also reports other descriptive statistics for the complaint and non-compliant samples as of the year 2000, and changes in these variables from 2000 to 2004. Consistent with our predictions, non-compliant firms experience a significantly larger decrease in the information asymmetry component of the spread (*IAC_Spread*), and a significantly larger increase in the number of management forecasts, analyst following, and institutional holdings, as compared to complaint firms. We note, however, that Table 1 also indicates that the compliant and non-complaint firms differ along several dimensions. Compliant firms are, on average, somewhat larger and older, have more leverage and less volatile stock returns, and have larger boards (with about one more director, on average). Therefore, these univariate findings should be interpreted with caution, and we turn now to our multivariate analyses.

5.2. First-stage model of Change in % Independent Directors

Table 2 presents the results from the first-stage model (Eq. 3 above) predicting the change in proportion of independent directors from 2000 to 2004 as a function of the minimum required change in the proportion of independent directors. As expected, the minimum required change is a strong, positive predictor of future changes in independent directors, and is consistent with non-compliant firms being required to increase their proportion of independent directors to avoid being in violation of the new regulation and possibly delisted. The R-squared of the regression is 24.8%, suggesting a reasonably good fit. The partial R-squared of the instrument is 22.1%, and is highly significant.

5.3. The effect of changes in independent directors on corporate transparency

Table 3 presents our second-stage results from estimating Eq. (4). In Panel A, we examine changes in information asymmetry, *IAC_Spread*, as a function of the predicted change in the proportion of independent directors from the first-stage model plus controls. Bid-ask spreads incorporate information from a wide range of sources, and as such, we view *IAC_Spread* as our most comprehensive measure of corporate transparency. In Panel B, we examine changes in the other information variables: number and precision of management forecasts, accruals quality, number and consensus of analysts, institutional holdings, and number of shareholders.

In Panel A, we find strong evidence that increases in the proportion of independent directors leads to reductions in the information asymmetry component of the bid-ask spread, a result consistent with our conjecture that a greater proportion of independent directors will require improved transparency. Given the 17% average increase in independent directors by non-compliant firms during the sample period, the -0.635 coefficient on the predicted change in the proportion of independent directors translates to a 10% decrease in information asymmetry.[17]

[17] The coefficient of -0.635 applies to a change in the log of information asymmetry, so a 17% increase in independent directors results in a decrease of 10% = exp(-0.635*17%) -1.

Panel B explores this conjecture further by testing for changes in more specific determinants of corporate transparency. We find that an increase in the proportion of independent directors leads to significant increases in both the frequency of management forecasts as well as institutional holdings. We also find marginally significant increases in the precision of management forecasts, analyst following, and analyst forecast consensus. We find no significant relation between the change in the proportion of independent directors and either accruals quality or the number of shareholders. Overall, these results provide some support for the hypothesis that firms can and do alter their information environments to facilitate the monitoring and advising functions of independent directors.

We note that these results are robust to controlling for levels and changes in many firm characteristics, as well as industry controls, as shown in Table 3. In particular, we note that Duchin et al. (2010) find that changes in independent directors lead to increases in performance. Given these prior results, a potential concern with our results is that increases in corporate transparency could be a manifestation of improved performance (since poorly performing firms have been shown to have greater information asymmetry). Because our controls include the change in *book-to-market* and the change in *log(price)*, we effectively control for the Duchin et al. (2010) documented increases in Tobin's Q (the inverse of *book-to-market*) and stock returns (approximately the change in *log(price)*).

5.4. Cross-sectional moderating effects of agency conflicts and information processing costs

We now consider the possibility that agency conflicts with management may prevent corporate transparency from improving to meet the informational demands of a more independent board. We also consider whether high information processing costs constrain improvements in corporate transparency.

We construct three variables that capture these potentially moderating effects on the relation between changes in the proportion of independent directors and changes in firms' information environments. As a measure of agency conflicts related to CEO entrenchment, we compute the proportion of each firm's independent directors who were appointed after the CEO assumed the office. Prior studies (e.g., Core, Holthausen, and Larcker, 1999) suggest that independent directors who are appointed by the CEO may be beholden to the CEO, and are therefore less independent. We have machine readable data on the date directors joined the board for about 55% of our sample companies; for the remainder we impute the fraction appointed by the CEO. To do this, we estimate a regression of the fraction appointed by the CEO on CEO tenure, and use the estimates and CEO tenure to predict the missing values. Because the dependent variable is a fraction ranging zero to one, we estimate a fractional logit model following Papke and Wooldridge (1996). As a second measure of management's ability to withstand pressure to improve transparency, we compute the fraction of shares owned by insiders (i.e., officers and directors). When insiders have greater voting control, independent directors may be less effective in changing corporate transparency.

We also construct a measure of inherent information processing costs, which we expect to affect newly appointed independent directors' ability to induce changes in their firm's information environment. Because prior studies have used a number of proxies to capture this construct, we use Principal Components Analysis (PCA) to reduce the dimensionality and produce a scalar measure that is more amendable to our research design. Specifically, we use the following variables (Compustat data labels in parentheses) measured at the beginning of our sample period (i.e., 2000) in our PCA: (1) the natural logarithm of the firm's total assets (AT), (2) annual research and development expenditures scaled by total annual sales (XRD / SALE)

and set to zero if annual research and development expenditures are missing, (3) leverage ((DLTT + DLC) / (DLTT + DLC + CEQ + PSTK)), (4) the natural logarithm of the total number of business segments, (5) the natural logarithm of the firm's age (measured using the first year during which appears in the CRSP database), (6) the standard deviation of monthly stock returns during the previous 24 months, and (7) the book-to-market ratio (AT / (LT + (CSHO*PRCC_F))). We use the first principal component as our measure of firms' inherent information processing costs, which we label *IA_factor*.

Table 4, Panels A through D presents a parsimonious tabulation of results that test whether the previously documented positive relations between changes in the proportion of independent directors and changes in corporate transparency are weaker for firms with more entrenched management or with high information processing costs. In Panel A, for comparison purposes, we summarize the results in Table 3 with respect to the relation between the change in independent directors and the various transparency variables (the results for all the control variables are suppressed in the presentation).

In Panel B, we allow the coefficient on the change in independent directors to vary as a function of our information processing costs proxy. Specifically, we estimate a separate coefficient for the change in the proportion of independent directors for firms with above and below the median value of the *IA_factor*. We find that the relation between the change in the proportion of independent directors and both analyst following and the number of shareholders is significantly stronger for firms with low information processing costs (Columns 5 and 8), consistent with our conjecture that high information processing costs mute the effects in Table 3. The other columns, however, show no significant differences.

In Panels C and D, we allow the coefficient on the change in the proportion of independent directors to vary as a function of our management entrenchment proxies, i.e., the proportion of independent directors appointed during the current CEO's tenure (Panel C) and inside ownership (Panel D). In Panel C, we partition the entrenchment proxy into above and below the median value, and we find that the relation between the change in the proportion of independent directors and both management forecast frequency and precision are significantly stronger for firms where fewer independent directors have been appointed during the current CEO's tenure (Columns 2 and 3). In Panel D, we partition the sample into firms with above and below 20% inside ownership, and find that the relations between the change in independent directors and both management forecast frequency and precision are again significantly stronger for firms with less than 20% inside ownership (Columns 2 and 3). The other columns show no significant differences. Overall, we interpret the evidence as providing modest support of the information processing costs and managerial entrenchment hypotheses.

6. Conclusion

In summary, our results are consistent with the interpretation that an exogenous increase in the proportion of independent directors results in improvements in transparency. This relation is predicated on the notion that independent directors require transparency to perform their monitoring and advising roles, and that both firms and independent directors are expected to take actions necessary to ensure that these directors have the information necessary to carry out their charge. The results are also nuanced by our findings with regard to how the prior relation changes in the presence of high information costs. Specifically, the results indicate that, for firms with high information processing costs, an exogenous (or regulated) increase in independent

directors may not have the intended effects on financial reporting and transparency (and may actually be detrimental to the information environment).

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Table 1
Descriptive Statistics

	Compliant			***Non-Compliant***			***Test of Differences***	
	Mean	*Median*		*Mean*	*Median*		*t*-stat	*z*-stat
Board Characteristics								
Number of Directors	9.15	9.00		7.99	8.00		7.78	8.03
% Independent Directors	72%	71%		40%	43%		61.57	34.74
Min. % Change ID	0%	0%		22%	18%		-71.95	-37.51
Change in % Independent Directors	2%	2%		17%	17%		-23.46	-20.15
Control Variables								
ΔLog(Total Assets)	30%	30%		31%	32%		-0.28	-0.34
ΔR&D	-0.01	0.00		-0.01	0.00		1.53	-0.42
ΔLeverage	-0.02	-0.02		-0.01	-0.01		-0.48	-1.02
ΔLog(Num. Bus. Seg.)	4%	0%		6%	0%		-0.82	-0.48
ΔLog(Firm Age)	38%	27%		49%	40%		-5.81	-6.94
ΔReturn Volatility	-0.06	-0.05		-0.07	-0.06		3.48	3.27
ΔLog(Share Price)	27%	38%		37%	39%		-1.76	-1.22
ΔBook-to-market	-0.05	-0.03		-0.09	-0.06		3.37	2.54
Log(Total Assets)	6.96	6.85		6.28	6.15		7.31	7.29
R&D	0.06	0.00		0.05	0.00		0.09	1.66
Leverage	0.37	0.37		0.31	0.27		4.30	4.56
Log(Num. Bus. Seg.)	0.39	0.00		0.31	0.00		2.84	2.50
Log(Firm Age)	2.66	2.71		2.33	2.30		7.17	7.01
Return Volatility	0.16	0.13		0.18	0.16		-5.39	-6.15
Log(Share Price)	2.76	2.84		2.51	2.58		5.23	5.07
Book-to-market	0.71	0.75		0.72	0.71		-0.51	-0.04
Moderating Factors								
IA_Factor	-0.53	-0.56		-0.42	-0.40		-7.79	-7.67
% CEO App. ID	68%	73%		71%	76%		-2.06	-2.40
% Inside Ownership	10.76	6.69		20.22	17.36		-15.82	-14.42
Information Environment Measures								
Change in Log(IAC_Spread)	-65%	-64%		-69%	-67%		4.20	3.67
Change in Log(1+ Management Forecasts)	6%	0%		15%	0%		-2.12	-1.67
Change in Management Forecast Precision	0.05	0.00		0.12	0.00		-0.81	-0.39
Change in MDD Absolute Accruals	-0.01	0.00		-0.01	0.00		1.84	1.20
Change in Log(1+Number Analysts)	5%	0%		10%	3%		-1.77	-1.88
Change in Analyst Consensus	21%	0%		40%	0%		-1.12	-0.21
Change in Log(Inst. Holdings %)	9%	8%		11%	9%		-3.03	-1.98
Change in Log(Number Shareholders)	-3%	-11%		1%	-6%		-0.96	-2.60
Number of Observations	1,322			570				

This table presents descriptive statistics (mean and median) for our sample of firms. *Compliant* is the subsample of 1,322 firms for which the proportion of independent directors more than 50% in 2000 and *Non-Compliant* is the subsample of 570 firms for which the proportion of independent directors was 50% or in 2000. *t*-stat is the *t*-statistic from a non-paired test of means assuming unequal variances. *z*-stat is the *z*-statistic from a Wilcoxon rank-sum test of equality of medians. Variables measured as *Change in Log()* are converted into percentage changes with the transformation exp() -1.

Board Characteristics are defined as follows. *Number of Directors* is the number of directors on the board in 2000. *%Independent Directors* is the number of independent directors scaled by the total number of directors in 2000. *Min. % Change ID* equals zero if *%Independent Directors* is greater than 50% in 2000, and equals the minimum number of independent directors required to achieve a majority of independent directors divided by *Number of Directors* if *%Independent Directors* is less than or equal to 50% in 2000. *Change in % Independent Directors* is the change in *%Independent Directors* between 2000 and 2004.

Control Variables include both changes, measured over the period 2000 to 2004, and levels, measured during 2000, and are defined as follows. *Log(Total Assets)* is the natural logarithm of total book value of assets (AT). *R&D* is annual research and development expenditures (set to zero if missing) scaled by total annual sales (XRD / SALE). *Leverage* is the sum of book value of long-term debt and current liabilities scaled by the sum of long-term debt, current liabilities, common equity, and preferred equity ((DLTT + DLC) / (DLTT + DLC + CEQ + PSTK)). *Log(Num. Bus. Seg.)* is the natural logarithm of the number of business segments recorded in the Compustat Segment file. *Log(Firm Age)* is the natural logarithm firm age measured as the earliest date on which it appears in the CRSP database. *Return Volatility* is the monthly standard deviation of the previous 24 months' stock returns. *Share price* is closing market price per share. *Book-to-market* is the book-to-market asset ratio (AT / (LT + (CSHO*PRCC_F))).

Moderating Factors are measured during 2000 and are defined as follows. *IA_Factor* is the first principal component from principal components analysis of the following variables measured during 2000: (1) *Log(Total Assets)*, (2) *R&D*, (3) *Leverage*, (4) *Log(Num. Bus. Seg.)*, (5) *Log(Firm Age)*, (6) *Return Volatility*, and (7) *Book-to-market*. *% CEO App. ID* is the proportion of independent directors who were appointed after the CEO took office if available, and imputed as described in the text if missing. *Inside Ownership* is obtained from Fahlenbrach and Stulz (2008), and insider as disclosed in the annual report divided by the number of shares outstanding for the month prior to the proxy date.

Information Environment Measures are changes measured over the period 2000 to 2004, and are defined as follows. *Change in IAC_spread* is the change in the average monthly adverse selection component of the bid-ask spread during the six months centered on the firm's fiscal year end. *Change in Log(1+Management Forecasts)* is the change in the natural logarithm of one plus the number of earnings per share forecasts issued by management during the six months centered on the firm's fiscal year end. *Change in Avg. Mgt. Forecast Precision* is the in the average precision of management forecasts issued during the six months centered on the firm's fiscal year end calculated following Rogers and Van Buskirk (2009): 4 for point estimates, 3 for range estimates, 2 for open-ended estimates,1 for qualitative estimates, 0 for no forecast. *Change in MDD Absolute Accruals* is the change in absolute accruals from the modified Dechow-Dichev model. *Change in Log(1+Number Analysts)* is the change in the natural logarithm of one plus the number of analysts that issued a one-year ahead earnings per share forecast during the six months centered on the firm's fiscal year end. *Change in Analyst Consensus* is the change in the natural logarithm of one plus the standard deviation of the IBES consensus earnings per share forecast (prior to the earnings announcement date) scaled by total assets per share during the six months centered on the firm's fiscal year end. *Change in Log(Inst. Holdings %)* is in the natural logarithm of the percentage of the firm's shares held by institutional investors either on, or as of the end of the most recent fiscal quarter after the fiscal year end. *Change in Log(Number Shareholders)* is the change in the natural logarithm of the number of shareholders as of the fiscal year end.

Table 2

First-stage Determinants of Change in the Proportion of Independent Directors

This table presents the results from an OLS regression in which the dependent variable is the change in the percentage of independent directors from the 2000 starting period through the 2004 ending period. *Min. % Change ID* equals the minimum percent change in the proportion of independent directors that is required for noncompliant firms to achieve a majority of independent directors, and zero for compliant firms. Δ denotes the change in the respective variable measured over the sample period and the remaining variables are measured at the start of the sample period (the exact timing is described in Section 3). Industry fixed-effects for the 48 Fama and French (1997) industries are included but not reported. *t*-statistics calculated based on robust standard errors clustered at the Fama and French (1997) industry level are reported in parentheses below the coefficient estimates. Statistical significance (two-sided) at the 1%, 5%, and 10% levels are denoted by ***, **, and *, respectively.

	Change in % Independent Directors	*Change in% Independent Directors*
Min. % Change ID		0.635***
		(20.61)
Δ*Log(Total Assets)*	-0.002	-0.004
	(-0.14)	(-0.44)
Δ*R&D*	-0.183***	-0.011
	(-2.89)	(-0.22)
Δ*Leverage*	-0.030	-0.023
	(-1.46)	(-1.24)
Δ*Log(Num. Bus. Seg.)*	0.008	0.005
	(0.79)	(0.62)
Δ*Log(Firm Age)*	0.015	0.056
	(0.34)	(1.29)
Δ*Return Volatility*	0.031	0.077
	(0.37)	(1.00)
Δ*Log(Share Price)*	-0.005	0.004
	(-0.52)	(0.52)
Δ*Book-to-market*	-0.060*	-0.010
	(-1.84)	(-0.44)
Log(Total Assets)	0.007***	0.011***
	(2.79)	(4.80)
R&D	-0.262***	-0.069**
	(-6.55)	(-2.10)
Leverage	-0.046**	-0.039*
	(-2.36)	(-1.87)
Log(Num. Bus. Seg.)	0.013	0.013
	(1.50)	(1.67)
Log(Firm Age)	-0.003	0.018
	(-0.25)	(1.35)
Return Volatility	0.194**	0.123*
	(2.05)	(1.73)
Log(Share Price)	-0.005	-0.003
	(-0.88)	(-0.62)
Book-to-market	-0.063***	-0.035**
	(-3.32)	(-2.19)
Observations	1,892	1,892
R-squared	0.027	0.248

Table 3

Second-stage regressions: Information Variables on Predicted Change in Ind. Directors

This table presents estimates of the second-stage regressions from Equation (4). The variables are defined in the notes of Table 1. Industry fixed-effects for the 48 Fama and French (1997) industries are included but not reported. *t*-statistics calculated based on robust standard errors clustered at the Fama and French (1997) industry level are reported in parentheses below the coefficient estimates. Statistical significance (two-sided) at the 1%, 5%, and 10% levels are denoted by ***, **, and *, respectively.

Panel A: Change in Information Asymmetry

	Change in Log (IAC_Spread)
	(1)
Δ*% Indep. Directors (predicted)*	-0.444***
	(-2.85)
Δ*Log(Total Assets)*	-0.341***
	(-13.07)
Δ*R&D*	0.203
	(0.95)
Δ*Leverage*	0.071
	(1.16)
Δ*Log(Num. Bus. Seg.)*	-0.034
	(-1.54)
Δ*Log(Firm Age)*	-0.193
	(-1.16)
Δ*Return Volatility*	-0.786**
	(-2.36)
Δ*Log(Share Price)*	-0.384***
	(-12.49)
Δ*Book-to-market*	0.206**
	(2.14)
Log(Total Assets)	0.041***
	(3.39)
R&D	-0.423*
	(-1.78)
Leverage	-0.209***
	(-3.61)
Log(Num. Bus. Seg.)	-0.039**
	(-2.22)
Log(Firm Age)	0.014
	(0.38)
Return Volatility	-0.926***
	(-3.04)
Log(Share Price)	-0.024
	(-1.00)
Book-to-market	-0.112
	(-1.44)
Observations	1,890
R-squared	0.563

Panel B: Changes in Other Information Environment Variables

	Change in Log(1+ Management Forecasts)	*Change in Management Forecast Precision*	*Change in MDD Absolute Accruals*	*Change in Log(1+ Number Analysts)*	*Change in Analyst Consensus*	*Change in Log(Inst. Holdings %)*	*Change in Log(Number Shareholders)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ% Indep. Directors	0.476*	0.784	-0.005	0.289	0.993	0.072*	-0.098
(predicted)	(1.83)	(1.63)	(-0.23)	(1.58)	(1.41)	(1.87)	(-0.30)
ΔLog(Total Assets)	0.100**	0.148	-0.003	0.370***	0.575***	0.046***	0.109
	(2.40)	(1.34)	(-0.96)	(9.95)	(3.14)	(3.71)	(1.62)
ΔR&D	-0.792	-0.971*	-0.049	0.940***	-1.393	-0.099	-0.610
	(-1.40)	(-1.80)	(-1.39)	(3.20)	(-0.94)	(-1.20)	(-1.01)
ΔLeverage	0.049	0.061	-0.009	-0.085	-0.031	-0.016	-0.223**
	(0.53)	(0.31)	(-0.77)	(-0.98)	(-0.08)	(-0.91)	(-2.23)
ΔLog(Num. Bus. Seg.)	-0.032	-0.074	0.005	-0.008	0.161	0.005	-0.068
	(-0.69)	(-0.74)	(1.53)	(-0.38)	(1.24)	(0.68)	(-1.08)
ΔLog(Firm Age)	0.361*	1.196**	-0.028*	-0.237*	-0.384	0.004	-0.478*
	(1.71)	(2.47)	(-1.92)	(-1.81)	(-0.60)	(0.10)	(-1.87)
ΔReturn Volatility	-0.262	-0.232	0.067**	0.472	-1.227	0.037	1.119
	(-0.64)	(-0.20)	(2.38)	(0.98)	(-0.57)	(0.37)	(1.18)
ΔLog(Share Price)	0.191***	0.295**	0.004	0.180***	0.916***	0.032**	-0.072
	(3.41)	(2.22)	(0.62)	(3.92)	(4.23)	(2.59)	(-1.10)
ΔBook-to-market	-0.084	-0.263	-0.000	-0.171*	-1.170**	-0.029	-0.173
	(-0.46)	(-0.68)	(-0.01)	(-1.69)	(-2.07)	(-1.07)	(-1.05)
Log(Total Assets)	-0.017	-0.045	0.000	-0.001	-0.033	0.001	0.042**
	(-1.04)	(-1.11)	(0.13)	(-0.06)	(-0.57)	(0.34)	(2.15)
R&D	-0.060	-0.619	0.050*	1.061***	1.096	0.031	0.332
	(-0.10)	(-0.94)	(1.94)	(4.46)	(0.84)	(0.41)	(0.70)
Leverage	0.149*	0.317	-0.003	-0.077	0.072	0.023	0.065
	(1.78)	(1.57)	(-0.35)	(-1.28)	(0.26)	(1.50)	(0.63)
Log(Num. Bus. Seg.)	-0.033	-0.075	-0.005**	0.017	0.164	0.009	0.056
	(-0.81)	(-0.88)	(-2.02)	(0.64)	(1.34)	(1.37)	(1.52)
Log(Firm Age)	0.069	0.263*	-0.001	-0.083**	-0.108	-0.014	-0.185**
	(1.03)	(1.78)	(-0.13)	(-2.27)	(-0.51)	(-1.54)	(-2.53)
Return Volatility	-1.048**	-1.368	0.012	0.456	-0.091	0.210	0.412
	(-2.07)	(-1.06)	(0.35)	(0.81)	(-0.04)	(1.60)	(0.53)
Log(Share Price)	0.051	0.122	0.006**	-0.013	-0.081	0.002	-0.081
	(1.56)	(1.46)	(2.02)	(-0.40)	(-0.91)	(0.27)	(-1.54)
Book-to-market	-0.224**	-0.355	0.012*	-0.175***	-0.654*	0.013	-0.271***
	(-2.06)	(-1.29)	(2.00)	(-2.69)	(-1.76)	(0.82)	(-2.80)
Number of Obs.	1,892	1,892	1,459	1,892	1,892	1,892	1,691
R-squared	0.125	0.074	0.087	0.349	0.223	0.171	0.053

Table 4
Second-stage Regressions with Interactions

This table presents two-stage least squares (2SLS) estimates from a modified second-stage regression of alternative measures of firms' information environments for the sample of non-controlled firms. Panel A re-presents estimates from Tables 4 and 5. Panels B, C, and D present estimates from a modified version of Eq. (4) in which a proxy for relatively high and low values of three partitioning variables are interacted with both Δ*% Indep. Directors* and all of the control variables. Panels B and C partition *IA_factor* and *% CEO App. ID* into *High* and *Low* values according to whether they are above or below the sample median, respectively. Panel D partitions *Inside Ownership* into *High* and *Low* values according to whether *Inside Ownership* is above or below 20%, respectively. The remaining variables are defined in the caption of Table 1. Industry fixed-effects for the 48 Fama and French (1997) industries and additional controls are included but not reported. *t*-statistics calculated based on robust standard errors clustered at the Fama and French (1997) industry level are reported in parentheses below the coefficient estimates. Statistical significance (two-sided) at the 1%, 5%, and 10% levels are denoted by ***, **, and *, respectively.

Panel A: No Interaction

	Change in Log (IAC_Spread)	*Change in Log(1+ Management Forecasts)*	*Change in Management Forecast Precision*	*Change in MDD Absolute Accruals*	*Change in Log(1+ Number Analysts)*	*Change in Analyst Consensus*	*Change in Log(Inst. Holdings %)*	*Change in Log(Number Shareholders)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ% Indep. Directors (predicted)	-0.444***	0.476*	0.784	-0.005	0.289	0.993	0.072*	-0.098
	(-2.85)	(1.83)	(1.63)	(-0.23)	(1.58)	(1.41)	(1.87)	(-0.30)
Number of Obs.	1,890	1,892	1,892	1,459	1,892	1,892	1,892	1,691
R-squared	0.563	0.125	0.074	0.087	0.349	0.223	0.171	0.053

Panel B: Information Processing Costs Partition

	Change in Log (IAC_Spread)	*Change in Log(1+ Management Forecasts)*	*Change in Management Forecast Precision*	*Change in MDD Absolute Accruals*	*Change in Log(1+ Number Analysts)*	*Change in Analyst Consensus*	*Change in Log(Inst. Holdings %)*	*Change in Log(Number Shareholders)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ% Indep. Directors (predicted) x	-0.223	0.536*	0.379	0.022	0.803**	2.569	0.029	1.239***
Low IA_factor	(-1.00)	(1.87)	(0.40)	(0.62)	(2.38)	(1.66)	(0.34)	(2.93)
Δ% Indep. Directors (predicted) x	-0.572***	0.449	0.938	-0.019	0.150	0.507	0.083	-0.589
High IA_factor	(-3.23)	(1.24)	(1.37)	(-0.67)	(0.84)	(0.78)	(1.66)	(-1.42)
High vs. Low	0.349	0.0873	-0.559	0.0411	0.653**	2.062	-0.0533	1.828*
t-stat	1.25	0.19	-0.45	0.90	1.96	1.40	-0.51	3.53
Number of Obs.	1,890	1,892	1,892	1,459	1,892	1,892	1,892	1,691
R-squared	0.584	0.147	0.098	0.120	0.376	0.248	0.225	0.086

Table 4 (cont'd)

Panel C: Independent Directors Appointed by CEO Partition

	Change in Log (IAC_Spread)	*Change in Log(1+ Management Forecasts)*	*Change in Management Forecast Precision*	*Change in MDD Absolute Accruals*	*Change in Log(1+ Number Analysts)*	*Change in Analyst Consensus*	*Change in Log(Inst. Holdings %)*	*Change in Log(Number Shareholders)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ% Indep. Directors (predicted) x	-0.348	0.992***	2.768***	-0.011	0.129	1.036	0.045	0.255
Low % CEO App. ID	(-1.36)	(2.86)	(3.69)	(-0.30)	(0.63)	(0.86)	(0.56)	(0.62)
Δ% Indep. Directors (predicted) x	-0.430*	-0.061	-0.937	-0.011	0.348	1.276	0.108**	0.002
High % CEO App. ID	(-1.88)	(-0.17)	(-1.30)	(-0.50)	(1.24)	(1.03)	(2.21)	(0.00)
High vs. Low	0.0820	1.053**	3.704***	0.000	-0.219	-0.240	-0.064	0.253
t-stat	0.21	2.16	3.45	0.00	-0.66	-0.13	-0.65	0.43
Number of Obs.	1,847	1,849	1,849	1,429	1,849	1,849	1,849	1,658
R-squared	0.577	0.163	0.112	0.117	0.368	0.243	0.195	0.075

Panel D: Inside Ownership Partition

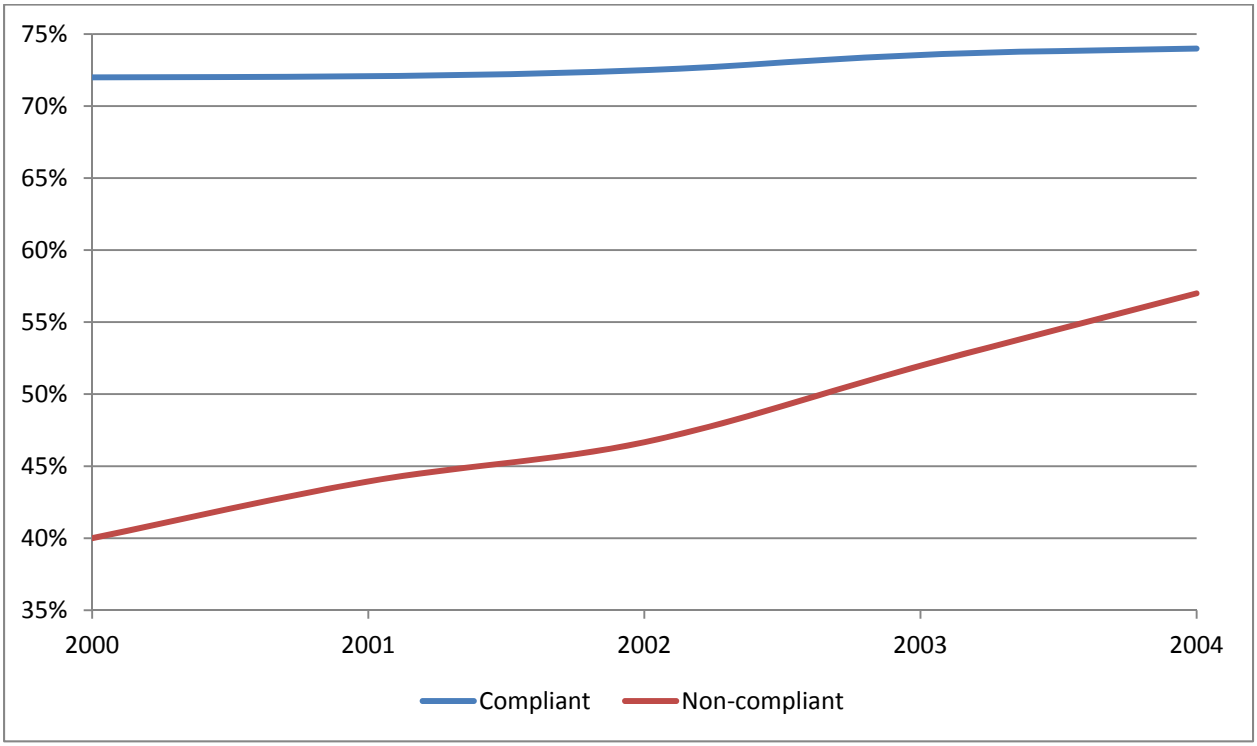
	Change in Log (IAC_Spread)	*Change in Log(1+ Management Forecasts)*	*Change in Management Forecast Precision*	*Change in MDD Absolute Accruals*	*Change in Log(1+ Number Analysts)*	*Change in Analyst Consensus*	*Change in Log(Inst. Holdings %)*	*Change in Log(Number Shareholders)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ% Indep. Directors (predicted) x	-0.454**	0.921**	2.310**	-0.004	0.188	0.508	0.080	-0.025
Low Inside Ownership	(-2.23)	(2.08)	(2.67)	(-0.12)	(0.77)	(0.40)	(1.56)	(-0.05)
Δ% Indep. Directors (predicted) x	-0.319	-0.085	-1.338	0.004	0.353	0.983	0.056	-0.561
High Inside Ownership	(-1.07)	(-0.26)	(-1.65)	(0.10)	(1.45)	(0.93)	(0.85)	(-1.58)
High vs. Low	-0.134	1.005*	3.648***	-0.008	-0.165	-0.475	0.0248	0.535
t-stat	-0.40	1.78	2.89	-0.17	-0.64	-0.29	0.27	0.96
Number of Obs.	1,890	1,892	1,892	1,459	1,892	1,892	1,892	1,691
R-squared	0.593	0.153	0.113	0.141	0.379	0.255	0.232	0.091

Figure 1
Timeline of Sample Alignment

	"2000 starting period"		**"2004 ending period"**	
Annual Meeting Dates	10/99 12/00	2003 Regulations	11/03 10/04	

Fiscal year-ends	5/00 6/01		5/04 6/05	

Figure 2

Change in the Fraction of Independent Directors for Compliant and Non-compliant firms

This figure plots the mean fraction of independent directors. Firms are classified as *Compliant* if the firm's proportion of independent directors is 50% or more in the 2000 starting period and *Non-compliant* otherwise.