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ORIGINAL ARTICLE

Board monitoring, firm risk, and external regulation

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Abstract We examine the relationship between board monitoring and firm characteristics using a broad sample of firms over the 8 year period from 1996 to 2003. We find that board independence and monitoring is negatively related to firm risk in the absence of external regulation. In addition, we find that external regulatory and political pressures affect the level of board monitoring, especially after the increased focus on board composition by the stock exchanges beginning in 1999 and the passage of the 2002 Sarbanes–Oxley Act. We find that the sensitivity of the negative relationship between board monitoring and firm risk decreases in the post 1999 period suggesting that firms have increased board monitoring in response to external regulations. We also find that these external regulations have had an asymmetrical impact on high-risk firm. In our empirical analysis we also control for other factors that affect board monitoring and find that firms in which the CEO has longer tenure and greater equity ownership have less board monitoring activity and that there is a negative relationship between the level of board monitoring and the level of shareholder rights.

Keywords Regulation · Board monitoring · Firm risk · Board independence

JEL Classification G34

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1 Introduction

Corporate governance has received increasing attention by the business press and community beginning in the late 1990s, with a high emphasis placed on board monitoring and board independence. In response to the 1998 Blue Ribbon Committee on Improving the Effectiveness of Corporate Audit Committees (henceforth the 1998 Blue Ribbon Committee Report), the NYSE started requiring firms to have only independent directors on the board's Audit Committee and the Nasdaq started requiring firms to have a majority of independent directors on the board's Audit Committee. The Code of Best Practice issued by the Cadbury Committee recommends that boards of U.K. corporations include at least three outside directors as it would lead to improved board oversight. The independent monitoring role of outside directors also underlies the intended governance reforms of the Sarbanes–Oxley Act of 2002 requiring more outside representation on the board.

Theoretically, and in the absence of regulation, the optimal level of monitoring is determined by the tradeoff between the costs and benefits of monitoring (Demsetz and Lehn 1985; Smith and Watts 1992). Monitoring is less desirable in uncertain environments because of information costs as argued by Prendergast (2000) and Raheja (2005). The implications of a negative relationship between board monitoring and firm risk also arises (as is shown in this article) in a standard theoretical principal-agent such as Holmstrom and Milgrom (1987). In these models, the inverse relationship comes from a tradeoff between salary/control benefits and incentive features in determining the optimal compensation contract. In risky environments, it is cheaper to reduce the level of board monitoring and allow the manager to consume salary/control benefits in order to reach the reservation wage.

External regulations and political attention can have two effects on the degree of board monitoring. First, the level of board monitoring will increase in response to such regulations. Second, we argue that the increase in the level of board monitoring is likely to be higher in high-risk firms. Theoretically, low-risk firms will have higher levels of board monitoring even in the absence of regulation and are more likely to be in compliance with regulation. High-risk firms, on the other hand, should theoretically have a lower level of board monitoring in the absence of regulation. Regulations and political pressures would induce high-risk firms to alter their behavior to be in compliance and to avoid potential costly stockholder litigation (Trueman 1997). External regulation, thus, can have the unintended consequence of forcing high-risk firms to depart from their optimal level of monitoring.

The focus of this article is on the relationship between firm risk and the level of board monitoring and the secular trend over the 8 year period from 1996–2003 that encompass the major external influences on the relationship between firm risk and board monitoring such as the 1998 Blue Ribbon Committee Report and the 2002 Sarbanes–Oxley Act. We empirically estimate the relationship between board monitoring and firm risk using a broad cross-section of firms over the 8 year period from 1996–2003.

We use two proxies for the level of board monitoring, commonly used in the literature, based on the composition of the board of directors. Our proxies are—the number of independent (outside) directors and the percent of independent directors on the

board (see Byrd and Hickman 1992; Brickley et al. 1994; Boone et al. 2007; Coles et al. 2006). The differences of these proxies in capturing the impact of the external regulations are discussed in more detail later in the article. We use stock volatility, as do Boone et al. (2007) and Coles et al. (2006), as our primary proxy for firm risk. For robustness we also use alternate measures of risk including a measure that calculates the risk of the firm's cash flows. To capture potential time trends we include year dummy variables and an interaction variable in our regressions. Our regressions indicate that there is a negative relationship between firm risk and the level of board monitoring. Our findings are consistent with the findings of Coles et al. (2006) and Boone et al. (2007) who show that the number of independent directors and the percentage of independent directors on the board are negatively related to firm risk. Our results extend their findings by incorporating the impact of the higher board of director accountability standards imposed by external regulation. We find that the sensitivity of the negative relationship between board monitoring and firm risk decreases throughout the sample period. Further, we find there is a significant difference between the volatility of the sample of firms with a majority of independent directors and the volatility of the sample of firms that have less than 50% independent directors before 1999, but these differences disappear after 1999. Our results thus imply that there exists an asymmetrical impact of external regulation on firms with varying levels of risk. In our multivariate regressions, we capture this effect by including a time-volatility interaction variable. We also find that in the regressions explaining the percentage of independent directors the coefficients on the year dummy variables are increasingly positive. Our evidence is consistent with the notion that the increasing public attention and focus on corporate governance have led companies to increase board independence and board monitoring over the entire sample period. An interesting aspect of these findings is that the level of monitoring began to change substantially several years prior to the 2002 Sarbanes–Oxley Act, consistent with the arguments of Romano (2005). In determining the relationship between firm risk and board monitoring, we also control for other factors that have been shown to be important in the literature. The level of board monitoring can be impacted by other governance features of the firm, such as the level of stockholder rights and the level of bargaining power of the CEO (see Hermalin and Weisbach 1998; Kieschnick and Moussawi 2004). It is therefore important to control for the relationship between board monitoring and stockholder rights and the bargaining power of the CEO. We use percentage managerial ownership and tenure of the manager to measure the bargaining power of the CEO and the Gompers et al. (2003) G-Index to measure the level of stockholder rights in the firm. We find that our board monitoring proxies are significantly negatively related to the bargaining power of the CEO and the level of stockholder rights.[1] Taken together, our results indicate that the level of board monitoring is endogenously determined, as proposed by Demsetz and Lehn (1985), Hermalin and Weisbach (2000), and John and Senbet (1998).

[1] We also examined the impact of external regulation on the relationship between the level of board monitoring and on each of the other governance variables. We do not find a similar impact on these factors as we find for firm risk.

The level of board monitoring can also be affected by firm performance (as proxied by Tobin's Q in our regressions). We expect board monitoring to be higher for firms that are doing poorly. This raises a potential endogeneity problem in our regressions, as board monitoring can influence firm performance. The effect of board monitoring on proxies of firm performance can arise for several reasons. First, the bargaining power of the manager is positively related to how well the company is doing. Second, board monitoring activity is negatively related to ex-post firm performance as shown by Adams (2005). Third, board monitoring may itself serve to change firm value. Indeed, Gertner and Kaplan (1996) and Yermack (1996) find that the size of the board impacts negatively on Tobin's Q. We use two approaches to correct our empirical specifications for the potential endogeneity problem arising from these effects. First, we use lagged Q as an alternative measures of firm performance. Second, we implement a two-stage least squares methodology. Our results hold in these alternate specifications as well.

Our result, that board independence is a function of firm characteristics, is also consistent with the finding of Lehn et al. (2004). They examine a sample of 81 firms that have survived for the entire period of 1935–2000 and find that board independence and monitoring evolve over the life of the firm. We are also able to show that the level of board monitoring and independence has a secular time trend, independent of the evolutionary history of any one particular firm.

In the next section, we provide a review of the literature on board monitoring and firm risk. Section 3 presents the data and the methodology used to establish the impact of risk and regulation upon board monitoring. Section 4 presents the results of our empirical analysis. Section 5 presents our robustness checks and Sect. 6 concludes.

2 Literature review

In this section we present a literature review and theoretical background on the relationship between firm risk and the level of board monitoring chosen by shareholders.

2.1 Monitoring and risk in the absence of regulation

Theoretically, the optimal level of monitoring is determined by the tradeoff between the costs and benefits of monitoring (Demsetz and Lehn 1985; Smith and Watts 1992). Prendergast (2000) demonstrates that monitoring is less desirable in uncertain environments because of information costs as argued by Prendergast (2000). Raheja (2005) argues that firms with higher information asymmetry can have higher verification costs. When verification costs are high, there is less incentives for shareholder to have their agents, the board of directors, to monitor firm management. Coles et al. (2006) find that the percentage of outsiders on the board decreases as risk increases consistent with the argument that the level of monitoring decreases as risk increases.

In addition, one can interpret the principal agent model of Holmstrom and Milgrom (1987) to provide predictions with respect to the level of board monitoring as a function of risk. In particular, Holmstrom and Milgrom (1987) assume that the linear sharing rule is $S = \alpha z + \beta$ (p. 323), where α provides the equity participation for

the manager and β is the salary. We can interpret β to include control benefits consumed by the manager. The total level of salary and control benefits received by the manager is a function of the level of monitoring. Specifically, $\beta = B - m$ where, B is the maximum level of control benefits and m is the level of board monitoring. Board monitoring serves to reduce the consumption of control benefits or perquisites (see for example Fama and Jensen 1983; Jensen 1993; Adams and Ferreira 2007). Holmstrom and Milgrom (1987) derive the optimal level of effort and compensation (Eqs. 30 and 32 on p. 323) assuming that the principal is risk neutral and the manager is risk averse with constant relative risk aversion r, and has a disutility of effort equal to $(k\mu^2)/2$. Substituting for the optimal level of effort and compensation into Eq. 29 representing the manager's reservation wage, we can see that the optimal level of salary and control benefits is $\beta = \bar{W} - 1/\{2(1 + rk\sigma^2)\}$. Substituting for $\beta = B - m$, to reflect the level of salary and control benefits, we find that the optimal level of board monitoring is:[2]

$$m = B - \bar{W} + \frac{1}{2(1 + rk\sigma^2)} \tag{1}$$

Note that $\partial m/\partial\sigma$ is negative, implying that the optimal level of board monitoring is inversely related to risk. The economic intuition of this result is as follows. As risk increases, it is optimal to shift the compensation risk from the risk-averse undiversified manager to the principal (representing the fully diversified stockholders) in order to maintain a constant reservation utility. The manager must, therefore, be allowed to increase consumption of control benefits to meet the reservation wage and the level of board monitoring will decline as risk increases. Further, the second derivative $\partial^2 m/\partial\sigma^2$ is positive, implying that the sensitivity of monitoring to risk is lower for high levels of risk.

2.2 Impact of regulation

External regulations and unwanted political attention can be expected to have an impact upon firm's governance as discussed by Hermalin and Weisbach (2006) and Romano (2005). In the summer of 2001, the Enron scandal publicized the weakness of governance structure in some of the firms. The lack of proper monitoring on the part of the board of directors also became apparent at Global Crossing, WorldCom, Parmalat, and Tyco, to name a few. The Sarbanes–Oxley Act was passed by Congress in 2002 to make board of directors more accountable and to strengthen board governance and the level of board independence. Linck et al. (2006) document the additional monitoring costs imposed upon firms as a result of this new regulation. Even before these events, firms were moving towards increasing board independence and monitoring. In response to the recommendation of the 1998 Blue Ribbon Committee Report, the NYSE started requiring firms to have only independent directors on the board's Audit Committee and the Nasdaq started requiring firms to have a majority of independent directors on the board's Audit Committee (Agrawal and Chadha 2005).

[2] See Appendix for more details of the model framework.

These regulations have two effects on the degree of board monitoring. First, the level of board monitoring will increase in response to the regulations in the post 1999 period. Second, the increase in the level of board monitoring is likely to be higher in high-risk firms. Trueman (1997) demonstrates that firms with higher risk will voluntarily disclose information to avoid lawsuits. We argue, similarly, that regulations create a greater degree of exposure to shareholder litigation if stock performance suffers. Moreover, higher firm risk increases the probability of firm poor performance, thereby increasing the probability of investor, media and political attention on the firm's governance in light of the increasing political focus of board of director accountability. This in turn could also increase the probability of shareholder litigation. As documented by Beck and Bhagat (1997) firms that have lawsuits filed against them have higher stock return volatility. As a consequence, external pressures and focus on governance may induce high-risk firms to choose a higher level of board monitoring than otherwise is optimal.

3 Data and methodology

We begin by describing the dependent and independent variables for our regressions and the data for our empirical tests. Data on board size and composition is collected from proxy statements for the eight years from 1996 to 2003.[3] We obtain compensation data from EXECUCOMP and firm accounting data from COMPUSTAT. From these sources, we are able to obtain a complete set of data for 4,162 firms (408 in year 1996, 379 in year 1997, 515 in year 1998, 509 in year 1999, 516 in year 2000, 549 in year 2001, 663 in year 2002, and 623 in year 2003). Table 1 shows the mean (median) sample values and distributional characteristics of the variables that we use in our regressions and empirical analysis.

3.1 Dependent variables

We use two proxies for the level of board monitoring: the number of independent directors (BDIND) and the percent of independent directors (PctBDIND). Much of the literature assumes that board monitoring increases with the level of board independence as measured by BDIND and PctBDIND. For example, Weisbach (1988) and Dennis and Sarin (1999) find that independent boards are more likely than other boards to replace poorly performing management. Byrd and Hickman (1992), Shivdasani (1993), Cotter et al. (1997), and McWilliams and Sen (1997) demonstrate that independent boards are more likely to obtain greater merger bids for the target shareholders than non-independent boards. Beasley et al. (2000), Dechow et al. (1996), Klein (2002), and Uzun et al. (2004) have also found that as the number of independent outside directors on a board increases, the incidence of corporate fraud decreases.

As is shown in Table 1, the mean (median) board size is 9.42 (9). The mean (median) number of independent directors, BDIND, is 6.15 (6) and the percentage of

[3] We thank Brick et al. (2006) for sharing this data.

Table 1 Board and firm characteristics

Variable	Mean	SD	Median	Min	Max
BDSIZE	9.424	2.574	9.000	3.000	26.000
BDIND	6.152	2.365	6.000	0.000	22.000
PctBDIND	0.650	0.170	0.667	0.000	0.938
VOL	0.427	0.189	0.379	0.120	1.527
EQUITY	7436.05	22547.36	1497.31	19.023	467092.88
EMP	8.534	15.588	5.336	0.071	342.366
TA	4739.52	12608.68	1313.11	32.89	304012
Q	2.032	1.631	1.532	0.165	29.493
LEV	0.198	0.157	0.188	0.000	1.467
RDD	0.036	0.069	0.006	0.000	0.933
CAPEX	0.068	0.055	0.053	0.000	0.597
NEW	0.142	0.349	0.000	0.000	1.000
FIRMAGE	22.269	12.083	22.484	0.238	41.942
TITLE	0.681	0.466	1.000	0.000	1.000
TENURE	7.905	7.122	5.526	0.082	52.195
NONCASH	0.549	0.249	0.582	0.000	1.000
MGROWN	0.018	0.048	0.003	0.000	0.570
G-Index	9.374	2.675	9.000	2.000	17.000
Number	13.965	10.715	12.000	0.000	67.000
Block	0.072	0.068	0.074	0.000	0.900

It reports the summary statistics of our variables. BDSIZE is the number of directors on the board. BDIND is the number of independent directors on the board. PctBDIND is the percentage of board that is independent. Q is the ratio of the total market value of the firm to the book value of the firm's assets. VOL is the SD of monthly stock returns for the 60 months preceding the end of the fiscal year. TA is the firm's book value of assets in millions of dollars at the beginning of the fiscal year. EMP is the number of employees in thousands scaled by total assets in millions at the start of the fiscal year. LEVERAGE is the ratio of debt to total assets. CAPEX is the ratio of capital expenditure to total assets. Q is the ratio of the book value of the firm's debt and equity to their market value. RDD is the ratio of R&D to total assets. CAPEX is the ratio of capital expenditure to total assets. NEW is a dummy variable identifying new economy firms. FIRMAGE is firm age as measured by the number of years the firm is listed on the exchange. TITLE is a dummy variable identifying firms where CEO is also Chairman. TENURE is the tenure of CEO measured in years. NONCASH is the CEO's percentage non-cash compensation. MGROWN is the percentage share ownership of insiders and directors. G-Index is a proxy for the level of shareholder rights as measured by the Gompers–Ishii–Metric Governance Index. Number is the number of analysts following the company. Block is the percentage of share ownership held by outside blockholders (BLOCK). There are 4,162 observations

independent directors, PctBDIND, is 65% (66.67%). We also find a remarkable time trend in these variables. Figure 1 shows the mean of board size and composition by year. As shown in the figure, we note that the size of the board as measured by the number of directors, decreases slightly over our data period from 1996–2003, from 10.22 in 1996 to 9.15 in 2003. The number of independent directors shows only a small increase over the same period—mean BDIND is 6.22 in 1996 and is 6.43 in 2003. The mean percentage of independent directors increases over the period, from 60% in 1993 to 70% in 2003. We argue that boards are essentially complying with regulations calling for independent boards by reducing the number of insiders, thereby slightly reducing board size, and not by necessarily hiring more independent directors. Thus BDIND stays essentially the same over the period, but there is an increase in PctBDIND.

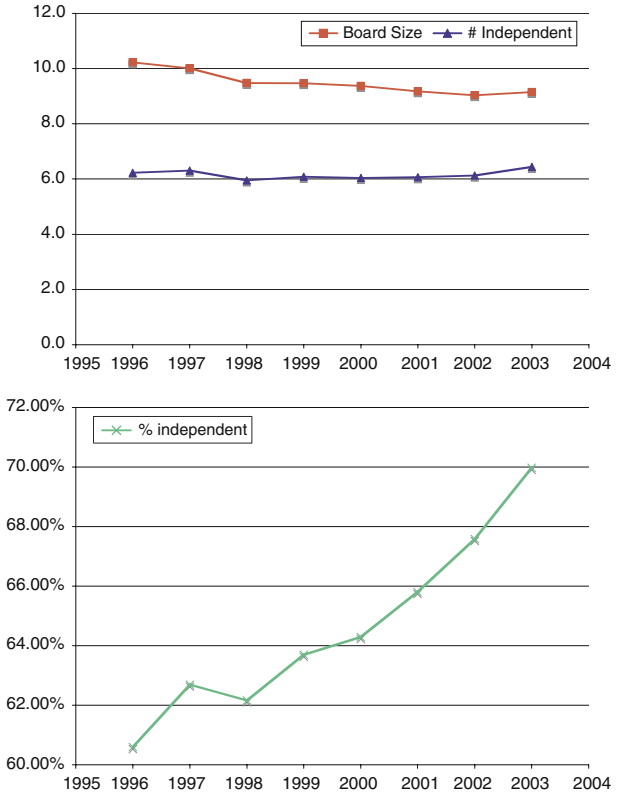

Fig. 1 Board monitoring by year. It plots the mean of the board size and composition by year in our sample of firms over a period from 1996–2003. The first figure above shows the mean of board size, i.e. the total number of directors in a firm, and the mean of the total number of independent directors in the firm. The second figure shows the mean of the percentage of independent directors

These findings have important implications on use of these proxies for measuring the sensitivity between risk and the level of board monitoring. We hypothesize that BDIND is more likely to reflect the optimum level of independent directors required by the firm in the absence of external regulation. PctBDIND on the other hand is more likely to show the effects of regulations. In the analysis that follows, we will seek to discern the differential impact of regulation across these two proxies for board monitoring.

3.2 Control variables

We use the volatility of stock returns reported by EXECUCOMP, denoted as VOL, as our measure of firm risk. The mean (median) VOL is 42.7% (37.9%). We expect board monitoring to be inversely related to firm risk in the absence of external regulation. As argued previously, the regulatory environment can impact the level of board monitoring chosen by firms. The NYSE and NASDAQ started requiring firms to have

mostly independent directors in the Audit Committee following the 1998 Blue Ribbon Committee Report and the Sarbanes–Oxley Act of 2002 imposed greater accountability standards on the directors. These regulations can have two effects. First they impose an exogenous time trend on the number of independent directors and the composition of the board. We use year dummies to capture the time trend in the level of board monitoring arising from such external regulatory changes. Second, as we argue it is possible that firms became more sensitive to firm risk and actually increased board monitoring to avoid possible future malfeasance lawsuits. To capture this possibility, we also include an interaction variable, VOL_TIME, which is equal to VOL for the post 1999 period, and zero otherwise. We also include VOLSQ, the squared value of VOL as an additional control variable to capture the non-linear negative relationship between monitoring and firm risk as implied by Eq.1

To proxy for firm size we use the book value of the firm's total assets at the end of the firm's prior fiscal year denoted as TA. Further, larger firms are more complex and, therefore, may require more monitoring (Crutchley et al. 2004; Lehn et al. 2004; Smith and Watts 1992). The mean (median) equity capitalization in our sample is $7.4 billion ($1.5 billion). In contrast to Lehn et al. (2004) and Boone et al. (2007) that focus on the evolution of the board over the life of the firm, our study has a broad sample of firms that includes firms both large (with a maximum equity value $467 billion) and small firms (with a minimum equity value $19 million). The sample of firms in Lehn et al. (2004) is dominated by very large firms that have survived for the entire sample period 1935 to 2000. In their sample the mean (median) equity capitalization is $32.07 billion ($6.87 billion). On the other hand, the sample of firms in Boone et al. (2007) is dominated by small IPO firms. The mean (median) equity capitalization in their sample is $150.2 million ($76.4 million). We also use EMP, the number of employees scaled by total assets at the start of the fiscal year, as another proxy for firm complexity. The mean (median) of EMP 8.532 (5.336) implying that on average there are 8.532 employees hired per $1,000 of assets.

Our next independent variable is LEVERAGE, defined as the firm's long-term debt divided by total assets. Since leverage can give rise to agency problems (see Jensen and Meckling 1976) that require additional monitoring, the coefficient on LEVERAGE can be positive. On the other hand, monitoring by debtholders could substitute for board monitoring, which would imply a negative coefficient. The mean (median) LEVERAGE is 19.8% (18.8%).

We would expect that there should be an inverse relationship between the level of board monitoring and firm performance since firms with superior performance need less monitoring (see Adams 2005). We use TOBIN's Q as the performance control variable. We calculate Q as the ratio of the total market value of the firm (defined as the market value of the equity plus the book value of total debt) to the book value of the firm's total assets. The mean (median) Q is 2.03 (1.53). Some articles have used Q as a measure of firm performance (see for example Himmelberg et al. 1999; Palia 2001; McConnell and Servaes 1990; Morck et al. 1988). In this interpretation, we would expect a negative relationship between the level of monitoring and Q since firms that do well need less monitoring (Adams 2005). In contrast, Q has also been interpreted as a measure of future growth opportunities implying potentially higher

agency problems in the firm (Barclay and Smith 1995 and Titman and Wessels 1988). In this case, the coefficient on Q can be expected to be positive.

One potential issue with using Q as a control variable is that the relationship between Q and the level of board monitoring may be endogenously determined (see Yermack 1996). We use two approaches to incorporate the potential endogeneity. In our first approach, we use 1-year lagged Q, denoted as Lag(Q), in our regressions instead of contemporaneous Q. The mean (median) Lag(Q) is 1.97 (1.33) in our sample. In our second approach, we use a structural econometric model and estimate via a 2-stage regression approach. We discuss the structural model we implement in a subsequent section of the article.[4]

We expect the level of board activity and monitoring to be a function of the level of activity in the firm. We therefore include R&D and Capital Expenditure, each scaled by Total Assets, as control variables. The mean (median) R&D (as a percentage of assets) denoted as RDD, is 3.6% (0.6%). The mean (median) Capital Expenditure as a percentage of total assets, denoted as CAPEX, is 6.8% (5.3%).

We control for industry effects by classifying firms into New Economy and Old Economy firms. As shown by Murphy (2003), corporate governance is systematically different between these two types of firms. We use a dummy variable NEW, that is set equal to 1 if the firm belongs to SIC codes (3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372, 7373), and 0 otherwise. In our sample, 14.2% of are classified as NEW. Alternatively, we include individual 2-digit SIC code industry dummies to capture industry effects. The results are not affected by the industry proxy we use and, therefore, we report results with the variable NEW.

We include a control variable to capture the age of the firm as board monitoring can vary with the firm's age (see Boone et al. 2007). On the one hand, older firms are larger and more complex and can require more monitoring. On the other hand, young rapidly growing firms may benefit the most from board monitoring. We calculate the number of integer years since the firm was first listed on CRSP and denote it as FIRMAGE. If FIRMAGE is equal to zero, we set FIRMAGE equal to 0.5 years. The mean (median) FIRMAGE is 22.27 years (22.47 years). We use the log of the firm's age, denoted as LFIRMAGE, in our regressions as the firm's complexity and requirement for monitoring stabilizes as the firm matures.

We also control for other factors, such as CEO entrenchment, shareholder rights, and incentive features in the management compensation contract, that can be important in determining the level of board monitoring. Firms with weaker shareholder rights can be expected to require more monitoring by the board of directors. We use the Gompers et al. (2003) governance index, denoted as G-Index, to capture the level of shareholder rights. Firms with high index values have weaker stockholder rights. The mean (median) G-Index is 9.37 (9.0).

The impact of the other variables is, however, ambiguous. For example, firms with entrenched CEOs may require more board monitoring. On the other hand entrenched managers may have greater bargaining rights (Hermalin and Weisbach 1998) leading

[4] We could alternatively use a fixed-effects panel regression approach. However, the broad set of cross-sectional variables we use exhibit low time series variation. As Zhou (2001) demonstrates, in this case the "within" estimator has low statistical power resulting in statistically insignificant parameter coefficients.

to less board monitoring. We control for entrenchment effects by including a dummy variable, denoted as TITLE, which is equal to one when the CEO is also Chair of the Board of Directors. 68.1% of 4,162 firms have the CEO serving both roles. We also expect that long-serving CEOs to be more entrenched (Chidambaran and Prabhala 2003). Consequently, we include as a control variable, the tenure of the manager as a CEO, denoted as TENURE. The mean (median) TENURE is 7.9 years (5.52 years).

The level of board monitoring may also be related to the incentive alignment of the manager. We measure the incentive alignment of the CEO by the percentage of non-cash compensation relative to the CEO's total compensation. We obtain data on total CEO compensation and the non-cash compensation components from EXECUCOMP. We define NONCASH as the ratio of the value of option and restricted stock grants to the total compensation of the CEO. The mean (median) NONCASH is 60.61% (62.21% years). Additionally, we use the percentage share ownership of the CEO as an alternative measure of managerial alignment with shareholder interests. We denote the percentage of shares held by insiders and directors by MGROWN. The mean (median) MGROWN is 1.77% (0.26%).

The amount of desired monitoring by shareholders through the board of directors should be positively related to the amount of the asymmetric information between insiders and the market. The number of analysts following a firm has been shown to be inversely correlated with the level of asymmetric information between managers and shareholders (see Brennan and Hughes 1991; Moyer et al. 1989). We, therefore, use as our control variable number, which is the number of analysts following the firm. We obtain the number of analysts from IBES. The mean (median) number of analysts is 13.96 (12). The minimum number of analysts is zero and the maximum is 67.

Finally, large shareholders may serve as an alternative source of monitoring thereby impacting on level of board monitoring activity. Consequently, we include as an independent variable the percentage of shares held by blockholders, denoted as Block. The mean (median) percentage of shares held by blockholders is 7.2% (7.4%).

Our dependent variable BDIND is discrete. Hence, we depart from ordinary least squares regressions and instead use Negative Binomial regressions. While PctBDIND is truncated at 0% and 100%, we do not have unusual clustering of the data at the extreme values—there are only six 0%-observations and no 100% observations out of 4,162 firm-year observations. We also verify that we obtain similar results when we use double-censored TOBIT or OLS regressions. Consequently we only report OLS results in the tables.

4 Empirical analysis

In this section, we present the results of our empirical analysis examining the relationship between board monitoring and firm characteristics. While our focus is on the relationship between firm risk and board monitoring, we also control for the level of shareholder rights, bargaining power of the CEO, other firm characteristics, that can impact on the optimal level of board monitoring, and the regulatory environment.

4.1 Univariate regression results

We begin by examining the relationship between board monitoring and firm risk in a univariate setting by regressing our dependent variables, BDIND and PctBDIND, on VOL. Table 2 presents the yearly and pooled univariate regression results. The table is divided into two panels. Panel A summarizes the relationship between BDIND and VOL for each year and Panel B summarizes the relationship between PctBDIND and VOL for each year. As shown in Panels A and B the coefficients of VOL are negative for each board monitoring proxy for each year. The coefficients become less negative over the years, indicating that the inverse relationship between board monitoring and risk has changed. Further, note that the percentage of independent directors (PctBDIND) is negatively related to firm risk in each year at greater than the 5% significance level, with the exception of years 2001 and 2003. However, in the pooled regressions, the negative relationship between PctBDIND and VOL is only weakly significant. This suggests that there is a strong secular time trend in the inverse relationship between board monitoring and risk and using a constant intercept across time in the regression specifications may not be appropriate.

We next examine whether there is a structural shift in board independence over our sample time period. We segregate the firms into two sub-samples as shown in Table 3. The first sub-sample group contains firms with the percentage of independent director, PctBDIND, greater or equal to 50%. PctBDIND for the second sample group is less than 50%. These sub-samples therefore differ in the degree of board monitoring–the sample with high PctBDIND has firms with higher levels of board monitoring that those with a low level of PctBDIND. For these sub-groups we calculate the mean and median level of firm risk, VOL, for each year and we test for differences in the mean and median across the two groups.

Columns (3) and (4) present the mean and median VOL for the group of firms with PctBDIND > 0.5. Column (5) reports the percentage of firms in our sample that had the majority of board members that are independent (PctBDIND > 0.5). Columns (7) and (8) present the mean and median VOL for the group of firms with PctBDIND ≤ 0.5. Differences in the mean and median between the two groups are reported in Columns (9) and (11), respectively.

Several observations can be made from the data presented in Table 3. First, the percentage of firms with independent board majorities increases throughout the sample period. Second, stock volatility also significantly increased during this time period. Third, the mean or median volatility of the majority independent board group is smaller and generally significantly so for years prior to 2001. After 2000, the differences between the two sample groups disappear.

These findings indicate that there could potentially be two explanations for the increase in board monitoring over the time period. First, we see from Eq.1 that the second derivative of monitoring with firm risk is positive. Since the average level of firm risk as measured by VOL is higher in both sub-samples of firms in the latter years, the equivalence in the level of board monitoring for both sub-samples in the latter years

Table 2 Yearly and pooled univariate regressions

Panel A									
BDIND	1996	1997	1998	1999	2000	2001	2002	2003	Pooled
VOL	−1.821	−1.598	−1.349	−1.323	−1.012	−0.790	−0.762	−0.608	−0.759
z-statistic	−9.43	−7.78	−9.31	−9.24	−8.57	−8.07	−9.53	−7.29	−20.98
Intercept	2.348	2.303	2.258	2.306	2.245	2.180	2.200	2.152	2.131
z-statistic	41.5	37.71	42.96	41.49	41.81	44.69	51.91	51.29	134.60
Log likelihood	−896.02	−849.68	−1134.2	−1125.2	−1133.2	−1200.3	−1427.6	−1349.5	−9213.309
Chi square	97.5	65.02	93.29	91.63	78.88	69.16	96.25	55.69	467.76
Pseudo R^2	0.052	0.037	0.040	0.039	0.034	0.028	0.033	0.020	0.0248
Panel B									
PCTBDIND	1996	1997	1998	1999	2000	2001	2002	2003	Pooled
VOL	−0.39	−0.243	−0.145	−0.158	−0.114	−0.054	−0.072	−0.042	−0.023
t-statistic	−4.14	−3.07	−2.68	−2.83	−2.5	−1.43	−2.48	−1.43	−1.65
Intercept	0.692	0.699	0.675	0.699	0.695	0.685	0.714	0.720	0.660
t-statistic	30.93	27.8	32	30.29	31.38	34.3	43.26	45.84	101.22
R-squared	0.04	0.024	0.014	0.016	0.012	0.004	0.009	0.003	0.001
Adj Rsqd	0.038	0.022	0.012	0.014	0.010	0.002	0.008	0.002	0.000
F	19.16	9.44	7.2	8.04	6.27	2.03	6.17	2.04	2.71

It reports the results of yearly and pooled univariate regressions for each of the two board monitoring proxies. BDIND is the number of independent directors on the board. PctBDIND is the percentage of board that is independent. VOL, the common independent variable in each panel, is the SD of monthly stock returns for the 60 months preceding the end of the fiscal year. Panel A reports results using BDIND as the dependent variable and Panel B reports the results using PctBDIND as the dependent variable. All regressions for BDIND are LOGIT regressions assuming a Negative Binomial distribution, and all regressions for PctBDIND are OLS regressions. The columns of Panel A and B report results for each year in our panel and for the entire sample

Table 3 Differences in volatility between firms with a majority of independent directors and those firms that do not

Sample of firms with PctBDIND > .5					Sample of firms with PctBDIND ≤ .5			Difference in means		Difference in medians	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	N	Mean VOL	Median VOL	% of sample	N	Mean VOL	Median VOL	Mean Diff.	T-Stat	Median Diff.	χ^2
1996	287	0.2826	0.2560	70.2	121	0.3316	0.3040	−0.047	−3.71***	−0.048	−13.73***
1997	285	0.2911	0.2610	75.2	94	0.3189	0.2950	−0.028	−2.11**	−0.034	−3.07*
1998	380	0.3539	0.3260	73.8	135	0.3918	0.3770	−0.038	−2.72***	−0.051	−7.75***
1999	381	0.3798	0.3470	74.9	128	0.4227	0.3950	−0.043	−3.02***	−0.048	−12.24***
2000	387	0.4415	0.4030	75.0	129	0.4937	0.4400	−0.052	−3.06***	−0.037	−4.56**
2001	431	0.4901	0.4450	78.5	118	0.5038	0.4485	−0.013	0.67	−0.004	0.075
2002	532	0.5248	0.4710	80.2	131	0.5238	0.4760	−0.005	−0.001	−0.005	−0.097
2003	536	0.4854	0.4280	86.0	87	0.5148	0.4760	−0.029	1.25	−0.048	1.33

It reports the differences of the mean and median between firms with a majority of independent directors and those firms that do not. PctBDIND is the percentage of board that is independent. VOL, the common independent variable in each panel, is the SD of monthly stock returns for the 60 months preceding the end of the fiscal year

*** denotes significance at the 1% level

** denotes significance at the 5% level

* denotes significance at the 10%

is consistent with the predictions of the principal-agent model.[5] Second, we note that both the NYSE and Nasdaq implemented the recommendations of the 1998 Blue Ribbon Commission Report to increase the number of independent directors, thereby requiring firms to have a minimum level of board independence. Since the level of board independence is low in high-risk firms in the absence of regulation, high-risk firms should be impacted more by these regulatory changes. Our finding that firms with a low level of board monitoring are less risky than firms with a high level of board monitoring in the period up to 1999, but have similar risk levels in the period after 1999, is consistent with the view that these external regulations have had an asymmetrical impact on the level of board monitoring.

Based on the above results, we conclude that it is important to account for the time trends and distinguish between the two alternative explanations for the increase in board monitoring over the time period of our sample. We therefore include the following control variables in our multivariate regressions. First, we include the square of VOL, VOLSQ, as a control variable. We expect the coefficient on VOLSQ to be positive. Second, we include an interaction term between time and firm risk in our analysis. The interaction term, VOL_TIME is set equal to zero for all years up to 1999 and is set equal to VOL for the subsequent years after 1999. Finally, we include time dummies as a pooled regression to capture the yearly time trend. We expect a positive coefficient for VOL_TIME, consistent with our hypothesis that regulations requiring higher levels of board independence asymmetrically impacts high-risk firms.

In summary, our univariate analysis indicates that there is a strong inverse relationship and time trend between board monitoring and firm risk consistent with the predictions of the literature as discussed before. Further, externally mandated regulation has had an impact and has resulted in a structural shift in the relationship between board monitoring and risk. The decrease in the coefficients on VOL in the latter years in the yearly regressions, reflects the increasing attention and focus on corporate governance has led companies to increase board independence and board monitoring in the latter years. Our results suggest that a change in the relationship between board monitoring and firm risk in response to external pressures, well before the introduction of new governance rules by the NYSE and Nasdaq and the 2002 Sarbanes–Oxley Act that further formalized these recommendations.

4.2 Multivariate regression results

We next turn to our multivariate specifications. We run separate regressions for both of our board monitoring proxies using the independent variables discussed in Sect. 3.1.

Table 4 reports the results of our multivariate specification. In this regression, we use the contemporaneous Q as the firm performance variable. We test for the potential endogeneity of Q in this specification using the Durbin–Wu–Hausman test (Davidson and MacKinnon, page 338). For each monitoring proxy, we first regress Q on the monitoring proxy variable, the instrumental variable LagQ, and all control variables and

[5] We thank an anonymous referee for this insight.

calculate the residual of the regression. We then regress the board monitoring proxy on Q, all control variables, and on the residual from the previous stage. We find that the coefficient on the first-stage residual is statistically significant at 5% significance for BDIND and 1% significance for PctBDIND. This implies that the coefficients of the multivariate specification in Table 4 may be biased. We therefore need to implement an endogeniety correction.

We use two econometric approaches to incorporate the endogeneity of board independence and firm performance in our regressions. First, we use 1-year lagged Q, Lag(Q), as the proxy for firm performance to reduce potential endogeneity problem between Q and our board monitoring proxies. Table 5 reports the results when we use Lag(Q) as a regressor. Second, we specify a structural model and use two-stage least squares to handle the endogeneity, with Lag(Q) as an instrument. In the first stage regression, we regress Q on an instrumental variable, and all other control variables. The instrumental variable that we use is Laq(Q). The first stage regression of Q on Lag(Q) has an *F-value* of 238.82, which is significant at the 1% level. We also find that the coefficient on Lag(Q) is positive and highly significant (*t-statistic* = 55.88, $p - value < 0.001$) in explaining Q. We use the predicted values of Q (QHAT) in the subsequent regression of the board monitoring proxy on the control variables. As before, we implement an OLS model in the second stage regression when the independent variable is the percent of independent directors (PctBDIND) and a LOGIT model assuming a binomial distribution, when the independent variable is the number of independent directors (BDIND). Table 6 reports the results of the second stage of our regressions. We find that both methods are effective in dealing with endogeneity issues and give similar results. In the following discussion we jointly discuss the results in Tables 4–6.

The results in Tables 4–6 show that the coefficient on VOL is negative in all our regressions, though not significant when PctBDIND is the monitoring proxy. The coefficient on VOLSQ is positive and significant in the BDIND regressions, but is negative and marginally significant in the PctBDIND regressions.[6] The results with BDIND as our monitoring proxy strongly support our hypothesis that the degree of monitoring is negatively related to firm risk, and are consistent with the predictions of the information cost model of Prendergast (2000) and the principal agent model presented in the previous section. The coefficients for VOL_TIME are positive and significant for both monitoring proxies in all specifications. These results are consistent with the notion that high risk firms are induced to further increase the level of monitoring in response to regulatory considerations.

The behavior of the coefficients on the time dummies diverges in the regressions using BDIND and the regression using PctBDIND as the monitoring proxy. Specifically, the time dummies are positive and significant in the PctBDIND regressions, but are not significant when BDIND is the dependent variable. The differences could arise

[6] A negative coefficient for VOL and a positive coefficient for VOLSQ may imply an interior minimum in the relationship between monitoring and VOL. Note that the specific values of the coefficients reported in Tables 4–6 for the BDIND regressions imply an interior minimum at a VOL level greater than 153%, which is the maximum VOL for our sample as shown in Table 1. This implies that the relationship between BDIND and VOL is downward sloping for our sample as predicted by Eq. 1.

Table 4 Board monitoring and firm characteristics

	BDIND	z	P > |z|		PCTBDIND	t	P > |t|
VOL	−1.115	−7.320	0.000	VOL	−0.010	−0.180	0.857
VOLSQ	0.356	2.440	0.015	VOLSQ	−0.084	−1.610	0.106
VOL_TIME	0.297	2.770	0.006	VOL_TIME	0.100	2.680	0.007
TA	0.000	6.370	0.000	TA	0.000	−0.510	0.609
EMP	−0.001	−2.570	0.010	EMP	0.000	−1.940	0.053
LEVERAGE	0.087	1.950	0.052	LEVERAGE	−0.004	−0.230	0.819
Q	−0.018	−3.600	0.000	Q	−0.004	−2.190	0.028
RDD	0.284	2.320	0.021	RDD	0.205	4.750	0.000
CAPEX	−0.008	−0.060	0.950	CAPEX	0.018	0.390	0.697
NEW	−0.070	−3.080	0.002	NEW	0.011	1.310	0.189
LFIRMAGE	0.087	8.290	0.000	LFIRMAGE	0.017	4.340	0.000
TITLE	0.113	7.600	0.000	TITLE	0.075	13.600	0.000
TENURE	−0.006	−5.510	0.000	TENURE	−0.003	−9.000	0.000
NONCASH	0.092	3.170	0.002	NONCASH	0.030	2.820	0.005
MGROWN	−1.170	−6.470	0.000	MGROWN	−0.449	−8.030	0.000
G-Index	0.025	9.610	0.000	G-Index	0.010	9.580	0.000
Number	0.006	8.770	0.000	Number	0.001	2.060	0.040
block	0.027	0.290	0.774	block	0.105	2.970	0.003
dum97	0.004	0.150	0.883	dum97	0.018	1.640	0.102
dum98	0.043	1.550	0.120	dum98	0.028	2.690	0.007
dum99	0.088	3.120	0.002	dum99	0.045	4.240	0.000
dum00	0.004	0.080	0.935	dum00	0.013	0.770	0.442
dum01	0.005	0.100	0.921	dum01	0.025	1.440	0.151
dum02	0.014	0.300	0.766	dum02	0.037	2.120	0.034
dum03	0.050	1.080	0.279	dum03	0.066	3.770	0.000
Intercept	1.458	23.130	0.000	Intercept	0.429	18.190	0.000
Log likelihood	−8696.77			R-Squared	0.1867		
Chi square	1500.83			Adj. Rsqd	0.1818		
Pseudo R^2	0.079			F	37.99		

It reports the results of multivariate regressions for each of the two board monitoring proxies, BDIND and PctBDIND, respectively. All regressions for BDIND are LOGIT regressions assuming a Negative Binomial distribution, and all regressions for PctBDIND are OLS regressions. BDIND is the number of independent directors on the board. PctBDIND is the percentage of board that is independent. Q is the ratio of the total market value of the firm to the book value of the firm's assets. VOL is the SD of monthly stock returns for the 60 months preceding the end of the fiscal year. VOLSQ is the squared value of VOL. VOL_TIME is an interaction variable that is equal to VOL for the post 1999 period and zero, otherwise. TA is the firm's book value of assets in millions of dollars at the beginning of the fiscal year. EMP is the number of employees in thousands scaled by total assets in millions at the start of the fiscal year. LEVERAGE is the ratio of debt to total assets. CAPEX is the ratio of capital expenditure to total assets. Q is the ratio of the book value of the firm's debt and equity to their market value. RDD is the ratio of R&D to total assets. CAPEX is the ratio of capital expenditure to total assets. NEW is a dummy variable identifying new economy firms. LFIRMAGE is the logarithm of firm age as measured by the number of years the firm is listed on the exchange. TITLE is a dummy variable, identifying firms where CEO is also Chairman. TENURE is the tenure of CEO measured in years. NONCASH is the CEO's percentage non-cash compensation. MGROWN is the percentage share ownership of insiders and directors. G-Index is a proxy for the level of shareholder rights as measured by the Gompers-Ishii-Metric Governance Index. Number is the number of analysts following the company. Block is the percentage of share ownership held by outside blockholders (BLOCK). Time dummy variables are denoted as dumXX for year XX. There are 4,162 observations

Table 5 Board monitoring and firm characteristics–Lag (Q) specification

	BDIND	z	P > |z|		PCTBDIND	t	P > |t|
VOL	−1.0947	−7.18	0.000	VOL	−0.0051	−0.09	0.928
VOLSQ	0.3373	2.31	0.021	VOLSQ	−0.0890	−1.71	0.087
VOL_TIME	0.3185	2.97	0.003	VOL_TIME	0.1061	2.84	0.005
TA	0.0000	6.58	0.000	TA	$-7.97E-08$	−0.37	0.711
EMP	−0.0013	−2.69	0.007	EMP	−0.0003	−2.03	0.042
LEVERAGE	0.0963	2.16	0.031	LEVERAGE	−0.0008	−0.05	0.962
LAG(Q)	−0.0103	−2.17	0.030	LAG(Q)	−0.0016	−0.99	0.324
RDD	0.2197	1.80	0.072	RDD	0.1875	4.39	0.000
CAPEX	0.0114	0.09	0.927	CAPEX	0.0227	0.50	0.619
NEW	−0.0677	−3.00	0.003	NEW	0.0111	1.36	0.173
LFIRMAGE	0.0878	8.38	0.000	LFIRMAGE	0.0172	4.43	0.000
TITLE	0.1156	7.77	0.000	TITLE	0.0753	13.73	0.000
TENURE	−0.0058	−5.56	0.000	TENURE	−0.0034	−9.03	0.000
NONCASH	0.0894	3.08	0.002	NONCASH	0.0293	2.72	0.007
MGROWN	−1.1773	−6.50	0.000	MGROWN	−0.4514	−8.07	0.000
G-Index	0.0254	9.76	0.000	G-Index	0.0096	9.68	0.000
Number	0.0058	8.35	0.000	Number	0.0005	1.72	0.086
block	0.0330	0.36	0.721	block	0.1062	3.00	0.003
dum97	0.0013	0.05	0.963	dum97	0.0175	1.59	0.113
dum98	0.0418	1.52	0.128	dum98	0.0279	2.67	0.008
dum99	0.0845	3.00	0.003	dum99	0.0443	4.14	0.000
dum00	−0.0063	−0.13	0.893	dum00	0.0105	0.60	0.548
dum01	−0.0028	−0.06	0.953	dum01	0.0231	1.31	0.191
dum02	0.0099	0.21	0.833	dum02	0.0361	2.04	0.041
dum03	0.0382	0.83	0.408	dum03	0.0625	3.60	0.000
Intercept	1.4352	22.85	0.000	Intercept	0.4225	17.96	0.000
Log likelihood	−8701.04			R-Squared	0.1860		
Chi square	1492.28			Adj. Rsqd	0.1811		
Pseudo R^2	0.079			F	37.80		

It reports the results of multivariate regressions for each of the two board monitoring proxies, BDIND and PctBDIND, respectively. All regressions for BDIND are LOGIT regressions assuming a Negative Binomial distribution, and all regressions for PctBDIND are OLS regressions. BDIND is the number of independent directors on the board. PctBDIND is the percentage of board that is independent. Lag (Q) is the ratio of the total market value of the firm to the book value of the firm's assets as the previous fiscal year. VOL is the SD of monthly stock returns for the 60 months preceding the end of the fiscal year. VOLSQ is the squared value of VOL. VOL_TIME is an interaction variable that is equal to VOL for the post 1999 period and zero, otherwise. TA is the firm's book value of assets in millions of dollars at the beginning of the fiscal year. EMP is the number of employees in thousands scaled by total assets in millions at the start of the fiscal year. LEVERAGE is the ratio of debt to total assets. CAPEX is the ratio of capital expenditure to total assets. Q is the ratio of the book value of the firm's debt and equity to their market value. RDD is the ratio of R&D to total assets. CAPEX is the ratio of capital expenditure to total assets. NEW is a dummy variable identifying new economy firms. LFIRMAGE is the logarithm of firm age as measured by the number of years the firm is listed on the exchange. TITLE is a dummy variable, identifying firms where CEO is also Chairman. TENURE is the tenure of CEO measured in years. NONCASH is the CEO's percentage non-cash compensation. MGROWN is the percentage share ownership of insiders and directors. G-Index is a proxy for the level of shareholder rights as measured by the Gompers-Ishii-Metric Governance Index. Number is the number of analysts following the company. Block is the percentage of share ownership held by outside blockholders (BLOCK). Time dummy variables are denoted as dumXX for year XX. There are 4,162 observations

Table 6 2SLS multivariate regressions

	BDIND	z	P > |z|		PCTBDIND	t	P > |t|
VOL	−1.1082	−7.24	0.00	VOL	−0.0073	−0.13	0.898
VOLSQ	0.3542	2.42	0.02	VOLSQ	−0.0863	−1.65	0.098
VOL_TIME	0.2955	2.74	0.01	VOL_TIME	0.1024	2.72	0.007
TA	2.68E−06	6.28	0.00	TA	−9.30E−08	−0.43	0.668
EMP	−0.0013	−2.60	0.01	EMP	−0.0003	−1.98	0.047
LEVERAGE	0.0888	1.96	0.05	LEVERAGE	−0.0020	−0.12	0.906
QHAT	−0.0163	−2.17	0.03	QHAT	−0.0026	−0.99	0.324
RDD	0.2705	2.06	0.04	RDD	0.1956	4.27	0.000
CAPEX	−0.0073	−0.06	0.95	CAPEX	0.0197	0.43	0.667
NEW	−0.0697	−3.09	0.00	NEW	0.0108	1.32	0.186
LFIRMAGE	0.0869	8.26	0.00	LFIRMAGE	0.0171	4.38	0.000
TITLE	0.1135	7.58	0.00	TITLE	0.0750	13.58	0.000
TENURE	−0.0058	−5.53	0.00	TENURE	−0.0034	−9.01	0.000
NONCASH	0.0907	3.11	0.00	NONCASH	0.0295	2.73	0.006
MGROWN	−1.1711	−6.47	0.00	MGROWN	−0.4504	−8.05	0.000
G-Index	0.0251	9.60	0.00	G-Index	0.0096	9.58	0.000
Number	0.0061	8.21	0.00	Number	0.0005	1.77	0.076
block	0.0277	0.30	0.77	block	0.1053	2.97	0.003
dum97	0.0038	0.13	0.89	dum97	0.0179	1.62	0.105
dum98	0.0418	1.52	0.13	dum98	0.0279	2.67	0.008
dum99	0.0879	3.11	0.00	dum99	0.0449	4.17	0.000
dum00	0.0039	0.08	0.94	dum00	0.0121	0.69	0.493
dum01	0.0050	0.10	0.92	dum01	0.0244	1.37	0.172
dum02	0.0142	0.30	0.76	dum02	0.0367	2.08	0.038
dum03	0.0509	1.09	0.28	dum03	0.0645	3.69	0.000
Intercept	1.4533	22.34	0.00	Intercept	0.4254	17.53	0.000
Log likelihood	−8701.05			R-Squared	0.1860		
Chi square	1492.28			Adj. Rsqd	0.1811		
Pseudo R^2	0.079			F	37.80		

It reports the results of multivariate regressions for each of the two board monitoring proxies, BDIND and PctBDIND, respectively. All regressions for BDIND are LOGIT regressions assuming a Negative Binomial distribution, and all regressions for PctBDIND are OLS regressions. BDIND is the number of independent directors on the board. PctBDIND is the percentage of board that is independent. QHAT is the predicted value of Q obtained from the first stage regression. VOL is the SD of monthly stock returns for the 60 months preceding the end of the fiscal year. VOLSQ is the squared value of VOL. VOL_TIME is an interaction variable that is equal to VOL for the post 1999 period and zero, otherwise. TA is the firm's book value of assets in millions of dollars at the beginning of the fiscal year. EMP is the number of employees in thousands scaled by total assets in millions at the start of the fiscal year. LEVERAGE is the ratio of debt to total assets. CAPEX is the ratio of capital expenditure to total assets. Q is the ratio of the book value of the firm's debt and equity to their market value. RDD is the ratio of R&D to total assets. CAPEX is the ratio of capital expenditure to total assets. NEW is a dummy variable identifying new economy firms. LFIRMAGE is the logarithm of firm age as measured by the number of years the firm is listed on the exchange. TITLE is a dummy variable identifying firms where CEO is also Chairman. TENURE is the tenure of CEO measured in years. NONCASH is the CEO's percentage non-cash compensation. MGROWN is the percentage share ownership of insiders and directors. G-Index is a proxy for the level of shareholder rights as measured by the Gompers-Ishii-Metric Governance Index. Number is the number of analysts following the company. Block is the percentage of share ownership held by outside blockholders (BLOCK). Time dummy variables are denoted as dumXX for year XX. There are 4,162 observations

from the fact that firms have several ways to increase the level of board monitoring as captured by the presence of independent directors. Firms could either add independent directors, eliminate insider directors, or substitute an insider director with an independent director. The dependent variable BDIND increases only when firms add independent directors and would remain unchanged if the firm simply eliminated an insider director, whereas the dependent variable PctBDIND increases in all cases. Our observation that board size has slightly decreased on average during our sample as shown in Fig. 1, whereas BDIND has increased slightly and PctBDIND has increased substantially, suggests that firms either reduced the size of the board by eliminating an inside director or by substituting inside board members with outside board members.

The combination of the pattern in the time dummies and the coefficients on VOL, VOLSQ, and VOL_TIME also reveals an interesting pattern. In the PctBDIND regressions, the coefficients on VOL and VOLSQ become less significant and the year dummies and the interaction term VOL_TIME dominate. When BDIND is the dependent variable, the time trend is not as strong and the variations with respect to VOL, VOLSQ, and the interaction term VOL_TIME dominate. Our results are consistent with the argument that firms have been pushed to alter the percentage of independent directors (rather than the number of independent directors), given the focus on board composition by regulators. Further, these regulations have had an asymmetrical impact on high-risk firms, pushing firms to increase the number and percentage of independent directors beyond their optimal levels. Finally, the time trends also indicate that firms were increasing the level of board monitoring even before the formal requirements by regulators and Congress, perhaps responding to pressure from activist shareholders and politicians.

Other results reported in Tables 4–6, are generally consistent with the notion that the firms' cross sectional characteristics determine the extent of board monitoring. The significant positive coefficient on TA in the BDIND regression is consistent with the prediction that monitoring increases as firm size and complexity increases. Board monitoring is also significantly positively related to R&D. Thus, board monitoring is higher when the size and complexity of the firm is higher. On the other hand, the coefficient on TA in the PctBDIND regression is negative and significant and the coefficients on EMP, the number of employees scaled by the total assets, is not significant. The coefficient on NEW is also negative and significant when BDIND is the dependent variable. Thus, firms in high technology industries have a lower number of independent directors perhaps because board monitoring may be less effective in uncertain environments (see Prendergast 2000) consistent with the inverse relationship between board monitoring and firm risk.

The coefficients on LEVERAGE are positive and significant for BDIND, consistent with the notion that board monitoring increases with agency costs. However, the coefficient is not significant when PctBDIND is the dependent variable.

We find a negative relationship between board monitoring and Q and LAG(Q) consistent with Gertner and Kaplan (1996) and Yermack (1996). Our results imply that better performing firms need less monitoring, but we note that the coefficients are significant only when BDIND is the proxy for monitoring.

Against our asymmetric information hypothesis, we find that our board proxies are not related to CAPEX and are positively associated with the number of analysts.

Perhaps the reason for this contrarian finding is that analysts are more likely to analyze a firm where they will have access to the board of directors, which is more likely in firms with more number of independent directors. Finally, we find that the level of board monitoring increases with firm age as is also shown by Boone et al. (2007).

Tables 4–6 also demonstrate that the firm's other governance characteristics impact on board composition and monitoring. BDIND and PctBDIND are positively associated with the G-Index. Recall that shareholder rights are inversely related to G-Index. Each of our board monitoring variables is thus inversely related to stockholder rights implying that the need for monitoring decreases as the level of stockholder rights increases. In other words, greater board monitoring is optimal in firms with weaker stockholder rights.

The tables also show that board monitoring is inversely related to MGROWN and TENURE and that the level of board monitoring is greater when the CEO is also the Chairman of the board. These results are consistent with an entrenchment hypothesis wherein managers with greater control and bargaining power reduce the level of board independence and monitoring. Managers with a greater control over their firm are able to bargain for a less independent board and board monitoring (Boone et al. 2007; Raheja 2005; Warther 1998). Alternatively, the negative coefficients for MGROWN are also consistent with lower monitoring requirements when the managerial interests are better aligned with that of shareholders. Furthermore, the negative coefficients for TENURE also suggest that there is less uncertainty about CEO ability and behavior for longer serving CEOs and that such managers require less board monitoring. Finally, the level of board monitoring is positively associated with NONCASH, suggesting that board monitoring and equity-based compensation are complements.

4.3 Summary of empirical results

In summary, our empirical results support the notion that the level of board monitoring activity is endogenously determined as proposed by Demsetz and Lehn (1985) and Hermalin and Weisbach (1998). In particular, our results essentially show that board monitoring is negatively related to firm risk, and that this negative relationship of monitoring to risk decreases for high risk firms. Our results thus lend support to the empirical implications of our principal-agent model. Moreover, our results show that regulation has pushed high risk firms to significantly increase their board monitoring.

We also find support for the argument that board monitoring is greater when the level of asymmetric information between the manager and the shareholders are reduced. We also find that governance characteristics, G-Index, TITLE, TENURE, and MGROWN, are very significant determinants of the level of board monitoring, suggesting that firms view governance as a package rather than optimize each measure independently of the other governance characteristics

5 Robustness checks

We check for the robustness of our results by using alternate measures to proxy for the firm risk in our regression analysis. We use two alternate measures one based on the

volatility of daily stock returns and the other based on the risk of the firm's cash flows. Note that, for all our robustness checks, we use the structural model specification and two-stage least squares, with Lag(Q) as an instrument, to handle the endogeneity of Q and board monitoring. We get similar results when we instead use Lag(Q) as a regressor to control for endogeneity. Consequently, we present only the structural equation versions of our robustness tests and therefore the regressor in these tables is QHAT.

5.1 Regressions using annual volatility measure

For each firm-year, we estimate the volatility based from a sample of daily stock returns during the fiscal year. We denote this proxy as ANNVOL and Table 7 reports the results for each of the two board monitoring proxies BDIND and PctBDIND using this proxy for firm risk. The results reported in Table 7 are fundamentally similar to the results reported in Table 6. Board monitoring is a function of firm characteristics such as firm risk, external regulation requirements and the governance characteristics of the firm as discussed before. Again, the coefficients on our interaction term ANNVOL_TIME are positive and significant, consistent with the asymmetric impact of regulation on high risk firms.

5.2 Regressions using cash flow risk measure

For each firm-year, we estimate the volatility of the firm's cash flows (CFRISK) and use CFRISK as our measure of firm risk in our regressions. CFRISK is calculated as follows. For each fiscal year, we determine the ratio of EBITDA to Total Assets of the firm for a total of eight years prior to the current fiscal year. We then calculate the difference in the ratio and estimate the SD of the differences. The SD in the differences of the ratio of EBITDA to Total Assets over the last eight years is our proxy for firm risk, CFRISK.

Table 8 presents the regression results for each of our monitoring proxies when we use CFRISK as our measure of risk. The results reported in Table 8 are fundamentally similar to the results reported in Tables 6 and 7.

5.3 Other robustness checks

In addition to the above alternatives for firm risk, we also check for the robustness of our results by using the SD of the residual from historical monthly Fama-French regressions and use the residual SD as the proxy for firm risk in our model. Our board monitoring regression results (not reported) are generally similar to results already reported when we use this measure of risk, with the exception that the coefficient on the time dummies are even more significant in the PctBDIND regressions. We note that it is not surprising that the results using a firm specific risk measure and a total risk are similar. As reported by other researchers (see Campbell et al. 2001) the firm specific component of risk has increased in the 1990s, which is consistent with our finding that the market model regressions R-Squares are low. Thus returns volatility

Table 7 Multivariate regressions with ANNVOL

	BDIND	z	P > |z|		PCTBDIND	t	P > |t|
ANNVOL	−0.8768	−9.09	0.000	ANNVOL	−0.0655	−1.99	0.047
ANNVOLSQ	0.1119	4.11	0.000	ANNVOLSQ	0.0008	0.10	0.923
ANNVOL_TIME	0.3428	3.72	0.000	ANNVOL_TIME	0.0535	1.94	0.052
TA	2.71E-06	6.36	0.000	TA	−1.13E−07	−0.52	0.600
EMP	−0.0014	−2.76	0.006	EMP	−0.0003	−1.95	0.051
LEVERAGE	0.0790	1.74	0.082	LEVERAGE	−0.0030	−0.18	0.855
QHAT	−0.0126	−1.71	0.088	QHAT	−0.0025	−0.96	0.337
RDD	0.2566	1.98	0.047	RDD	0.1841	4.07	0.000
CAPEX	−0.0068	−0.05	0.956	CAPEX	0.0179	0.39	0.695
NEW	−0.0777	−3.47	0.001	NEW	0.0109	1.35	0.178
LFIRMAGE	0.0863	8.21	0.000	LFIRMAGE	0.0166	4.23	0.000
TITLE	0.1139	7.62	0.000	TITLE	0.0744	13.48	0.000
TENURE	−0.0058	−5.53	0.000	TENURE	−0.0034	−8.93	0.000
NONCASH	0.0886	3.04	0.002	NONCASH	0.0289	2.68	0.007
MGROWN	−1.1543	−6.38	0.000	MGROWN	−0.4485	−8.01	0.000
G-Index	0.0255	9.78	0.000	G-Index	0.0096	9.61	0.000
Number	0.0060	8.16	0.000	Number	0.0005	1.86	0.063
block	0.0184	0.20	0.842	block	0.1063	3.00	0.003
dum97	−0.0116	−0.41	0.685	dum97	0.0170	1.54	0.124
dum98	0.0004	0.01	0.989	dum98	0.0244	2.37	0.018
dum99	0.0406	1.48	0.138	dum99	0.0412	3.95	0.000
dum00	−0.0567	−1.40	0.162	dum00	0.0303	2.14	0.033
dum01	−0.0464	−1.12	0.262	dum01	0.0429	2.99	0.003
dum02	−0.0286	−0.69	0.490	dum02	0.0554	3.85	0.000
dum03	0.0222	0.53	0.595	dum03	0.0832	5.72	0.000
Intercept	1.4222	23.32	0.000	Intercept	0.4371	19.62	0.000
Log likelihood	−8703.6807			R-Squared	0.1853		
Chi square	1487.01			Adj. Rsqd	0.1804		
Pseudo R^2	0.0787			F	37.63		

It reports the results of multivariate regressions for each of the two board monitoring proxies, BDIND and PctBDIND, respectively. All regressions for BDIND are LOGIT regressions assuming a Negative Binomial distribution, and all regressions for PctBDIND are OLS regressions. Each column in the table reports results for 15 separate regressions and each entry in the table is the coefficient on a particular independent variable. BDIND is the number of independent directors on the board. PctBDIND is the percentage of board that is independent. QHAT is the predicted value of Q obtained from the first stage regression. ANNVOL is the SD of daily stock returns for the fiscal year. ANNVOLSQ is the squared value of ANNVOL. ANNVOL_TIME is an interaction variable that is equal to ANNVOL for the post 1999 period and zero, otherwise. TA is the firm's book value of assets in millions of dollars at the beginning of the fiscal year. EMP is the number of employees in thousands scaled by total assets in millions at the start of the fiscal year. LEVERAGE is the ratio of debt to total assets. CAPEX is the ratio of capital expenditure to total assets. Q is the ratio of the book value of the firm's debt and equity to their market value. RDD is the ratio of R&D to total assets. CAPEX is the ratio of capital expenditure to total assets. NEW is a dummy variable identifying new economy firms. LFIRMAGE is the logarithm of firm age as measured by the number of years the firm is listed on the exchange. TITLE is a dummy variable identifying firms where CEO is also Chairman. TENURE is the tenure of CEO measured in years. NONCASH is the CEO's percentage non-cash compensation. MGROWN is the percentage share ownership of insiders and directors. G-Index is a proxy for the level of shareholder rights as measured by the Gompers-Ishii-Metric Governance Index. Number is the number of analysts following the company. Block is the percentage of share ownership held by outside blockholders (BLOCK). Time dummy variables are denoted as dumXX for year XX. There are 4,162 observations

Table 8 Multivariate regressions with CFRISK

	BDIND	z	P > |z|		PCTBDIND	t	P > |t|
CFRISK	−2.2752	−5.21	0.000	CFRISK	−0.0811	−0.54	0.587
CFRISKSQ	2.1686	2.39	0.017	CFRISKSQ	−0.1599	−0.55	0.584
CFRISK_TIME	0.7618	2.05	0.040	CFRISK_TIME	0.2688	2.18	0.029
TA	3.15E−06	7.58	0.000	TA	−1.36E−07	−0.64	0.523
EMP	−0.0021	−3.77	0.000	EMP	−0.0004	−2.58	0.010
LEVERAGE	0.0880	1.78	0.075	LEVERAGE	−0.0127	−0.71	0.477
QHAT	−0.0087	−1.19	0.235	QHAT	−0.0032	−1.19	0.234
RDD	0.1164	0.82	0.412	RDD	0.1606	3.30	0.001
CAPEX	0.0759	0.57	0.570	CAPEX	0.0453	0.93	0.354
NEW	−0.1160	−4.83	0.000	NEW	0.0099	1.15	0.251
LFIRMAGE	0.1199	8.79	0.000	LFIRMAGE	0.0263	5.30	0.000
TITLE	0.1251	7.96	0.000	TITLE	0.0774	13.41	0.000
TENURE	−0.0063	−5.73	0.000	TENURE	−0.0033	−8.40	0.000
NONCASH	0.0709	2.32	0.021	NONCASH	0.0291	2.59	0.010
MGROWN	−1.2887	−6.49	0.000	MGROWN	−0.4736	−7.79	0.000
G-Index	0.0261	9.51	0.000	G-Index	0.0099	9.58	0.000
Number	0.0060	7.78	0.000	Number	0.0005	1.69	0.092
block	−0.0054	−0.06	0.956	block	0.0846	2.32	0.020
dum97	−0.0053	−0.18	0.858	dum97	0.0182	1.62	0.106
dum98	−0.0042	−0.15	0.884	dum98	0.0184	1.71	0.088
dum99	0.0285	1.00	0.317	dum99	0.0397	3.66	0.000
dum00	−0.0093	−0.29	0.769	dum00	0.0331	2.78	0.006
dum01	−0.0240	−0.77	0.444	dum01	0.0431	3.67	0.000
dum02	−0.0139	−0.45	0.653	dum02	0.0574	4.96	0.000
dum03	0.0275	0.89	0.371	dum03	0.0856	7.38	0.000
Intercept	1.1453	19.14	0.000	Intercept	0.3895	17.94	0.000
Log likelihood	−7684.6291			R-Squared	0.1981		
Chi square	1223.85			Adj. Rsqd	0.1926		
Pseudo R^2	0.0738			F	35.78		

It reports the results of multivariate regressions for each of the two board monitoring proxies, BDIND and PctBDIND, respectively. All regressions for BDIND are LOGIT regressions assuming a Negative Binomial distribution, and all regressions for PctBDIND are OLS regressions. BDIND is the number of independent directors on the board. PctBDIND is the percentage of board that is independent. QHAT is the predicted value of Q obtained from the first stage regression. CFRISK is the SD of first differences in ROA for the prior eight years; CFRISKSQ is the squared value of CFRISK. CFRISK_TIME is an interaction variable that is equal to CFRISK for the post 1999 period and zero, otherwise. TA is the firm's book value of assets in millions of dollars at the beginning of the fiscal year. EMP is the number of employees in thousands scaled by total assets in millions at the start of the fiscal year. LEVERAGE is the ratio of debt to total assets. CAPEX is the ratio of capital expenditure to total assets. Q is the ratio of the book value of the firm's debt and equity to their market value. RDD is the ratio of R&D to total assets. CAPEX is the ratio of capital expenditure to total assets. NEW is a dummy variable identifying new economy firms. LFIRMAGE is the logarithm of firm age as measured by the number of years the firm is listed on the exchange. TITLE is a dummy variable identifying firms where CEO is also Chairman. TENURE is the tenure of CEO measured in years. NONCASH is the CEO's percentage non-cash compensation. MGROWN is the percentage share ownership of insiders and directors. G-Index is a proxy for the level of shareholder rights as measured by the Gompers-Ishii-Metric Governance Index. Number is the number of analysts following the company. Block is the percentage of share ownership held by outside blockholders (BLOCK). Time dummy variables are denoted as dumXX for year XX. There are 3,647 observations

has a large firm specific component and the residual SD and total volatility are highly correlated.

We have used the number of analysts to proxy for the degree of information asymmetry in our regressions. The dispersion of analysts' estimates has also been used to proxy for information asymmetry in the literature (see Lang and Lundholm 1996; Diether et al. 2002; Parkash et al. 1995; D'Mello and Ferris 2000; Autore and Kovacs 2006; Gruninger Hirschvogl 2007; Mansi et al. 2006; Brick et al. 2007). We check the robustness of our results using this alternate measure of asymmetric information as well. We measure dispersion of analysts' estimates as the SD of the EPS forecast for the fiscal across all the analysts. To control for measurement error, we restrict the sample to firms that have at least three analysts following the firm. We find that our results (not reported) are similar to those reported in Tables 5 and 6 for this alternate specification as well.

6 Conclusions

The board of directors of a firm, especially members who are independent (outside) directors, serves an important role in monitoring firm management. It is natural that the level of board monitoring is related to firm characteristics and is endogenous. Theoretical models have shown, for example that the level of risk is an important factor in determining the level of board monitoring. Prendergast (2000) and Raheja (2005) argue that there should be a negative relationship between board monitoring and firm risk because monitoring is less efficient in uncertain environments. Such a negative relationship between monitoring and firm risk is also a direct implication of principal-agent models.

Recent developments in the regulatory environment also have an impact the level of board monitoring chosen by the firm. The period from 1996–2003 has seen increased board related regulation by the exchanges and includes year 2002 when Congress passed the Sarbanes–Oxley Act. We argue that such externally imposed regulations can have an impact beyond the specifics of the regulation, as firms calibrate their requirements for board monitoring in a transformed regulatory environment. For example, the increased accountability that has been a focus of the recent regulations can make it more costly to choose lower levels of board monitoring by increasing the probability of shareholder lawsuits when firms perform poorly. Since the probability of poor performance is higher for high-risk firms it is likely that the relationship between risk and board monitoring changes as a consequence of the changes in the regulatory environment.

In this article, we empirically examine the level of monitoring chosen by a firm using a broad sample of firms in the eight-year period from 1996 to 2003, with a focus on the relationship between board monitoring and firm risk. We find and present three major results with respect to the relationship between board monitoring and firm risk. First, we show that there is a secular time trend in that the level of board monitoring has increased over the sample period as regulators have required firms to have mostly independent directors on audit committees. Second, although we find that the relationship between board monitoring and firm risk is negative, the negative sensitivity of board

monitoring to firm risk decreases over time. This is consistent with firms increasing the level of board monitoring over time, either driven by external regulation or by an increase in the level of firm risk over the data period. Third, we distinguish between the effects of higher firm risk and the regulatory impact and show that regulation has had an impact on the level of board monitoring. While there has been a general increase through time in the level of board monitoring in firms of our sample, we find that high-risk firms have chosen to have an even higher level of board monitoring in the post 1999 period following the regulatory changes. Thus, it is the high-risk firms that have been pushed to have a higher level of board monitoring and external regulation has had an asymmetrical impact on high-risk firms.

In our regressions, we also control for other firm characteristics. We find that firms having more complex operations as evidenced by larger size and a larger employee base require a greater level of monitoring. We also find that the level of board monitoring is negatively associated with the CEO's bargaining power and the level of shareholder rights.

Our evidence shows that firms respond to shareholder and political demands for better governance as evidenced by the fact that firms have increased the level of board monitoring over time. In particular, firms have increased board monitoring in response to the 1998 NYSE and Nasdaq exchange regulations and the formal implementation of even greater director accountability as reflected by the Sarbanes–Oxley Act of 2002. However, given our finding of an asymmetrical impact on high-risk firms, our results suggest that a one-size fits all regulation such as the Sarbanes–Oxley Act can lead to perhaps unintended consequences.

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Appendix

In this appendix we present a brief outline of the Holmstrom and Milgrom (1987) principal agent model. Holmstrom and Milgrom (1987) determine the optimal compensation contract that a risk neutral principal should use to compensate a risk-averse manager. In their model, firm performance is given by $z = \mu + \varepsilon$, where $\varepsilon \sim N[0, \sigma_\varepsilon^2]$, σ_ε^2 is the variance on the measure of performance and μ is the manager's level of effort.

The manager's utility function is given by,

$$U(S(z), \mu) = -\exp[-r(S(z) - k\mu^2/2)]$$

where $S(z)$ is the wage paid to the manager, r is the manager's coefficient of absolute risk aversion, and k is the curvature of his disutility of effort, μ. The manager chooses

effort level μ to maximize his expected utility given compensation contract S(z). The optimal effort level μ is:

$$\mu = \frac{1}{k(1 + rk\sigma_{\varepsilon}^2)}$$

The principal chooses S(z) in order to maximize expected output, E(z), taking in to account the manager's optimal response in determining the level of action μ. Holmstrom and Milgrom (1987) show that the optimal compensation contract is linear in output and is given by, $S(z) = \alpha z + \beta$, where β represents salary and α represents the performance-related component of compensation (pay-performance sensitivity).

They show that the optimal salary component and the optimal pay-performance sensitivity component of the contract for a risk-averse manager are:

$$\alpha = \frac{1}{1 + rk\sigma_{\varepsilon}^2}$$

$$\beta = \bar{W} - \frac{1}{2(1 + rk\sigma_{\varepsilon}^2)}$$

The relationship between the non-equity component of the manager's compensation, β, and the level of risk is a residual that is set to ensure that the manager receives the reservation wage, $\bar{W}$. Our focus in this article is on the optimal level of this component of the manager's compensation function. The relationship between risk and the pay-performance component in the manager's salary has been the subject of several studies and the evidence is mixed (and not the focus of our article). On the one hand, Aggarwal and Samwick (1999), Cichello (2005), and Garen (1994) find that the optimal risk sharing rule between a risk-neutral principal and a risk-averse manager is to provide less equity based incentives as firm risk increases. On the other hand Core and Guay (2002), show that firm risk is significantly positively associated with pay-performance sensitivity and Tufano (1996) shows that managers with more option based compensation are less likely to hedge risk.

We expand the basic model by positing that the manager receives salary *and control benefits*. In our framework, $\beta = B - m$ where B is the maximum level of control benefits and m is the level of board monitoring. By substituting $B - m$ for β in the equation above and solving for m, we obtain the optimal level of board monitoring given by Eq. 1 in the article. We interpret m as the level of monitoring performed by the board to ensure that the manager does not take more than β level of salary and control benefits.

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