Corporate Governance and Bankruptcy Risk

Abstract
We examine how firm characteristics, particularly the degree of firm complexity and the firm's need for specialty knowledge, affect the relationship between corporate governance and the risk of bankruptcy. We find that having larger boards reduces the risk of bankruptcy only for complex firms. Our results also suggest that the proportion of inside directors on the board is inversely associated with the risk of bankruptcy in firms that require more specialist knowledge, and that the reverse is true in technically unsophisticated firms. The results further reveal that the additional explanatory power from corporate governance variables becomes stronger as the time to bankruptcy is increased, implying that although corporate governance variables are important predictors, governance changes are likely to be too late to save a firm on the verge of bankruptcy.

Keywords
Bankruptcy, corporate governance, board characteristics, CEO characteristics, management characteristics

Acknowledgements

We appreciate helpful comments and suggestions from Bharat Sarath (the editor) and an anonymous referee.

"The fall of Enron was a direct result of failed corporate governance and consequently has led to a complete reevaluation of corporate governance practice in the United States…"

(Munzig, 2003)

Introduction

Since the accounting scandals of the early 21st century, ethics and corporate governance issues have increasingly attracted the attention of researchers, practitioners, and policy makers. WorldCom overstated its profits by $3.8 billion by improperly classifying expenses as investments. Enron, the icon of corporate fraud and corruption, moved debt off its own books and presented a misleading financial status. Adelphia, the fifth largest cable company in the U.S., collapsed into bankruptcy after it disclosed $2.3 billion in off-balance-sheet debt.

Although corporate governance is apparently associated with the risk of bankruptcy, there has been only scant research on the nature of the association grounded on comprehensive empirical tests. The existing studies mainly deal with the link between corporate governance and operating performance or firm value (see Weisbach, 1987; Gilson, 1990; Lipton and Lorsch, 1992; Jensen, 1993; Yermack, 1996; Shleifer and Vishny, 1997; Eisenberg, Sundgren, and Wells, 1998; Brown and Caylor, 2006; Boone, Field, Karpoff, and Raheja, 2007; Coles, Daniel and Naveen, 2008; Linck, Netter and Yang, 2008; Fich and Slezak, 2008; Duchin, Matsusaka and Ozbas, 2010; Adams, Mansi and Nishikawa, 2010; and Masulis and Mobbs, 2011).

However, we posit that the effect of governance is not uniform across all firms and that one-size-fits-all governance practices can be counter-productive. The findings from non-bankrupt (healthy) firms, documented in the above studies, may not explain the effectiveness of certain governance features for situations in which firms are close to becoming financially distressed or bankrupt. There are at least two reasons for this difference. First, governance structures that are effective and useful for some firms can be ineffective and even counter-

productive for others. For example, it appears that Enron actually incurred financial leverage to manipulate reported earnings and thus increased agency costs even though debt can discipline management by forcing it to pay out cash rather than overinvesting (Jensen, 1986). Second, firm performance is not a single factor directly causing bankruptcy, and bad performance may not necessarily lead to immediate insolvent status. Bankruptcy is associated with several conditions including a firm's fixed costs (i.e., operating and financial leverage), sales sensitivity (especially to economic downturns), and the proportion of illiquid assets.

There have been a number of studies that link corporate governance to the risk of bankruptcy (e.g., Elloumi and Gueyie, 2001; Parker, Peters, and Turetsky, 2002; and Fich and Slezak, 2008). However, most prior studies deal with restricted samples and examine the effects of some corporate governance variables without considering the potential impact of firm specific characteristics, particularly the degree of firm complexity and firm's need for specialty knowledge. To fill this gap in the literature, we examine the effect that these firm characteristics have on the relationship between corporate governance attributes (such as board size and director independence) and the risk of corporate bankruptcy.

We find that a larger board is likely to reduce the probability of bankruptcy, inconsistent with the suggestion of some studies that larger boards can be less effective than small boards (Lipton and Lorsch, 1992; Jensen, 1993; Yermack, 1996; and Eisenberg et al., 1998). Our results further suggest that the reduction in the probability of bankruptcy occurs only when complex firms employ larger boards (Boone et al., 2007; Coles et al., 2008; and Linck et al., 2008). These findings imply that a larger board brings to the firm wider networks and knowledge as well as richer experience and expertise. The enhanced advisory capacity of a larger board appears to be relatively more beneficial to more complex firms when they are under serious financial pressure.

However, we also find that larger boards are of no benefit to simpler firms, where the more marginal gains from additional advisory capacity seem to be offset by coordination and free-riding problems.

Corporate boards have two important functions – monitoring and advising. We find that in circumstances where relatively little specialist knowledge is required to properly understand the firm's operations, firms with a greater proportion of outside directors have a lower probability of bankruptcy. For these firms, the monitoring function of the board is more important, and our findings accord well with the view that outside directors are likely to be superior at this function. Conversely, we find that in situations where relatively more specialist knowledge is required to properly understand the firm's operations, firms with a greater proportion of inside directors have a lower probability of bankruptcy. This is consistent with the posture that, in more technically sophisticated firms, the advisory function of the board requires more insiders with specialist knowledge.

We further examine several other corporate governance attributes that have been linked to operating performance. The evidence we find suggests that the majority of these variables are robustly related to the probability of bankruptcy. For example, our results suggest that firms with more diverse boards (a greater proportion of female representation) are less likely to file for bankruptcy, which is consistent with studies that find a positive link between board gender diversification and operating performance attributable to improved monitoring (Adams and Ferreira, 2009). In addition, we find that firms with more powerful CEOs, who also serve as board chairman or hold a larger proportion of the firm's stock, are more likely to file for bankruptcy. This is consistent with the literature that reports a negative relationship between

CEO power and operating performance (Daily and Dalton, 1994; Adams, Almeida and Ferreira, 2005; and Elloumi and Gueyie, 2001).

The results also suggest that firms that have recently replaced their CEO are less likely to file for bankruptcy, similar to the evidence of Bonnier and Bruner (1989) who report a significantly positive stock price reaction to the departure of CEOs of poorly performing firms. This implies that CEO departures do not have a signaling role – that there are other sources of information that signal the financial health of the firm and, conditional on poor financial health, the departure of the CEO is a positive development. We also find a negative relationship between CEO tenure and the probability of bankruptcy. Taken together, these results suggest that, when the CEO is not replaced, the firm is better served by a longer-standing CEO.

Our analysis explores the marginal ability of corporate governance attributes to assist in the prediction of corporate bankruptcies beyond traditional bankruptcy prediction models based on accounting ratios and firm characteristics. As expected, we find that firms are more likely to file for bankruptcy if they are less profitable, more highly leveraged, smaller, and have more volatile returns. The corporate governance variables that we examine achieve significant explanatory power beyond the accounting ratios and firm characteristics.

Finally, the evidence we obtained suggests that the additional explanatory power gained from adding corporate governance variables becomes stronger as the time to bankruptcy is increased, suggesting that while corporate governance characteristics are important, they have a longer-term effect and cannot by themselves save a firm on the verge of bankruptcy. Although accounting ratios echo current firm performance, corporate governance factors reflect the framework within which the firm operates, which is likely to have an effect that plays out over a longer time horizon.

The remainder of this paper proceeds as follows. The next section develops our hypotheses. In the third section we discuss the data sources and sample construction. The fourth section presents our empirical results, and the last section concludes.

Hypotheses Development

The main purpose of this study is to examine how the relationship between corporate governance and the risk of bankruptcy is affected by firm-specific characteristics such as the degree of firm complexity and the firm's need for specialty knowledge.

The two primary functions of the board of directors are the monitoring and advisory roles. The independence of the board has been specifically linked to the monitoring function and the board size has been linked to the advisory function. The literature focuses mainly on the monitoring role of the board and generally reports that an efficient internal monitoring mechanism reduces agency problems and improves managerial efficiency. It is also generally suggested that smaller boards are more efficient in the monitoring role due to better co-ordination and less free-riding (Lipton and Lorsch, 1992, and Jensen, 1993). In relation to the advisory role, Dalton and Daily (1999) find that large and diversified boards generally provide better advice to the CEO. Hermalin and Weisbach (1988) report that independent directors offer better advice, but Duchin et al. (2010) and Coles et al. (2008) find that operating performance only benefits from the advice of outside directors in cases where it is relatively easier for them to learn more about the firm. These results suggest that there may be a trade-off between the monitoring role of the board (which may benefit from smaller numbers) and the board advisory function (which may benefit from larger numbers and greater independence in some circumstances).

A theoretical rationale behind the effect of board size on the risk of bankruptcy is that firms face two types of information asymmetries (endogenous vs. exogenous) and the mechanisms in mitigating each type of information asymmetry are different (De Groote, 1990). The monitoring function of the board deals with endogenous hidden information produced from consequent managerial decisions within the firm. In contrast, the advising function of the board is more likely to mitigate the exogenous hidden information that is independent of the firm decisions. It is plausible that both types of information asymmetry affect more complex firms, whereas endogenous issues are more relevant for less complex firms. We argue that large boards are better in solving the exogenous information asymmetry but weaker in endogenous issues. Therefore, large boards may function better for complex firms, while small boards are more efficient in solving the endogenous hidden information in simpler firms via their monitoring function.[1]

Coles et al. (2008) contend that the literature often overlooks the advisory role of the board despite its profound importance in certain circumstances. They suggest that complex (simple) firms with larger (smaller) boards perform better due to greater (less) advisory requirements. This proposition receives empirical support in Boone et al. (2007) and Linck et al. (2008). In contrast, other studies find smaller boards to be more effective in monitoring tasks (e.g., Jensen, 1993; Yermack, 1996; and Fich and Slezak, 2008). These authors argue that, unlike large boards with high coordination costs, smaller boards are more cohesive and have fewer free-rider problems and are thus able to monitor more effectively. Yermack (1996) reports a negative relationship between board size and Tobin's Q, while Fich and Slezak (2008) contend that distressed firms with smaller boards are more likely to avoid bankruptcy.

In summary, the literature has established a link between board size and the likelihood of bankruptcy and further suggests that optimal board size is related to firm complexity. We bring these two strands of literature together in our first hypothesis (H1), which posits that a firm is more likely to fail if it has a board size that is inappropriate to its circumstances:

H1: Other things being equal, complex (simple) firms are more likely to fail if they have smaller (larger) boards.

Another key feature of board composition is the degree of independence. It is generally presumed that boards with greater independence are more effective in performing the monitoring role of the board. For example, Nguyen and Nielson (2010) investigate stock price reactions to sudden deaths and conclude that independent directors are generally viewed as being beneficial to the firm. Byrd and Hickman (1992) report that independent boards are more likely to remove CEOs because of poor performance and Fich and Slezak (2008) suggest that firms with more independent boards are better able to avoid bankruptcy after entering distress.

However, other studies suggest that the link between board independence and the advisory function also depends upon the specific circumstances of the firm. Duchin et al. (2010) argue that greater board independence may adversely influence the firm performance when it is difficult for independent directors to acquire information about the firm. Coles et al. (2008) report that outside directors contribute to the board advisory function if the firm has multiple business units or extensive relationships with external parties, but that inside directors make a superior contribution to the advisory function where the firm's operations are technically more sophisticated and require specialist knowledge.

In sum, in circumstances where specialist knowledge is required to properly understand the firm's operations, there seems to be a trade-off between increasing board independence to

support the board monitoring function and increasing the proportion of insiders to support the board advisory function – for a given board size.

Since bankruptcy is an indication (or an outcome) of firm performance, we postulate that, in circumstances where relatively little specialist knowledge is required to properly understand the firm's operations, firms with a greater proportion of outside directors have a lower probability of bankruptcy. For these firms, the monitoring function of the board is more important. Conversely, we postulate that in circumstances where relatively more specialist knowledge is required to properly understand the firm's operations, firms with a greater proportion of inside directors have a lower probability of bankruptcy. The advisory function of the board requires more insiders with specialist knowledge in these types of firms. We examine this formally through our second hypothesis:

H2: Other things being equal, firms whose operations require more (less) specialist knowledge are more likely to fail if they have a smaller (greater) proportion of inside directors.

Data and Measurement of Variables

Data Sources and Sample Selection

We compile our firm bankruptcies data from various sources including UCLA-LoPucki Bankruptcy Research Database (http://lopucki.law.ucla.edu/), New Generation Research (www.bankruptcydata.com), Compustat, and the Center for Research in Security Prices (CRSP). The sample contains listed Compustat firms and covers a 10-year period from 1996 to 2006 because the Investor Responsibility Research Center (IRRC) data start from 1996. Following prior research, we classify a firm as being bankrupt if it makes a Chapter 11 filing. We obtain accounting data such as firm diversification and financial ratios from Compustat, and CRSP provides daily and monthly data on stock returns. We hand collect most of the corporate

governance data of bankrupt firms from SEC.GOV text files and data for non-bankrupt firms from IRRC.

Following Begley, Ming and Watts (1996), we assume that annual financial statements are available by the end of the fourth month after the firm's fiscal year-end. For each bankrupt firm, the end of the last fiscal year must be at least four months prior to bankruptcy. If it is within four months, we treat the previous year's financial statements as the last available observation. [2] We have 67,095 observations (11,511 firms) with valid accounting and market data. For compatibility with previous studies (e.g., Begley et al. 1996, and Shumway, 2001), we exclude firms with a Standard Industrial Classification (SIC) code between 6000 and 6999 (financial firms). Thus, we exclude firms in the financial services and real estate sector whose financial structures appear quite different from the rest of the firms in our sample.[3] This process results in 14,328 observations and 2,443 firms being excluded from the sample. There are 11,116 firm year observations (1,972 firms) that have both corporate governance data and accounting data available. We exclude firms that are delisted from CRSP or deleted from Compustat for reasons other than bankruptcy or liquidation. We also delete firms with board size smaller than three to guard against possible errors in data entry (3 observations were excluded on this basis).

The final sample includes 217 bankrupt firms with accounting and corporate governance data one year prior to bankruptcy.[4] Among the bankrupt firms, 186 firms have data over two years prior to bankruptcy. For those bankrupt firms without an exact filing date, we treat their delisting date from CRSP or Compustat (whichever comes first) as the bankruptcy date. All estimations are on a yearly basis. The final sample also contains 9,100 non-bankrupt (healthy) firm-years excluding years for bankrupt firms.

Accounting and Market-based Variables

Our base model uses constructs similar to Campbell, Hilscher, and Szilagyi (2008) for the role of accounting and market-based control variables. The accounting variables reflect profitability, liquidity and leverage; and the market-based variables reflect past excess stock returns, idiosyncratic risk, firm size, market to book ratio and fiscal year end closing price. Consistent with prior research, we expect that more profitable and liquid firms should exhibit a lower probability of bankruptcy while higher leverage increases the probability of bankruptcy. We also expect that larger firms with low market to book ratio, higher stock returns and lower volatility have a lower probability of bankruptcy.

Firm Complexity

Coles et al. (2008), and Linck et al. (2008) suggest that a firm's level of complexity depends on three dimensions: scope of operations, size and leverage. A diversified firm tends to be more complex and thus requires a greater range of advice from the board of directors (Hermalin and Weisbach, 1988). Yermack (1996) shows that more complex firms tend to have larger boards. Large firms are also more complex because they often have more external contracting relationships (Booth and Deli, 1996) and thus have greater advisory requirements and a need for larger boards (Pfeffer, 1972). Klein (1998) also argues that firms with high leverage are likely to have greater advisory needs because they rely more on external resources. These contentions also find empirical support in Linck et al. (2008). Following Coles et al. (2008), and Linck et al. (2008), we employ a principal components analysis to produce for each firm-year observation a complexity score based on the number of business segments, log (sales), and leverage (defined as total liabilities to market value of assets). We define any firm as "complex" if its complexity score is above the median value, and the firm is deemed to be "simple" otherwise.

Specialty Knowledge

Independent of firm breadth, size and leverage, the operations of some firms are more technically demanding thus requiring specialist knowledge, whereas other firms' operations are more straightforward. Prior literature suggests two ways of measuring the cost of acquiring information. First, Coles et al. (2008) use R&D expenditure as a proxy for the specialist knowledge required to understand the firm's operations. Second, Duchin et al. (2010) use the availability, homogeneity, and the accuracy of analysts' earnings forecasts in Krishnaswami and Subramaniam (1999) to measure the information about the firm that is available to outsiders. Both Coles et al. (2008) and Duchin et al. (2010) show that operating performance is positively related to the appointment of outsiders in firms that have low R&D and for which there are more consistent analyst forecasts. These findings indicate that outside directors have a positive effect when it is easier to become informed about the firm's operations. In this paper, we follow Coles et al. (2008) and use R&D expenditure to measure the extent to which directors require specialist knowledge. In particular, we develop an R&D dummy variable that is assigned a value of 1 if the firm's R&D intensity (i.e., R&D expenditures scaled by total assets) is higher than the 75 percentile and 0 otherwise.

Board Diversification

Adams and Ferreira (2009) argue that diversified boards in gender (consisting of both men and women) provide more effective monitoring that could enhance management efficiency. We measure board diversification by the proportion of female directors and expect that firms are more likely to fail if the board is less diversified in gender.

CEO Power

Adams et al. (2005) argue that the volatility of stock returns is higher for firms run by powerful CEOs who are also either the founder of the firm or the board chairman. Daily and Dalton (1994) and Elloumi and Gueyie (2001) find that a duality of roles (a CEO also serving as the board chairman) is relatively more common in bankrupt firms. This suggests a positive relationship between CEO power concentration and the probability of bankruptcy.

We measure CEO power concentration in two ways. First, we construct a dummy variable that is set to one if the CEO also serves as board chairman. Hambrick and D'Aveni (1992) find that the probability of bankruptcy increases with the degree of CEO dominance. Daily and Dalton (1994) examine the relationship between governance structure and corporate bankruptcy and report that bankrupt firms are more likely to have CEOs serving simultaneously as the board chairman, compared to a sample of matched firms. Therefore, we expect a positive association between the duality of roles and the probability of bankruptcy.

Second, we measure the proportions of the firm's stock that are owned by the CEO (CEOs who own greater proportions of the firm's stock are considered to be more powerful). Myers (1977) contends that equity ownership and option compensation may induce management to engage in value decreasing risk shifting behavior when a firm is distressed. Therefore, we expect a positive association between the CEO stockholding and the probability of bankruptcy.

Management Stability

The past literature on the relationship between bankruptcy risk and management stability suggest both directions. On one hand, turnover in senior management ranks is relatively more common in firms filing for bankruptcy or privately restructuring their debts to avoid bankruptcy. Gilson (1989) finds that 52% of sampled firms that file for bankruptcy experience a senior management change. Hambrick and D'aveni (1992) insists that poor organizational performance leads to CEO

departure, which includes voluntary departures for better rewards, voluntary departures to avoid stigma, and purposive attempts to modify the team. Schwartz and Menon (1985) report that 45% of bankrupt firms change CEOs compared to 19% of control firms. Daily and Dalton (1995) find that the likelihood of bankruptcy more than doubled for financially distressed firms that have their CEOs replaced by outsiders, relative to a matched sample of solvent firms. Parker et al. (2002) find that firms replacing their CEO with an outsider are more than twice as likely to experience bankruptcy. Therefore, this stream of the literature suggests that replacing CEOs might indicate firm's unhealthy financial situation.

On the other hand, we note that stock prices tend to react positively to the announcement of top management turnover in poorly performing firms (Bonnier and Bruner, 1989). This is consistent with the notion that the removal of incumbent managers enhances the firm's prospects of being able to improve future performance. As to bankruptcy prediction, it is unlikely that the departure of the CEO has a significant signaling effect in relation to the financial health of the firm since there are other sources of more direct information on the firm financial condition. If this is the case, it is likely that, conditional on poor financial health, the departure of the CEO is a positive development that would reduce the probability of bankruptcy.

We measure management stability in two ways. First we construct a dummy variable that is set to one if the firm has replaced its CEO within the previous three years. Hill and Phan (1991) find that CEOs with longer tenure may become too powerful, with an adverse effect on firm performance. Therefore, we measure the tenure of current CEOs. Whereas a long-serving CEO may negatively affect the operating performance of a firm, the types of expropriation identified by Hill and Phan (1991) are less likely to be tolerated (or even possible) as the firm becomes more distressed. Rather, as the financial performance of the firm declines, it becomes

more likely that its senior management will be replaced. Given that the incumbent CEO is not replaced, it may be that the firm is better served by a longer-standing CEO. Ultimately, this is an empirical question that we address in this paper.

Empirical Results

Summary Statistics

Table 1 reports summary statistics for all explanatory variables in the model. The mean values are reported in bold if they are significantly different between the bankrupt and non-bankrupt sub-samples at the 5% level or better. We winsorize all data on accounting and firm characteristics at the 1st and the 99th percentiles. One may think that distressed firms tend to exhibit extreme values of financial data and thus original values need to be used in the study. However, as addressed in Shumway (2001) among others, winsorizing data is a proper way to mitigate the statistical problem resulting from extreme outliers. We do not winsorize variables on firm diversification (the number of business segments) and corporate governance since they are constructed in such a manner that outliers are not an issue.

[Table 1 about here]

The top panel in Table 1 reports the descriptive statistics for the accounting variables and other firm characteristics. The accounting variables capture three key elements of the financial strength of a firm: profitability, liquidity, and leverage. Shumway (2001) and Campbell et al. (2008) demonstrate that these variables embody useful information about bankruptcy risk.

The profitability variables gauge the ability of the firm to generate sufficient returns to remain solvent. We measure profitability as the ratio of net income to the market value of total assets (NIMTA). The average profitability ratio for firms that became bankrupt in the following

year is -0.16, whereas it is 0.02 for healthy firms. Leverage (the ratio of total liability to the market value of total assets, TLMTA) gauges the relative burden of debt and other firm obligations. On average, and as expected, bankrupt firms have considerably higher leverage compared to other firms in the sample. Liquidity (the ratio of cash and short-term assets to the market value of total assets, CASHMTA) captures the firm's ability to meet its short-term obligations. Firms prior to bankruptcy display similar liquidity compared to other firms.

Shumway (2001) argues that firms with lower excess returns and more volatile stock returns have higher bankruptcy risk. We measure the firm's past excess return (EXRET) by the return in year *t* minus the value-weighted CRSP NYSE/AMEX index return in year *t*. The idiosyncratic risk (SIGMA) is the standard deviation of the residuals derived from regressing monthly stock returns on the value-weighted CRSP NYSE/AMEX index returns in year *t-1*. We find that bankrupt firms have lower and more volatile stock returns than other firms in the sample. The mean and median bankrupt firm reveals substantial underperformance (lower excess returns) in the year prior to bankruptcy. Firms that ultimately file for bankruptcy also have, on average, lower stock prices, lower sales revenue, fewer business segments (less diversified), and higher R&D intensity.

The bottom panel in Table 1 displays summary statistics on board structure and key CEO characteristics. The median board size is typically smaller for bankrupt firms (7 directors) compared to other firms (9 directors). Bankrupt firms also tend to have a higher proportion of inside directors (median of 20% for bankrupt firms and 17% for other firms), and a smaller proportion of female directors (median of 0% for bankrupt firms and 9% for other firms). These results are consistent with previous research (e.g., Yermack, 1996 and Adams and Ferreira, 2009)

suggesting that firms perform better with relatively more independent directors and more diversified boards in gender.

Firms that subsequently file for bankruptcy also tend to have shorter CEO tenure, are more likely to have changed CEO in the previous three years and to have the CEO serving as the chairman. Firms that subsequently file for bankruptcy also tend to have a larger proportion of stocks held by the CEO, which is consistent with them being smaller firms.

Table 2 presents the distribution of sample firms that are bankrupt within one year by year and Fama-French 12 industry code. We find that the bankrupt firms are not evenly distributed across industries. For example, among 217 bankruptcies, wholesale and retail industry takes 41 events over the period, 1997 to 2007, followed by business equipment industry (37 bankruptcies) manufacturing industry (33 bankruptcies). In contrast, only one bankruptcy is found from utilities during the same period. The number of bankruptcies is not fairly distributed by year and reaches its peak right after the dot-com bubble burst.[5]

[Table 2 about here]

The Logit Model

Following Shumway (2001) and Campbell et al. (2008), we assess the association between bankruptcy risk and corporate governance factors using a multi-period logit model. Since there are multiple observations of the same firm, we adjust standard errors for clustering following Petersen (2008). We measure the model fit using log-likelihood ratio tests, Pseudo R^2 and the Receiver Operating Characteristics area (ROC area).[6] A model with a higher Pseudo R^2 and a larger ROC area is considered to provide a superior fit to the data.

The multi-period logit model takes the general form:

$$P_{i,t} = (1+\exp\{-y_{i,t}\})^{-1} \quad (1)$$

where $P_{i,t}$ represents the conditional probability at time *t* that firm *i* will be bankrupt within one year. This probability is conditional on the observed value of $y_{i,t}$, which is a linear combination of the explanatory and control variables. For example, when we examine firms that file for bankruptcy within one year, we have:

$$y_{i,t} = a + \beta' X_{i,t-1} = \beta' \begin{bmatrix} X_{1,t-1} \ldots X_{1,t-j} \\ \ldots\ldots \\ X_{n,t-1} \ldots X_{n,t-j} \end{bmatrix} \quad (2)$$

where $X_{1,t-1}$ represents the value of the first explanatory variable, observed four months after the end of the financial year immediately prior to bankruptcy, and so on. That is, these models measure the likelihood of bankruptcy within one year conditional on the observed values of the explanatory and control variables.

We also measure the ability of the explanatory and control variables to predict bankruptcy two years in advance, in which case the variables are measured four months after the end of the penultimate financial year prior to bankruptcy.

Availability of bankruptcy data is limited, with most having only three firm-year observations prior to filing. Because firms often experience financial distress several years prior to bankruptcy, we do not include in our sample of non-bankrupt firm-years any observation for any firm that ultimately filed for bankruptcy.

Board Size, Board Independence, and Bankruptcy Risk

Table 3 reports the regression results from the logit model. In the first two columns, the dependent variable is set to 1 if the firm files for bankruptcy within one year, and 0 otherwise. In the last two columns, the dependent variable is set to 1 if the firm files for bankruptcy between

one and two years in the future, and 0 otherwise. The *t*-statistics are based on robust standard errors adjusted for clustering at the six-digit CNUM code from CRSP (Petersen, 2008).

[Table 3 about here]

Model 1, which contains only accounting ratios and firm characteristics as explanatory variables, serves as the base model. Consistent with expectations, the results for Model 1 suggest that more profitable and liquid firms have a lower probability of bankruptcy and that higher leverage increases the probability of bankruptcy. We also find that larger firms and firms with higher stock prices and lower volatility have a lower probability of bankruptcy. There is no relationship between stock returns and the probability of bankruptcy two years before bankruptcy, but higher stock returns one year prior to bankruptcy are associated with a significantly higher probability of bankruptcy. This is consistent with the notion that in any given period, firms that generate the highest stock returns are likely to be more risky than average. Consequently, a high stock return is likely to be an indication of risk, where more risky firms are more likely to become distressed at some point.

Model 2 adds key corporate governance variables – board size and insider director fraction. We find that the log board size variable is insignificantly different from zero, indicating that on average there is no relationship between board size and the probability of bankruptcy. However, the interaction between the log of board size and the complexity dummy variable is significantly negative. Thus, for complex firms, larger boards are associated with a lower probability of bankruptcy. This finding lends support to our first hypothesis. It is also consistent with the recent evidence that larger boards are associated with improved operating performance, but only for complex firms (Boone et al. 2007, Coles et al. 2008; and Linck et al. 2008).

The results for Model 2 also indicate that, on average, firms with a larger proportion of inside directors are more likely to subsequently file for bankruptcy. However, the interaction between this variable and our measure of the technical sophistication of the firm's operations (R&D intensity) is significantly negative and larger in magnitude than the coefficient on the proportion of inside directors itself. This implies that a greater proportion of inside directors increases the probability of bankruptcy for firms with low R&D intensity, and reduces the probability of bankruptcy for firms with high R&D intensity. These empirical results support our second hypothesis. Note further that these results also accord well with recent research on board composition and firm performance, which reports that boards with a lower proportion of inside directors are associated with improved operating performance, but only for technically unsophisticated firms (Coles et al. 2008; and Duchin et al. 2010). The results moreover support the evidence in Adams et al. (2010) as well as Masulis and Mobbs (2011) that insiders are beneficial to the firm.

Table 3 also reports *p*-values for likelihood ratio statistics of the joint significance of our corporate governance variables. The *p*-values reported under the Model 2 columns are for testing the joint significance (relative to the base Model 1) of the board size, inside director variables, and the interaction terms. As shown in Table 3, the corporate governance variables proved jointly highly significant.

Other Corporate Governance Characteristics and Bankruptcy Risk

In the following tests, we explore the effects of other corporate governance variables such as female director fraction, CEO/chairman duality, CEO shareholding, turnover, and tenure. Results in Table 4 indicate that, on average, bankruptcy is less likely for firms with a higher proportion of female directors. The estimated coefficient of female director fraction is significant

at the 10% level in the test for two year prior to bankruptcy. This evidence accords well with Adams and Ferreira (2009) who report that more diversified boards improve operating performance.

[Table 4 about here]

Table 4 further suggests that bankruptcy is more likely when the CEO serves as board chairman. This finding is consistent with our postulate that CEO power is positively related to the probability of bankruptcy. The results also suggest that bankruptcy is less likely when the CEO has been replaced within the previous three years (achieves significance only one year prior to bankruptcy) and that bankruptcy is negatively related to CEO tenure. These results accord with Bonnier and Bruner (1989) who report a significantly positive stock price reaction to the departure of CEOs of poorly performing firms. These findings imply that CEO departures do not have a signaling role, that there are other sources of information on the financial health of the firm and, conditional on poor financial health, the departure of the CEO reduces the probability of bankruptcy. Therefore, it appears beneficial to remove a poorly-performing CEO. However, when the CEO is not removed (for whatever reason) bankruptcy becomes less likely if the firm is managed by a longer-standing CEO.[7,8]

Table 5 displays the results from estimating regressions that include a complete set of the governance variables. We find that most governance variables are jointly highly significant. The *p*-values reported for testing the joint significance (relative to Model 1 of Table 3) are statistically significant at the 1 percent level.

[Table 5 about here]

The contribution of the corporate governance variables is relatively greater two years prior to bankruptcy compared to the year immediately preceding it. The statistical significance

of the corporate governance coefficients is almost uniformly higher two years prior to bankruptcy and the likelihood ratio test statistic is more than double the corresponding value in the year prior to bankruptcy. Furthermore, in the year before bankruptcy, adding the corporate governance variables increases the pseudo R-squared statistic by only 9.7% (from 0.557 for Model 1 in Table 3 to 0.611 for Model 2 in Table 5). Two years before bankruptcy, the addition of the corporate governance variables increases the pseudo R-squared statistic by 18.5%, (from 0.379 for Model 3 in Table 3 to 0.449 for Model 4 in Table 5). In contrast, the statistical significance of the coefficients on the accounting ratio and firm characteristic variables in the base model are almost uniformly lower two years prior to bankruptcy. This suggests that the additional explanatory power gained from adding corporate governance variables becomes larger as the time to bankruptcy increases. Furthermore, the relative importance of the accounting ratios decreases and the relative importance of the corporate governance variables increases with the time to bankruptcy. Thus, while corporate governance attributes are important, they have a "longer-term" effect and cannot by themselves save a firm on the verge of bankruptcy.

The results with additional governance variables in Models 2 and 4 reveal that firms are less likely to be bankrupt if CEOs have more option value relative to total compensation, if insiders and institutional blockholders own fewer shares, and if audit committee is independent.[9]

Prediction Success Rates

Figure 1 reports the sum of Type I and Type II errors from the models in the previous tables. The figure shows the sum of Type I errors (classifying a bankrupt firm as healthy) and Type II errors (classifying a healthy firm as bankrupt) according to the predicted values computed from each model. As expected, prediction accuracy declines with the length of the prediction horizon and the sum of Type I and Type II errors is higher for predictions made two years prior to bankruptcy.

Consistent with previous results, the relative improvement from adding corporate governance variables is greater two years prior to bankruptcy than it is one year prior.

[Figure 1 about here]

Robustness Tests

We test the robustness of our results in various ways. First, we provide additional tests for the key variables (firm complexity and specialty knowledge) by using diverse cutoff values and by constructing them in different manners. In previous tests, we consider a firm as complex if its complexity score is above the median value, and the firm is deemed to be simple otherwise. In Table 6, we define the firm as being complex only if its complexity score is above the 75 percentile. Similarly, we previously defined a firm to be R&D intensive if its R&D score is above the 75 percentile. In Table 6, we examine the robustness of our results to the case where we define any firm with an R&D score above the median as R&D intensive.[10]

Table 7 measures firm complexity using the business segment assets-based Herfindahl Index calculated as the ratio of the sum of squared segment assets to the squared value of total assets. This index decreases when the firm is more diversified and consequently more complex. We also change the proxy for specialty knowledge, using patent citation information obtained from the patent citation data supplied by the National Bureau Economic Research.[11] We use the median values to generate a complexity dummy (taking a value of 1 if the Herfindahl Index is below the median) and a specialty knowledge dummy (taking a value of 1 if the patent citation score is above the median). We further examine the robustness of our results to the case where firms are having Herfindahl scores in the bottom quartile, and where firms are said to require specialist knowledge only if their patent citation score is in the top quartile.

These alternative results are all qualitatively similar to those reported in the previous table. Therefore, it is unlikely that our results are driven by specific cutoff values or by the particular methods used to measure firm complexity and specialty knowledge.

[Table 6 about here]

[Table 7 about here]

Second, we perform a matched pairs analysis where each bankrupt firm is matched with a non-bankrupt firm on the basis of firm's total assets and two digits SIC industry classification code measured two years prior to bankruptcy. We perform the same logit analysis, but on the matched pairs sub-sample. This is designed to test the sensitivity of our analysis to the possibility that non-bankrupt firms in our larger sample systematically differ from the bankrupt firms in a way that distorts the coefficient estimates.

Table 8 reports the results from the matched pairs logit analysis. As expected, more profitable firms with less leverage are less likely to file for bankruptcy. More volatile and smaller firms have a higher probability of bankruptcy, other things being equal. Consistent with the results in other tables, board size is unrelated to the probability of bankruptcy, on average, but larger boards reduce the probability of bankruptcy for more complex firms. However, results in Table 8 do not clearly support the presence of significant relationships between the probability of bankruptcy and the interaction of the proportion of inside directors to the technical sophistication of the firm's operations.

Consistent with Table 4, and similar to Adams and Ferreira (2009), more diversified boards with a higher proportion of female directors have a lower probability of bankruptcy. The other corporate governance variables are not consistently and individually significant in this

smaller sample. However, as the results in Tables 3 and 5 suggest, the likelihood ratio test statistics indicate that corporate governance variables are jointly significant.

[Table 8 about here]

Also, similar to the original results, the matched-pair analysis suggests that the contribution of the corporate governance variables is relatively greater two years prior to bankruptcy than it is in the year immediately preceding bankruptcy. For example, in the year before bankruptcy, adding the corporate governance variables increases the pseudo R-squared statistic by 13.7% (from 0.620 to 0.705). Two years prior to bankruptcy, the addition of the corporate governance variables improves the same statistic by 18.8% (from 0.478 to 0.568). These results confirm our previous conclusion that the relative importance of the accounting ratios decreases, while the relative importance of the corporate governance variables increases with the time to bankruptcy.

In the third round of our robustness checks, we consider an issue related to cause and effect between corporate governance and bankruptcy. We have thus far showed that corporate governance variables are important predictors of bankruptcy. However, as discussed in Gilson (1989), many firms experience a senior management change when they are financially distressed. In addition, he shows that the turnover rate for non-financially-distressed firms significantly drops although these firms are extremely unprofitable. Therefore, it is also plausible to speculate that a firm's financial status can also affect management turnover and corporate governance. To operationalize this issue, we use corporate governance variables from year t-1 or year t-2 (i.e., two years or three years prior to bankruptcy) to estimate bankruptcy in year t+1. We report the results from the restricted sample in Table 9. We find that the main relationships reported in the

previous tables are qualitatively similar even after we exclude firms whose management could have been affected by the possibility of bankruptcy. [12]

[Table 9 about here]

In the final robustness check, we attempt to mitigate any potential problem of multicollinearity by using principal components analysis to examine the variation of bankruptcy prediction power from accounting and firm characteristic variables on the one hand, and from corporate governance variables on the other. As is common in the corporate governance literature (e.g., Boone et al. 2007; Coles et al. 2008; and Linck et al. 2008), the principal components method identifies (normalized) linear combinations of the variables that explain maximum portions of the variance in firms' financial and corporate governance variables. We use this method to construct a single accounting factor to represent all accounting and other firm characteristics variables, and another corporate governance factor to collectively represent the corporate governance variables. A higher score for either factor indicates a lower probability of bankruptcy. Figure 2 plots the average value of each factor for non-bankrupt firms in Panel A and for bankrupt firms in Panel B.

[Figure 2 about here]

In Figure 2a, the horizontal axis represents the eleven years of our sample, 1996-2006. The plot indicates that on average the accounting factor for non-bankrupt firms declines during the early years and then ascends in the later period. This seems consistent with the behavior of the U.S. economy during these two sub-periods. However, the corporate governance factor for non-bankrupt firms exhibits little variations, remaining largely stable over the entire period.

The horizontal axis in Figure 2b represents years relative to bankruptcy. For example, the values for each factor at time -1 are the average values of the factor across the 208 firms for

which we have data one year prior to bankruptcy. The values at time -2 are the averages across the 186 firms for which we have the necessary data two years prior to bankruptcy and so on. The plot in Figure 2b shows that the value of the accounting factor for firms that ultimately file for bankruptcy deteriorates dramatically in the years prior to bankruptcy. By contrast, there is much less variation in the corporate governance factor. For several years prior to bankruptcy, the corporate governance factor is substantially lower for firms that ultimately file for bankruptcy than for those that do not. These results are consistent with the conclusions from previous tables that the relative importance of the accounting ratios decreases while the relative importance of the corporate governance variables increases with the time to bankruptcy. Although the corporate governance factor offers some discriminatory power in the year preceding bankruptcy, the gain is rather small relative to the accounting information factor. As the time to bankruptcy increases, the discriminatory power of the corporate governance factor is maintained, whereas the power of the accounting factor is reduced. Consequently, the effects of the corporate governance variables are relatively more important when the firm's financial position has not deteriorated to the extent where bankruptcy is imminent.

We extend our analysis further by estimating the models with the principal components factors (rather than using the individual explanatory variables) in a multi-period logit context. Models 1 and 2 predict bankruptcy 1 year prior to the event; Models 3 and 4 do the same 2 years prior to bankruptcy, and Models 5 and 6 predict bankruptcy 3 years prior. Models 1, 3, and 5 are estimated with only the accounting factor and Models 2, 4, and 6 are estimated with both accounting and corporate governance factors. Table 10 displays the results. We gauge model performance by the ROC and Pseudo R^2, and measure the significance of the various models

using likelihood ratio test statistics. We calculate the *t*-statistics using robust standard errors adjusted for firm clustering.

The results in Table 10 suggest that both principle component factors are negatively associated with the probability of bankruptcy. Importantly, the coefficient magnitudes of the accounting factor become smaller when we predict bankruptcy earlier. We find a distinctly different pattern from the corporate governance factor. The estimated coefficients increase in magnitude when making bankruptcy prediction further away from the event. Moreover, the results indicate that adding corporate governance structure does improve the model performance and the overall bankruptcy prediction and, once again, the improvement is more substantial when firms are further away from bankruptcy.

[Table 10 about here]

These findings are consistent with our earlier conclusion that corporate governance structure improves bankruptcy prediction especially when firms are several years away from bankruptcy filing. On the contrary, accounting ratios can distinguish between healthy and bankrupt firms but only much closer to bankruptcy.

Concluding Remarks

This paper examines the association between corporate governance and bankruptcy risk. It explores the ability of corporate governance attributes to predict the risk of bankruptcy beyond traditional bankruptcy prediction models based on accounting ratios and firm characteristics. Although corporate governance is known to be an important factor in predicting bankruptcy, the nature of the relationship between governance and bankruptcy has not been thoroughly examined in the literature. Our study contributes to the literature by providing a comprehensive analysis of

the effects that firm characteristic, specifically the degree of firm complexity and firm's need for specialty knowledge, have on the relationship between corporate governance and the probability of bankruptcy.

We find that having larger boards reduces the risk of bankruptcy, contrary to several previous studies. However, this reduction is only significant for complex firms. The results suggest that having a greater proportion of inside directors reduces the risk of bankruptcy in firms that require more specialist knowledge, and that the reverse is true in technically unsophisticated firms. We further find that bankruptcy is more likely when the board is less diversified in gender, when the CEO has more power, and when poorly-performing management teams are left in place.

Our results further suggest that the additional explanatory power gained from corporate governance variables becomes stronger as the time to bankruptcy is increased, implying that while corporate governance variables are important, they have a longer-term effect so that governance changes are unlikely to be able to save a firm on the verge of bankruptcy. The evidence from our principal components analysis indicates that firms that ultimately file for bankruptcy suffer from relatively poor corporate governance structures well before the bankruptcy event. An interesting issue for future research is whether firms entering financial distress adjust their corporate governance structure to avoid bankruptcy.

In summary, our findings broadly imply some difficulty for regulators attempting to propose a standardized board composition since the optimal board structure varies across different types of firms and also across time. Nevertheless, the results indicate that poor corporate governance does provide an early signal for bankruptcy, which is particularly useful

for regulators and policy-makers. Corporate governance practices may also benefit investors in their attempt to identify at an early stage firms under financial distress.

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Table 1. Summary statistics

	Non-bankruptcies (N=9,100)			Bankruptcies					
				Bankrupt in one year (N=217)			Bankrupt in two years (N=186)		
Variable	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Accounting ratios and other firm characteristics									
NIMTA	0.02	0.03	0.06	**-0.16**	-0.09	0.17	**-0.07**	-0.02	0.13
TLMTA	0.34	0.31	0.21	**0.68**	0.76	0.24	**0.56**	0.63	0.27
CASHMTA	0.07	0.03	0.09	0.07	0.03	0.11	0.07	0.03	0.10
EXRET	0.06	0.00	0.46	**-0.39**	-0.55	0.52	**-0.14**	-0.36	0.68
SIGMA	0.10	0.09	0.06	**0.22**	0.19	0.09	**0.20**	0.18	0.09
SIZE	-8.66	-8.80	1.53	**-11.76**	-11.94	1.40	**-11.20**	-11.27	1.52
MB	0.95	0.87	0.73	**0.24**	0.07	1.10	**0.49**	0.31	1.08
PRICE	3.27	3.36	0.73	**1.28**	1.12	0.96	**1.85**	1.81	1.01
SEGMENTS	6.32	4.00	5.11	**3.43**	2.00	3.47	**4.39**	3.00	3.64
SALES ($billions)	4760	1432	11143	**1618**	285	7400	**1486**	290	4324
R&D	0.03	0.00	0.06	**0.05**	0.00	0.17	**0.04**	0.00	0.14
Corporate governance factors									
Board size	9.25	9.00	2.52	**7.46**	7.00	2.24	**7.60**	7.00	2.45
Insider director fraction	0.20	0.17	0.11	**0.24**	0.20	0.14	**0.25**	0.20	0.14
Outsider	0.66	0.67	0.17	**0.57**	0.57	0.20	**0.54**	0.57	0.20
Female director fraction	0.09	0.09	0.09	**0.05**	0.00	0.09	**0.05**	0.00	0.08
CEO/Chairman duality	0.51	1.00	0.50	**0.56**	1.00	0.50	**0.60**	1.00	0.49
CEO shareholding (%)	2.14	0.27	5.69	**3.81**	0.35	8.78	**4.98**	0.60	10.50
CEO turnover	0.32	0.00	0.47	**0.41**	0.00	0.49	**0.41**	0.00	0.49
CEO tenure	8.28	6.00	7.49	**6.24**	5.00	5.42	**6.48**	5.00	5.02
CEO age	55.59	56.00	7.30	**52.81**	54.00	8.02	**53.02**	53.00	8.50
CEO option value / total compensation	0.52	0.57	0.28	**0.22**	0.00	0.32	**0.23**	0.00	0.32
Insider shareholding (%)	6.37	1.59	13.21	**16.94**	8.06	23.32	**16.02**	7.33	20.87
Institutional blockholding (%)	16.09	14.37	13.18	**24.06**	19.73	21.71	**22.32**	19.64	19.27
Independent audit committee dummy	0.63	1.00	0.48	**0.48**	0.00	0.50	**0.47**	0.00	0.50

Notes: This table reports summary statistics for all variables over the period 1996 to 2006. The sample contains 217 bankruptcies (186 bankruptcies with 2 years of prior data) and 9,100 non-bankrupt firm year observations. NIMTA = the ratio of net income to the market value of total assets; TLMTA = the ratio of total liabilities to the market value of total assets; CASHMTA = the ratio of cash and short-term assets to the market value of total assets; EXRET = cumulative annual return in year *t* minus the value-weighted CRSP NYSE/AMEX return in year *t*; SIGMA = standard deviation of the residual derived from regressing monthly stock return on market return in year *t*; SIZE = log of the ratio of firm's market capitalization to the total market capitalization of all firms; MB = the ratio of market value equity to book value equity; PRICE = log of closing price at end of previous fiscal year; SEGMENTS = the number of business segments in the firm; SALES = the amount of gross sales; R&D = the ratio of research development expenditures to total assets; Board size = the number of directors; Inside director fraction = proportion of inside directors; Female director fraction = proportion of female directors; CEO/Chairman duality =1 if CEO is also the Board Chairman; CEO shareholding (%) = the percentage of shares held by CEO, excluding option and warrants; CEO turnover =1 if there has been a CEO turnover within the previous three years; CEO tenure = the tenure of CEO in years; CEO age = the age of CEO; CEO option value / total compensation = the ratio of CEO option value to total compensation; Insider shareholding (%) = the percentage of shares held by inside directors; Institutional blockholding (%) = the percentage of shares held by institutional block holders; Independent audit committee dummy = 1 if the audit committee is composed of all outside directors.

Table 2. Distribution of sample firms bankrupt within one year

Fama-French 12 Industries	Industry description	Year											
		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
1	Consumer Nondurables	0	2	1	3	5	4	1	3	0	0	0	19
		(0.0%)	(25.0%)	(6.7%)	(9.4%)	(10.4%)	(11.1%)	(3.3%)	(15.0%)	(0.0%)	(0.0%	(0.0%)	(8.8%)
2	Consumer Durables	0	0	2	2	1	1	3	1	0	0	0	10
		(0.0%)	(0.0%)	(13.3%)	(6.3%)	(2.1%)	(2.8%)	(10.0%)	(5.0%)	(0.0%)	(0.0%	(0.0%)	(4.6%)
3	Manufacturing	1	1	2	8	7	2	4	3	3	1	1	33
		(100.0%)	(12.5%)	(13.3%)	(25.0%)	(14.6%)	(5.6%)	(13.3%)	(15.0%)	(20.0%)	(14.3%	(20.0%)	(15.2%)
4	Oil, Gas, and Coal Extraction and Products	0	0	2	1	0	0	2		0	0	0	5
		(0.0%)	(0.0%)	(13.3%)	(3.1%)	(0.0%)	(0.0%)	(6.7%)	(0.0%)	(0.0%)	(0.0%	(0.0%)	(2.3%)
5	Chemicals and Allied Products	0	0	0	0	3	2	2	0	0	0	0	7
		(0.0%)	(0.0%)	(0.0%)	(0.0%)	(6.3%)	(5.6%)	(6.7%)	(0.0%)	(0.0%)	(0.0%	(0.0%)	(3.2%)
6	Business Equipment	0	0	2	3	11	8	7	2	2	2	0	37
		(0.0%)	(0.0%)	(13.3%)	(9.4%)	(22.9%)	(22.2%)	(23.3%)	(10.0%)	(13.3%)	(28.6%	(0.0%)	(17.1%)
7	Telephone and Television Transmission	0	2	1	0	3	0	1	1	0	0	0	8
		(0.0%)	(25.0%)	(6.7%)	(0.0%)	(6.3%)	(0.0%)	(3.3%)	(5.0%)	(0.0%)	(0.0%	(0.0%)	(3.7%)
8	Utilities	0	0	0	0	0	0	1	0	0	0	0	1
		(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(3.3%)	(0.0%)	(0.0%)	(0.0%	(0.0%)	(0.5%)
9	Wholesale, Retail, and Some Services	0	3	2	3	11	5	3	7	3	2	2	41
		(0.0%)	(37.5%)	(13.3%)	(9.4%)	(22.9%)	(13.9%)	(10.0%)	(35.0%)	(20.0%)	(28.6%)	(40.0%)	(18.9%)
10	Healthcare, Medical Equipment, and Drugs	0	0	1	2	1	5	2	0	1	1	0	13
		(0.0%)	(0.0%)	(6.7%)	(6.3%)	(2.1%)	(13.9%)	(6.7%)	(0.0%)	(6.7%)	(14.3%)	(0.0%)	(6.0%)
11	Finance	-	-	-	-	-	-	-	-	-	-	-	-
12	Other industries	0	0	2	10	6	9	4	3	6	1	2	43
		(0.0%)	(0.0%)	(13.3%)	(31.3%)	(12.5%)	(25.0%)	(13.3%)	(15.0%)	(40.0%)	(14.3%)	(40.0%)	(19.8%)
Total		1	8	15	32	48	36	30	20	15	7	5	217
		(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)

Notes: This table presents the distribution of sample firms bankrupt within one year by industry and year. The information on Fama-French 12 industry classifications is extracted from Kenneth French web site at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. The percentages are reported in parentheses for each year.

Table 3. Board Size, Board Independence, and Bankruptcy Risk

	One year prior to bankruptcy		Two years prior to bankruptcy	
	Model 1	Model 2	Model 3	Model 4
Accounting ratios and other firm characteristics				
NIMTA	-1.52*	-1.64*	0.74	0.55
	(-1.71)	(-1.82)	(0.75)	(0.54)
TLMTA	3.77***	5.21***	2.53***	3.93***
	(5.89)	(6.66)	(4.43)	(5.40)
CASHMTA	-1.80	-2.30*	-2.15*	-2.51*
	(-1.45)	(-1.74)	(-1.67)	(-1.85)
EXRET	-0.51**	-0.42*	-0.17	-0.10
	(-2.04)	(-1.71)	(-0.98)	(-0.58)
SIGMA	6.60***	6.63***	8.82***	8.74***
	(4.59)	(4.51)	(6.72)	(6.49)
SIZE	-0.92***	-0.75***	-1.08***	-0.89***
	(-7.38)	(-5.78)	(-7.97)	(-6.35)
MB	0.55***	0.67***	0.60***	0.68***
	(3.97)	(4.54)	(4.15)	(4.55)
PRICE	-0.45**	-0.50**	-0.08	-0.15
	(-2.05)	(-2.19)	(-0.36)	(-0.65)
Corporate Governance Variables				
Log of board size		0.39		0.17
		(0.75)		(0.35)
Log of board size*complexity dummy		-0.89***		-0.76***
		(-4.61)		(-4.48)
Insider director fraction		1.53		2.06***
		(1.58)		(2.70)
Insider director fraction*high R&D dummy		-2.83**		-3.02**
		(-2.06)		(-2.46)
Intercept	-15.18***	-13.55***	-16.93***	-14.85***
	(-8.45)	(-6.03)	(-9.16)	(-6.77)
No. of bankruptcies	217	217	186	186
No. of healthy firm years	9100	9100	8358	8358
Likelihood ratio test (*p* value)		<0.01		<0.01
Pseudo R^2	0.557	0.572	0.379	0.401

Notes: This table presents the parameter estimates from multi-period logit bankruptcy prediction models. LRT is the likelihood ratio test statistics between models 1 and 2. Refer to Table 1 and Appendix 1 for the variable descriptions. The t-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Board Gender Diversity, CEO Characteristics, and Bankruptcy Risk

	One year prior to bankruptcy			Two years prior to bankruptcy		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Accounting ratios and other firm characteristics						
NIMTA	-1.54*	-1.62*	-1.50*	0.65	0.49	0.85
	(-1.74)	(-1.82)	(-1.69)	(0.66)	(0.49)	(0.85)
TLMTA	3.83***	3.65***	3.82***	2.64***	2.36***	2.57***
	(5.98)	(5.64)	(5.93)	(4.50)	(4.12)	(4.51)
CASHMTA	-1.78	-1.77	-1.83	-2.15*	-2.15*	-2.08*
	(-1.44)	(-1.41)	(-1.50)	(-1.69)	(-1.67)	(-1.66)
EXRET	-0.50**	-0.52**	-0.51**	-0.16	-0.15	-0.17
	(-2.04)	(-2.09)	(-2.02)	(-0.94)	(-0.91)	(-0.99)
SIGMA	6.52***	6.54***	6.71***	8.71***	8.85***	8.93***
	(4.55)	(4.49)	(4.57)	(6.66)	(6.71)	(6.79)
SIZE	-0.89***	-0.93***	-0.92***	-1.04***	-1.04***	-1.08***
	(-7.04)	(-7.21)	(-7.31)	(-7.59)	(-7.33)	(-8.02)
MB	0.54***	0.53***	0.54***	0.58***	0.56***	0.59***
	(3.88)	(3.85)	(3.87)	(3.98)	(3.93)	(4.09)
PRICE	-0.46**	-0.46**	-0.44**	-0.08	-0.12	-0.05
	(-2.08)	(-2.08)	(-1.97)	(-0.38)	(-0.53)	(-0.25)
Corporate Governance Variables						
Female director fraction	-2.12			-2.73*		
	(-1.45)			(-1.96)		
CEO/Chairman duality		0.37			0.45**	
		(1.62)			(2.21)	
CEO shareholding (%)		0.01			0.02	
		(0.42)			(1.58)	
CEO turnover			-0.50*			-0.19
			(-1.84)			(-0.78)
CEO tenure			-0.06**			-0.05**
			(-2.52)			(-2.48)
Intercept	-14.76***	-15.37***	-14.64***	-16.44***	-16.69***	-16.64***
	(-8.11)	(-8.41)	(-8.08)	(-8.74)	(-8.61)	(-9.08)
No. of bankruptcies	217	217	217	186	186	186
No. of healthy firm years	9100	9100	9100	8358	8358	8358
Pseudo R^2	0.559	0.559	0.561	0.382	0.385	0.383

Notes: This table presents the parameter estimates from multi-period logit bankruptcy prediction models. Refer to Table 1 and Appendix 1 for the variable descriptions. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5. Complete multi-period logit results

	One year prior to bankruptcy		Two years prior to bankruptcy	
	Model 1	Model 2	Model 3	Model 4
Accounting ratios and other firm characteristics				
NIMTA	-1.85**	-1.93**	0.43	0.53
	(-2.03)	(-2.01)	(0.42)	(0.51)
TLMTA	5.04***	5.22***	3.73***	4.04***
	(6.33)	(6.41)	(5.07)	(5.57)
CASHMTA	-2.17*	-1.44	-2.35*	-1.71
	(-1.68)	(-1.04)	(-1.83)	(-1.26)
EXRET	-0.40	-0.43	-0.09	-0.13
	(-1.61)	(-1.63)	(-0.54)	(-0.78)
SIGMA	6.50***	6.92***	8.94***	9.28***
	(4.29)	(4.35)	(6.66)	(6.80)
SIZE	-0.76***	-0.47***	-0.87***	-0.62***
	(-5.60)	(-3.41)	(-5.97)	(-4.37)
MB	0.62***	0.58***	0.60***	0.56***
	(4.18)	(3.78)	(3.97)	(3.70)
PRICE	-0.50**	-0.66***	-0.15	-0.21
	(-2.27)	(-2.74)	(-0.65)	(-0.96)
Corporate Governance Variables				
Log of board size	0.64	0.53	0.54	0.44
	(1.17)	(0.93)	(1.11)	(0.87)
Log of board size*complexity dummy	-0.86***	-0.87***	-0.76***	-0.78***
	(-4.33)	(-4.07)	(-4.41)	(-4.38)
Insider director fraction	2.01*	1.48	2.35***	1.77**
	(1.87)	(1.27)	(2.70)	(2.01)
Insider director fraction*high R&D dummy	-2.99**	-2.34*	-3.00**	-2.55**
	(-2.18)	(-1.77)	(-2.38)	(-2.12)
Female director fraction	-1.81	-1.79	-2.61*	-2.55*
	(-1.19)	(-1.18)	(-1.84)	(-1.87)
CEO/Chairman duality	0.49**	0.51**	0.62***	0.68***
	(2.08)	(2.15)	(2.96)	(3.24)
CEO shareholding (%)	0.01	-0.01	0.03*	0.01
	(0.70)	(-0.62)	(1.85)	(0.85)
CEO turnover	-0.46*	-0.39	-0.09	0.02
	(-1.70)	(-1.36)	(-0.36)	(0.07)
CEO tenure	-0.08***	-0.07***	-0.07***	-0.07***
	(-2.96)	(-2.66)	(-3.30)	(-3.09)
Log of CEO age		-0.45		-0.56
		(-0.56)		(-0.79)
CEO option value / total compensation		-1.87***		-1.96***
		(-4.35)		(-4.90)
Insider shareholding (%)		0.02**		0.01
		(2.25)		(0.97)
Institutional blockholdings (%)		0.02***		0.01**
		(2.70)		(2.23)
Independent audit committee dummy		-0.53**		-0.66***
		(-2.21)		(-3.25)
Intercept	-13.59***	-7.90**	-15.10***	-9.37***
	(-5.86)	(-2.14)	(-6.57)	(-2.73)
No. of bankruptcies	217	216	186	186
No. of healthy firm years	9100	9079	8358	8340
Likelihood ratio test (*p* value)	<0.01	<0.01	<0.01	<0.01
Pseudo R^2	0.582	0.611	0.419	0.449

Notes: This table presents the parameter estimates from multi-period logit bankruptcy prediction models. LRT is the likelihood ratio test statistics between the reported model and model 2 of Table 3. Refer to Table 1 and Appendix 1 for the variable descriptions. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Alternative cutoffs for complexity and high R&D dummies

	One year prior to bankruptcy			Two years prior to bankruptcy		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Accounting ratios and other firm characteristics						
NIMTA	-1.67*	-1.70*	-2.00**	0.38	0.26	0.32
	(-1.82)	(-1.83)	(-1.99)	(0.38)	(0.27)	(0.31)
TLMTA	6.02***	5.77***	5.48***	3.75***	3.44***	3.51***
	(7.33)	(6.82)	(6.39)	(5.30)	(4.85)	(4.97)
CASHMTA	-1.58	-1.41	-0.77	-1.90	-1.74	-1.02
	(-1.22)	(-1.11)	(-0.58)	(-1.46)	(-1.41)	(-0.78)
EXRET	-0.42	-0.42	-0.46*	-0.08	-0.07	-0.13
	(-1.64)	(-1.58)	(-1.66)	(-0.44)	(-0.41)	(-0.72)
SIGMA	6.79***	6.67***	7.12***	9.06***	9.12***	9.58***
	(4.42)	(4.30)	(4.32)	(6.60)	(6.76)	(6.97)
SIZE	-0.73***	-0.73***	-0.48***	-0.92***	-0.91***	-0.68***
	(-5.50)	(-5.25)	(-3.37)	(-6.53)	(-6.16)	(-4.74)
MB	0.53***	0.50***	0.46***	0.58***	0.51***	0.47***
	(3.52)	(3.24)	(2.96)	(3.71)	(3.21)	(2.92)
PRICE	-0.47**	-0.50**	-0.63**	-0.13	-0.14	-0.19
	(-2.07)	(-2.23)	(-2.56)	(-0.59)	(-0.64)	(-0.85)
Corporate Governance Variables						
Log of board size	0.17	0.35	0.13	-0.14	0.18	-0.04
	(0.33)	(0.65)	(0.25)	(-0.29)	(0.37)	(-0.08)
Log of board size*Complexity dummy (=1 if complexity score > 75th percentile and 0 otherwise)	-0.79***	-0.72***	-0.62***	-0.40***	-0.35***	-0.29**
	(-5.79)	(-5.27)	(-4.38)	(-3.38)	(-3.00)	(-2.41)
Insider director fraction	1.45	1.71	1.42	2.32***	2.47**	1.86*
	(1.49)	(1.58)	(1.25)	(2.83)	(2.52)	(1.94)
Insider fraction*High R&D dummy (=1 if R&D intensity > 50th percentile and 0 otherwise)	-2.80***	-2.85***	-2.81***	-2.26**	-2.25**	-1.96**
	(-2.83)	(-2.85)	(-2.86)	(-2.39)	(-2.33)	(-2.15)
Female director fraction		-2.18	-1.75		-2.89**	-2.74**
		(-1.46)	(-1.18)		(-2.05)	(-2.00)
CEO/Chairman duality		0.49**	0.48**		0.65***	0.68***
		(2.03)	(2.01)		(3.00)	(3.20)
CEO shareholding (%)		0.01	-0.01		0.03**	0.01
		(0.96)	(-0.73)		(2.01)	(0.82)
CEO turnover		-0.44	-0.40		-0.10	-0.03
		(-1.61)	(-1.41)		(-0.41)	(-0.12)
CEO tenure		-0.07***	-0.07***		-0.07***	-0.07***
		(-2.64)	(-2.61)		(-2.97)	(-3.06)
Log of CEO age		-0.16	-0.08		-0.28	-0.37
		(-0.20)	(-0.10)		(-0.38)	(-0.51)
CEO option value / total compensation			-1.78***			-1.98***
			(-4.19)			(-4.90)
Insider shareholding (%)			0.02***			0.01
			(2.65)			(1.11)
Institutional blockholdings (%)			0.02***			0.01*
			(2.62)			(1.83)
Independent audit committee dummy			-0.41*			-0.64***
			(-1.69)			(-3.14)
Intercept	-13.84***	-12.89***	-9.56**	-15.45***	-14.43***	-10.52***
	(-6.03)	(-3.30)	(-2.49)	(-7.00)	(-4.06)	(-3.01)
No. of bankruptcies	217	216	216	186	186	186
No. of healthy firm years	9100	9079	9079	8358	8340	8340
Likelihood ratio test (*p* value)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pseudo R^2	0.580	0.589	0.614	0.400	0.418	0.447

Notes: This table presents the parameter estimates from multi-period logit bankruptcy prediction models with alternative cutoffs for complexity and high R&D dummies. LRT is the likelihood ratio test statistics between the reported model and model 2 of Table 3. Refer to Table 1 and Appendix 1 for the variable descriptions. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7. Alternative measures of complexity and specialty knowledge

	One year prior to bankruptcy				Two years prior to bankruptcy			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Accounting ratios and other firm characteristics								
NIMTA	-1.75*	-1.87*	-1.80**	-1.93*	0.20	0.14	0.22	0.13
	(-1.95)	(-1.89)	(-1.96)	(-1.92)	(0.20)	(0.14)	(0.22)	(0.13)
TLMTA	4.12***	4.23***	4.12***	4.27***	2.91***	2.99***	2.93***	3.04***
	(5.85)	(5.52)	(5.85)	(5.67)	(4.44)	(4.45)	(4.49)	(4.56)
CASHMTA	-1.60	-0.62	-1.61	-0.61	-2.08	-1.09	-2.08	-1.07
	(-1.22)	(-0.45)	(-1.22)	(-0.45)	(-1.55)	(-0.81)	(-1.53)	(-0.79)
EXRET	-0.40	-0.38	-0.39	-0.37	-0.11	-0.14	-0.09	-0.12
	(-1.57)	(-1.43)	(-1.52)	(-1.37)	(-0.60)	(-0.79)	(-0.47)	(-0.64)
SIGMA	6.34***	6.83***	6.42***	6.96***	8.86***	9.53***	8.87***	9.57***
	(4.37)	(4.37)	(4.43)	(4.47)	(6.47)	(6.91)	(6.47)	(6.95)
SIZE	-0.85***	-0.56***	-0.83***	-0.54***	-0.99***	-0.74***	-0.98***	-0.73***
	(-6.14)	(-3.81)	(-5.98)	(-3.63)	(-6.98)	(-5.08)	(-6.88)	(-5.00)
MB	0.53***	0.46***	0.55***	0.47***	0.56***	0.46***	0.57***	0.46***
	(3.62)	(2.97)	(3.63)	(3.03)	(3.59)	(2.84)	(3.58)	(2.83)
PRICE	-0.44*	-0.61**	-0.45*	-0.62**	-0.09	-0.14	-0.11	-0.15
	(-1.90)	(-2.39)	(-1.93)	(-2.45)	(-0.41)	(-0.60)	(-0.49)	(-0.67)
Corporate Governance Variables								
Log of board size	-0.08	-0.15	-0.18	-0.22	-0.15	-0.03	-0.22	-0.07
	(-0.15)	(-0.28)	(-0.36)	(-0.41)	(-0.33)	(-0.07)	(-0.48)	(-0.16)
Insider director fraction	1.31	1.15	1.39	1.24	1.90**	1.36	1.92**	1.33
	(1.34)	(0.99)	(1.44)	(1.07)	(2.14)	(1.36)	(2.16)	(1.32)
Log of board size*Alternative complexity (=1 if	-0.25**	-0.19			-0.27**	-0.24**		
Herfindahl Index < 50th percentile and 0 otherwise)	(-2.17)	(-1.57)			(-2.46)	(-2.14)		
Insider fraction*Alternative specialty knowledge (=1	-1.74	-1.31			-2.45**	-2.18*		
if patent citation > 50th percentile and 0 otherwise)	(-1.48)	(-1.05)			(-2.21)	(-1.89)		
Log of board size*Alternative complexity (=1 if			-0.29***	-0.27**			-0.31***	-0.31***
Herfindahl Index < 25th percentile and 0 otherwise)			(-2.58)	(-2.16)			(-2.80)	(-2.61)
Insider fraction*Alternative specialty knowledge (=1			-2.94**	-2.73*			-2.58**	-2.34*
if patent citation > 75th percentile and 0 otherwise)			(-2.18)	(-1.81)			(-1.97)	(-1.71)
Female director fraction		-1.55		-1.72		-2.91**		-3.02**
		(-0.99)		(-1.08)		(-1.96)		(-2.00)
CEO/Chairman duality		0.46*		0.46*		0.63***		0.63***
		(1.90)		(1.87)		(2.92)		(2.91)
CEO shareholding (%)		-0.03		-0.03		0.01		0.01
		(-1.32)		(-1.33)		(0.63)		(0.69)
CEO turnover		-0.54*		-0.56*		-0.05		-0.07
		(-1.88)		(-1.94)		(-0.19)		(-0.28)
CEO tenure		-0.07**		-0.07**		-0.07***		-0.07***
		(-2.47)		(-2.49)		(-3.14)		(-3.16)
Log of CEO age		-0.22		-0.19		-0.20		-0.22
		(-0.27)		(-0.23)		(-0.26)		(-0.30)
CEO option value / total compensation		-1.83***		-1.84***		-1.94***		-1.92***
		(-4.11)		(-4.14)		(-4.67)		(-4.63)
Insider shareholding (%)		0.02**		0.02**		0.01		0.01
		(2.53)		(2.51)		(0.94)		(0.95)
Institutional blockholdings (%)		0.02***		0.02***		0.01**		0.01**
		(2.75)		(2.84)		(2.02)		(2.21)
Independent audit committee dummy		-0.66***		-0.65***		-0.73***		-0.73***
		(-2.73)		(-2.66)		(-3.42)		(-3.43)
Intercept	-14.37***	-9.11**	-13.99***	-8.85**	-15.99***	-11.66***	-15.76***	-11.37***
	(-6.03)	(-2.27)	(-5.89)	(-2.27)	(-7.21)	(-3.26)	(-7.10)	(-3.20)
No. of bankruptcies	208	208	208	208	177	177	177	177
No. of healthy firm years	8398	8377	8398	8377	7730	7713	7730	7713
Likelihood ratio test (*p* value)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pseudo R^2	0.567	0.607	0.570	0.610	0.405	0.452	0.406	0.454

Notes: This table presents the parameter estimates from multi-period logit bankruptcy prediction models with alternative measures of complexity and specialty knowledge. LRT is the likelihood ratio test statistics between the reported model and model 2 of Table 3. Refer to Table 1 and Appendix 1 for the variable descriptions. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8. Bankruptcy prediction with matched-pairs sample

	One year prior to bankruptcy				Two years prior to bankruptcy			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Accounting ratios and other firm characteristics								
NIMTA	-5.67**	-6.23**	-5.42*	-5.45	-4.11	-3.52	-2.24	-2.16
	(-2.12)	(-1.96)	(-1.71)	(-1.57)	(-1.48)	(-1.25)	(-0.83)	(-0.69)
TLMTA	3.98***	6.94***	7.39***	7.95***	3.47***	5.69***	5.89***	6.48***
	(3.79)	(5.39)	(5.12)	(4.70)	(3.62)	(4.98)	(4.80)	(4.96)
CASHMTA	-0.46	-1.06	-0.26	1.33	0.06	-0.35	-0.43	-0.65
	(-0.25)	(-0.47)	(-0.11)	(0.50)	(0.03)	(-0.18)	(-0.22)	(-0.29)
EXRET	-0.44	-0.59	-0.51	-0.34	0.08	0.02	-0.14	-0.15
	(-1.32)	(-1.55)	(-1.25)	(-0.81)	(0.29)	(0.06)	(-0.47)	(-0.49)
SIGMA	6.06*	4.78	5.42	4.49	9.12***	7.67**	8.38***	8.08**
	(1.74)	(1.23)	(1.38)	(1.09)	(2.96)	(2.55)	(2.82)	(2.47)
SIZE	-1.00***	-0.73***	-0.70**	-0.26	-0.97***	-0.75***	-0.68***	-0.59**
	(-3.76)	(-2.79)	(-2.25)	(-0.74)	(-4.15)	(-3.14)	(-2.71)	(-2.14)
MB	0.92**	0.92**	1.08***	0.72**	0.67*	0.69*	0.78*	0.61
	(2.51)	(2.49)	(2.77)	(2.03)	(1.69)	(1.83)	(1.89)	(1.51)
PRICE	-0.40	-0.26	-0.39	-0.73	-0.17	-0.13	-0.23	-0.28
	(-1.06)	(-0.69)	(-0.87)	(-1.57)	(-0.45)	(-0.33)	(-0.61)	(-0.68)
Corporate Governance Variables								
Log of board size		0.17	0.58	-0.09		-0.87	-0.40	-0.75
		(0.15)	(0.51)	(-0.07)		(-1.08)	(-0.45)	(-0.84)
Log of board size*complexity dummy		-1.50***	-1.55***	-1.68***		-0.87***	-0.93***	-0.92***
		(-4.19)	(-3.64)	(-3.53)		(-3.47)	(-3.63)	(-3.33)
Insider director fraction		0.66	1.28	0.63		0.34	1.13	0.98
		(0.39)	(0.67)	(0.31)		(0.21)	(0.62)	(0.52)
Insider director fraction*high R&D dummy		0.24	0.29	1.76		1.31	2.82	4.07*
		(0.08)	(0.10)	(0.60)		(0.63)	(1.37)	(1.71)
Female director fraction			-4.21*	-4.11*			-6.54***	-5.04**
			(-1.87)	(-1.79)			(-2.84)	(-1.97)
CEO/Chairman duality			0.69*	0.79**			0.74*	0.92**
			(1.79)	(1.98)			(1.81)	(2.13)
CEO shareholding (%)			-0.03*	-0.08***			0.01	-0.00
			(-1.90)	(-3.64)			(0.61)	(-0.21)
CEO turnover			-0.19	-0.53			0.52	0.47
			(-0.41)	(-1.05)			(1.14)	(1.06)
CEO tenure			-0.04	-0.06			-0.03	-0.03
			(-1.05)	(-1.37)			(-0.98)	(-0.85)
Log of CEO age				0.59				-2.16
				(0.35)				(-1.35)
CEO option value / total compensation				-1.64**				-0.49
				(-2.23)				(-0.86)
Insider shareholding (%)				0.05***				0.02
				(3.46)				(1.38)
Institutional blockholdings (%)				0.01				-0.01
				(1.14)				(-1.14)
Independent audit committee dummy				-0.76*				-0.74**
				(-1.80)				(-2.17)
Intercept	-13.04***	-9.72**	-10.04**	-4.81	-12.63***	-8.09*	-8.50*	2.23
	(-3.70)	(-2.27)	(-2.01)	(-0.51)	(-3.70)	(-1.94)	(-1.86)	(0.25)
No. of bankruptcies	216	216	216	216	185	185	185	185
No. of healthy firm years	216	216	216	216	185	185	185	185
Likelihood ratio test (*p* value)		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01
Pseudo R^2	0.620	0.655	0.672	0.705	0.478	0.512	0.548	0.568

Notes: This table provides the parameter estimates from bankruptcy prediction models using matched pair sampling methods. LRT is the likelihood ratio test statistics between models 1 and 2, and between models 2 and 3. Refer to Table 1 and Appendix 1 for the variable descriptions. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.

Table 9. Endogeneity Test

	One year prior to bankruptcy				Two years prior to bankruptcy			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Accounting ratios & other firm characteristics								
NIMTA	-2.11**	-2.16**	-2.39*	-2.43*	1.97	1.89	3.10*	3.05*
	(-1.97)	(-2.04)	(-1.76)	(-1.74)	(1.60)	(1.55)	(1.69)	(1.65)
TLMTA	5.49***	5.51***	4.88***	4.68***	4.16***	4.13***	5.05***	5.07***
	(5.82)	(5.95)	(4.37)	(4.07)	(4.85)	(4.86)	(4.07)	(4.21)
CASHMTA	-3.21*	-3.01*	-3.21*	-3.28*	-2.36	-2.54	-0.21	-0.28
	(-1.94)	(-1.85)	(-1.75)	(-1.72)	(-1.46)	(-1.53)	(-0.10)	(-0.14)
EXRET	-0.58**	-0.65**	-0.38	-0.39	-0.07	-0.03	-0.52	-0.52
	(-2.04)	(-2.11)	(-1.22)	(-1.24)	(-0.35)	(-0.17)	(-1.21)	(-1.23)
SIGMA	7.44***	7.83***	8.86***	8.57***	8.47***	8.05***	5.89**	5.68**
	(4.49)	(4.87)	(4.54)	(4.38)	(5.47)	(5.16)	(2.45)	(2.35)
SIZE	-0.83***	-0.76***	-0.85***	-0.90***	-0.89***	-0.93***	-0.43**	-0.45**
	(-5.68)	(-5.02)	(-5.15)	(-5.34)	(-6.01)	(-6.19)	(-2.47)	(-2.40)
MB	0.62***	0.62***	0.64***	0.67***	0.70***	0.67***	0.35	0.38
	(3.70)	(3.81)	(3.60)	(3.55)	(4.24)	(4.02)	(1.37)	(1.42)
PRICE	-0.23	-0.25	-0.29	-0.29	-0.26	-0.24	-0.40	-0.41
	(-0.93)	(-1.01)	(-1.06)	(-1.03)	(-1.11)	(-1.02)	(-1.28)	(-1.25)
Corporate Governance Variables								
Log of board size (*t*-1)	0.24	0.33			1.29**	1.22**		
	(0.45)	(0.57)			(2.56)	(2.42)		
Log of board size (*t*-1)*complexity dummy	-1.11***	-1.12***			-0.95***	-0.92***		
	(-4.52)	(-4.50)			(-4.33)	(-4.28)		
Insider fraction (*t*-1)	1.56	1.11			1.07	1.35		
	(1.12)	(0.77)			(0.86)	(1.10)		
Insider fraction (*t*-1)*high R&D dummy	-2.43	-2.27			-2.25	-2.18		
	(-1.35)	(-1.34)			(-1.44)	(-1.38)		
Female director fraction (*t*-1)	0.37	0.48			1.56	1.53		
	(0.24)	(0.31)			(1.15)	(1.15)		
CEO/Chairman duality (*t*-1)	0.57**	0.57**			0.23	0.22		
	(2.18)	(2.16)			(1.01)	(0.95)		
CEO shareholding (%) (*t*-1)	-0.00	-0.01			-0.00	-0.00		
	(-0.22)	(-0.57)			(-0.15)	(-0.17)		
CEO turnover (*t*-1)	0.08	0.10			-0.63*	-0.62*		
	(0.24)	(0.31)			(-1.70)	(-1.69)		
CEO tenure (*t*-1)	-0.03	-0.02			-0.02	-0.02		
	(-1.20)	(-0.99)			(-1.09)	(-0.82)		
Log of CEO age (*t*-1)		-0.23				-0.37		
		(-0.26)				(-0.43)		
CEO option value / total compensation (*t*-1)		-0.65				1.01**		
		(-1.46)				(2.29)		
Insider shareholding (%) (*t*-1)		0.00***				0.00		
		(3.10)				(0.85)		
Institutional blockholdings (%) (*t*-1)		0.01				0.00		
		(1.40)				(0.42)		
Independent audit committee dummy (*t*-1)		-0.29				0.02		
		(-1.12)				(0.08)		
Log of board size (*t*-2)			0.42	0.29			-0.05	-0.25
			(0.75)	(0.50)			(-0.07)	(-0.34)
Log of board size (*t*-2)*complexity dummy			-1.11***	-1.07***			-0.90***	-0.92***
			(-4.03)	(-3.79)			(-2.66)	(-2.72)
Insider fraction (*t*-2)			3.08**	3.53**			-0.60	-0.91
			(2.28)	(2.48)			(-0.28)	(-0.41)
Insider fraction (*t*-2)*high R&D dummy			-4.49**	-4.54**			-0.86	-0.69
			(-2.25)	(-2.27)			(-0.40)	(-0.32)

Female director fraction (*t*-2)			1.22	1.32			-1.91	-1.78
			(0.71)	(0.76)			(-0.91)	(-0.87)
CEO/Chairman duality (*t*-2)			0.39	0.31			-0.16	-0.25
			(1.43)	(1.14)			(-0.50)	(-0.77)
CEO shareholding (%) (*t*-2)			-0.04	-0.02			-0.05	-0.04
			(-1.22)	(-0.44)			(-0.86)	(-0.60)
CEO turnover (*t-2*)			-0.49	-0.58			0.41	0.41
			(-1.35)	(-1.53)			(1.02)	(1.01)
CEO tenure (*t*-2)			-0.05**	-0.05**			-0.05	-0.05*
			(-2.06)	(-2.18)			(-1.54)	(-1.78)
Log of CEO age (*t*-2)				0.95				1.19
				(0.90)				(0.94)
CEO option value / total compensation (*t*-2)				0.56				-0.13
				(1.17)				(-0.23)
Insider shareholding (%) (*t*-2)				-0.02				-0.02
				(-1.54)				(-1.30)
Institutional blockholdings (%) (*t*-2)				-0.00				-0.00
				(-0.35)				(-0.15)
Independent audit committee dummy (*t*-2)				-0.15				-0.66**
				(-0.49)				(-1.98)
Intercept	-14.68***	-12.98***	-15.01***	-19.05***	-16.64***	-16.11***	-8.50***	-12.18**
	(-6.30)	(-3.19)	(-5.98)	(-4.03)	(-7.36)	(-4.05)	(-2.89)	(-2.16)
No. of bankruptcies	167	167	115		112	112		53
No. of healthy firm years	7,561	7,561	7,561		6,215	6,215		6,215
Likelihood ratio test (*p* value)		<0.01				<0.01		
Pseudo R^2	0.566	0.570	0.540		0.361	0.371		0.283

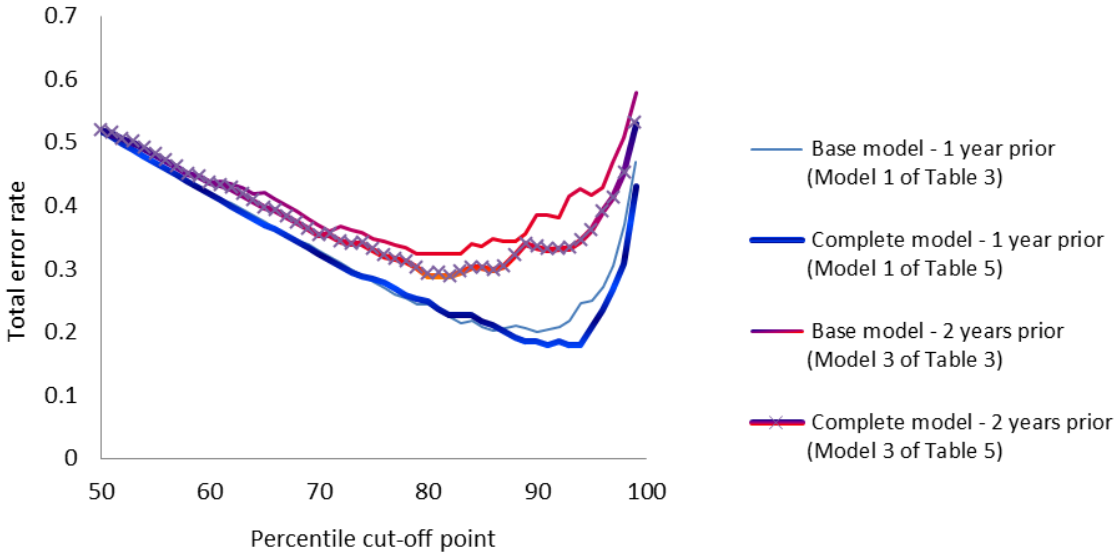
Notes: This table provides the parameter estimates from various bankruptcy prediction models using lagged corporate governance variables. LRT is the likelihood ratio test statistics between models 1 and 2, and between models 2 and 3. Refer to Table 1 and Appendix 1 for the variable descriptions. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.

Table 10. Results from Logit Regressions on Principal Components Factors

	One year prior to bankruptcy		Two years prior to bankruptcy		Three years prior to bankruptcy	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	-5.37***	-5.46***	-4.60***	-4.74***	-4.52***	-4.70***
	(-36.50)	(-34.80)	(-41.32)	(-38.87)	(-40.70)	(-36.75)
Accounting Factor	-1.73***	-1.69***	-1.30***	-1.25***	-1.04***	-0.98***
	(-22.78)	(-21.61)	(-18.98)	(-17.54)	(-15.14)	(-13.26)
Corporate Governance Factor		-0.38***		-0.47***		-0.51***
		(-4.38)		(-6.32)		(-6.33)
No. of bankrupt firms	217	217	186	186	130	130
No. of non-bankrupt firms	9100	9100	8358	8358	7428	7428
Likelihood ratio test (*p* value)		<0.01		<0.01		<0.01
Accuracy ratio	0.454	0.464	0.242	0.265	0.142	0.174
Pseudo R^2	0.948	0.951	0.880	0.890	0.835	0.843

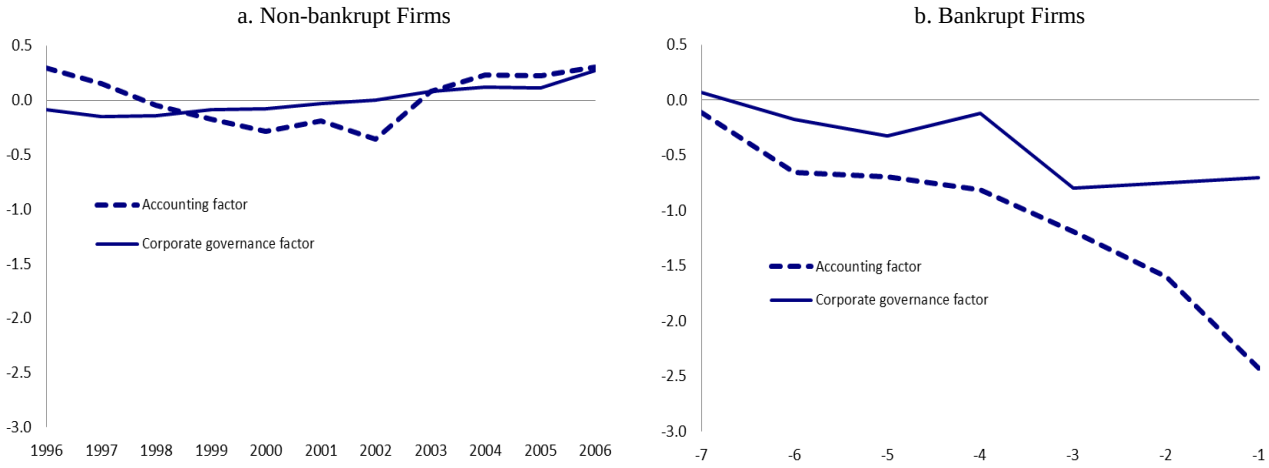
Notes: This table presents the parameter estimates from logit regression on principal components factors. LRT represents the likelihood ratio test statistics between Models 1 and 2. The Accuracy Ratio measures the model ability to discriminate between bankrupt and healthy firms with a higher score indicating improved predictive ability. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). *** indicates statistical significance at the 1% level.

Figure 1. Bankruptcy Classification Rates



Notes: This figure plots the incidence of Type I errors (classifying a bankrupt firm as healthy) and Type II errors (classifying a healthy firm as bankrupt) according to model scores. Model bankruptcy probabilities are ranked from lowest to highest. For a given percentile, we report the frequency of Type I and Type II errors. For example, at the 50th percentile we consider the incidence of Type I and Type II errors if all observations with a model bankruptcy probability above the 50th percentile are classified as bankrupt and all others are classified as healthy. The horizontal axis presents the cut-off point while the vertical axis presents the sum of Type I and Type II errors.

Figure 2. Results from principal components analysis



Notes: This figure plots the average (across firms) of the principal components factors over time. Panel (a) plots the average factors for all non-bankrupt firms while Panel (b) does the same for all bankrupt firms. In Panel (a), the horizontal axis represents the actual year of data. In Panel (b), the horizontal axis represents the year relative to filing for bankruptcy.

Appendix 1. Hypotheses, Variables and Measurements

Variable	Measurement	Source	Hypothesized sign
	Accounting and market-based variables		
1) Profitability: The more profitable the firm, the lower the probability of bankruptcy			
	NIMTA (Net income/Market value of total assets)	Compustat	Negative
2) Liquidity: The more liquid the firm, the lower the probability of bankruptcy			
	CASHMTA (Cash and short-term assets/Market value of total assets)	Compustat	Negative
3) Leverage: The more leveraged the firm, the higher the probability of bankruptcy			
	TLMTA (Total liabilities/Market value of total assets)	Compustat	Positive
4) Volatility: The more volatile the firm, the higher the probability of bankruptcy			
	SIGMA (Standard deviation of the residual derived from regressing monthly stock return on market return in year *t*)	CRSP	Positive
5) Past excess return : The larger the past excess return, the lower the probability of bankruptcy			
	EXRET (Cumulative annual return in year *t* minus the value-weighted CRSP NYSE/AMEX return in year *t*)	CRSP	Negative
6) Firm size: The larger the firm, the lower the probability of bankruptcy			
	SIZE (Log of the ratio of firm's market capitalization to the total market capitalization of all firms)	CRSP, Compustat	Negative
	PRICE (Log of stock price at the end of fiscal year)	CRSP	Negative
7) Market to book ratio: It captures the relative value placed on the firm's equity by stockholders and by accountants.			
	MB (Market value equity to book value equity)	CRSP, Compustat	Positive
	Main hypotheses		
H1: Other things being equal, complex (simple) firms are more likely to fail if they have smaller (larger) boards			
	Log(Board Size); Complexity Dummy	IRRC, Proxy statements	Negative for simple firms; Positive for complex firms
H2: Other things being equal, firms whose operations require more (less) specialist knowledge are more likely to fail if they have a smaller (greater) proportion of inside directors			
	Insider director fraction; R&D intensity	IRRC, Proxy statements, Annual reports	Negative for technically unsophisticated firms, Positive for technically sophisticated firms
	Other corporate governance controls		
	Female director proportion	IRRC, Proxy statements	Negative
	CEO serves as Chairman simultaneously	Proxy statements	Positive
	The percentage of CEO ownership	Thomson Reuters	Positive
	Turnover of CEO in previous three years (dummy variable)	Proxy statements	Negative
	Tenure of CEO (years)	Proxy statements	Uncertain
	CEO age	Compustat, Risk Metrics, Proxy statements, Annual reports	Negative
	CEO option value / total compensation	Compustat, Proxy statements	Negative
	Insider shareholding (%)	Compustat, Risk Metrics, Proxy statements, Annual reports	Negative
	Institutional blockholdings (%)	Thomson Reuters, Annual report	Negative
	Independent audit committee dummy	Risk Metrics, Proxy statements, Annual reports	Negative

Appendix 2. Controlling for year-fixed and industry-fixed effects

	One year prior to bankruptcy				Two years prior to bankruptcy			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Accounting ratios and other firm characteristics								
NIMTA	-2.14**	-2.11**	-2.22**	-2.28**	-0.17	-0.17	-0.15	-0.19
	(-2.19)	(-2.12)	(-2.23)	(-2.25)	(-0.16)	(-0.16)	(-0.15)	(-0.17)
TLMTA	4.15***	5.74***	5.65***	5.81***	3.11***	4.46***	4.27***	4.52***
	(5.97)	(7.12)	(7.17)	(7.07)	(4.94)	(5.87)	(5.57)	(5.99)
CASHMTA	-1.45	-2.18	-2.03	-1.50	-1.12	-1.69	-1.71	-1.37
	(-1.08)	(-1.56)	(-1.47)	(-1.05)	(-0.87)	(-1.24)	(-1.33)	(-0.99)
EXRET	-0.37	-0.31	-0.31	-0.32	0.20	0.21	0.19	0.14
	(-1.32)	(-1.15)	(-1.14)	(-1.13)	(1.14)	(1.24)	(1.14)	(0.83)
SIGMA	6.17***	5.86***	5.79***	6.26***	8.33***	8.01***	8.28***	8.62***
	(4.14)	(3.96)	(3.81)	(3.88)	(5.69)	(5.42)	(5.73)	(5.77)
SIZE	-0.90***	-0.70***	-0.70***	-0.42***	-1.01***	-0.82***	-0.81***	-0.56***
	(-6.31)	(-4.81)	(-4.60)	(-2.76)	(-6.74)	(-5.31)	(-5.06)	(-3.52)
MB	0.57***	0.68***	0.63***	0.62***	0.58***	0.66***	0.58***	0.53***
	(4.15)	(4.73)	(4.37)	(3.86)	(3.93)	(4.41)	(3.67)	(3.34)
PRICE	-0.46*	-0.52**	-0.53**	-0.71***	-0.15	-0.23	-0.22	-0.30
	(-1.93)	(-2.13)	(-2.20)	(-2.76)	(-0.65)	(-1.00)	(-0.92)	(-1.27)
Corporate Governance Variables								
Log of board size		0.17	0.44	0.39		0.06	0.43	0.40
		(0.32)	(0.81)	(0.68)		(0.13)	(0.87)	(0.79)
Log of board size*complexity dummy		-0.94***	-0.92***	-0.97***		-0.71***	-0.72***	-0.76***
		(-4.41)	(-4.22)	(-4.19)		(-3.86)	(-3.86)	(-3.92)
Insider director fraction		1.14	1.87*	1.36		1.56*	1.96**	1.56*
		(1.10)	(1.65)	(1.12)		(1.92)	(2.20)	(1.70)
Insider director fraction*high R&D dummy		-2.90**	-3.13**	-2.30*		-3.00**	-2.91**	-2.30*
		(-2.03)	(-2.23)	(-1.71)		(-2.17)	(-2.05)	(-1.78)
Female director fraction			-1.87	-1.90			-2.12	-2.42
			(-1.20)	(-1.19)			(-1.37)	(-1.63)
CEO/Chairman duality			0.53**	0.53**			0.60***	0.67***
			(2.18)	(2.18)			(2.81)	(3.21)
CEO shareholding (%)			0.00	-0.01			0.02	0.01
			(0.35)	(-0.84)			(1.48)	(0.60)
CEO turnover			-0.50*	-0.45			-0.12	-0.05
			(-1.80)	(-1.53)			(-0.47)	(-0.18)
CEO tenure			-0.08***	-0.08***			-0.07***	-0.07***
			(-3.06)	(-2.87)			(-3.30)	(-3.37)
Log of CEO age				-0.06				-0.05
				(-0.08)				(-0.07)
CEO option value / total compensation				-1.76***				-1.88***
				(-4.04)				(-4.71)
Insider shareholding (%)				0.02*				0.01
				(1.87)				(1.17)
Institutional blockholdings (%)				0.03***				0.02***
				(3.34)				(2.98)
Independent audit committee dummy				-0.40				-0.42*
				(-1.54)				(-1.86)
Intercept	-14.20***	-11.90***	-12.26***	-8.38**	-15.04***	-12.85***	-13.45***	-10.27***
	(-6.72)	(-4.89)	(-4.90)	(-2.10)	(-7.49)	(-5.54)	(-5.52)	(-2.78)
Year-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of bankruptcies	217	217	217	216	186	186	186	186
No. of healthy firm years	9100	9100	9100	9079	8358	8358	8358	8340
Likelihood ratio test (*p* value)		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01
Pseudo R^2	0.576	0.591	0.601	0.630	0.423	0.440	0.455	0.481

Notes: This table presents the parameter estimates from multi-period logit bankruptcy prediction models that control for year-fixed and industry-fixed effects. LRT is the likelihood ratio test statistics between the reported model and model 2 of Table 3. Refer to Table 1 and Appendix 1 for the variable descriptions. The *t*-values reported in parentheses are based on robust standard errors adjusted for clustering at the six-digit CNUM code (firm ID from CRSP). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

[1] We wish to thank Bharat Sarath (the editor) for alerting us to this important aspect of our theoretical analysis.

[2] We also restrict the board composition data with directors serving more than 6 months within the fiscal year. The results (available upon request) are qualitatively similar.

[3] Our results remain essentially the same if we exclude firms with a SIC code from 4900 to 4999 (regulated industries).

[4] We miss one observation when testing the complete set of corporate governance variables.

[5] The results are qualitatively similar when we account for year and industry effects in our empirical models. Appendix 2 reports these alternative results.

[6] The Pseudo and ROC curves are widely used in the bankruptcy prediction literature. See, for example, Chava and Jarrow (2004) and Agarwal and Taffler (2008).

[7] One might argue that creditor control could also be associated with bankruptcy risk. Parker et al. (2002) measure two proxies including creditor ownership and the presence of a troubled debt restructuring. Their results indicate that these two variables are not significantly related to the survival likelihood of distressed firms.

[8] We further interact firm complexity and need for specialty knowledge and find that the negative effects of CEO turnover and CEO tenure are stronger when firms are more complex and need more specialty knowledge. Detailed results are available from the authors upon request.

[9] One possible reason for the positive relationship between institutional blockholding and bankruptcy risk, which is inconsistent with our expectation, is that bankrupt firms tend to be smaller and the percentage of shares owned by institutional blockholders are relatively high.

[10] We further test the models using various alternative cutoffs and find that the results continue to hold.

[11] Number of citations per patent applied for in year t by firm i with citations of each patent adjusted for truncation bias following Hall, Jaffe, and Trajtenberg (2001). We scale citations of a given patent by the average number of citations received by all patents in that year in the same technological class as the patent.

[12] Alternatively, we retest the model by assuming no effect of firm's financial status on CEO turnover or corporate governance variables. Thus, we restrict the sample to be without any CEO turnover between year *t*-2 to *t* or to have no change in other corporate governance variables. The regressions results from these additional sub-samples do not alter our conclusions deduced from Table 9.