The Influence of Board Structure on Firm Performance

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ABSTRACT

This study examines the influence of board structure on firm performance. The results not only provide strong empirical evidence, which is in contrast with the common notions that small board size is better and that board composition is uncorrelated with firm performance, but also explain the internal tradeoff within the board—a matter that is not settled in literature. We argue and find that complicated and simple firms have dramatically different needs for performance-enhancing board structure. Although large boards suffer from cumbersome communication and decision-making problems, they benefit firms via providing more advisory functions. The benefits outweigh the costs in the complicated firms. Furthermore, excessively independent boards may cause over-monitoring problem, which undermine board effectiveness.

Keywords: Corporate governance, Firm performance, Board size, Diversification, Firm size

INTRODUCTION

Board size and its impact on firms is one of the most debated issues in corporate governance. Yermack (1996), most influentially, concludes the results on the relation between board size and firm performance. He provides strong empirical evidence for the notion that smaller boards are better boards. However, we argue that board size varies across firms to accommodate the specific characteristics of the firm. Large, diversified, and leveraged firms may have more advisory needs. According to the scope of operations hypothesis of Boone et al. (2007), in addition to monitoring purpose the firms growing into new product lines or new geographic territory have more needs for new directors with specialized knowledge applying to the new growth areas. Furthermore, Coles et al. (2008) argue that leveraged firms depend on external resources to a greater extent and have greater advisory needs for directors with financial expertise to facilitate access to external finance. Therefore, board size is a tradeoff between costs and benefits. In the one hand, larger board size may suffer from impaired coordination and communication problems and thus influence board effectiveness (Lipton and Lorsch, 1992; Guest, 2008, 2009). Further, larger board size also may reduce the board’s ability to oppose the control of top managers due to less candid discussion of managerial performance (Jensen, 1993; Eisenberg et al., 1998). In the other hand, larger boards may benefit firms by offering better advice, which comes from directors’ knowledge, expertise, experience, or their external links (Booth and Deli, 1999; Agrawal and Knoeber, 2001; Carpenter and Westphal, 2001; Güner et al., 2008). Therefore, the prior studies actually yield inconclusive arguments about the board size that facilitates board effectiveness to enhance firm performance.

Accordingly, we examine the relation between board size and firm performance: Namely, what types of firms should have larger board size and what types of firms should have smaller board size? We argue that to improve firm performance, complicated firms—defined by large firm size, high
diversification, and high leverage—should have larger boards, and the other firms, which are termed simple firms, should have smaller boards. Therefore, the argument leads to the following hypotheses: Hypothesis 1: For complicated firms, there is a positive association between board size and firm performance. Hypothesis 2: For simple firms, there is an inverse association between board size and firm performance. In addition to board size, we also take into account the relation between board composition and firm performance for two purposes: (a) to control the board composition effect when we explore how board size affects firm performance and (b) to shed more light on board structure which includes both board size and board composition. We argue that excessively independent boards may be detrimental to firms due to the over-monitoring problem.

DATA

We obtain our sample of 2,310 firm-year observations from RiskMetrics (formerly Investor Responsibility Research Center) and COPUSTAT between 1996 and 2006. We start with firms from the entire RiskMetrics database for board structure variables (board size and outsider fraction); then calculate firm performance and firm characteristic variables (Tobin’s Q, business segments, R&D intensity, firm size, leverage, return on assets [ROA], intangible assets, and free cash flow) from COMPUSTAT. Among firm characteristic variables, business segments are calculated from Compustat Segments tape; the other variables come from Compustat Industrial Annual tape. We merge the two data sources and trim the data with a criterion of complete data throughout the sample period for each firm. Therefore, the data set is a complete balanced panel data over the time period form 1996 to 2006 on firms.

Table 1 reports descriptive statistics for all firms on firm performance, board structure, and firm characteristic variables. The proxy variable for firm performance is Tobin’s Q (the book value of total assets minus the book value of common equity plus the market value of common equity, all divided by the book value of total assets). The proxy is commonly used in empirical studies for firm performance (e.g., Yermack, 1996; Andrés and Vallelado, 2008; Dahya et al., 2008). The descriptive statistics of the board structure variables are similar to those in Farrell and Hersch (2005), Brick and Chidambaran (2010), and Duchin et al. (2010). Table 1 also provides statistics on firm characteristic variables. Among them, the median firm size, which is measured as the log of sales ($million), is 7.8438. The descriptive statistics for leverage and ROA are close to those in Brick and Chidambaran (2010) where leverage is the ratio of book value of total debt to book value of total assets; ROA is the ratio of operating income before interest expense, taxes, and depreciation to book value of total assets. The intangible assets and free cash flow are defined as 1 minus the ratio of net property, plant, and equipment to book value of total assets and the ratio of operating cash flow less preferred and common equity dividend payments to the book value of total assets, respectively.

The table reports descriptive statistics, mean, median, standard deviation, the first quartile, and the third quartile values, for all firm performance, board structure, and firm characteristic variables where firm performance variable is measured by Tobin’s Q. The balanced panel data set consists of 2,310 firm-year observations over the time period 1996~2006 from RiskMetrics (formerly Investor Responsibility Research Center) and COMPUSTAT. Board structure variables are from RiskMetrics and firm characteristic variables are from COMPUSTAT (Business segments are calculated from Compustat Segments tape; the other variables are from Compustat Industrial Annual tape). Board structure variables include board size and outsider fraction. Firm characteristic variables include number of business
segments, R&D intensity, firm size, leverage, return on assets (ROA), intangible assets, and free cash flow.

Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobin’s Q</td>
<td>2.2953</td>
<td>1.8136</td>
<td>1.5576</td>
<td>1.3699</td>
<td>2.6154</td>
</tr>
<tr>
<td>Board size</td>
<td>9.9009</td>
<td>10.0</td>
<td>2.3993</td>
<td>8.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Outsiders</td>
<td>6.8693</td>
<td>7.0</td>
<td>2.4103</td>
<td>5.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Insiders</td>
<td>3.0316</td>
<td>3.0</td>
<td>1.7937</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Outsider fraction</td>
<td>0.6894</td>
<td>0.7273</td>
<td>0.1693</td>
<td>0.5714</td>
<td>0.8182</td>
</tr>
<tr>
<td>Business segments</td>
<td>3.0558</td>
<td>3.0</td>
<td>1.8408</td>
<td>1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>0.0428</td>
<td>0.0256</td>
<td>0.0505</td>
<td>0.0065</td>
<td>0.0581</td>
</tr>
<tr>
<td>Firm size</td>
<td>7.9798</td>
<td>7.8438</td>
<td>1.3697</td>
<td>7.0180</td>
<td>8.9127</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.2077</td>
<td>0.2087</td>
<td>0.1403</td>
<td>0.1027</td>
<td>0.3005</td>
</tr>
<tr>
<td>ROA</td>
<td>0.1601</td>
<td>0.1539</td>
<td>0.0777</td>
<td>0.1096</td>
<td>0.2013</td>
</tr>
<tr>
<td>Intangible assets</td>
<td>0.7144</td>
<td>0.7441</td>
<td>0.1685</td>
<td>0.6190</td>
<td>0.8444</td>
</tr>
<tr>
<td>Free cash flow</td>
<td>0.0987</td>
<td>0.0899</td>
<td>0.0712</td>
<td>0.0558</td>
<td>0.1306</td>
</tr>
</tbody>
</table>

MODEL SPECIFICATION

We conduct both linear and nonlinear regressions to test our hypotheses. The linear full model’s specification is:

\[
Tobin’s \ Q = \beta_0 + \beta_1 \text{BOARD\_SIZE} + \beta_2 \text{BOARD\_SIZE} \times \text{COMPLICATED} + \beta_3 \text{OUTSIDER} + \beta_4 \text{COMPLICATED} + \beta_5 \text{FIRM\_SIZE} + \beta_6 \text{LEVERAGE} + \beta_7 \text{DIV} + \beta_8 \text{R&D} + \beta_9 \text{ROA} + \beta_{10} \text{INTANGIBLE\_ASSETS} + \beta_{11} \text{FREE\_CASH\_FLOW} + \epsilon, \tag{1}
\]

where the dependent variable, Tobin’s \( Q \), is a proxy for firm performance. The continuous explanatory variables include \text{BOARD\_SIZE} (board size), \text{OUTSIDER} (outsider fraction), \text{FIRM\_SIZE} [\log(\text{sales})], \text{LEVERAGE}, \text{ROA}, \text{INTANGIBLE\_ASSETS}, and \text{FREE\_CASH\_FLOW}. The dummy explanatory variables are \text{COMPLICATED}, which indicates complicated firms, \text{DIV}, which indicates diversified firms, and \text{R&D}, which indicates R&D-intensive firms. \text{COMPLICATED} equals one if all levels of firm size, leverage, and diversification, proxied by the log of sales, total debt to total assets ratio, and the number of business segments respectively, are greater than their medians, and zero otherwise. Analogically, \text{DIV} (R&D) equals one if the level of diversification (R&D intensity) is greater than the median, and zero otherwise.

The nonlinear full model has a similar specification as the linear full model but adds supplementary variables to capture additional curvature effects:

\[
Tobin’s \ Q = \beta_0 + \beta_1 \text{BOARD\_SIZE} + \beta_2 \text{BOARD\_SIZE} \times \text{COMPLICATED} + \beta_3 \text{OUTSIDER} + \delta_1 (\text{BOARD\_SIZE} - \text{mean(BOARD\_SIZE)})^2 + \delta_2 (\text{OUTSIDER} - \text{mean(OUTSIDER)})^2 + \gamma (\text{COMPLICATED} - \text{mean(COMPLICATED)})^2 + \beta_4 \text{COMPLICATED} + \beta_5 \text{FIRM\_SIZE} + \beta_6 \text{LEVERAGE} + \beta_7 \text{DIV} + \beta_8 \text{R&D} + \beta_9 \text{ROA} + \beta_{10} \text{INTANGIBLE\_ASSETS} + \beta_{11} \text{FREE\_CASH\_FLOW} + \epsilon, \tag{2}
\]

where \( \delta_1 \) and \( \delta_2 \) capture additional curvature effects of \text{BOARD\_SIZE} for simple firms and complicated firms, respectively. \( \gamma \) captures additional curvature effects of \text{OUTSIDER}. 

ANALYSIS RESULTS

We now examine relations between board size and firm performance for simple firms and for complicated firms. The main explanatory variables are \( BOARD_SIZE \) and \( BOARD_SIZE \times COMPLICATED \). For clarity, we simplify the expression for the linear full model as follows:

\[
Tobin's\ Q = \beta_0 + \beta_1 \cdot BOARD_SIZE + \beta_2 \cdot BOARD_SIZE \times COMPLICATED + \beta_3 \cdot OUTSIDER \\
+ \beta_4 \cdot COMPLICATED + \text{Other control variables} + \varepsilon, \tag{3}
\]

where \( \beta_1 \) captures the board size effect for simple firms, and \( \beta_2 \) is the incremental board size effect for complicated firms (large firm size, high leverage, and high diversification). Hence, \( \beta_1 + \beta_2 \) is the total board size effect for complicated firms. According to our hypothesis for simple firms, \( \beta_1 \) should be significantly negative and for complicated firms, both \( \beta_2 \) and \( \beta_1 + \beta_2 \) should be significantly positive.

The linear regression results in Table 2 are consistent with our hypotheses. The results show that for simple firms, Tobin’s Q increases significantly as the board size decreases (\( \beta_1 < 0, \ p\text{-value} < 0.01 \)). For complicated firms, Tobin’s Q increases significantly as the board size increases (\( \beta_2 > 0, \ p\text{-value} < 0.01 \) and \( \beta_1 + \beta_2 > 0, \ p\text{-value} < 0.01 \)). The nonlinear regression results in Table 2 also provide support for our hypotheses. The signs and absolute effects of all coefficients are the same and robust, respectively. The findings are compatible with those in Yermack (1996) and Coles et al. (2008).

Furthermore, in Table 2 we find evidence of an adverse outsider effect where Tobin’s Q decreases as the outsider fraction increases (\( \beta_3 < 0 \)). The result indicates that firms may suffer from the over-monitoring problem due to excessively independent boards, which also cause inefficient advisory functions from lack of advice from inside directors and inhibits firms from obtaining higher performance.

This table reports the quantitative estimation of the linear and nonlinear relationships between board structure and firm performance (measured as Tobin’s Q) where the nonlinear estimation including the curvature effects of board structure. The dependent variable is the Tobin’s Q. The corresponding main explanatory variables of our hypotheses regarding the relations between board size and firm performance are \( BOARD_SIZE \) and \( BOARD_SIZE \times COMPLICATED \); the corresponding coefficients are \( \beta_1 \) and \( \beta_2 \). The linear full model presents the central results with controlling firm type for board structure. The nonlinear full model is presented for the following graphic illustrations. Standard errors for the corresponding coefficient estimates are presented in parentheses. ***, **, and * denote significance levels at the 1%, 5%, and 10%, respectively.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Linear full model</th>
<th>Nonlinear full model</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_0 ) INTERCEPT</td>
<td>-0.3052 ( \text{(0.2433)} )</td>
<td>-0.6208 ** ( \text{(0.2797)} )</td>
</tr>
<tr>
<td>( \beta_1 ) BOARD_SIZE</td>
<td>-0.0634 *** ( \text{(0.0145)} )</td>
<td>-0.0560 *** ( \text{(0.0146)} )</td>
</tr>
<tr>
<td>( \beta_2 ) BOARD_SIZE \times COMPLICATED</td>
<td>0.0874 *** ( \text{(0.0253)} )</td>
<td>0.0808 ** ( \text{(0.0387)} )</td>
</tr>
<tr>
<td>( \beta_3 ) OUTSIDER</td>
<td>-0.4359 ** ( \text{(0.1999)} )</td>
<td>-0.2199 ** ( \text{(0.2558)} )</td>
</tr>
<tr>
<td>( \delta_1 ) ( (BOARD_SIZE-\text{mean(BOARD_SIZE)})^2 )</td>
<td>0.0189 *** ( \text{(0.0039)} )</td>
<td></td>
</tr>
</tbody>
</table>
\[ \delta_2 (\text{BOARD\_SIZE} - \text{mean(BOARD\_SIZE)})^2 \times \text{COMPLICATED} \quad -0.0194^{***} \]
\[ \gamma (\text{OUTSIDER} - \text{mean(OUTSIDER)})^2 \quad 0.8312 \]
\[ \beta_4 \text{COMPLICATED} \quad -1.0033^{***} \quad -0.8660^{**} \]
\[ \beta_5 \text{FIRM\_SIZE} \quad 0.1084^{***} \quad 0.1084^{***} \]
\[ \beta_6 \text{LEVERAGE} \quad -1.5127^{***} \quad -1.4728^{***} \]
\[ \beta_7 \text{DIV} \quad -0.7084^{***} \quad -0.5801^{**} \]
\[ \beta_8 \text{R\&D} \quad 1.1535^{***} \quad 1.4182^{***} \]
\[ \beta_9 \text{ROA} \quad 10.2148^{***} \quad 10.1319^{***} \]
\[ \beta_{10} \text{INTANGIBLE\_ASSETS} \quad 1.3389^{***} \quad 1.3334^{***} \]
\[ \beta_{11} \text{FREE\_CASH\_FLOW} \quad 1.4619^{***} \quad 1.4324^{***} \]

Adjusted R\(^2\) 0.4899 0.4955
Number of observations 2,310 2,310
Model p-value <0.01 <0.01

Figure 1 illustrates the patterns between board size and firm performance by type of firms. The overall nonlinear pattern is plotted via the nonlinear full model of Table 2. In order to present our multivariate regression results in a two-dimensional plot, we hold control variables at means of their own firm type (complicated firms or simple firms) where the control variable are the variables other than the main variables, BOARD\_SIZE and BOARD\_SIZE \( \times \) COMPLICATED, and the corresponding curvature variables. As demonstrated in the overall nonlinear pattern, we can more intuitively observe that firm performance decreases with board size for simple firms but increases with board size for complicated firms.
Figure 1: The Overall Pattern between Board Size and Firm Performance by Firm Type

Notes: This figure presents the graphic illustration for the overall pattern between board size (along the X-axis) and firm performance measured as Tobin’s Q (along the Y-axis) by different types of firms: all firms, complicated firms, and simple firms. The pattern of all firms is the base line. The overall nonlinear pattern of complicated firms and simple firms are the focus of this study, which are plotted via the nonlinear full model of Table 2, where—except for the main variables, BOARD_SIZE and BOARD_SIZE \times COMPLICATED, and the corresponding curvature variables—the control variables are held at means of their own firm type.

On the whole, our findings shed more light than the literature on efficient board structure including board size and board composition. The results provide strong empirical evidence, which is in contrast to the common notions that small board size is always better and that board composition is uncorrelated with firm performance.

Finally, we examine firms’ self-selection in the market. Generally, firms’ self-selection of board size for pursuing better performance in the market is in the right direction (although it is not always optimal). The results in Table 3 show that complicated firms choose a larger board size than simple firms (both t test and Wilcoxon rank sum test are significant, \( p\)-value<0.01). Market self-selection indicates that firms choose different kinds of board size to meet their unique needs.
This table reports firm self-selection for board size in the market for each firm type. In the table, simple firms are used as the base to examine whether complicated firms self-select in the correct direction to pursue higher firm performance. \( t \) test and Wilcoxon rank sum test results are also reported.

<table>
<thead>
<tr>
<th>Firm type</th>
<th>Mean</th>
<th>Median</th>
<th>( t ) test</th>
<th>Rank sum test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated firms</td>
<td>11.4605</td>
<td>11</td>
<td>16.6196</td>
<td>647,095.0</td>
</tr>
<tr>
<td>Simple firms</td>
<td>9.4777</td>
<td>9</td>
<td>(&lt;0.01)</td>
<td>(&lt;0.01)</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Overall, the results fully support our hypotheses and contribute to the literature on board structure and firm performance. The results provide an explanation for the internal tradeoff within the board—a matter that is not settled in the literature and, therefore, the main contribution of this paper. Through the examination of the relations between board structure and firm performance, we can discern what the number and balance of outside and inside directors are suitable—based on characteristics of the firms in which the directors serve—to create higher firm performance for each type of firm under review.

Several avenues remain open for future research. First, the relations between board structure and variability of firm performance can extend several research lines. We argue that the effective board structure is valuable for enhancing firm performance as well as for enhancing stability of firm performance. For example, Cheng (2008) shows that firms with larger boards have less variability in firm performance. The results indicate that board size is negatively associated with the variability of Tobin’s Q, monthly stock returns, annual accounting ROA, and so on. These research findings in board size layer might be extended to board structure layer to include board composition and other board characteristic variables in the future. Furthermore, to investigate whether dual monitoring and advisory roles of boards play an important part in related issues is also an interesting research line (Adams and Ferreira, 2007; Linck et al., 2008; Pathan and Skully, 2010).

**REFERENCES**


