

EFFECTS OF FIRM COMPLEXITY ON THE ADAPTION OF BOARD STRUCTURE: EVIDENCE FROM U.S. ELECTRIC UTILITIES FOLLOWING DEREGULATION

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Abstract

This paper examines the adaptation of board structure in U.S. electric utilities following deregulation, with a new focus on the impact of changes in firm complexity resulting from deregulation. A comparative static approach is used to evaluate changes in the board structure of 92 electric utilities in both pre- and post-deregulation periods. Post-deregulation changes in board size and the number of outside directors are positively related to changes in the complexity of a firm's operations. These results have an offsetting impact to the overall result of decreased board size after deregulation. Board size is significantly reduced for electric utilities

that do not become more complex after deregulation, with fewer outside and inside directors serving on these boards. By contrast, board size does not change for electric utilities that become more complex following deregulation; there are more outsiders but fewer inside directors on these boards after deregulation. We conclude that electric utility boards adapt to deregulation by accommodating for changes in firm complexity in addition to other effects induced by deregulation.

Keywords: Board of Directors, Outside Directors, Board Size, Corporate Governance, Deregulation, Electric Utilities

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INTRODUCTION

Much of the corporate governance literature is based on a Darwinian view of organizations. One implication of this view is that firm survival is dependent on the adaption of the firm's corporate governance structure in response to changes in the business environment. To date, a number of researchers have examined this implication by studying the evolution of corporate governance mechanisms in airlines, banks and electric utilities following deregulation. The results show that after deregulation 1) equity ownership of outside shareholders and managers is more concentrated, 2) executive incentive compensation increases, and 3) board size decreases (Crawford, Ezzell, and Miles, 1995; Hubbard and Palia, 1995; Bryan, Hwang, and Lilien, 2005; Kole and Lehn 1999; Rennie, 2006): in other words, a change in operating environment results in a change in governance structure. In our paper we delve more deeply into the offsetting factors that drive changes in board size and structure following deregulation. In particular, we assess the impact of post deregulation changes in firm complexity on changes in board size and the number of outside directors.

We chose to evaluate changes in board size following deregulation in light of recent literature that emphasizes the tradeoffs between larger

and smaller boards as well as the dual role of boards, to monitor and to advise. In the deregulation literature, authors have focused on the board's monitoring role. The prevailing interpretation of post deregulation changes in board size has been that deregulation raises the incremental costs associated with additional directors (i.e., a larger board) but has little effect on the corresponding incremental monitoring benefits (Kole and Lehn, 1999), which would imply that *ceteris paribus* deregulation would result in a smaller board. However, recent findings on board determinants identify another factor that impacts board size. Coles, Daniel and Naveen (2008), Boone, Field, Karpoff, and Raheja (2007) and Linck, Netter, and Yang (2008) find that boards are expanded and outside directors added as complexity of the firm's operations increases. Accordingly, firm complexity has been shown to be positively related to the incremental benefits associated with additional directors, and these benefits include not only monitoring but also advising. This raises intriguing, unexplored research questions concerning board adaptation following deregulation: How does firm complexity affect the evolution of boards of directors following deregulation? Could large, positive changes in firm complexity after deregulation (such as increases in firm size, scope of operations, geographic reach and reliance on debt financing) tilt the decision on board size in favor expansion rather than contraction?

In this study, we examine these research questions using a sample of electric utilities following partial deregulation of the industry. Our intuition is straightforward: if deregulation makes it possible to increase the complexity of electric utilities, and if some become more complex while others do not, then utility boards should follow a more nuanced evolutionary path after deregulation than the one currently documented in the existing literature. More specifically, depending on the extent of the changes in firm complexity, it is plausible that some boards could contract while others could either expand or stay unchanged after deregulation.

We use a comparative static approach to conduct the analysis. The objective is to identify two disparate regulatory regimes: a snapshot

before deregulation and another after deregulation. Consistent with Coles et al. (2008), we use factor analysis to measure changes in complexity by aggregating the over time changes in firm size, debt, scale and scope of the firm's operations. The sample consists of 1052 firm-year observations from 92 publicly-owned electric utilities over the period 1989-2000. We use annual data from 1989-1992 to create a before-deregulation "equilibrium" snapshot for each sample firm. When possible we use up to eight years of data from 1993-2000 to calibrate the post-deregulation snapshot. Incremental change is defined as the change between the two equilibrium snapshots.

Consistent with the extant literature, we find a significant reduction in overall board size following deregulation; however, this overall outcome masks sizeable differences between utilities that become more complex and those that do not. Board size declines significantly for electric utilities that become less complex or exhibit little change in complexity. By contrast, board size remains largely unchanged for utilities that become substantially more complex; moreover, significantly more outside directors serve on these boards in the post-deregulation period. Our univariate results are reinforced by multivariate regressions that control for variables such as lagged board size, CEO tenure, board ownership, firm performance and regulation level.

These findings extend the literature that examines how deregulation affects the adaptation of corporate governance (Crawford, et al., 1995; Hubbard and Palia, 1995; Bryan, et al., 2005; Kole and Lehn, 1999; Rennie, 2006). In particular, they help clarify, inform and extend our understanding of the evolutionary path boards take following deregulation. Our findings indicate that that deregulation potentially induces two opposite effects on boards, one caused by increased agency costs and the other caused by increased firm complexity. The former condition induces a reduction in board size while the latter condition can have an offsetting effect. An increase in a firm's incremental complexity leads to an increase in the number of outside directors. In some cases the effect of increased firm

complexity after deregulation could be large enough to neutralize the effects of increased agency costs.

Finally, our results are related to recent studies reexamining board determinants. Coles et al. (2008), Boone et al. (2007), Linck et al. (2008), and Lehn, Patro, and Zhao (2009) find that firm complexity is positively related board size and the number of outside directors serving on the board. In this study we expand on the prior research by taking a different focus. We assess the impact of changes in firm complexity resulting from deregulation. We find a strong relationship between incremental complexity and changes in board size and the number of outside directors. Post-deregulation changes in board size and the number of outside directors are positively associated with changes in firm complexity following deregulation. However, the impact of increased firm complexity on board size following deregulation is masked by the offsetting effects on board size caused by increased agency costs.

INDUSTRY BACKGROUND

Underpinning our analysis is the assumption that electric utility deregulation increases the potential for greater flexibility in both operations and organization that could lead to changes in firm complexity. By electric utility deregulation, we mean changes in regulations and regulatory enforcement that resulted from the 1992 Energy Policy Act (EPACT), which is customarily regarded as the landmark legislature demarcating two regulatory regimes in the U.S. electric utility industry (Bryan, et al., 2005; Rennie, 2006). In this section we highlight the changes in the business environment triggered by EPACT along with their potential impact on firm complexity.

For most of the 20th century, federal and state regulations rigidly prescribed the business of operating an electric utility. As a result, electric utilities were essentially restricted to the business of generation, transmission and distribution of electricity to customers within a confined

geographic territory. The passage of EPACT and the ensuing partial deregulation of the industry resulted in reduced regulatory oversight, expanded product markets and increased flexibilities in business combinations and operations. EPACT promoted competition at the wholesale level by introducing a competitive new class of power generator, and made it possible for electric utilities' scope of operation to be expanded both across geographic regions and across industries. For the first time, electric utilities were permitted to own and operate non-utility generators anywhere in the country (within non-regulated subsidiaries) and to invest in foreign power companies. With increased pressure to improve operational efficiency, and with a more relaxed interpretation of permissible merger partners by regulators, utilities could now pursue horizontal, vertical and congeneric mergers. Moreover, wholesale competition increased to the level where commodity trading of electricity became a viable business (e.g., Enron), and increased choice for industrial customers created a market for consulting services.

The electric utility industry is a capital-intensive industry with stable cash flows, which traditionally has been characterized by heavy debt financing. However, debt levels of electric utilities were reduced in the 1980s as plant construction slowed following a period of overexpansion and in anticipation of deregulation. By the early 1990s, many electric utilities were poised to increase their reliance on debt financing.

In short, the proceeding discussion suggests that following deregulation managers of electric utilities have had greater flexibility to change the scale and scope of operations, the firm size and the level of debt financing. In other words, a range of different business strategies could be adopted to cope with deregulation, and these strategies could make the firms either more or less complex.

LITERATURE REVIEW

This study is motivated by the juxtaposition of two literature streams, which we discuss below: the first examines changes in corporate governance following deregulation, while the second contains recent studies that examine factors affecting board size and composition.

Deregulation and Changes in Corporate Governance Mechanisms

Deregulation causes substantial changes in the business environment; as such, it provides an ideal laboratory in which to examine how boards of directors evolve. Deregulation induces instability in the operating environment, reduces barriers to entry, increases product market competition, and enhances disciplinary pressure from capital and corporate control markets. The cumulative effect is that managerial functions become more important after deregulation but managerial performance is either less observable or more costly to monitor (Kole and Lehn, 1997). Two resulting effects are 1) an increase in the severity of potential agency problems, and 2) a reduction in the effectiveness of monitoring activities. These simultaneous effects have the same implication for changes in ownership concentration and managerial compensation, indicating increases in ownership and incentive pay after deregulation, which are supported by the prior literature (Crawford, et al., 1995; Hubbard and Palia 1995; Bryan, et al., 2005; Kole and Lehn, 1999; and Rennie, 2006). However, their implications for board size and composition are complicated and uncertain. The increase in the severity of agency problems could increase the costs of sluggish decision-making and free riding associated with larger boards (Kole and Lehn, 1999), leading to an increase in the incremental costs associated with additional directors. Alternatively, it could lead to an increase in the incremental benefits of additional directors if additional directors bring valuable information and expertise that facilitate monitoring.

Despite the theoretical ambiguity, the empirical evidence indicates that board size contracts after deregulation (Kole and Lehn, 1999; and Rennie, 2006). A plausible interpretation can be fashioned by focusing on the board's monitoring function: deregulation leads to an increase in the incremental costs associated with additional directors but has little or no effect on the corresponding incremental monitoring benefits. Nevertheless, this interpretation may be insufficient in light of recent findings on board determinants (Coles et al., 2008), since it neglects the board's advisory role.

Effects of Firm Complexity on Board Size and the Number of Outside Directors

The board of directors is meant to perform two critical functions: to monitor the CEO (Fama and Jensen, 1983) and to provide the CEO with expert advice (Mace, 1971; Lorsch and MacIver, 1989). Firms with more complex operations will require a broader range of expertise to provide salient advice and informed monitoring. Accordingly, board size and composition should be systematically related to firm complexity. We discuss the relevant literature and related arguments in the following discussion.

Outside directors are non-employee directors who are experts in their chosen fields, and some, such as CEOs from other firms, may also have expertise in decision control and ratification (Fama and Jensen, 1983). Although outside directors may lack firm-specific information, they could bring alternate and specialized knowledge and experience to board deliberations. Outside directors are a likely source of wide-ranging expert advice to the CEO that is otherwise unavailable from the firm's current executives and other inside directors who are closely related to the firm and its management (Pearce and Zahra, 1989; Baysinger and Zardkoohi, 1986). Consistent with this view a growing body of evidence indicates that outside directors are sought as board members for their ability to provide expert advice (Agarwal and Knoeber, 2001; Guner, Malmendier, and Tate, 2005; and Fich, 2005).

Coles et al. (2008) formally test the hypothesis that board size and the use of outside directors are positively related to firm complexity. They use factor analysis to measure firm complexity along several dimensions, including firm size and debt level as well as the scale and scope of the firm's operations. Their findings indicate that complex firms have larger boards with more outsiders. Moreover, recent large-scale studies on board determinants also provide similar results (Boone et al., 2007; Linck et al., 2008; and Lehn et al., 2009). The findings in these studies indicate that board size and the number of outside directors are directly related to firm complexity because increases in firm complexity lead to greater demand for advice and/or more monitoring. In this paper we evaluate whether this relationship holds in the context of deregulation.

HYPOTHESES

When a utility becomes more complex after deregulation, two opposing conditions can elicit decisions on board structure. The first is an increase in the severity of potential agency problems and a reduction in the effectiveness of monitoring activities (Kole and Lehn, 1997); its impact is the reduction of board size, including the reduction of both inside directors and outside directors. The second potentially offsetting condition results from an increase in incremental firm complexity, which could lead to an increase the number of outside directors and potentially to an increase in board size as well. Since this offsetting condition only applies to firms that become more complex, we expect a difference in the board size changes of such firms. This line of reasoning leads to the following hypotheses, which are stated in the alternate form.

Hypothesis 1. Changes in board size after deregulation are different between firms that become more complex and firms with little change or a reduction in firm complexity.

Hypothesis 2. Changes in the number of outside directors after deregulation are different between firms that become more

complex and firms with little change or a reduction in firm complexity.

More generally, we expect changes in firm complexity to be positively related to the number of outside directors and board size, which we state more formally as two additional hypotheses in the alternate form.

Hypothesis 3. Following electric utility deregulation, changes in board size are positively related to incremental changes in firm complexity.

Hypothesis 4. Following electric utility deregulation, changes in the number of outside directors are positively related to incremental changes in firm complexity.

METHODOLOGY AND DATA

In this section we describe our analytical approach and the construction of the data set. Also, we provide basic statistics to show the differences between board characteristics and firm characteristics in the pre- and post-deregulation periods. One key firm characteristic is a measure of incremental complexity, which is described in detail.

We examine our hypotheses by analyzing comparative statics over two equilibrium states. Firm-level observations from 1989 to 1992 are used to construct variables for the equilibrium state prior to deregulation. We deemed this time frame sufficient to characterize the pre-deregulation period. When possible, up to 8 years of firm-level observations are used during the period 1993-2000 to create the post-deregulation variables. We use 8 years of data following the passage of EPACT because implementation of the enacted regulatory changes occurred gradually over the remaining years of the decade.

An advantage of this comparative static approach is that it eliminates noise associated with year-to-year changes in board size and membership that are driven by transitory factors such as CEO succession and firm

performance (Hermalin and Weisbach, 1988). In addition, it minimizes the impact of institutional constraints, such as classified boards and director tenure, which prevent firms from changing board size or membership quickly. Moreover, just as it takes time for board structure to change, incremental changes in the firm's complexity would probably be gradual as well.

Our sample consists of 92 electric utilities for which we are able to construct measures of incremental complexity, board size, board membership and other firm characteristics, in both the pre- and post-deregulation states. We calculate the pre-deregulation variables for each sample firm as the mean over the 4-year period 1989-1992, and we calculate the post-deregulation period variables for each sample firm as the mean for up to 8 years, from 1993 to 2000. All sample firms have four years of available data during the pre-deregulation period. By contrast, some of the firms have fewer than 8 years of data in the post-deregulation period because they merged or were acquired. The final sample contains 184 firm-level equilibrium observations spanning two different regulatory regimes, with 92 firm-observations in each regime.

Table 1 provides variable definitions and reports the mean values of board and firm characteristics in the two regulatory regimes. We use data from SEC filings, such as proxy statements and annual reports, to construct board size and membership variables. As Table 1 reveals, there is a significant reduction in board size but a significant increase in the fraction of outside directors after deregulation. On average, post-deregulation electric utility boards have 0.44 fewer board members but the fraction of outsiders serving on the board increases by 3.5 percent. These changes are statistically significant ($p < 0.01$) using the matched-pair t-test. The pattern of board structure changes is in line with Rennie (2006) and consistent with his monitoring argument.

With respect to changes in director type, we find a significant drop in the number of inside directors following deregulation: the average number of inside directors drops from 2.7 to 2.2, a reduction of 0.5

directors. This difference is significant ($p < 0.01$) using the matched-pair t-test. By contrast, there is no difference in the number of outside directors.

Firm Characteristics

A key assumption underpinning our analysis is that managers of electric utilities react to deregulation by adjusting their firm characteristics along three dimensions: firm size, scope of operations and reliance on debt financing. The data in Table 1 confirm this expectation: total assets (TA), net sales (Sales), total debt (TD) and the number of business segments (Segments) all increase substantially after deregulation. Further, all of these changes are significant using the matched-pair t-test ($p < 0.01$), except for the change in total debt which is significant at the 10 percent level ($p = 0.06$).

Incremental Complexity

Table 1 also reports the mean values of incremental complexity in the two regulatory regimes. We use factor analysis to measure a firm's incremental complexity. *Incremental complexity* is the factor score generated by applying factor analysis to proportional changes in four firm characteristics. Following other studies that have used factor analysis (Guay 1999; Gaver and Gaver, 1993), we compute a factor score based on percentage changes in total assets, net sales, total debt and the number of business segments for each equilibrium snapshot in the sample. We use percentage changes rather than levels to capture the firm's incremental complexity rather than its complexity level.

The model specification is consistent with Coles et al. (2008). We use total assets (in constant 2000 dollars) as a proxy for firm size, net sales (in constant 2000 dollars) as a proxy for scale of operations, number of business segments to capture scope of operations, and total debt (in constant 2000 dollars) to capture reliance on external financing.

We use the full sample of 184 firm-level equilibrium observations to perform the factor analysis. The first factor has an eigenvalue of 2.28 (not

shown) that accounts for 57% of the total variance, but the other factors are excluded because their eigenvalues are less than the critical cutoff of 1.0. *Incremental complexity*, our key test variable, is the factor score from the model, which is computed as a linear combination of the transformed values of the four variables. We expect that electric utility deregulation will lead to a measurable change in incremental complexity, and Table 1 provides evidence to support this expectation. As with assets, sales, segments and debt, there is also a significant increase in incremental complexity over the two regulatory regimes ($p < 0.01$).

RESULTS

Univariate Results

In this subsection we assess Hypotheses 1 and 2, namely, whether post-deregulation incremental firm complexity is related to changes in board size and the number of outside directors. To do so, we separate the post-deregulation sample into two groups, using median *Incremental complexity* to divide the sample, and we refer to the subsamples as low incremental complexity (below median) and high incremental complexity (above median).

Table 2 reports mean changes in board size and board membership. The board size of low-incremental-complexity firms decreases by 0.828 directors on average in the post-deregulation period, and the change is significant ($p < 0.01$). By contrast the board size of high-incremental-complexity firms does not change significantly, and the average reduction in board size is a scant 0.057 directors. Furthermore, changes in board size differ significantly across the two subsamples as shown by the parametric F-test for a standard ANOVA ($p = 0.006$) for equal means and the Wilcoxon rank-sum test ($p = 0.002$) for equal medians. These results provide support for Hypothesis 1, which states that changes in board size after deregulation are different between firms that become more complex and firms with little change or a reduction in firm complexity.

We also examine changes in the number of outside directors following deregulation. For low-incremental-complexity firms the average number of outside directors declines by 0.306 directors and the decrease is not significant ($p = 0.07$). By contrast, the number of outside directors serving on boards of high-incremental-complexity firms increases by 0.432 on average and the increase is significant that the five percent level. ($p < 0.03$). Furthermore, changes in the number of outside directors differ significantly across the two groups as shown by the parametric F-test for a standard ANOVA ($p = 0.003$) for equal means and the Wilcoxon rank-sum test ($p = 0.003$) for equal medians. These results provide support for Hypothesis 2, which states that changes in the number of outside directors after deregulation are different between firms that become more complex and firms with little change or a reduction in firm complexity.

There is no evidence that incremental complexity has any effect on changes in the number of inside directors following deregulation. On average, for the high-incremental-complexity subsample, the average number of insiders declines by 0.489 and for firms in the low-incremental-complexity subsample, the average number of insiders declines by 0.522. These changes are both significant ($p < 0.01$). Moreover, there is no evidence that changes in insiders differ across the two subsamples at conventional significance levels.

Correlations

In this subsection, we describe the correlations between post-deregulation firm characteristics and changes in board size, the number of insider directors and the number of outside directors. The correlations provide validity for the incremental firm complexity measure developed from factor analysis and provide preliminary evidence in support of Hypotheses 3 and 4.

Table 3 reports the Pearson correlation coefficients between the relevant variables during the post-deregulation period from 1993 to 2000. As expected, incremental complexity is positively related to percentage changes in total assets, net sales, total debt and number of business

segments, and the correlation coefficients are all significant ($p < 0.01$); these results provide validity for the factor analysis. Moreover, incremental complexity is positively related to changes in board structure: changes in board size and changes in the number outside directors are both positively and significantly correlated with incremental complexity ($p < 0.01$). These relationships provide support for Hypotheses 3 and 4, which posit that post deregulation changes in board size and the number of outside directors are positively related to incremental changes in firm complexity. Also, changes in board size and the number of outside directors are positively related to changes in assets, sales, debt and business segments, and most correlations are significant at 5 percent or better. Lastly, there is a significant correlation between changes in the number of inside directors and changes in board size ($p < 0.01$). However, correlations between changes in the number of inside directors and other variables are not significant at the conventional levels, although they are generally positive.

Empirical Specification

We further explore the relationships between board structure changes and incremental complexity by estimating the following equations:

$$(1) \Delta \text{Board size}_t = \alpha + \beta_1 \text{Incremental complexity}_t + \varepsilon$$

$$(2) \Delta \text{Board size}_t = \alpha + \beta_1 \text{Board Size}_{t-1} + \beta_2 \text{Incremental complexity}_t + \beta_3 \text{Control}_{t-1} + \varepsilon$$

$$(3) \Delta \text{Outsidert} = \alpha + \beta_1 \text{Incremental complexity}_t + \varepsilon$$

$$(4) \Delta \text{Outsidert} = \alpha + \beta_1 \text{Board Size}_{t-1} + \beta_2 \text{Incremental complexity}_t + \beta_3 \text{Control}_{t-1} + \varepsilon$$

where Δ is the over time change from before-deregulation to after-deregulation, subscript $t-1$ denotes the before-deregulation period from 1989 to 1992, subscript t denotes the after-deregulation period from 1993 to 2000, and Control_{t-1} is a vector of instrumental control variables. These regressions are used to provide additional evidence for Hypotheses 3 and

4. In this subsection, we explain the rationale for our chosen specification, we describe the variable definitions and the variable selections for the regressions.

We use OLS regressions to analyze post-deregulation change in board size ($\Delta Board\ size_t$) and the number of outside directors ($\Delta Outsiders_t$). This approach differs from existing research on board evolution following deregulation (Kole and Lehn, 1999; and Rennie, 2006), which uniformly uses panel regressions to analyze levels of board structure. We focus on changes rather than levels because Hypotheses 3 and 4 predict positive relationships between post-deregulation changes in board size and the number of outside directors and the firm's incremental complexity.

Models 1 and 3 are designed to provide the baseline results. The specification of these regression models is parsimonious as it includes only two terms: the intercept term and the test variable (*Incremental complexity*). The intercept term provides a rough estimate of the average post-deregulation change in board structure due to factors unrelated to incremental firm complexity. These factors include reduced regulatory oversight, increased product market competition, increased instability in the business environment, reduced barriers to entry, enhanced disciplinary pressure from capital and corporate control markets, and time trends.

The variable, *Incremental complexity_t*, is designed to capture incremental change in the complexity of the firm's operations following deregulation. It is the test variable in $\Delta Board\ size_t$ regressions (Model 1 and 2) and $\Delta Outsiders_t$ regressions (Model 3 and 4). In these regressions, the estimated coefficient on *Incremental complexity_t* offers a direct test of Hypotheses 3 and 4, which predict positive estimates for β_1 in both Equation 1 and 3 and for β_2 in both Equation 2 and 4.

We include board size before deregulation (*Board Size_{t-1}*) in the empirical model because pre-existing board size should have a strong influence on changes in the number of directors and changes in the number of outsiders, holding other factors constant. A number of other variables are included in the empirical model to control for the effects of CEO power,

firm performance, and differences in the firm-level competitive/regulatory environment. We use lagged values for these variables; more specifically, all control variables, except firm performance, are calibrated using data from the before-deregulation period between 1989 and 1992. Hermalin and Weisbach (1998) reason that CEOs exercise greater influence over board composition when they have more power, and empirical work has supported this view (Boone et al., 2007). For our control variables, we use CEO tenure and board ownership as proxy for CEO power. Hermalin and Weisbach (1988) find that insiders are more likely to leave and outsiders are more likely to join after a firm performs poorly. Accordingly, we also include accounting firm performance before-deregulation (ROA_{t-1}) and after deregulation (ROA_t) as control variables in the empirical model. We use two variables, *State deregulation* and *Holding company status*, to isolate the differential competitive/regulatory environment at the firm level. *State deregulation* takes the value of 1 if the company is located or operates in states that initiated plans to deregulate their retail electricity markets; it equals zero otherwise. This variable is intended to isolate the effect of state deregulation of the retail market. Since all states did not initiate plans to deregulate their retail markets, electric utilities operating in such states could face differential product market competition. *Holding company status* is a dummy variable that equals one if the company is a holding company in 1992, otherwise it equals 0. This variable is included because firms already organized as a holding company before the onset of deregulation might have a relative organizational advantage in diversification and expansion following deregulation.

REGRESSION RESULTS

Table 4 presents estimates from regressions of $\Delta Board\ size_t$ and $\Delta Outsiders_t$ on incremental change in firm complexity, board size before deregulation and other control variables. First we discuss Models 1 and 3, which provide our baseline results. Next we discuss Models 2 and 4, which include the impact of the control variables in the regressions.

The intercept estimate (-0.525) for the regression of $\Delta Board\ size_t$ (Model 1) is negative and significant ($p < 0.01$). This result implies that electric utility boards are about one-half of a director smaller following deregulation, holding constant the effect of incremental complexity, and it is in line with that of Rennie (2006) who reports that, on average, electric utility boards are about one-half of a director smaller following deregulation (Table 1 in the study). Although the intercept estimate is also negative for the regression for $\Delta Outsiders_t$ (Model 3), it is not significant at conventional levels. Thus, there is no evidence that factors unrelated to incremental firm complexity have a significant effect on the number of outside directors after deregulation.

For both regressions, the estimated coefficient on *Incremental complexity_t* is positive and significant ($p < 0.01$). According to the parameter estimate in Model 1, post-deregulation electric utility boards add about 0.35 board members for every standard deviation increase in *Incremental complexity_t* ($0.35 = 1.2 \times 0.292$, where the standard deviation of post-deregulation *Incremental complexity_t* is 1.2 as reported in Table 3 and 0.292 is the estimated coefficient on *Incremental complexity_t* from Model 1). Model 3's parameter estimate implies an analogous increase of about 0.34 outside directors ($0.34 = 1.2 \times 0.285$). These results provide support for Hypotheses 3 and 4, which posit that that post deregulation changes in board size and the number of outside directors are positively related to incremental changes in firm complexity.

We use the full specification in Models 2 and 4. The dependent variable in Model 2 is $\Delta Board\ size_t$ and it is $\Delta Outsiders_t$ in Model 4. For both regressions, the estimated coefficients on *Incremental complexity_t* remain significantly positive ($p = 0.02$ in Model 2 and $p = 0.04$ in Model 4). These parameter estimates imply that electric utility boards add about 0.36 board members for every standard deviation increase in *Incremental complexity_t* ($0.36 = 1.2 \times 0.301$). The analogous increase in the number of outside directors implied by Model 4's parameter estimate is 0.34 ($0.34 = 1.2 \times 0.282$). These results provide further support for Hypotheses

3 and 4, which posit that post deregulation changes in board size and the number of outside directors are positively related to incremental changes in firm complexity.

In these models, the equation $\alpha + \beta_1 Board\ size_{t-1}$ can be used to determine a measure that is analogous to the intercept estimate in the baseline models (Model 1 and 3), which provides a rough estimation of the post-deregulation change in board size due to other factors unrelated to incremental firm complexity. While α refers to the intercept estimate, β_1 is the parameter estimate for *Board size*_{*t-1*}. We note that this measure differs from those in the baseline models in that it takes pre-existing board size into consideration. On average, electric utility boards have about 11.76 directors before deregulation (Table 1). Using this estimate and the parameter estimates for α and β_1 in Model 2 and 4, we find the implied reduction in board size is about 1.21 board members after deregulation, while the implied reduction in the number of outsiders is about 0.23 following deregulation.

In sum, the results of these four regressions are consistent with Hypothesis 3 and 4, which state that incremental firm complexity is positively related to changes in board size and changes in the number of outside directors after deregulation, and they confirm that on average the board size of electric utilities is reduced following deregulation. Our results are consistent with the extant literature on deregulation (Kole and Lehn, 1999; Rennie, 2006), which shows board size decreases following deregulation; however, our results also show an offsetting effect that ensues when firms become more complex following deregulation: an increase in the firm's complexity has an offsetting positive impact on the number of outside directors and the board size (as shown by the coefficient estimates for *Incremental complexity*_{*t*}).

SUMMARY AND CONCLUSION

The data and analysis presented in this paper illustrate a strong, direct link between incremental complexity and board adaptation in the U.S. electric utility industry following the 1992 Energy Policy Act. Post-deregulation changes in board size and the number of outside directors are positively associated with changes in firm complexity following deregulation. These effects run counter to the other effects of deregulation unrelated to complexity such as increases in product market competition, increases in agency conflicts etc. The effect of incremental complexity on the number of outside directors is much stronger than the corresponding effect on the board size. Indeed, we find that the increase in the number of outside directors induced by a one-unit increase in incremental complexity is enough to outweigh the opposing effect of factors unrelated to complexity. The board size of electric utilities that become more complex does not change appreciably following deregulation: there is a reduction in the number of inside directors and an increase in the number of outside directors. By contrast, the board size of utilities that do not become more complex decreases significantly after deregulation, with reductions in both the number of insiders and the number of outsiders.

In general, these findings support the view the board structure of electric utilities is adapted to accommodate a variety of changing needs induced by deregulation. In this context, our results are consistent with two complementary views. On the one hand, deregulation induces a greater need for monitoring since agency problems become more severe after deregulation. On the other hand, deregulation induces a greater need for advice and/or monitoring because it causes utilities to adopt business strategies that increase firm complexity.

Although increases in firm complexity can induce greater needs for monitoring, the incremental monitoring benefits associated with additional outside directors are likely tempered by the reduction in effectiveness of monitoring activities after deregulation. It is therefore doubtful that the needs for monitoring contribute significantly to the

strong link between the number outside directors and incremental complexity in utilities following deregulation. By contrast, the argument that changes in outside directors are caused by the need for expert advice seems more plausible, since incremental advising benefits associated with additional outside directors are unaffected by the reduction in monitoring effectiveness after deregulation. Accordingly, we offer an alternative interpretation as follows. Increases in firm complexity disproportionately raise the need for expert advice, leading to increases in the number of outside directors, which, in turn, offset the opposing effects due to increased product market competition, agency costs etc.

REFERENCES

- Agrawal, A., & Knoeber, C. (April 2001) "Do Some Directors Play a Political Role?" *Journal of Law and Economics*, 179-198. <http://dx.doi.org/10.1086/320271>
- Baysinger, B., & Zardkoohi, A. (Fall 1986), "Technology, Residual Claimants and Corporate Control," *Journal of Law, Economics, and Organization*, 339-344.
- Boone, A., Field, L., Karpoff, J., & Raheja, C. (July 2007) "The Determinants of Corporate Board Size and Composition: An Empirical Analysis," *Journal of Financial Economics*, 66-101. <http://dx.doi.org/10.1016/j.jfineco.2006.05.004>
- Booth, J., & Deli, D. (September 1999) "On Executives of Financial Institutions as Outside Directors," *Journal of Corporate Finance*, 227-250. [http://dx.doi.org/10.1016/S0929-1199\(99\)00004-8](http://dx.doi.org/10.1016/S0929-1199(99)00004-8)
- Bryan, S., Hwang, L., & Lilien, S. (September 2005) "CEO Compensation After Deregulation: The Case of Electric Utilities," *Journal of Business*, 1709-1752. <http://dx.doi.org/10.1086/431440>
- Coles, J., Daniel, N., & Naveen, L. (February 2008) "Boards: Does One Size Fit All?" *Journal of Financial Economics*, 329-356. <http://dx.doi.org/10.1016/j.jfineco.2006.08.008>

- Crawford, A., Ezzell, J., & Miles, J. (April 1995) "Bank CEO Pay Performance Relations and the Effects of Deregulation," *Journal of Business*, 231-256. <http://dx.doi.org/10.1086/296662>
- Fama, E. & Jensen, M. (June 1983) "Separation of Ownership and Control," *Journal of Law and Economics*, 301-325. <http://dx.doi.org/10.1086/467037>
- Fich, E. (September 2005) "Are Some Outside Directors Better Than Others? Evidence from Director Appointments from Fortune 1000 Firms," *Journal of Business*, 1943-1971. <http://dx.doi.org/10.1086/431448>
- Gaver, J., & Gaver, K. (January 1993) "Additional Evidence on the Association between the Investment Opportunity Set and Corporate Financing, Dividend and Compensation Policies," *Journal of Accounting and Economics*, 125-160. [http://dx.doi.org/10.1016/0165-4101\(93\)90007-3](http://dx.doi.org/10.1016/0165-4101(93)90007-3)
- Geddes, R. (January 1996) "Time to Repeal the Public Utility Holding Company Act." *The CATO Journal*, 63-76.
- Gruner, A., Malmendier, U., & Tate, G. (May 2008) "Financial Expertise of Directors," *Journal of Financial Economics*, 323-354.
- Guay, W. (July 1999) "The Sensitivity of CEO Wealth to Equity Risk: An Analysis of Magnitude and Determinants," *Journal of Financial Economics*, 43-72. [http://dx.doi.org/10.1016/S0304-405X\(99\)00016-1](http://dx.doi.org/10.1016/S0304-405X(99)00016-1)
- Hermalin, B., & Weisbach, M. (Winter 1988) "The Determinants of Board Composition," *The Rand Journal of Economics*, 589-607. <http://dx.doi.org/10.2307/2555459>
- Hermalin, B., & Weisbach, M. (March 1998) "Endogenously Chosen Boards of Directors and Their Monitoring of the CEO," *American Economic Review*, 86-118.
- Hubbard, G., & Palia, D. (September 1995) "Executive Pay and Performance: Evidence from the U.S. Banking Industry?" *Journal of Financial Economics*, 105-130. [http://dx.doi.org/10.1016/0304-405X\(94\)00816-J](http://dx.doi.org/10.1016/0304-405X(94)00816-J)

- Kole, S., & Lehn, K. (May 1997) "Deregulation, the Evolution of Governance Structure and Survival," *American Economic Review*, 421-425.
- Kole, S., & Lehn, K. (April 1999) "Deregulation and the Adaptation of Governance Structure: The Case of the U.S. Airline Industry," *Journal of Financial Economics*, 79-117. [http://dx.doi.org/10.1016/S0304-405X\(99\)00005-7](http://dx.doi.org/10.1016/S0304-405X(99)00005-7)
- Lehn, K., Patro, S., & Zhao, M. (Winter 2009) "Determinants of the Size and Structure of Corporate Boards: 1935 – 2000," *Financial Management*, 747-780. <http://dx.doi.org/10.1111/j.1755-053X.2009.01055.x>
- Linck, J., Netter, J., & Yang, T. (February 2008) "The Determinants of Board Structure," *Journal of Financial Economics*, 308-328. <http://dx.doi.org/10.1016/j.jfineco.2007.03.004>
- Lorsch, J., & MacIver, E. (1989) *Pawns and Potentates: The Reality of Americas Corporate Boards*, (Boston: Harvard Business School Press).
- Mace, M. (1971) *Directors: Myth and Reality*, (Boston: Harvard Business School Press).
- Rennie, C. (July 2006) "Governance Structure Changes and Product Market Competition: Evidence from U.S. Electric Utility Deregulation," *Journal of Business*, 1989-2017. <http://dx.doi.org/10.1086/503654>
- Zahra, S.A., & Pearce II, J.A. (June 1989) "Boards of Directors and Financial Performance: A Review and Integrative Model," *Journal of Management*, 291-344. <http://dx.doi.org/10.1177/014920638901500208>

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WEB APPENDIX

A web appendix for this paper is available at:

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