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How Important Is Corporate Governance? Evidence from Machine Learning

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ABSTRACT

We use machine learning to assess the predictive ability of over a hundred corporate governance features for firm outcomes. We consider financial-statement restatements, class-action lawsuits, business failures, operating performance, firm value, stock returns, and credit ratings. We discover that adding corporate governance features does not improve the models' predictive accuracy beyond the predictive accuracy captured by firm characteristics. Our results raise doubts about the existence of strong causal effects of corporate governance on a range of firm outcomes studied in prior research.

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1. Introduction

Three broad interrelated questions have long been prominent in corporate governance research: measurement, prediction, and causation. Researchers and practitioners have been interested in the *measurement* of corporate governance for at least two reasons. First, researchers and practitioners have been interested in constructing measures of corporate governance that can be used to *predict* unfavorable corporate outcomes, such as financial-statement restatements, class-action lawsuits, business failures, or declines in operating performance, firm value, and credit rating. Second, researchers are generally interested in causal questions, such as whether worse corporate governance increases the probability of or *causes* unfavorable corporate outcomes.

The results have been mixed.[1] With regard to prediction, researchers have struggled to find compelling evidence that measures of corporate governance can reliably predict firm outcomes, whether the measures be researcher-constructed (e.g., Larcker et al., 2007) or provided by commercial rating services (Daines et al., 2010). With regard to causation, researchers have faced the additional challenge that corporate governance features are not randomly assigned, but result from complex choices by firms. For example, Gompers et al. (2003) find that "firms with stronger shareholder rights [a dimension of corporate governance] had higher firm value, higher profits, higher sales growth, lower capital expenditures, and made fewer corporate acquisitions," but warn that their evidence "[does] not allow strong conclusions about causality" because they are based on associations

[1] Internet Appendix A discusses three examples of research on CEO duality, board independence, and staggered boards.

without random assignment.

In this paper, we leverage the link between causal and predictive modelling and use machine learning to address all three of these broad research questions of measurement, prediction, and causation. This link arises because understanding a phenomenon requires both causal explanation and prediction (e.g., Watts, 2014; Yarkoni and Westfall, 2017; Hofman et al., 2021). Many social scientists and philosophers find it self-evident that causal explanation must also be predictive; that is, the knowledge identified by the causal mechanism can be used to predict an outcome on new data (e.g., Hempel and Oppenheim, 1948; Freedman, 1991; Manski, 2009). Although primarily concerned with testing causal hypotheses, corporate governance research typically does not test for predictive power of proposed causal models. It often assumes a model's explanatory power translates into its predictive power, which is not always the case (Shmueli, 2010). Although, strictly speaking, an underspecified model may predict better than a fully specified causal model (see examples in Hagerty and Srinivasan, 1991; Wu et al., 2007),[2] some predictive power is a necessary condition for a causal mechanism to exist (Watts, 2014).

The reliance on predictive ability facilitates evaluation of causal models in the following sense. In general, if addition of corporate governance characteristics does not substantially improve out-of-sample predictive performance for firm outcomes, two conclusions can be drawn[3]—both undermining the relevance of causal claims in corporate governance research. First, while the existence of a causal effect cannot be completely ruled out, the

[2]From Hagerty and Srinivasan (1991, p. 84): "We note that the practice in applied research of concluding that a model with a higher predictive validity is "truer" is *not* a valid inference. This paper shows that a parsimonious but less true model can have a higher predictive validity than a truer but less parsimonious model."

[3]These statements are shown for linear models in Wu et al. (2007).

causal effect of these characteristics, if any, is trivial relative to the noise in an outcome.

Second, most of the information that these characteristics contribute to prediction of an outcome is incorporated in the other variables included into the model. The absence of distinct predictive power provides a justification to favor the set of other variables from the theory-completeness point of view as in Peysakhovich and Naecker (2017), Agrawal et al. (2020), and Fudenberg et al. (2022). These papers use the out-of-sample predictive accuracy of machine learning models to assess an upper bound for the explainable variation of an outcome. This upper bound is a limit on the potential predictive power of a theory built on the variables used in these models. Leveraging machine learning and many governance variables, thus, allows us to both evaluate the economic significance of the causal effect of corporate governance and to assess an upper bound on predictive power of a theory built on these governance characteristics.

We collect comprehensive data on over a hundred corporate governance characteristics, including institutional investor holdings, anti-takeover provisions, executive compensation, and board characteristics such as financial expertise (e.g., Bhojraj and Sengupta, 2003; Larcker et al., 2007; Daines et al., 2010). We also collect data on firm characteristics drawn from prior literature. For firm outcomes, we draw on extant corporate governance research in considering financial-statement restatements (Dechow et al., 2011), class-action lawsuits (Rogers and Stocken, 2005), business failures (Campbell et al., 2008), operating performance (Daines et al., 2010), firm value (Daines et al., 2010), stock returns (Fama and French, 2015), and credit ratings (Daines et al., 2010). We train models, which use current characteristics to predict future outcomes, using cross-validation in the earlier part of the sample. As for machine learning, we apply gradient boosting of regression trees (Fried-

man, 2001; Friedman et al., 2009), which easily accommodates both non-linearities and interactions between variables. We benchmark predictive ability of corporate governance characteristics against an uninformed baseline, i.e., a prediction using an average outcome on the estimation data, and also models based solely on firm characteristics.

For virtually all outcomes, we find corporate governance characteristics do not improve the predictive ability of firm characteristics. In out-of-sample tests, the models based on firm characteristics alone outperform uninformed baseline. Although adding corporate governance characteristics leads to a reduction in errors, this reduction is not statistically significant. The finding that adding corporate governance does not improve the predictive ability has two interpretations. First, corporate governance has a trivial causal effect, if any, on firm outcomes we consider, and thus, the predictive ability of combined models stems from firm characteristics alone. Second, corporate governance captures the same predictive variation as firm characteristics, and thus, does not add distinct predictive power in combined models, which provides a justification to favor firm characteristics in causal models.

To examine the second explanation, we consider firm and corporate governance characteristics on their own and find a similar pattern. Corporate-governance-only models do not perform better than baseline with the exception of compensation and board characteristics and, typically, have larger errors. Compensation and board characteristics often outperform baseline but have accuracy that is statistically similar or even inferior to the firm-characteristics-only models. Firm characteristics is also the most important group of predictors. Based on these results, we conclude that little support exists for a strong causal relation between corporate governance and firm outcomes, which are primarily predicted

by firm characteristics. From a theory-development perspective, an amount of explainable variation in firm outcomes that can be achieved by a theory that incorporates corporate governance does not exceed that of firm characteristics alone.

Our paper contributes to our understanding of corporate governance in a number of ways. First, we contribute to the literature examining the predictive ability of corporate governance measures. Prior research (e.g., Gompers et al., 2003) has often used simple indexes constructed, perhaps to avoid concerns about data-dredging or overfitting. Machine-learning approaches are explicitly designed to facilitate prediction and modern methods such as those we use are widely regarded as the state of the art for this purpose. No paper that we know of has examined the predictive ability of machine learning–derived governance measures. Our results provide additional evidence of the predictive ability of corporate governance measures being somewhere between zero and very weak (Larcker et al., 2007; Daines et al., 2010) and suggests that these results generalize beyond the specific classes of governance measures that those papers study.

Second, we believe our paper provides evidence regarding the existence and strength of causal relations between corporate governance and firm outcomes. In this regard, our paper draws on recent research in the social sciences that seeks to integrate explanatory and predictive modelling (Hofman et al., 2021) and to use prediction to test theories (Peysakhovich and Naecker, 2017; Fudenberg et al., 2022; Agrawal et al., 2020). The failure of corporate governance measures to predict the kinds of outcomes studied in prior research suggests that either corporate governance theories offer little in terms of explanatory power for firm outcomes and that further work is needed to develop models with greater predictive power or that the effect of corporate governance on firm outcomes, if any, is in

fact too small to be detected even in large samples.

Finally, our paper contributes to the literature on measurement of corporate governance. The fitted values from the models we train using machine-learning methods can be viewed as measures of corporate governance. Our results provide additional evidence on the difficulty of constructing meaningful and useful measures of corporate governance, consistent with results in Larcker et al. (2007) and Daines et al. (2010).

Our results are, naturally, subject to a number of caveats. First, our focus on easily measured corporate governance characteristics may limit the predictive ability of models derived from them. It may be that dimensions of corporate governance less easily measured and observed by researchers have significant explanatory power for firm outcomes. Second, our study examines the explanatory power of corporate governance in a single large, developed economy—the United States—where variation in governance practices may be too limited to allow corporate governance to offer much in the way of explanatory power. Additionally, our use of firm characteristics as the basis for a benchmark model provides a reference that is subject to the same caveats. Third, it is possible that causal relations between corporate governance and firm outcomes are too complex to be recovered by any association-based evidence from observational data. These caveats are applicable to most research on corporate governance and thus arguably implies that the results of our paper suggest the need for more research on exactly how corporate governance affects firm outcomes, if at all.

2. Causal models and out-of-sample predictive ability

Mixed findings on the relation between various corporate governance characteristics and firm outcomes question the existence of strong causal mechanisms claimed in some studies. We propose leveraging out-of-sample predictive ability of corporate governance characteristics in assessing the plausibility of these causal claims. In our analyses, we compare out-of-sample predictive ability of machine learning models based on firm characteristics, corporate governance characteristics, or a combination of the two. The basic idea is that, if a relation between a corporate governance characteristic and an outcome is causal, this characteristic should help predict the outcome out of sample by making prediction of the outcome more accurate. In other words, causality should result in out-of-sample predictive ability.

While this idea is intuitive, prior research has established conditions under which an incomplete causal model predicts better than a true (complete) causal model. Selection of a true causal model thus cannot be based on its predictive ability alone in a strict sense (e.g., Hagerty and Srinivasan, 1991; Wu et al., 2007; Shmueli, 2010). We discuss a limited set of conditions in which a true causal model does not produce superior out-of-sample predictions to facilitate interpretation of our analyses. Under these conditions, the lack of better predictive ability when adding, say, corporate governance characteristics into the model does not necessary indicate that these corporate governance characteristics have no causal relation with the dependent variable. This latter point is directly related to our analyses and conclusions, and is the one we specifically aim to address in this section. Before we discuss these conditions though, we briefly discuss the literature that uses

prediction to test theories.

2.1 Using prediction to test theories

Prediction on out-of-sample data provides a harsher test than fitting many models on in-sample data (Freedman, 1991; Hofman et al., 2021). Low out-of-sample predictive ability of a model with good in-sample fit can be due to incompleteness of a theory or the irreducible noise of an outcome. Dhar (2013) contrasts physics and social sciences as being on opposite ends of the spectrum in terms of the predictive power of their theories. In physics, theories are expected to be complete; that is, they make perfect predictions subject to measurement error. For instance, the behavior of a space shuttle is explained completely by the causal model describing the physical forces acting on it. In the social sciences, however, models are intended to be partial approximations of reality, making simplifying assumptions about the behavior of agents. As a result, the predictive accuracy of models in the social sciences could be poor because the theory is incomplete.

Fudenberg et al. (2022) implemented the idea of theory "completeness" by developing a measure of the amount of predictable variation a theory captures in the data. Their approach uses prediction to isolate the irreducible error in an outcome and thus assesses an upper bound on how well one can predict an outcome using a given set of features. Similarly, Peysakhovich and Naecker (2017) propose using the predictive accuracy of machine learning models to assess an upper bound for the explainable variance of an outcome, which serves as an upper bound for the potential predictive power of a theory. Thus, one can iteratively modify a theoretical model until the machine learning model and the theoretical model converge on the predictive accuracy, as in Agrawal et al. (2020). Similarly,

in our paper, the extent of predictive ability of machine-learning-based models that use corporate governance features would provide an upper bound on an amount of explainable variation in firm outcomes that can be achieved by a corporate governance theory and potentially suggest ways to extend the theory to match this predictive accuracy.

2.2 Omitting causal factors and prediction

We rely on out-of-sample predictive accuracy to draw conclusions about causal models. There is a limited set of conditions, however, under which a true causal model can produce worse out-of-sample predictive accuracy or, put differently, omission of causal factors can lead to better predictive accuracy. Understanding these conditions is important for interpretation of our results, e.g., omission of corporate governance characteristics can still lead to better predictive accuracy even though they are part of the causal mechanism that determines firm outcomes. We mostly follow Wu et al. (2007) and focus on linear models because these allow for explicit derivations.

Consider a linear model with two groups of causal factors

$$Y = X_1\beta_1 + X_2\beta_2 + \epsilon,\ \epsilon \sim (0, \sigma^2). \tag{1}$$

We refer to this model as an extended model and assume that this is the true model. Intuitively, in this model, the notion of causality is well-defined as being equivalent to the requirement of non-zero coefficients. The simplified model that omits the second group

of variables can be defined as

$$Y = X_1\beta_1 + e,\ e = X_2\beta_2 + \epsilon. \tag{2}$$

Once both models are estimated, they can be used to make predictions of the dependent variable given a new set Z of inputs. This new set of inputs Z can be future values of X or X for new cross-sectional units. Similar to X, Z is also split into two groups $Z = (Z_1\ Z_2)$, where only the first group is used to make predictions in the simplified model. The predictions are, correspondingly,

$$\widehat{Y}_E = Z\hat{\beta}_E = Z_1\hat{\beta}_{1E} + Z_2\hat{\beta}_{2E}, \tag{3}$$

$$\widehat{Y}_S = Z_1\hat{\beta}_{1S}, \tag{4}$$

where $\hat{\beta}_{ij},\ i = \{1, 2\},\ j = \{E, S\}$ are the estimated parameters of the corresponding models. These models estimate the target function that corresponds to the true model in (1). To compare model predictions, Wu et al. (2007) uses their mean-squared errors (MSE) that equal $\mathbb{E}\left[(Y - \widehat{Y})^2\right]$, where $\widehat{Y} = \{\widehat{Y}_E, \widehat{Y}_S\}$ are predictions from the corresponding models or estimated target function at a new observation with value $Z = z$ and Y is the true value of the dependent variable or target function at z. As given by Friedman et al. (2009), p. 223, MSE or the expected prediction error equals the sum of three elements: irreducible error, squared bias, and variance. The irreducible error is, in this case, the variance of the noise in the outcome σ^2. This error cannot be avoided no matter how well the target function is estimated. The bias is the amount by which the average of the estimated target function

differs from the true mean of the target function. This bias is the result of misspecifying the statistical model, e.g., using the simplified model instead of the extended model. The variance is the variance of the estimated target function around its mean. This variance is the result of using a sample to estimate the target function.

The comparison of the MSEs for predictors from the extended and simplified models are derived in Wu et al. (2007) and summarized here.[4] First, the omission of a causal variable increases the bias but decreases the variance of model predictions. If the omitted variable has little influence on the dependent variable causing only a small bias when omitted, excluding it from the model may cause a substantial decrease in the variance of predictions, so that the overall MSE also decreases. This effect is stronger when the causal effect of omitted variables in absolute terms is much lower relative to the noise in the dependent variable. Second, there can be no loss in the predictive ability of the model if most of the information contained in the omitted variables is already contained in the included variables. Third, the inclusion of irrelevant variables with zero effect on the dependent variable increases the variance and MSE of model predictions.

2.3 Implications

While the results for the linear-model case cannot be directly applied to the machine learning approach we use in the paper, the intuition certainly extends beyond the linear case. In general, if addition of corporate governance characteristics into a model does not substantially improve its out-of-sample predictive ability, two conclusions can be drawn.

[4]The complete set of conditions for the simplified model to have lower MSE than the extended model is in Wu et al. (2007), p. 389 and p. 391: (1) the data are noisy, i.e., large irreducible noise σ^2; (2) the true absolute values of effects of omitted variables are small, i.e., small β_2; (3) high correlation between omitted and included predictors, i.e., X_1 and X_2; or (4) the sample size is small.

First, while the existence of a causal effect cannot be completely ruled out, these corporate governance characteristics have a trivial causal effect, if any, relative to the noise in the dependent variable. Second, most of the information that these characteristics contribute to prediction of the dependent variable is incorporated in the other variables that are already included into the model, e.g., firm characteristics already capture most of the information contained in corporate governance characteristics. Put differently, if predictive ability of models based on corporate governance characteristics or firm characteristics alone is similar, one cannot rule out the possibility that they are equally informative for predicting an outcome.

3. Data

We collect comprehensive data on over a hundred corporate governance characteristics from Equilar, WhaleWisdom, and FactSet. In addition to considering all governance features, we also split them into groups: institutional investor holdings, anti-takeover provisions, compensation, board financial expertise, and board characteristics. The corporate governance characteristics mostly come from prior literature, e.g., Bhojraj and Sengupta (2003), Larcker et al. (2007), and Daines et al. (2010). We use different firm characteristics based on firm outcomes. We select these firm characteristics from the extant literature. For restatements of financial statements, we use Model 1 from Dechow et al. (2011). For class-action lawsuits, we use prediction model from Rogers and Stocken (2005). For business failures, we use prediction model from Campbell et al. (2008).[5] For stock returns, we use

[5] Ogneva et al. (2020) provide details on computing the variables.

firm characteristics from the five-factor model from Fama and French (2015). For operating performance, firm value, and credit ratings, we use firm characteristics from Daines et al. (2010). Table A.1 provides definitions of the variables.

Our sample covers data for 2001–2016 period. The sample starts in 2001 because Equilar executive compensation and board characteristics coverage starts at that time. The sample ends in 2016 mainly because of the restatements of financial statements. It takes about two-three years for an error in financial statements to get detected (Zakolyukina, 2018). Thus, our data covers restatements uncovered in 2019, which is the last pre-COVID-19 year, making our data complete with respect to pre-COVID-19 outcomes. For each firm outcome, we use the last three years of data as an out-of-sample test set and the remaining data from earlier periods as a training set.

Table 1 provides descriptive statistics for each of the corporate governance sub-groups and outcome-specific firm characteristics. Summary statistics for corporate governance characteristics are consistent with the prior literature. Our largest sub-group is compensation of CEO and non-CEO executives. This category includes means, variances, and ratios of various compensation measures. The next largest category is board characteristics with variables found to be important in the literature, e.g, number of directors appointed after a CEO takes office, number of directors over 69 years old, number of busy directors. The categories that follow are financial expertise of the board, anti-takeover provisions, and institutional investor holdings. The number of observations varies by firm-outcome groups because of the different requirements for the number of non-missing observations.

4. Prediction models

We use gradient boosting of regression trees (Freund and Schapire, 1997; Friedman, 2001)[6] to relate corporate governance features and firm characteristics in year t to firm outcomes in year $t+1$ or $t+3$.[7] Boosting methods have proved remarkably successful in producing highly accurate out-of-sample predictive performance by combining many relatively inaccurate models such as regression trees (Schapire and Freund, 2012). A regression tree partitions the feature space into a set of regions and uses the mean of the dependent variable as the fitted value for each partition as depicted in Figure 1.[8] For instance, a tree can split the sample by *CEO equity ownership* and use the average operating performance in each region as the estimate. The algorithm can further split these regions by, for instance, *Board tenure*. The second split produces a regression tree with an interaction depth of two because both *CEO equity ownership* and *Board tenure* define a region. This approach estimates a target function by searching in the function space and is shown to provide a consistent estimate when the boosting process is stopped early (Jiang, 2004; Zhang and Yu, 2005; Bartlett and Traskin, 2007).[9]

As discussed in Friedman et al. (2009) (Section 10.7), of all of the predictive methods, trees are the best candidates for the off-the-shelf predictive algorithms because they are fast

[6] We use gradient boosting of regression trees as implemented in the `gbm` R package by Ridgeway (2020).

[7] By using firm and corporate governance characteristics at time t to predict outcomes in $t+1$ or $t+3$, we rely on the notion of "predictive causality" or "Granger causality" Granger (1969). Diebold (2006) explains it as follows: "the notion of predictive causality contains little if any information about causality in the philosophical sense [...] is just a shorthand for [...] y_i contains useful information for predicting y_j [...] over and above the past histories of the other variables in the system."

[8] Strictly speaking, this is the approach that minimizes squared error; other loss functions will yield different estimators, such as the median.

[9] Experiments and theoretical studies have shown that boosting methods can overfit in the limit of large time or the number of rounds (e.g., Grove and Schuurmans, 1998; Jiang, 2004) and, to achieve consistency, some regularization such as early stopping is necessary.

to construct, interpretable, invariant to strictly monotone transformations of features, and immune to the effects of outliers in features. Regression trees also perform internal feature selection and, as a result, are resistant to the inclusion of irrelevant predictor features. Thus, when we include over a hundred corporate governance features and firm characteristics, the algorithm tends to ignore features that are irrelevant for predicting firm outcomes. However, a single tree is inaccurate and a gradient boosted model often dramatically improves its accuracy while maintaining desirable properties. The boosted tree model is essentially a weighted sum of trees that minimizes a loss function. Each iteration adds a new tree that maximally improves the fit to the data given the already existing model and its fit (Friedman, 2001). This procedure divides the feature space with much higher granularity than a single tree. For firm outcomes captured by indicator variables, we use AdaBoost exponential loss function. For continuous firm outcomes, we use squared error loss function. This is a standard choice for prediction problems with continuous outcomes.

The gradient boosting algorithm depends on three meta-parameters. The first parameter is the interaction depth of the regression trees, which is the number of splits considered for each tree or the highest level of variable interactions allowed.[10] As the optimal value of interaction depth is low in most problems (Friedman et al., 2009), we set this parameter equal to 1, 2, 3, 5, or 7, and select an optimal parameter using cross-validation. The second parameter is the shrinkage or learning parameter, which scales the contribution of each new tree that is added to the model. This parameter controls the learning rate with smaller values reducing over-fitting and thus improving out-of-sample performance (Friedman, 2001). We set the shrinkage parameter to 0.01, which James et al. (2013, p. 323) identifies

[10] A value of 1 implies an additive model, a value of 2 implies a model with up to two-way interactions, etc.

as a "typical value." The third parameter is the number of trees in the model. There is a trade-off between shrinkage and the optimal number of trees in the model. Smaller values of shrinkage require correspondingly larger values for the number of trees. We set the maximum number of trees to 50,000. Because the algorithm starts with a single tree and grows the model one tree at a time, this means we fit 50,000 models with various interaction depths.

Two parameters—the interaction depth of the regression trees and the number of trees—are chosen by cross-validation in the training data. We set the cross-validation on a rolling basis. For each year t in the training data, we use all the data up to and including year t to estimate the model and then use the following year $t + 1$ as the validation set, i.e., apply the estimated model to the data from $t + 1$ to compute the prediction error (validation set error). For instance, we estimate a model using data from 2001, and then apply the estimated model to the data from 2002 to compute the prediction error. Next, we estimate a model using combined data from 2001 and 2002, and then apply the estimated model to the data from 2003 to compute the prediction error. We continue doing that until the last year in the training sample that is also the last validation year. This process produces average validation errors for each combination of the interaction depth and the number of trees in the model. We then choose the simplest model with an average validation error within 0.001 of the smallest average validation error achieved by models with various numbers of tress and interaction depths. This process favors simpler models with a smaller number of trees and lower interaction depths (e.g., Friedman et al., 2009; Kuhn et al., 2013).

5. Results

After selecting the meta-parameters for each of the models on the training data, we apply these models to each of the three test years from the end of the sample period. The meta-parameters are thus fixed from the training data. However, we still allow the models to learn from the most recent data available for a test year. For instance, data for restatements of financial statements covers the period from 2001 to 2016. We use data from 2001 to 2012 for training and selection of meta-parameters and data from 2013 to 2015 for the out-of-sample test period. For 2013 test data, we re-estimate the model using 2001–2012 data (with meta-parameters from 2001–2012 training data) and apply it to 2013 test data to compute test error. For 2014 test data, we re-estimate the model using 2001–2013 data (again, with meta-parameters from 2001–2012 training data) and apply it to 2014 test data to compute test error. For 2015 test data, we re-estimate the model using 2001–2014 data (again, with meta-parameters from 2001–2012 training data) and apply it to 2015 test data to compute test error. Importantly, the test-year data is *not* used in meta-parameter selection or model re-estimation, and thus allows for a genuine out-of-sample test of the model. For the outcomes measured by the indicator variables, we compute the test error as $ln(1 + \texttt{AdaBoost error})$. For the outcomes measured by the continuous variables, we compute the test error as RMSE (Root Mean Squared Error). By construction, both errors are positive with lower values corresponding to a better model, i.e., a model with better prediction accuracy. Because general patterns of results are similar for different outcomes, we present the results for three outcomes—serious financial-statement restatements, operating performance, and credit ratings—in the main

text of the paper and for the remaining outcomes in the Internet Appendix.

5.1 Meta-parameters choice

Table 2 and Table IA.2 in Internet Appendix provide meta-parameters for the gradient boosting of regression trees models (GBM) selected on the training data by the cross-validation procedure in Section 4. We chose the tree depth and the number of trees to minimize cross-validation errors. We consider the models that include firm and corporate governance characteristics combined and on their own to predict future outcomes at $t + 1$ and $t + 3$.

The following general pattern emerges for all outcomes. The models that combine firm and corporate governance characteristics or that only include corporate governance are generally more complex. They have greater tree depth, i.e., include more complex interaction terms, and have greater number of trees, i.e., include larger number of terms. This increase in model complexity entails greater computational cost with more complex models taking longer to estimate. Among different outcomes, models for S&P credit ratings are the most complex. All models for S&P credit ratings have the tree depth of 7, i.e., the highest level of variable interactions allowed is 7-way interactions. The size of the model increases from $5,100$ trees for firm characteristics, $20,650$ trees for firm and corporate governance characteristics, and $40,850$ for corporate governance alone.

However, this increase in complexity does not come with the substantial improvement in cross-validation errors. While adding corporate governance to the firm-characteristics-only models does often reduce the cross-validation errors, this reduction is not substantial. By contrast, having corporate governance on its own, again, results in more complex but

less accurate models. For instance, for return on assets, the tree depth is 3, i.e., allows for 3-way interactions, and the size of the model is 1,050 producing an error of 0.086 for firm characteristics; the tree depth is 3 and the size of the model is 1,380 producing the same error of 0.086 for firm and corporate governance characteristics combined; and the tree depth is 7 and the size of the model is 42,700 producing the larger error of 0.138 for corporate governance alone. Greater complexity of corporate-governance-only models and the lack of substantial improvement in cross-validation errors suggests that the GBM has a difficulty with extracting an informative signal about an outcome using these variables. Perhaps this happens because corporate governance is not as informative about outcomes as firm characteristics, which weighs against a strong causal effect of corporate governance.

5.2 Out-of-sample predictive performance

Out-of-sample errors are reported separately for each test year in sub-panels of Tables 3–8 and Tables IA.3–IA.14 in Internet Appendix. We also report t-statistics values that test for statistically significant differences in errors for each test year. With t-statistics, we compare the model in the column to the model in the corresponding row. That is, the value is positive when the model in the column is more accurate than the model in the corresponding row, i.e., has *lower* error; the value is negative when the model in the column is less accurate than the model in the corresponding row, i.e., has *higher* error. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction.

For each outcome, there are two tables. The first table contrasts errors from models that include firm characteristics alone and firm characteristics combined with corporate

governance. The second table contrasts errors from models that include firm characteristics and corporate governance on their own. Out-of-sample prediction errors for more serious financial-statement restatements are in Tables 3–4, for operating performance in Tables 5–6, and for credit ratings in Tables 7–8. In Internet Appendix, out-of-sample prediction errors for the broader definition of financial-statement restatements are in Tables IA.3–IA.4, for class-action lawsuits in Tables IA.5–IA.6, for business failures in Tables IA.7–IA.8, for firm value in Tables IA.9–IA.10, for stock returns in Tables IA.11–IA.12, and for investment-grade debt in Tables IA.13–IA.14. All of the firm outcomes for year t are computed as leads $t+1$ and $t+3$. Considering a longer horizon $t+3$ allows us to capture the possibility of a long-term effect of governance variables.

The following general pattern emerges. Models based on firm characteristics alone outperform base models. The exception is stock returns for which none of the models outperform the base model. Although adding corporate governance leads to a reduction in errors, this reduction is not statistically significant. Thus, adding corporate governance to the firm-characteristics-only models does not improve prediction accuracy. A similar pattern emerges when considering firm and corporate governance characteristics on their own. Corporate-governance-only models do not perform better than base models with two exceptions of compensation and board characteristics and, typically, have larger errors. Compensation and board characteristics often outperform base models but do not deliver accuracy that is statistically different from the accuracy of firm-characteristics-only models, e.g., financial restatement events, class-action lawsuits, business failures, or deliver performance that is statistically inferior to the firm-characteristics-only models, e.g., operating performance, firm value, having an investment grade debt, and S&P credit rating.

The two outcomes that deviate from the general pattern in a meaningful way are S&P credit rating in Tables 7–8 and having an investment grade debt in Tables IA.13–IA.14 in Internet Appendix. For S&P credit ratings, adding compensation or board characteristics improves the accuracy over firm-characteristics-only models in Table 7. As for Tables 8, while the accuracy of corporate-governance-only models outperforms base models for *all* corporate governance groups, these models are statistically inferior to firm-characteristics-only models. Both of the outcomes come from the S&P credit ratings data and, hence, these accuracy patterns can capture the S&P's credit-rating methodology. Indeed, the S&P discloses that it evaluates management and governance of a firm as part of its credit rating process,[11] and our machine learning models could have just uncovered this fact from the data.

To frame these results, one can think of two extreme possibilities. First, only firm characteristics, X_1, are relevant and corporate governance characteristics, X_2, are irrelevant for firm outcomes, Y. Second, X_1 fully captures the effect of X_2 on Y. If X_1 and X_2 are capturing the same information about Y, we should see similar accuracy for the models that include X_1 and X_2 on their own, which is not the case. Instead, the two patterns are: (1) X_1-only models outperform base models but X_2-only models perform similarly to base models, e.g., financial restatement events, class-action lawsuits, business failures and (2) X_2-only models outperform base models but under-perform X_1-only models, e.g., operating performance, firm value, having investment grade debt, and S&P credit rating. For (1), while X_2-only models are similar to base models, they are often not statistically

[11] See S&P Global Ratings disclosures "Criteria | Corporates | General: Corporate Methodology" and "General Criteria: Methodology: Management And Governance Credit Factors For Corporate Entities General Criteria: Methodology: Management And Governance Credit Factors For Corporate Entities".

inferior to X_1-only models, which outperform base models, suggesting substantial noise in Y. For (2), while X_2-only models are informative for Y, they are statistically inferior to X_1-only models suggesting that X_1 is relatively more informative. This last point is consistent with the results when X_2 is *added* to X_1-only models in which case errors decrease but not much.

Based on this evidence, while we cannot say that corporate governance characteristics X_2 are irrelevant, omitting them in predictive models bears no substantial loss of accuracy. By contrast, omitting firm characteristics X_1 triggers a substantial accuracy loss. Because we find little evidence for X_1 and X_2 providing the same information about Y, according to Section 2.3, the more likely interpretation of our results is that corporate governance has a trivial causal effect relative to firm characteristics, if any. Explainable variation in firm outcomes is thus mainly captured by firm characteristics.

5.3 Variable importance

Figures 2–4 and Figures IA.1–IA.6 in Internet Appendix show the characteristics that matter most for predicting firm outcomes in the models that include firm and all corporate governance variables. We compute the relative importance of various characteristics as the reduction of the error attributable to this predictor as described in Friedman (2001). There is a mix of firm and corporate governance characteristics among the top predictors for some outcomes, e.g., financial restatement events, class-action lawsuits, stock returns. For other outcomes, top predictors comprise of firm characteristics alone, e.g., business failures, return on assets, firm value, having investment grade debt, S&P credit rating.

The most important variables align well with the extant literature. For financial restate-

ment events, having financial experts on the board and executive compensation matters (e.g., Cohen et al., 2014; Armstrong et al., 2010). For class-action lawsuits, the most important predictors are industry and size (e.g., Rogers and Stocken, 2005). For business failures, the most important predictors are stock price and excess stock return (e.g., Campbell et al., 2008). For return on assets and firm value, the most important predictor is their lagged values (e.g., Larcker et al., 2007). Interestingly, for stock returns, growth in CEOs' equity holdings is the most important predictor followed by book-to-market ratio. However, these models do not outperform the uninformed baseline out-of-sample. For credit-rating outcomes, industry and size are the most important predictors (e.g., Daines et al., 2010).

We also aggregate variable importance by firm and corporate governance groups. For all outcomes except for stock returns, firm characteristics is the most important group of predictors. It is often followed by compensation as the second tangibly relevant group of predictors, which is consistent with a large literature on the importance of compensation incentives (e.g., Edmans et al., 2017). These relative importance rankings corroborate in-sample and out-of-sample results that firm characteristics contain the most predictive variation for firm outcomes.

6. Conclusion

Some predictive ability is a necessary condition for a causal effect to exist (Freedman, 1991; Manski, 2009; Watts, 2014). We evaluate predictive ability of over a hundred of corporate governance characteristics for important firm outcomes. We discover that adding corporate governance does not improve the models' predictive accuracy beyond the predictive

accuracy captured by firm characteristics. While the models become more complex, firm characteristics still dominate in terms of their relative importance for prediction. Based on these results, we conclude that little support exists for a strong causal relation between corporate governance and firm outcomes, which are primarily driven by firm characteristics.

We have focused on the criterion of out-of-sample predictive ability. Underspecified models may predict better than fully specified causal models (Hagerty and Srinivasan, 1991; Wu et al., 2007). Suppose that a fully specified (causal) model includes both firm and corporate governance features. It is hard to conceive that an underspecified model with a better predictive ability derived from such a model would omit *all* of the (causal) corporate governance features as our results suggest. So, the existence of such a fully-specified model is unlikely.

We might have missed some of the governance features and could have used a different machine learning algorithm. Our approach can easily incorporate corporate governance attributes we might have missed. As for the choice of the machine learning algorithm, as Athey and Imbens (2019, p. 686) put it: "There are no formal results that show that, for supervised learning problems, deep learning or neural net methods are uniformly superior to regression trees or random forests, and it appears unlikely that general results for such comparisons will soon be available, if ever." Nevertheless, future research can test sensitivity of our findings to both of these choices.

References

Adams, R. B., 2017. Boards, and the directors who sit on them. In: *The Handbook of the Economics of Corporate Governance*, Elsevier, vol. 1, pp. 291–382.

Agrawal, A., Knoeber, C. R., 1996. Firm performance and mechanisms to control agency problems between managers and shareholders. Journal of Financial and Quantitative Analysis 31, 377–397.

Agrawal, M., Peterson, J. C., Griffiths, T. L., 2020. Scaling up psychology via scientific regret minimization. Proceedings of the National Academy of Sciences 117, 8825–8835.

Amihud, Y., Schmid, M., Davidoff Solomon, S., 2017. Do staggered boards affect firm value? Available at SSRN 2948141 .

Amihud, Y., Stoyanov, S., 2017. Do staggered boards harm shareholders? Journal of Financial Economics 123, 432–439.

Armstrong, C. S., Jagolinzer, A. D., Larcker, D. F., 2010. Chief executive officer equity incentives and accounting irregularities. Journal of Accounting Research 48, 225–271.

Ashbaugh-Skaife, H., Collins, D. W., LaFond, R., 2006. The effects of corporate governance on firms' credit ratings. Journal of Accounting and Economics 42, 203–243.

Athey, S., Imbens, G. W., 2019. Machine learning methods that economists should know about. Annual Review of Economics 11, 685–725.

Avedian, A., Cronqvist, H., Weidenmier, M., 2015. Corporate governance and the creation of the SEC. Swedish House of Finance Research Paper .

Baliga, B. R., Moyer, R. C., Rao, R. S., 1996. CEO duality and firm performance: What's the fuss? Strategic Management Journal 17, 41–53.

Bartlett, P. L., Traskin, M., 2007. AdaBoost is consistent. Journal of Machine Learning Research 8, 2347–2368.

Bebchuk, L., Cohen, A., Ferrell, A., 2009. What matters in corporate governance? Review of Financial Studies 22, 783–827.

Bhagat, S., Black, B., 2001. The non-correlation between board independence and long-term firm performance. Journal of Corporation Law 27, 231.

Bhojraj, S., Sengupta, P., 2003. Effect of corporate governance on bond ratings and yields: The role of institutional investors and outside directors. Journal of Business 76, 455–475.

Boyd, B. K., 1995. CEO duality and firm performance: A contingency model. Strategic Management Journal 16, 301–312.

Brickley, J. A., Coles, J. L., Jarrell, G., 1997. Leadership structure: Separating the CEO and chairman of the board. Journal of Corporate Finance 3, 189–220.

Campbell, J. Y., Hilscher, J., Szilagyi, J., 2008. In search of distress risk. Journal of Finance 63, 2899–2939.

Cohen, A., Wang, C. C., 2013. How do staggered boards affect shareholder value? Evidence from a natural experiment. Journal of Financial Economics 110, 627–641.

Cohen, A., Wang, C. C., 2017. Reexamining staggered boards and shareholder value. Journal of Financial Economics 125, 637–647.

Cohen, J. R., Hoitash, U., Krishnamoorthy, G., Wright, A. M., 2014. The effect of audit committee industry expertise on monitoring the financial reporting process. The Accounting Review 89, 243–273.

Cohen, L., Frazzini, A., Malloy, C. J., 2012. Hiring cheerleaders: Board appointments of "independent" directors. Management Science 58, 1039–1058.

Coles, J. L., Daniel, N. D., Naveen, L., 2014. Co-opted boards. Review of Financial Studies 27, 1751–1796.

Cremers, K. M., Litov, L. P., Sepe, S. M., 2017. Staggered boards and long-term firm value, revisited. Journal of Financial Economics 126, 422–444.

Daines, R., Li, S. X., Wang, C. C., 2021. Can staggered boards improve value? Causal evidence from Massachusetts. Contemporary Accounting Research 38, 3053–3084.

Daines, R. M., Gow, I. D., Larcker, D. F., 2010. Rating the ratings: How good are commercial governance ratings? Journal of Financial Economics 98, 439–461.

Dalton, D. R., Daily, C. M., Ellstrand, A. E., Johnson, J. L., 1998. Meta-analytic reviews of board composition, leadership structure, and financial performance. Strategic Management Journal 19, 269–290.

Dechow, P. M., Ge, W., Larson, C. R., Sloan, R. G., 2011. Predicting material accounting misstatements. Contemporary Accounting Research 28, 17–82.

Dey, A., Engel, E., Liu, X., 2011. CEO and board chair roles: To split or not to split? Journal of Corporate Finance 17, 1595–1618.

Dhar, V., 2013. Data science and prediction. Communications of the ACM 56, 64–73.

Diebold, F. X., 2006. Elements of Forecasting.

Duchin, R., Matsusaka, J. G., Ozbas, O., 2010. When are outside directors effective? Journal of Financial Economics 96, 195–214.

Edmans, A., Gabaix, X., Jenter, D., 2017. Executive compensation: A survey of theory and evidence. The Handbook of the Economics of Corporate Governance 1, 383–539.

Faleye, O., 2007. Classified boards, firm value, and managerial entrenchment. Journal of Financial Economics 83, 501–529.

Fama, E. F., French, K. R., 2015. A five-factor asset pricing model. Journal of Financial Economics 116, 1–22.

Fracassi, C., Tate, G., 2012. External networking and internal firm governance. Journal of Finance 67, 153–194.

Francis, B. B., Hasan, I., Wu, Q., 2012. Do corporate boards matter during the current financial crisis? Review of Financial Economics 21, 39–52.

Freedman, D. A., 1991. Statistical models and shoe leather. Sociological Methodology pp. 291–313.

Freund, Y., Schapire, R. E., 1997. A decision-theoretic generalization of on-line learning and an application to boosting. Journal of Computer and System Sciences 55, 119–139.

Friedman, J., Hastie, T., Tibshirani, R., 2009. The elements of statistical learning: Data mining, inference, and prediction. New York, NY: Springer-Verlag New York.

Friedman, J. H., 2001. Greedy function approximation: A gradient boosting machine. Annals of Statistics pp. 1189–1232.

Fudenberg, D., Kleinberg, J., Liang, A., Mullainathan, S., 2022. Measuring the completeness of economic models. Journal of Political Economy 130, 956–990.

Ge, W., Tanlu, L., Zhang, J. L., 2016. What are the consequences of board destaggering? Review of Accounting Studies 21, 808–858.

Goergen, M., Limbach, P., Scholz-Daneshgari, M., 2020. Firms' rationales for CEO duality: Evidence from a mandatory disclosure regulation. Journal of Corporate Finance 65, 101770.

Gompers, P., Ishii, J., Metrick, A., 2003. Corporate governance and equity prices. Quarterly Journal of Economics 118, 107–156.

Granger, C. W., 1969. Investigating causal relations by econometric models and cross-spectral methods. Econometrica: Journal of the Econometric Society pp. 424–438.

Grove, A. J., Schuurmans, D., 1998. Boosting in the limit: Maximizing the margin of learned ensembles. In: *AAAI/IAAI*, pp. 692–699.

Guo, R.-J., Kruse, T. A., Nohel, T., 2008. Undoing the powerful anti-takeover force of staggered boards. Journal of Corporate Finance 14, 274–288.

Hagerty, M. R., Srinivasan, V., 1991. Comparing the predictive powers of alternative multiple regression models. Psychometrika 56, 77–85.

Hempel, C. G., Oppenheim, P., 1948. Studies in the logic of explanation. Philosophy of Science 15, 135–175.

Hennes, K. M., Leone, A. J., Miller, B. P., 2008. The importance of distinguishing errors from irregularities in restatement research: The case of restatements and CEO/CFO turnover. The Accounting Review 83, 1487–1519.

Hermalin, B., Weisbach, M., 2003. Boards of directors as an endogenously determined institution: A survey of the economic literature. Economic Policy Review 9, 7–26.

Hermalin, B. E., Weisbach, M. S., 1991. The effects of board composition and direct incentives on firm performance. Financial Management pp. 101–112.

Hofman, J. M., Watts, D. J., Athey, S., Garip, F., Griffiths, T. L., Kleinberg, J., Margetts, H., Mullainathan, S., Salganik, M. J., Vazire, S., et al., 2021. Integrating explanation and prediction in computational social science. Nature 595, 181–188.

Hwang, B.-H., Kim, S., 2009. It pays to have friends. Journal of Financial Economics 93, 138–158.

James, G., Witten, D., Hastie, T., Tibshirani, R., 2013. An Introduction to Statistical Learning with Applications in R. Springer Texts in Statistics, Spring-Verlag, New York.

Jiang, W., 2004. Process consistency for AdaBoost. Annals of Statistics 32, 13–29.

Klein, A., 1998. Firm performance and board committee structure. Journal of Law and Economics 41, 275–304.

Knyazeva, A., Knyazeva, D., Masulis, R. W., 2013. The supply of corporate directors and board independence. Review of Financial Studies 26, 1561–1605.

Krause, R., Semadeni, M., Cannella Jr, A. A., 2014. CEO duality: A review and research agenda. Journal of Management 40, 256–286.

Kuhn, M., Johnson, K., et al., 2013. Applied predictive modeling, vol. 26. Springer.

Larcker, D., Tayan, B., 2015. Corporate governance matters: A closer look at organizational choices and their consequences. Pearson education.

Larcker, D. F., Ormazabal, G., Taylor, D. J., 2011. The market reaction to corporate governance regulation. Journal of Financial Economics 101, 431–448.

Larcker, D. F., Richardson, S. A., Tuna, I., 2007. Corporate governance, accounting outcomes, and organizational performance. The Accounting Review 82, 963–1008.

Larcker, D. F., Tayan, B., 2016. Chairman and CEO: The controversy over board leadership structure. Rock Center for Corporate Governance at Stanford University Closer Look Series: Topics, Issues and Controversies in Corporate Governance No. CGRP-58, Stanford University Graduate School of Business Research Paper .

Manski, C. F., 2009. Identification for prediction and decision. Harvard University Press.

Nguyen, B. D., 2012. Does the rolodex matter? Corporate elite's small world and the effectiveness of boards of directors. Management Science 58, 236–252.

Nguyen, B. D., Nielsen, K. M., 2010. The value of independent directors: Evidence from sudden deaths. Journal of Financial Economics 98, 550–567.

Ogneva, M., Piotroski, J. D., Zakolyukina, A. A., 2020. Accounting fundamentals and systematic risk: Corporate failure over the business cycle. The Accounting Review 95, 321–350.

Peysakhovich, A., Naecker, J., 2017. Using methods from machine learning to evaluate behavioral models of choice under risk and ambiguity. Journal of Economic Behavior & Organization 133, 373–384.

Ridgeway, G., 2020. gbm: Generalized Boosted Regression Models. R package version 2.1.8.

Rogers, J. L., Stocken, P. C., 2005. Credibility of management forecasts. The Accounting Review 80, 1233–1260.

Rosenstein, S., Wyatt, J. G., 1990. Outside directors, board independence, and shareholder wealth. Journal of Financial Economics 26, 175–191.

Schapire, R., Freund, Y., 2012. Boosting: Foundations and Algorithms. MIT Press.

Shmueli, G., 2010. To explain or to predict? Statistical Science 25, 289–310.

Terry, S. J., Whited, T. M., Zakolyukina, A. A., 2022. Information versus investment. Review of Financial Studies, *Forthcoming* .

Watts, D. J., 2014. Common sense and sociological explanations. American Journal of Sociology 120, 313–351.

Wu, S., Harris, T., McAuley, K., 2007. The use of simplified or misspecified models: Linear case. The Canadian Journal of Chemical Engineering 85, 386–398.

Yarkoni, T., Westfall, J., 2017. Choosing prediction over explanation in psychology: Lessons from machine learning. Perspectives on Psychological Science 12, 1100–1122.

Zakolyukina, A. A., 2018. How common are intentional GAAP violations? Estimates from a dynamic model. Journal of Accounting Research 56, 5–44.

Zhang, T., Yu, B., 2005. Boosting with early stopping: Convergence and consistency. Annals of Statistics 33, 1538–1579.

Table A.1: **Variable definitions**

Panel A: Corporate governance: Institutional investor holdings

Variable	Definition
Instit. ownership	Company's common stock held by institutional investors (%)
Instit. ownership., top 5	Company's common stock held by the five largest institutional investors (%)
Blockholder	Percent of company's stock held by institutions owning 5% or more

Panel B: Corporate governance: Anti-takeover provisions

Variable	Definition
PA, OH, WI, MA incorporated	An indicator for the firm being incorporated in Pennsylvania, Ohio, Wisconsin, or Massachusetts
Staggered board	An indicator variable for the firm having a staggered board
Unequal voting rights	An indicator variable for the unequal voting rights across common shareholders
Poison pill	An indicator variable for the firm having adopted a poison pill (in effect)
Supermajority to amend charter	An indicator variable for the firm having a supermajority provision to amend charter
Supermajority to approve mergers	An indicator variable for the firm having a supermajority provision to approve mergers
Supermajority to amend bylaws	An indicator variable for the firm having a supermajority provision to amend bylaws

Panel C: Corporate governance: Executive compensation

Variable	Definition
Shares held (%), CEO	Percent of common shares held by the CEO
Total shares held (%), exec.	Percent of common shares held by non-CEO executives
Avg. shares held (%), exec.	Average non-CEO executive share ownership
Var. shares held (%), exec.	Variance of non-CEO executive share ownership
Comp-type, CEO	Compensation-type received by the CEO (see comp-type below)
Avg. comp-type, exec.	Average compensation-type received by non-CEO executives (see comp-type below)
Var. comp-type, exec.	Variance of compensation-type received by non-CEO executives (see comp-type below)
Comp-type, exec., ratio	Log-ratio of CEO to non-CEO executives compensation-type (see comp-type below)
Comp-type: Stock awards	Restricted stock awards (number of shares in millions)
Comp-type: Cash compensation	Total cash compensation
Comp-type: Value option grants	Black-Scholes value of new option grants
Comp-type: Value vested options	Black-Scholes value of vested unexercised options
Comp-type: Value non-vested options	Black-Scholes value of non-vested options
Comp-type: Value shares held	Value of shares held
Comp-type: Delta option grants	Black-Scholes delta of new option grants

Table A.1: —*Continued*

Variable	Definition
Comp-type: Delta vested options	Black-Scholes delta of vested unexercised options
Comp-type: Delta non-vested options	Black-Scholes delta of non-vested options
Comp-type: Delta shares held	Delta of shares held (i.e., the number of shares held)
Comp-type: Vega option grants	Black-Scholes vega of new option grants
Comp-type: Vega vested options	Black-Scholes vega of vested unexercised options
Comp-type: Vega non-vested options	Black-Scholes vega of non-vested options
Comp-type: Value all equity	Black-Scholes value of all equity held
Comp-type: Delta all equity	Black-Scholes delta of all equity held
Comp-type: Vega all equity	Black-Scholes vega of all equity held
Comp-type: Value vested equity	Black-Scholes value of all vested equity
Comp-type: Delta vested equity	Black-Scholes delta of all vested equity
Comp-type: Vega vested equity	Black-Scholes vega of all vested equity
Comp-type: Value all equity log-growth	Log-growth of Black-Scholes value of all equity
Comp-type: Delta all equity log-growth	Log-growth of Black-Scholes delta of all equity
Comp-type: Vega all equity log-growth	Log-growth of Black-Scholes vega of all equity

Panel D: Corporate governance: Board's financial expertise

Variable	Definition
Num. financial experts	Number of financial experts on the board
Financial experts (%)	Percent of financial experts on the board
Num. audit insiders	Number of insider directors on the audit committee
Audit insiders (%)	Percent of insider directors on the audit committee
Num. finance insiders	Number of insider directors on the finance committee
Finance insiders (%)	Percent of insider directors on the finance committee
Num. audit directors	Number of directors on the audit committee
Audit directors (%)	Percent of directors on the audit committee
Num. finance directors	Number of directors on the finance committee
Finance directors (%)	Percent of directors on the finance committee

Panel E: Corporate governance: Board characteristics

Variable	Definition
Num. post-CEO directors	Number of directors who joined the board after CEO was appointed
Post-CEO directors (%)	Percent of directors who joined the board after CEO was appointed

Table A.1: —*Continued*

Variable	Definition
Num. over 69 directors	Number of directors who are older than 69 years old
Over 69 directors (%)	Percent of directors who are older than 69 years old
Avg. director age	Average director age
Num. busy directors	Number of directors who are busy (on at least three boards)
Busy directors (%)	Percent of directors who are busy (on at least three boards)
Num. directors	Number of directors on the board
CEO Chairman of the board	An indicator variable for CEO also holding the title of the Chairman of the board
Num. CEO directors	Number of directors who are also CEOs of another firm
CEO directors (%)	Percent of directors who are also CEOs of another firm
Num. outsider directors	Number of directors who are not also officers of the firm
Outsider directors (%)	Percent of directors who are not also officers of the firm
Num. insider directors	Number of directors who are also officers of the firm
Insider directors (%)	Percent of directors who are also officers of the firm
Num. affiliate directors	Number of directors who are affiliated
Affiliate directors (%)	Percent of directors who are affiliated
Board tenure	The average tenure of outsider directors
Female directors (%)	Percent of female directors
Total equity, director	Total equity owned by directors
Avg. equity, director	Average equity owned by directors
Var. equity, director	Variance of equity owned by directors
Num. nomination insiders	Number of insider directors on the nomination committee
Nomination insiders (%)	Percent of insider directors on the nomination committee
Num. compensation insiders	Number of insider directors on the compensation committee
Compensation insiders (%)	Percent of insider directors on the compensation committee
Num. compliance insiders	Number of insider directors on the compliance committee
Compliance insiders (%)	Percent of insider directors on the compliance committee
Num. governance insiders	Number of insider directors on the governance committee
Governance insiders (%)	Percent of insider directors on the governance committee
Num. nomination directors	Number of directors on the nomination committee
Nomination directors (%)	Percent of directors on the nomination committee
Num. compensation directors	Number of directors on the compensation committee
Compensation directors (%)	Percent of directors on the compensation committee
Num. compliance directors	Number of directors on the compliance committee

Table A.1: —*Continued*

Variable	Definition
Compliance directors (%)	Percent of directors on the compliance committee
Num. governance directors	Number of directors on the governance committee
Governance directors (%)	Percent of directors on the governance committee
Avg. value shares held, director	Average value of shares held by directors
Var. value shares held, director	Variance of value of shares held by directors
Value shares held, director, ratio	Log-ratio of CEO to director value of shares held
Panel F: Outcome group: Restatements of financial statements	
Variable	Definition
Restatements as in Hennes et al. (2008)	An indicator variable for more serious financial-statement restatements as defined in Terry et al. (2022) that incorporate criteria from Hennes et al. (2008)
Restatement events	An indicator variable for the broad category of financial-statement restatement events as defined in Terry et al. (2022)
RSST accruals	Accruals following Richardson et al. (2005) divided by average total assets (AT)
Receivables growth	Change in receivable (RECT) divided by average total assets (AT)
Inventory growth	Change in inventory (INVT) divided by average total assets (AT)
Soft assets	(Total Assets (AT) - PP&E (PPENT) - Cash and Cash Equivalent (CHE))/Total Assets (AT)
Cash sales growth	Change in cash sales [Sales (SALE) - Change Accounts Receivable (RECT)] divided by average total assets (AT)
Return on assets, growth	One-year growth in return on assets
Issuance	An indicator variable for actual issuance, that is, sale of common and preferred stock or long-term debt issuance greater than zero
Panel G: Outcome group: Class-action lawsuits	
Variable	Definition
Class-action lawsuits	An indicator variable for the fiscal year overlapping with a class-action period
Size, log	Log of the average market value of equity measured in dollars
Turnover	Average daily trading volume divided by the average shares outstanding
Beta	Slope from regressing daily returns on CRSP value-weighted index
Stock returns, 12-month	Stock returns over 12 months
Volatility, 12-month	Standard deviation of daily returns over 12 months
Daily returns, skewness	Skewness of daily returns
Min. daily returns	Minimum of the daily returns

Table A.1: —*Continued*

Variable	Definition
Bio-technology industry	An indicator variable for SIC being between 2833 and 2836
Computer hardware industry	An indicator variable for SIC being between 3570 and 3577
Computer software industry	An indicator variable for SIC being between 7371 and 7379
Electronics industry	An indicator variable for SIC being between 3600 and 3674
Retailing industry	An indicator variable for SIC being between 5200 and 5961
	Panel H: Outcome group: Business failure
Variable	Definition
Business failure within 3 years	An indicator variable for a business failure within the next 3 years as defined in Ogneva et al. (2020)
Profit ratio	Moving average of quarterly profitability over the prior fiscal year with higher weights assigned to more recent values as in Campbell et al. (2008), where profitability is equal to net income (NIQ) divided by market-valued total assets. Market-valued total assets are a sum of the market value of equity (CSHOQ x PRCCQ) and total liabilties (LTQ)
Total liabilities to total assets	Total liabilities (LT) divided by market-valued total assets at the fiscal year end (defined as previously)
Excess stock return	Moving average of log excess stock return relative to S&P 500 index over prior 12 months, with higher weights assigned to more recent returns as in Campbell et al. (2008)
Sigma	Standard deviation of daily stock returns over the previous three months
Relative size	A logarithm of the ratio of stock's market value of equity to the total market capitalization of the S&P 500 index at the fiscal year-end
Cash to total assets	Cash holdings divided by market-valued total assets at the fiscal year end (defined as previously)
Market-to-book	Market-to-book as computed in Ogneva et al. (2020)
Price	Logarithm of the stock price (PRCC). We set prices above $15 to $15 as in Campbell et al. (2008)
	Panel I: Outcome group: Return on assets
Variable	Definition
Return on assets, adj.	Industry-adjusted ROA, or the difference between ROA for a firm and the median ROA for its industry in that fiscal year (using two-digit Standard Industrial Classification (SIC) codes for industry classification)
Log market value	Log of market value of common equity
	Panel J: Outcome group: Firm value
Variable	Definition
Tobin's Q	Defined as the ratio (TA+MVE BVE)/TA, where TA is total assets (AT), MVE is market capitalization (PRCC_F x CSHO), and BVE is the book value of equity (CEQ)

Table A.1: —*Continued*

Panel K: Outcome group: Stock returns

Variable	Definition
Stock returns, 12-months	Stock returns over 12 months, starting 3 months after the fiscal year end
Log market value	Log of market value of common equity
Book-to-market	Book value of common equity (CEQ) divided by the market value of common equity
Operating profitability	Operating profitability is (REV - COGS - SG&A - XINT)/CEQ
Investment	Investment is the rate of growth of total assets, i.e. ln(AT t-1/AT t-2)

Panel L: Outcome group: Credit ratings

Variable	Definition
S&P credit rating	The S&P credit rating converted into numerical value following Ashbaugh-Skaife et al. (2006)
Investment grade debt	An indicator variable for having an investment-grade debt, i.e., credit rating at or above speculative grade BBB
Log market value	Log of market value of common equity
Book-to-market	Book value of common equity (CEQ) divided by the market value of common equity
Return on assets	Income from operations (OIADP) divided by average total assets (AT)
Leverage	Ratio of book value of debt (DLTT+DLC) to market value of common equity (PRCCF x CSHO)
Beta	Slope from regressing daily returns on CRSP value-weighted index
Volatility, 12-month	Standard deviation of daily returns over 12 months

Figure 1: **Regression tree**

This figure provides a hypothetical example of a regression tree with 2-way interactions between *CEO equity ownership* and *Board tenure* for *Return on assets* outcome. The final predictions are denoted by R_1, R_2, and R_3. The right figure shows the actual tree. The left figure shows the split of the space of characteristics that corresponds to that tree.

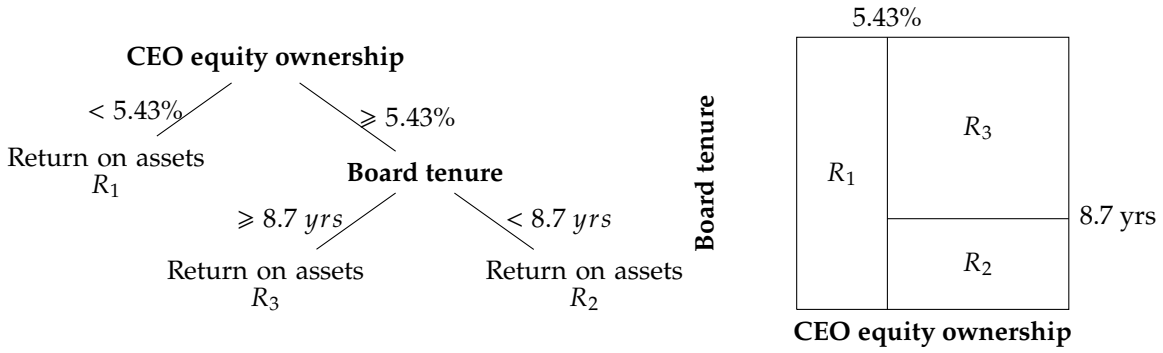
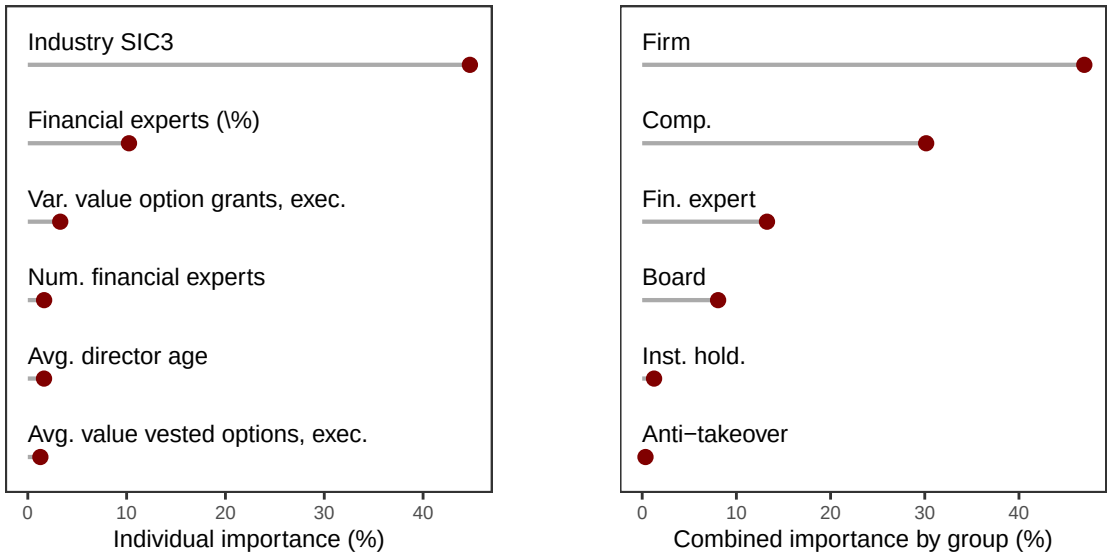


Figure 2: **Variable importance for restatements as in Hennes et al. (2008)**

This figure depicts the relative importance of the top characteristics for predicting restatements as in Hennes et al. (2008) at $t+1$ and $t+3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Restatements as in Hennes et al. (2008)** $t+1$



(b) **Restatements as in Hennes et al. (2008)** $t+3$

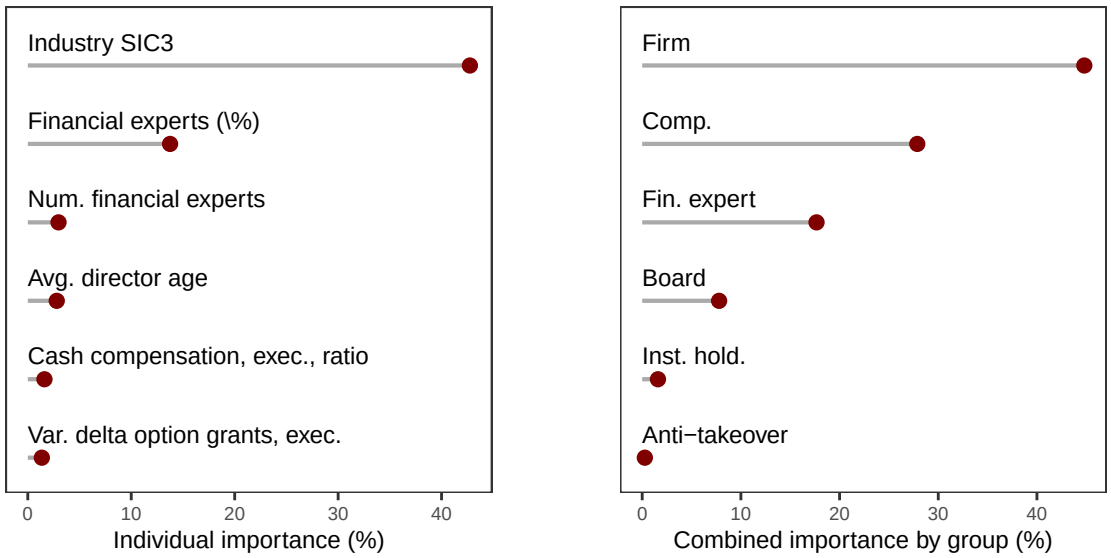
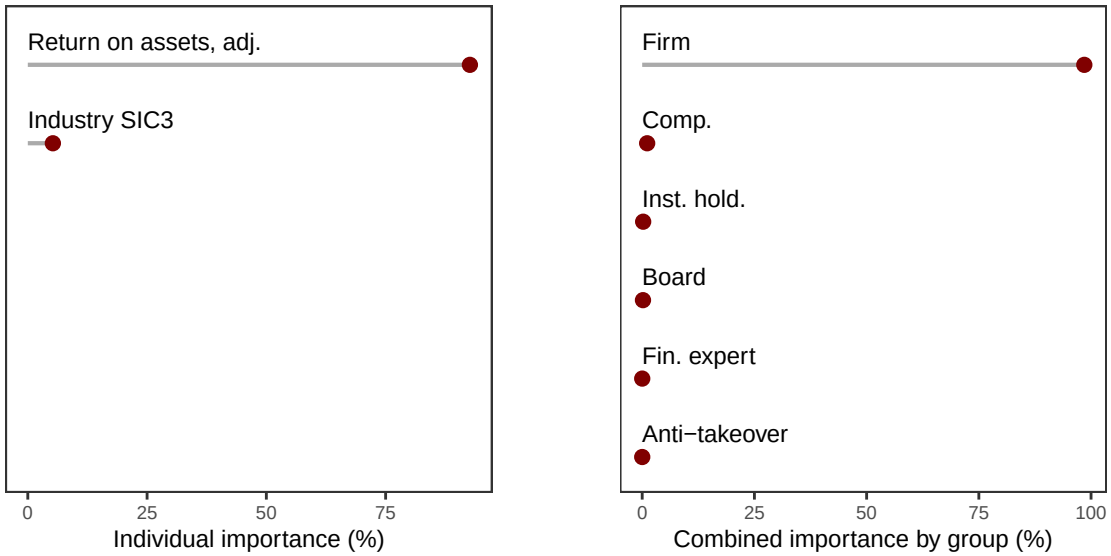


Figure 3: **Variable importance for operating performance**

This figure depicts the relative importance of the top characteristics for predicting operating performance at $t+1$ and $t+3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Return on assets, adj.** $t+1$



(b) **Return on assets, adj.** $t+3$

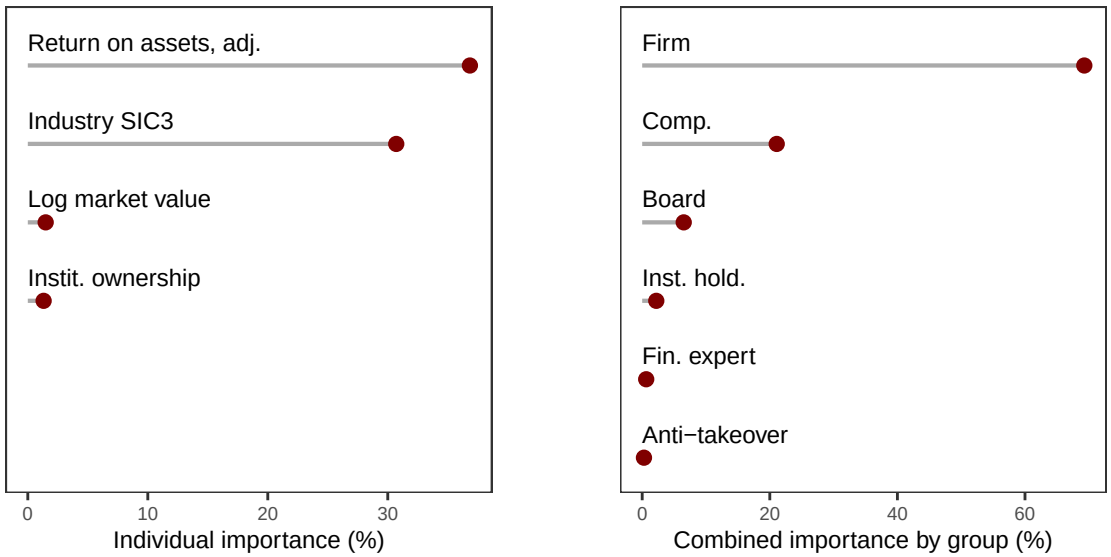
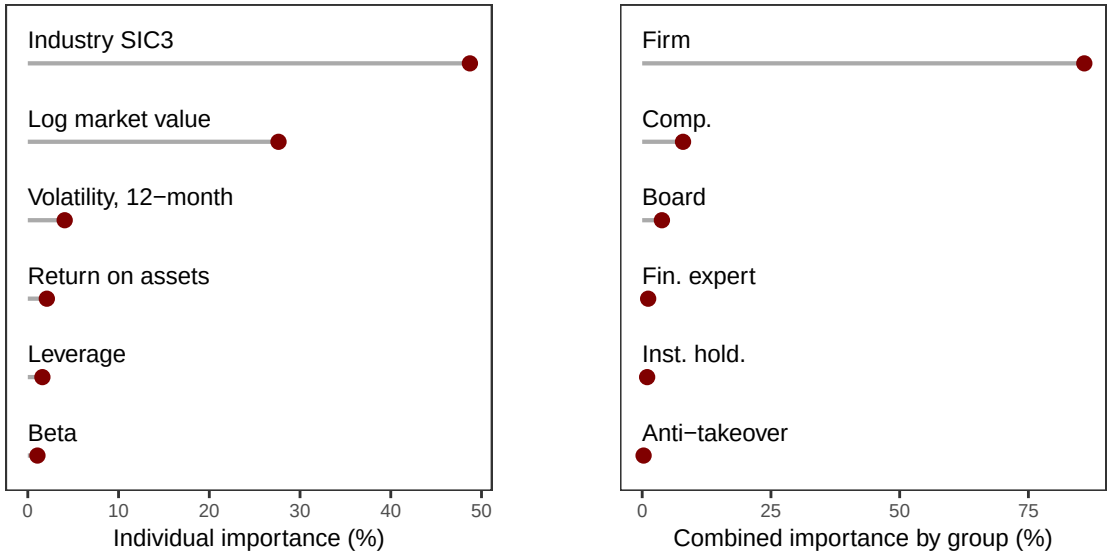


Figure 4: **Variable importance for S&P credit rating**

This figure depicts the relative importance of the top characteristics for predicting S&P credit rating at $t+1$ and $t+3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **S&P credit rating** $t+1$



(b) **S&P credit rating** $t+3$

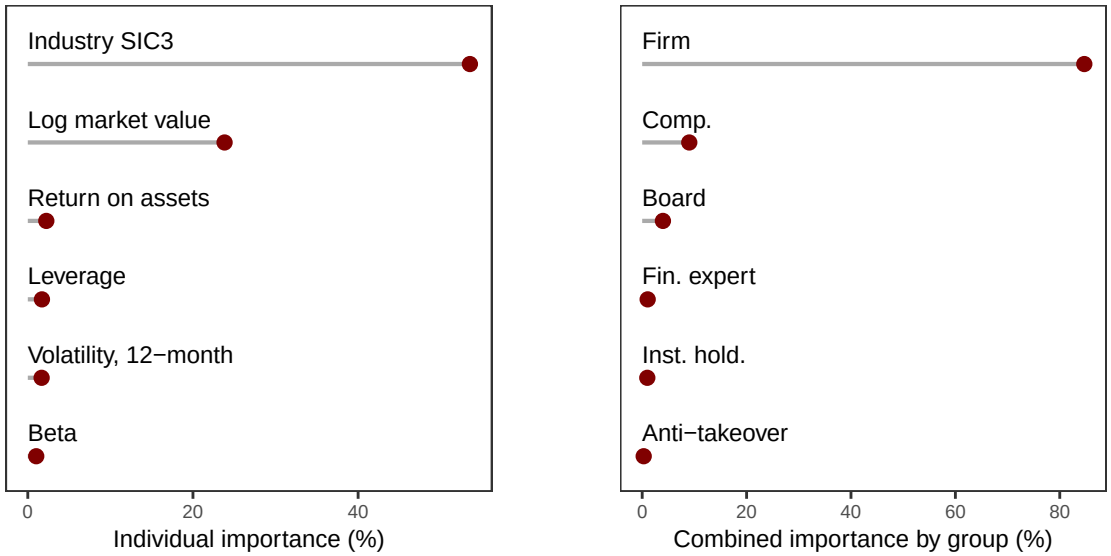


Table 1: **Summary statistics**

This table provides descriptive statistics for the variables used in the analyses defined in Table A.1. All variables are winsorized at the 1st and 99th percentiles.

Panel A: Corporate governance: Institutional investor holdings

Variable	Obs.	Mean	SD	Q25	Median	Q75
Instit. ownership	50,439	60.689	27.347	39.530	65.211	83.352
Instit. ownership., top 5	50,439	27.107	12.639	18.990	26.201	33.915
Blockholder	50,439	18.562	15.428	6.461	15.796	27.407

Panel B: Corporate governance: Anti-takeover provisions

Variable	Obs.	Mean	SD	Q25	Median	Q75
PA, OH, WI, MA incorporated	50,439	0.073	0.261	0.000	0.000	0.000
Staggered board	50,439	0.462	0.499	0.000	0.000	1.000
Unequal voting rights	50,439	0.089	0.285	0.000	0.000	0.000
Poison pill	50,439	0.267	0.442	0.000	0.000	1.000
Supermajority to amend charter	50,439	0.211	0.408	0.000	0.000	0.000
Supermajority to approve mergers	50,439	0.409	0.492	0.000	0.000	1.000
Supermajority to amend bylaws	50,439	0.550	0.498	0.000	1.000	1.000

Panel C: Corporate governance: Executive compensation

Variable	Obs.	Mean	SD	Q25	Median	Q75
Shares held (%), CEO	50,439	4.193	9.618	0.174	0.651	2.716
Total shares held (%), exec.	50,439	2.440	6.697	0.161	0.484	1.417
Avg. shares held (%), exec.	50,439	0.640	1.735	0.040	0.122	0.379
Var. shares held (%), exec.	50,439	8.799	48.510	0.001	0.007	0.100
Stock awards, CEO	50,439	1.029	1.966	0.000	0.089	1.146
Avg. stock awards, exec.	50,439	0.330	0.613	0.000	0.069	0.380
Var. stock awards, exec.	50,439	0.197	0.817	0.000	0.001	0.033
Stock awards, exec., ratio	50,439	0.233	0.389	0.000	0.017	0.426
Cash compensation, CEO	50,439	1.511	1.596	0.545	0.962	1.853
Avg. cash compensation, exec.	50,439	0.689	0.605	0.319	0.489	0.822
Avg. cash compensation, exec.	50,439	0.240	0.938	0.004	0.016	0.075
Cash compensation, exec., ratio	50,439	0.312	0.278	0.132	0.267	0.466
Value option grants, CEO	50,439	0.964	2.110	0.000	0.035	0.920
Avg. value option grants, exec.	50,439	0.295	0.592	0.000	0.054	0.308
Var. value option grants, exec.	50,439	0.253	1.110	0.000	0.001	0.033
Value option grants, exec., ratio	50,439	0.214	0.400	0.000	0.000	0.374
Value vested options, CEO	50,439	5.722	13.009	0.027	0.959	4.799
Avg. value vested options, exec.	50,439	1.132	2.295	0.044	0.293	1.082
Var. value vested options, exec.	50,439	6.722	30.715	0.001	0.064	0.905
Value vested options, exec., ratio	50,439	0.558	0.762	0.000	0.335	1.030
Value non-vested options, CEO	50,439	1.684	3.816	0.000	0.187	1.469
Avg. value non-vested options, exec.	50,439	0.474	1.000	0.000	0.096	0.453
Var. value non-vested options, exec.	50,439	0.682	3.072	0.000	0.004	0.088
Value non-vested options, exec., ratio	50,439	0.289	0.489	0.000	0.070	0.521
Value shares held, CEO	50,439	40.777	128.583	1.269	5.430	19.999
Avg. value shares held, exec.	50,439	5.634	18.388	0.232	0.927	2.953
Var. value shares held, exec.	50,439	1,185.883	7,857.835	0.035	0.543	6.749
Value shares held, exec., ratio	50,439	1.133	1.365	0.302	0.958	1.711
Delta option grants, CEO	50,439	0.016	0.035	0.000	0.001	0.015
Avg. delta option grants, exec.	50,439	0.005	0.010	0.000	0.001	0.005
Var. delta option grants, exec.	50,439	0.000	0.000	0.000	0.000	0.000
Delta option grants, exec., ratio	50,439	0.011	0.025	0.000	0.000	0.010

Table 1: —*Continued*

Variable	Obs.	Mean	SD	Q25	Median	Q75
Delta vested options, CEO	50,439	0.093	0.206	0.001	0.017	0.079
Avg. delta vested options, exec.	50,439	0.019	0.038	0.001	0.005	0.018
Var. delta vested options, exec.	50,439	0.002	0.007	0.000	0.000	0.000
Delta vested options, exec., ratio	50,439	0.058	0.122	0.000	0.010	0.057
Delta non-vested options, CEO	50,439	0.027	0.062	0.000	0.003	0.024
Avg. delta non-vested options, exec.	50,439	0.008	0.016	0.000	0.002	0.007
Var. delta non-vested options, exec.	50,439	0.000	0.001	0.000	0.000	0.000
Delta non-vested options, exec., ratio	50,439	0.018	0.043	0.000	0.001	0.016
Delta shares held, CEO	50,439	1.895	5.468	0.085	0.293	1.027
Avg. delta shares held, exec.	50,439	0.260	0.782	0.016	0.051	0.144
Var. delta shares held, exec.	50,439	2.103	12.957	0.000	0.002	0.017
Delta shares held, exec., ratio	50,439	0.408	0.703	0.035	0.171	0.530
Vega option grants, CEO	50,439	0.015	0.032	0.000	0.000	0.013
Avg. vega option grants, exec.	50,439	0.004	0.009	0.000	0.001	0.004
Var. vega option grants, exec.	50,439	0.000	0.000	0.000	0.000	0.000
Vega option grants, exec., ratio	50,439	0.010	0.023	0.000	0.000	0.008
Vega vested options, CEO	50,439	0.034	0.073	0.000	0.007	0.030
Avg. vega vested options, exec.	50,439	0.008	0.016	0.000	0.002	0.008
Var. vega vested options, exec.	50,439	0.000	0.001	0.000	0.000	0.000
Vega vested options, exec., ratio	50,439	0.024	0.052	0.000	0.004	0.022
Vega non-vested options, CEO	50,439	0.018	0.040	0.000	0.002	0.015
Avg. vega non-vested options, exec.	50,439	0.005	0.010	0.000	0.001	0.005
Var. vega non-vested options, exec.	50,439	0.000	0.000	0.000	0.000	0.000
Vega non-vested options, exec., ratio	50,439	0.012	0.029	0.000	0.001	0.010
Value all equity, CEO	50,439	50.306	135.823	3.425	10.825	33.457
Avg. value all equity, exec.	50,439	7.739	20.233	0.740	2.081	5.611
Var. value all equity, exec.	50,439	1,295.718	8,365.271	0.189	1.927	18.415
Value all equity, exec., ratio	50,439	1.255	1.141	0.593	1.153	1.760
Delta all equity, CEO	50,439	2.050	5.528	0.147	0.433	1.276
Avg. delta all equity, exec.	50,439	0.294	0.798	0.030	0.076	0.192
Var. delta all equity, exec.	50,439	2.137	13.058	0.000	0.003	0.026
Delta all equity, exec., ratio	50,439	0.455	0.691	0.068	0.238	0.608
Vega all equity, CEO	50,439	0.068	0.130	0.002	0.019	0.067
Avg. vega all equity, exec.	50,439	0.017	0.031	0.001	0.006	0.018
Var. vega all equity, exec.	50,439	0.001	0.002	0.000	0.000	0.000
Vega all equity, exec., ratio	50,439	0.043	0.080	0.001	0.011	0.046
Value vested equity, CEO	50,439	47.243	133.725	2.542	8.841	28.917
Avg. value vested equity, exec.	50,439	6.884	19.537	0.521	1.590	4.493
Var. value vested equity, exec.	50,439	1,266.779	8,240.708	0.133	1.443	14.496
Value vested equity, exec., ratio	50,439	1.237	1.238	0.509	1.123	1.804
Delta vested equity, CEO	50,439	2.001	5.518	0.124	0.386	1.196
Avg. delta vested equity, exec.	50,439	0.281	0.792	0.024	0.066	0.173
Var. delta vested equity, exec.	50,439	2.130	13.045	0.000	0.002	0.023
Delta vested equity, exec., ratio	50,439	0.442	0.697	0.057	0.218	0.589
Vega vested equity, CEO	50,439	0.034	0.073	0.000	0.007	0.030
Avg. vega vested equity, exec.	50,439	0.008	0.016	0.000	0.002	0.008
Var. vega vested equity, exec.	50,439	0.000	0.001	0.000	0.000	0.000
Vega vested equity, exec., ratio	50,439	0.024	0.052	0.000	0.004	0.022
Value all equity log-growth, CEO	50,439	0.000	0.000	−0.000	0.000	0.000
Avg. value all equity log-growth, exec.	50,439	0.000	0.000	−0.000	0.000	0.000

Table 1: —*Continued*

Variable	Obs.	Mean	SD	Q25	Median	Q75
Var. value all equity log-growth, exec.	50,439	0.000	0.000	0.000	0.000	0.000
Value all equity log-growth, exec., ratio	50,439	−0.000	0.000	−0.000	−0.000	0.000
Delta all equity log-growth, CEO	50,439	0.000	0.000	−0.000	0.000	0.000
Avg. delta all equity log-growth, exec.	50,439	0.000	0.000	−0.000	0.000	0.000
Var. delta all equity log-growth, exec.	50,439	0.000	0.000	0.000	0.000	0.000
Delta all equity log-growth, exec., ratio	50,439	−0.000	0.000	−0.000	−0.000	0.000
Vega all equity log-growth, CEO	50,439	0.000	0.000	−0.000	0.000	0.000
Avg. vega all equity log-growth, exec.	50,439	0.000	0.000	−0.000	0.000	0.000
Var. vega all equity log-growth, exec.	50,439	0.000	0.000	0.000	0.000	0.000
Vega all equity log-growth, exec., ratio	50,439	−0.000	0.000	−0.000	0.000	0.000

Panel D: Corporate governance: Board's financial expertise

Variable	Obs.	Mean	SD	Q25	Median	Q75
Num. financial experts	50,439	1.498	1.106	1.000	1.000	2.000
Financial experts (%)	50,439	18.258	13.146	11.111	14.286	25.000
Num. audit insiders	50,439	0.000	0.000	0.000	0.000	0.000
Audit insiders (%)	50,439	0.000	0.000	0.000	0.000	0.000
Num. finance insiders	50,439	0.067	0.298	0.000	0.000	0.000
Finance insiders (%)	50,439	1.493	6.702	0.000	0.000	0.000
Num. audit directors	50,439	3.609	0.936	3.000	3.000	4.000
Audit directors (%)	50,439	44.179	11.978	36.364	42.857	50.000
Num. finance directors	50,439	0.605	1.564	0.000	0.000	0.000
Finance directors (%)	50,439	6.100	15.567	0.000	0.000	0.000

Panel E: Corporate governance: Board characteristics

Variable	Obs.	Mean	SD	Q25	Median	Q75
Num. post-CEO directors	50,439	4.049	2.699	2.000	4.000	6.000
Post-CEO directors (%)	50,439	48.176	29.686	22.222	50.000	77.778
Num. over 69 directors	50,439	1.054	1.235	0.000	1.000	2.000
Over 69 directors (%)	50,439	12.433	14.385	0.000	10.000	20.000
Avg. director age	50,439	59.039	4.644	56.167	59.333	62.143
Num. busy directors	50,439	1.298	1.492	0.000	1.000	2.000
Busy directors (%)	50,439	14.625	15.845	0.000	12.500	25.000
Num. directors	50,439	8.515	2.342	7.000	8.000	10.000
CEO Chairman of the board	50,439	0.483	0.500	0.000	0.000	1.000
Num. CEO directors	50,439	0.300	0.617	0.000	0.000	0.000
CEO directors (%)	50,439	3.304	6.668	0.000	0.000	0.000
Num. outsider directors	50,439	6.211	2.307	4.000	6.000	8.000
Outsider directors (%)	50,439	72.426	15.438	62.500	75.000	85.714
Num. insider directors	50,439	1.527	0.855	1.000	1.000	2.000
Insider directors (%)	50,439	18.693	10.120	11.111	14.286	25.000
Num. affiliate directors	50,439	0.766	1.122	0.000	0.000	1.000
Affiliate directors (%)	50,439	8.782	12.542	0.000	0.000	14.286
Board tenure	50,439	9.156	4.348	5.967	8.700	11.831
Female directors (%)	50,439	9.792	10.097	0.000	10.000	16.670
Total equity, director	50,439	10.407	23.424	0.312	1.510	9.080
Avg. equity, director	50,439	1.488	3.333	0.043	0.218	1.263
Var. total equity, director	50,439	36.601	137.272	0.002	0.088	5.466
Num. nomination insiders	50,439	0.014	0.119	0.000	0.000	0.000

Table 1: —*Continued*

Variable	Obs.	Mean	SD	Q25	Median	Q75
Nomination insiders (%)	50,439	1.447	11.943	0.000	0.000	0.000
Num. compensation insiders	50,439	0.028	0.165	0.000	0.000	0.000
Compensation insiders (%)	50,439	0.814	4.886	0.000	0.000	0.000
Num. compliance insiders	50,439	0.000	0.000	0.000	0.000	0.000
Compliance insiders (%)	50,439	0.000	0.000	0.000	0.000	0.000
Num. governance insiders	50,439	0.023	0.149	0.000	0.000	0.000
Governance insiders (%)	50,439	0.634	4.285	0.000	0.000	0.000
Num. nomination directors	50,439	0.014	0.119	0.000	0.000	0.000
Nomination directors (%)	50,439	0.167	1.397	0.000	0.000	0.000
Num. compensation directors	50,439	3.512	1.067	3.000	3.000	4.000
Compensation directors (%)	50,439	42.864	13.425	33.333	42.857	50.000
Num. compliance directors	50,439	0.130	0.661	0.000	0.000	0.000
Compliance directors (%)	50,439	1.406	7.113	0.000	0.000	0.000
Num. governance directors	50,439	2.855	1.839	2.000	3.000	4.000
Governance directors (%)	50,439	34.281	22.231	23.077	37.500	50.000
Avg. value shares held, director	50,439	14.629	47.516	0.410	1.373	6.111
Var. value shares held, director	50,439	9,371.180	54,117.210	0.153	3.309	126.970
Value shares held, director, ratio	50,439	0.759	1.713	−0.113	0.780	1.804

Panel F: Outcome group: Restatements of financial statements

Variable	Obs.	Mean	SD	Q25	Median	Q75
Restatements as in Hennes et al. (2008) $_{t+1}$	44,391	0.018	0.134	0.000	0.000	0.000
Restatements as in Hennes et al. (2008) $_{t+3}$	40,014	0.012	0.108	0.000	0.000	0.000
RSST accruals	44,391	0.033	0.196	−0.029	0.016	0.079
Receivables growth	44,391	0.015	0.054	−0.006	0.006	0.029
Inventory growth	44,391	0.005	0.031	−0.001	0.000	0.009
Soft assets	44,391	0.578	0.271	0.365	0.607	0.811
Cash sales growth	44,391	0.055	0.205	−0.024	0.038	0.134
Return on assets, growth	44,391	0.001	0.134	−0.025	0.000	0.023
Issuance	44,391	0.925	0.264	1.000	1.000	1.000

Panel G: Outcome group: Return on assets

Variable	Obs.	Mean	SD	Q25	Median	Q75
Return on assets, adj. $_{t+1}$	47,866	0.018	0.170	−0.020	0.011	0.076
Return on assets, adj. $_{t+3}$	43,113	0.021	0.169	−0.018	0.011	0.074
Log market value	47,866	6.607	1.751	5.389	6.526	7.765
Return on assets, adj.	47,866	0.019	0.169	−0.019	0.012	0.079

Panel H: Outcome group: Credit ratings

Variable	Obs.	Mean	SD	Q25	Median	Q75
S&P credit rating $_{t+1}$	16,962	3.466	1.086	3.000	3.917	4.000
S&P credit rating $_{t+3}$	13,339	3.515	1.083	3.000	4.000	4.000
Log market value	16,962	7.955	1.507	6.951	7.920	9.002
Book-to-market	16,962	0.554	0.426	0.276	0.473	0.720
Return on assets	16,962	0.080	0.073	0.038	0.072	0.116
Leverage	16,962	0.337	0.205	0.190	0.314	0.455
Beta	16,962	1.126	0.489	0.786	1.059	1.402
Volatility, 12-month	16,962	0.391	0.224	0.238	0.327	0.468

Table 2: **Optimal GBM parameters and cross-validation errors**

This table presents optimal meta-parameters for the gradient boosting of regression trees models (GBM) selected on the training data by the cross-validation procedure in Section 4. We chose the tree depth, i.e., the level of interaction between variables, and the number of trees, i.e., the number of terms in the model, to minimize cross-validation errors.

Panel A: Restatements as in Hennes et al. (2008)

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	31,872	5	160	0.221	23,712	7	135	0.187
Firm, Inst. hold.	31,872	7	170	0.217	23,712	7	150	0.186
Firm, Anti-takeover	31,872	7	155	0.219	23,712	7	140	0.187
Firm, Comp.	31,872	5	235	0.215	23,712	7	165	0.185
Firm, Fin. expert	31,872	7	175	0.216	23,712	7	165	0.179
Firm, Board	31,872	7	195	0.216	23,712	7	165	0.183
Firm, All govern.	31,872	7	215	0.213	23,712	7	170	0.181
Models without firm characteristics								
Inst. hold.	31,872	7	365	0.244	23,712	7	240	0.211
Anti-takeover	31,872	7	190	0.247	23,712	7	210	0.212
Comp.	31,872	2	900	0.229	23,712	2	660	0.200
Fin. expert	31,872	3	405	0.240	23,712	3	490	0.197
Board	31,872	3	1,490	0.228	23,712	5	800	0.196
All govern.	31,872	2	1,120	0.221	23,712	2	870	0.192

Table 2: —*Continued*

Panel B: Return on assets, adj.

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	37,345	3	1,050	0.086	33,645	5	780	0.114
Firm, Inst. hold.	37,345	3	1,650	0.086	33,645	5	1,050	0.113
Firm, Anti-takeover	37,345	3	1,490	0.086	33,645	5	790	0.114
Firm, Comp.	37,345	3	1,050	0.086	33,645	7	2,650	0.111
Firm, Fin. expert	37,345	3	770	0.086	33,645	7	495	0.114
Firm, Board	37,345	5	425	0.086	33,645	7	5,800	0.112
Firm, All govern.	37,345	3	1,380	0.086	33,645	7	15,750	0.109
Models without firm characteristics								
Inst. hold.	37,345	1	2,350	0.159	33,645	1	1,480	0.161
Anti-takeover	37,345	5	660	0.167	33,645	5	1,160	0.167
Comp.	37,345	7	9,700	0.148	33,645	7	8,550	0.151
Fin. expert	37,345	2	640	0.166	33,645	2	570	0.166
Board	37,345	7	23,500	0.149	33,645	7	22,800	0.152
All govern.	37,345	7	42,700	0.138	33,645	7	44,000	0.142

Table 2: —*Continued*

Panel C: S&P credit rating

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	12,969	7	5,100	0.562	9,672	7	3,600	0.607
Firm, Inst. hold.	12,969	7	6,800	0.549	9,672	7	4,950	0.595
Firm, Anti-takeover	12,969	7	7,650	0.541	9,672	7	6,100	0.588
Firm, Comp.	12,969	7	10,200	0.526	9,672	7	9,350	0.579
Firm, Fin. expert	12,969	7	6,550	0.542	9,672	7	6,000	0.592
Firm, Board	12,969	7	20,850	0.496	9,672	7	20,900	0.538
Firm, All govern.	12,969	7	20,650	0.486	9,672	7	19,900	0.540
Models without firm characteristics								
Inst. hold.	12,969	5	590	0.969	9,672	3	820	0.973
Anti-takeover	12,969	5	3,550	1.057	9,672	5	7,500	1.060
Comp.	12,969	7	12,000	0.723	9,672	7	4,000	0.798
Fin. expert	12,969	2	1,170	0.959	9,672	2	1,200	0.978
Board	12,969	7	37,850	0.686	9,672	7	30,950	0.734
All govern.	12,969	7	40,850	0.618	9,672	7	32,550	0.694

Table 3: **Mean out-of-sample errors and t-statistics for restatements as in Hennes et al. (2008): Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Restatements as in Hennes et al. (2008) $t+1$

2013	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.186	2.151**	2.245**	2.277**	2.456**	2.493**	2.418**	2.507**
Firm	0.158		0.118	0.123	0.393	0.419	0.308	0.466
Firm, Inst. hold.	0.156			0.004	0.276	0.301	0.190	0.350
Firm, Anti-takeover	0.156				0.276	0.301	0.188	0.350
Firm, Comp.	0.152					0.023	−0.090	0.074
Firm, Fin. expert	0.152						−0.114	0.053
Firm, Board	0.153							0.165
Firm, All govern.	0.151							
2014	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.170	2.630***	2.832***	2.770***	3.226***	3.017***	2.974***	3.197***
Firm	0.141		0.211	0.143	0.701	0.513	0.419	0.718
Firm, Inst. hold.	0.139			−0.068	0.496	0.311	0.212	0.516
Firm, Anti-takeover	0.139				0.563	0.377	0.279	0.582
Firm, Comp.	0.133					−0.175	−0.279	0.029
Firm, Fin. expert	0.135						−0.100	0.200
Firm, Board	0.136							0.303
Firm, All govern.	0.133							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.152	3.224***	3.462***	3.418***	4.189***	3.879***	3.833***	4.238***
Firm	0.124		0.272	0.242	1.091	0.822	0.722	1.201
Firm, Inst. hold.	0.122			−0.028	0.819	0.557	0.453	0.934
Firm, Anti-takeover	0.122				0.843	0.581	0.478	0.956
Firm, Comp.	0.115					−0.244	−0.360	0.128
Firm, Fin. expert	0.117						−0.110	0.365
Firm, Board	0.118							0.481
Firm, All govern.	0.114							

Table 3: —*Continued*

Panel B: Restatements as in Hennes et al. (2008) $t+3$

2011	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.178	2.060**	2.069**	2.046**	2.074**	2.236**	2.221**	2.130**
Firm	0.145		0.028	−0.008	0.068	0.338	0.219	0.236
Firm, Inst. hold.	0.144			−0.036	0.040	0.310	0.190	0.208
Firm, Anti-takeover	0.145				0.076	0.345	0.226	0.243
Firm, Comp.	0.144					0.268	0.147	0.168
Firm, Fin. expert	0.139						−0.128	−0.095
Firm, Board	0.141							0.029
Firm, All govern.	0.141							
2012	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.162	2.302**	2.333**	2.304**	2.382**	2.683***	2.443**	2.514**
Firm	0.129		0.058	0.015	0.134	0.552	0.227	0.387
Firm, Inst. hold.	0.129			−0.043	0.076	0.492	0.169	0.329
Firm, Anti-takeover	0.129				0.119	0.536	0.212	0.372
Firm, Comp.	0.127					0.416	0.093	0.255
Firm, Fin. expert	0.121						−0.322	−0.152
Firm, Board	0.126							0.164
Firm, All govern.	0.124							
2013	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.139	2.118**	2.165**	2.107**	2.243**	2.655***	2.370**	2.581***
Firm	0.114		0.087	0.010	0.165	0.626	0.308	0.566
Firm, Inst. hold.	0.112			−0.076	0.077	0.533	0.218	0.474
Firm, Anti-takeover	0.113				0.154	0.612	0.295	0.552
Firm, Comp.	0.111					0.458	0.141	0.399
Firm, Fin. expert	0.105						−0.317	−0.055
Firm, Board	0.109							0.259
Firm, All govern.	0.106							

Table 4: **Mean out-of-sample errors and t-statistics for restatements as in Hennes et al. (2008): Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Restatements as in Hennes et al. (2008) $t+1$

2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.186	2.151**	0.249	0.316	1.152	0.782	1.003	1.153
Firm	0.158		−1.810*	−1.726*	−0.640	−1.162	−0.716	−0.499
Inst. hold.	0.183			0.066	0.908	0.527	0.773	0.929
Anti-takeover	0.182				0.844	0.461	0.713	0.871
Comp.	0.168					−0.402	−0.091	0.081
Fin. expert	0.175						0.292	0.461
Board	0.170							0.165
All govern.	0.166							
2014	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.170	2.630***	0.400	0.573	1.928*	1.196	1.481	1.933*
Firm	0.141		−2.154**	−1.931*	−0.235	−1.179	−0.537	−0.023
Inst. hold.	0.165			0.176	1.556	0.804	1.142	1.598
Anti-takeover	0.163				1.383	0.626	0.987	1.442
Comp.	0.144					−0.779	−0.280	0.168
Fin. expert	0.155						0.434	0.890
Board	0.149							0.421
All govern.	0.141							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.152	3.224***	0.872	0.706	2.856***	1.917*	3.066***	3.336***
Firm	0.124		−2.385**	−2.169**	0.309	−0.989	0.501	0.919
Inst. hold.	0.144			−0.069	2.181**	1.144	2.388**	2.696***
Anti-takeover	0.145				2.065**	1.095	2.253**	2.555**
Comp.	0.121					−1.093	0.160	0.538
Fin. expert	0.134						1.276	1.630
Board	0.119							0.387
All govern.	0.114							

Table 4: —*Continued*

Panel B: Restatements as in Hennes et al. (2008) $t + 3$

2011	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.178	2.060**	−0.045	0.171	0.517	0.492	0.738	0.712
Firm	0.145		−1.918*	−1.810*	−1.206	−1.207	−1.004	−0.884
Inst. hold.	0.179			0.200	0.522	0.500	0.728	0.708
Anti-takeover	0.175				0.357	0.336	0.571	0.560
Comp.	0.168					−0.016	0.189	0.207
Fin. expert	0.168						0.202	0.220
Board	0.164							0.031
All govern.	0.163							
2012	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.162	2.302**	0.167	0.249	0.697	0.774	0.816	0.702
Firm	0.129		−2.031**	−1.981**	−1.152	−1.143	−1.060	−0.965
Inst. hold.	0.160			0.077	0.539	0.607	0.652	0.560
Anti-takeover	0.159				0.478	0.545	0.591	0.504
Comp.	0.150					0.045	0.094	0.063
Fin. expert	0.149						0.051	0.023
Board	0.148							−0.023
All govern.	0.148							
2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.139	2.118**	0.486	0.154	1.370	1.271	1.387	1.864*
Firm	0.114		−1.671*	−1.780*	−0.514	−0.589	−0.434	0.026
Inst. hold.	0.134			−0.281	0.964	0.870	0.996	1.475
Anti-takeover	0.137				1.132	1.044	1.159	1.603
Comp.	0.121					−0.074	0.058	0.485
Fin. expert	0.122						0.130	0.553
Board	0.120							0.416
All govern.	0.113							

Table 5: **Mean out-of-sample errors and t-statistics for operating performance: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Return on assets, adj. $t+1$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.181	13.662***	13.754***	13.733***	13.645***	13.606***	13.548***	13.767***
Firm	0.099		0.058	0.058	−0.013	−0.052	−0.118	0.094
Firm, Inst. hold.	0.099			0.000	−0.071	−0.111	−0.176	0.037
Firm, Anti-takeover	0.099				−0.071	−0.110	−0.176	0.036
Firm, Comp.	0.099					−0.039	−0.104	0.108
Firm, Fin. expert	0.099						−0.065	0.147
Firm, Board	0.100							0.212
Firm, All govern.	0.098							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.181	16.018***	16.170***	16.134***	15.905***	15.887***	15.968***	16.025***
Firm	0.085		0.224	0.193	−0.157	−0.198	−0.074	0.031
Firm, Inst. hold.	0.084			−0.030	−0.381	−0.422	−0.298	−0.192
Firm, Anti-takeover	0.084				−0.350	−0.390	−0.267	−0.161
Firm, Comp.	0.086					−0.040	0.083	0.188
Firm, Fin. expert	0.086						0.124	0.228
Firm, Board	0.085							0.105
Firm, All govern.	0.085							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.183	13.922***	13.984***	13.953***	13.986***	13.907***	13.922***	14.038***
Firm	0.089		0.044	0.028	0.040	−0.024	−0.048	0.086
Firm, Inst. hold.	0.089			−0.016	−0.004	−0.068	−0.092	0.042
Firm, Anti-takeover	0.089				0.012	−0.052	−0.076	0.058
Firm, Comp.	0.089					−0.064	−0.088	0.046
Firm, Fin. expert	0.089						−0.024	0.110
Firm, Board	0.089							0.135
Firm, All govern.	0.088							

Table 5: —*Continued*

Panel B: Return on assets, adj. $t + 3$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.177	10.882***	11.048***	10.877***	10.893***	10.846***	11.096***	11.409***
Firm	0.113		0.152	−0.006	−0.055	−0.063	0.185	0.412
Firm, Inst. hold.	0.112			−0.158	−0.210	−0.216	0.032	0.258
Firm, Anti-takeover	0.113				−0.049	−0.057	0.191	0.418
Firm, Comp.	0.113					−0.009	0.242	0.475
Firm, Fin. expert	0.113						0.249	0.479
Firm, Board	0.112							0.226
Firm, All govern.	0.111							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.181	10.376***	10.637***	10.315***	10.778***	10.419***	11.049***	11.056***
Firm	0.116		0.285	−0.050	0.511	0.045	0.792	0.855
Firm, Inst. hold.	0.114			−0.334	0.230	−0.240	0.510	0.577
Firm, Anti-takeover	0.116				0.559	0.095	0.838	0.901
Firm, Comp.	0.113					−0.467	0.274	0.343
Firm, Fin. expert	0.115						0.747	0.811
Firm, Board	0.111							0.072
Firm, All govern.	0.111							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.173	9.276***	9.390***	9.283***	9.651***	9.230***	9.452***	10.064***
Firm	0.109		0.088	0.009	0.274	−0.036	0.141	0.659
Firm, Inst. hold.	0.109			−0.078	0.187	−0.124	0.054	0.573
Firm, Anti-takeover	0.109				0.265	−0.045	0.132	0.649
Firm, Comp.	0.107					−0.311	−0.132	0.392
Firm, Fin. expert	0.109						0.177	0.695
Firm, Board	0.108							0.519
Firm, All govern.	0.105							

Table 6: **Mean out-of-sample errors and t-statistics for operating performance: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Return on assets, adj. $t+1$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.181	13.662***	1.689*	0.239	3.621***	0.476	3.448***	5.536***
Firm	0.099		−12.866***	−13.592***	−11.436***	−13.496***	−11.643***	−9.911***
Inst. hold.	0.172			−1.455	1.998**	−1.221	1.813*	4.010***
Anti-takeover	0.180				3.402***	0.237	3.228***	5.338***
Comp.	0.161					−3.180***	−0.193	2.040**
Fin. expert	0.178						3.003***	5.132***
Board	0.162							2.242**
All govern.	0.151							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.181	16.018***	1.730*	0.202	4.071***	0.656	3.538***	5.827***
Firm	0.085		−15.748***	−16.019***	−14.165***	−15.951***	−14.408***	−12.650***
Inst. hold.	0.171			−1.532	2.458**	−1.082	1.900*	4.343***
Anti-takeover	0.180				3.892***	0.454	3.355***	5.667***
Comp.	0.159					−3.474***	−0.550	1.932*
Fin. expert	0.177						2.930***	5.284***
Board	0.162							2.462**
All govern.	0.149							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.183	13.922***	1.641	0.260	3.872***	0.696	3.762***	5.569***
Firm	0.089		−13.360***	−13.855***	−11.997***	−13.726***	−11.883***	−10.566***
Inst. hold.	0.173			−1.385	2.320**	−0.953	2.213**	4.134***
Anti-takeover	0.182				3.635***	0.436	3.524***	5.354***
Comp.	0.160					−3.231***	−0.087	1.887*
Fin. expert	0.179						3.121***	4.984***
Board	0.161							1.950*
All govern.	0.150							

Table 6: —*Continued*

Panel B: Return on assets, adj. $t + 3$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.177	10.882***	1.422	0.300	3.143***	0.535	3.533***	5.183***
Firm	0.113		−10.093***	−10.718***	−8.700***	−10.654***	−8.473***	−7.044***
Inst. hold.	0.169			−1.123	1.778*	−0.895	2.177**	3.913***
Anti-takeover	0.175				2.858***	0.234	3.250***	4.919***
Comp.	0.159					−2.649***	0.391	2.154**
Fin. expert	0.174						3.044***	4.739***
Board	0.157							1.781*
All govern.	0.148							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.181	10.376***	1.285	0.255	2.916***	0.541	3.135***	4.599***
Firm	0.116		−9.804***	−10.269***	−8.531***	−10.158***	−8.413***	−7.059***
Inst. hold.	0.173			−1.032	1.699*	−0.748	1.925*	3.482***
Anti-takeover	0.179				2.679***	0.286	2.899***	4.383***
Comp.	0.163					−2.413**	0.221	1.817*
Fin. expert	0.178						2.635***	4.142***
Board	0.162							1.608
All govern.	0.154							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.173	9.276***	0.977	0.256	2.799***	0.438	2.437**	4.415***
Firm	0.109		−8.888***	−9.160***	−7.466***	−9.091***	−7.774***	−6.084***
Inst. hold.	0.167			−0.721	1.898*	−0.540	1.518	3.613***
Anti-takeover	0.171				2.561**	0.182	2.195**	4.201***
Comp.	0.155					−2.395**	−0.386	1.755*
Fin. expert	0.170						2.026**	4.054***
Board	0.158							2.139**
All govern.	0.146							

Table 7: **Mean out-of-sample errors and t-statistics for S&P credit rating: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: S&P credit rating $t+1$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	1.041	19.538***	20.350***	20.524***	21.485***	20.576***	22.574***	23.230***
Firm	0.541		1.050	1.372	2.498**	1.456	4.360***	5.280***
Firm, Inst. hold.	0.519			0.336	1.440	0.422	3.364***	4.288***
Firm, Anti-takeover	0.512				1.078	0.086	2.990***	3.892***
Firm, Comp.	0.490					−0.987	2.056**	3.005***
Firm, Fin. expert	0.510						2.900***	3.797***
Firm, Board	0.451							0.841
Firm, All govern.	0.435							

2015	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	1.074	19.081***	19.511***	19.717***	19.989***	19.923***	20.792***	21.125***
Firm	0.509		0.853	1.196	1.844*	1.482	3.428***	4.229***
Firm, Inst. hold.	0.492			0.333	0.994	0.601	2.565**	3.382***
Firm, Anti-takeover	0.485				0.674	0.264	2.260**	3.093***
Firm, Comp.	0.471					−0.430	1.546	2.378**
Firm, Fin. expert	0.479						2.052**	2.911***
Firm, Board	0.438							0.882
Firm, All govern.	0.419							

2016	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	1.037	17.989***	18.268***	18.585***	18.658***	18.663***	19.871***	19.825***
Firm	0.477		0.532	1.339	1.545	1.326	4.389***	4.340***
Firm, Inst. hold.	0.467			0.829	1.041	0.796	3.932***	3.891***
Firm, Anti-takeover	0.451				0.216	−0.067	3.019***	3.006***
Firm, Comp.	0.447					−0.291	2.767***	2.762***
Firm, Fin. expert	0.452						3.251***	3.225***
Firm, Board	0.395							0.091
Firm, All govern.	0.393							

Table 7: —*Continued*

Panel B: S&P credit rating $t + 3$

2012	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	1.050	19.069***	19.138***	19.353***	19.546***	19.763***	20.081***	20.395***
Firm	0.501		0.175	0.544	1.049	1.044	2.038**	2.577**
Firm, Inst. hold.	0.498			0.366	0.872	0.856	1.855*	2.389**
Firm, Anti-takeover	0.490				0.514	0.479	1.501	2.034**
Firm, Comp.	0.478					−0.065	0.966	1.484
Firm, Fin. expert	0.479						1.088	1.639
Firm, Board	0.456							0.510
Firm, All govern.	0.444							
2013	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	1.080	14.957***	15.354***	15.606***	16.377***	15.571***	16.750***	17.258***
Firm	0.604		0.559	0.917	1.981**	0.854	2.602***	3.326***
Firm, Inst. hold.	0.589			0.358	1.418	0.294	2.047**	2.768***
Firm, Anti-takeover	0.580				1.057	−0.065	1.690*	2.408**
Firm, Comp.	0.553					−1.125	0.654	1.374
Firm, Fin. expert	0.582						1.759*	2.480**
Firm, Board	0.537							0.702
Firm, All govern.	0.519							
2014	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	1.032	15.462***	16.129***	16.046***	16.902***	16.335***	18.038***	18.383***
Firm	0.549		1.108	1.065	2.489**	1.516	4.645***	5.397***
Firm, Inst. hold.	0.524			−0.024	1.392	0.421	3.568***	4.348***
Firm, Anti-takeover	0.525				1.387	0.436	3.505***	4.263***
Firm, Comp.	0.494					−0.958	2.173**	2.983***
Firm, Fin. expert	0.515						3.106***	3.883***
Firm, Board	0.450							0.877
Firm, All govern.	0.433							

Table 8: **Mean out-of-sample errors and t-statistics for S&P credit rating: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: S&P credit rating $t+1$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.041	19.538***	4.715***	1.725*	13.819***	5.534***	15.672***	19.155***
Firm	0.541		−15.446***	−17.259***	−6.866***	−14.164***	−4.662***	−1.234
Inst. hold.	0.923			−2.869***	9.329***	0.906	11.302***	14.976***
Anti-takeover	0.996				11.707***	3.696***	13.514***	16.841***
Comp.	0.696					−8.208***	2.190**	6.083***
Fin. expert	0.900						10.136***	13.672***
Board	0.646							3.770***
All govern.	0.566							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	1.074	19.081***	4.561***	1.572	15.012***	4.872***	15.217***	18.620***
Firm	0.509		−16.308***	−16.903***	−6.692***	−15.325***	−5.900***	−1.557
Inst. hold.	0.945			−2.821***	11.459***	0.415	11.713***	15.758***
Anti-takeover	1.026				12.928***	3.153***	13.147***	16.420***
Comp.	0.651					−10.663***	0.542	5.657***
Fin. expert	0.933						10.922***	14.769***
Board	0.639							4.858***
All govern.	0.539							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	1.037	17.989***	3.332***	1.767*	12.603***	4.490***	13.751***	16.555***
Firm	0.477		−15.314***	−16.106***	−8.015***	−14.765***	−6.419***	−2.745***
Inst. hold.	0.935			−1.518	9.474***	1.131	10.709***	13.734***
Anti-takeover	0.982				10.678***	2.643***	11.836***	14.651***
Comp.	0.661					−8.574***	1.598	5.616***
Fin. expert	0.901						9.873***	13.077***
Board	0.623							3.976***
All govern.	0.532							

Table 8: —*Continued*

Panel B: S&P credit rating $t + 3$

2012	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.050	19.069***	3.930***	1.359	12.815***	4.132***	15.027***	16.917***
Firm	0.501		−15.465***	−17.431***	−7.891***	−14.799***	−5.163***	−3.445***
Inst. hold.	0.939			−2.523**	8.911***	0.260	11.223***	13.161***
Anti-takeover	1.012				11.251***	2.742***	13.444***	15.289***
Comp.	0.693					−8.449***	2.709***	4.868***
Fin. expert	0.931						10.700***	12.564***
Board	0.625							2.047**
All govern.	0.576							
2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.080	14.957***	3.491***	1.272	9.793***	4.067***	11.411***	13.797***
Firm	0.604		−12.351***	−13.325***	−5.978***	−11.548***	−3.985***	−1.655*
Inst. hold.	0.971			−2.118**	6.666***	0.634	8.438***	11.040***
Anti-takeover	1.039				8.289***	2.695***	9.881***	12.184***
Comp.	0.772					−5.950***	1.904*	4.494***
Fin. expert	0.952						7.705***	10.250***
Board	0.716							2.486**
All govern.	0.647							
2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.032	15.462***	2.986***	1.623	10.490***	3.698***	12.577***	14.404***
Firm	0.549		−13.080***	−13.670***	−6.680***	−12.300***	−3.958***	−1.627
Inst. hold.	0.939			−1.308	7.698***	0.739	9.943***	11.919***
Anti-takeover	0.980				8.694***	2.019**	10.786***	12.607***
Comp.	0.714					−6.904***	2.713***	5.144***
Fin. expert	0.916						9.156***	11.132***
Board	0.644							2.396**
All govern.	0.586							

Internet Appendix for "How important is corporate governance? Evidence from machine learning"

Ian D. Gow David F. Larcker Anastasia A. Zakolyukina*

A. Three examples

There is a large literature on the effects of corporate governance on firm outcomes. While research methods and settings differ across studies, the unifying goal is to show a causal relation between a corporate governance characteristic and an outcome. Overall, there is mixed evidence for the direction of the effects with papers providing a strong argument and robust findings of a positive, a negative, or an insignificant association for the same characteristic and the outcome.[1] We use the well-studied board characteristics—CEO chair duality, board independence, and staggered elections—to provide examples of corporate governance studies.

A.1 CEO duality

Firms can combine the roles of CEO and board chairman (CEO duality). Most studies have found little or no evidence that duality leads to worse firm outcomes (e.g., Larcker and Tayan, 2016). In meta-analysis of over thirty studies, Dalton et al. (1998) find no relation between CEO duality and firm performance. Similarly, the review of over forty studies by Krause et al. (2014) concludes that CEO duality has little impact on performance, managerial entrenchment, risk taking, or executive compensation. Research has focused on market reaction to changes in CEO duality (e.g., Baliga et al., 1996; Dey et al., 2011; Larcker et al., 2011) or association between CEO duality status and firm outcomes (e.g., Boyd, 1995). A number of studies found no effect on market reaction to changes in CEO duality status, firm value, or performance (e.g., Boyd, 1995; Baliga et al., 1996; Brickley et al., 1997; Larcker et al., 2011). Although for a subset of firms, the association between CEO duality and performance is positive (Boyd, 1995). Indeed, when the split of the CEO and chairman roles is forced by investors, there is a negative market reaction to such a split as well as worse subsequent performance suggesting CEO duality being an efficient

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[1]For review, see, e.g., Larcker and Tayan (2015) and Adams (2017).

choice for these firms (Dey et al., 2011). Goergen et al. (2020) exploit the 2009 amendments to Regulation S-K to examine firms' first-time disclosures of the reasons for combining or separating the roles of CEO and chairman. The stock market reaction to the reasons firms disclose varies depending on firms' characteristics, that is, value implications of CEO duality differ across firms.

A.2 Board independence

Exchange-listing requirements and securities regulations require that public companies have a majority of independent directors. At the same time, most studies fail to find a relation between formal board independence and improved firm outcomes (e.g., Hermalin and Weisbach, 2003; Larcker and Tayan, 2015). For instance, Hermalin and Weisbach (1991), Klein (1998), and Bhagat and Black (2001) find no relation between outside directors and firm performance. Two exceptions are Rosenstein and Wyatt (1990), which finds the appointment of an outside director increases firm value, and Agrawal and Knoeber (1996), which finds the negative effect of outsiders firm performance. The subsequent studies refined the notion of independence and also attempted to modify research design to be able to make causal claims. Research finds that directors with social ties to CEOs (e.g., Hwang and Kim, 2009; Nguyen, 2012; Francis et al., 2012), directors with prior favorable views of the firm (e.g., Cohen et al., 2012), directors with external network connections to CEOs (e.g., Fracassi and Tate, 2012), or directors appointed after CEOs assume office (e.g., Coles et al., 2014), while formally independent, have compromised monitoring effectiveness resulting in worse outcomes for firms. In the studies with explicit intent to establish a casual relation for board independence, the evidence stays mixed. Duchin et al. (2010) use changes in board composition stemming from new regulations to show that the positive effect of having outside directors depends on the cost of acquiring information about the firm, i.e., when the cost of information is low, performance improves, and when the cost of information is high, performance worsens. Also in the regulatory context, Avedian et al. (2015) find that, while the creation of SEC caused boards to become significantly less independent, there was no corresponding effects on firm valuation. Two studies showing that independence is valuable rely on sudden deaths of independent directors (Nguyen and Nielsen, 2010) and local director pools as an instrument for board independence (Knyazeva et al., 2013).

A.3 Staggered board

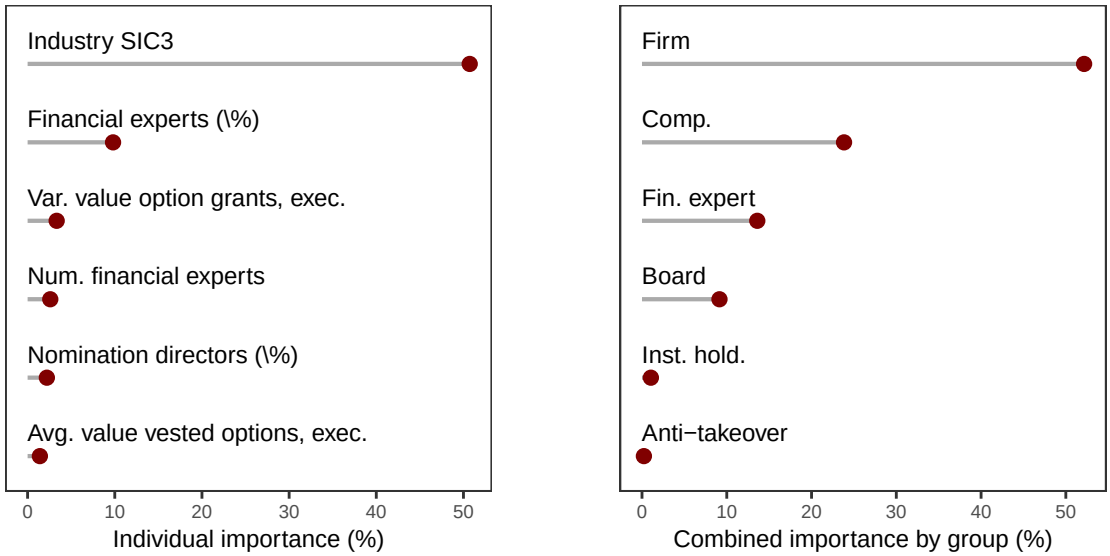
Boards can have staggered election years, which protects firms from hostile takeover attempts because a corporate raider cannot gain control of the board in a single year. Instead, at least two board elections—one year apart from each other—must be won to gain majority representation. Research finds that staggered (or classified) boards have positive as well as negative implications for shareholders (Larcker and Tayan, 2015). Guo et al. (2008) examine announcements of managerial intention to de-stagger their boards. They find that de-staggering the board is beneficial to shareholders. This is consistent with including staggered boards into an entrenchment index by Bebchuk et al. (2009). Elaborating on this view, Cohen and Wang (2013) and Cohen and Wang (2017) examine

the causal relation between staggered board and firm value using two Delaware court rulings. They show that market views staggered boards as value-reducing for the affected firms. Similarly, Faleye (2007) shows that investors react negatively to the establishment of staggered boards and welcome de-staggering. By contrast, Cremers et al. (2017) find no evidence that staggered board changes are negatively related to firm value; however, there is a positive association between staggered board adoptions and firm value for firms engaged in innovation. Exploiting another quasi-experimental setting of law that imposed staggered boards on all Massachusetts-incorporated firms, Daines et al. (2021) argue that staggered boards benefit early-life-cycle firms facing higher information asymmetries by allowing them to focus on long-term investment and innovation. Corroborating the view that staggered boards can be a value-maximizing governance choice, Larcker et al. (2011) and Ge et al. (2016) find that de-staggering hurts shareholder value. In general, however, Amihud and Stoyanov (2017) and Amihud et al. (2017) suggest there is no evidence that staggered boards are harmful or helpful for all firms.

Figure IA.1: **Variable importance for restatement events**

This figure depicts the relative importance of the top characteristics for predicting restatement events at $t + 1$ and $t + 3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Restatement events** $t + 1$



(b) **Restatement events** $t + 3$

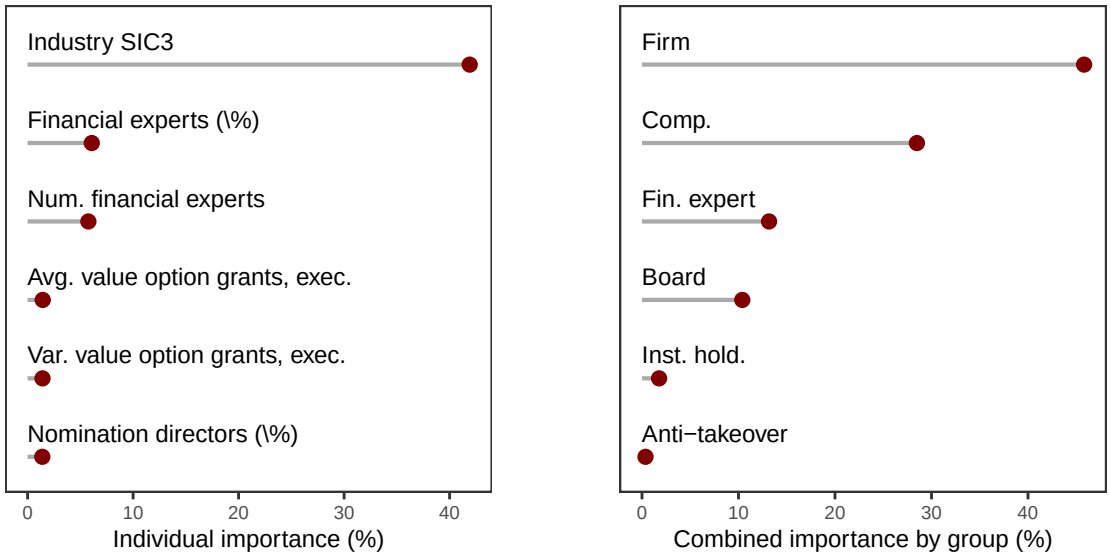
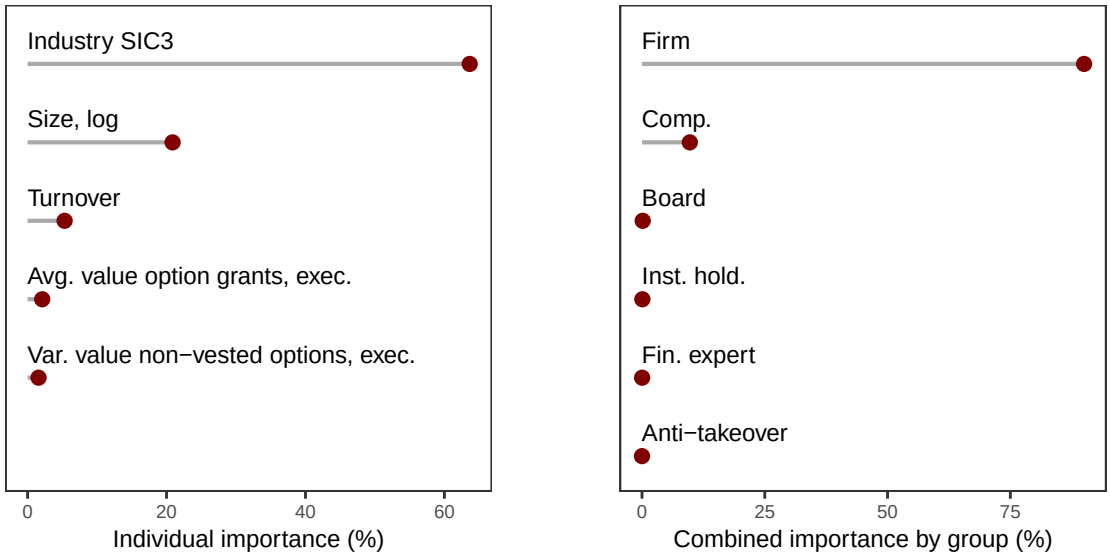


Figure IA.2: **Variable importance for class-action lawsuits**

This figure depicts the relative importance of the top characteristics for predicting class-action lawsuits at $t+1$ and $t+3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Class-action lawsuits** $t+1$



(b) **Class-action lawsuits** $t+3$

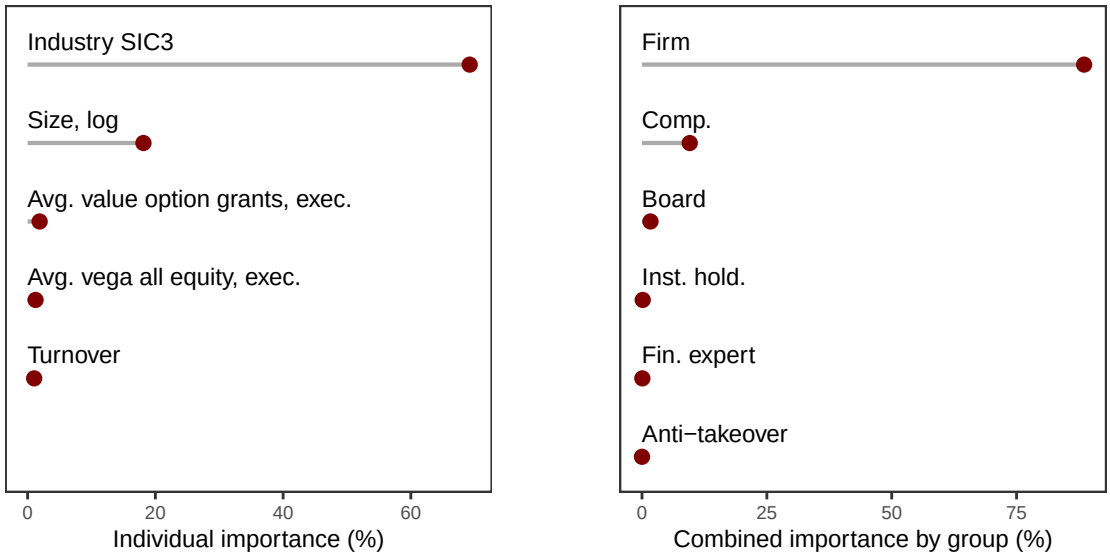
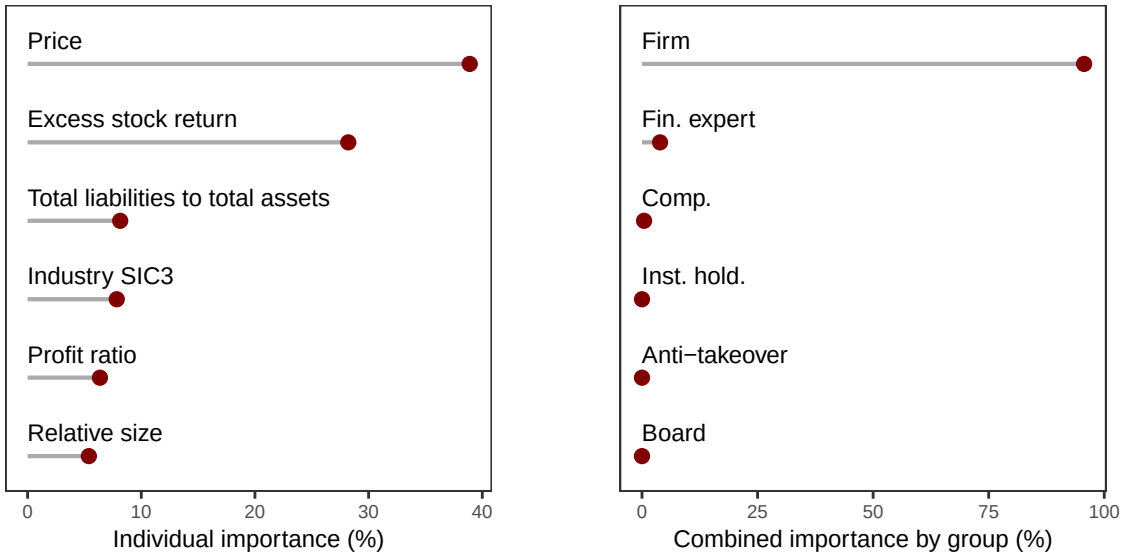


Figure IA.3: **Variable importance for business failures**

This figure depicts the relative importance of the top characteristics for predicting business failures at $t + 1$ and $t + 3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Business failures within 3 years** $t + 1$



(b) **Business failures within 3 years** $t + 3$

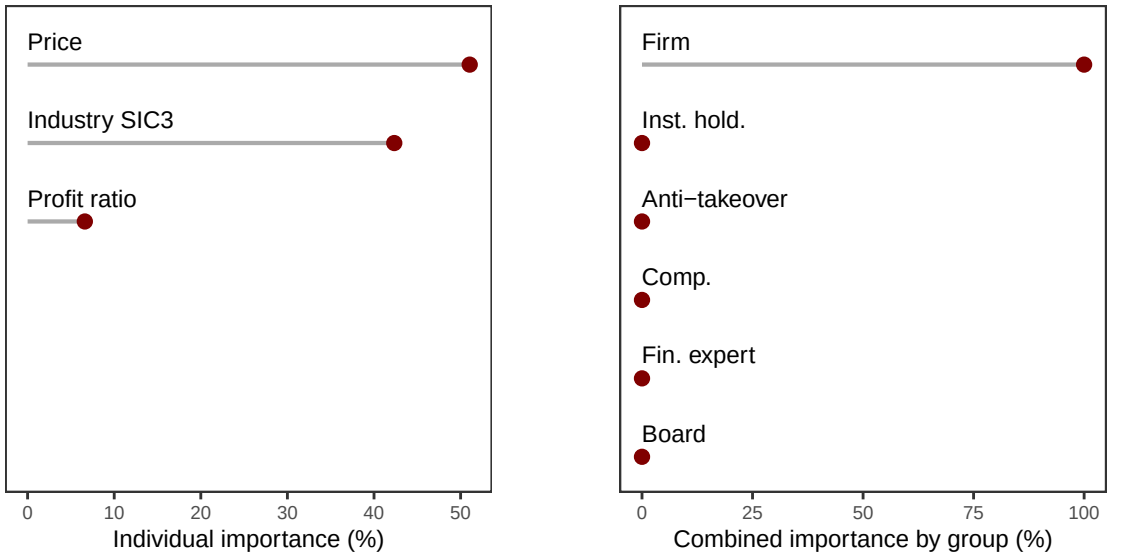
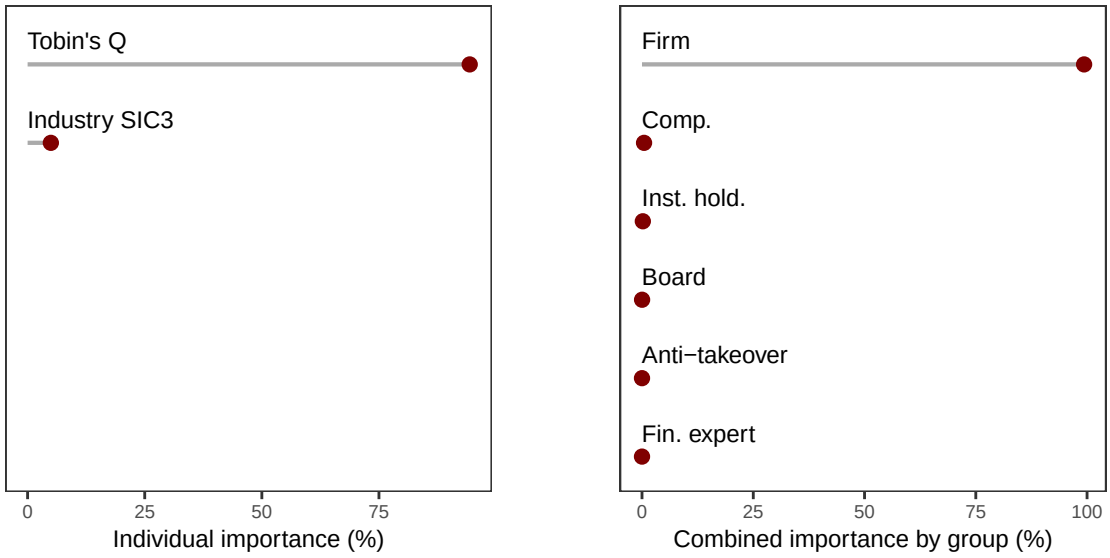


Figure IA.4: **Variable importance for Tobin's Q**

This figure depicts the relative importance of the top characteristics for predicting Tobin's Q at $t+1$ and $t+3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Tobin's Q** $t+1$



(b) **Tobin's Q** $t+3$

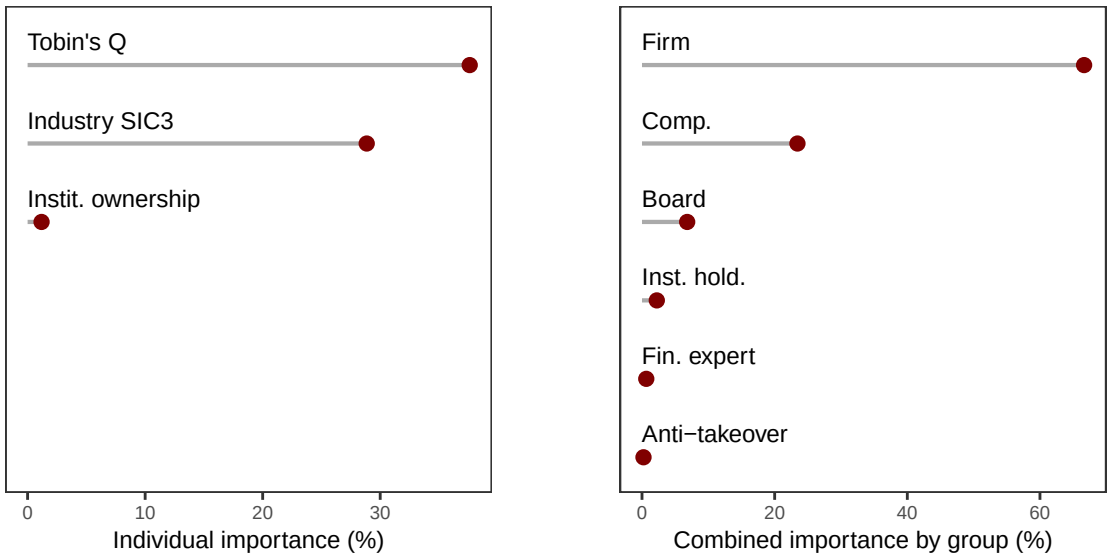


Figure IA.5: **Variable importance for stock returns**

This figure depicts the relative importance of the top characteristics for predicting stock returns at $t+1$ and $t+3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Stock returns, 12-months** $t+1$

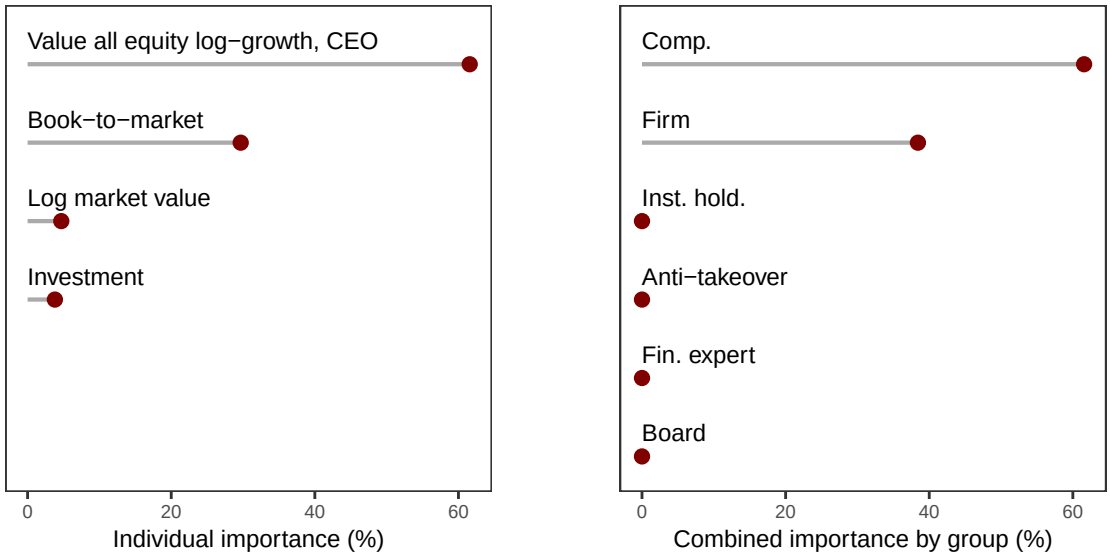
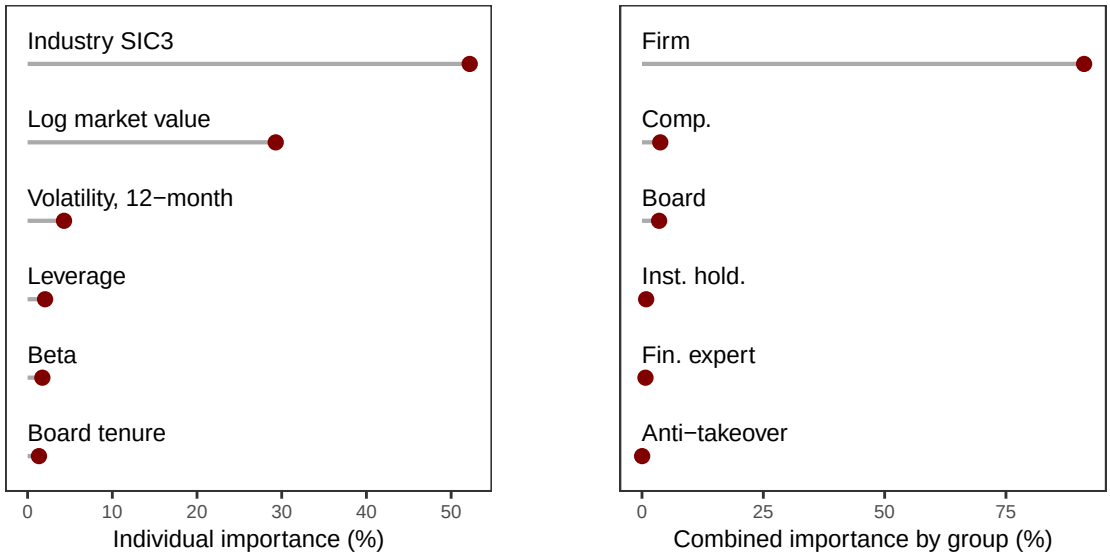


Figure IA.6: **Variable importance for investment grade bonds**

This figure depicts the relative importance of the top characteristics for predicting investment grade bonds at $t+1$ and $t+3$ from the model that includes both firm and corporate governance characteristics. For each characteristic (left panels), importance is computed as the reduction of the error attributable to this characteristic as described in Friedman (2001) using the estimation sample. For each group of characteristics (right panels), importance is computed as the sum of individual importance values of characteristics in that group. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics.

(a) **Investment grade debt** $t+1$



(b) **Investment grade debt** $t+3$

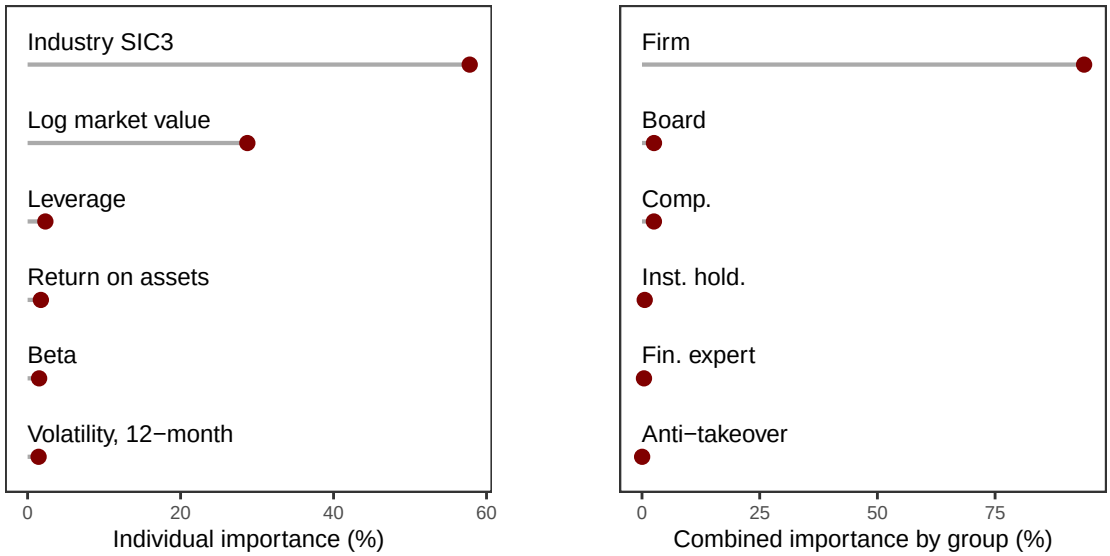


Table IA.1: **Summary statistics: Additional outcomes**

Panel A: Outcome group: Restatements of financial statements

Variable	Obs.	Mean	SD	Q25	Median	Q75
Restatement events $_{t+1}$	44,391	0.017	0.130	0.000	0.000	0.000
Restatement events $_{t+3}$	40,014	0.011	0.103	0.000	0.000	0.000
RSST accruals	44,391	0.033	0.196	−0.029	0.016	0.079
Receivables growth	44,391	0.015	0.054	−0.006	0.006	0.029
Inventory growth	44,391	0.005	0.031	−0.001	0.000	0.009
Soft assets	44,391	0.578	0.271	0.365	0.607	0.811
Cash sales growth	44,391	0.055	0.205	−0.024	0.038	0.134
Return on assets, growth	44,391	0.001	0.134	−0.025	0.000	0.023
Issuance	44,391	0.925	0.264	1.000	1.000	1.000

Panel B: Outcome group: Class-action lawsuits

Variable	Obs.	Mean	SD	Q25	Median	Q75
Class-action lawsuits $_{t+1}$	48,455	0.092	0.289	0.000	0.000	0.000
Class-action lawsuits $_{t+3}$	43,763	0.082	0.274	0.000	0.000	0.000
Size, log	48,455	13.484	1.707	12.275	13.368	14.604
Turnover	48,455	0.008	0.007	0.003	0.006	0.011
Beta	48,455	1.073	0.543	0.708	1.043	1.405
Stock returns, 12-month	46,458	0.162	0.742	−0.174	0.082	0.344
Volatility, 12-month	48,455	0.473	0.258	0.286	0.406	0.590
Daily returns, skewness	48,455	0.257	1.115	−0.178	0.214	0.660
Min. daily returns	48,455	−0.120	0.082	−0.151	−0.096	−0.063
Bio-technology industry	48,455	0.078	0.268	0.000	0.000	0.000
Computer hardware industry	48,455	0.015	0.122	0.000	0.000	0.000
Computer software industry	48,455	0.051	0.219	0.000	0.000	0.000
Electronics industry	48,455	0.060	0.237	0.000	0.000	0.000
Retailing industry	48,455	0.059	0.236	0.000	0.000	0.000

Panel C: Outcome group: Business failures

Variable	Obs.	Mean	SD	Q25	Median	Q75
Business failures within 3 years $_{t+1}$	48,722	0.011	0.106	0.000	0.000	0.000
Business failures within 3 years $_{t+3}$	44,640	0.014	0.117	0.000	0.000	0.000
Profit ratio	48,722	−0.004	0.032	−0.003	0.004	0.010
Total liabilities to total assets	48,722	0.407	0.272	0.174	0.358	0.611
Excess stock return	48,722	−0.005	0.046	−0.024	−0.001	0.019
Sigma	48,722	0.479	0.317	0.268	0.389	0.576
Relative size	48,722	−9.771	1.750	−10.978	−9.831	−8.622
Cash to total assets	48,722	0.108	0.129	0.023	0.062	0.143
Market-to-book	48,722	2.349	1.754	1.213	1.798	2.811
Price	48,722	2.277	0.769	2.110	2.708	2.708

Panel D: Outcome group: Firm value

Variable	Obs.	Mean	SD	Q25	Median	Q75
Tobin's Q $_{t+1}$	48,441	1.912	1.362	1.088	1.425	2.152
Tobin's Q $_{t+3}$	43,564	1.889	1.346	1.078	1.415	2.120
Tobin's Q	48,441	1.946	1.419	1.090	1.433	2.188

Table IA.1: —*Continued*

Panel E: Outcome group: Stock returns

Variable	Obs.	Mean	SD	Q25	Median	Q75
Stock returns, 12-months $_{t+1}$	43,247	0.142	0.705	−0.194	0.064	0.329
Stock returns, 12-months $_{t+3}$	36,792	0.120	0.695	−0.185	0.055	0.296
Log market value	43,247	6.632	1.745	5.410	6.532	7.780
Book-to-market	43,247	0.591	0.450	0.285	0.487	0.760
Operating profitability	43,247	0.179	0.446	0.089	0.207	0.320
Investment	43,247	0.095	0.263	−0.022	0.058	0.161

Panel F: Outcome group: Credit ratings

Variable	Obs.	Mean	SD	Q25	Median	Q75
Investment grade debt $_{t+1}$	16,962	0.498	0.500	0.000	0.000	1.000
Investment grade debt $_{t+3}$	13,339	0.525	0.499	0.000	1.000	1.000
Log market value	16,962	7.955	1.507	6.951	7.920	9.002
Book-to-market	16,962	0.554	0.426	0.276	0.473	0.720
Return on assets	16,962	0.080	0.073	0.038	0.072	0.116
Leverage	16,962	0.337	0.205	0.190	0.314	0.455
Beta	16,962	1.126	0.489	0.786	1.059	1.402
Volatility, 12-month	16,962	0.391	0.224	0.238	0.327	0.468

Table IA.2: **Optimal GBM parameters and cross-validation errors: Additional outcomes**

Panel A: Restatement events

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	31,872	2	200	0.217	23,712	7	145	0.182
Firm, Inst. hold.	31,872	5	215	0.214	23,712	7	150	0.181
Firm, Anti-takeover	31,872	7	160	0.216	23,712	7	150	0.181
Firm, Comp.	31,872	5	250	0.211	23,712	7	165	0.180
Firm, Fin. expert	31,872	5	190	0.213	23,712	7	165	0.176
Firm, Board	31,872	7	210	0.212	23,712	7	170	0.178
Firm, All govern.	31,872	5	275	0.210	23,712	7	175	0.176
Models without firm characteristics								
Inst. hold.	31,872	7	260	0.240	23,712	7	235	0.204
Anti-takeover	31,872	7	245	0.242	23,712	7	205	0.205
Comp.	31,872	2	1,100	0.225	23,712	2	1,000	0.191
Fin. expert	31,872	3	395	0.235	23,712	7	220	0.192
Board	31,872	3	1,410	0.225	23,712	5	820	0.190
All govern.	31,872	2	1,400	0.218	23,712	3	850	0.186

Table IA.2: —*Continued*

Panel B: Class-action lawsuits

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	37,760	7	175	0.407	28,641	7	145	0.405
Firm, Inst. hold.	37,760	7	170	0.407	28,641	7	135	0.405
Firm, Anti-takeover	37,760	7	170	0.407	28,641	7	140	0.405
Firm, Comp.	37,760	7	200	0.407	28,641	7	155	0.405
Firm, Fin. expert	37,760	7	170	0.407	28,641	7	135	0.405
Firm, Board	37,760	7	175	0.407	28,641	7	155	0.405
Firm, All govern.	37,760	5	250	0.407	28,641	7	160	0.405
Models without firm characteristics								
Inst. hold.	37,760	2	600	0.434	28,641	1	760	0.430
Anti-takeover	37,760	5	560	0.442	28,641	3	2,100	0.435
Comp.	37,760	2	970	0.421	28,641	2	800	0.418
Fin. expert	37,760	1	1,460	0.441	28,641	1	990	0.435
Board	37,760	5	890	0.421	28,641	7	610	0.417
All govern.	37,760	2	1,800	0.418	28,641	2	1,000	0.417

Table IA.2: —*Continued*

Panel C: Business failures within 3 years

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	37,970	1	200	0.171	29,300	2	12	0.217
Firm, Inst. hold.	37,970	1	255	0.169	29,300	2	23	0.218
Firm, Anti-takeover	37,970	1	265	0.169	29,300	2	33	0.217
Firm, Comp.	37,970	1	290	0.167	29,300	3	16	0.217
Firm, Fin. expert	37,970	1	300	0.170	29,300	2	19	0.217
Firm, Board	37,970	1	255	0.168	29,300	3	11	0.217
Firm, All govern.	37,970	1	310	0.168	29,300	1	14	0.218
Models without firm characteristics								
Inst. hold.	37,970	1	810	0.179	29,300	1	115	0.215
Anti-takeover	37,970	1	29	0.196	29,300	1	36	0.217
Comp.	37,970	1	510	0.159	29,300	1	250	0.209
Fin. expert	37,970	1	530	0.192	29,300	1	225	0.217
Board	37,970	1	670	0.174	29,300	1	365	0.208
All govern.	37,970	1	650	0.159	29,300	1	370	0.204

Table IA.2: —*Continued*

Panel D: Tobin's Q

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	37,746	2	550	0.822	33,921	2	590	0.957
Firm, Inst. hold.	37,746	2	620	0.821	33,921	2	850	0.956
Firm, Anti-takeover	37,746	2	640	0.822	33,921	2	800	0.957
Firm, Comp.	37,746	2	700	0.822	33,921	5	3,600	0.935
Firm, Fin. expert	37,746	2	550	0.823	33,921	2	820	0.957
Firm, Board	37,746	2	570	0.823	33,921	5	2,500	0.948
Firm, All govern.	37,746	2	540	0.822	33,921	7	10,300	0.917
Models without firm characteristics								
Inst. hold.	37,746	1	86	1.345	33,921	1	27	1.287
Anti-takeover	37,746	3	5,750	1.332	33,921	5	880	1.273
Comp.	37,746	7	19,300	1.201	33,921	7	31,950	1.179
Fin. expert	37,746	1	820	1.324	33,921	1	710	1.269
Board	37,746	7	31,650	1.233	33,921	7	36,700	1.191
All govern.	37,746	7	42,400	1.128	33,921	7	44,650	1.109

Table IA.2: —*Continued*

Panel E: Stock returns, 12-months

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	34,025	5	37	0.782	27,842	1	1	0.756
Firm, Inst. hold.	34,025	5	39	0.782	27,842	1	1	0.756
Firm, Anti-takeover	34,025	5	45	0.781	27,842	1	1	0.756
Firm, Comp.	34,025	5	48	0.782	27,842	1	1	0.756
Firm, Fin. expert	34,025	1	1	0.791	27,842	1	1	0.756
Firm, Board	34,025	3	49	0.782	27,842	1	1	0.756
Firm, All govern.	34,025	1	175	0.790	27,842	1	1	0.756
Models without firm characteristics								
Inst. hold.	34,025	1	1	0.791	27,842	1	1	0.756
Anti-takeover	34,025	1	1	0.791	27,842	1	1	0.756
Comp.	34,025	3	660	0.781	27,842	1	1	0.756
Fin. expert	34,025	1	1	0.791	27,842	1	1	0.756
Board	34,025	1	1	0.791	27,842	1	1	0.756
All govern.	34,025	1	97	0.790	27,842	1	1	0.756

Table IA.2: —*Continued*

Panel F: Investment grade debt

	$t+1$				$t+3$			
Model	Obs.	Tree depth	Trees	Error	Obs.	Tree depth	Trees	Error
Models with firm characteristics								
Firm	12,969	7	425	0.425	9,672	7	400	0.438
Firm, Inst. hold.	12,969	7	450	0.421	9,672	7	390	0.437
Firm, Anti-takeover	12,969	7	430	0.423	9,672	7	375	0.440
Firm, Comp.	12,969	7	490	0.413	9,672	7	400	0.437
Firm, Fin. expert	12,969	7	460	0.419	9,672	7	380	0.437
Firm, Board	12,969	7	520	0.410	9,672	7	410	0.431
Firm, All govern.	12,969	7	560	0.400	9,672	7	425	0.429
Models without firm characteristics								
Inst. hold.	12,969	2	1,050	0.649	9,672	2	1,010	0.652
Anti-takeover	12,969	5	1,230	0.677	9,672	5	1,050	0.679
Comp.	12,969	5	1,600	0.543	9,672	7	970	0.562
Fin. expert	12,969	2	930	0.633	9,672	2	740	0.642
Board	12,969	7	1,800	0.520	9,672	7	1,600	0.535
All govern.	12,969	7	1,360	0.486	9,672	7	1,140	0.515

Table IA.3: **Mean out-of-sample errors and t-statistics for restatement events: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Restatement events $t+1$

2013	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.170	2.269**	2.412**	2.306**	2.766***	2.683***	2.637***	2.918***
Firm	0.144		0.173	0.059	0.596	0.535	0.438	0.792
Firm, Inst. hold.	0.143			−0.114	0.423	0.365	0.265	0.620
Firm, Anti-takeover	0.144				0.534	0.475	0.377	0.730
Firm, Comp.	0.138					−0.052	−0.159	0.200
Firm, Fin. expert	0.138						−0.105	0.250
Firm, Board	0.139							0.359
Firm, All govern.	0.135							
2014	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.169	1.607	1.630	1.694*	1.888*	2.044**	1.886*	2.031**
Firm	0.148		0.071	0.073	0.351	0.437	0.293	0.510
Firm, Inst. hold.	0.147			0.000	0.274	0.355	0.216	0.431
Firm, Anti-takeover	0.147				0.282	0.366	0.222	0.443
Firm, Comp.	0.142					0.070	−0.065	0.158
Firm, Fin. expert	0.141						−0.140	0.093
Firm, Board	0.143							0.227
Firm, All govern.	0.140							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.153	2.227**	2.517**	2.325**	2.719***	2.776***	2.596***	2.929***
Firm	0.129		0.243	0.090	0.619	0.604	0.433	0.835
Firm, Inst. hold.	0.127			−0.152	0.399	0.378	0.204	0.619
Firm, Anti-takeover	0.128				0.535	0.519	0.347	0.752
Firm, Comp.	0.122					−0.031	−0.192	0.208
Firm, Fin. expert	0.122						−0.165	0.245
Firm, Board	0.124							0.404
Firm, All govern.	0.119							

Table IA.3: —*Continued*

Panel B: Restatement events $t + 3$

2011	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.155	2.150**	2.164**	2.180**	2.110**	2.426**	2.228**	2.301**
Firm	0.125		0.012	0.026	0.029	0.413	0.124	0.306
Firm, Inst. hold.	0.125			0.014	0.018	0.402	0.113	0.295
Firm, Anti-takeover	0.125				0.004	0.389	0.099	0.282
Firm, Comp.	0.125					0.373	0.092	0.270
Firm, Fin. expert	0.119						−0.288	−0.097
Firm, Board	0.124							0.184
Firm, All govern.	0.121							
2012	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.151	2.191**	2.117**	2.216**	2.302**	2.468**	2.395**	2.481**
Firm	0.121		−0.053	0.028	0.157	0.441	0.246	0.426
Firm, Inst. hold.	0.122			0.080	0.208	0.486	0.296	0.471
Firm, Anti-takeover	0.121				0.130	0.415	0.219	0.399
Firm, Comp.	0.119					0.287	0.086	0.270
Firm, Fin. expert	0.115						−0.206	−0.020
Firm, Board	0.118							0.188
Firm, All govern.	0.115							
2013	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.135	1.310	1.283	1.288	1.406	1.712*	1.497	1.714*
Firm	0.116		−0.015	−0.002	0.099	0.417	0.187	0.393
Firm, Inst. hold.	0.117			0.013	0.113	0.429	0.201	0.405
Firm, Anti-takeover	0.116				0.100	0.414	0.186	0.390
Firm, Comp.	0.115					0.318	0.088	0.292
Firm, Fin. expert	0.109						−0.231	−0.030
Firm, Board	0.113							0.204
Firm, All govern.	0.110							

Table IA.4: **Mean out-of-sample errors and t-statistics for restatement events: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Restatement events $t+1$

2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.170	2.269**	0.225	0.428	1.167	1.030	0.986	1.183
Firm	0.144		−1.918*	−1.733*	−0.584	−1.000	−0.703	−0.376
Inst. hold.	0.167			0.191	0.949	0.780	0.782	0.990
Anti-takeover	0.165				0.795	0.603	0.632	0.852
Comp.	0.153					−0.259	−0.119	0.124
Fin. expert	0.157						0.119	0.369
Board	0.155							0.232
All govern.	0.151							
2014	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.169	1.607	0.036	0.457	1.065	0.959	0.895	1.111
Firm	0.148		−1.469	−1.141	−0.317	−0.600	−0.421	−0.158
Inst. hold.	0.169			0.388	0.981	0.863	0.825	1.036
Anti-takeover	0.163				0.674	0.512	0.525	0.755
Comp.	0.153					−0.216	−0.107	0.123
Fin. expert	0.156						0.091	0.333
Board	0.155							0.220
All govern.	0.151							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.153	2.227**	0.181	0.466	1.765*	1.451	1.849*	2.167**
Firm	0.129		−1.909*	−1.608	−0.082	−0.650	0.007	0.406
Inst. hold.	0.151			0.270	1.537	1.198	1.618	1.937*
Anti-takeover	0.148				1.288	0.918	1.370	1.698*
Comp.	0.130					−0.474	0.079	0.431
Fin. expert	0.137						0.559	0.922
Board	0.129							0.354
All govern.	0.124							

Table IA.4: —*Continued*

Panel B: Restatement events $t + 3$

2011	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.155	2.150**	0.221	0.236	0.911	0.794	1.174	1.140
Firm	0.125		−1.826*	−1.878*	−0.795	−1.018	−0.667	−0.533
Inst. hold.	0.152			0.008	0.704	0.578	0.940	0.930
Anti-takeover	0.152				0.712	0.584	0.956	0.942
Comp.	0.139					−0.145	0.160	0.212
Fin. expert	0.142						0.322	0.363
Board	0.136							0.065
All govern.	0.135							
2012	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.151	2.191**	−0.024	0.307	0.819	0.626	0.925	0.932
Firm	0.121		−2.000**	−1.852*	−0.837	−1.179	−0.860	−0.702
Inst. hold.	0.152			0.303	0.790	0.605	0.884	0.897
Anti-takeover	0.147				0.575	0.363	0.661	0.690
Comp.	0.136					−0.215	0.036	0.104
Fin. expert	0.141						0.267	0.323
Board	0.135							0.073
All govern.	0.134							
2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.135	1.310	0.059	0.222	0.900	1.049	1.117	1.194
Firm	0.116		−1.178	−1.081	−0.269	−0.269	−0.133	0.007
Inst. hold.	0.135			0.147	0.805	0.927	1.003	1.086
Anti-takeover	0.133				0.703	0.820	0.902	0.992
Comp.	0.121					0.025	0.138	0.258
Fin. expert	0.121						0.126	0.256
Board	0.119							0.131
All govern.	0.116							

Table IA.5: **Mean out-of-sample errors and t-statistics for class-action lawsuits: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Class-action lawsuits $t + 1$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.492	2.243**	2.225**	2.194**	2.154**	2.198**	2.236**	2.162**
Firm	0.459		−0.027	−0.050	−0.041	−0.045	−0.010	−0.027
Firm, Inst. hold.	0.460			−0.023	−0.015	−0.018	0.017	−0.000
Firm, Anti-takeover	0.460				0.008	0.005	0.040	0.022
Firm, Comp.	0.460					−0.003	0.031	0.014
Firm, Fin. expert	0.460						0.035	0.017
Firm, Board	0.459							−0.017
Firm, All govern.	0.460							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.493	2.544**	2.535**	2.532**	2.477**	2.527**	2.568**	2.587***
Firm	0.455		−0.015	−0.016	−0.017	−0.016	0.026	0.089
Firm, Inst. hold.	0.455			−0.001	−0.003	−0.001	0.041	0.104
Firm, Anti-takeover	0.455				−0.002	−0.000	0.041	0.105
Firm, Comp.	0.455					0.002	0.043	0.105
Firm, Fin. expert	0.455						0.042	0.105
Firm, Board	0.455							0.064
Firm, All govern.	0.454							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.481	1.441	1.462	1.501	1.560	1.522	1.493	1.507
Firm	0.458		0.017	0.052	0.127	0.071	0.046	0.084
Firm, Inst. hold.	0.458			0.035	0.111	0.055	0.029	0.067
Firm, Anti-takeover	0.458				0.076	0.020	−0.006	0.033
Firm, Comp.	0.456					−0.057	−0.082	−0.043
Firm, Fin. expert	0.457						−0.025	0.013
Firm, Board	0.458							0.038
Firm, All govern.	0.457							

Table IA.5: —*Continued*

Panel B: Class-action lawsuits $t + 3$

2012	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.476	1.907*	1.901*	1.914*	1.948*	1.890*	1.929*	1.947*
Firm	0.446		−0.016	0.000	0.044	−0.025	0.028	0.047
Firm, Inst. hold.	0.446			0.016	0.060	−0.010	0.044	0.063
Firm, Anti-takeover	0.446				0.044	−0.026	0.028	0.047
Firm, Comp.	0.445					−0.069	−0.016	0.003
Firm, Fin. expert	0.446						0.053	0.072
Firm, Board	0.445							0.019
Firm, All govern.	0.445							
2013	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.486	1.900*	1.910*	1.923*	1.978**	1.923*	1.940*	1.949*
Firm	0.456		−0.002	0.012	0.072	0.008	0.042	0.052
Firm, Inst. hold.	0.456			0.014	0.074	0.011	0.044	0.055
Firm, Anti-takeover	0.456				0.060	−0.004	0.030	0.040
Firm, Comp.	0.455					−0.064	−0.030	−0.019
Firm, Fin. expert	0.456						0.033	0.044
Firm, Board	0.455							0.011
Firm, All govern.	0.455							
2014	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.474	1.184	1.201	1.187	1.116	1.164	1.140	1.165
Firm	0.455		0.011	−0.000	−0.054	−0.023	−0.036	−0.009
Firm, Inst. hold.	0.455			−0.011	−0.065	−0.034	−0.046	−0.020
Firm, Anti-takeover	0.455				−0.054	−0.023	−0.036	−0.009
Firm, Comp.	0.456					0.032	0.019	0.045
Firm, Fin. expert	0.456						−0.013	0.014
Firm, Board	0.456							0.026
Firm, All govern.	0.455							

Table IA.6: **Mean out-of-sample errors and t-statistics for class-action lawsuits: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Class-action lawsuits $t+1$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.492	2.243**	0.275	0.359	1.480	−0.024	1.571	1.668*
Firm	0.459		−1.934*	−1.903*	−0.761	−2.230**	−0.737	−0.559
Inst. hold.	0.488			0.076	1.182	−0.294	1.262	1.370
Anti-takeover	0.487				1.133	−0.377	1.216	1.326
Comp.	0.471					−1.479	0.047	0.198
Fin. expert	0.493						1.568	1.665*
Board	0.470							0.157
All govern.	0.468							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.493	2.544**	0.463	0.416	2.192**	0.008	1.921*	2.435**
Firm	0.455		−2.080**	−2.153**	−0.385	−2.501**	−0.691	−0.135
Inst. hold.	0.486			−0.052	1.722*	−0.448	1.445	1.967**
Anti-takeover	0.487				1.792*	−0.402	1.513	2.039**
Comp.	0.461					−2.152**	−0.305	0.253
Fin. expert	0.493						1.884*	2.393**
Board	0.465							0.560
All govern.	0.457							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.481	1.441	0.339	0.047	1.007	0.109	1.248	1.334
Firm	0.458		−1.108	−1.383	−0.438	−1.326	−0.258	−0.125
Inst. hold.	0.476			−0.289	0.671	−0.228	0.898	0.997
Anti-takeover	0.480				0.952	0.062	1.188	1.276
Comp.	0.466					−0.893	0.198	0.318
Fin. expert	0.479						1.128	1.218
Board	0.462							0.131
All govern.	0.460							

Table IA.6: —*Continued*

Panel B: Class-action lawsuits $t+3$

2012	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.476	1.907*	0.205	0.268	0.874	0.023	0.989	0.996
Firm	0.446		−1.697*	−1.646*	−0.991	−1.853*	−0.923	−0.875
Inst. hold.	0.473			0.062	0.672	−0.178	0.781	0.793
Anti-takeover	0.472				0.615	−0.241	0.724	0.737
Comp.	0.462					−0.837	0.090	0.116
Fin. expert	0.476						0.949	0.958
Board	0.461							0.029
All govern.	0.460							
2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.486	1.900*	0.445	0.317	1.857*	0.011	1.526	2.021**
Firm	0.456		−1.472	−1.595	−0.127	−1.863*	−0.463	0.028
Inst. hold.	0.480			−0.128	1.409	−0.427	1.074	1.572
Anti-takeover	0.482				1.537	−0.301	1.203	1.701*
Comp.	0.458					−1.817*	−0.352	0.163
Fin. expert	0.486						1.491	1.978**
Board	0.463							0.516
All govern.	0.456							
2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.474	1.184	0.194	0.017	0.758	0.157	1.097	0.951
Firm	0.455		−0.988	−1.152	−0.431	−1.025	−0.147	−0.248
Inst. hold.	0.471			−0.174	0.562	−0.037	0.891	0.752
Anti-takeover	0.474				0.731	0.138	1.065	0.921
Comp.	0.462					−0.599	0.304	0.187
Fin. expert	0.471						0.930	0.790
Board	0.458							−0.111
All govern.	0.459							

Table IA.7: **Mean out-of-sample errors and t-statistics for business failures: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Business failure within 3 years $t+1$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.231	2.517**	2.725***	2.739***	2.782***	2.758***	2.688***	2.792***
Firm	0.174		0.246	0.266	0.331	0.292	0.212	0.336
Firm, Inst. hold.	0.169			0.021	0.087	0.047	−0.033	0.091
Firm, Anti-takeover	0.168				0.066	0.026	−0.053	0.070
Firm, Comp.	0.167					−0.041	−0.119	0.004
Firm, Fin. expert	0.168						−0.079	0.044
Firm, Board	0.169							0.123
Firm, All govern.	0.167							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.204	3.389***	3.590***	3.660***	3.774***	3.752***	3.678***	3.753***
Firm	0.139		0.272	0.350	0.500	0.468	0.359	0.464
Firm, Inst. hold.	0.135			0.077	0.226	0.194	0.085	0.190
Firm, Anti-takeover	0.133				0.150	0.118	0.007	0.114
Firm, Comp.	0.131					−0.032	−0.144	−0.037
Firm, Fin. expert	0.132						−0.111	−0.004
Firm, Board	0.133							0.107
Firm, All govern.	0.132							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.177	2.394**	2.604***	2.632***	2.715***	2.725***	2.605***	2.679***
Firm	0.131		0.234	0.275	0.374	0.370	0.242	0.339
Firm, Inst. hold.	0.127			0.041	0.141	0.137	0.008	0.108
Firm, Anti-takeover	0.126				0.100	0.095	−0.033	0.066
Firm, Comp.	0.124					−0.005	−0.133	−0.033
Firm, Fin. expert	0.124						−0.128	−0.028
Firm, Board	0.127							0.099
Firm, All govern.	0.125							

Table IA.7: —*Continued*

Panel B: Business failure within 3 years $t + 3$

2012	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.238	0.119	0.215	0.312	0.231	0.162	0.109	0.138
Firm	0.235		0.096	0.193	0.111	0.043	−0.010	0.018
Firm, Inst. hold.	0.233			0.097	0.015	−0.053	−0.106	−0.078
Firm, Anti-takeover	0.230				−0.083	−0.150	−0.203	−0.175
Firm, Comp.	0.232					−0.068	−0.121	−0.093
Firm, Fin. expert	0.234						−0.053	−0.025
Firm, Board	0.235							0.029
Firm, All govern.	0.234							
2013	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.212	0.154	0.284	0.343	0.192	0.232	0.148	0.165
Firm	0.209		0.129	0.189	0.038	0.078	−0.006	0.010
Firm, Inst. hold.	0.207			0.061	−0.091	−0.051	−0.135	−0.119
Firm, Anti-takeover	0.205				−0.151	−0.111	−0.196	−0.179
Firm, Comp.	0.208					0.040	−0.044	−0.028
Firm, Fin. expert	0.208						−0.084	−0.068
Firm, Board	0.209							0.017
Firm, All govern.	0.209							
2014	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.198	0.150	0.257	0.376	0.251	0.244	0.153	0.177
Firm	0.195		0.108	0.226	0.101	0.094	0.003	0.027
Firm, Inst. hold.	0.193			0.118	−0.007	−0.014	−0.104	−0.081
Firm, Anti-takeover	0.191				−0.125	−0.133	−0.223	−0.200
Firm, Comp.	0.193					−0.007	−0.098	−0.075
Firm, Fin. expert	0.193						−0.091	−0.067
Firm, Board	0.195							0.024
Firm, All govern.	0.195							

Table IA.8: **Mean out-of-sample errors and t-statistics for business failures: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Business failure within 3 years $t+1$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.231	2.517**	0.847	0.037	2.067**	0.212	1.374	2.068**
Firm	0.174		−1.535	−2.486**	−0.314	−2.312**	−1.039	−0.319
Inst. hold.	0.210			−0.813	1.159	−0.647	0.492	1.158
Anti-takeover	0.230				2.035**	0.176	1.341	2.036**
Comp.	0.181					−1.870*	−0.682	−0.004
Fin. expert	0.226						1.173	1.870*
Board	0.198							0.679
All govern.	0.181							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.204	3.389***	0.794	0.031	2.914***	0.225	1.560	2.875***
Firm	0.139		−2.317**	−3.362***	−0.425	−3.170***	−1.683*	−0.461
Inst. hold.	0.186			−0.765	1.906*	−0.584	0.689	1.871*
Anti-takeover	0.203				2.887***	0.194	1.532	2.847***
Comp.	0.146					−2.696***	−1.256	−0.036
Fin. expert	0.199						1.344	2.657***
Board	0.170							1.220
All govern.	0.147							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.177	2.394**	1.546	0.024	2.611***	0.287	2.469**	2.673***
Firm	0.131		−0.855	−2.375**	0.247	−2.155**	−0.048	0.278
Inst. hold.	0.147			−1.525	1.091	−1.288	0.857	1.135
Anti-takeover	0.176				2.593***	0.263	2.450**	2.655***
Comp.	0.126					−2.379**	−0.308	0.028
Fin. expert	0.171						2.224**	2.441**
Board	0.132							0.344
All govern.	0.126							

Table IA.8: —*Continued*

Panel B: Business failure within 3 years $t + 3$

2012	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.238	0.119	0.390	0.051	0.452	0.151	0.577	0.828
Firm	0.235		0.271	−0.069	0.334	0.032	0.460	0.712
Inst. hold.	0.229			−0.340	0.067	−0.241	0.192	0.443
Anti-takeover	0.236				0.402	0.100	0.528	0.780
Comp.	0.227					−0.305	0.123	0.370
Fin. expert	0.234						0.430	0.683
Board	0.224							0.247
All govern.	0.219							
2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.212	0.154	0.161	0.052	0.710	0.205	0.487	0.786
Firm	0.209		0.010	−0.103	0.559	0.049	0.339	0.640
Inst. hold.	0.209			−0.110	0.539	0.038	0.323	0.619
Anti-takeover	0.211				0.660	0.153	0.438	0.738
Comp.	0.197					−0.516	−0.205	0.095
Fin. expert	0.208						0.295	0.599
Board	0.202							0.293
All govern.	0.195							
2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.198	0.150	0.188	0.028	0.787	0.164	0.578	0.828
Firm	0.195		0.042	−0.121	0.638	0.013	0.429	0.681
Inst. hold.	0.194			−0.161	0.584	−0.029	0.379	0.626
Anti-takeover	0.197				0.759	0.135	0.550	0.801
Comp.	0.183					−0.629	−0.207	0.046
Fin. expert	0.195						0.419	0.672
Board	0.187							0.252
All govern.	0.182							

Table IA.9: **Mean out-of-sample errors and t-statistics for Tobin's Q: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Tobin's Q $t+1$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	1.443	12.047***	12.049***	12.029***	12.049***	12.055***	12.047***	12.060***
Firm	0.808		−0.006	−0.027	−0.025	0.011	−0.002	0.002
Firm, Inst. hold.	0.808			−0.021	−0.019	0.018	0.005	0.008
Firm, Anti-takeover	0.809				0.002	0.039	0.026	0.029
Firm, Comp.	0.809					0.037	0.024	0.027
Firm, Fin. expert	0.807						−0.013	−0.010
Firm, Board	0.808							0.003
Firm, All govern.	0.808							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	1.403	12.418***	12.435***	12.417***	12.474***	12.415***	12.407***	12.454***
Firm	0.744		0.026	0.000	0.110	−0.001	−0.017	0.068
Firm, Inst. hold.	0.743			−0.026	0.084	−0.027	−0.043	0.042
Firm, Anti-takeover	0.744				0.110	−0.001	−0.017	0.068
Firm, Comp.	0.741					−0.111	−0.127	−0.042
Firm, Fin. expert	0.744						−0.016	0.069
Firm, Board	0.745							0.085
Firm, All govern.	0.742							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	1.646	11.919***	11.945***	11.988***	12.038***	11.920***	11.932***	11.910***
Firm	0.894		0.041	0.112	0.173	0.001	0.019	−0.035
Firm, Inst. hold.	0.892			0.071	0.132	−0.040	−0.022	−0.076
Firm, Anti-takeover	0.889				0.060	−0.111	−0.093	−0.148
Firm, Comp.	0.886					−0.172	−0.154	−0.209
Firm, Fin. expert	0.894						0.018	−0.036
Firm, Board	0.893							−0.054
Firm, All govern.	0.896							

Table IA.9: —*Continued*

Panel B: Tobin's Q $t + 3$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	1.603	8.129***	8.219***	8.197***	9.237***	8.190***	8.722***	9.588***
Firm	1.119		0.096	0.078	1.396	0.073	0.776	1.911*
Firm, Inst. hold.	1.115			−0.018	1.305	−0.023	0.683	1.824*
Firm, Anti-takeover	1.115				1.320	−0.006	0.699	1.837*
Firm, Comp.	1.054					−1.324	−0.607	0.540
Firm, Fin. expert	1.116						0.704	1.841*
Firm, Board	1.082							1.130
Firm, All govern.	1.030							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	1.537	8.097***	8.188***	8.153***	8.981***	8.132***	8.695***	9.249***
Firm	1.077		0.111	0.056	1.124	0.041	0.746	1.483
Firm, Inst. hold.	1.072			−0.055	1.014	−0.070	0.635	1.373
Firm, Anti-takeover	1.075				1.072	−0.015	0.691	1.432
Firm, Comp.	1.028					−1.084	−0.382	0.362
Firm, Fin. expert	1.075						0.705	1.443
Firm, Board	1.044							0.744
Firm, All govern.	1.012							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	1.659	8.275***	8.351***	8.358***	9.335***	8.328***	8.838***	9.436***
Firm	1.120		0.101	0.105	1.423	0.068	0.789	1.613
Firm, Inst. hold.	1.115			0.004	1.321	−0.033	0.689	1.513
Firm, Anti-takeover	1.115				1.320	−0.037	0.686	1.511
Firm, Comp.	1.050					−1.356	−0.618	0.212
Firm, Fin. expert	1.117						0.722	1.547
Firm, Board	1.080							0.817
Firm, All govern.	1.040							

Table IA.10: **Mean out-of-sample errors and t-statistics for Tobin's Q: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Tobin's Q $t+1$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.443	12.047***	−0.021	0.462	4.076***	0.408	3.250***	5.348***
Firm	0.808		−12.067***	−11.850***	−9.336***	−11.940***	−10.339***	−8.547***
Inst. hold.	1.444			0.484	4.098***	0.430	3.272***	5.370***
Anti-takeover	1.418				3.653***	−0.055	2.809***	4.946***
Comp.	1.232					−3.718***	−0.935	1.326
Fin. expert	1.421						2.873***	5.016***
Board	1.276							2.298**
All govern.	1.171							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	1.403	12.418***	−0.024	0.390	3.493***	0.349	2.957***	5.141***
Firm	0.744		−12.423***	−12.289***	−10.219***	−12.334***	−10.895***	−9.130***
Inst. hold.	1.404			0.413	3.515***	0.372	2.979***	5.161***
Anti-takeover	1.382				3.133***	−0.041	2.587***	4.806***
Comp.	1.219					−3.177***	−0.597	1.723*
Fin. expert	1.384						2.631***	4.851***
Board	1.248							2.348**
All govern.	1.136							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	1.646	11.919***	−0.013	0.530	3.445***	0.474	2.846***	4.954***
Firm	0.894		−11.929***	−11.629***	−9.323***	−11.679***	−10.118***	−8.109***
Inst. hold.	1.647			0.543	3.458***	0.487	2.859***	4.967***
Anti-takeover	1.612				2.942***	−0.056	2.330**	4.473***
Comp.	1.430					−2.999***	−0.663	1.557
Fin. expert	1.616						2.387**	4.530***
Board	1.470							2.249**
All govern.	1.339							

Table IA.10: —*Continued*

Panel B: Tobin's Q $t + 3$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.603	8.129***	−0.002	0.363	3.332***	0.340	3.001***	4.602***
Firm	1.119		−8.133***	−7.871***	−5.229***	−7.881***	−5.663***	−3.983***
Inst. hold.	1.604			0.365	3.334***	0.343	3.004***	4.605***
Anti-takeover	1.581				2.991***	−0.023	2.654***	4.277***
Comp.	1.401					−3.010***	−0.376	1.333
Fin. expert	1.582						2.674***	4.295***
Board	1.423							1.725*
All govern.	1.327							
2015	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.537	8.097***	−0.001	0.337	3.440***	0.280	2.988***	4.768***
Firm	1.077		−8.096***	−7.860***	−5.008***	−7.910***	−5.643***	−3.745***
Inst. hold.	1.537			0.338	3.440***	0.281	2.989***	4.768***
Anti-takeover	1.517				3.127***	−0.058	2.667***	4.471***
Comp.	1.336					−3.184***	−0.522	1.370
Fin. expert	1.520						2.724***	4.527***
Board	1.364							1.925*
All govern.	1.262							
2016	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	1.659	8.275***	−0.001	0.386	3.307***	0.321	2.665***	4.398***
Firm	1.120		−8.275***	−8.019***	−5.442***	−8.059***	−6.258***	−4.407***
Inst. hold.	1.659			0.387	3.307***	0.322	2.666***	4.399***
Anti-takeover	1.633				2.948***	−0.065	2.293**	4.055***
Comp.	1.440					−3.008***	−0.720	1.140
Fin. expert	1.637						2.355**	4.112***
Board	1.484							1.885*
All govern.	1.370							

Table IA.11: **Mean out-of-sample errors and t-statistics for stock returns: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Stock returns, 12-months $t + 1$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.421	−0.081	−0.091	−0.141	−0.369	0.000	−0.072	−0.554
Firm	0.422		−0.010	−0.059	−0.287	0.082	0.009	−0.472
Firm, Inst. hold.	0.422			−0.049	−0.276	0.092	0.019	−0.462
Firm, Anti-takeover	0.423				−0.227	0.141	0.068	−0.413
Firm, Comp.	0.427					0.370	0.295	−0.188
Firm, Fin. expert	0.421						−0.072	−0.554
Firm, Board	0.422							−0.480
Firm, All govern.	0.430							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.592	−0.025	−0.022	−0.037	−0.027	−0.000	−0.029	−0.063
Firm	0.595		0.003	−0.011	−0.002	0.025	−0.004	−0.038
Firm, Inst. hold.	0.595			−0.015	−0.005	0.022	−0.008	−0.041
Firm, Anti-takeover	0.596				0.010	0.036	0.007	−0.027
Firm, Comp.	0.595					0.027	−0.003	−0.037
Firm, Fin. expert	0.592						−0.029	−0.063
Firm, Board	0.595							−0.034
Firm, All govern.	0.599							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.465	−0.061	−0.047	−0.080	−0.109	−0.000	−0.080	−0.192
Firm	0.467		0.014	−0.019	−0.049	0.060	−0.019	−0.132
Firm, Inst. hold.	0.466			−0.033	−0.063	0.046	−0.033	−0.146
Firm, Anti-takeover	0.467				−0.030	0.080	−0.000	−0.114
Firm, Comp.	0.469					0.109	0.030	−0.083
Firm, Fin. expert	0.465						−0.079	−0.192
Firm, Board	0.467							−0.113
Firm, All govern.	0.472							

Table IA.12: **Mean out-of-sample errors and t-statistics for stock returns: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Stock returns, 12-months $t+1$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.421	−0.081	−0.000	−0.002	−1.110	0.009	0.001	−0.516
Firm	0.422		0.081	0.080	−1.029	0.090	0.082	−0.433
Inst. hold.	0.421			−0.001	−1.110	0.009	0.001	−0.516
Anti-takeover	0.421				−1.109	0.010	0.003	−0.514
Comp.	0.440					1.118	1.111	0.617
Fin. expert	0.421						−0.008	−0.524
Board	0.421							−0.517
All govern.	0.429							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.592	−0.025	0.000	−0.000	−0.204	−0.000	−0.000	−0.034
Firm	0.595		0.025	0.025	−0.179	0.025	0.025	−0.009
Inst. hold.	0.592			−0.000	−0.204	−0.000	−0.000	−0.034
Anti-takeover	0.592				−0.204	−0.000	−0.000	−0.034
Comp.	0.612					0.204	0.204	0.171
Fin. expert	0.592						0.000	−0.034
Board	0.592							−0.034
All govern.	0.596							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.465	−0.061	−0.000	−0.000	−0.642	0.000	−0.001	−0.133
Firm	0.467		0.061	0.061	−0.585	0.061	0.060	−0.073
Inst. hold.	0.465			−0.000	−0.642	0.000	−0.000	−0.132
Anti-takeover	0.465				−0.642	0.000	−0.000	−0.132
Comp.	0.488					0.643	0.642	0.509
Fin. expert	0.465						−0.001	−0.133
Board	0.465							−0.132
All govern.	0.469							

Table IA.13: **Mean out-of-sample errors and t-statistics for investment grade bonds: Firm characteristics vs firm and governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Investment grade debt $t+1$

2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.693	16.578***	17.464***	16.870***	18.405***	17.625***	16.704***	18.774***
Firm	0.456		0.390	0.054	0.913	0.553	0.753	1.641
Firm, Inst. hold.	0.447			−0.338	0.526	0.166	0.381	1.269
Firm, Anti-takeover	0.455				0.864	0.502	0.705	1.597
Firm, Comp.	0.435					−0.359	−0.123	0.756
Firm, Fin. expert	0.443						0.221	1.103
Firm, Board	0.438							0.844
Firm, All govern.	0.417							
2015	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.693	19.863***	21.637***	20.061***	22.265***	21.224***	21.479***	25.454***
Firm	0.423		0.422	0.013	0.868	0.513	0.912	1.984**
Firm, Inst. hold.	0.414			−0.410	0.459	0.099	0.513	1.598
Firm, Anti-takeover	0.423				0.858	0.502	0.903	1.980**
Firm, Comp.	0.404					−0.354	0.063	1.123
Firm, Fin. expert	0.412						0.409	1.474
Firm, Board	0.403							1.034
Firm, All govern.	0.381							
2016	**Error**	**Firm**	**Firm, Inst. hold.**	**Firm, Anti-takeover**	**Firm, Comp.**	**Firm, Fin. expert**	**Firm, Board**	**Firm, All govern.**
Base model	0.693	26.711***	27.805***	26.877***	30.268***	28.889***	32.461***	35.335***
Firm	0.391		0.344	0.066	1.189	0.574	1.598	2.414**
Firm, Inst. hold.	0.385			−0.278	0.847	0.228	1.254	2.074**
Firm, Anti-takeover	0.390				1.123	0.508	1.531	2.348**
Firm, Comp.	0.369					−0.626	0.394	1.215
Firm, Fin. expert	0.381						1.033	1.860*
Firm, Board	0.362							0.835
Firm, All govern.	0.348							

Table IA.13: —*Continued*

Panel B: Investment grade debt $t + 3$

2012	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.692	20.769***	21.572***	21.475***	21.727***	21.923***	22.045***	23.060***
Firm	0.415		0.069	−0.030	0.278	0.045	0.353	0.777
Firm, Inst. hold.	0.413			−0.100	0.213	−0.025	0.289	0.720
Firm, Anti-takeover	0.415				0.313	0.076	0.390	0.822
Firm, Comp.	0.409					−0.240	0.075	0.502
Firm, Fin. expert	0.414						0.317	0.751
Firm, Board	0.407							0.429
Firm, All govern.	0.398							
2013	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.693	17.772***	18.254***	17.650***	19.135***	18.524***	18.895***	20.857***
Firm	0.450		0.054	−0.202	0.391	0.019	0.332	0.984
Firm, Inst. hold.	0.449			−0.259	0.341	−0.036	0.281	0.939
Firm, Anti-takeover	0.455				0.600	0.225	0.540	1.200
Firm, Comp.	0.442					−0.380	−0.059	0.598
Firm, Fin. expert	0.450						0.320	0.985
Firm, Board	0.443							0.656
Firm, All govern.	0.429							
2014	Error	Firm	Firm, Inst. hold.	Firm, Anti-takeover	Firm, Comp.	Firm, Fin. expert	Firm, Board	Firm, All govern.
Base model	0.692	21.550***	23.058***	21.483***	23.858***	22.455***	23.177***	26.476***
Firm	0.420		0.176	−0.257	0.436	−0.054	0.411	1.178
Firm, Inst. hold.	0.416			−0.442	0.266	−0.236	0.242	1.027
Firm, Anti-takeover	0.425				0.706	0.208	0.677	1.461
Firm, Comp.	0.411					−0.502	−0.020	0.761
Firm, Fin. expert	0.421						0.476	1.265
Firm, Board	0.412							0.770
Firm, All govern.	0.397							

Table IA.14: **Mean out-of-sample errors and t-statistics for investment grade bonds: Firm characteristics vs governance characteristics**

This table reports mean out-of-sample test errors in the first column and t-statistics for the differences in these errors. With t-statistics, we compare the model in the column to the model in the corresponding row. *Base model* denotes an uninformed baseline that uses an average outcome in the estimation data for prediction. *Firm* denotes firm characteristics. *Inst. hold.* denotes institutional investor holdings. *Anti-takeover* denotes anti-takeover provisions. *Comp.* denotes executive compensation. *Fin. expert* denotes board's financial expertise. *Board* denotes board characteristics. *All govern.* denotes all governance characteristics that is the union of *Inst. hold.*, *Anti-takeover*, *Comp.*, *Fin. expert*, and *Board*.

Panel A: Investment grade debt $t+1$

2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.693	16.578***	8.772***	5.567***	14.509***	9.652***	14.735***	17.094***
Firm	0.456		−12.310***	−14.175***	−4.899***	−10.808***	−3.511***	−2.100**
Inst. hold.	0.649			−3.331***	8.692***	1.989**	9.581***	11.674***
Anti-takeover	0.671				11.139***	5.041***	11.789***	13.968***
Comp.	0.549					−6.820***	1.389	3.076***
Fin. expert	0.633						7.861***	9.847***
Board	0.526							1.589
All govern.	0.499							
2015	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.693	19.863***	7.113***	6.117***	15.606***	9.721***	15.654***	19.736***
Firm	0.423		−15.018***	−16.774***	−5.718***	−13.100***	−4.498***	−3.055***
Inst. hold.	0.653			−2.053**	9.947***	2.542**	10.557***	13.562***
Anti-takeover	0.668				11.914***	4.733***	12.356***	15.735***
Comp.	0.532					−7.775***	1.110	2.992***
Fin. expert	0.631						8.536***	11.285***
Board	0.513							1.736*
All govern.	0.483							
2016	**Error**	**Firm**	**Inst. hold.**	**Anti-takeover**	**Comp.**	**Fin. expert**	**Board**	**All govern.**
Base model	0.693	26.711***	7.157***	5.915***	13.781***	9.372***	15.266***	19.731***
Firm	0.391		−20.365***	−21.822***	−8.513***	−16.935***	−6.586***	−5.079***
Inst. hold.	0.656			−1.480	9.127***	3.013***	10.751***	14.122***
Anti-takeover	0.666				10.246***	4.416***	11.842***	15.430***
Comp.	0.542					−6.515***	1.636	3.583***
Fin. expert	0.630						8.177***	11.067***
Board	0.513							1.798*
All govern.	0.481							

Table IA.14: —*Continued*

Panel B: Investment grade debt $t + 3$

2012	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.692	20.769***	8.112***	4.452***	16.114***	8.397***	16.421***	16.136***
Firm	0.415		−15.374***	−18.283***	−6.693***	−14.575***	−5.085***	−4.263***
Inst. hold.	0.647			−4.009***	9.523***	0.795	10.524***	10.747***
Anti-takeover	0.674				12.985***	4.637***	13.675***	13.662***
Comp.	0.537					−8.640***	1.507	2.175**
Fin. expert	0.640						9.704***	9.983***
Board	0.513							0.700
All govern.	0.500							
2013	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.693	17.772***	7.481***	5.065***	12.659***	8.883***	12.210***	14.733***
Firm	0.450		−13.061***	−15.264***	−6.073***	−12.053***	−4.721***	−3.276***
Inst. hold.	0.650			−3.061***	7.230***	1.401	7.649***	9.791***
Anti-takeover	0.672				9.706***	4.504***	9.777***	12.082***
Comp.	0.563					−6.091***	1.069	2.763***
Fin. expert	0.638						6.646***	8.735***
Board	0.545							1.558
All govern.	0.516							
2014	Error	Firm	Inst. hold.	Anti-takeover	Comp.	Fin. expert	Board	All govern.
Base model	0.692	21.550***	6.342***	5.867***	12.863***	7.512***	13.252***	14.898***
Firm	0.420		−16.475***	−18.102***	−7.773***	−14.974***	−5.978***	−4.991***
Inst. hold.	0.656			−1.502	8.035***	1.510	8.994***	10.401***
Anti-takeover	0.667				9.479***	3.039***	10.293***	11.787***
Comp.	0.559					−6.637***	1.438	2.545**
Fin. expert	0.643						7.714***	9.060***
Board	0.535							1.032
All govern.	0.516							