# Using High-Dimensional Corporate Governance Variables to Predict Firm Performance

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Abstract

The purpose of this paper is to empirically identify and quantify correlations between firms' corporate governance and their future financial performance. In the initial stage, LASSO estimation technique was used on a comprehensive set of corporate governance-related variables provided by The Board Director Training Institute of Japan and compared to firms' total shareholder returns (TSR) as well as other performance measures for the listed firms in Japan. Through LASSO, we find: First, a number of corporate governance policies or attributes that relate mainly to external monitoring have positive correlations with future TSR as expected. Second, somewhat unexpectedly, only a few variables associated mainly with internal monitoring and incentive practices show correlations with future TSR. Third, such unconditional associations between specific corporate governance practices and TSR are affected by certain other governance practices. In the latter stage, after confirming the stability of these results through OLS estimation, we constructed a prediction model of firms' future TSR and show that the investment strategy based on the model prediction could generate non-negligible improvement in returns by including the corporate governance-related variables to the predictors. These results suggest that high-dimensional corporate governance variables contain informative signals associated with future firm performance over and above reliance on purely financial data.

Key Words: *Corporate Governance; Total Shareholder Return, LASSO, Stability, Quantitative Impacts, Prediction, Investment Strategy*
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# 1. Introduction

Corporate governance practices are frequently designed to mitigate agency problems that exist between shareholders and managers. Agency problems inevitably arise in modern corporations, because corporate ownership and control are often separated. Managers, who tend to pursue their own self-interest, often have a natural incentive to maximize their own private benefits even at the expense of shareholders' interests. Corporate governance comprises numerous practices to mitigate agency problems, such as performance-based compensation, ownership structure, board structure, and others. Researchers of corporate governance have theoretically and empirically analyzed the effectiveness of individual practices by examining each practice's predictive power on firm performance (Dalton et al., 2007 and Shleifer & Vishny, 1997 are comprehensive reviews of this field).

Nonetheless, no studies have empirically examined the power of individual corporate governance practices to predict future firm performance while controlling for the fact that other practices are often adopted simultaneously. Although numerous corporate governance practices are prevalent among listed firms, firms generally adopt multiple practices simultaneously. However, the effectiveness of each corporate governance practice may vary when practices are bundled because multiple practices that are simultaneously adopted may interact with one another. Previous studies of corporate governance rarely seem to examine such interactive effects. Besides, because prior studies have not fully controlled for all the governance practices adopted in the sampled firms, their findings may be subject to an omitted variable bias. As supporting evidence, despite the fact that numerous studies have reported significant impact for certain corporate governance practices, several meta-analyses reported that there are negligible correlational relationships between corporate governance practices and firm performance (e.g., Bhagat, Black, & Blair, 2004; Dalton, Daily, Ellstrand, & Johnson, 1998; Dalton, Daily, Certo, & Roengpitya, 2003; Sundaramurthy, Rhoades, & Rechner, 2005).

As a result, we still have limited insight regarding how each corporate governance practice actually affects firm performance and other practice/structure aspects. This is a major gap in our overall understanding of corporate governance, because we have not uncovered the true impact of various practices, either alone or in combination. Accordingly, as a society, we may have invested invaluable financial resources in corporate governance practices that have no value or have no value unless combined with other practices.

As an exploratory study, in the present paper, we tackle the research question

through a machine-learning method. Namely, using a comprehensive dataset on corporate governance and firm characteristics of Japanese listed firms in Tokyo Stock Exchange from 2015 to 2022 provided by the GoToData platform of The Board Director Training Institute of Japan (BDTI), we generate predictions of firm performance— namely, total shareholder return.

Our findings are summarized as follows: First, external monitoring practices, - such as shareholder concentration, CEO approval rates, disclosure of individual director compensation, and the existence of large or controlling shareholders - are positively associated with future TSR. Second, only a few internal monitoring and incentive practices, such as stock options offered to employees, the percentage of outside corporate (statutory) auditors on the board, and the total number of corporate (statutory) auditors, are associated with future TSR. Third, such unconditional associations between specific corporate governance practices (e.g., internal monitoring) and TSR vary depending on governance practices (e.g., external monitoring). Fourth, given these results obtained from our LASSO estimation, we also confirm the stability and reliability of those findings in terms of its sign and size. Namely, we employ a standard OLS framework to confirm that the pattern of signs associated with each coefficient is consistent between that obtained from LASSO and OLS. Then, using a bootstrapping experiment, we confirm that the sizes of each coefficient are stable over multiple subsamples. Finally, we construct a prediction model for firms' future TSR and use it to show that an investment strategy based on the model's predictions could generate non-negligible improvement in investment returns. These results suggest that high-dimensional corporate governance variables contain informative signals associated with future firm performance over and above a model using purely financial data.

Our study will make two contributions to corporate governance literature. First, in this study we statistically confirmed the effectiveness of corporate governance practices. The relations are stable and consistently improve firm performance over time. Although management researchers have tackled the research question regarding which corporate governance practices influence firm performance, their findings have been limited to small-scale, qualitative testing (e.g., Misangyi & Acharya, 2014). Our study is the first attempt to answer this question in a large-scale, quantitative way. Second, from a practical standpoint, our prediction model suggests a list of target firms for investment. Our prediction model indicates that a certain profile of corporate governance practices will consistently contribute to firm performance in both the short term and the long term. Accordingly, based on our research, investors can draw inferences as to which firms will overperform in their industry just from looking at companies from a corporate

governance perspective.

The rest of the paper proceeds as follows: Section 2 provides a brief literature review of background information on the correlation between corporate governance practices/structure and firm performance. In Section 3, we explain the empirical approach employed in this paper. In Section 4, we explain the data we use in our analysis. Section 5 presents the results, and Section 6 sets forth our conclusions.

## 2. Related Literature on Corporate Governance Practices

Agency theory (Fama & Jensen, 1983; Jensen & Meckling, 1976, Jensen, 1983) assumes that shareholders, who are the owners of the firm, are exploited by managerial opportunistic behaviors. This is called an agency problem. Managers are responsible for strategic decision-making and daily management, but shareholders only have access to limited information about the firm and its management. Accordingly, there inevitably exists information asymmetry between managers and shareholders. Moreover, managers' personal interests and motivations differ from those of shareholders. Because of information asymmetry and these differences in interests, managers have both the incentive and the ability to pursue their own interest at the expense of shareholders' foremost goal, the maximization of firm value.

The purpose of most corporate governance practices is to mitigate the agency problems that arise between managers and shareholders. Corporate governance practices include both monitoring and incentive alignment. Monitoring is designed to reduce agency problems by evaluating and approving major managerial decisions so that they increase firm value. If managers find that shareholders or outside directors can observe and intervene (directly or indirectly) in their strategic decision-making processes, they will hesitate to engage in opportunistic behavior counter to increasing firm value because such behavior will be detected and penalized. On the other hand, incentive alignment is a practice intended to provide managers with rewards when taking actions consistent with the interests of shareholders. If managers see that it is in their own interest to pursue shareholders' interests, they will proactively make strategic decisions that accommodate those interests rather than ignore them in favor of opportunistic, unaligned decisions.

There are several corporate governance attributes or practices that serve as monitoring practices. First, the presence of large shareholders functions as a monitoring practice (Shleifer & Vishny, 1997). Large shareholders can wield control over managers by directly nominating directors who will ensure decision-making that is in shareholders' interests and prevent managerial opportunistic behavior. Additionally, large shareholders

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are more likely to have superior access to information. Because of their large stake, large shareholders are often willing and able to bear monitoring costs such as engaging with management in multiple meetings, attending earnings calls and road shows, examining annual reports and other disclosures, obtaining information from the investor relations department, and examining analysts' reports.

The impact of large shareholders on firm value may vary depending on the type of large shareholders. For example, institutional investors, banks, insurance companies, brokerage firms, and pension funds, are "external" equity owners in the sense that they themselves almost never sit on the board or take a very active role in engaging with management. This "external" quality persists despite institutional investors having greater expertise and stronger incentives to monitor managers than individual shareholders. Institutional investors generally own more shares than the vast majority of individual shareholders, which increases their power and "voice" vis-a vis managers. Based on this power, they are more likely to be receive responses when directly asking managers questions. However, several studies show that many institutional investors do not monitor the managerial decisions of each portfolio firm in detail, especially in the case where their investment approach is a "passive" or index-based one (Dalton et al., 2007; Hawley & Williams, 2000).

Alternatively, cross-shareholdings (cross-ownership) or "allegiant holdings" (known as *seisaku hoyuukabu,* or 政策保有株 in Japanese), which are particularly common in Japan (Prowse, 1992), tend to isolate managers from the discipline of the capital markets, because such shareholders play a role as "yes-men" by exercising their voting rights to support managerial decisions in return for receiving other expected benefits, such as continuing business contracts.

Second, board composition functions as a monitoring practice. Diversity of board members will promote effective monitoring because managerial decisions will be evaluated from various perspectives. Appointing "non-executive" outside directors is a common monitoring practice. Affiliated outside directors have existing family and/or professional relationships with the firm or firm management, whereas non-affiliated outside directors, or independent directors, have no such relationships (Peng, 2004). Because of their independence, independent directors are expected to objectively evaluate managerial decisions. Independent directors, as members of the board of directors, are expected to perform two functions to contribute to strategic decision-making: board monitoring and expert advice and counsel provision (Hillman & Dalziel, 2003; Pfeffer & Salancik, 1978; Westphal, 1999). Wang, Xie, & Zhu (2015) showed that independent directors with relevant industry expertise perform effective monitoring.

Likewise, specialists, such as academics, accountants, and attorneys, are appointed as independent directors. Such specialist independent directors may give advice based on their specific areas of expertise, bringing additional perspective to board discussions. Further, the proportion of female directors has slowly increased in Japanese listed firms. Female directors have been shown to provide unique advice and counsel, particularly in male-dominant boards (Hillman, Shropshire, and Cannella, 2007).

CEO duality, defined as the condition that the same person serves as both CEO and board chairperson (Dalton et al., 2007), is thought to reduce board independence because CEOs have broader discretion to set the agenda of board meetings and recruit directors, thereby reducing the separation between management and control (Finkelstein et al., 2008; Misangyi & Acharya, 2014). Besides, boards may not be able to objectively evaluate the CEOs' performance when the CEO is chair, which, in the resulting vacuum, might lead to a "CEO grading his own homework" problem (Brickley, Coles, & Jarrell, 1997: 190). Accordingly, CEO duality is expected to weaken the effectiveness of monitoring practices.

As incentive alignment, performance-based compensation is widely used. Although managers are willing to take actions which are in their own interests, which may be different from shareholders' best interests, they will, consciously or unconsciously, take actions in shareholders' interest when their own interests are aligned with those of shareholders. Accordingly, CEOs' compensation and shareholders' wealth will tend to move in tandem. As supporting evidence, Jensen and Murphy (1990) found that a CEO's wealth increases by 3.25 US dollars for each 1,000 US dollars change in shareholders' wealth. Providing stock options to managers is prevalent among firms as a performance-based compensation scheme. Provision of stock options to CEOs in particular is positively associated with IPO firm valuation (Certo, Daily, Cannella, and Dalton, 2003).

Further, managerial equity ownership is another practice of incentive alignment. Managerial equity ownership is an alignment practice, whereas external ownership is a control practice (Dalton et al., 2007). By holding a firm's shares, managers will be incentivized to take actions that increase firm value by taking well-considered risks. Without such ownership, managers tend to be more risk averse in terms of strategic decision-making than shareholders because part of their human capital is bounded by their firm's performance (Jensen & Meckling, 1976). Risky choices, in which the variance in outcomes is large, increase the likelihood of managerial dismissal should the decision lead to low performance, and only provide potential downside to management in the absence of stockholdings. Several empirical studies have confirmed this positive

linear relationship between managerial equity ownership and firm performance (e.g., Demsetz & Lehn, 1985; Mehran, 1995). At the same time, Morck, Shleifer, and Vishny (1998) reported that the relationship between managerial equity ownership and firm performance is an inverted U-shape, because excessive managerial power facilitates entrenchment, which is detrimental to firm performance. For instance, Benson and Davidson (2009) empirically demonstrated that the relationship between managerial ownership and firm value was an inverted U-shape in a sample of S&P firms from 1995 to 2003.

The market for corporate control is another external monitoring practice (Alchian & Demsetz, 1972; Fama, 1980; Grossman & Hart, 1988; Dann & DeAngelo, 1983; Manne, 1965). If managers engage in opportunistic behaviors and as a result do not maximize firm value, their firms will be acquired in the capital market; and after the acquisition, the managers will be dismissed. In order to avoid managerial dismissal after acquisition, managers are have an incentive to increase firm value. Accordingly, threats of takeovers will protect shareholders from managerial opportunistic behaviors (Jensen, 1984). From this viewpoint, actions of corporate takeover defense, such as poison pills, dual-class stock, golden parachutes and other practices, will tend to isolate firms from the market for corporate control because they will set a higher hurdle for acquisitions.

Nonetheless, existing research on corporate governance provides limited evidence on the predictive power of various corporate governance-related practices and attributes on firm performance. There are two reasons for this lack of evidence. Firstly, previous studies have rarely considered the full range of corporate governance practices and firm characteristics. Secondly, they have rarely considered the fact that corporate governance practices can be correlated with each other. For example, to reduce the risk of takeovers, managers may increase or maintain cross-shareholdings and adopt takeover defenses simultaneously. In such a case, the effect of cross-shareholding on firm performance can only be estimated if the adoption of takeover defense is controlled, and vice versa. Although existing studies have detected significant impact for separate corporate governance practices, they rarely controlled for all other corporate governance variables. Accordingly, most corporate governance studies are subject to an omitted variable bias. As supporting evidence of this criticism, for example, Dalton, Daily, Ellstrand, and Johnson (1998), a meta-analysis of board composition and board leadership, show that these board attributes had no significant impact on firm performance. However, because of the possibility of omitted variable bias, we cannot identify those situations in which these factors might have a significant impact when other factors were (or were not) present.

As a result of the aforementioned reasons for a lack of evidence, previous studies rarely tested various combinations of corporate governance practices, but rather, theorized and tested the impact of individual practices of incentives alignment and monitoring practices on firm performance. Nonetheless, incentive alignment and monitoring practices may strengthen each other. We have limited knowledge regarding whether corporate governance practices are complementary or substitutional in terms of their impact. The bundle of corporate governance practices-- in particular, the mix of internal and external monitoring and incentive alignment--will complement one another, thereby increasing their effectiveness (Rediker & Seth, 1995). For example, according to goal-setting theory, granting individuals huge incentives for goal achievement will shift their focus exclusively on goal attainment so that they do not hesitate to engage in unethical behaviors and misconduct in pursuit of the larger goal. Therefore, monitoring practices need to be simultaneously adopted in order to make such incentive practices effective. Some previous studies provide supporting evidence of this proposal. For example, Misangyi and Acharya (2014) examined corporate governance practices of high and low-performing firms through qualitative comparative analysis. They found that high-performing firms had both internal and external monitoring practices. Likewise, Peng (2004) empirically demonstrated that simply appointing outside directors does not always improve firm performance.

Regarding the impact of corporate governance practices on total shareholder return, management studies have investigated how practices improve firm performance. The purpose of corporate governance practices is to support and discipline board members so that they make strategic decisions in the interest of stakeholders. That is, it is thought that effective corporate governance practices will cause board members to be more likely to make strategic decisions and shape corporate behavior in order to maximize their firms' value in line with their fiduciary duties as management. For example, outside directors contribute to boards by engaging in board monitoring and advice provision. Kassinis and Vafeas (2002) found that, during 1994-1998, US firms with higher ratios of outside directors were less likely to violate environmental laws. Likewise, Flammer and Bansal (2017) found that long-term financial incentives, such as stock options for directors, will promote long-term investment. Based on this logic behind corporate governance, a firm's financial performance will continuously increase over the long term if its corporate governance practices have been appropriately designed and incentivize good behavior.

Previous studies of corporate governance provide support for its positive impact on firm performance. As a meta-analysis of 251 papers, Dao and Nguyen (2020)

empirically showed that board independence and high corporate governance ratings significantly improved firm performance as measured by accounting and market-based performance. In contrast, high levels of director ownership significantly decreased firm performance. Likewise, Mutlu, Essen, Peng, Saleh, and Duran (2018) quantitatively analyzed 84 studies of corporate governance practices and firm performance, using 547,622 firm observations in China. The results showed the positive associations between firm performance and both board independence and managerial incentives. In contrast, CEO duality, which had been supposed to decrease board independence, had no negative effect on firm performance. Further, the positive relationships became stronger over time, suggesting that the improvement in the quality of market institutions and development of financial markets in China might facilitate more effective corporate governance practices.

As is indicated by the results of meta-analyses, corporate governance practices significantly improve firm performance in general. At the same time, such results suggest the positive relationship will be conditional on some factors. First, not all corporate governance practices contribute to firm performance. Rather, as shown in Dao and Nguyen (2020), higher levels of director ownership may have a negative impact. Second, the effectiveness of relationships may vary depending on the institutional context. If so, we should not simply apply findings derived from data on the Western and Chinese firms to Japanese firms, because the institutional background of the Japanese context is different from the others. Accordingly, it is worthwhile to statistically confirm which corporate governance practices consistently improve firm performance over time in the case of Japan, a market which only recently adopted a corporate governance code and where the majority of most corporations' boards are still executive ("inside") directors.

## 3. Empirical Strategy

### 3.1 LASSO Regression

As intensively discussed in the previous section, one major difficulty in empirically examining the correlations between firms' corporate governance policies or attributes and their performance impact as measured by, for example, total shareholder return (TSR), is the potential high-dimensionality of the corporate governance variables. This difficulty is further exacerbated if we attempt to take into account not only each corporate governance policy or attribute as an individual independent variable but also the interactions among them.

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One typical way to handle the high-dimensionality of independent variables is to employ the machine learning methods such as Least Absolute Shrinkage and Selection Operator (a.k.a. LASSO) regression. In the following equation, $y_i$ and $\bar{x}_i$ denote the dependent variable (i.e., TSR in our case) and the $k$-th dimensional vector of the standardized independent variables for $i$-th observation. In addition to the squared sum of the residual associated with the data along with the objective function of the minimization problem to obtain the vector of estimated coefficients $w \equiv (w_1 \cdots, w_k, \cdots w_K)$, we add the sum of the absolute values of the coefficients multiplied by the hyper-parameter $\theta$ as seen in the following equation:

$$\min_{w \in \mathbb{R}^K} \sum_{i=1}^N (y_i - f(\bar{x}_i; w))^2 + \theta \sum_{k=1}^K |w_k| \quad \text{where} \quad f(\bar{x}_i; w) := \sum_{k=1}^K w_k \bar{x}_{i,k}$$

Using N-fold cross-validation procedure to obtain the optimized $\theta$, we can reduce some of the coefficient in $w$ to zero under the $\theta$ so as to pick up relatively more important independent variables out of the original set of independent variables. Note that due to the inclusion of the penalized terms $\theta \sum_{k=1}^K |w_k|$ in the process of the estimation, the estimated $w$ do not necessarily coincide with the estimated coefficients based on the OLS estimation with the selected independent variables. Nonetheless, we can use the sign of the estimated $w$ and their relative size in a given estimation. We use the information to identify the most impactful correlations between firms' corporate governance policies and attributes and their future performance.

**3.2 LASSO and OLS**

In the companion paper (Benes et al. 2023) to the present study, we employed the LASSO estimation technique to find which variables strongly correlated with future industry-adjusted TSR. Because the coefficients obtained from this LASSO estimation could suffer from bias due to the inclusion of the penalty term in the objective function used for the estimation, we could not determine the quantitative implication (i.e., the size of the estimated coefficients) but only the qualitative implication (i.e., sign) of the coefficients. In the present paper, given the set of explanatory variables suggested by the LASSO estimation, we run OLS analyses so that we will be able to confirm both the consistency between the two estimations as well as the quantitative implication of the estimates.

**3.3 Stability of OLS Estimates**

One of the concerns associated with LASSO estimation is the stability of the results (Mullainathan and Spiess 2017). Given this concern, we implement an experiment in which 1000 random subsamples are extracted from the original data to run OLS analyses based on the results of LASSO estimation. If the set of chosen variables based on LASSO have stable correlations with future TSR regardless of the subsample chosen, the OLS estimates should also be stable over those subsamples.

**3.4 Investment Experiments**

After confirming the consistency between the LASSO and OLS estimates as well as the stability of the OLS estimates, we evaluate the contribution of different corporate governance variables' contribution to our prediction task by conducting investment experiments. Specifically, we split the data into two parts, training data and test data, so that we may construct a prediction model based on the OLS estimates and test the performance of the investment strategy suggested by that particular prediction model. For this sample split, we carefully choose the training and test data such that those two datasets do not overlap in terms of either timing or in the selection of firms. In other words, we use the data of a set of firms up to a certain period of time as our training data, then use the data of firms and a period of time, both of which were not used in the training data, as our test data. This rigorous sample selection allows us to avoid any information that originates from the training data from seeping into the test data. Figure 1 illustrates our methodology for selecting the training and test data.

To construct the prediction model, we use a linear model and estimate it using OLS. After obtaining the prediction model, we use it to predict the industry-adjusted TSR. When the predicted value of the industry-adjusted TSR is positive (negative), we construct a long (short) position in the corresponding stock and evaluate its investment performance based on realized TSR. Figure 2 illustrates the way we construct the investment strategy based on the prediction results.

**4. Data**

The data we use in the present paper come from the two sources. First, we employ a comprehensive list of corporate governance policies/practices, attributes, and selected disclosure data obtained from the GoToData database provided by The Board Director Training Institute of Japan (BDTI). We also utilize detailed financial data from Toyo Keizai and market sources. Table 1 and Table 2 are the lists of the corporate governance items and financial indicators that we use as the independent variables in our LASSO

regression. Note that we use both the single terms of these corporate governance variables and financial indicators as well as the interaction terms between the corporate governance variables, resulting in well over 60 independent variables.

Second, we employ each listed firm's market capitalization and dividend payments to compute the total shareholder return (TSR) over $\tau$ years starting from the end of the year $t$. To compute TSR, we measure the ratio of the market capitalization as of the end point of the measurement window (i.e., $t + \tau$) and the sequence of dividend payments over the window (i.e., $t + 1, \cdots, t + \tau$) to the market capitalization as of the start of the measurement window (i.e., $t$). Subtracting one from the ratio, we obtain firms' TSR. In the present paper, we employ $\tau = 1,3,5$ to examine the correlation between firms' corporate governance policies and attributes and their future performance in the short, medium, and long-term. To take care of the industry heterogeneity of the TSR variables, we subtract the industry average of the TSR measured by using either "Industry Sector" (a.k.a. the 33 industry classifications traditionally used to define industries in Japan) or the more expansive "JSIC_Medium" as the industry classification.

## 5. Empirical Results

In this section, we present the estimated results based on the LASSO regression. Given the mechanics of the regression, we focus on the pattern of the selected variables and the sign associated with each independent variable.

### 5.1 Short-, Medium, and Long-Term Results

Table 3 summarizes the results of the LASSO regression using all listed firms in Japan's stock markets as our sample and considers TSR as the outcome variable. The first, second, and third set of the two consecutive columns account for the results for TSR over one year (short-term), three years (medium-term), and five years (long-term) periods starting from the end of the year $t$, respectively. Each row indicates the name of independent variables chosen through the LASSO regression accompanied by the definition. We also classify (as best one can) each independent variable into either internal monitoring, external monitoring, incentive, or basic characteristics, based on the major role of each governance-related data point.

From Table 3, first, we can notice that there are some variables showing consistent sign for the medium- and long-term windows. To illustrate, cg51 (Herfindahl Shareholders) shows a positive sign, which means that highly concentrated shareholder composition – having large owners – is associated with higher TSR both over the

medium- and long-term prediction windows. In the similar fashion, cg28 (Disclosure of Individual Directors' Compensation) shows a positive sign. Also, cg68 (CEO Approval Under 90%) shows a negative sign. These results suggest that the stronger corporate governance variables related to external monitoring are associated with higher future TSR, which standard theories presume.

Second, somewhat unexpectedly, only a few corporate governance variables related to internal monitoring (cg17, Number of Auditors) and incentive scheme (cg23, Employee Stock Options) are selected, because a large number of them are dropped from the model by the LASSO regression. Moreover, the negative sign of the coefficient associated with cg17 (Number of Corporate/Statutory Auditors) is the opposite of what we expect based on theory and that of cg23 (Employee Stock Options) is selected only for the short-term window.

Third, there are a number of variables that relate to firms' basic characteristics, that show relatively strong association with firms' future TSR. Namely, cg55 (Firm Age) shows a negative sign for all the three windows of TSR. However, contrary to the negative association between firm age and future performance, cg70 (Average Age of Employees) shows a positive sign. Somewhat interestingly, cg59 (Advertising Intensity) shows a negative association with future TSR.

In sum, we confirm that a specific set of corporate governance policies and firm characteristics as strong correlation with firms' future performance. Using these results as our benchmark, in the next section we examine how the patterns of selected variables are similar or vary in alternative contexts such as a specific stock market section, and for different outcomes.

**5.2 All Markets vs. TSE PRIME Section**

In Table 4, we repeat the same exercise by focusing on the firms listed in TSE's PRIME (formerly 1st) Section.[e] The purposes of this exercise are twofold. First, we intend to confirm that the results presented in the previous sub-section are due to the variation between different markets. As is apparent from Table 4, the number of the selected variables through LASSO regression is substantially smaller than that for all the markets. This implies that the majority of the correlations between corporate governance variables and TSR arise from differences between the firms in, for example, TSE PRIME and other emerging markets such as TSR GROWTH. Note that this does not necessarily mean that the results reported in Table 3 are spurious, as we are controlling for a large

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[e] For historical data, TSE 1st Section listed firms are considered to be PRIME. TSE 2nd and JASDAQ listed firms are considered to be STANDARD. And TSE MOTHERS listed firms are considered to be GROWTH.

number of financial indicators. We would rather claim that it appears different corporate governance attributes of firms in different stock market sections have substantial correlation with firms' future performance.

Second, we can also confirm that a set of variables such as cg51 (Herfindahl Shareholders), cg55 (Firm Age), cg59 (Advertising Intensity), and cg68 (CEO Approval Under 90%) are correlated with future TSR in a manner that is consistent with the results reported in Table 3. This means that even among relatively homogeneous firms in a selected stock market section, certain differences in terms of corporate governance policies and attributes still show correlation with future performance.

**5.3 TSR vs. PBR**

In Table 5, once again analyzing the firms in all listed stock market sections, we summarize the results of the same exercise using the price-to-book ratio (PBR) instead of TSR as the dependent variable. In order to compare the patterns between short, medium, and long-term windows, we compute the average of PBR over the 1 year (short-term), 3 year (medium-term), and 5 year (long-term) windows starting from year $t + 1$.

First, we can notice that a larger number of independent variables classified as "internal monitoring" are chosen than in the case of using TSR as the outcome. For example, cg7 (Ratio of Accountants) and cg9 (Ratio of Academics) have positive correlations with the PBR over the short-, medium-, and long-term windows. Note that both the cg3 (Independent Director Ratio, per TSE) and cg8 (Ratio of Lawyers) are negatively associated with PBR, which suggests subtle differences in the impact of each type of outside director on the effectiveness of internal monitoring.

Second, while a few items that account for external monitoring are correlated with future PBR in the same manner as we observed for future TSR (e.g., cg68 (CEO Approval Under 90%), cg28 (Disclosure of Individual Directors' Compensation[f]), and cg51 (Herfindahl Shareholders), a certain number of other external monitoring-related independent variables are selected. Among those items, one may observe a positive correlation between PBR and cg48 (Domestic Institutional Ownership) as well as cg37 (Correspondence: Foreign Investors) while a negative correlation is seen between PBR and cg49 (Domestic Private Firm Ownership). This is consistent with a hypothesis that companies with a high-level of cross-shareholding or allegiant holders are more insulated from the demands of their other (neutral) shareholders, and is consistent with our other results about the negative impact of such holdings.

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[f] Note that the case when companies must disclose individual directors' total compensation, is the case where one or more directors (almost always executives) have received more than 100 million Yen, which generally means the company has a relatively high compensation level for executives in the context of the Japanese market.

Third, we also observe correlations between future PBR and firms' basic characteristics. Nonetheless, it is important to highlight the fact that the sign of the correlation does not necessarily coincide with that which we observed from TSR. Namely, cg55 (Firm Age) and cg70 (Average Age of Employees) are positively and negatively correlated with PBR, results which are the complete opposite of what we reported in Table 3. We need more analysis to gain insight as to whether this is related to the fact that so many (a majority) of firms in Japan have a low PBR (e.g. lower than 1.0), and because average PBR is very different between industries. A seemingly small change in PBR for a low-PBR firm may still result in relatively high TSR for that firm.

Fourth, we apply the same empirical framework to other performance measures such as return on assets (ROA), return on invested capital (ROIC), and return on equity (ROE). As we present in the Appendix, based on using our LASSO methodology, there are few correlations between these outcome variables and corporate governance policies and attributes.[g] One important finding here is regardless of the choice of prediction window, cg50 (Foreign Ownership Ratio) seems to be positively correlated with ROA. We also confirmed cg50 (Foreign Ownership Ratio) is positively correlated with ROE in the case of long prediction window.

**5.4 Interaction Between Corporate Governance Variables in the case of TSR**

As we noted, in the LASSO regression, we include not only the single terms of the corporate governance variables but also the interaction terms among them, which allows us to consider both the unconditional and conditional correlations between firms' future performance and corporate governance policies and attributes.

As an illustrative example, we find the following conditional correlation between firms' future TSR and cg68 (CEO Approval Under 90%). As detailed in the previous section, the existence of a CEO with a low level of voting support is associated with lower TSR. In other words, firms' performance is worse if they have weak external monitoring which allows CEOs with low approval ratings to remain in their positions. Here, the issue should be how this unconditional negative correlation between TSR and cg68 (CEO Approval Under 90%) can be aggravated through the interactions with moderator variables. Based on our estimation results, we find that such a negative correlation becomes stronger, for example, when cg11 (Female Director Ratio) is lower, cg28 (Disclosure of Individual Directors' Compensation) is zero, and/or cg34 (Public Announcement of Disclosure Policy) is zero. These results suggest that the implication of a specific external monitoring practice can be weaker when an internal monitoring

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[g] In fact, no independent variables analyzed showed correlations with ROIC.

practice (cg11, Female Director Ratio) and/or other external monitoring practices (cg28, Disclosure of Individual Directors' Compensation, and cg34, Public Announcement Of Disclosure Policy) are weaker.

As another example, we also find that the positive association between short-term TSR and cg23 (Employee Stock Options) becomes stronger with cg46 (Existence of a Controlling Shareholder). This result implies that a specific incentive practice contributes to firms' performance more with the existence of an appropriate external monitoring scheme.

There are many other interesting conditional correlations between corporate governance policies and attributes and TSR. First, whereas cg2 (Independent Director Ratio, per firm), based on firms' own generally more lax criteria defining "independence" seldom shows any conditional correlations with future TSR, the ratio calculated by applying the stricter independence criteria set by the TSE, cg3 (Independent Director Ratio, per TSE), is positively correlated with future TSR as cg4 (Board Size) becomes larger. To speculate, this might suggest that larger firms, which tend to have larger boards[h] and are more sensitive to global institutional investors' voting policies and expectations, are receiving benefits from having a higher level of independence among directors who are aware of those expectations, as well as a larger number of such independent directors.

Second, cg11 (Female Director Ratio) is positively correlated with future TSR when the percentage of ex-manager outside directors on the board is smaller (i.e., cg10, Ratio of Ex-Managers, is smaller). This might suggest that women are more likely to make comments at the board, or to be heeded, when the number of former senior corporate executives[i] is smaller.

Third, the existence of a takeover defense measure (cg43, Takeover Defense Measure in Place?) has a positive correlation with future TSR as the advertisement expenditure share of revenue grows (cg59, Advertising Intensity). This might suggest that when a company's management has good reason to believe that ad spending will result in future revenue growth than the market presently reflects in its stock price, the firm realizes it is more likely to be a target for takeover. Note that this direction of correlation for advertising intensity is the opposite of the general case noted above.

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[h] The average board sizes of PRIME, STANDARD, and GROWTH listed firms in 2022 are 9.1, 7.5, and 6.3 directors, respectively.
[i] We would note that almost all "former managers" appointed to Japanese boards are male, and a large proportion of them have served in senior positions of other companies, where there is of course a managerial hierarchy within which they were at or near the top. In contrast, other categories of outside directors for which there is data – for instance accountants, lawyers, or academics – generally do not hail from organizations where there is as strong a hierarchy, and/or are professional service providers.

Fourth, the simultaneous provision of stock options to employees (cg23, Employee Stock Options) and internal corporate/statutory auditors (cg24, Internal Auditor Stock Options), or to employees and outside corporate/statutory auditors (cg25, Outside Auditor Stock Options), are positively correlated with future TSR. Since this would be the case when a company has a (relatively rare) policy to distribute stock options to a broad base and a larger number of persons, rather than just to the top tier of executives, this might suggest that such firms either will generate more profit or growth in the future, or at any rate are perceived by the market to be more likely to do so.

**5.5 Consistency between OLS Estimation and LASSO estimation**

The first and second columns of Table 6 summarize the results of LASSO estimation for the medium-term TSR and those of the OLS estimates using the set of variables selected through LASSO. As we have already mentioned, the estimated coefficients in the LASSO estimation could be biased due to the existence of the penalty term in the objective function even though the signs of the coefficients are correctly identified.

Two results emerge. First, the sign of those two estimates are completely consistent with each other. As we expected, the estimated results of LASSO and OLS coincide. Second, nonetheless, the estimated OLS coefficients are in general different from those derived by in LASSO in terms of their magnitude.

**5.6 Stability of the Estimated Coefficients Associated with Corporate Governance Variables**

The left panel of Figure 3 depicts the estimated 1000 coefficients of HHI (Herfindahl Index), which is one of the corporate governance variables chosen through LASSO, corresponding to each one of 1000 subsamples randomly extracted from the original data. In addition to the point estimates, we also depict the 95% confidence bands. While there are a number of cases where the confidence bands include zero, we would note that such cases are typically at the extreme ends of the confidence bands.

To see the stability of the estimated coefficients more explicitly, the right panel of Figure 3 depicts the histogram of the 1000-point estimates. It is immediately clear that most of the estimated coefficients are positive. These two panels largely confirm the stability of the OLS estimates.

The upper and lower two panels of Figure 4 show the results of the same exercise for the percentage of shares of a company that are held by "friendly shareholders" ("allegiant shareholders") and the dummy variable taking the value of one if disclosure policy is publicly available (which means a company states that they have posted/announced their policies on transparency and disclosure) and zero if the

disclosure policy is not made public, both of which are the chosen corporate governance variables through LASSO. Similar to the case of HHI, the result is to confirm stability. In this way, we can confirm the stability of the OLS results.


**5.7 Investment Experiments**

The upper and lower five panels in Figure 5 show the results of our investment experiments based on 1000 randomly selected samples for the short-term and medium-term TSR, respectively. In these figures, we are comparing the investment performance obtained from the prediction model only with a constant term (the distribution with solid line, which may be considered a simple extrapolation model) with that of the combination of the constant term and the set of chosen corporate governance variables chosen by LASSO (the distribution with dashed line, which when compared to the simple model shows the value of also taking corporate governance variables into consideration). In a similar fashion, the upper and lower five panels in Figure 6 compare the investment performance obtained from the prediction model with a constant term in combination with financial indicators chosen by LASSO (the distribution with solid line, which may be considered a purely financial model) with that of the constant term, the financial indicators chosen by LASSO, and the set of chosen corporate governance variables chosen by LASSO (the distribution with dashed line, which compared to the financial model shows the value of adding into consideration corporate governance variables over and above that of solely using pure financial analysis). The year indicated in each figure accounts for the end point of the training data. For example, "Y=2017" means that we use the data of independent variables up to year 2017 for the training data while the data accounting for the rest of the years are used to test the data. Because of this methodology for setting up the data, as the end training year moves from older to newer, the size of training (test) data becomes larger (smaller).

Two results emerge. First, these figures suggest that in many cases, adding the corporate governance variables to the prediction model leads to the improvement of investment performance. This is specifically confirmed in the comparison between the model using only with constant term and the result of using both the constant term and corporate governance variables. Second, although such an improvement in the investment performance is less visible in the comparison between the models with the constant and financial indicators and the model which includes corporate governance variables in addition to financial indicators, we can still confirm that the difference of the means of returns between those two models are statistically significant in their

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difference from zero in a number of cases such as seen in the medium-term prediction.

How does the choice of markets (e.g., TSE First Section) and/or the inclusion in the large-capitalization index (e.g., TOPIX-500) affect the results we have observed? Figure A1 and Figure A2 show the results of the exact same investment exercises when we focus on non-TSE First Section stocks, TOPIX 500 stocks, and the stocks in the TSE First Section excluding TOPIX 500, respectively. Note that since all the stocks included in TOPIX 500 are also in the TSE First Section, these three subsets of listed company stocks are mutually exclusive.

First, we notice that in the case of non-TSE First Section stocks, we obtain relatively stable results indicating that the inclusion of corporate governance variables to the prediction model improves investment performance. Second, somewhat interestingly, even in the case of the stocks included in TOPX 500, we can see the same pattern of the improvement in investment performance, especially when we employ larger training data sets (i.e., "Y=2017" and "Y=2018").

## 6. Concluding remarks

In the present paper, we empirically examine correlations between firms' corporate governance policies and attributes and their future performance by using comprehensive corporate governance data provided by BDTI's GoToData platform. The results based on LASSO regression reveal that a number of corporate governance variables related to external monitoring have positive correlations with future TSR. Second, several variables associated with internal monitoring and incentive practices—such as stock options offered to employees and the number of auditors—show correlations with future TSR. Third, firms' basic characteristics or actions such as firm age, average employee age, and investment in intangible assets such as advertisement have strong predictive power for future TSR. It could be the case that some of these basic characteristics are influencing the effectiveness of external or internal monitoring. Although the established correlations are sparser in the case when we focus on the firms listed in the TSE First Section (PRIME) and partly different from the case when using PBR as the outcome variable, we still observe common positive patterns of correlation between corporate governance variables and firms' future performance. Fourth, having demonstrated that the sign and the size of the coefficients associated with the corporate governance variables are stable, we constructed a prediction model of firms' future TSR and used it to show that the investment strategy based on the model's predictions could generate non-negligible improvement in returns. The ratio of independent directors did not show up as a significant independent variable in the LASSO analysis, except in combination

with other factors.  Therefore, possible implications of this research are that Japan may not have enough independent directors on most companies' boards to make a difference (they are rarely in the majority), or that the average quality of independent directors in Japan is low, or possibly both. Further research is needed to reveal other circumstances or combinations of practices that appear to lead to a contribution to TSR by independent directors. In any case, the results jointly suggest that high-dimensional corporate governance variables contain informative signals associated with future firm performance that can improve investment decisions compared to the case of only using financial indicators.

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# Figures and Tables

Table 1. Corporate Governance Variables

| Variable Name | Definition | Additional Notes/Explanation |
|---|---|---|
| **cg1** | Outside Director Ratio | *(# of Outside Directors) / (# of Directors)* |
| **cg2** | Independent Director Ratio (Firm) | *Number of Outside Directors the firm claims to be Independent* |
| **cg3** | Independent director ratio (TSE) | *Number of Outside Directors w/ no disclosed relationships that may affect independence as defined by the Tokyo Stock Exchange* |
| **cg4** | Board Size | *Total Number of Directors on the Board* |
| **cg5** | CEO Duality | *TRUE if the CEO is also the Chairman* |
| **cg6** | Outsider Chairman | *TRUE if the Chairman is an Outside Director* |
| **cg7** | Ratio of Accountants | *% of Outside Directors who are Accountants by Background* |
| **cg8** | Ratio of Lawyers | *% of Outside Directors who are Lawyers by Background* |
| **cg9** | Ratio of Academics | *% of Outside Directors who are Academics by Background* |
| **cg10** | Ratio of Ex-Managers | *% of Outside Directors who are Other Firm Executives by Background* |
| **cg11** | Female Director Ratio | *% of Females on the Board (including Shikkoyaku and Auditors)* |
| **cg12** | Report Information on Retired CEOs | *Does the firm self-report information on Retired CEOs who may be advising the board?* |
| **cg13** | Has a Compensation Committee? | *TRUE if a compensation committee (including voluntary) exists* |
| **cg14** | Compensation Chair is an Outsider? | *TRUE if the committee chair an outside director* |

| cg15 | Has a Nominations Committee? | *TRUE if a nominations committee (including voluntary) exists* |
|---|---|---|
| cg16 | Nominations Chair is an Outsider? | *TRUE if the committee chair an outside director?* |
| cg17 | Number of Auditors (Kansayaku) | *Pure number of internal auditors* |
| cg18 | Percentage of Outside Auditors | *(# of Outside Auditors) / (# of Auditors)* |
| cg19 | CEO Approval Rate | *% Approval by Shareholders of the First-Listed Director at the AGM* |
| cg20 | Stock Option Dummy | *TRUE if the firm offer any stock options to persons described by any of the cg21-cg25 categories* |
| cg21 | Insider Director Stock Options | *TRUE if Inside Directors get stock options* |
| cg22 | Outsider Director Stock Options | *TRUE if Outside Directors get stock options* |
| cg23 | Employee Stock Options | *TRUE if Non-Director Employees get stock options* |
| cg24 | Internal Auditor Stock Options | *TRUE if Internal Auditors get stock options* |
| cg25 | Outside Auditor Stock Options | *TRUE if Outside Auditors (persons) get stock options* |
| cg26 | Performance-Based Incentives | *TRUE if the firm offer Performance-Based Incentives* |

| cg27 | Other Incentives | *TRUE if the firm offer incentives aside from stock options or performance-based incentives* |
|------|------------------|---------------------------------------------------------------------------------------------|
| cg28 | Disclosure Of Individual Directors' Compensation[1] | *TRUE if the firm disclose at least some individual director compensation* |
| cg29 | Highly Paid Director(s) | *TRUE if the firm pays at least one director over 100 million JPY per year* |
| cg30 | Methods To Determine Compensation | *TRUE if the firm have a documented compensation policy* |
| cg31 | AGM During Concentrated Days | *TRUE if the AGM is during the "concentrated" period of too many AGMs in Japan* |
| cg32 | Virtual Participation at AGM? | *TRUE if the firm provide ways to participate/vote at the AGM electronically?* |
| cg33 | English AGM Notice | *TRUE if the firm provide their AGM notice in English?* |
| cg34 | Public Announcement of Disclosure Policy | *TRUE if there is a public announcement of disclosure policy* |
| cg35 | Correspondence: Individual Investors | *TRUE if the firm communicates with individual investors (mail, meetings, etc.)* |
| cg36 | Correspondence: Analysts and Institutional Investors | *TRUE if the firm communicates with analysts and intistutional investors (mail, meetings, etc.)* |

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[1] Note that the case when companies must disclose individual directors' total compensation, is the case where one or more directors (almost always executives) have received more than 100 million Yen, which generally means the company has a relatively high compensation level for executives in the context of the Japanese market.

| | | |
|---|---|---|
| **cg37** | Correspondence: Foreign Investors | *TRUE if the firm communicates with foreign investors (mail, meetings, etc.)* |
| **cg38** | Promoting Internal Regulations | *TRUE if the firm sets forth provisions in the internal regulations concerning respect for the stakeholders' position* |
| **cg39** | Promoting CSR | *TRUE if the firm promotes their environmental preservation activities and CSR activities* |
| **cg40** | Reasons for Non-Compliance w/ CG Code (Length) | *Character count of the reported reasons for non-compliance with the Corporate Governance Code* |
| **cg41** | Basic Policy on Corporate Governance (Length) | *Character count of the "Basic Policy on Corporate Governance" section in the Corporate Governance Report* |
| **cg42** | Disclosures Required by CG Code (Length) | *Character count of the disclosure section of the CG Report required under the Corporate Governance Code* |
| **cg43** | Takeover defense measures in place? | *TRUE if takeover defenses are in place (poison pill, etc.)* |
| **cg44** | Number of CG Reports each year? | *Outside of once annually, a firm is supposed to (but not legally required) to submit a new CG Report when there is "significant change"* |
| **cg45** | Number of Yuho submissions each year? | *Yuhos are re-submitted to EDINET when there is information which needs to be corrected* |
| **cg46** | Existence of a Controlling Shareholder? | *TRUE is there is at least once controlling shareholder* |

| cg47 | Government Ownership Ratio | *The % of the company owned by Government-Related Entities* |
|---|---|---|
| cg48 | Domestic Institutional Ownership | *The % of the company owned by Financial Institutions and Securities Firms* |
| cg49 | Domestic Private Firm Ownership | *The % of the company owned by domestic private firms* |
| cg50 | Foreign Ownership Ratio | *The % of the company owned by foreign firms and foreign individuals* |
| cg51 | Herfindahl Shareholders | *The Herfindahl Index (the sum of squares) of shareholder ownership* |
| cg52 | Allegiant Holdings Ratio | *Total Allegiant Holdings (securities held for "non-investment purposes") over Total Assets Ratio* |
| cg53 | Percent of Shares Held by Friendly Holders | *Percent of firm securities held by other firms for "non-investment purposes"* |
| cg54 | Firm Size | *Number of employees employed by the firm* |
| cg55 | Firm Age | *Number of years since the company's founding* |
| cg56 | Organizational Slack | *The ratio of selling, general, and administrative expenses (SGAE) to sales* |
| cg57 | Debt Ratio | *Debt / equity* |
| cg58 | R&D Intensity | *R&D expenditure / revenue* |
| cg59 | Advertising Intensity | *Advertising expenditure / revenue* |
| cg60 | CAPEX Intensity | *CAPEX / revenue* |

| cg61 | Are Treasury Stocks Retired? | *TRUE if Treasury Stocks are retired/canceled/liquidated* |
|---|---|---|
| cg62 | Labor Share | *Also known as 労働分配率 in Japanese* |
| cg65 | Cash over Assets | |
| cg66 | Long-Term Securities over Assets | |
| cg67 | Firm had a Contentious Resolution? | *The firm had a resolution at the AGM which received between 30 and 70% support* |
| cg68 | CEO Approval Under 90% | *TRUE if CEO support at the AGM was under 90%* |
| cg69 | Articles Recently Changed | *TRUE if a firm recently changed their Articles of Incorporation* |
| cg70 | Average Age of Employees | |

# Table 2. Financial Indicator Variables

| Variable n | Definition | Variable n | Definition |
|---|---|---|---|
| find1 | FIN_GID_LiquidAsset, use as an % of total assets | find33 | FIN_GID_当期純利益, use for CAGR, and to calc ROE in each period., sales share |
| find2 | FIN_GID_CurrentAsset, use as an % of total assets | find34 | FIN_GID_（配当金）use as % of 純利益；if can add buybacks to calc a separate item for total returns paid to shareholders (which is different from TSR). We CAN produce the amounts of buybacks in each year, but not immediately in next few weeks. profit ratio if profit is |
| find3 | FIN_GID_Cash, use as an % of total assets | find35 | FIN_GID_営業活動によるキャッシュフロー, use as % of |
| find4 | FIN_GID_Securities, use as an % of total assets | find36 | FIN_GID_投資活動によるキャッシュフロー, use as % of |
| find5 | FIN_GID_FixedAssets, use as an % of total assets | find37 | FIN_GID_財務活動によるキャッシュフロー, use as % of |
| find6 | FIN_GID_TangibleFixedAssets, use as an % of total assets | find38 | FIN_GID_現金及び現金同等物の期末残高, use as % of sales; may have been calculated from the above. |
| find7 | FIN_GID_IntangibleFixedAssets, use as an % of total | find39 | FIN_GID_設備投資額（注記）, CAGR, % of sales |
| find8 | FIN_GID_InvestmentSecurities, use as an % of total | find40 | FIN_GID_設備投資額（注記）, CAGR, % ofTA |
| find9 | FIN_GID_TotalAssets, use to compute ratios AND as indicator of size, log | find41 | FIN_GID_研究開発費（注記）, CAGR, % of sales, (investing more?)] |
| find10 | FIN_GID_LiquidLiability, use as an % of TA + to compute rough WC measure | find42 | FIN_GID_連結子会社数, size proxy when compared to industry average |
| find11 | FIN_GID_ShortBorrowinguse as % of TA | find43 | FIN_GID_期末従業員数, size proxy when compared to industry average |
| find12 | FIN_GID_ShortBorrowingalso to compute interest-bearing liabilitiees (社債 ・短期借入金 ・長期) | find44 | AGE and MINDSET indicator , use fnc_gid_平均年齢, |
| find13 | FIN_GID_固定負債, use as % of TA | find45 | FIN_GID_総資産回転率, raw |
| find14 | FIN_GID_（社債合計）, use as % of TA | find46 | FIN_GID_総資産回転率, adjusted |
| find15 | FIN_GID_（長期借入金）, use as % of TA + also to compute interest-bearing liabilitiees (社債 ・短期借入金 | find47 | FIN_GID_財務レバレッジ, raw |
| find16 | FIN_GID_負債合計, use as % of TA | find48 | FIN_GID_財務レバレッジ, adjusted |
| find17 | FIN_GID_資本金, use as % of TA | find49 | FIN_GID_有形固定資産回転率, ind |
| find18 | FIN_GID_資本剰余金, use as % of 資本金 above | find50 | FIN_GID_有形固定資産回転率, adjusted |
| find19 | FIN_GID_利益剰余金, use as % of 資本金 above | find51 | FIN_GID_手元流動性比率, raw |
| find20 | FIN_GID_（△）自己株式, use as % of 株主資本 below | find52 | FIN_GID_手元流動性比率, adjusted |
| find21 | FIN_GID_株主資本, use as % of TA | find53 | FIN_GID_労働装備率, raw |
| find22 | FIN_GID_新株予約権, use as % of 株主資本 | find54 | FIN_GID_労働装備率, adjusted |
| find23 | FIN_GID_自己資本, use as % of TA | find55 | FIN_GID_設備生産性, raw |
| find24 | FIN_GID_純資産合計, use as % of TA | find56 | FIN_GID_設備生産性, adjusted |
| find25 | FIN_GID_売上高, log | find57 | FIN_GID_損益分岐点, raw |
| find26 | FIN_GID_売上総利益, sales share | find58 | FIN_GID_損益分岐点, adjusted |
| find27 | FIN_GID_販売費・一般管理費合計, sales share | find59 | FIN_GID_変動費, use as % of sales, raw |
| find28 | FIN_GID_（人件費合計）, sales share | find60 | FIN_GID_変動費, use as % of sales, adjusted |
| find29 | FIN_GID_営業利益, sales share | find61 | FIN_GID_固定費, use as % of sales, raw |
| find30 | FIN_GID_（受取配当金）, use as % of net profit , | find62 | FIN_GID_固定費, use as % of sales, adjusted |
| find31 | FIN_GID_経常利益, calculate diff from 営業利益、then diff/net provit, sales share, | find63 | FIN_GID_限界利益率, raw |
| find32 | FIN_GID_特別損失, % of 営業利益。may want to avg 2 yrs, single year, sales share, | find64 | FIN_GID_限界利益率, adjusted |

## Table 3. Estimation Results: TSR & All Markets

Dep =TSR

| All Markets | | | Short-term | | Medium-term | | Long-term | |
|---|---|---|---|---|---|---|---|---|
| Indep | | | | | | | | |
| cg9 | ratio of specialists | Internal monitoring | | | -0.001 | -0.001 | | |
| cg17 | number of auditors (監査役) | Internal monitoring | | | -0.002 | -0.001 | -0.001 | 0.000 |
| cg18 | Percentage of Outside Auditors | External monitoring | | | 0.000 | 0.000 | 0.002 | 0.002 |
| cg23 | Employee stock options | Incentive | 0.007 | 0.003 | | | | |
| cg28 | CG_DisclosureOfDirectorsCompensation | External monitoring | | | 0.001 | 0.001 | 0.003 | 0.003 |
| cg34 | CG_PublicAnnouncementOfDisclosurePolicy | External monitoring | | | 0.001 | 0.000 | | |
| cg44 | More CG Reports each year? | External monitoring | | | 0.001 | 0.002 | | |
| cg46 | CG_ExistenceOfAControllingShareholders | External monitoring | | | | | 0.001 | 0.001 |
| cg51 | CG_HerfindahlShareholders | External monitoring | | | 0.003 | 0.005 | 0.004 | 0.005 |
| cg52 | 政策保有株/総資産 | External monitoring | -0.004 | -0.007 | -0.001 | -0.001 | | |
| cg53 | Shares of the company held by friendly shareholders | External monitoring | | | -0.002 | 0.000 | | |
| cg55 | Firm age | Basic characteristics | -0.005 | -0.001 | -0.004 | -0.003 | -0.004 | -0.003 |
| cg57 | Debt ratio | Basic characteristics | 0.004 | 0.008 | | | | |
| cg59 | Advertising intensity | Basic characteristics | | | -0.001 | -0.003 | -0.003 | -0.004 |
| cg68 | VTG_CEOAppUnder90 | External monitoring | | | -0.001 | -0.001 | -0.001 | 0.000 |
| cg70 | Average age of employees | Basic characteristics | | | 0.004 | 0.005 | 0.002 | 0.005 |

# Table 4. Estimation Results: TSR & PRIME Section

| Dep =TSR | | | | | | | |
|---|---|---|---|---|---|---|---|
| TSE-1 | | | Short-term | | Medium-term | | Long-term |
| Indep | | | | | | | |
| cg4 | Board size | Internal monitoring | | | | | 0.001 |
| cg18 | Percentage of Outside Auditors | External monotoring | | | | | 0.000 |
| cg23 | Employee stock options | Incentive | | | 0.000 | 0.000 | |
| cg26 | Performance-based incentives | Incentive | | | | | 0.000 |
| cg31 | CG_CorrespondenceConcentratedDays | External monotoring | | | 0.001 | 0.003 | 0.002 |
| cg34 | CG_PublicAnnouncementOfDisclosurePolicy | External monotoring | | | | | 0.001 |
| cg44 | More CG Reports each year? | External monotoring | | | | | 0.001 |
| cg51 | CG_HerfindahlShareholders | External monotoring | | | 0.002 | 0.005 | 0.004 |
| cg55 | Firm age | Basic characteristics | -0.007 | -0.006 | -0.006 | -0.006 | -0.002 |
| cg56 | Organizational slack | Internal monitoring | | | | | -0.001 |
| cg59 | Advertising intensity | Basic characteristics | | | -0.002 | -0.002 | |
| cg61 | YUHO_TreasuryRetiredOrNot | ? | | | 0.000 | -0.002 | -0.004 |
| cg68 | VTG_CEOAppUnder90 | External monotoring | | | -0.001 | -0.003 | |

8

# Table 5. Estimation Results: PBR & All Markets

Dep =PBR
All Markets
Indep

| | | | Short-term | | Medium-term | | Long-term | |
|---|---|---|---|---|---|---|---|---|
| cg3 | Independent director ratio (TSE) | Internal monitoring | -0.004 | -0.003 | -0.004 | -0.003 | -0.001 | -0.002 |
| cg4 | Board size | Internal monitoring | 0.001 | 0.001 | | | | |
| cg7 | ratio of specialists | Internal monitoring | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.001 |
| cg8 | ratio of specialists | Internal monitoring | -0.002 | -0.001 | | | | |
| cg9 | ratio of specialists | Internal monitoring | 0.001 | 0.001 | 0.002 | 0.003 | 0.002 | 0.002 |
| cg12 | CG_InformationOnRetiredCEOsHoldingAdvisoryPositions | Internal monitoring | 0.001 | 0.002 | | | | |
| cg18 | Percentage of Outside Auditors | External monitoring | -0.003 | -0.004 | -0.002 | -0.004 | | |
| cg20 | Stock option dummy | ? | | | 0.001 | 0.001 | | |
| cg27 | CG_OtherIncentives | ? | -0.002 | -0.003 | -0.002 | -0.003 | | |
| cg28 | CG_DisclosureOfDirectorsCompensation | External monitoring | 0.001 | 0.001 | 0.001 | 0.001 | | |
| cg32 | CG_CorrespondenceElectronicExecution | External monitoring | 0.001 | 0.003 | 0.002 | 0.004 | 0.001 | 0.004 |
| cg34 | CG_PublicAnnouncementOfDisclosurePolicy | External monitoring | 0.003 | 0.002 | 0.004 | 0.003 | 0.001 | 0.000 |
| cg35 | CG_CorrespondenceIndividualInvestors | External monitoring | -0.002 | -0.001 | | | | |
| cg36 | CG_CorrespondenceAnalystsAndInstitutionalInvestors | External monitoring | 0.002 | 0.002 | 0.001 | 0.001 | | |
| cg37 | CG_CorrespondenceForeignInvestors | External monitoring | 0.002 | 0.003 | | | 0.001 | 0.002 |
| cg39 | CG_CorrespondenceCSR | External monitoring | 0.000 | 0.001 | | | | |
| cg43 | Takeover defense messures in place? | ? | 0.002 | 0.001 | 0.000 | 0.001 | | |
| cg46 | CG_ExistenceOfAControllingShareholders | External monitoring | | | 0.000 | 0.000 | | |
| cg48 | Domestic Instituitional Ownership | External monitoring | 0.004 | 0.006 | 0.002 | 0.005 | | |
| cg49 | Domestic Private Firm Ownership | External monitoring | | | 0.000 | -0.002 | -0.001 | -0.003 |
| cg51 | CG_HerfindahlShareholders | External monitoring | 0.003 | 0.001 | | | | |
| cg53 | Shares of the company held by friendly shareholders | External monitoring | 0.001 | 0.000 | | | | |
| cg55 | Firm age | Basic characteristics | 0.015 | 0.011 | 0.011 | 0.007 | 0.006 | 0.004 |
| cg61 | YUHO_TreasuryRetiredOrNot | ? | 0.000 | 0.001 | | | | |
| cg68 | VTG_CEOAppUnder90 | External monitoring | -0.001 | -0.001 | 0.000 | -0.001 | | |
| cg69 | VTG_ArticleChanged | ? | -0.001 | -0.001 | | | 0.001 | 0.003 |
| cg70 | Average age of employees | Basic characteristics | -0.002 | -0.001 | -0.003 | -0.002 | | |

# Table 6. Consistency between LASSO and OLS estimates
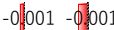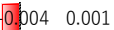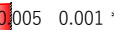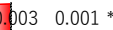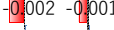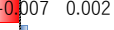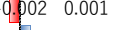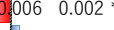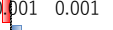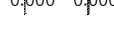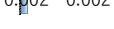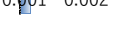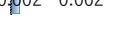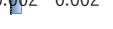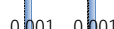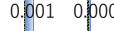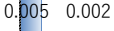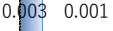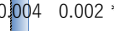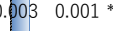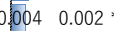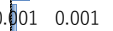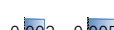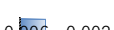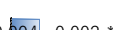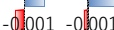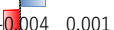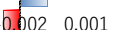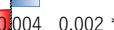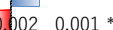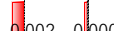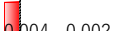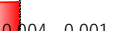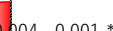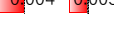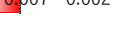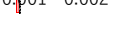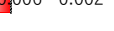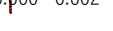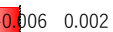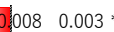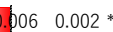
| LASSO | | | | | OLS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep =TSR | | | | | | Adjustment-1 | | | | Adjustment-2 | | | |
| All Markets | | | | Medium-term | | All Market | | Medium-term | | All Market | | Medium-term | |
| Indep | | | | | Indep | Coef. | SE | Coef. | SE | Coef. | SE | Coef. | SE |
| | | | | | l1_tsr_s0_e3_a1 | | | 0.558 | 0.014 *** | | | 0.559 | 0.014 *** |
| cg9 | ratio of specialists | Internal monitoring | -0.001 | -0.001 | cg9 | -0.004 | 0.001 *** | -0.002 | 0.001 ** | -0.005 | 0.001 *** | -0.003 | 0.001 ** |
| cg17 | number of auditors (監査役) | Internal monitoring | -0.002 | -0.001 | cg17 | -0.007 | 0.002 *** | -0.002 | 0.001 | -0.006 | 0.002 *** | -0.001 | 0.001 |
| cg18 | Percentage of Outside Auditors | External monitoring | 0.000 | 0.000 | cg18 | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| cg23 | Employee stock options | Incentive | | | | | | | | | | | |
| cg28 | CG_DisclosureOfDirectorsCompensation | External monitoring | 0.001 | 0.001 | cg28 | 0.006 | 0.002 *** | 0.004 | 0.001 *** | 0.005 | 0.002 *** | 0.004 | 0.001 *** |
| cg34 | CG_PublicAnnouncementOfDisclosurePolicy | External monitoring | 0.001 | 0.000 | cg34 | 0.005 | 0.002 *** | 0.003 | 0.001 ** | 0.004 | 0.002 ** | 0.003 | 0.001 * |
| cg44 | More CG Reports each year? | External monitoring | 0.001 | 0.002 | cg44 | 0.003 | 0.002 * | 0.000 | 0.001 | 0.004 | 0.002 ** | 0.001 | 0.001 |
| cg46 | CG_ExistenceOfAControllingShareholders | External monitoring | | | | | | | | | | | |
| cg51 | CG_HerfindahlShareholders | External monitoring | 0.003 | 0.005 | cg51 | 0.006 | 0.002 *** | 0.004 | 0.002 *** | 0.007 | 0.002 *** | 0.004 | 0.002 *** |
| cg52 | 政策保有株/総資産 | External monitoring | -0.001 | -0.001 | cg52 | -0.004 | 0.001 *** | -0.002 | 0.001 ** | -0.004 | 0.002 *** | -0.002 | 0.001 * |
| cg53 | Shares of the company held by friendly shareholders | External monitoring | -0.002 | 0.000 | cg53 | -0.004 | 0.002 ** | -0.004 | 0.001 *** | -0.003 | 0.002 | -0.004 | 0.001 *** |
| cg55 | Firm age | Basic characteristics | -0.004 | -0.003 | cg55 | -0.007 | 0.002 *** | -0.001 | 0.002 | -0.006 | 0.002 *** | 0.000 | 0.002 |
| cg57 | Debt ratio | Basic characteristics | | | | | | | | | | | |
| cg59 | Advertising intensity | Basic characteristics | -0.001 | -0.003 | cg59 | -0.008 | 0.003 *** | -0.006 | 0.002 ** | -0.008 | 0.003 *** | -0.006 | 0.002 *** |
| cg68 | VTG_CEOAppUnder90 | External monitoring | -0.001 | -0.001 | cg68 | -0.004 | 0.002 ** | -0.003 | 0.001 ** | -0.003 | 0.002 * | -0.003 | 0.001 ** |
| cg70 | Average age of employees | Basic characteristics | 0.004 | 0.005 | cg70 | 0.008 | 0.002 *** | 0.002 | 0.002 | 0.008 | 0.002 *** | 0.003 | 0.001 * |
| | | | | | _cons | -0.008 | 0.002 *** | -0.006 | 0.001 *** | -0.006 | 0.002 *** | -0.005 | 0.001 *** |
| | | | | | Num of ob | 9,899 | | 9,899 | | 9,899 | | 9,899 | |
| | | | | | F | 11.550 | | 121.770 | | 10.340 | | 121.830 | |
| | | | | | Prob>F | 0.000 | | 0.000 | | 0.000 | | 0.000 | |
| | | | | | R2 | 0.016 | | 0.360 | | 0.015 | | 0.359 | |
| | | | | | RootMSE | 0.165 | | 0.133 | | 0.164 | | 0.132 | |

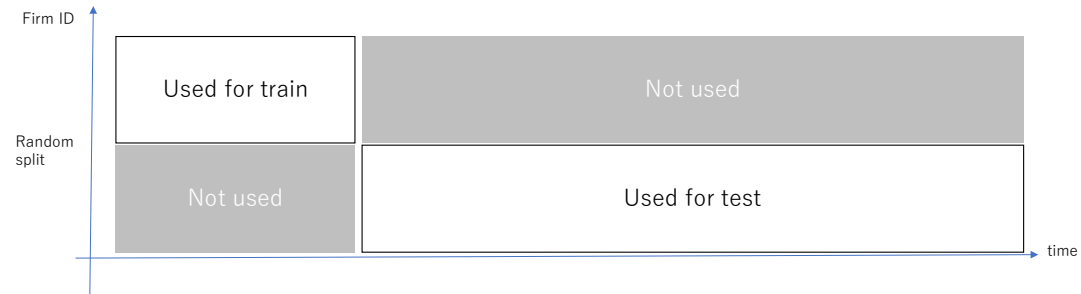Figure 1. Investment Experiment Training and Test Procedure



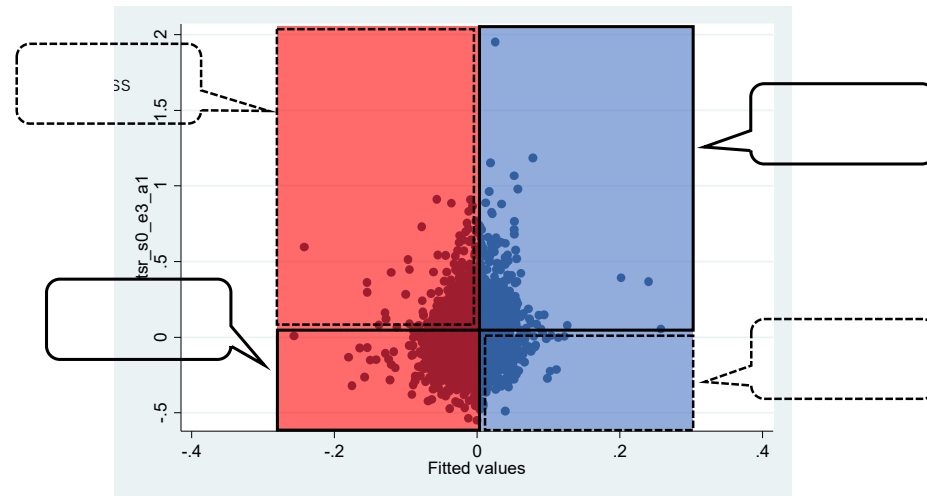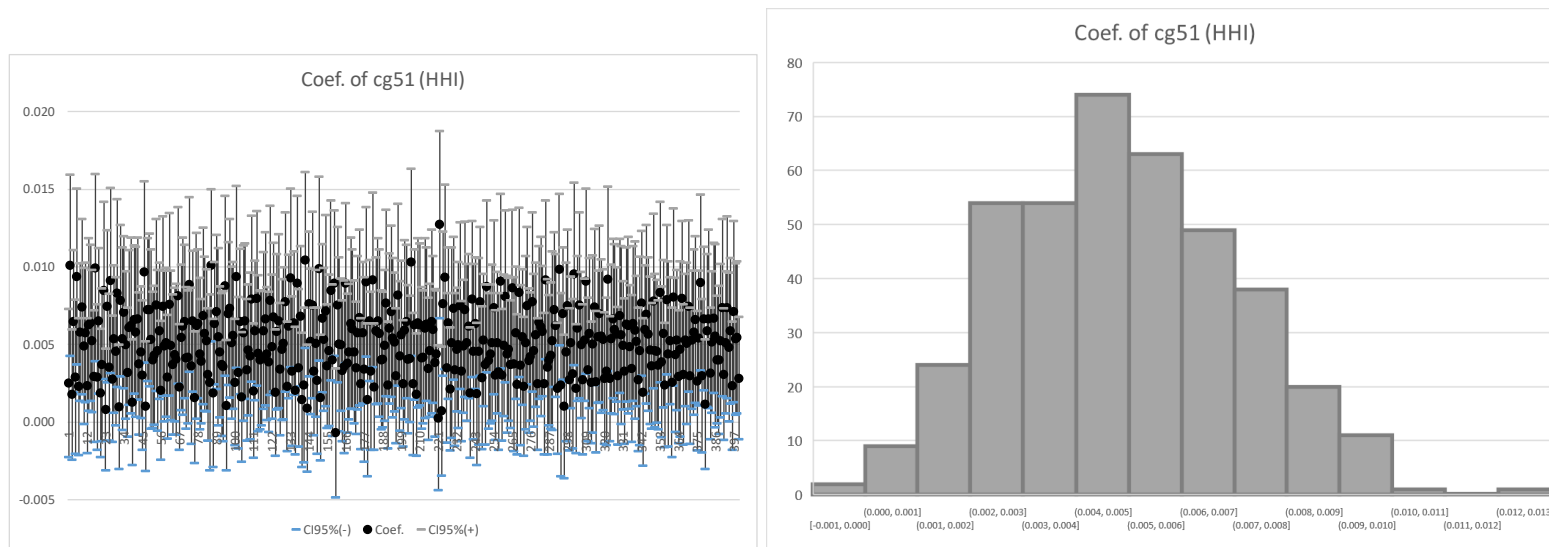Figure 2. Illustrative Concept of Investing through Model Prediction

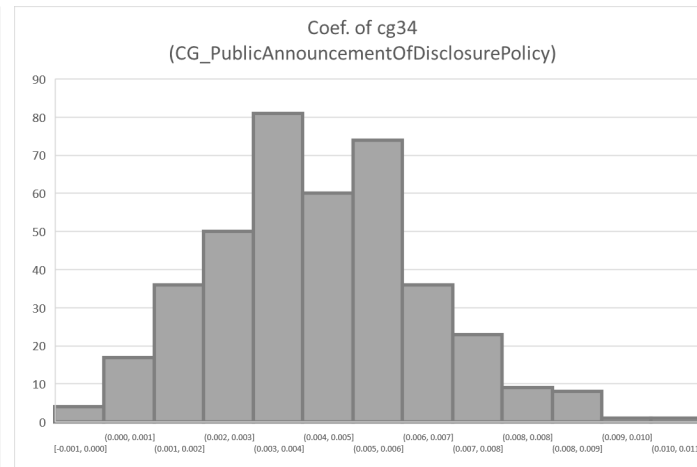Figure 3. Stability of OLS Estimates
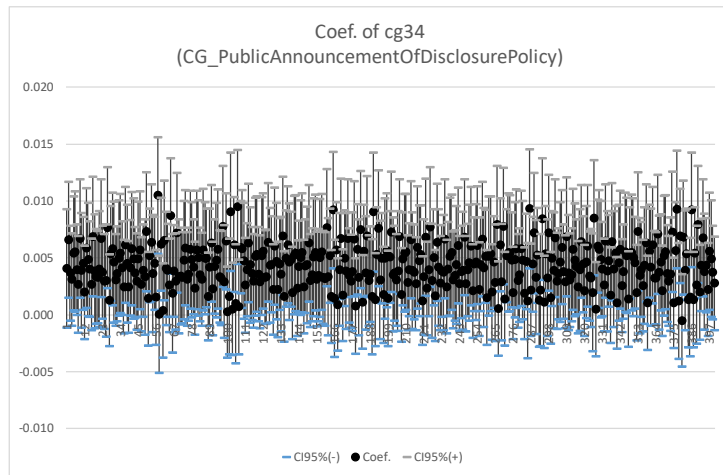
Figure 4. Stability of OLS Estimates



Coef. of cg53
(Shares of the company held by friendly shareholders)



Coef. of cg53
(Shares of the company held by friendly shareholders)



Coef. of cg34
(CG_PublicAnnouncementOfDisclosurePolicy)



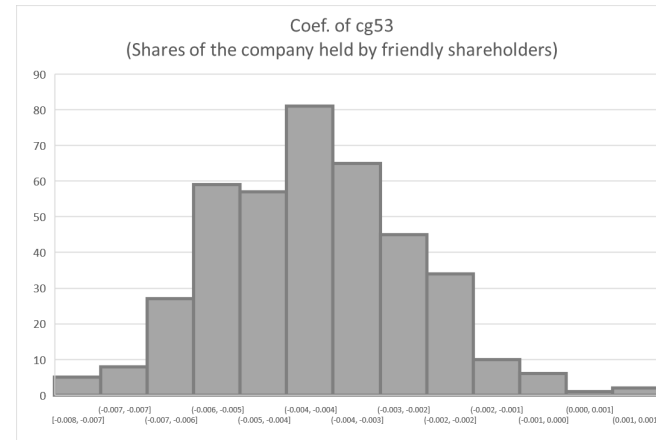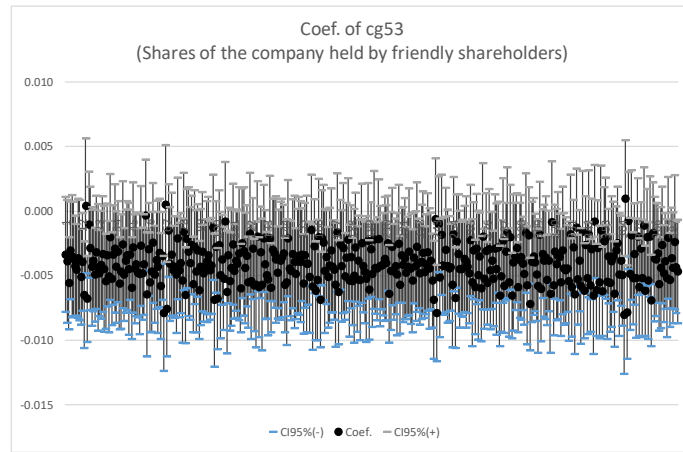Coef. of cg34
(CG_PublicAnnouncementOfDisclosurePolicy)

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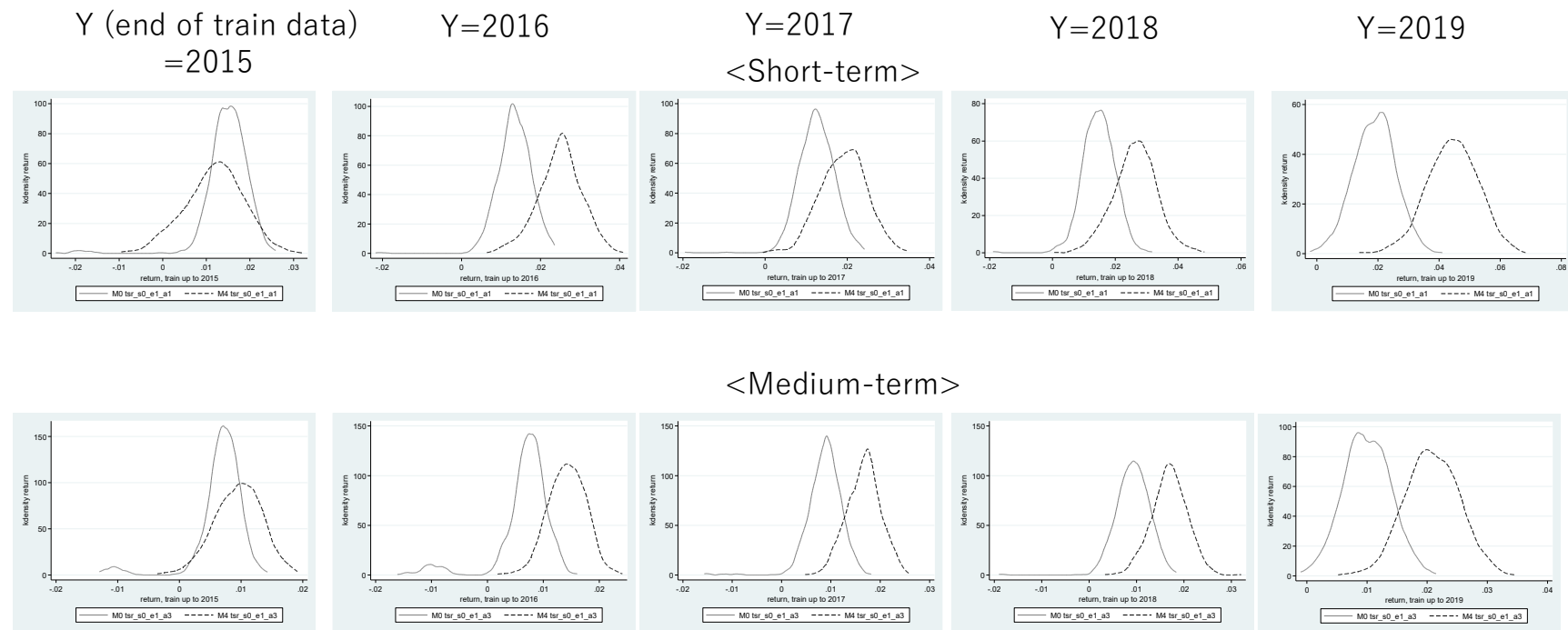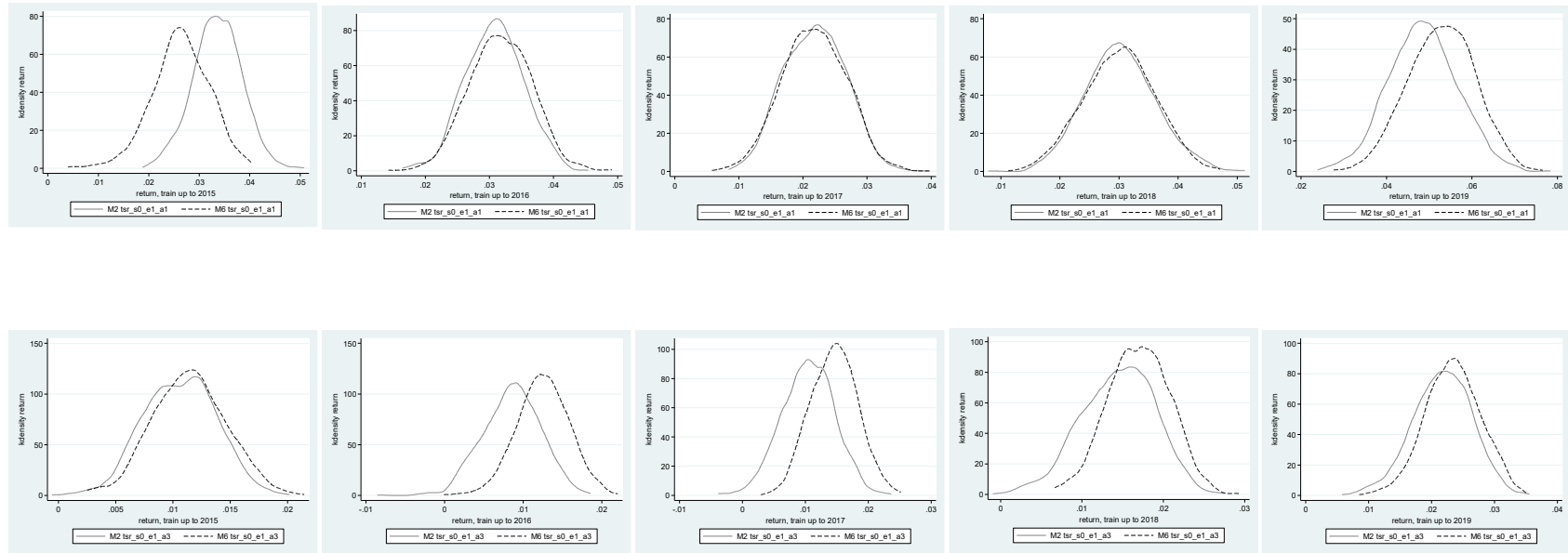Figure 5. Constant Only Simple Model vs. Constant & CG Variables

Figure 6. Constant & Financial Indicators vs. Constant & Financial Indicators & CG Variables

Appendix

## Table A1. Estimation Results: ROA & All Markets

| Dep =ROA | | | Short-term | | Medium-term | | Long-term | |
|---|---|---|---|---|---|---|---|---|
| All Markets | | | | | | | | |
| Indep | | | | | | | | |
| cg50 | Foreign Ownership Ratio | External monitoring | 0.256 | 0.209 | 0.409 | 0.237 | 0.150 | 0.112 |

## Table A2. Estimation Results: ROA & All Markets

| Dep =ROE | | | Short-term | Medium-term | Long-term | |
|---|---|---|---|---|---|---|
| All Markets | | | | | | |
| Indep | | | | | | |
| cg36 | CG_CorrespondenceAnalystsAndInstitutionalInvestors | External monitoring | | | 0.114 | 0.028 |
| cg50 | Foreign Ownership Ratio | External monitoring | | | 0.636 | 0.681 |

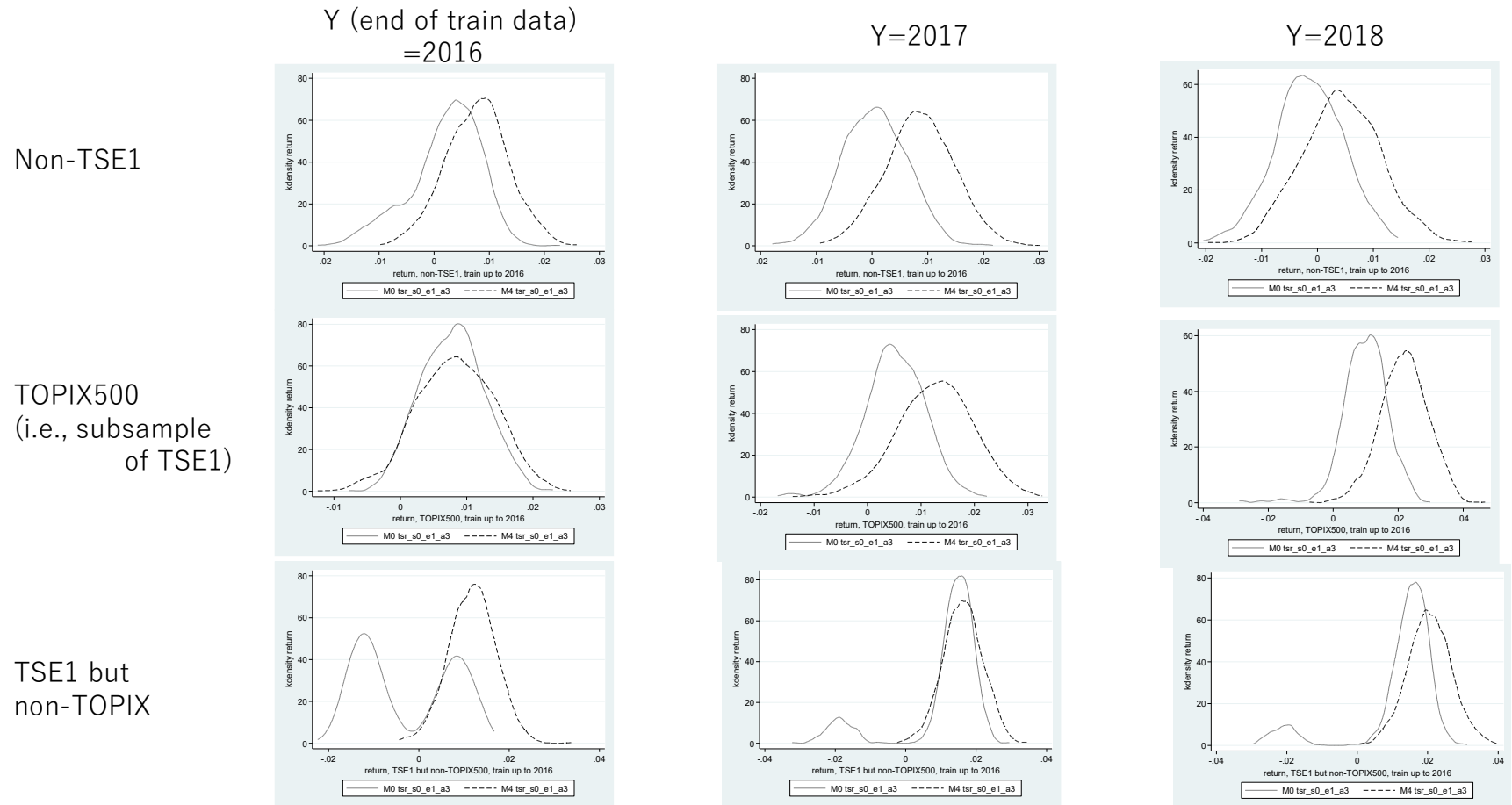Figure A1. Constant Only Simple Model vs. Constant & CG variables

# Figure A2. Constant & Financial Indicators vs. Constant & Financial Indicators & CG Variables