Report on the Effectiveness Verification of ESG Factors and Corporate Value

June 2025

Government Pension Investment Fund

Table of contents

Background and Objectives

- This report represents the final deliverable of a consulting project on measuring the effectiveness of investment in stewardship activities and ESG – specifically, their effects on improving corporate value and investment returns

- Research Background
  - In recent years, ESG investing, which makes investment decisions from the perspectives of the environment, society, and governance, has become popular worldwide, and many index companies evaluate companies' sustainability initiatives to inform their investment decisions
  - While key performance indicators (KPIs) of ESG indices are an important tool for identifying effects on areas such as sustainability, it is not clear how ESG measures affect core business variables, such as corporate value and profitability
  - Discussions about the impact of ESG initiatives on financial performance and the stock market are an area of active debate. Accordingly, there is merit in quantitatively analyzing, using real data, the extent to which these indicators may influence corporate value.

- Research Objectives
  - Performing a quantitative analysis on how each ESG KPI affects corporate value indicators
  - By clarifying the specific impact of ESG KPIs on corporate value, we aim to support investment decisions accounting for both social sustainability and profitability
  - Understanding which ESG efforts are linked to economic success provides actionable insights for sustainable economic development

Background and Objectives
- Current literature on the impact of ESG indicators on corporate value

Author *	Year	Title	Analysis model	Data Source	conclusion
Pelliex et. al.	2021	Does It Pay to Invest in Japanese Women? Evidence from the MSCI Japan Empowering Women Index	Fixed-effect model. Comparison of performance indicators of WIN and other indices (IMI, etc.) in FF3 and FF5	MSCI ESG	There is no significant difference between the performance of the MSCI Japan Empowering Women Index (WIN) and the MSCI Japan IMI Top Index (IMI)
Aono and Okimoto	2021	When does the Japan empowering women index outperform its parent and the ESG select leaders indexes?	Fixed-effect model. In addition to Pelliex's analysis, Smooth-transition FF5 takes into account changes in the overall market regime	MSCI ESG, and WIN, SLI index	WIN returns are higher than overall market portfolio returns when the previous month's market volatility is relatively low, but below when volatility is high
Ghoul et al.	2011	Does corporate social responsibility affect the cost of capital?	Fixed-effect model. Analysis of the impact of corporate social responsibility (CSR) on the cost of capital as a model (predecessor of ESG research)	Compustat North America, Thompson Institutional Brokers Earnings Services, KLD Stats, CRSP monthly returns files	The higher the CSR, the lower the cost of equity.
Henry Cervius, and Tamayo	2013	The Impact of Corporate Social Responsibility on Firm Value: The Role of Customer Awareness	Fixed-effect model. Analyzing the improvement of CSR through advertising expenditure and the impact on Tobin's q	Factiva database for CSR	In companies with a high level of customer recognition (measured by advertising spending), there is a positive correlation between CSR, corporate value (Tobin's q), ROA, and other profitability indices
Bolton and Kacpercz yk	2021	1. Global Pricing of Carbon-Transition Risk 2. Do investors care about carbon risk?	Fixed-effect model. Analyzing the impact of the greeh house gas (GHG) emissions on excess returns	S&P Trucost for GHG emission and FactSet for corporate information	Companies with high GHG emissions tend to have higher equity returns. Companies with high emissions are required to have a high cost of capital.

* Details of each reference are provided in the reference list at the end of this report.

Background and Objectives
- Structure of this report

- Approach in this study
  - **Data Collection and Exploratory Analysis:** We gather time-series data on ESG scores, related KPIs, corporate value, and investment returns. Through exploratory analysis, we identify ESG indicators likely to have a significant impact on these metrics. Statistical evaluations are conducted to determine the significance of these indicators. Additionally, we assess the consistency of our findings with established ESG principles, such as the positive impact of improving diversity and increasing the ratio of independent outside directors on corporate value and investment returns.
  - **Causal Relationship Analysis:** To explore potential causal relationships, we select appropriate control variables from financial data corresponding to each corporate value index under analysis. This ensures a more accurate examination of the influence of ESG factors.
  - **Fixed-Effects Model Analysis:** To account for time-invariant factors, such as internal culture and management strategies that differ across companies, we employ a fixed-effects model. This approach helps mitigate the influence of time-invariant factors, allowing for a clearer analysis of the variables of interest.
- Regarding the relationship between ESG factors and corporate value, we hypothesize that corporate value will increase when ESG indicators (KPIs) that affect ESG scores improve, and test whether the analysis results meet the hypothesis. Examples of indicators that increase or decrease each indicator and ESG score include the following:

ESG Score	Metrics to improve E/S/G scores
E-Score	・Initiatives to reduce climate change and carbon emissions ・Carbon emissions have been reduced
S-Score	・Diversity of employees ・Women's active participation is being promoted
G-score	・Diversity of management team ・Transparency of governance structure and shareholder returns ・Actively disseminate reports to the outside world

- Report structure
  - Explanation of the target corporate value indicators, and how ESG indicators are incorporated in the fixed-effect model
  - Overview of the ESG metrics and how this data was preprocessed in the analysis
  - Fixed-effect model analysis for each corporate value index and impact assessment based on statistical significance
  - Analysis summary and suggestions for further research

Table of contents

Analytical Methods and Modeling
- A model with firm-level and time fixed effects with control variables, using Tobin's q as the dependent variable

- The model is based on prior Tobin's q models (Li, et al., 2018; Fatemi, et al., 2018; Aouadi, et al., 2018; Irawan, et al., 2022) and is constructed using the following fixed-effects model as a foundation. The model includes both time effects and time-invariant fixed effects. Time effects were considered based on the objectives of the analysis and the data (discussed in the next page)

$$Q_{i,t} = \alpha_i + \alpha_t + \beta_{ESG}\, f(ESGFACTOR) + \sum_n \rho_n \times X_{n,i,t} + \epsilon_{i,t} \quad ,$$

$$f(ESGFACTOR) = \begin{cases} ESGFACTOR_{i,t-1} & (\text{Lag 1 case}) \\ ESGFACTOR_{i,t-1} + ESGFACTOR_{i,t-2} & (\text{Lag 1 + Lag 2 case}) \end{cases}$$

  - Time *t* is in fiscal years
  - The control variables X for Tobin's q are summarized in the table on the bottom-right of this page
  - In addition to the variables cited in the aforementioned references, we added EBITDA_mg during the research process (details to follow)

Variable definitions

variable	definition
$Q_{i,t}$	Corporate value (dependent variable): Tobin's q (or PBR, ROE, market capitalization)
α_i	Time-invariant firm-specific terms
α_t	Fixed effect of time
$ESGFACTOR_{i,t-1}$ $ESGFACTOR_{i,t-2}$	ESG metrics or KPIs. Both cases were examined using the one-period lag or the sum of the first-period lag and the second-period lag as explanatory variables.
$X_{n,i,t}$	Control variables. n is the identifier of each control variable (table on the right)
β_{ESG}	Regression coefficient of *ESGFACTOR*
ρ_n	Partial regression coefficients for each control variable
$\epsilon_{i,t}$	Error term

Tobin's q Control Parameters $X_{n,i,t}$

#	Control variable	symbol	Calculation formula
1	Log of Total Assets	log_TASSETS	=log (Total Assets)
2	Return on Total Assets	ROA	=ROA
3	Total Asset Turnover Ratio	SALES	= Sales / Total Assets
4	Debt to Total Assets Ratio	LEV	= Total liabilities / Total assets
5	Capital Expenditure to Total Assets Ratio	CAPX	= Capital Expenditure / Total Assets
6	Dividend to Total Assets Ratio	DIV	= Total annual dividends / Total assets
7	EBITDA margin	EBITDA_mg	=EBITDA / Sales

* Data sources are described in the chapter Data Characteristics and Preprocessing

Analytical Methods and Modeling
- Consideration of the number of lag periods for ESG indicators

- Beyond ESG metrics, various elements influence the valuation of a company. By employing a fixed-effects multiple regression analysis to isolate and control for these variables, we can more accurately assess the unique impact of ESG factors on corporate value, thereby minimizing potential biases.
- In this study, as we conduct an exploratory evaluation of multiple ESG indicators, we aim to use a simple model expression to balance the risk of overfitting and the interpretability that comes from keeping the model straightforward. For this purpose, we have limited the inclusion of the impact of ESG indicators ($f_{i,t}(ESGFACTOR)$) that consider delayed effects to a uniform and linear addition to the model.
- The evaluation focuses on comparing the statistical significance of the estimated partial regression coefficients for the ESG indicators, specifically examining whether the null hypothesis (that ESG indicators have no explanatory power for corporate value) can be rejected, thereby supporting the alternative hypothesis
  - In the model that considers a second-order lag when selecting $f_{i,t}(ESGFACTOR)$, it is possible to independently consider the first and second lags. However, if there is a discrepancy in the signs of the partial regression coefficients, there is a concern of overfitting (model overfitting), which would reduce the reliability. Moreover, if similar trends are observed in both the results using only the first lag and those considering both the first and second lags, it suggests that the analysis results are robust in terms of their long-term impact on corporate value
  - Therefore, when including a second-order lag, it is integrated into the model as a linear combination with the first-order lag indicator. If, under the assumptions of this model, the significance is greater than when using only a first-order lag, it suggests that the indicator may exert an influence over a longer period.
- Lags of third order or higher for ESG indicators were not considered due to the complexity of the dynamics and the validity of making assumptions of linear models, the tendency of the coefficient of determination of the analysis results to decrease, and the limitation of the population of the data to be analyzed
- In the construction of this model, no self-lag is introduced for the explanatory variable. Thus, the analysis is based on the following assumptions:
  - Elimination of the bidirectional impact of the previous fiscal year's corporate value indicators and ESG indicators by including self-lag
  - Past corporate value indicators do not affect current actions in the model
  - When including the own lag in the model, the effectiveness of variables such as the log of total assets, which are believed to influence Tobin's q, decreases, as suggested by the results of the hypothesis test (Wald test) that the coefficients of these explanatory variables can be set to zero. This result contradicts the intuition that Tobin's q is influenced by factors such as the log of total assets and asset turnover

* Formulas for each lag case are provided on the previous page

Analytical Methods and Modeling
- Consideration of Additional Control Variables

- In addition to the previous model of Irawan et al. (2021), we examined ordinary profit to sales (OPRO_mg), EBITDA margin (EBITDA_mg), and annual rate of change in BPS (BPS_PCT) as profit margin indicators. The results of the table below show that the statistical significance of each variable is tested by the Wald test for panel data in which these data exist
  - The lag number of control variables is 0 or 1, and the profitability is evaluated by the coefficient of determination and significance of the model based on either ordinary profit to sales ratio or EBITDA margin, or a combination of both.
  - For the reasons described after the below table, a model excluding the BPS growth rate from the EBITDA-only model (Model ②) has been selected.
    - In the test results of the adopted model, the null hypothesis is rejected at a 10% significance level for sales versus total assets, and a 5% significance level for other variables

Item	Profitability Indicator	The number of lag periods for the control variable	R2 (within)	Log of total assets	Total Assets Turnover	Dividend to Total Assets Ratio	Debt to Total Assets Ratio	Capital Expenditure to Total Assets Ratio	ROA	Ordinary Profit to Sales Ratio	EBITDA margin	BPS growth rate
①	Both Operating Income and EBITDA Margin	0	0.175	0.010	0.045	0.000	0.000	0.019	0.000	0.032	0.091	0.371
②	EBITDA Margin only	0	0.171	0.006	0.081	0.000	0.000	0.011	0.000		0.013	0.369
③	Operating Income only	0	0.174	0.009	0.055	0.000	0.000	0.016	0.000	0.011		0.375
④	EBITDA Margin only	1	0.141	0.633	0.155	0.000	0.000	0.007	0.000		0.825	0.129

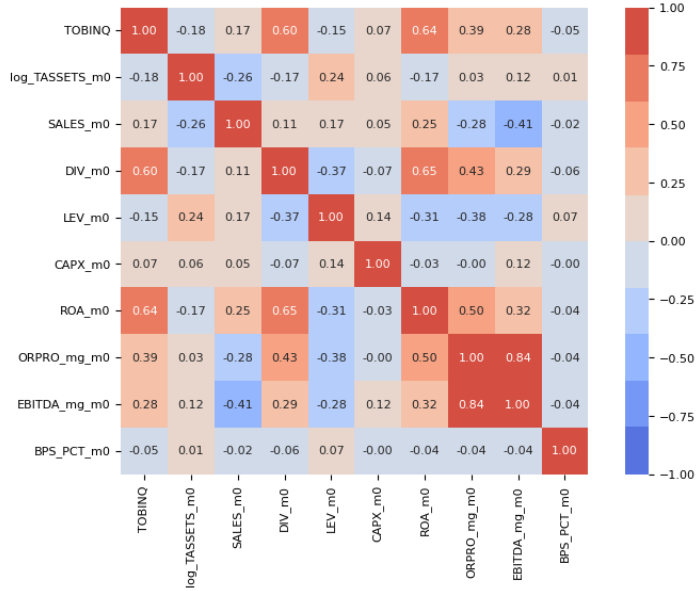
Control variables of the adopted model

Legend for Significance Levels: p-value < 0.01 | 0.01 ≤ p-value < 0.05 | 0.05 ≤ p-value < 0.1

The reason for selecting Model ② from among the candidates is as follows:

- Including a lag in the control variables results in a significant decrease in the model's coefficient of determination (R2).
- Correlations between Tobin's q and each control variable are shown on the right. Note that there is a strong correlation between ordinary profit to sales and EBITDA margin (correlation coefficient r~0.85). It is desirable to include only one of them to combat multicollinearity
  - Including both ordinary variables inflates p-values. Among the two, including only EBITDA margin slightly yields lower p-values.
  - Since EBITDA is a used more widely internationally, especially in the industrial and telecommunications industries (which are strongly linked to GHG indicators), only EBITDA margin is considered among these two
- The test result of the variance expansion coefficient (VIF) when considering the time effect and the firm-fixed effect for the above control variables did not exceed 2
  - This fact suggests that **there is no strong multicollinearity between the selected variables**

Correlation between Tobin's q and control variables (same year)

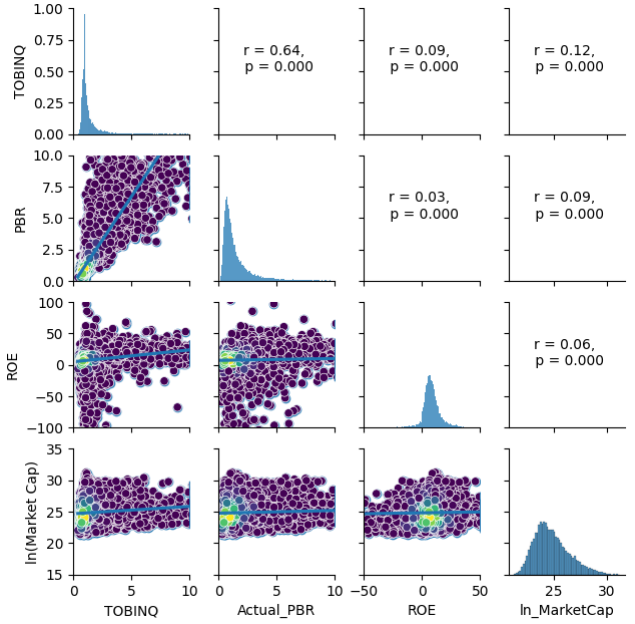


Analytical Methods and Modeling
- Correlation of corporate value indicators as dependent variables and selection of control variables

- Tobin's q is calculated as follows: $$Tobin's\ q = \frac{Market\ Capitalization + Total\ Debt}{Total\ Assets}$$

- The table on the right shows the correlation between 'Tobin's *q*', 'PBR (equity to book ratio)', 'ROE (capital adequacy ratio)', and 'ln(MarketCap) (logarithm of market capitalization)'
  - In the grid plot, the diagonal elements show the distributions, the lower triangular matrix displays the scatter plots with linear regression lines, and the upper triangular matrix shows Pearson's correlation coefficient r and the p-value
  - There is almost no correlation for the pair of ROE or market capitalization with the other three indicators (r~0). There is a strong correlation between PBR and Tobin's q (0.6<r<0.7)
- In a subsequent analysis, the same control variables were used, now using PBR instead of Tobin's *q* as the dependent variable. For the logarithm of ROE and market capitalization, the control variables in the table below are used after the following examination
  - The logarithm of total assets is included in for all models as a control variable for the size of the company
  - Based on the high correlation, it can be expected that when using control variables within the same framework, Tobin's q and PBR will yield relatively similar analysis results. On the other hand, since there is no correlation in the distribution between Tobin's q, PBR, and the other variables, different results are expected with similar control variables
  - For the analysis where ROE and the log of market capitalization are the dependent variables, variables that showed no statistical significance among the control variables considered for Tobin's q were excluded based on the Wald test result (significance level p<0.05) .
  - In the ROE analysis, the Return on Assets (ROA) is excluded from the control variables due their interdependence: $$ROE = ROA \times \frac{Total\ Assets}{Shareholder\ Equity}(Financial\ Leverage)$$

Distribution and correlation of each corporate value index



Control variables X_n of corporate value indicators used in subsequent analyses

Corporate Value Indicators	Log of Total Assets	Return on Total Assets	Total assets turnover	Debt to Total Assets Ratio	Capital Expenditure to Total Assets Ratio	Dividend to Total Assets Ratio	EBITDA margin
	Log_TASSETS	ROA	SALES	LEV	CAPEX	DIV	EBITDA_mg
Tobin's q	✔	✔	✔	✔	✔	✔	✔
PBR	✔	✔	✔	✔	✔	✔	✔
ROE	✔		✔			✔	
Log of market capitalization	✔	✔		✔		✔	

Analytical Methods and Modeling
- Handling Time-Fixed Effects in Fixed-Effects Models

- In this report, the analyses are reported for the two approaches below:

What to analyze	Inclusion of time effects
Analysis over the entire period: use all available data in a single analysis	To account for temporal factors common to each company, **a model with time effects** was used
Rolling window method: use a rolling window of 4 years to identify changes over time	In this case, since there is analytical interest in the temporal changes of the estimated partial regression coefficients of the KPI, the discussion primarily focuses on analyses conducted over 4-year periods **using a model without time effects**

- The inclusion of time-fixed effects in the model for each case is distinguiched according to the purpose of the study:
  - When time-fixed effect should be included for the analysis:
    - If the observed data is **subject to temporal changes due to external factors** (e.g., economic growth, policy changes, gradual technological progress), these temporal changes are accounted for by including time effects in the model
    - **If you want to eliminate common temporal effects.** These include the effects of economic crises or natural disasters that affect the entire data for a specific time period, it is possible to mitigate the pseudo-effects of these by including time effects in the model
  - When time-fixed effect should be omitted:
    - **If the interest of the study is to capture the temporal evolution of the explanatory variable in question itself**, including a temporal effect in the model may obscure the impact of those transitions
    - If the underlying data population varies by year, misleading time effects may occur—consider using a model without time effects.
    - If the observation period is short and temporal changes are negligible, omit the time effect as it is unnecessary.

Analytical Methods and Modeling
- Handling of the statistical significance index (*p*-value) of partial regression coefficients in the report

- In the context of many economic studies, if it is not at the 5% significance level or the 10% significance level, it means that the obtained result does not provide sufficient evidence to reject the null hypothesis and is considered to not increase the explanatory power of the model
- On the other hand, the significance may be further strengthened by the duration of the data and additional assumptions not taken into account in the fixed-effects model, which may be considered in the future
- In this report, while acknowledging the aforementioned assumptions, we primarily rely on a 5% significance level (p-value ≤ 0.05). However, we also present results using a p-value of 0.1 as a threshold for reference, though these are not included in the main discussion. These variables are positioned as reference information for future model considerations as the volume of data increases or additional data becomes available

Table of contents

Data Characteristics and Preprocessing
- Summary statistics for corporate value indicators and candidate control variables

- Summary statistics of the corporate value indicators analyzed and the control variables examined are summarized below
  - Data from FY2013-2022 are analyzed
  - The target of fixed-effect model analysis is limited to the case where multiple control variables are fixed for the corporate value indicator (only cases where all variables exist for the same year)
  - In the tables on the current and next pages, the columns count-max are summary statistics for the entire period of each data (std: standard deviation, min: minimum, max:maximum)
  - The time series distribution of each variable is provided in the Appendix

Corporate Value Indicators and Control Variables		Symbol	DataSource	Summary Statistics						Number of data in the fiscal year									
				count	mean	std	min	50%	max	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Corporate Value Indicators	Tobin's q	**TOBINQ**	Corporate Governance Evaluation System	18,511	1.48	1.69	0.38	1.04	40.81	-	1,855	1,925	1,982	2,050	2,099	2,141	2,172	2,146	2,141
	Price Book-value Ratio	**PBR**	NIKKEI NEEDS	20,475	1.90	4.01	0.11	1.08	290.61	1,787	1,868	1,941	2,004	2,078	2,133	2,160	2,185	2,170	2,149
	Return on Equity (ROE)	**ROE**	NIKKEI NEEDS	19,755	7.49	32.96	- 3,928.04	7.59	951.02	1,718	1,814	1,876	1,931	1,986	2,054	2,079	2,113	2,094	2,090
	Log of Market Cap (issued Shares)	**log_MarketCap**	NIKKEI NEEDS	20,506	24.82	1.61	21.18	24.57	31.22	1,793	1,873	1,947	2,004	2,078	2,135	2,160	2,186	2,173	2,157
Candidate Control Variables	Log of Total Assets	**log_TASSETS**	NIKKEI NEEDS	18,247	11.58	1.64	7.15	11.39	19.53	1,585	1,664	1,720	1,767	1,840	1,896	1,922	1,956	1,952	1,945
	Return on Assets (ROA)	**ROA**	NIKKEI NEEDS	18,975	6.73	6.76	- 80.87	5.80	76.43	1,637	1,728	1,791	1,848	1,903	1,976	2,001	2,040	2,025	2,026
	Total Asset Turnover Ratio	**SALES**	NIKKEI NEEDS	20,133	1.02	0.63	0.00	0.91	7.05	1,746	1,840	1,908	1,964	2,022	2,096	2,123	2,157	2,139	2,138
	Debt to Total Assets Ratio	**LEV**	NIKKEI NEEDS	18,244	0.47	0.19	0.04	0.46	1.61	1,585	1,664	1,720	1,767	1,840	1,896	1,922	1,955	1,951	1,944
	Capital Expenditure to Total Assets Ratio	**CAPX**	Corporate Governance Evaluation System, Nikkei NEEDS	17,579	0.04	0.04	0.00	0.03	0.94	1,528	1,603	1,657	1,702	1,767	1,829	1,852	1,888	1,884	1,869
	Dividend to Total Assets Ratio	**DIV**	NIKKEI NEEDS	17,107	0.01	0.01	0.00	0.01	0.33	1,478	1,569	1,637	1,679	1,756	1,803	1,797	1,763	1,814	1,811
	EBITDA margin	**EBITDA_mg**	Corporate Governance Evaluation System, Nikkei NEEDS	16,323	0.11	0.11	- 2.70	0.09	2.47	-	1,629	1,678	1,726	1,778	1,856	1,885	1,924	1,918	1,929

Data Characteristics and Preprocessing
- Summary of ESG-related KPI data integrated into panel data

- For ESG metrics, we focused on indicators that can be measured quantitatively through raw data, and have a strong bearing on ESG scores. In addition, the FTSE ESG score was used for the analysis as an ESG score. The data year is based on the availability of financial data, and the data available for the period 2013-2022
  - The ESG-consistent (Belief) column shows the direction of the sign of the contribution of corporate value to the increase in explanatory variables, which is desirable from an ESG perspective.
  - The indicators related to the presence or absence of disclosure and installation were organized as dummy variables with values of 0 for none and 1 for yes
  - Absolute GHG emissions, total assets, and market capitalization were analyzed using the natural logarithm of the data. This aims to mitigate the impact of outliers on the analysis results and to bring the distribution closer to the normal distribution
  - The time series distribution of each variable is shown in the Appendix of this report

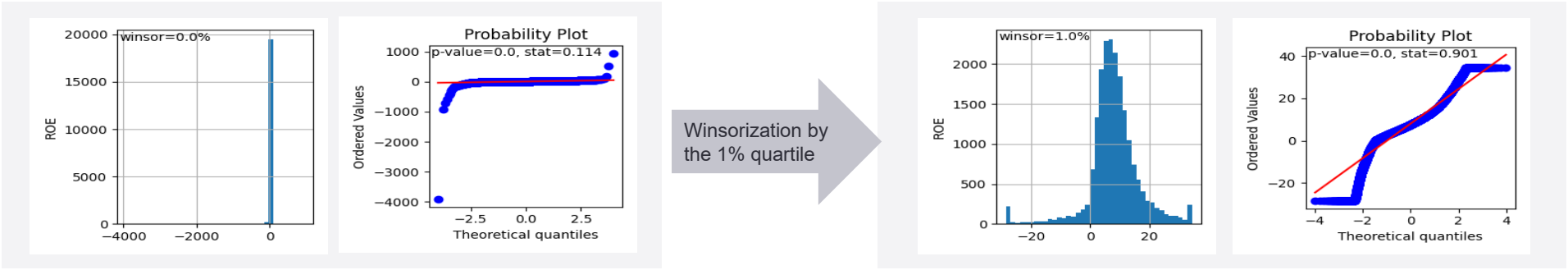
Category	ESG Indicator Name	ESG-consistent	DataSource	Summary Statistics						Number of data in the fiscal year									
		Belief		count	mean	Std	min	50%	Max	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
E	GHG Emission Intensity (Scope 1&2) [*1]	-1	S&P Trucost	14,714	1.21	4.00	0.00	0.37	84.07	440	493	499	1,400	1,865	1,933	1,955	2,018	2,041	2,070
	Log of GHG Emissions (Scope 1&2)	-1	S&P Trucost	14,714	10.67	2.27	3.08	10.60	18.70	440	493	499	1,400	1,865	1,933	1,955	2,018	2,041	2,070
S	Ratio of Female Directors	1	NIKKEI NEEDS	12,480	9.85	7.46	0.00	9.00	60.00		770	1,126	1,153	1,230	1,380	1,503	1,640	1,776	1,902
	Ratio of Female Managers	1	MSCI	3,061	9.86	8.04	0.00	9.70	45.45						470	644	656	646	645
	Ratio of Women in the Workforce	1	MSCI	2,314	24.74	15.93	0.00	20.20	93.68						336	468	493	491	526
	Ratio of Women among New Hires	1	MSCI	1,913	31.48	16.91	0.00	28.30	100.00						303	398	426	418	368
	Difference in Average Years of Employment Between Men and Women [*2]	1	MSCI	2,128	-3.06	3.23	-28.80	-2.90	22.00						308	432	464	441	483
G	Existence of Stock Option System	1	Corporate Governance Evaluation System	18,297	0.30	0.46	0.00	0.00	1.00		1,749	1,819	1,880	2,071	2,128	2,159	2,181	2,162	2,148
	Presence of Controlling Shareholders (more than one-third of the shares) [*3]	-1	Corporate Governance Evaluation System	12,849	0.08	0.27	0.00	0.00	1.00					2,071	2,128	2,159	2,181	2,162	2,148
	Cross-shareholding Ratio	-1	Corporate Governance Evaluation System	12,809	7.54	9.42	0.00	3.80	65.30					2,060	2,119	2,155	2,178	2,153	2,144
	Minimum Approval Rate for Director Appointments	1	Corporate Governance Evaluation System	12,326	89.24	8.42	19.20	91.30	100.00					2,001	1,999	2,097	2,104	2,075	2,050
	Performance-based Remuneration System	1	Corporate Governance Evaluation System	16,785	0.47	0.50	0.00	0.00	1.00			1,937	1,999	2,071	2,128	2,159	2,181	2,162	2,148
	Establishment of Nomination committees	1	Corporate Governance Evaluation System	18,652	0.03	0.17	0.00	0.00	1.00		1,867	1,937	1,999	2,071	2,128	2,159	2,181	2,162	2,148
	Existence of Integrated Report [*4]	1	Corporate Value Reporting Laboratory	16,908	0.21	0.41	0.00	0.00	1.00	1,422	1,499	1,569	1,635	1,704	1,769	1,789	1,825	1,849	1,847
	Total Return Ratio	1	NIKKEI NEEDS	18,402	69.38	724.13	-106.66	33.88	86300.00	1,651	1,722	1,775	1,849	1,944	1,953	1,875	1,784	1,944	1,905
	Ratio of Independent Outside Directors	1	NIKKEI NEEDS	20,506	26.34	17.57	0.00	28.57	100.00	1,793	1,873	1,947	2,004	2,078	2,135	2,160	2,186	2,173	2,157
	Adoption of Anti-Takeover Measures	-1	NIKKEI NEEDS	16,700	0.13	0.34	0.00	0.00	1.00			1,807	2,004	2,078	2,135	2,160	2,186	2,173	2,157
Score	FTSE E Score	1	FTSE	7,853	1.70	1.28	0.00	1.50	5.00		462	459	493	507	741	1,296	1,297	1,294	1,304
	FTSE S Score	1	FTSE	7,853	1.56	1.13	0.00	1.33	5.00		462	459	493	507	741	1,296	1,297	1,294	1,304
	FTSE G Score	1	FTSE	7,853	2.63	0.82	0.00	2.60	5.00		462	459	493	507	741	1,296	1,297	1,294	1,304
	FTSE ESG Overall Score	1	FTSE	7,853	1.94	0.91	0.00	1.77	4.70		462	459	493	507	741	1,296	1,297	1,294	1,304

[*1] The emission intensity of S&P Trucost, which was used as a data source, is calculated based on GHG emissions relative to sales in USD. In order to determine the intensity of emissions per JPY, sales are converted by the JPY-USD conversion rate International Monetary Fund (IMF).
[*2] The difference in the average years of employment between men and women was calculated by taking (average number of years of employment for women) - (average number of years of employment for men) for companies for which data is available in each fiscal year.
[*3] The original variable name on the data source (CBASE) for the presence or absence of a controlling shareholder (more than one-third of the major shareholders) is RTO_CTRC_FLG. When the controlling shareholder can be confirmed, categories in this variable is further divided into listed companies and unlisted ones. In this analysis, the case of a listed company and unlisted ones are unified as one variable.
[*4] In the case where the Integrated Report has not been reported by the Corporate Value Reporting Lab, the data are supplemented with stocks that have Tobin's q and PBR explanatory variables in 2022 as the population and no (No). In FY2022, 7,667 companies were reported to have prepared an integrated report.

Data Characteristics and Preprocessing
- Annual panel data processing pipeline

- The annual data for corporate value and control variables on the left-hand side of the fixed-effects model is based on the fiscal year. If monthly data is available, it is processed as the average value of the data within the fiscal year
  - As an exception, the emissions indicators provided by S&P are per calendar year. For ESG indicators, we have introduced a lag of more than one year in the model, which ensured that the time series of these indicators precedes the annual corporate value indicators
- Outlier handling of continuous variables was performed by winsorization, to prevent affecting sample sizes
  - Winsorization is a processing method that replaces outliers in the upper and lower percentages with values of the specified percentage
  - Conducted to reduce the impact of outliers when outliers can have a significant impact on outcomes
  - Data was defined as continuous when it contained 100 or more unique values

Example of outlier handling of ROE indicators by Winsorization
Left: Distribution before treatment and Q-Q plot, Right: Distribution and Q-Q plot after winsorization at 1%



- The outliers in the distribution before the transformation process are very large, dominating the scale of the y-axis. As can be seen on the right, winsorization mitigates the impact of outliers
- The figure on the right of the distribution is a diagram comparing the corresponding Q-Q plot and Shapiro-Wilk's statistics (p-value, stat) before and after Winsorization, taking ROE as an example
  - A Shapiro-Wilk p-value close to 0 means that the data is very unlikely to have been sampled from a normal distribution. However, a statistic (stat) close to 1 was observed after addressing outliers, indicating that the distribution is closer to normal

Table of contents

Table of contents

Summary of the partial regression coefficients and statistical significance for the analysis of Tobin's q, PBR, ROE, and market capitalization over the entire period

- Using the fixed effects model that accounts for time effects, we conducted an analysis with lags for the explanatory variables set to one period (Lag1) and a combination of one and two periods (Lag1+Lag2). The following table summarizes the estimated partial regression coefficients and p-values of ESG indicators for each corporate value indicator. The subsequent pages will describe each corporate value indicator in detail.
  - In the following sections of this chapter, we will present the analysis results considering time effects for each corporate value indicator and discuss the significant findings.
  - In the table, "Parameter" indicates the estimated partial regression coefficients of the ESG indicators. The significance levels of the partial regression coefficients are also categorized by $p<0.05$ and $0.05 \leqq p<0.1$.
  - The table below highlights statistical significance (cases where the p-value is below 0.05 and 0.1) and uses a blue mask for positive estimated partial regression coefficients and a red mask for negative ones.

Categ-ory	ESG indicator	ESG-consistent	Tobin's q		PBR		ROE		Log of Market Cap	
		Belief	Lag1	Lag1+Lag2	Lag1	Lag1+Lag2	Lag1	Lag1+Lag2	Lag1	Lag1+Lag2
			Parameter	Parameter	Parameter	Parameter	Parameter	Parameter	Parameter	Parameter
E	GHG Emission Intensity (Scope 1&2)	-1	-1.30E-03	-5.00E-04	1.30E-03	1.70E-03	5.48E-02	4.97E-02	2.40E-03	2.80E-03
	Log of GHG Emissions (Scope 1&2)	-1	-3.24E-02*	-1.34E-02	-4.47E-02*	-1.80E-02	-2.44E-01	-3.13E-02	-1.23E-02	-4.40E-03
S	Ratio of Female Directors	1	3.40E-03**	1.60E-03**	1.20E-03	-2.00E-04	-2.15E-02	-2.37E-02*	-6.00E-04	-6.00E-04
	Ratio of Female Managers	1	4.20E-03*	4.00E-04	-6.20E-03*	-4.30E-03	3.72E-02	2.72E-02	-2.10E-03	-1.80E-03
	Ratio of Women in the Workforce	1	-2.70E-03	1.38E-05	9.48E-05	6.00E-04	2.45E-02	1.77E-02	-4.00E-04	1.30E-03
	Ratio of Women among New Hires	1	3.50E-03	6.10E-03**	5.90E-03**	4.30E-03	2.53E-02	4.97E-02	1.40E-03	9.00E-04
	Difference in Average Years of Employment Between Men and Women	1	-3.30E-03	1.05E-02	1.33E-02**	1.56E-02	1.47E-01	4.17E-02	8.80E-03**	6.40E-03
G	Existence of Stock Option System	1	-9.90E-03	-1.46E-02	1.48E-02	-8.50E-03	8.33E-02	8.45E-02	2.00E-03	8.40E-05
	Presence of Controlling Shareholders (more than one-third of the shares)	-1	1.55E-02	-7.48E-02	-1.78E-01	-9.76E-02	2.03E-01	7.71E-01	-6.90E-02	-3.83E-02
	Cross-shareholding Ratio	-1	-1.80E-03	3.00E-04	-1.80E-03	7.00E-04	-1.44E-02	-9.00E-03	8.00E-04	8.00E-04
	Minimum Approval Rate for Director Appointments	1	1.00E-04	8.16E-05	1.80E-03	2.40E-03**	-7.70E-03	-4.80E-03	5.00E-04	8.00E-04*
	Performance-based Remuneration System	1	1.64E-02	1.85E-02	2.98E-02	2.81E-02	3.24E-01**	2.54E-01**	1.44E-02	1.17E-02
	Establishment of Nomination committees	1	1.95E-02	5.61E-02	6.34E-02	1.15E-01	7.91E-01	1.71E+00	-5.63E-02	7.50E-03
	Existence of Integrated Report	1	1.51E-02	3.30E-03	-4.11E-02	-7.00E-03	-2.47E-01	-1.16E-01	-2.89E-02*	-1.31E-02
	Total Return Ratio	1	7.61E-07	9.52E-07	-3.34E-06	-2.53E-06	-7.16E-05	-1.63E-05	2.96E-06**	-9.24E-07
	Ratio of Independent Outside Directors	1	-8.00E-04	-4.00E-04	-9.00E-04	-5.00E-04	4.90E-03	1.17E-02**	5.00E-04	4.00E-04
	Adoption of Anti-Takeover Measures	-1	-2.71E-02	-1.64E-02	1.20E-02	1.06E-02	-6.22E-02	5.57E-02	3.00E-03	7.00E-03
Score	FTSE E Score	1	6.40E-03	6.10E-03	2.90E-02	2.10E-02	2.10E-01	2.11E-01	2.13E-02	1.58E-02**
	FTSE S Score	1	8.80E-03	8.30E-03	8.90E-03	9.00E-03	2.24E-01	3.12E-01	1.80E-03	4.60E-03
	FTSE G Score	1	-1.57E-02	-1.69E-02	-1.05E-02	-1.21E-02	6.26E-02	1.04E-01	-1.12E-02	-3.00E-03
	FTSE ESG Overall Score	1	2.80E-03	-4.00E-04	1.87E-02	9.60E-03	3.12E-01	3.70E-01	1.05E-02	1.11E-02

Positive / Negative

※ In the table, "E-01" corresponds to the notation for 10 to the power of -1, and "E+02" corresponds to the notation for 10 to the power of +2, etc.
※ Significance level: * p-value between 0.05 and 0.1, ** p-value less than 0.05

Overall analysis results over the entire period

- The table below focuses on ESG indicators with statistical significance at the 5% significance level
  - In DE&I-related indicators, the ratio of female directors and the ratio of women among new hires are significant variables for Tobin's q and PBR, which is desireble from the ESG perspective. In addition, the difference in average number of years of employment between men and women was significant in terms of PBR and logarithmic market capitalization, which is consistent with the ESG perspective as well
  - Among the FTSE scores, a significant coefficient with a sign consistent with the hypothesis was identified for the E-score for market capitalization

Corporate Value Indicators	Summary of effects significant at the 5% siginificance level
Tobin's q	• In both the Lag1 and Lag1 + Lag2 models, the only variable that is consistent with the hypothesis and shows high statistical significance is the ratio of female directors • In the Lag1 + Lag2 model, the ratio of women among new hires is consistent with the hypothesis
PBR	• In the Lag1 model, the proportion of women among new hires was consistent with the hypothesis. The same is true for the difference in average number of years of employment between men and women • In the Lag1+Lag2 model, the minimum approval rate for director appointments is significant
ROE	• Both in Lag1 and Lag1+Lag2, the performance-based remuneration system was significant in the predicted direction • In addition, the ratio of independent outside directors in Lag1 + Lag2 followed our hypothesis
Market Cap	• In the Lag1 model, the total return ratio and the difference in average years of employment between men and women are consistent with our hypotheses • In the Lag1 + Lag2 model, the FTSE E score is consistent with our hypothesis

Table of contents

Results of Tobin's q analysis over the entire period
- Summary of results with a p-value of 0.1 or less

	Lag1	Lag1 + Lag2
Consistent with ESG perspective	▸ Log of GHG Emissions (Scope 1&2) ▸ Ratio of Female Directors ▸ Ratio of Female Managers	▸ Ratio of Female Directors ▸ Ratio of Women among New Hires
Inconsistent with ESG perspective	▸ Not applicable	▸ Not applicable

Note: underlining indicates a p-value of 0.05 or less

- Among the ESG indicators that are significant for Tobin's q (corporate value), the results of the 5% significance level are as follows.
  - In both the Lag1 and Lag1 + Lag2 models, the only variable that is consistent with the hypothesis and shows high statistical significance is the ratio of female directors
  - In the Lag1 + Lag2 model, the effect of ratio of women among new hires is consistent with the hypothesis.
    - However, this indicator is based on a limited number of data years and companies, so further accumulation of data is desirable

Results of Tobin's q analysis over the entire period
- (Reference) Summary of results with a p-value of 0.1 or less – statistical table

Consisntent with ESG perspective

Lag1

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Ratio of Female Directors	1	3.4 x10^{-3}	0.013	1.4 x10^{-3}	0.117	0.109	8,147
Log of GHG Emissions (Scope 1&2)	-1	-0.032	0.052	0.017	0.134	0.133	10,335
Ratio of Female Managers	1	4.2 x10^{-3}	0.065	2.3 x10^{-3}	0.113	0.102	1,981

Lag1 + Lag2

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Ratio of Women among New Hires *1	1	6.1 x10^{-3}	0.000	1.3 x10^{-3}	0.178	0.155	813
Ratio of Female Directors	1	1.6 x10^{-3}	0.038	7.0 x10^{-4}	0.115	0.110	6,541

Inconsistent with ESG perspective

Lag1

Not applicable

Lag1 + Lag2

Not applicable

- Explanation of each item in the table:

- Belief: The desired sign that the explanatory variable affects the corporate value, 1 (positive) or -1 (negative))
- Parameter: Estimated Partial Regression Coefficient
- p-value: An index that measures the significance of the estimated partial regression coefficient under the null hypothesis
- Std. Err. : Standard Error of Each Partial Regression Coefficient
- R2: Coefficient of determination for the entire data to be handled
- R2_within: Coefficient of determination focusing only on the variation within each individual
- Obs. : Number of samples used for analysis

*1 Analysis result for this indicator is based on an extremely limited number of data years and companies, so further accumulation of data is prospected

Results of Tobin's q analysis over the entire period
- (reference) Hypotheses for each ESG index

- On the previous page, we confirmed ESG indicators that are significant for Tobin's q as a corporate value. The hypotheses on how each ESG indicator has a positive or negative impact on corporate value are as follows

ESG indicator name	Hypothesis content
Log of GHG Emissions (Scope 1&2)	As GHG emissions increase, environmental impact grows. In the future, stricter environmental regulations, the introduction of environmental taxes, changes in consumer preferences, and reputational risks may lead to a decline in long-term corporate value.
Ratio of Female Managers	This variable serves as an indicator that personnel with more diverse backgrounds are being hired. Such diversity can lead to active discussions of varied opinions, spur innovation, and potentially enhance corporate value.
Ratio of Female Directors	
Ratio of Women among New Hires	

Table of contents

Results of PBR analysis over the entire period
- Summary of results with a p-value of 0.1 or less

	Lag1	Lag1 + Lag2
Consistent with ESG perspective	▸ Difference in Average Years of Employment Between Men and Women ▸ Ratio of Women among New Hires ▸ Log of GHG Emissions (Scope 1&2)	▸ Minimum Approval Rate for Director Appointments
Inonsisntent with ESG perspective	▸ Ratio of Female Managers	▸ Not applicable

Note: underlining indicates a p-value of 0.05 or less

- Among the ESG indicators that are significant for the price-to-book ratio (PBR), the results of the 5% significance level are as follows.
  - In the Lag1 model, the proportion of women among new hires was consistent with the hypothesis. The same is true for the difference in the average number of years employed by men and women
  - In the Lag1+Lag2 model, the minimum approval rate for director appointments is significant

Results of PBR analysis over the entire period
- (Reference) Summary of results with a p-value of 0.1 or less – statistical table

Consisntent with ESG perspectives

Lag1

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Difference in Average Years of Employment Between Men and Women	1	0.013	0.031	6.2×10^{-3}	0.141	0.122	1,374
Ratio of Women among New Hires	1	5.9×10^{-3}	0.045	2.9×10^{-3}	0.175	0.139	1,290
Log of GHG Emissions (Scope 1&2)	-1	-0.045	0.093	0.027	0.186	0.205	10,402

Lag1 + Lag2

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Minimum Approval Rate for Director Appointments	1	2.4×10^{-3}	0.016	1.0×10^{-3}	0.124	0.120	6,144

Inconsistent with ESG perspectives

Lag1

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Ratio of Female Managers	1	-6.2×10^{-3}	0.077	3.5×10^{-3}	0.166	0.164	2,002

Lag1 + Lag2

Not applicable

Results of PBR analysis over the entire period
- (Reference) Hypotheses for each ESG indicator

- On the previous page, we identified ESG indicators that are significant for price-to-book ratio (PBR). The hypotheses on how each ESG indicator has a positive or negative impact on corporate value are as follows

ESG indicator name	Hypothesis content
Log of GHG Emissions (Scope 1&2)	As GHG emissions increase, environmental impact grows. In the future, stricter environmental regulations, the introduction of environmental taxes, changes in consumer preferences, and reputational risks may lead to a decline in long-term corporate value.
Ratio of Women among New Hires	The higher the variable, the likelier the company is to hire individuals with diverse backgrounds, leading to active discussions with diverse opinions, fostering innovation, and potentially increasing corporate value.
Ratio of Female Managers	
Difference in Average Years of Employment Between Men and Women	
Minimum Approval Rate for Director Appointments	When the approval rate for director appointments is high, it reflects that investors trust the management's strategy and future prospects for the company, positioning them more optimistically. This could have a positive impact on the company's stock price.

Comparison of Tobin's q and PBR analysis results over the entire period

- Among the ESG indicators, proportion of women among new hires had the hypothesized effect both on Tobin's q, a corporate metric, and PBR, an investment indicators
- On the other hand, there were no ESG indicators that were inconsistent with the hypothesis for either Tobin's q or PBR

Table of contents

Results of ROE analysis over the entire period
- Summary of results with a p-value of 0.1 or less

	Lag1	Lag1 + Lag2
Consistent with ESG perspective	▸ Performance-based Remuneration System	▸ Percentage of Independent Outside Directors ▸ Performance-based Remuneration System
Inconsistent with ESG perspective	▸ Not applicable	▸ Ratio of Female Directors

Note: underlining indicates a p-value of 0.05 or less

- Among the ESG indicators that have a significant return on equity (ROE), the results of the 5% significance level are as follows.
  - Both in Lag1 and Lag1+Lag2, the performance-based remuneration system was significant in the predicted direction
  - In addition, the ratio of independent outside directors in Lag1 + Lag2 followed our hypothesis

Results of ROE analysis over the entire period
- (Reference) Summary of results with a p-value of 0.1 or less – statistical table

Consistent with ESG perspectives

Lag1

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Performance-based Remuneration System	1	0.324	0.043	0.160	0.135	0.129	11,788

Lag1 + Lag2

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Percentage of Independent Outside Directors	1	0.012	0.028	5.3×10^{-3}	0.128	0.108	12,924
Performance-based Remuneration System	1	0.254	0.032	0.118	0.134	0.136	9,960

Inconsistent with ESG perspectives

Lag1

Not applicable

Lag1 + Lag2

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Ratio of Female Directors	1	-0.024	0.064	0.013	0.127	0.128	6,769

Results of ROE analysis over the entire period
- (reference) Hypotheses for each ESG indicator

- On the previous page, we identified ESG indicators that are significant for ROE. The hypotheses on how each ESG indicator has a positive or negative impact on corporate value are as follows

ESG indicator name	Hypothesis content
Performance-based Remuneration System	When there is a performance-based remuneration system, it provides motivation for executives and employees to improve performance, which could potentially increase corporate value.
Percentage of Independent Outside Directors	A higher ratio of independent outside directors suggests the company is hiring individuals with diverse backgrounds, leading to active discussions of diverse opinions, fostering innovation, and potentially increasing corporate value.
Ratio of Female Directors	The higher the proportion of female directors, the likelier the company is to hire individuals with diverse backgrounds, leading to active discussions with diverse opinions, fostering innovation, and potentially increasing corporate value.

A Study on the Significance of Partial Regression Coefficients in ROE Compared to Tobin's q and PBR

- Tobin's q and PBR tend to have a correlation with each other, while ROE tends to have a low correlation coefficient with both
  - Therefore, the pattern of correlations to ESG indices may be more distinct from the patterns observed for Tobin’s q and PBR
- When comparing the formulas for calculating PBR and ROE, there is a difference between the PBR numerator being the stock price and the ROE numerator being net income. Therefore, PBR reflects the market's expectations of a company, while ROE reflects a company's profitability
- If Tobin's q improves as a company's ESG factors improve, it is likely that the PBR will improve as it is factored into market expectations for the company. On the other hand, corporate profitability is expected to occur later, and ROE is not expected to improve at the same time

Formula for calculating PBR	Formula for calculating ROE
$PBR = \frac{\text{Stock Price}}{\text{Book Value per share}}$	$ROE = \frac{\text{Net Income for the Current Fiscal Period}}{\text{Equity}} \times 100$

Table of contents

Results of market capitalization analysis over the entire period
- Summary of results with a p-value of 0.1 or less

	Lag1	Lag1 + Lag2
Consistent with ESG perspective	▸ Total Return Ratio ▸ Difference in Average Years of Employment Between Men and Women	▸ FTSE E-Score ▸ Minimum Approval Rate for Director Appointments
Inconsistent with ESG perspective	▸ Existence of Integrated Report	▸ Not applicable

Note: underlining indicates a p-value of 0.05 or less

- Among the ESG indicators that are significant for market capitalization, the results at the 5% significance level are as follows
  - In the Lag1 model, the total return ratio and the difference in average years of employment between men and women are consistent with our hypotheses
  - In the Lag1 + Lag2 model, the FTSE E score is consistent with our hypothesis

Results of market capitalization analysis over the entire period
- (Reference) Summary of results with a p-value of 0.1 or less – statistical table

Consistent with ESG perspectives

Lag1

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Diff. in Avg. Years of Employment Men/Women	1	8.8×10^{-3}	0.011	3.4×10^{-3}	0.257	0.193	1,387
Total Return Ratio	1	3.0×10^{-6}	0.042	1.5×10^{-6}	0.397	0.380	13,940

Lag1 + Lag2

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
FTSE E-Score	1	0.016	0.040	7.7×10^{-3}	0.283	0.176	4,282
Minimum Approval Rate for Director Appointments	1	8.0×10^{-4}	0.060	4.0×10^{-4}	0.244	0.234	6,349

Inconsistent with ESG perspectives

Lag1

Variable name	Belief	Parameter	p-value	Std. Err.	R2	R2_within	Obs.
Existence of Integrated Report	1	-0.029	0.061	0.015	0.411	0.377	13,630

Lag1 + Lag2

Not applicable

Results of market capitalization analysis over the entire period
- (Reference) Hypotheses for each ESG indicator

- On the previous page, we identified ESG indicators that are significant for market capitalization. The hypotheses on how each ESG indicator has a positive or negative impact on corporate value are as follows

ESG indicator name	Hypothesis content
FTSE E-Score	Higher scores, indicate that the company has a strong commitment to environmental issues, which could lead to improved investor evaluation and potentially increase corporate value.
Difference in Average Years of Employment Between Men and Women	A difference in average years of employment between men and women (with women having shorter employment durations) may indicate a workplace environment where it is difficult for women to work according to life events, and a decrease in diversity could lead to a decline in corporate value.
Total Return Ratio	Companies with a high total return ratio are focused on shareholder returns. As a result, reducing internal reserves could help mitigate agency problems between management and shareholders.
Minimum Approval Rate for Director Appointments	When the approval rate for director appointments is high, it reflects that investors trust the management's strategy and future prospects for the company, positioning them more optimistically. This could have a positive impact on the company's stock price.
Existence of Integrated Report	Integrated reports provide a comprehensive view of how a company creates long-term value. This enhances transparency, allowing investors and stakeholders to make more informed decisions. If the integrated report meets stakeholder expectations, it is expected to positively impact corporate value.

Summary of the difference in the effect patterns of market capitalization and other corporate value indicators

- Among all corporate value indices included in this study, significant effects of FTSE score (E score) were observed only for logarithmic market capitalization
- For both market capitalization and all other corporate value indicators, no variables were found that were inconsistent with the hypothesis at p<=0.05

Table of contents

Rolling window analysis
- Approach

- Analysis using a fixed-effects model was conducted repeatedly over a 4-year period of corporate value indicators as the dependent variable, focusing on the transitions in partial regression coefficients
  - The data for corporate value indicators was analyzed for the period from 2014 to 2022
    - Note that when focusing on the 4 years from 2014 to 2017, the explanatory variables with a lag of 1 year correspond to data from 2013 to 2016, and those with a lag of 2 years correspond to data from 2012 to 2015
    - To compare the changes in partial regression coefficients over multiple periods, we estimated the partial regression coefficients using a model that does not account for time effects
  - To focus on experimental results that are significant across multiple rolling windows, we present only the results that meet the following criteria:
    - Among the six periods analyzed, based on 4-year intervals starting from 2014 to 2019, at least three periods must have a p-value of 0.1 or less
    - To differentiate from the entire period analysis, the periods with the same sign must not exceed 70% of the total periods
    - In the periods where significance is observed, there must be noticeable changes in the sign of contribution to corporate value

Rolling window analysis
- Results: statistical significance of partial regression coefficients with changes in sign

- The filtered transitions according to the filter conditions mentioned in the previous page in the partial regression coefficients of Tobin's q, PBR, ROE, and Log of Market Cap are listed below

Corporate value indicator	Lag setting	ESG indicator	ESG-consistent	[2014, 2017]		[2015, 2018]		[2016, 2019]		[2017, 2020]		[2018, 2021]		[2019, 2022]	
			Belief	Param.	Obs.	Param.	Obs.	Param.	Obs.	Param.	Obs.	Param.	Obs.	Param.	Obs.
Tobin's q	Lag1	Adoption of Anti-Takeover Measures	-1	-0.076	2,967	-0.113 **	4,589	-0.095 **	6,255	-5.0 x10^{-3}	6,467	0.054	6,619	0.100 *	6,714
ROE	Lag1	Establishment of Nomination committees	1	-8.002 **	4,689	-6.277 *	6,374	-2.709 *	6,584	-1.663	6,703	3.960 **	6,842	6.749 **	6,925
ROE	Lag1+Lag2	Establishment of Nomination committees	1	-3.063	3,052	-1.467	4,670	-1.566 **	6,333	-2.036 **	6,494	3.094 *	6,659	4.862 **	6,790

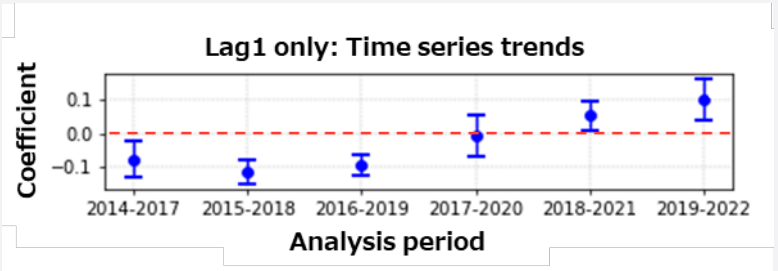
Sign of the Belief or partial regression coefficient column: Positive / Negative,

Significance level: * p-value between 0.05 and 0.1, ** p-value less than 0.05

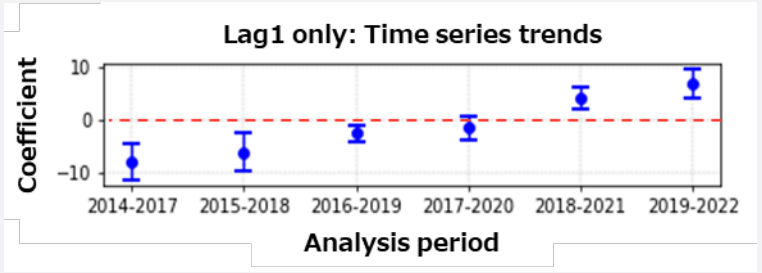
Note: "Param." represents the partial regression coefficients of the ESG indicators, and "Obs." indicates the number of observations in the panel data available for analyzing the respective indicators

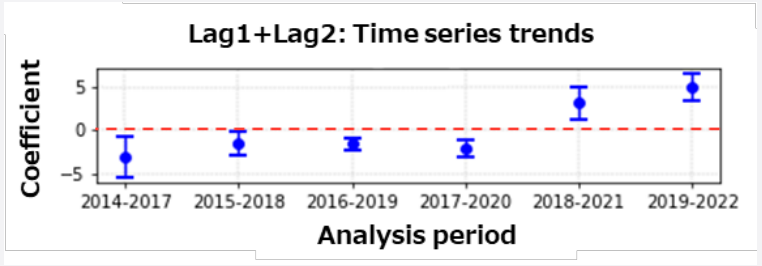
- Significant changes are observed from the early analysis period with available data (2014–2017) to recent years (2019–2022) in Tobin's q regarding the adoption of anti-takeover measures and ROE concerning the establishment of nomination committees. The sign for the adoption of anti-takeover measures transitions to one inconsistent with the hypothesis, while the sign for the establishment of nomination committees aligns with the hypothesis.

Adoption of Anti-Takeover Measures for Tobin's q



Establishment of Nomination committees for ROE





- Error bars in each graph indicate the standard error of the partial regression coefficient for the year analyzed.

Rolling window analysis
- Summary

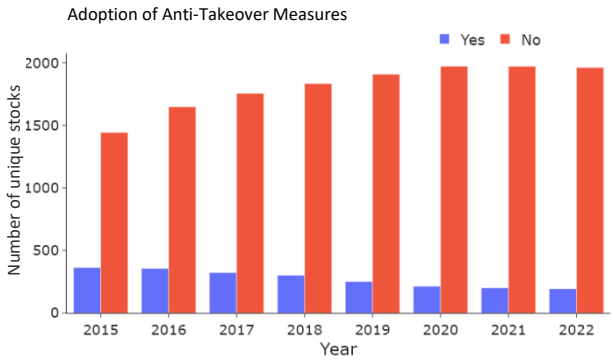
- The variables for which a clear transition of partial regression coefficients were observed during the analyzed period were as follows:

Corporate Value Indicator	Consistent with Belief ➡ Inconsistent	Inconsistent with Belief ➡ Consistent
Tobin's q	Adoption of Anti-Takeover Measures	-
PBR	-	-
ROE	-	Establishment of Nomination committees
Market Cap	-	-

- The hypotheses of whether each ESG indicator has a positive or negative impact on corporate value are as follows for ESG indicators in which changes in impact were significant during the analysis period

ESG indicator name	Hypothesis content
Adoption of Anti-Takeover Measures	The introduction of takeover defense measures has the potential to protect companies from hostile takeovers and support the continuation of long-term strategies. However, when the interests of management and shareholders do not align, it may compromise efficient corporate governance and opportunities for value creation.
Establishment of Nomination committees	The establishment of a nomination committee can enhance the transparency of corporate management and increase investor confidence. It is also expected to improve the quality of the management team through the oversight of the officer selection and evaluation process. Increased investor confidence can positively affect the company's stock price and contribute to the enhancement of corporate value. On the other hand, the establishment of a nomination committee could complicate the decision-making process and potentially have negative effects, depending on the relationships with stakeholders.

- The adoption of anti-takeover measures and the establishment of nomination committees have evolved as follows, based on a small number of companies that have implemented them.



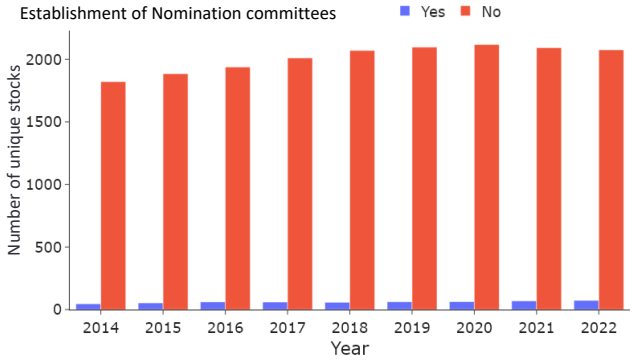


Table of contents

Concluding Remarks

- We conducted a statistical analysis to explore whether ESG scores and related indicators significantly impact corporate value and profitability, focusing on four corporate value indicators: Tobin's q, PBR, ROE, and market capitalization
- The model selection involved determining control variables based on significance, using a fixed-effects model to account for time-invariant confounding factors
- The analysis focused on two approaches: a fixed-effects model covering the entire period and a rolling window analysis to uncover temporal trends and changes over time
  - For the full-period analysis, we examined whether the effect of the ESG indicators which is considered desirable (e.g. lower emissions, higher diversity) matched the significant results from the fixed-effects model
  - In the rolling analysis, we highlighted ESG indicators with temporal transitions in statistical significance
- Potential model improvements and suggesting future research directions
  - This study considered two simplistic ways to handle lag effects of ESG indicators on corporate value. Future work could focus on more realistic lag effects and dynamic treatment methods
  - Some indicators have unique distributions or non-linear effects. Testing robustness through methods like binary classification is important
  - Finally, indicators related to disclosure don't address the quality or content of the disclosure. If data on these aspects is available, further analysis may add valuable different perspectives

References abbreviated in the text of this document

- Aouadi, A. & Marsat, S. (2018). Do ESG Controversies Matter for Firm Value? Evidence from International Data. Journal of Business Ethics, 151(4):1027–1047
- Aono, Kohei, and Tatsuyoshi Okimoto. (2021). "When the Japan Empowering Women Index Outperforms its Parent and the ESG Select Leaders Indexes?."
- Fatemi, A., Glaum, M., & Kaiser, S. (2018). ESG performance and firm value: The moderating role of disclosure, Global Finance Journal Volume 38, November 2018, Pages 45-64
- Irawan, D. & Okimoto, T. (2021). How does ESG performance and awareness affect firm values and overinvestments? RIETI Discussion Paper, 21-e-033.
- Irawan, D. & Okimoto, T. (2021). Sustainability and Credit Spreads in Japan, RIETI Discussion Paper, 21-E-052.
- Wu, S., Li, X., Du, X., & Li, Z. (2022) The Impact of ESG Performance on Firm Value: The Moderating Role of Ownership Structure, Sustainability 2022, 14, 14507.
- Zhang, S. (2022). Firm value and ESG performance during the covid-19 pandemic. In 2022 2nd International Conference on Enterprise Management and Economic Development (ICEMED 2022) (pp. 200-205). Atlantis Press.
- Peillex, J. & Boubaker, S. & Comyns, B. (2021). "Does It Pay to Invest in Japanese Women? Evidence from the MSCI Japan Empowering Women Index," Journal of Business Ethics, Springer, vol. 170(3), pages 595-613.
- El Ghoul, S., Guedhami, O., Kwok, C. C., & Mishra, D. R. (2011). Does corporate social responsibility affect the cost of capital?. Journal of banking & finance, 35(9), 2388-2406.
- Servaes, H., & Tamayo, A. (2013). The impact of corporate social responsibility on firm value: The role of customer awareness. Management science, 59(5), 1045-1061.
- Bolton, P., & Kacperczyk, M. (2021). Global pricing of carbon-transition risk (No. w28510). National Bureau of Economic Research.
- Tomonori Yuyama. (2020). "ESG 投資とパフォーマンス: SDGs・持続可能な社会に向けた投資はどうあるべきか." , Kinzai Institute for Financial Affairs, Inc., (Book)

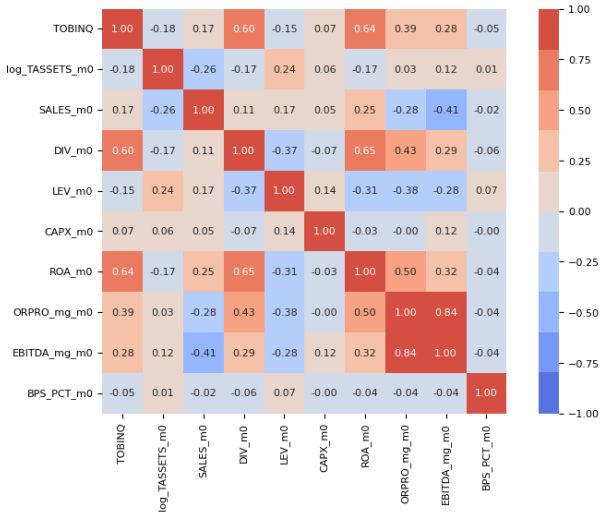
Table of contents

Appendix : Correlation between Tobin's q and explanatory variables

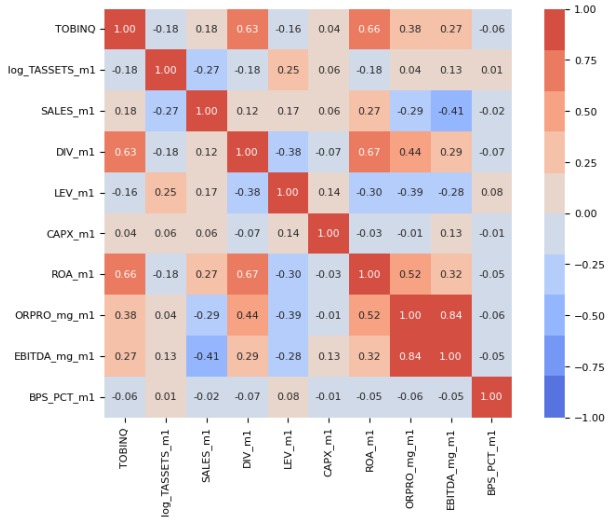
- The correlations for variables, excluding ESG's KPI, can be seen in the color map below. The symbols are explained in the table on the right. (The suffixes "_m0" and "_m1" in the correlation table correspond to no lag and a one-period lag, respectively)
- There is little difference between the correlation coefficients for lag 0 and lag 1. While a lag of 0 is used in the analysis, this suggests that using a one-period lag would have minimal impact
  - Formula for lag period 0: $Q_{i,t} = \alpha_i + \alpha_t + \sum_n \rho_n \times X_{n,i,t} + \epsilon_{i,t}$,
  - Formula for lag period 1: $Q_{i,t} = \alpha_i + \alpha_t + \sum_n \rho_n \times X_{n,i,t-1} + \epsilon_{i,t}$,
- Since EBITDA and ordinary profit margin (ORPRO) are highly correlated, it is preferable to use only one or the other.

Correlation Table between Tobin's q ($Q_{n,t}$) and Control Variables $X_{n,i,t}$

Lag = 0 for control variables



Lag = 1 for control variables



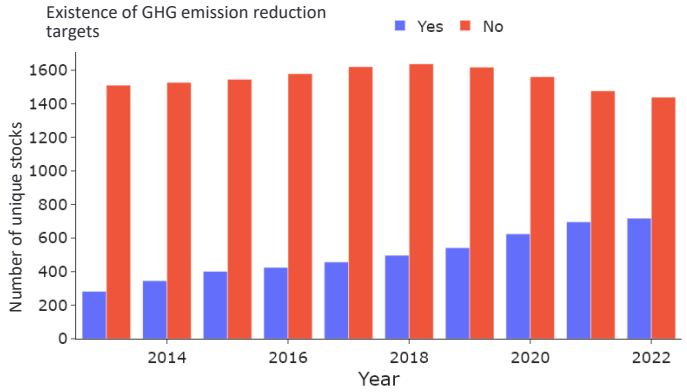
Control Variable Candidates $X_{n,i,t}$

#	Control variables	Symbols in correlation results
1	**Log of Total Assets**	log_TASSETS
2	**Return on Assets (ROA)**	ROA
3	**Total Asset Turnover Ratio**	SALES
4	**Debt to Total Assets Ratio**	LEV
5	**Capital Expenditure to Total Assets Ratio**	CAPX
6	**Dividend to Total Assets Ratio**	DIV
7	**EBITDA margin**	EBITDA_mg
8	**Ordinary Profit Margin**	ORPRO_mg
9	**Change in book-value per share**	BPS_PCT

Table of contents

Appendix : Analysis of GHG emission reduction targets and actual emission reductions (1/3)

- Background and Objectives
  - It has been confirmed that the number of companies that set reduction targets for GHG emission will increase through engagement
  - The correspondence between the targets set by companies and the reduction of emissions itself has not yet been clarified, and thus conduct a quantitative analysis
- Approach
  - Based on the GHG emission reduction target index provided by MSCI, the contribution to the actual emission reduction provided by S&P is evaluated using a simple model.
  - As an emissions indicator, we will use the logarithmic GHG emissions index of Scope 1 & 2
  - In order to implicitly consider the contribution of time-invariant confounding factors, such as industrial dummies, we introduce an individual fixed effect term
  - Considering the evolution of emissions due to advances in electricity technology and the change in the accuracy of emissions indicators over time, we examined the time-effect term in the model
    - As a matter of fact, the amount of reduction itself is decreasing, as shown in the distribution of 440 companies on the next page
  - Since the current emissions are considered to be affected by the company's annual emissions, a self-lag (one-term lag) is introduced
  - Introduce the logarithmic total assets of each company as a control variable



Time-series changes in the presence or absence of reduction targets. It can be confirmed that the number of companies setting reduction targets is increasing rapidly year by year.

- Based on the above assumptions, the following simple model is assumed for this analysis. To evaluate long-term effects, the lag number t′ on the right-hand side is treated as variable to assess the degree of impact over time. Here, the dummy variable for the presence of emission reduction targets takes a value of 1 when a reduction target is set.

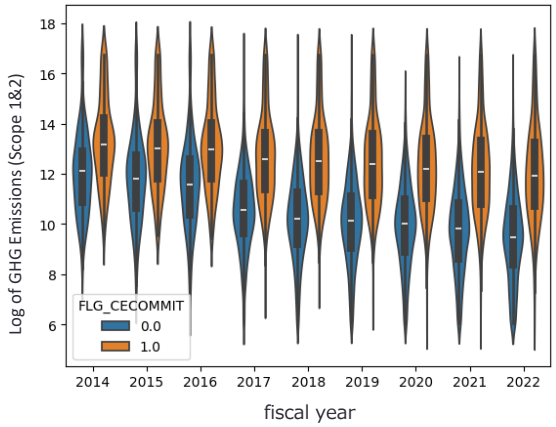
$$\log(\text{GHG emissions})_{i,t} = \beta_{i,t-t'} \times (\text{dummy for existance of emission reduction target})_{i,t-t'} + \gamma_1 \log(\text{GHG } emissions)_{i,t-1} + \gamma_2 \log(total\ assets)_{i,t-1} + a_i + a_t$$

(where a_i and a_t represent individual fixed effects and time fixed effects, respectively)

Appendix : Analysis of GHG emission reduction targets and actual emission reductions (2/3)

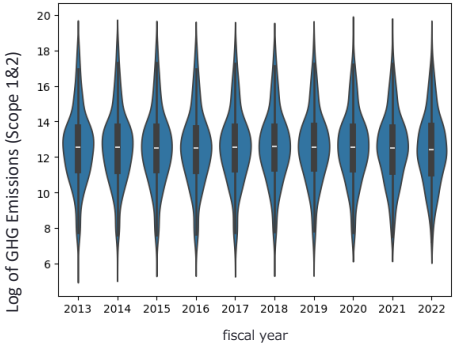
- Supplementary Discussion
  - Note that the assumption of the model for a large lag period (t') is less effective because the model can not take into account the dynamics of other control variables over the period
  - The figure on the left shows a graph that visualizes the distribution of S&P's GHG emissions Scope 1 and 2 after classifying companies according to whether or not they have reduction targets.
    - Here, the transition in the distribution from 2016 to 2017 is due to the significant change in the universe due to the data availability. For reference, data limited to those with emissions data in 2013 are added to the right.
    - From the difference in the distribution of emissions by the presence or absence of GHG emission reduction targets in the graph of emissions distribution (1st and 3rd from the left), it can be seen that companies with higher emissions are more willing to adopt reduction targets

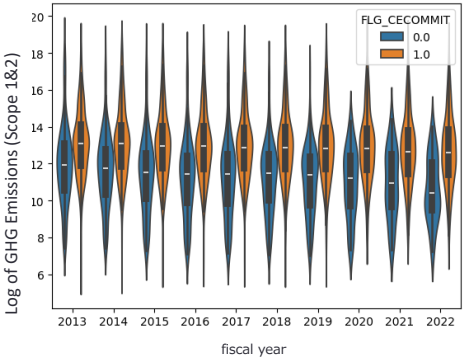
Time transition of log-transformed GHG emissions (Scope 1 & 2) classified by the presence of reduction targets for each year (FLG_CECOMMIT).

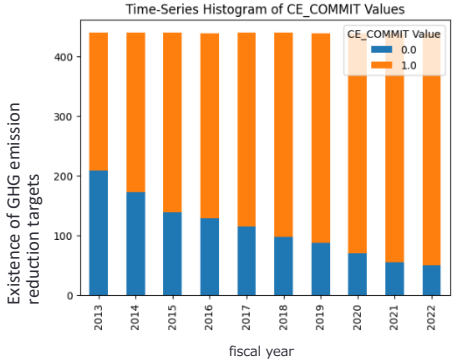


Log-transformed emission distribution for the 440 companies with GHG emission data in 2013 (left chart), and the same distribution classified by reduction targets (middle chart). Also, the presence of corresponding reduction targets (right chart).

Most of the companies with long-term emissions reporting have set emission reduction targets in 2022







Summary statistics for data

ESG Indicator Name	ESG integration	DataSource	Summary Statistics						Number of data in the fiscal year									
	Belief		count	mean	Std	min	50%	Max	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Log of GHG Emissions (Scope 1&2)	-1	S&P Trucost	14,714	10.67	2.27	3.08	10.60	18.70	440	493	499	1,400	1,865	1,933	1,955	2,018	2,041	2,070

Appendix : Analysis of GHG emission reduction targets and actual emission reductions (3/3)

Analysis results

- To simplify the discussion, we focused our analysis on emissions data in 2013
- Time effects and control variables are shown below. Note that coefficient of determination R2 refers to R2 of the entire model, and there was almost no difference to R2 (within)

With time effects

Number of lag periods *t'*	1		2		3		4		5	
Analysis (partial regression coefficient and p-value)	Parameter	p-value	Parameter	p-value	Parameter	p-value	Parameter	p-value	Parameter	p-value
Existence of GHG emission reduction targets (*t'* lag)	0.061	0.106	0.028	0.417	-0.006	0.877	-0.014	0.583	-0.007	0.812
Logarithmic Total Assets	0.214	0.001	0.241	0.000	0.245	0.002	0.236	0.005	0.269	0.003
Logarithmic GHG emissions	0.603	0.000	0.572	0.000	0.563	0.000	0.508	0.000	0.430	0.002
R2	0.378		0.341		0.328		0.279		0.213	
Obs. (Data Points)	3,603		3,201		2,800		2,399		1,997	

Without time effects (for reference)

Number of lag periods *t'*	1		2		3		4		5	
Analysis (partial regression coefficient and p-value)	Parameter	p-value	Parameter	p-value	Parameter	p-value	Parameter	p-value	Parameter	p-value
Existence of GHG emission reduction targets (*t'* lag)	0.018	0.653	0.001	0.978	-0.047	0.083	-0.081	0.000	-0.070	0.028
Logarithmic Total Assets	0.040	0.543	0.069	0.428	0.046	0.653	-0.019	0.825	0.008	0.936
Logarithmic GHG emissions	0.618	0.000	0.586	0.000	0.577	0.000	0.522	0.000	0.446	0.001
R2	0.370		0.334		0.322		0.277		0.214	
Obs. (Data Points)	3,603		3,201		2,800		2,399		1,997	

Legend for Significance Levels: p-value < 0.01 | 0.01 ≤ p-value < 0.05 | 0.05 ≤ p-value < 0.1

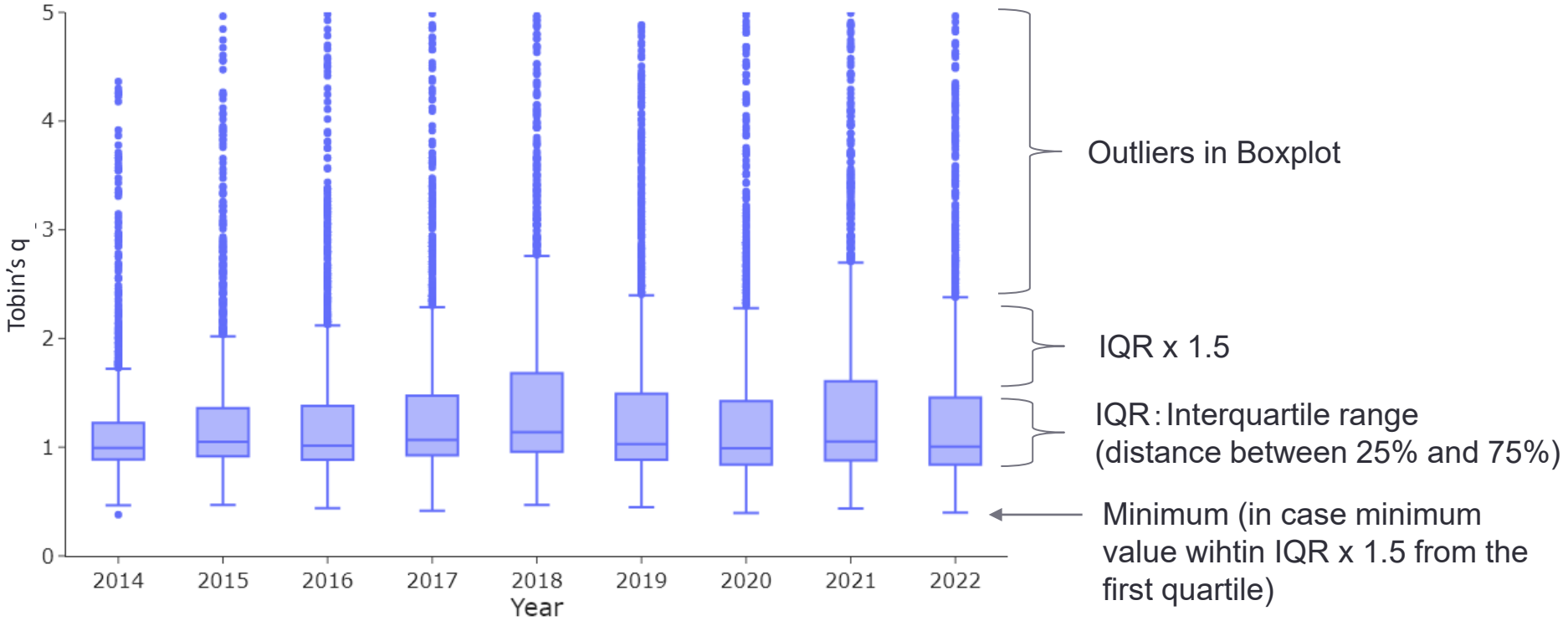
Discussions and conclusion

- Regardless of whether there is a time effect or not, and whether or not there is a self-lag, the presence or absence of an emissions reduction target did not contribute to emission reduction itself in spans of two lags or less
- If there time-fixed effect not included in the model,
  - Logarithmic total assets have no significance. This result goes against the counterintuitive belief that total assets affect emissions
  - When the number of lag periods to be examined is changed from 2 to 3, the significance fluctuates greatly. This is due to the fact that the availability of data is reduced by increasing the number of lag periods
  - The standard error in the logarithmic GHG emissions data is 2.27, and the contribution of the target reduction amount is small even when significant is observed (no time effect, lag period t' is greater than or equal to 3)
- In this model, significantly lower R2 are obtained when the number of lag order *t'* is increases. This indicate the remaining challenge for the more realistic modeling of control variables and related factors.
- From the distribution on the previous page, it was confirmed that the distribution of the reduction amount itself decreased with each year
- If we want to see the relationship between reduction targets and emissions reductions, it is desirable to consider not only the existence of GHG emission reduction targets, but also the fiscal year in which the reduction targets are targeted

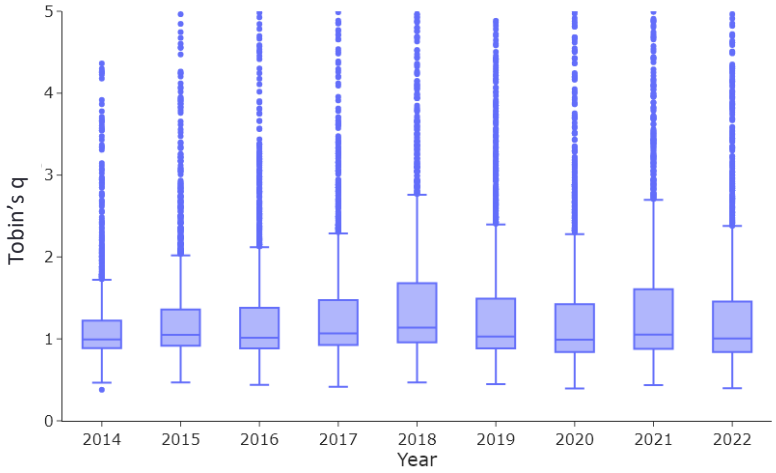
Table of contents

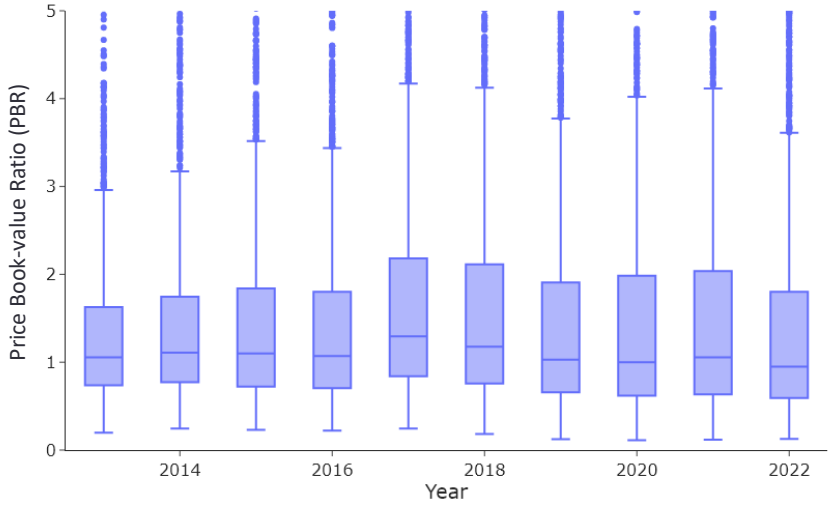
Appendix: Data Distribution Overview
- Definition of the boxplot visualized in the following pages

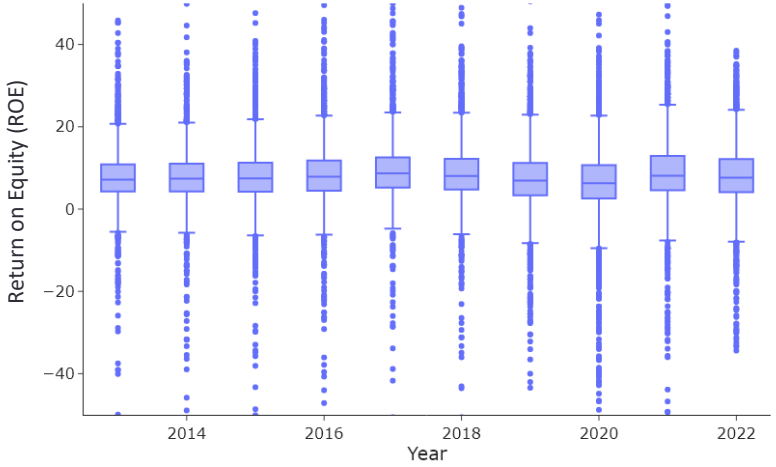
- The time series distribution of the data used in this analysis is summarized in a box plot from the next page onwards
  - Each box shows a range from quartile 1 (Q1) to quartile 3 (Q3). Quartile 2 (Q2: which is the median) is indicated by the line in the box. The upper and lower whiskers of the box indicate the maximum or minimum value if there are no outliers, and up to 1.5 times the distance of the interquartile range (IQR: Q3-Q1) from the edge of the box if there are outliers
  - The distributions of the data shown below are based on the datasets that could be linked as panel data for each stock. However, due to the availability of corporate value indicators and other control variables, not all of these datasets are necessarily used in the analysis.
- Example of the distribution of corporate value indicators (Tobin's q)

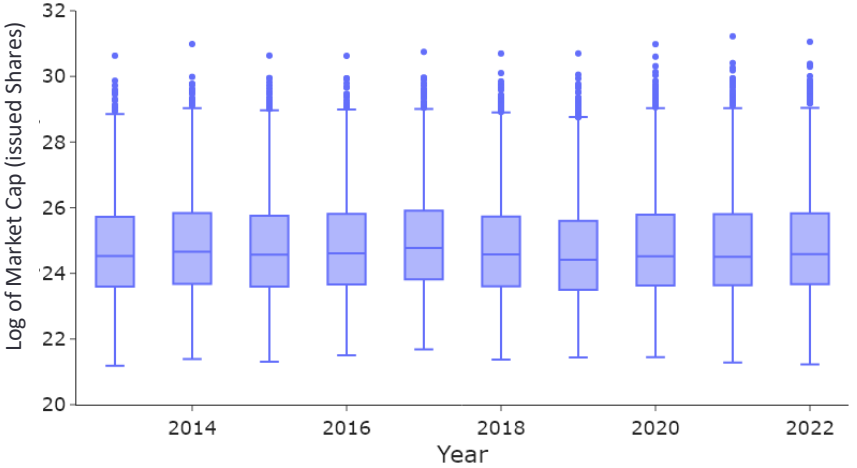


Appendix: Data Distribution Overview
- Corporate Value Indicators

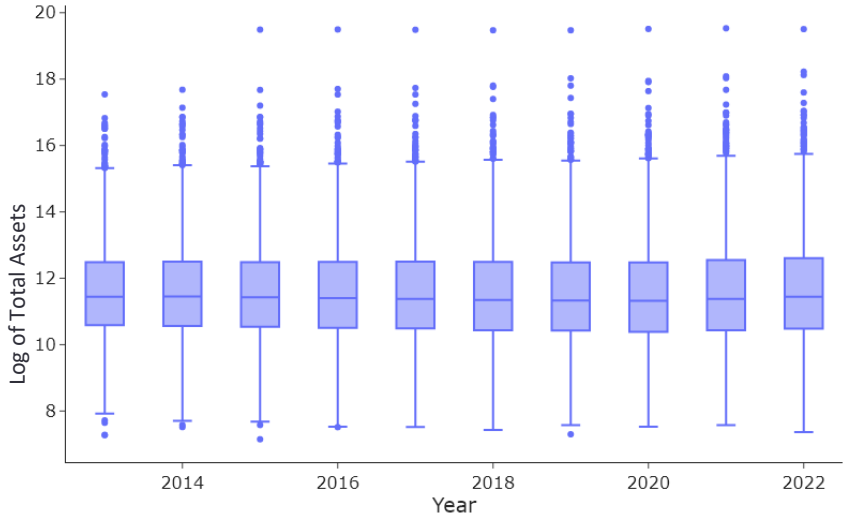


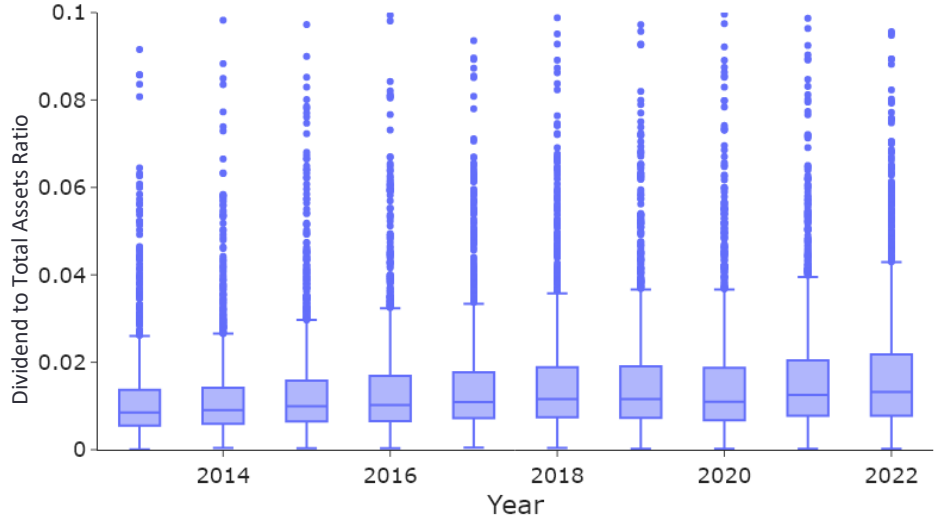


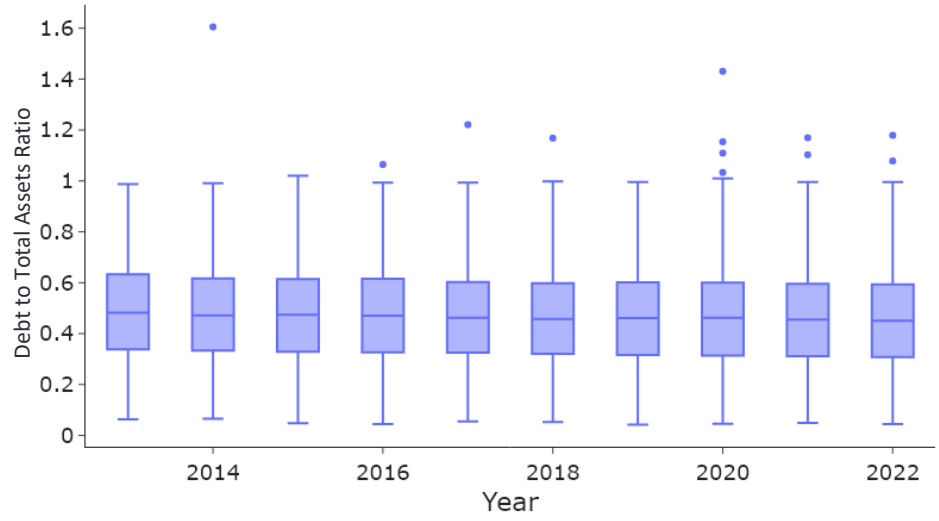


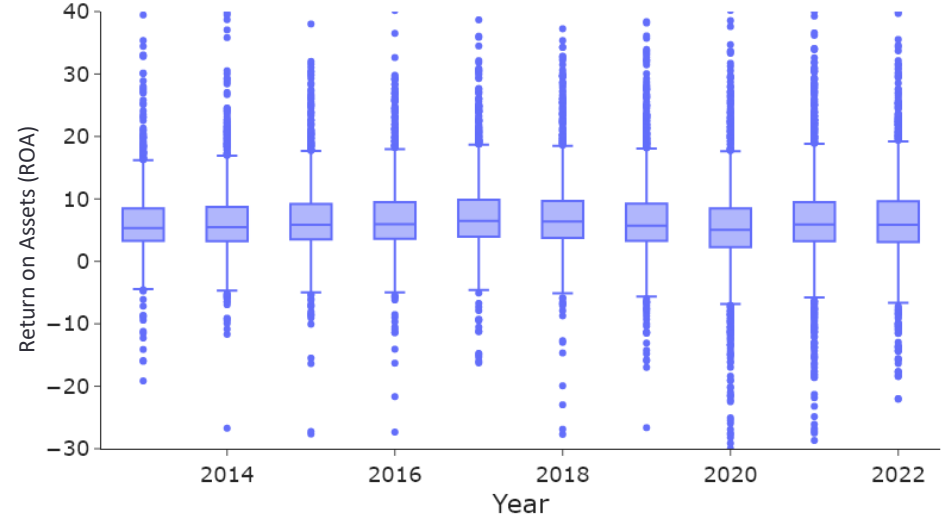


Appendix: Data Distribution Overview
- Control Variables (1/2)

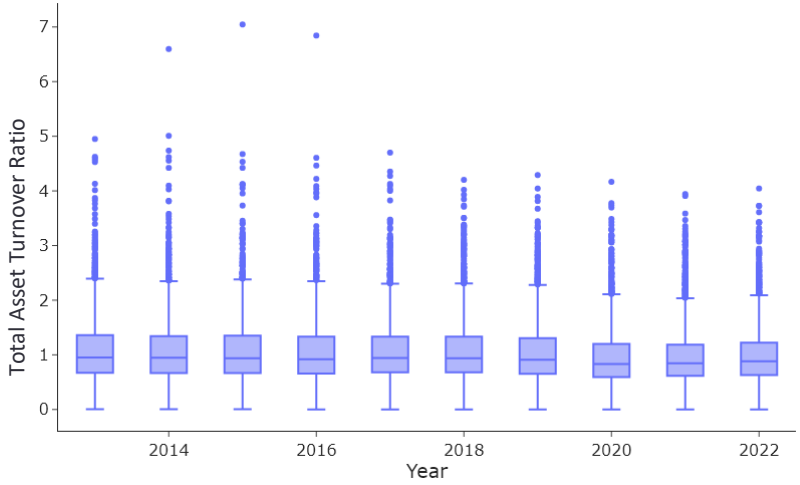


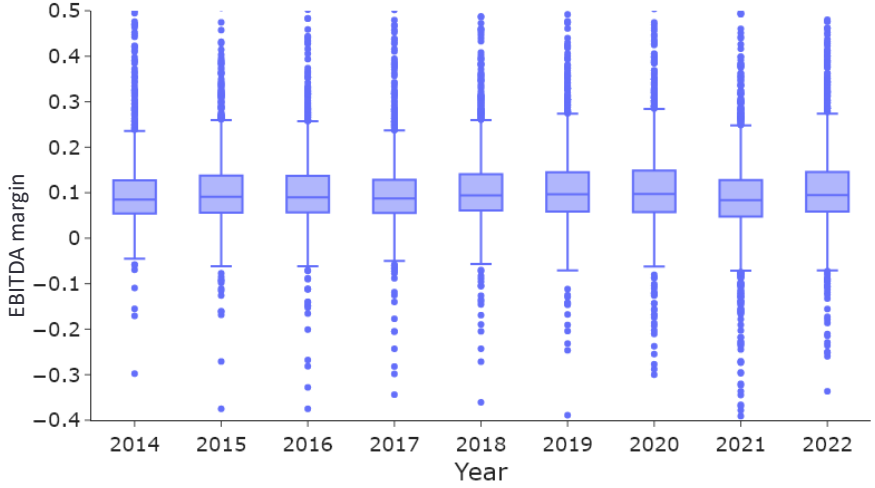


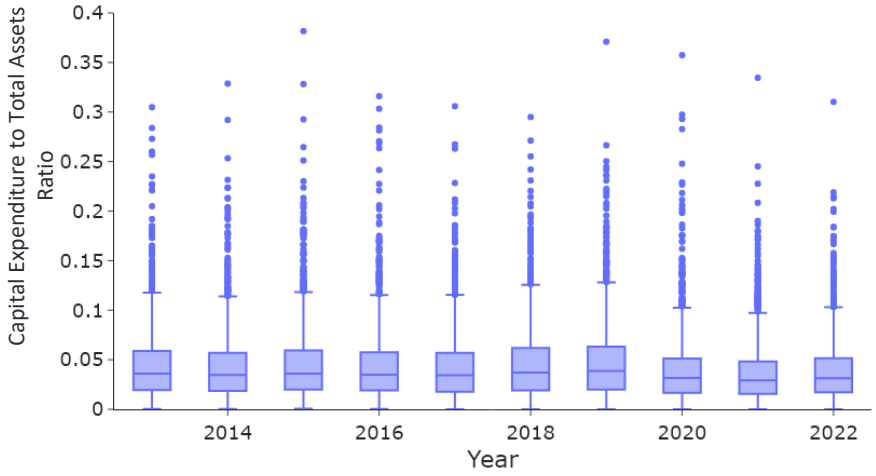




Appendix: Data Distribution Overview
- Control Variables (2/2)

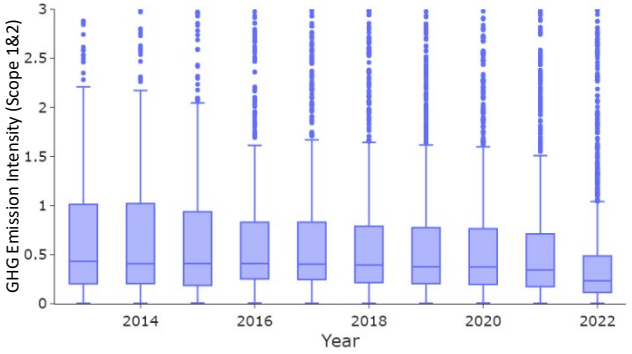


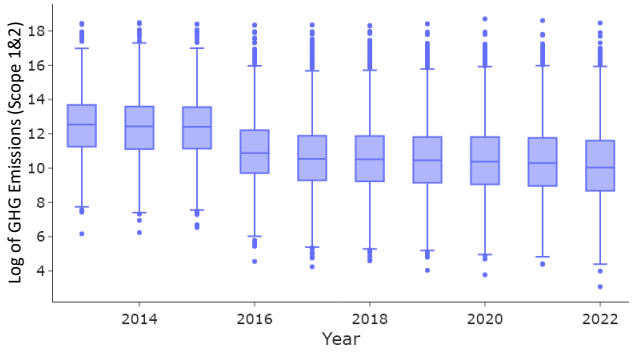




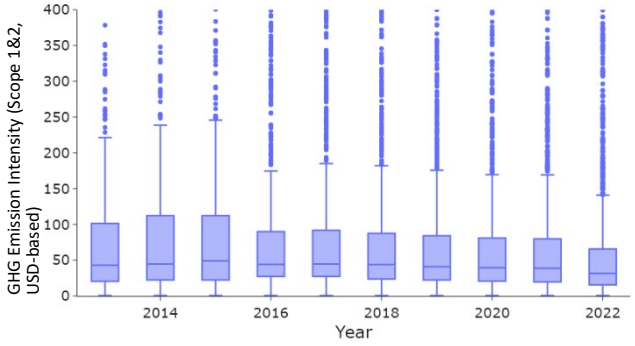
Appendix: Data Distribution Overview - ESG indicators (1/6)

Category	ESG Indicator
E	GHG Emission Intensity (Scope 1&2) *1
	Log of GHG Emissions (Scope 1&2)
S	Ratio of Female Directors
	Ratio of Female Managers
	Ratio of Women in the Workforce
	Ratio of Women among New Hires
	Difference in Average Years of Employment Between Men and Women
G	Existence of Stock Option System
	Presence of Controlling Shareholders (more than one-third of the shares)
	Cross-shareholding Ratio
	Minimum Approval Rate for Director Appointments
	Performance-based Remuneration System
	Establishment of Nomination committees
	Existence of Integrated Report
	Total Return Ratio
	Ratio of Independent Outside Directors
	Adoption of Anti-Takeover Measures
Score	FTSE E Score
	FTSE S Score
	FTSE G Score
	FTSE ESG Overall Score



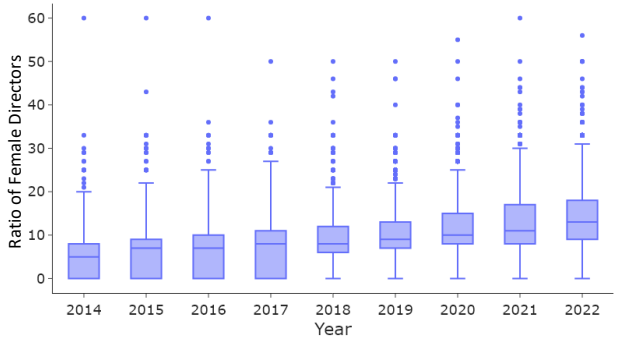


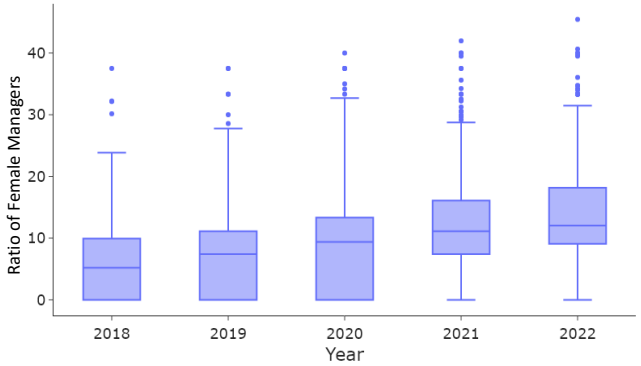
*1 The intensity of S&P's emissions used as a data source is calculated based on GHG emissions relative to sales (U.S. dollars), but in order to determine the intensity of emissions per yen, sales figures were converted into yen in the settlement year using the USD-JPY exchange rate announced by the International Monetary Fund (IMF). The distribution before conversion to yen is as follows

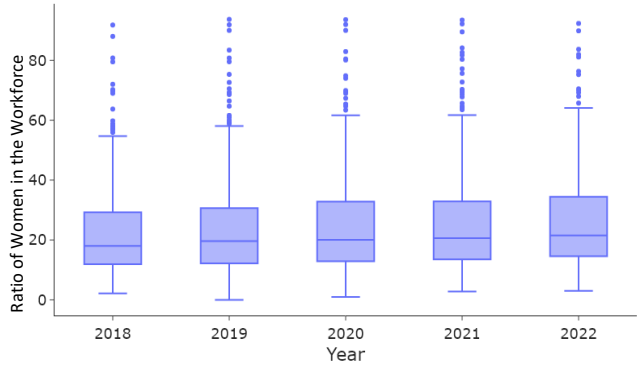


Appendix: Data Distribution Overview
- ESG indicators (2/6)

Category	ESG Indicator
E	GHG Emission Intensity (Scope 1&2)
	Log of GHG Emissions (Scope 1&2)
S	Ratio of Female Directors
	Ratio of Female Managers
	Ratio of Women in the Workforce
	Ratio of Women among New Hires
	Difference in Average Years of Employment Between Men and Women
G	Existence of Stock Option System
	Presence of Controlling Shareholders (more than one-third of the shares)
	Cross-shareholding Ratio
	Minimum Approval Rate for Director Appointments
	Performance-based Remuneration System
	Establishment of Nomination committees
	Existence of Integrated Report
	Total Return Ratio
	Ratio of Independent Outside Directors
	Adoption of Anti-Takeover Measures
Score	FTSE E Score
	FTSE S Score
	FTSE G Score
	FTSE ESG Overall Score

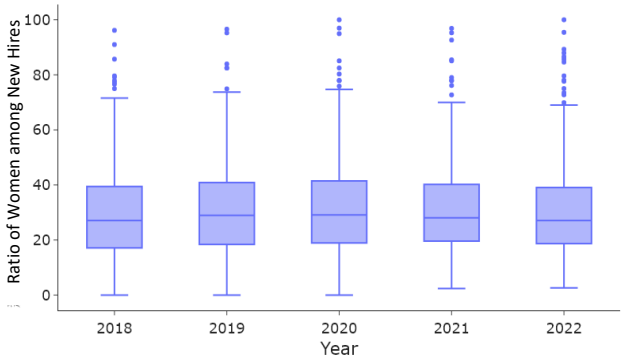


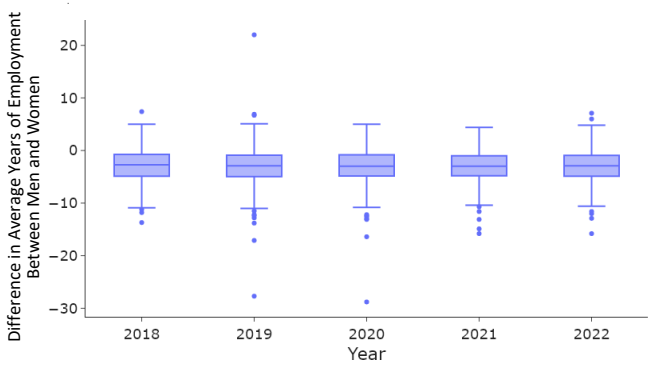


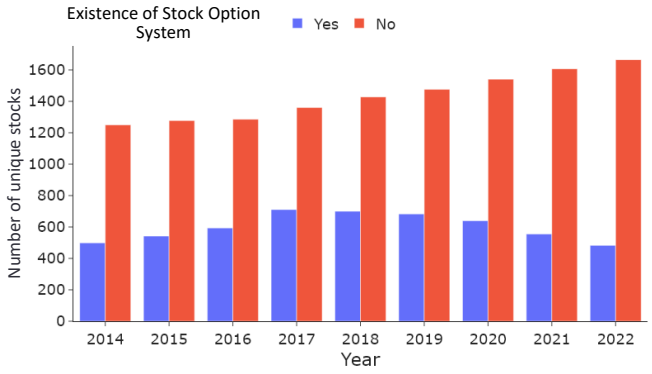


Appendix: Data Distribution Overview
- ESG indicators (3/6)

Category	ESG Indicator
E	GHG Emission Intensity (Scope 1&2)
	Log of GHG Emissions (Scope 1&2)
S	Ratio of Female Directors
	Ratio of Female Managers
	Ratio of Women in the Workforce
	Ratio of Women among New Hires
	Difference in Average Years of Employment Between Men and Women
G	Existence of Stock Option System
	Presence of Controlling Shareholders (more than one-third of the shares)
	Cross-shareholding Ratio
	Minimum Approval Rate for Director Appointments
	Performance-based Remuneration System
	Establishment of Nomination committees
	Existence of Integrated Report
	Total Return Ratio
	Ratio of Independent Outside Directors
	Adoption of Anti-Takeover Measures
Score	FTSE E Score
	FTSE S Score
	FTSE G Score
	FTSE ESG Overall Score

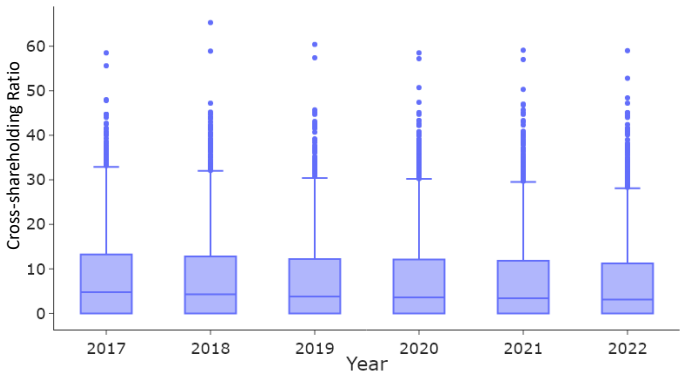


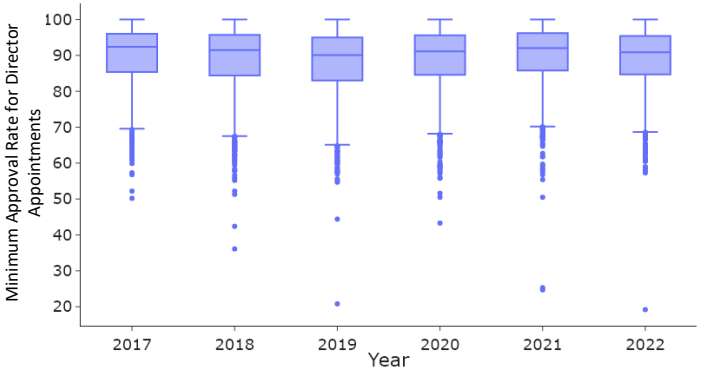


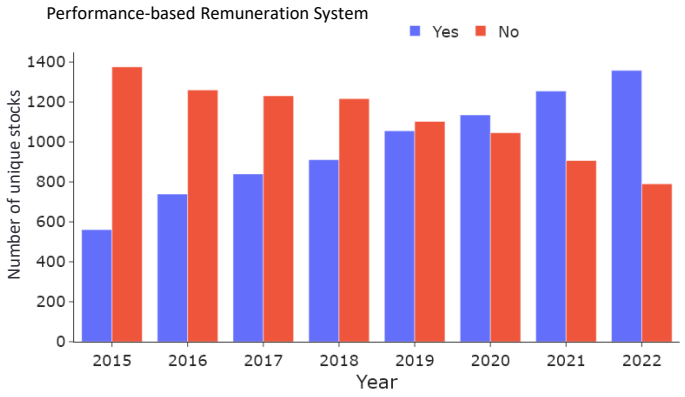


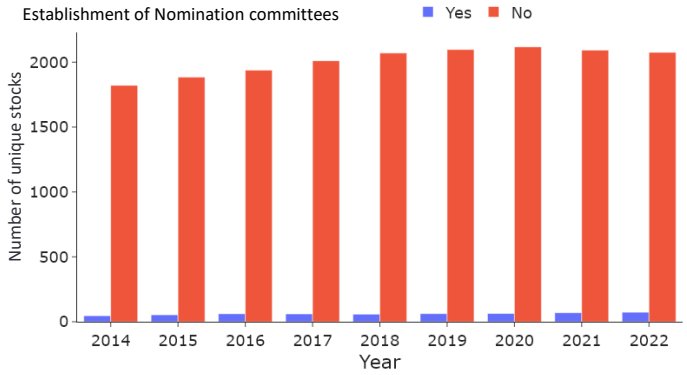
Appendix: Data Distribution Overview
- ESG indicators (4/6)

Category	ESG Indicator
E	GHG Emission Intensity (Scope 1&2)
	Log of GHG Emissions (Scope 1&2)
S	Ratio of Female Directors
	Ratio of Female Managers
	Ratio of Women in the Workforce
	Ratio of Women among New Hires
	Difference in Average Years of Employment Between Men and Women
G	Existence of Stock Option System
	Presence of Controlling Shareholders (more than one-third of the shares)
	Cross-shareholding Ratio
	Minimum Approval Rate for Director Appointments
	Performance-based Remuneration System
	Establishment of Nomination committees
	Existence of Integrated Report
	Total Return Ratio
	Ratio of Independent Outside Directors
	Adoption of Anti-Takeover Measures
Score	FTSE E Score
	FTSE S Score
	FTSE G Score
	FTSE ESG Overall Score



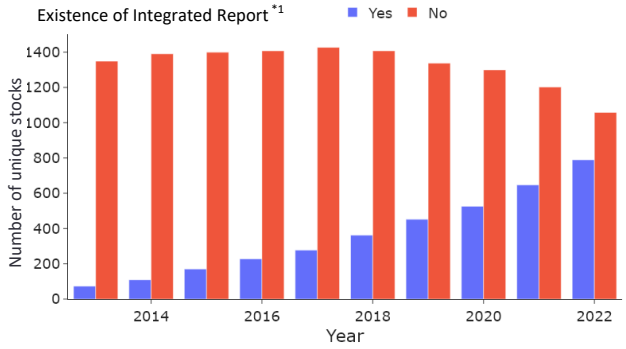


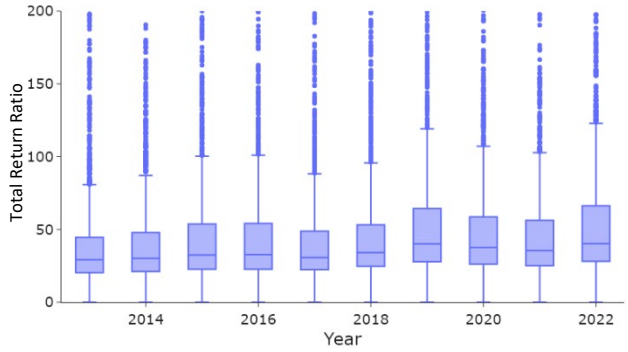


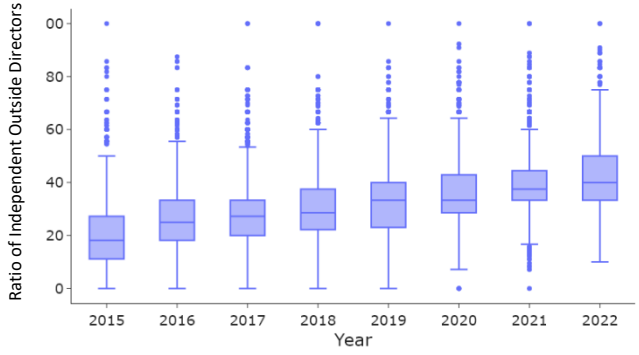


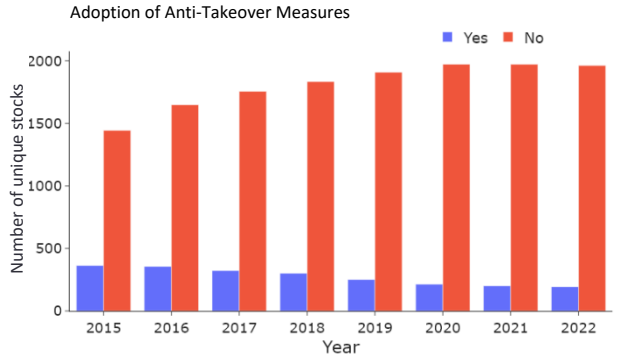
Appendix: Data Distribution Overview
- ESG indicators (5/6)

Category	ESG Indicator
E	GHG Emission Intensity (Scope 1&2)
	Log of GHG Emissions (Scope 1&2)
S	Ratio of Female Directors
	Ratio of Female Managers
	Ratio of Women in the Workforce
	Ratio of Women among New Hires
	Difference in Average Years of Employment Between Men and Women
G	Existence of Stock Option System
	Presence of Controlling Shareholders (more than one-third of the shares)
	Cross-shareholding Ratio
	Minimum Approval Rate for Director Appointments
	Performance-based Remuneration System
	Establishment of Nomination committees
	Existence of Integrated Report *1
	Total Return Ratio
	Ratio of Independent Outside Directors
	Adoption of Anti-Takeover Measures
Score	FTSE E Score
	FTSE S Score
	FTSE G Score
	FTSE ESG Overall Score





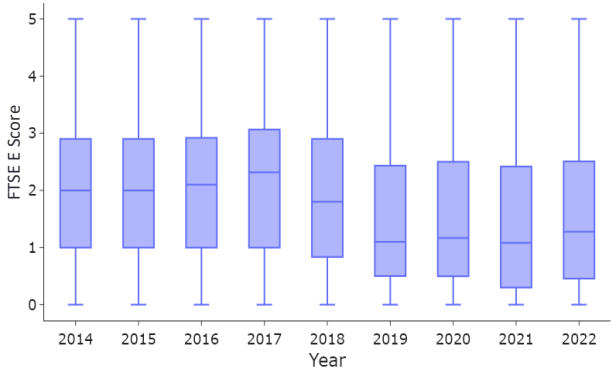


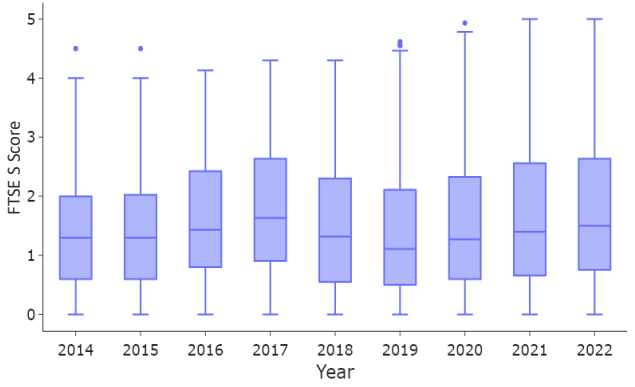


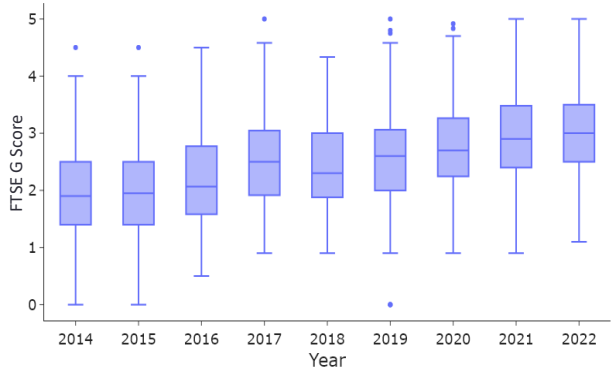
*1 If the Corporate Value Reporting Laboratory has not reported an integrated report, the data are supplemented with no (No) as the population of stocks for which Tobin's explanatory variables for Tobin's q and PBR are present in the 2022 report. According to the data source, 789 companies were reported to have prepared integrated reports in FY2022

Appendix: Data Distribution Overview - ESG indicators (6/6)

Category	ESG Indicator
E	GHG Emission Intensity (Scope 1&2)
	Log of GHG Emissions (Scope 1&2)
S	Ratio of Female Directors
	Ratio of Female Managers
	Ratio of Women in the Workforce
	Ratio of Women among New Hires
	Difference in Average Years of Employment Between Men and Women
G	Existence of Stock Option System
	Presence of Controlling Shareholders (more than one-third of the shares)
	Cross-shareholding Ratio
	Minimum Approval Rate for Director Appointments
	Performance-based Remuneration System
	Establishment of Nomination committees
	Existence of Integrated Report
	Total Return Ratio
	Ratio of Independent Outside Directors
	Adoption of Anti-Takeover Measures
Score	FTSE E Score
	FTSE S Score
	FTSE G Score
	FTSE ESG Overall Score







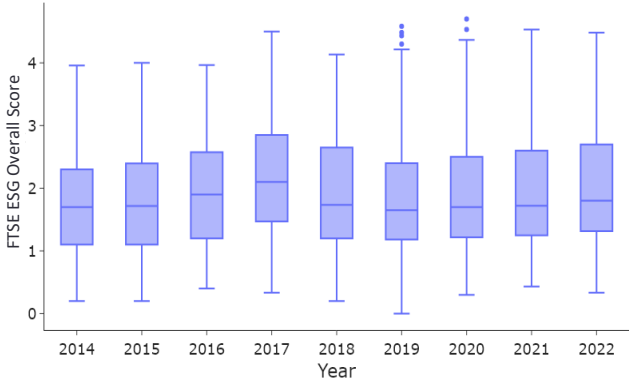
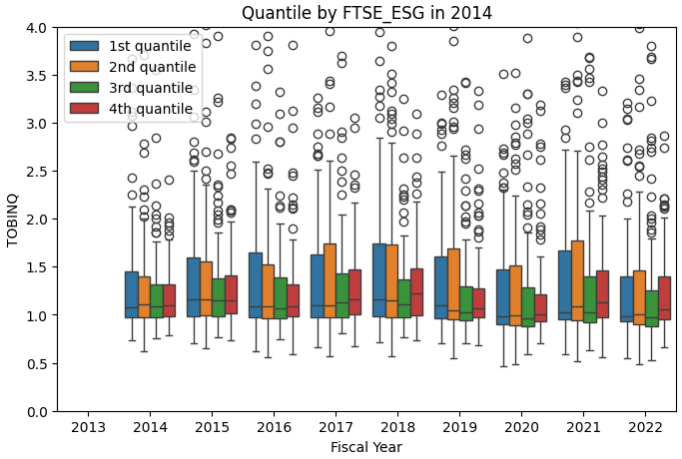


Table of contents

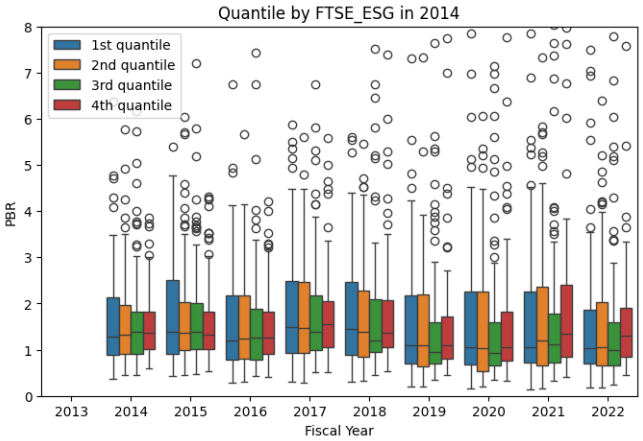
Appendix: Time-series analysis of corporate value indicators for companies grouped by ESG score (1/2)

- The results are presented as a reference, classifying corporate value indicators (Tobin's q, PBR, ROE, logarithmic market capitalization) divided by quartiles of the comprehensive ESG score of FTSE for the fiscal year 2014, and tracking the distribution changes of the corresponding stocks up to the fiscal year 2022.
  - It was found that ESG scores are heavily influenced by market capitalization
  - For the trends of Tobin's q, PBR, or ROE, no clear difference based on ESG scores can be observed over time.

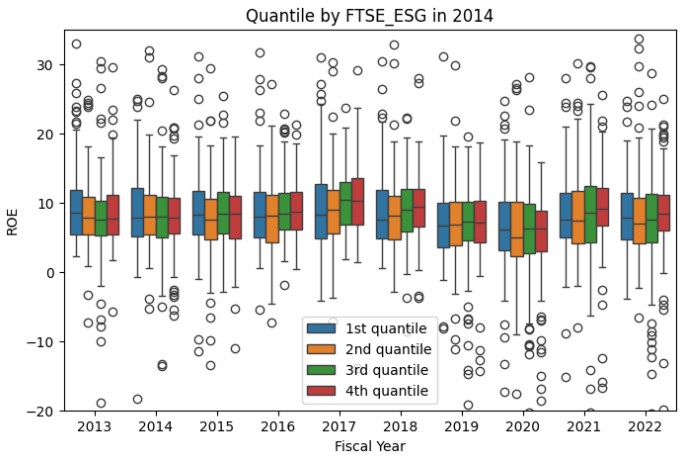
Tobin's q



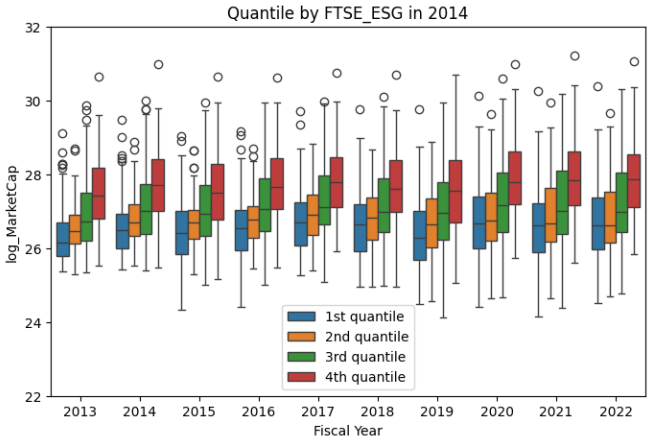
PBR



ROE



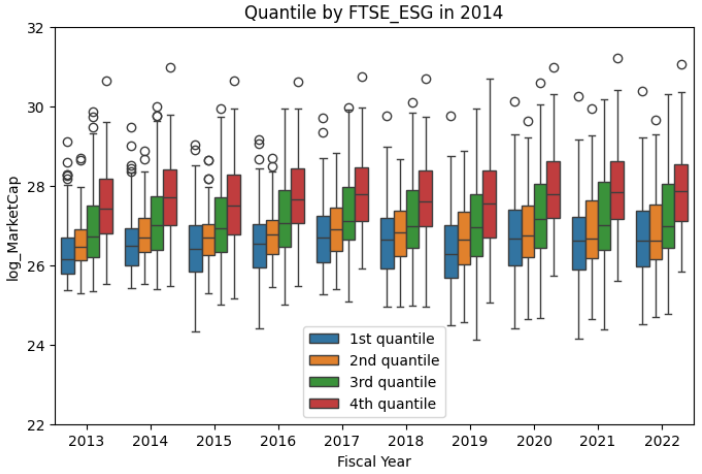
Market Cap



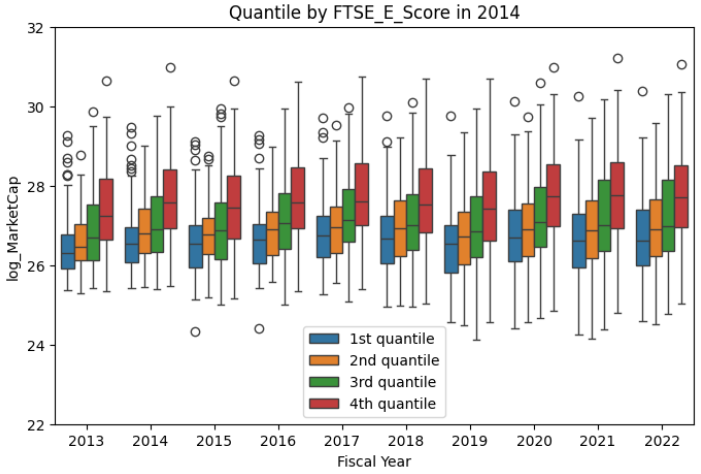
Appendix: Time-series analysis of corporate value indicators for companies grouped by ESG score (2/2)

- The results of further tracking **the distribution transition of logarithmic market capitalization** for stocks corresponding to each group divided by the quartile of the E/S/G scores of FTSE for the fiscal year 2014 up to the fiscal year 2022 are as follows
  - For each of the E/S/G scores, the group with higher scores tends to have a larger market capitalization as in the previous page.
  - Throughout the analysis period, S score shows a shift in the ranking of market capitalization between the first and second groups

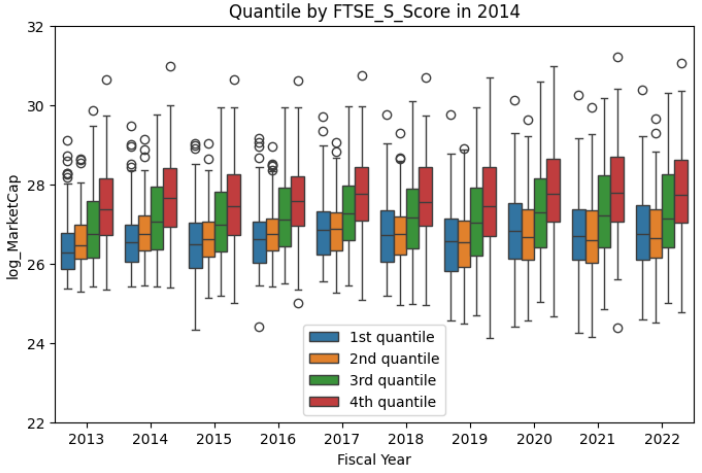
Market Cap quartiled by ESG Overall Score



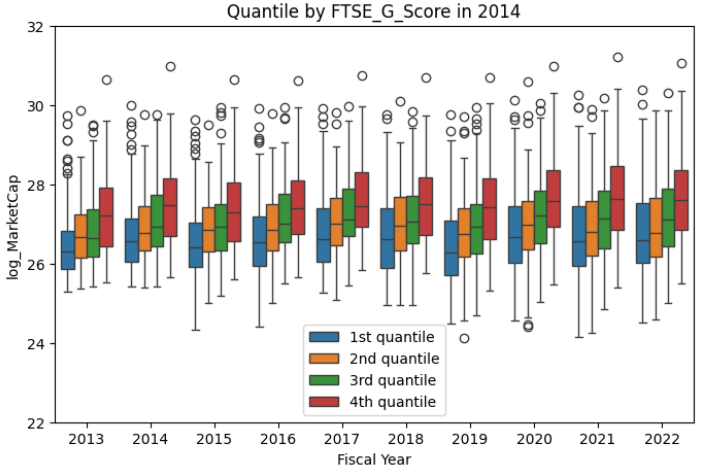
Market Cap quartiled by E-Score



Market Cap quartiled by S-Score



Market Cap quartiled by G-score




GPIF