Erasmus University Rotterdam

Erasmus School of Economics

International Bachelor Economics and Business Economics

The Effect of CEO Attributes on Sustainable Performance; US Firm in 2000-2019

Mike van Haagen (616904)

Supervisor:	C.W.A. van der Kraats
Second Assessor:	E.F. de Weerd
Date:	08-07-2024

ABSTRACT

This thesis examines the impact of CEO characteristics (age, gender, tenure, and compensation) on the sustainable performance of publicly listed US firms from 2000 to 2019, creating a sample from the MSCI ESG scores and the Compustat Execucomp dataset. Initial findings suggest positive correlations between older age and female gender of CEOs with higher ESG scores. However, these correlations weaken in fixed-effects models, indicating that firm-specific factors might play a significant role. Contrasting relationships are observed between short-term and long-term compensation. While short-term compensation is negatively associated with sustainability in fixed-effects models, long-term compensation shows a positive effect only after a lag of five years. The study also finds that longer CEO tenure initially correlates with lower ESG scores, but this relationship diminishes when controlling for firm-specific factors, with positive effects emerging after extended periods. These results underscore the necessity of considering firm-specific contexts and employing comprehensive models to understand the influence of CEO characteristics on sustainable performance accurately. The findings offer valuable insights for policymakers and corporate governance, emphasizing the complexity of attributing sustainability outcomes to leadership attributes without accounting for broader organizational environments.

I. INTRODUCTION

Driven by increasing environmental challenges and societal expectations, sustainability has emerged as a crucial consideration for businesses worldwide. It encompasses a broad range of practices aimed at promoting the responsible management of resources to ensure environmental, social, and economic health and resilience. Naturally, the integration of sustainability into the core strategies of firms has escalated, not only due to increasing regulatory pressures but also because of a growing recognition of its long-term economic and social benefits (Dyllick, 2001). In 1984 Hambrick and Mason proposed the Upper Echelons Theory (UET) stating that the characteristics and values of top executives significantly influence organizational outcomes. Essentially, the experiences, values, and personalities of executives influence their interpretations and actions, which in turn shape the strategic direction and performance of the organization (Hambrick & Mason, 1984). The existing literature presents vast amount of evidence supporting UET, specifically for firms' financial performance (e.g. Belenzon et al., 2019; Bertrand et al., 2003; Ghardallou et al., 2020). Over time this body of research has led to more informed and structured CEO selection practices, incorporating these attributes into their decisions. Additionally, UET emphasizes the role of top management team heterogeneity in enhancing decision-making quality and innovation. Organizations have adopted practices to ensure a more varied mix of backgrounds and perspectives among their top leaders, fostering environments where different viewpoints are valued and considered. The impact of UET on sustainable performance outcomes has not been extensively researched. However, given the significant relationship found with financial performance and the uprising importance of sustainability in general, this relationship should be further explored as significant results could further impact the CEO selection process and policies on the diversity of board compositions. For instance, if female CEOs generally obtain a better sustainable performance, firms focused on increasing their sustainable performance should consider CEO gender during the CEO selection process. This study therefore seeks to understand the relation between different CEO characteristics and firms' sustainable performance.

In the existing literature, researchers have examined specific CEO attributes in isolation, often without considering how these characteristics' effects might change when accounting for multiple traits simultaneously. For example, Manner (2010) discovered that attributes such as being female, having higher long-term compensation, or possessing an educational background in humanities are positively associated with sustainable performance. Additionally, he found a negative association for short-term CEO compensation and an educational background in economics. Another study by Won-Yong Oh et al. (2014) focused on CEO age and its impact on firms' sustainable performance, hypothesizing that a shorter career horizon would reduce incentives for sustainable practices, thereby leading to lower sustainability scores. In these studies Manner (2010) does not account for age, and Won-Yong Oh et al. (2014) does not account for compensation. This introduces the risk of omitted variable bias (OVB), potentially compromising the validity of the results. Moreover, many studies in the existing literature

have not controlled for variations in firm-specific factors, such as industry, region and competition. This again leads to potential OVB. For instance, California's introduction of the "world's first plan to achieve net zero carbon pollution" (California Governor, 2022) could force local companies to become more sustainability-focused. If by coincidence California has more female CEOs, the observed increase in sustainable performance could mistakenly be attributed to female leadership, rather than to the policy changes in California. These incorrect conclusions could lead to ineffective policy changes for the CEO selection process and board composition diversity. This paper aims to enhance the validity of the results by presenting a more robust model that controls for these variations.

II. RESEARCH QUESTION AND HYPOTHESES

In this study the following research question is proposed: *Do CEO characteristics have a significant effect on firm sustainable performance?* To answer this question, four hypotheses have been constructed. All hypotheses are repeated in Table 1 at the end of this section.

CEO Age

CEO age has a significant impact on investments, sales growth, profitability and survival rate (Belenzon et al., 2019). This raises the question of whether CEO age might affect sustainable performance of the firm. Therefore, the main hypothesis is proposed:

Hypothesis 1*: CEO age significantly affects sustainable firm performance.*

Corporate social responsibility (CSR) is recognized as a long-term investment that demands sustained attention and commitment of corporate managers to their investment decisions (Mahapatra, 1984; Orlitzky et al., 2003; Won-Yong Oh et al., 2014). This suggests that the horizon or age of the CEO likely influences CSR initiatives. As a CEO's time horizon decreases with age, a negative relationship between CEO age and sustainable performance is expected. In addition to examining this linear relationship, a quadratic relationship between age and sustainable performance will also be investigated. This approach considers the potential trade-off between the negative effects of a decreasing time horizon (Won-Yong Oh et al., 2014) and the positive effects associated with an increase in pro-environmental behaviour that often accompanies aging. As individuals age, they often develop a greater focus on helping others and contributing to the greater good. For older adults, engaging in environmentally friendly behaviours can help them achieve these objectives (Wang et al., 2021). It is expected that the estimates will reveal this trade-off through by showing significant effects in opposite directions. To specifically test these expectations, two sub-hypotheses have been formulated:

Hypothesis 1a: *CEO age negatively affects firm sustainable performance*

Hypothesis 1b: *A non-monotonic relationship exists between CEO age and firm sustainable performance*

CEO Compensation

CEO compensation is an important factor in evaluating a firm's sustainable efforts. Higher CEO compensation might indicate a poor commitment to sustainability, as it could suggest that firms prioritize executive pay over investing in sustainable initiatives (McGuire et al., 2003). Sustainable performance is often linked to long-term firm performance (Ameer & Othman, 2011). Long-term compensation plans, such as stock holdings and options, which tend to increase with overall performance, are expected to incentivize CEOs to engage in more sustainable practices. This expectation is, however, opposed by McGuire et al. (2003), who found a negative relationship between long-term compensation and sustainable performance. To address this inconsistency, the hypothesis (H2) that *CEO compensation affects sustainable firm performance* will be reevaluated to determine if a more comprehensive model yields the same conclusion. Given that sustainable performance is recognized as critical for ensuring long-term economic and social benefits (Dyllick, 2001), long-term compensation should theoretically incentivize sustainable performance, leading to a positive relationship. To investigate the distinct impacts of short-term and long-term compensation on sustainable performance, the following subset of hypotheses has been formulated:

Hypothesis 2a*: Short-term compensation significantly decreases sustainable performance.*

Hypothesis 2b*. Long-term compensation significantly increases sustainable performance.*

CEO Tenure

The effect of CEO tenure on sustainable firm performance has not been extensively researched in the existing literature. However, Khan et al. (2020) found an adverse relationship between CEO tenure and sustainability for publicly listed firms in China, suggesting that longer tenures might correlate with lower sustainability performance. Given these findings, a similar relationship is expected for other contexts. In the existing literature, the relationship between CEO tenure and firm performance is often described as being inversely U-shaped. This is often explained by new CEOs starting at the bottom of the learning curve, leading to improved performance over time, followed by a decline in performance as longer-tenured CEOs may become overly committed to the status quo and less adaptive to change (Hambrick & Fukutomi, 1991; Miller & Shamsie, 2001). This raises the question of whether a similar relationship exists between CEO tenure and sustainability performance. To investigate this, the following hypotheses have been constructed:

Hypothesis 3a*: CEO tenure significantly affects sustainable performance &*

Hypothesis 3b*: The relationship between CEO tenure and sustainable performance is inversely U-shaped.*

CEO Gender

Manner (2010) found that female CEOs positively impact sustainable performance, a finding supported by Shoham et al. (2017), who reported that firms become more proactive in environmental sustainability when a woman is appointed to the board of directors. Furthermore, Hirsch (2010) identified that personality traits such as agreeableness and openness are positively correlated with increased sustainable concerns. These traits are statistically more prevalent in females (Costa et al., 2001), potentially leading to differences in managerial styles that favour sustainability. Davidson et al. (1996) also found that women tend to express higher levels of environmental concern than men. Given these findings, it is reasonable to expect a positive correlation between female leadership and sustainable performance. This study aims to reevaluate this expectation using a more robust model by testing the following hypothesis:

Hypothesis 4*. Female CEOs significantly improve sustainable firm performance.*

Table 1. Overview of all hypotheses.

Reference	Hypothesis
H1.	*CEO age significantly effects sustainable firm performance*
H1a.	*CEO age negatively affects firm sustainable performance*
H1b.	*A non-monotonic relationship exists between CEO age and firm sustainable performance*
H2.	*Compensation significantly affects sustainable performance*
H2a.	*Short-term compensation significantly decreases sustainable performance*
H2b.	*Long-term compensation significantly increases sustainable performance*
H3a.	*CEO tenure significantly affects sustainable performance*
H3b.	*The relationship between CEO tenure and sustainable performance is inversely U-shaped*
H4.	*Female CEOs significantly improve sustainable firm performance*

III. DATA AND METHODOLOGY

Sample

The sample consists of publicly listed companies in the United States that are listed in both the WRDS Compustat Execucomp dataset and the MSCI ESG KLD STATS dataset for the period 2000-2019. The WRDS Compustat Execucomp dataset is constructed by Standard & Poor's (S&P) Global, a company that specializes in integrating data into a variety of tools to help track and understand a vast amount of companies. The Execucomp dataset provides annual data on CEO age, tenure, gender and detailed information on different forms of CEO compensation for firms that are, or have been listed in the S&P 1500 Index. The S&P 1500 Index consists of companies in 3 different market capitalization size segments (S&P 500, S&P MidCap 400, S&P SmallCap 600). This dataset covers in total 2615 firms, which is approximately 90% of the investible US stock market (S&P Dow Jones Indices, 2019). The Execucomp dataset collects its data primarily from SEC filings, such as annual proxy statements and is supplemented with data from company annual reports and direct disclosures from companies, such as press releases and statements on corporate websites. Execucomp is widely utilized in academic research to analyse executive pay and its determinants, and to study the relationship between CEO characteristics and various corporate outcomes (e.g., Core & Guay, 1999; Murphy, 1999). The data is recognized for its thoroughness and accuracy, making it a reliable source for examining executive compensation patterns.

The variables that are of interest in this dataset are age, gender, the date the CEO assumed office, total compensation and total current compensation. The age reported in the dataset is the age of the CEO in each respective year. Gender indicates the sex of the CEO and was transformed into a binary variable, indicating whether the CEO is a female. Female was chosen for the binary variable instead of male as the large majority of CEOs in the dataset is male. From the date the CEO assumed office the year and month were isolated and used to calculate the CEO's tenure in full years. When calculating the tenure for a specific year, it was assumed that that year had already passed. For instance, if someone became CEO in May of 2016, his tenure for 2019 would be 3 years. Finally, from the data set total current compensation is adopted as short-term compensation (COMPST), and describes all cash remunerations, this specifically includes salary, bonus and other cash compensation. In order to obtain long-term compensation (COMPLT) we took the difference between the total compensation and current compensation. Long-term compensation therefore only includes long-term remunerations such as stocks and options. Both COMPLT and COMPST are reported in millions USD.

The MSCI ESG KLD STATS dataset originates from the work of KLD Research & Analytics Inc., which was later acquired by MSCI. MSCI is a leading provider of critical decision support tools and services for the investment community. The dataset consists of environmental, social and governance (ESG) performance indicators and includes companies that are included in certain indexes.

For the US, the dataset covers companies based on the MSCI USA Investible Market Index. This index covers 99% percent of investible US stock market, consisting of a total of 3115 US companies (MSCI, 2019). The dataset contains a total of 159 positive or negative ESG performance indicators spread over 4 categories, namely environment, social, corporate government and other controversial business involvement (OCBI). Environmental indicators include pollution and waste management, carbon footprint and supply chain management. Social indicators are divided over the categories: community, human rights, employee relations, diversity and product characteristics. Examples of governance performance indicators are indicators based on corruption, controversial investments and fraud. KLD Research & Analytics created the dataset by standardizing performance indicators to match specific criteria and rating companies based on information from company reports, government agencies and news sources. The datasets are merged based on company ticker symbols, often a combination of 4 letters or numbers that are unique to that company. The ESG performance indicators provided by the ESG KLD STATS dataset take value 1 if a company meets the assessment criteria for an indicator, 0 when the criteria are not met and a missing value when the indicator was deemed not relevant for a company, given its industry or product, and was therefore not researched. This should be considered when comparing companies. When assessing for the indicator regarding carbon footprint KLD Research explains that "scores are based on companies' reliance on carbon intensive products; and efforts to measure and reduce the carbon footprint of their supply chains. Management metrics include efforts to reduce exposure through measurement and reduction of carbon emissions associated with raw materials production, product manufacturing, distribution, and retail." (MSCI, 2019). The dataset consists of positive and negative indicators, often interpreted as indicating strong or weak sustainable performance (e.g. Mahoney & Thorne, 2005; McGuire et al., 2003). Strong performance indicators are designed to capture management best practices regarding ESG risks and opportunities. These indicators are rated on management strategy and governance, company initiatives and performance. In contrast, weak performance indicators aim to provide consistent assessments of ESG controversies. For weak performance indicators, KLD investigates and assesses controversies related to the impact of company operations, products, and services that allegedly violate national or international laws, regulations, and commonly accepted global norms.

To create the final dependent variable, the indicators of weak sustainable performance are transformed to obtain a value of -1 if the assessment criteria are met. This enables the final dependent variable to a score based on the sum of all indicators for each company. A negative score therefore signifies that the assessment has identified more negative indicators than positive ones. This construction of the dependent variable allows for two companies with both an aggregate score of 0 to highly differ in the amount of total indicators that met the criteria, company 1 could have a total of 0 positive and negative indicators whilst company 2 could have 10 positive and 10 negative sustainable performance indicators. This score however enables the comparison between different firms. This

difference in companies with the same score can further be ignored when exclusively looking at the change in score over time. The construction of this score has been used in numerous academic studies that utilize KLD ratings as a proxy for ESG score (e.g. Waddock & Graves, 1997; Hillman & Keim, 2001; Graves & Waddock, 1994).

By merging the datasets 30,442 observations are dropped, an initial assumption would be that this loss in observations is the effect of the Execucomp dataset covering less of the investible stock market than the ESG KLD STATS dataset. However, when looking at the dropped observations, only 68% of the dropped observations originated from the Execucomp dataset, meaning that the list of companies in this dataset is not a perfect subset of the companies in the sample of the ESG indicators. The base sample further used in this research does therefore not perfectly match either sample of the datasets. The potential effect on external validity will be further discussed in the discussion section. Two different adaptations of this sample are used. The first sample consists of all companies listed in both datasets, this sample consist of 17,633 observations for 1493 companies in 48 different states and 159 different industries. The second sample consists of exclusively companies who had a change in CEO, this sample consists of 12,862 observations for 903 companies in 47 states and 152 different industries. By only looking at the companies who had a change in CEO, and controlling for firm fixed-effects, we try to control for all time-invariant biases such as industry, location or local regulations. For instance, if a state has high corporate taxes that remain constant over time, budget for sustainable initiatives could be significantly lower for companies in that state, resulting in poorer sustainable performance. Without controlling for this bias, we might incorrectly attribute differences in sustainable performance to CEO characteristics rather than firm-specific differences. Additionally, to enhance the internal validity of the results, outliers based on compensation have been removed. For example, in sample 1 Elon Musk, CEO of Tesla, received 1.34 billion USD in 2016, which is 483.58 times the median annual long-term compensation of 2.771 million USD. This outlier could significantly impact the outcome of the analyses and should therefore be removed. These selection criteria try to enhance the internal validity of the results.

Table 2 shows that the mean age of CEOs is relatively consistent. This indicates a stable age and distribution across the samples, suggesting that the restrictions imposed on sample 2 do not significantly impact this variables. For both compensation variables small deviations in the means are shown, however the standard deviation for both variables decreases significantly. For short-term compensation the standard deviation decreases from 2.1 million USD to 1.4 million USD, for long-term compensation it decreases from 17 million USD to 11 million USD. This could be explained by the removal of outliers, which generally decreases the variability of the values for these variables, leading to smaller standard deviations. Tenure shows the most notable differences across the samples, sample 1 has a longer mean tenure at 7.8 years while sample 2 has an average tenure of 6.4 years. These differences are likely inherent to the selection criteria. Sample 2 only consists of companies who had a

change in CEO and therefore consists of relatively more new CEOs, lowering the mean tenure. Finally, the proportion of females also increases from 3.6% to 4.0% in the second sample. This could also be a side effect of the selection criteria, specifically by focussing on newer CEOs. As nations try enhance gender equality in the workforce, it makes sense that an increasing proportion of new CEOs is female, leading to an increase in the proportion of females in sample 2. The effect of this selection bias needs to be considered when interpreting the data. Table 2 furthermore shows a higher mean ESG score for firms in sample 2 which is primarily caused by differences in environmental and social indicators. This could be caused by the dropped industries on average decreasing the mean score for sample 1. However when test this the dropped industries on average only have a mean ESG score of -0.238, and only 84 total observations for these industries are present in sample 1. The combination of these arguments imply that the variation in mean ESG score is the result of another factor. It could be argued that companies that replace their CEO are inherently more forward-looking and therefore focussed on sustainability.

To better understand the relations between variables, Table 3 presents the correlation matrix for the relevant variables from sample 2. Additional figures were created to visualise the relationship between CEO attributes and ESG score. The primary variable of interest, the total ESG score, shows notable correlations with several CEO attributes and compensation measures. The total ESG score is highly correlated with the social score (0.902) and the environmental score (0.627), indicating that these components significantly contribute to the overall ESG performance. The governance score and OCBI show weaker correlations with the total ESG score at 0.375 and 0.128, respectively. CEO age shows a minimal correlation with the total ESG score (0.015), suggesting age has no significant relation with sustainable performance. Age however shows a relatively high correlation with tenure (0.463). This high correlation brings up multicollinearity concerns, however test return a VIF (Variance Inflator Factor) of 1.29 and 1.30 for age and tenure, respectively, showing only moderate correlation and implies absence of multicollinearity. Figure 1 supports H1a and H1b with a slight inverse U-shaped relationship, indicating middle-aged CEOs are associated with higher ESG scores. Short-term compensation has a small positive correlation with the total ESG score (0.015) and a stronger negative correlation with the governance and OCBI indicators, implying that higher short-term compensation might be related to controversial management. Long-term compensation shows a higher positive correlation with the total ESG score (0.156) and specifically social scores (0.173). Figure 1 indicates both short-term and long-term compensations positively relate to ESG scores, with long-term incentives having a more pronounced effect, suggesting compensation structures can drive sustainability. CEO tenure has a weak negative correlation with the total ESG score (-0.061) and a weak correlation with most variables besides age. Figure 2 shows a weak inverse relationship between tenure and ESG score, suggesting newer CEOs might drive more sustainability initiatives, while long-tenured CEOs may maintain the

Table 2. Descriptive statistics for the different samples.

	Sample 1			Sample 2		
	Mean	Min	Max	Mean	Min	Max
CEO Attributes						
Age (years)	56.358	31	88	56.339	32	88
	(7.150)			(6.758)		
Short-term compensation	1.393	0	105.53	1.428	0	39.21
(million $)	(2.111)			(1.611)		
Long-term compensation	6.319	0	1340.10	6.091	0	204.93
(million $)	(17.331)			(10.778)		
Tenure (years)	7.844	0	56	6.372	0	48
	(7.342)			(6.270)		
Female (proportion)	0.036			0.040		
ESG Scores						
Total	0.362	-12	19	0.423	-12	19
	(2.662)			(2.855)		
Environment	0.213	-5	6	0.240	-5	6
	(0.893)			(0.967)		
Social	0.448	-10	14	0.532	-10	14
	(2.038)			(2.171)		
Governance	-0.156	-4	2	-0.183	-4	2
	(0.626)			(0.653)		
OCBI	-0.134	-3	0	-0.153	-3	0
	(0.416)			(0.435)		
Observations (#)	17,633			12,862		
Companies (#)	1493			903		
Industries (#)	159			152		
States (#)	48			47		
CEOs (#)	2970			2381		

Notes: Standard deviations are reported in brackets under the mean. The variable Female is a binary variable which obtains a value of 1 when the CEO is female; the value therefore reports the proportion of female CEOs in the sample. This table presents descriptive statistics for two samples, detailing the mean, minimum, and maximum values of various CEO attributes and ESG scores. The samples consist of publicly listed firms in the United States.

Table 3. Correlation table for relevant variables from sample 2.

	Total ESG score	Environment	Social	Governance	OCBI	Age	S.T. comp.	L.T. comp.	Tenure	Female
Total ESG score	1									
Environment	0.627	1								
Social	0.902	0.354	1							
Governance	0.375	0.127	0.131	1						
OCBI	0.128	-0.067	-0.006	0.003	1					
Age	0.015	0.010	0.015	0.031	-0.049	1				
Short-term compensation	0.015	0.011	0.102	-0.170	-0.140	0.097	1			
Long-term compensation	0.156	0.153	0.173	-0.057	-0.086	0.068	0.228	1		
Tenure	-0.061	-0.045	-0.072	0.018	0.029	0.463	0.033	0.088	1	
Female	0.104	0.063	0.104	0.026	-0.009	-0.039	-0.019	0.014	-0.064	1

*Notes: This table presents correlation coefficients among CEO attributes and ESG performance indicators. Statistical significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The analysis uses data from publicly listed U.S. firms from 2000-2019.*

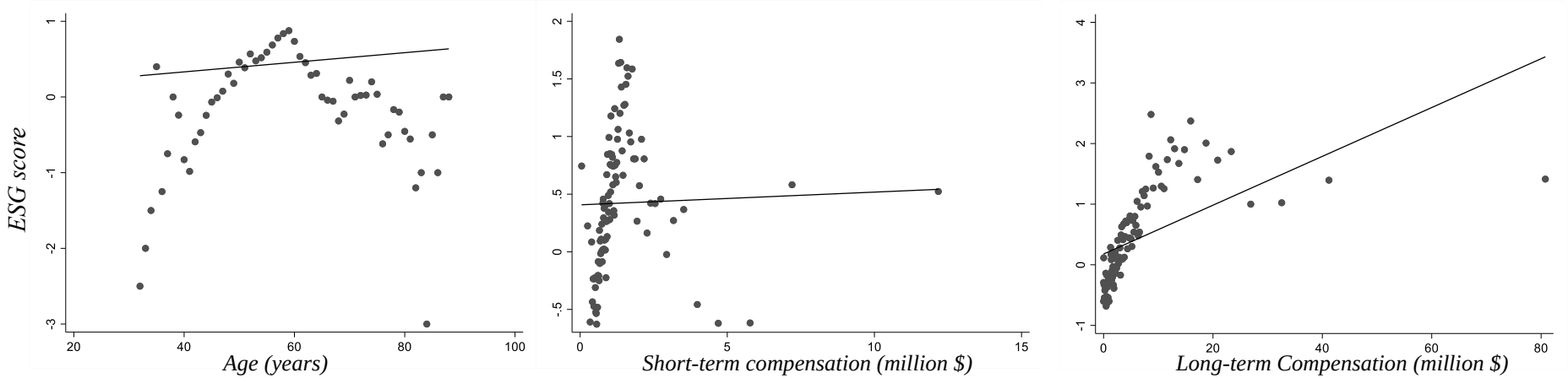

Figure 1. Bin scatter plots for total ESG score with age, short- and long-term compensation for sample 2.

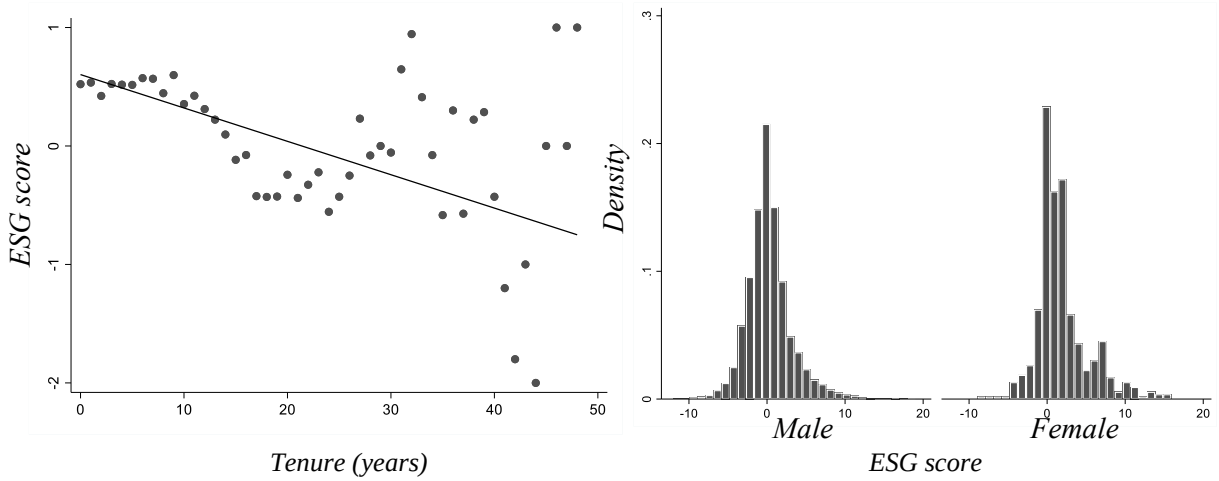

Figure 2. Bin scatter plot for total ESG score with tenure and histogram showing distribution of ESG score by gender for sample 2.

status quo. The presence of female CEOs is positively correlated with the total ESG score (0.104) and social scores (0.104). Figure 2 supports this by showing a slight positive shift in the ESG score distribution for firms with female CEOs.

Statistical estimations & control variables.

To minimize OVB from firm characteristics fixed-effects regression are applied to control for all time-invariant firm characteristics. This means that control variables such as firm industry, geographic location or initial ownership structure need not to be put in the model. The model furthermore includes dummy variables for each year to account for nation-level changes, such as changes in regulation or public sentiment towards sustainability. First a standard Ordinary Least Squares (OLS) regression will be applied to both sample 1 and 2 to identify initial differences between samples, these models will include industry dummy variables which the coefficients will not be presented in the regression table. The 3rd to 9th model will apply firm fixed-effects to sample 2, and estimate the coefficient for each independent variable separately. When a quadratic relationship is tested for age and tenure, both the linear and quadratic variable are included. The 10th model will apply fixed-effects to estimate all linear relationships simultaneously. The 11th builds on this and also includes the quadratic variables. The general regression can be written down as follows:

$$ESG_{ij} = a + \beta_1 Age_{ij} + \beta_2 Age_{ij}^2 + \beta_3 STcomp_{ij} + \beta_4 LTcomp_{ij} + \beta_5 Fema_{ij} + \beta_6 Tenu_{ij} + \beta_7 Tenu_{ij}^2 + \delta_i Firm_i + \theta_j Year_j + \varepsilon_{ij}$$

In which ESG_{ij} describes the sustainable performance, as measured by the MSCI ESG scores, for firm i in period j. Additionally, a is the constant, the independent variables are abbreviated to 4 letters, the betas are the estimated coefficients of each respective variable, $\delta_i Firm_i$ describes the fixed effect of firm i, $\theta_j Year_j$ describes effect of the year dummy in year j and ε is the error term.

The effects of a CEO change could however be limited in the short-term due to organisational inertia, which could be caused by the immobility of resources or status quo bias. This is supported by Bernard et al. (2018) who found that for French firms a change in CEO had significant positive effect on sustainable performance only after 5 years. Possible lagged effects of CEO attributes on sustainable performance will therefore be analysed also be analysed. The analysis will include models incorporating lags ranging from 1 year to 5 years, which will be compared to identify potential differences. This analysis will be carried out by creating a lead variable for the ESG score for all lag sizes. The lead variable for a lag of 1 year will obtain the ESG score of the next year, enabling the regression of current CEO characteristics on future ESG scores. The analysis on lagged effects will not individually estimate the coefficient of each variable. If lagged effects are significant for sustainable performance, we expect to see an increase in both the size and significance of the coefficients as the lag size increases. To know whether robust standard errors need to be used in calculating the estimates the sample is tested for heteroskedasticity by performing a Breusch-Pagan test. This test was selected instead of the Goldfeld-Quandt test due to the short time-period of the data, which could threaten reliability. The Breusch-Pagan shows evidence for heteroskedasticity in both samples at a 0.01 significance level. Consequently, robust standard errors are used in the calculation of all estimates. Statistical significance was determined at threshold $P < 0.05$.

To ensure the robustness of the findings, additional tests are conducted by examining the relationships between CEO characteristics and different dimensions of ESG performance separately. This approach allows for a greater understanding of how CEO variables influence specific aspects of environmental, social, and governance performance individually, rather than aggregating them into a single ESG score. The environmental score includes indicators related to pollution and waste management, carbon footprint, and supply chain management. The social score includes aspects related to community engagement, human rights, employee relations, diversity, and product characteristics. Governance scores include indicators on corruption, controversial investments, and fraud. Finally, indicators on OCBI include special cases in which companies e.g. take part in the gambling, tobacco or firearms industry. This analysis helps in isolating the effects of CEO attributes on each ESG dimension, thereby providing a more nuanced understanding of these relationships.

IV. RESULTS

This section outlines the statistical outcomes of the regression models, highlighting the relationships between CEO characteristics, such as age, gender, tenure, and compensation, and firm sustainability as measured by MSCI (KLD) ESG scores. The initial results from standard OLS regressions are compared to those from fixed-effects models and fixed-effects lagged models in Tables 4 and 5 respectively. Finally, Table 6 presents the results from the robustness checks where the different

Table 4. Regression results

	1	2	3	4	5	6	7	8	9	10	11
Age	0.281***	0.297***	0.003	-0.046						0.004	-0.037
	(0.023)	(0.032)	(0.005)	(0.056)						(0.007)	(0.054)
Age^2	-0.002***	-0.002***		0.000							0.000
	(0.000)	(0.000)		(0.000)							(0.000)
ST Comp	0.050***	0.063***			-0.077***					-0.075***	-0.075***
	(0.016)	(0.019)			(0.021)					(0.022)	(0.022)
LT Comp	0.011**	0.026***				-0.001				0.000	0.000
	(0.004)	(0.003)				(0.003)				(0.003)	(0.003)
Tenure	-0.058***	-0.045***					0.000	-0.010		0.000	-0.008
	(0.006)	(0.008)					(0.005)	(0.010)		(0.007)	(0.012)
Tenure^2	0.001***	0.001***						0.000			0.000
	0.000	(0.000)						(0.000)			(0.000)
Female	1.120***	1.074***							0.272	0.256	0.253
	(0.108)	(0.123)							(0.281)	(0.280)	(0.279)
R^2	0.264	0.288	0.105	0.103	0.101	0.104	0.105	0.104	0.107	0.102	0.101
N	17.633	12.862	12.862	12.862	12.862	12.862	12.862	12.862	12.862	12.862	12.862

1	*Standard OLS regression for sample 1*
2	*Standard OLS regression for sample 2*
3-9	*Fixed-effects regression separate for each variable or exponential relationship in sample 2*
10	*Fixed-effects regressions measured for each linear variable simultaneously in sample 2*
11	*Fixed-effects regressions measured for each variable simultaneously in sample 2*

*Notes: Standard errors are presented in parentheses. Statistical significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. This table presents the regression results examining the impact of various CEO attributes on ESG performance. Key variables include Age, Age^2, Short-term Compensation (ST Comp), Long-term Compensation (LT Comp), Tenure, Tenure^2, and Female. The analysis uses data from publicly listed U.S. firms for the period 2000-2019. Models 1 and 2 are standard OLS regressions for samples 1 and 2, respectively, and include industry dummies to control for industry fixed-effects. Models 3-9 are fixed-effects regressions for individual variables in sample 2. Models 10 and 11 are fixed-effects regressions for all linear and quadratic variables estimated simultaneously in sample 2. All models include dummy year variables.*

Table 5. Regression results, controlled for lagged effect

	1 year lag		*2 year lag*		*3 year lag*		*4 year lag*		*5 year lag*	
	Ex. Linear	*Complete*	*Ex. Linear*	*Complete*	*Ex. Linear*	*Complete*	*Ex. Linear*	*Complete*	*Ex. Linear*	*Complete*
Age	0.007	-0.024	0.011	-0.014	0.011	0.003	0.011	0.042	0.006	0.069
	(0.008)	(0.057)	(0.008)	(0.061)	(0.009)	(0.062)	(0.009)	(0.065)	(0.009)	(0.068)
Age^2		0.000		0.000		0.000		0.000		-0.001
		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)
ST Comp	-0.079***	-0.078***	-0.096***	-0.096***	-0.108***	-0.107***	-0.127***	-0.126***	-0.060**	-0.058**
	(0.024)	(0.024)	(0.024)	(0.024)	(0.026)	(0.026)	(0.030)	(0.030)	(0.027)	(0.027)
LT Comp	-0.002	-0.002	-0.002	-0.002	0.001	0.002	0.007*	0.007*	0.010**	0.011***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Tenure	-0.003	-0.012	-0.010	-0.020	-0.014	-0.029*	-0.016	-0.038**	-0.013	-0.051***
	(0.007)	(0.013)	(0.008)	(0.014)	(0.009)	(0.015)	(0.010)	(0.016)	(0.011)	(0.018)
Tenure^2		(0.000)		0.000		0.001		0.001		0.002**
		(0.000)		(0.000)		(0.001)		(0.001)		(0.001)
Female	-0.020	-0.023	-0.331	-0.335	-0.465*	-0.475*	-0.498*	-0.520*	-0.381	-0.427
	(0.283)	(0.282)	(0.272)	(0.271)	(0.275)	(0.274)	(0.287)	(0.287)	(0.293)	(0.294)
R^2	0.097	0.096	0.092	0.092	0.089	0.089	0.082	0.083	0.077	0.078
N	11653	11653	10738	10738	9865	9865	9010	9010	8179	8179

*Notes: Standard errors are presented in parentheses. Statistical significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. This table presents the regression results examining the impact of various CEO attributes on ESG performance. Key variables include Age, Age^2, Short-term Compensation (ST Comp), Long-term Compensation (LT Comp), Tenure, Tenure^2, and Female. The analysis uses data from publicly listed U.S. firms for the period 2000-2019. Each combination of 2 columns present the regression output for a fixed-effect regression controlled for lags ranging from 1 – 5 years. Columns named "Ex. Linear" present regression output for models who simultaneously estimated coefficients for exclusively linear variables. The other columns named "Complete" present regression output where all coefficients for all variables are estimated simultaneously. All models include dummy year variables.*

Table 6. Regression results, robustness checks

	Environment		*Social*		*Corporate Government*		*OCBI*	
	Ex. Linear	*Complete*	*Ex. Linear*	*Complete*	*Ex. Linear*	*Complete*	*Ex. Linear*	*Complete*
Age	-0.004	-0.025	0.005	0.011	0.001	-0.006	0.002	-0.017*
	(0.003)	(0.019)	(0.005)	(0.040)	(0.002)	(0.017)	(0.001)	(0.010)
Age^2		0.000		0.000		0.000		0.000*
		(0.000)		(0.000)		(0.000)		(0.000)
CompST	-0.040***	-0.041***	-0.011	-0.010	-0.028***	-0.028***	0.005*	0.005*
	(0.009)	(0.009)	(0.016)	(0.016)	(0.007)	(0.007)	(0.003)	(0.003)
CompLT	-0.001	-0.001	-0.001	-0.001	0.001*	0.001*	0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Tenure	0.007***	0.012***	-0.006	-0.017*	0.001	0.001	-0.001	-0.004**
	(0.002)	(0.004)	(0.005)	(0.009)	(0.002)	(0.003)	(0.001)	(0.002)
Tenure^2		0.000		0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)		(0.000)
Female	-0.005	-0.001	0.247	0.241	-0.041	-0.041	0.049	0.048
	(0.109)	(0.109)	(0.168)	(0.168)	(0.058)	(0.058)	(0.037)	(0.037)
R^2	0.080	0.079	0.068	0.069	0.163	0.162	0.003	0.003
N	12862	12862	12862	12862	12862	12862	12862	12862

*Notes: Standard errors are presented in parentheses. Statistical significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. This table presents the regression results examining the impact of various CEO attributes on different areas of ESG performance. Key variables include Age, Age^2, Short-term Compensation (ST Comp), Long-term Compensation (LT Comp), Tenure, Tenure^2, and Female. The analysis uses data from publicly listed U.S. firms for the period 2000-2019. All models include dummy year variables.*

CEO attributes are regressed against the more specific ESG areas, environment, social, governance and OCBI. These different models try to enhance the validity of the results.

The OLS estimates for sample 2 exhibit only minor deviations from those of sample 1. All variables remain significant, with most showing little change in magnitude or direction. The estimates for tenure and both compensation variables show slight differences. The negative association between tenure and ESG score decreases, while the association for both compensation variables strengthens in the second sample. This is likely due to the previously discussed selection bias, as the sample only includes companies that experienced a CEO change during the sample period.

Age

In the initial OLS regression models in Table 4, both samples exhibit a significant positive relationship between age and the ESG score with a small deviation in the exact estimate. The estimate from model 2 specifically indicates that an increase in age by one year corresponds to an increase in the ESG score by 0.297. The significant negative estimate for the quadratic age variable, however, suggests a non-monotonic relationship, indicating that age has an inverse U-shaped relationship with the ESG score. The estimate values imply an optimal age of 148 years before decreasing marginal returns appear. Given the implausibility of this age, the potential negative marginal effect is disregarded. Thus, models 1 and 2 suggest a positive effect of age on the ESG score with diminishing marginal returns.

In the models applying firm fixed effects, controlling for lagged effects and testing for ESG subcategories the estimates are found to be insignificant. This indicates that changes in CEO age within a firm do not significantly affect the predicted ESG score. Consequently, the significant effects observed in models 1 and 2 may be attributed to selection bias. An explanation of this selection bias could say that firms that are more sustainability-focused may be more mature and stable and therefore prefer older CEOs with more experience. In contrast, developing firms who are in the growth stage and therefore less concerned with ESG, could prefer younger CEOs that are able to drive rapid innovation and expansion. These younger CEOs might focus more on short-term financial performance and aggressive market strategies rather than long-term sustainability goals. This selection bias highlights the importance of considering the lifecycle stage and strategic priorities of firms when analysing the impact of CEO age on ESG performance. It suggests that the observed positive relationship in the initial models might reflect the strategic alignment of older, more experienced CEOs with more sustainability-focused firms, rather than a direct causal effect of age on ESG scores.

Short-Compensation

The analysis of short-term compensation revealed significant relationships with the sustainable performance of firms. The OLS regression models show that short-term compensation is positively associated with ESG scores. Specifically, the estimate from sample 2 indicates that a one million USD

increase in short-term compensation corresponds to an increase in the ESG score by 0.063. This positive association contradicts the initial hypothesis that short-term compensation would negatively impact sustainability due to its focus on immediate financial returns. However, when controlling for firm-specific factors using fixed-effects models, the relationship between short-term compensation and ESG scores changes direction, though it remains significant. The standard fixed-effects models for sample 2 show a significant negative relationship, with the estimate indicating that a one million USD increase in short-term compensation leads to a decrease in the ESG score by approximately 0.075. This suggests that the initial result that higher short-term compensation leads to better sustainability performance is not robust when accounting for firm-specific characteristics. In the fixed-effects models with lagged effects, the negative relationship remains significant across different lag periods. For instance, with a one-year lag, an increase in short-term compensation is associated with a decrease in the ESG score by approximately 0.079. An increase in the lag only increases the negative effect with a maximum ESG score decrease of 0.127 for a 4 year lag. These findings suggest that higher short-term compensation might incentivize behaviours that harm long-term sustainability, reflecting a misalignment between immediate financial incentives and sustainable practices. The robustness checks further support these findings, indicating that the negative relationship between short-term compensation and ESG score is specifically the result of its effect on governance and social performance. In terms of governance, this could be caused by a reduced focus on ethical practices, transparency, and accountability, potentially leading to increased risks of regulatory non-compliance or corporate scandals. For social performance, the negative impact suggests that firms might neglect employee relations, community engagement, and other social initiatives when short-term financial incentives are increased.

Overall, the consistent significance of short-term compensation across various models highlights an important role in influencing sustainable performance. While the initial OLS models suggested a positive impact, the fixed-effects models reveal an adverse effect. This change in the direction of the relationship can be explained by the possibility that firms with high short-term compensation packages might also have underlying characteristics that are not immediately evident in the OLS models. In these models, the positive relationship may reflect that firms with higher short-term compensation also have better overall resources or existing sustainable practices, thus masking the true impact of short-term incentives. When categorizing observations based on whether they fall above or below the median short-term compensation, the selection bias becomes more apparent.

Figure 3 shows a noticeable shift in the distribution of ESG scores between the lower and upper 50th percentiles of short-term compensation. The mean ESG score for the lower 50th percentile is 0.08, whereas the mean for the upper 50th percentile is 0.76. This figure, along with the difference in means, helps explain why the OLS models estimated a positive coefficient. The higher average ESG scores in the upper 50th percentile indicate that firms with higher short-term compensation also tend to have better sustainability practices. However, when controlling for firm-specific effects, the negative

relationship suggests that, within a given firm, increasing short-term compensation is associated with reduced emphasis on sustainability. This could indeed be because firms that heavily reward short-term performance might prioritize immediate financial gains over long-term sustainability. These findings show the importance of considering firm-specific contexts when designing compensation structures, further underlying the importance of ensuring that they align with sustainable business practices to achieve long-term ESG goals.

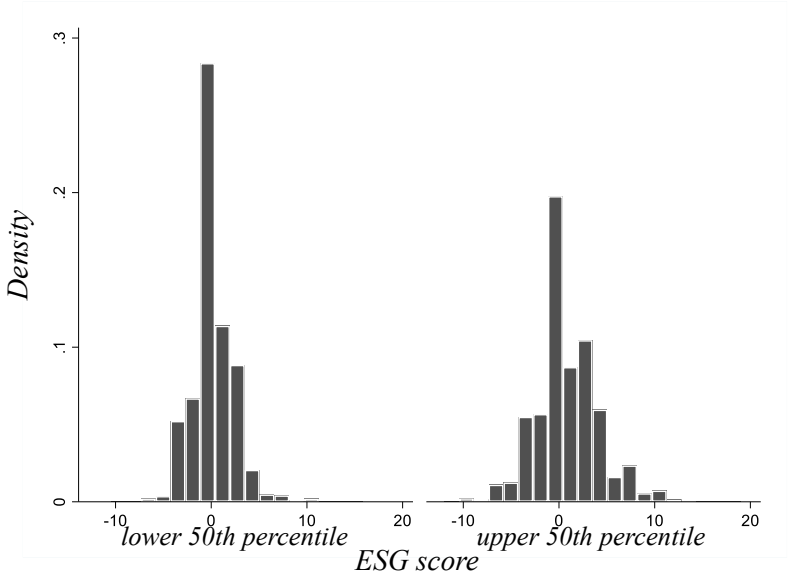

Figure 3. Distribution of ESG score for observations categorised by median short-term compensation
Long-term compensation

The analysis of long-term compensation revealed mixed results regarding its relationship with the sustainable performance of firms. The initial OLS regression models indicated a positive association between long-term compensation and ESG scores. Specifically, the estimate from model 2 shows that a one million USD increase in long-term compensation corresponds to an increase in the ESG score by 0.026. This positive relationship aligns with the hypothesis that long-term incentives encourage CEOs to prioritize sustainability, as these incentives are typically tied to the long-term financial health and strategic goals of the firm. However, this positive relationship did not persist in the standard fixed-effects models. When accounting for firm-specific factors, the relationship between long-term compensation and ESG scores became insignificant. This suggests that the initial positive correlation observed in the OLS models may be driven by unobserved firm-specific characteristics rather than a direct causal effect of long-term compensation on sustainability. These firm-specific factors could include existing corporate cultures, strategic commitments to sustainability, or industry-specific practices that overshadow the influence of long-term compensation on ESG outcomes.

While the relationship between long-term compensation and ESG scores remains generally insignificant across different lag periods, in the five-year lagged model the relationship becomes

significant and is slightly positive. This implies that a one million USD increase in long-term compensation is associated with a significant increase in the ESG score by approximately 0.011, after 5 years. This indicates that the impact of long-term compensation on sustainability may manifest over extended periods, reflecting the delayed nature of sustainability initiatives. The robustness checks further deny the positive association observed in the OLS models by showing insignificant estimates for relationships with all different ESG dimensions.

Overall, while the initial OLS models suggested a significant relationship between long-term compensation and ESG, this was generally not confirmed by subsequent fixed-effects models. A small significant positive effect was observed only when a 5-year lag was accounted for. The disparity in results between the OLS and fixed-effects models suggests that the initial significant positive effect was influenced by unobserved firm characteristics. This selection bias is further evidenced by Table 3 and Figure 1, which present the positive correlation in the raw data, illustrating how unobserved firm characteristics can obscure the true impact of long-term compensation on ESG scores.

Tenure

The OLS regression models show that CEO tenure is negatively associated with ESG scores. Specifically, the estimate from sample 2 indicates that an additional year in tenure corresponds to a decrease in the ESG score by approximately 0.045. This negative association suggests that longer-tenured CEOs might become too entrenched in the status quo, potentially leading to a reduced focus on forward-looking sustainability initiatives. Additionally, the significant positive estimate for the quadratic tenure variable supports the hypothesized inverse U-shaped relationship, indicating diminishing negative effects at higher levels of tenure. More specifically, the estimates suggest that tenure has a marginal negative impact until age 22.5, and that net effect turns positive from age 45 onwards. This effect does not hold when controlling for firm-specific factors using the fixed-effects models, as the relationship between CEO tenure and ESG scores becomes insignificant. This suggests that the initial negative relationship observed in the OLS models is not robust when accounting for firm-specific characteristics, highlighting that these associations may be influenced by between-firm differences rather than a direct causal effect of tenure on sustainability. For instance, firms that have recently had a change in CEO might inherently be more forward-looking and therefore sustainability focused. To investigate this, observations were categorized into two groups: those within 5 years before the CEO change and those within 5 years after the CEO change. Figure 4 displays the distribution of these two subsamples.

Figure 4 clearly shows a shift in the distribution of ESG scores for firms who have recently had a change in CEOs. This is further supported by the difference in means between these two groups, indicating an increase of 0.715 in the ESG score for the group with a recently introduced CEO. These findings suggest that firms that have recently had a change in CEO are different from those who have

not had this. This could explain the significant results from the OLS regressions, incorrectly attributing a negative effect to an increase in tenure.

In the fixed-effects models with lagged effects, a quadratic relationship between tenure and ESG scores only becomes significant when accounted for a lagged effect of 5 years. The linear estimate for tenure is also significant when accounting for a lag of 4 years, however, as their quadratic counterpart

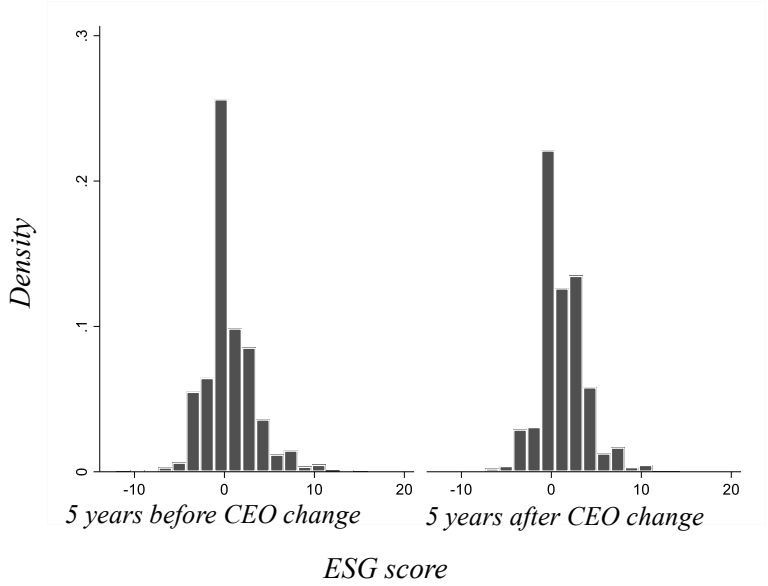

Figure 4. Distribution of ESG score for observations categorised by being 5 years before and after change in CEO

Notes: Figure 4 is based on a subset of sample 2, where the observations are limited to a maximum of 5 years before or after the year of a CEO change. This subsample includes 5,146 observations.

is not, we cannot interpret this quadratic relation. The estimates for the 5 year lag again suggest there are increasing negative marginal returns until a tenure of 12.5 years, after which the marginal returns increase and the effect becoming net positive for a tenure of 25 years and beyond. This lagged effect suggests that the impact of longer CEO tenure on sustainability may manifest more clearly over extended periods, reflecting possible organizational inertia. The robustness checks across different ESG dimensions report a significant positive linear association with environmental scores, implying that longer-tenured CEOs perform better in the environmental dimension of sustainability. In some models estimating a potential quadratic relationship only again only the linear variable shows significant results, resulting in the inability to interpret either linear of quadratic relationships.

Overall, the relationship between CEO tenure and sustainable performance reveals significant insights across various models. Initially, the OLS models indicate a negative quadratic association, implying decreasing marginal returns until age 22.5 and a net positive effect from 45 years and beyond. However, the fixed-effects models show that this relationship becomes insignificant when controlling

for firm-specific factors, suggesting the initial results may be influenced by unobserved firm characteristics. Testing for selection bias found that firms with recent CEO changes tend to have higher ESG scores, with a mean increase of 0.715, indicating they may be more proactive in sustainability. Further, fixed-effects models with a lagged effect of 5 years again reveal a quadratic relationship between tenure and ESG scores, with negative impacts diminishing over time and potential positive effects emerging after 25 years. Robustness checks furthermore found a positive effect of an increase in tenure with environmental scores.

Gender

The initial OLS regression models indicated a positive association between having a female CEO and higher ESG scores. Specifically, the estimate from model 2 shows that firms with female CEOs tend to have an ESG score that on average is 1.074 points higher than those led by male CEOs. However, this positive relationship did not hold in any of the standard fixed-effects models, the lagged fixed-effects model, or the robustness checks, as the estimates became insignificant. This suggests that the initial positive correlation observed in the OLS models may be driven by unobserved firm-specific characteristics rather than a direct causal effect of CEO gender on sustainability. These firm-specific factors could include existing corporate cultures, strategic commitments to sustainability, or industry-specific practices that overshadow the influence of CEO gender on ESG outcomes. To better understand

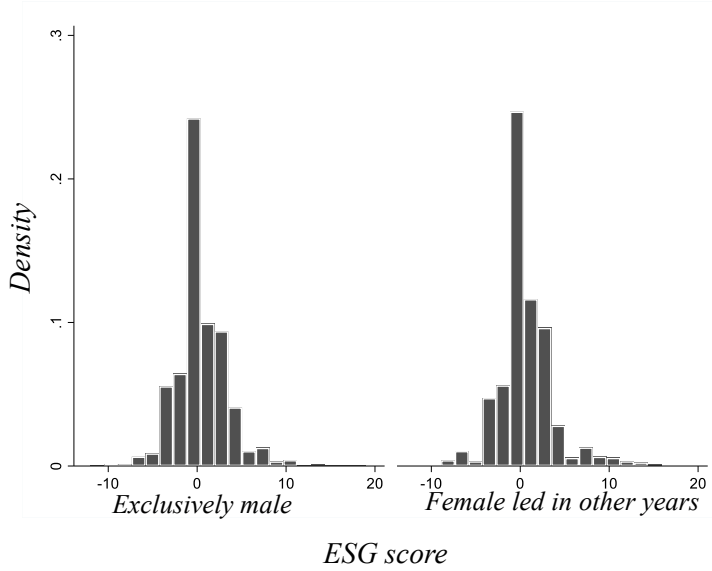

Figure 5. Distribution of ESG score for observations for companies led by male CEOs categorised by whether a female has ever been a CEO.

Notes: Figure 5 is based on a subset of sample 2, where the observations are limited to companies who are led by male CEOs, categorised by whether there has ever been a female CEO. This subsample includes 12,350 observations.

the potential selection bias due to firm-specific characteristics, we compare observations of firms with male CEOs to those of firms that currently have a male CEO, but have had a female CEO in other years. The results of this comparison, shown in Figure 5, reveal a slight change in distribution. Companies that have been led by female CEOs at any time display a shift toward the positive side of the distribution. This is furthermore supported by an increase in mean ESG score of 0.136.

This suggests that firms with female CEOs may have pre-existing characteristics or practices that support higher ESG scores. For instance, companies that hire female CEOs might already prioritize sustainability, diversity, and ethical practices, which contribute to higher ESG scores. These firms might implement robust diversity programs, long-term environmental strategies, and transparent governance practices. Therefore, the simple OLS models may capture these pre-existing conditions rather than a direct effect of female leadership on sustainability. This highlights the importance of considering firm-specific contexts when evaluating the impact of CEO gender on ESG performance.

V. DISCUSSION

Comparison to existing literature

The results of this study provide insights into the relationship between CEO characteristics and sustainable performance, contributing to the existing literature in several significant ways. First, the positive association estimated for CEO age with ESG score align with the more general observation by Belenzon et al. (2019) that older CEOs tend to have a positive impact on firm performance. However, the significant positive relationship between CEO age and ESG scores found in the OLS models dissipates in the fixed-effects models, suggesting that firm-specific factors play a critical role. This difference in outcomes for the OLS and fixed-effects models highlights the necessity of considering contextual factors.

The study's results concerning CEO compensation provide a complex picture that partially aligns with previous findings. The initial OLS regression models indicated a positive relationship between short-term compensation and ESG scores, contradicting McGuire et al.'s (2003) assertion that short-term incentives might undermine sustainable performance. However, when firm-specific effects were controlled for, the relationship turned negative, supporting the argument that short-term compensation can indeed deter long-term sustainability efforts. This finding showcases the importance of incentive structures in aligning CEO motivations with sustainable practices, as highlighted by Ameer and Othman (2011), who suggested that long-term compensation is crucial for fostering sustainability. The analysis of long-term compensation yielded mixed results. The initial OLS models suggested a positive relationship between long-term compensation and ESG scores, consistent with the hypothesis that long-term incentives align CEO interests with sustainability goals. However, this relationship was only repeated to be significant in the models accounting for a lag of 5 years, implying that actual

increases in ESG score as a result of an increase in long-term compensation might take years to foster. This ambiguity aligns with the conflicting findings in the literature, where studies like those by Mahoney and Thorne (2005) have shown varying impacts of compensation structures on sustainability.

The investigation into CEO tenure revealed that longer tenures were initially associated with lower ESG scores, or, that newer CEOs are generally linked to better sustainable performance. However, this relationship became insignificant in the fixed-effects models, indicating that firm-specific factors might again be at play. The lagged effects analysis suggested that the impact of tenure on sustainability might need to manifest more clearly and is only observed after 5 years, reflecting the possibility of organizational inertia, as suggested by Bernard et al. (2018). The quadratic relationship described by the lagged model describes a U-shaped relationship in which there is an initial negative impact with decreasing returns, until age 25 from when the net returns become positive. This contradicts the hypothesized inversely U-shaped relationship by Hambrick and Fukutomi (1991) and Miller and Shamsie (2001). The inversely U-shaped relationship as was found in the existing literature was likely a result of selection bias, as this research found that generally firms generally have an increase in CEO performance when a new CEO assumes office.

Regarding CEO gender, the initial positive association between female CEOs and higher ESG scores found in the OLS models did not hold in the fixed-effects models. This discrepancy suggests that firms with female CEOs might possess pre-existing characteristics that promote sustainability, rather than gender directly influencing ESG performance. This finding contradicts the literature, which partly attributes differences in sustainable performance to CEO gender (Manner, 2010). The contradiction is likely due to underlying mechanisms related to firm characteristics. This paper investigated potential selection bias and found that companies with male CEOs who have been or will be led by a female CEO generally outperform firms that have never had female leadership in terms of sustainable performance. This difference in firms, which is not directly caused by female leadership, could explain why previous OLS regressions estimated a significant positive relationship.

Overall, the relationships between CEO characteristics and sustainable performance reveal varying degrees of economic significance. There is little economical significance for the impact of CEO age and gender on sustainable performance, as the results are insignificant when controlling for firm-fixed effects. To better interpret the size of the impact on sustainable performance of firms we could look at the total variability of the ESG scores, which ranges from -12 to 19. Considering short-term compensation negatively affects ESG scores with a decrease of 0.075 points per million USD increase, it could be said that short-term compensation has moderate effects on sustainable performance. The same can be said for long-term compensation, which shows a delayed positive effect of 0.011 points per million USD after five years, indicating a small impact. CEO tenure initially negatively impacts ESG scores, but positive effects with increasing marginal returns emerge after 25 years, suggesting long-term economic significance. Overall, while CEO characteristics influence sustainability, their

economic impacts are moderate, highlighting the need for nuanced policies and further research with broader samples.

In summary, this study's findings underscore the complexity of the relationships between CEO characteristics and sustainable performance, with significant implications for policymakers. The results reveal that initial associations often align with existing literature; however, the application of fixed-effects models highlights the significant role of firm-specific factors. This points to the necessity of developing more comprehensive models that account for these variables to avoid selection bias, which has notably impacted the results in existing literature. The introduction discussed how selection bias, such as omitting critical firm-specific factors, has influenced previous studies and, by extension, current policies on CEO selection and board composition diversity. Policies have been shaped by research that may have not fully accounted for these biases, leading to potentially ineffective or misdirected guidelines. For example, policies promoting specific CEO attributes like gender or age as key determinants of sustainable performance might overlook the broader, firm-specific context that significantly influences these outcomes. The findings from this research suggest that policymakers should consider the firm-specific nature of these relationships when crafting guidelines and regulations. It is crucial to promote policies that not only encourage diversity and specific CEO traits but also emphasize a holistic approach that includes firm-specific factors such as industry context, regional regulations, and company lifecycle stages. Additionally, the call for broader samples in future research is vital to ensure that policies are based on robust and generalizable findings, reducing the risk of ineffective interventions based on incomplete data.

Internal Validity

The application of fixed effects models in this study significantly enhances internal validity by addressing potential omitted variable bias (OVB). Fixed effects models control for time-invariant characteristics of the firms, such as industry, region, or intrinsic firm culture, that might influence both CEO characteristics and sustainable performance. By doing so, these models isolate the effect of CEO attributes on sustainability outcomes, minimizing the risk of attributing changes in sustainable performance to CEO characteristics when they might actually be driven by unobserved firm-specific factors. When comparing the results of this study to existing literature, it becomes evident that controlling for more attributes simultaneously alters the observed relationships between CEO characteristics and sustainable performance. OLS models, similar to many previous studies, often found significant associations. However, these associations frequently dissipated in fixed effects models. This contrast underscores the role of firm-specific factors and suggests that some prior research might have overstated the impact of CEO characteristics due to OVB. Many studies in the existing literature have not accounted for fixed-effects, potentially leading to biased estimates and misleading conclusions about the influence of CEO attributes on sustainability.

Despite efforts to control for a wide range of variables, certain factors may still be omitted, potentially influencing the results. For example, unmeasured variables such as specific CEO traits (e.g. educational attainment, personal values) or dynamic firm strategies (e.g., shifts in market focus or innovation initiatives) could impact sustainable performance. Additionally, broader economic conditions and industry-specific trends not fully captured in the fixed effects models might also play a role. These omissions could lead to either an overestimation or underestimation of the true effects of CEO characteristics on sustainability. To further improve internal validity, future research should aim to incorporate a more comprehensive set of control variables and utilize advanced econometric techniques. Longitudinal studies with more extended timeframes and larger, more diverse samples can provide deeper insights into the dynamic relationships between CEO characteristics and sustainable performance. Including qualitative data on CEO behaviour and decision-making processes might also enrich the analyses, offering a more nuanced understanding of how CEO characteristics influence sustainable outcomes.

External Validity

The sample in this study is drawn from the WRDS Compustat Execucomp and MSCI ESG KLD STATS datasets, which cover different aspects of publicly listed companies in the United States. The WRDS Compustat Execucomp dataset includes detailed information on CEO characteristics and compensation for firms listed in the S&P 1500 Index, covering approximately 90% of the investable U.S. stock market. On the other hand, the MSCI ESG KLD STATS dataset provides ESG performance indicators for companies based on the MSCI USA Investable Market Index, covering 99% of the investable U.S. stock market. When these two datasets are merged, the resulting sample does not perfectly cover either of the original datasets. The Execucomp dataset's focus on the S&P 1500 and the ESG KLD STATS dataset's broader coverage mean that some firms included in one dataset may not be present in the other. Consequently, the final merged sample includes only firms listed in both datasets, which introduces a selection bias. This merged dataset consists of 1,493 companies, representing a subset of the broader population of U.S. public firms. This difference between the sample and the total population can affect the external validity of the findings. Smaller firms and those not listed on major stock exchanges are underrepresented, potentially limiting the generalizability of the results. Additionally, the merged sample might over-represent firms with better reporting practices and higher visibility, which could bias the analysis towards more prominent and potentially more sustainable firms. Furthermore, when interpreting the estimates based on sample 2, additional selection bias may in be play. This selection bias could be caused by the sample only representing firms who have had a change in CEO in the years 2000 to 2019. This leads to an underrepresentation of firms who have had stable leadership in this time period. These differences underscore the need for caution when extrapolating the study's findings to the entire population of U.S. public firms.

In 2003 a paper produced by John Entine (2003) criticised the academic use of the KLD statistics, arguing that the performance indicators oversimplified the complexity of modern corporations, he additionally argued that the publisher had yet to build a case for why its criteria were socially or ethically responsible. Many academia disagreed and in the same year Waddock (2003) published a paper discrediting Entine's criticism, calling the KLD data the "de facto research standard at the moment". More recently the reliability of ESG ratings has again been criticised, Berg et al. (2022) investigated 6 prominent ESG rating companies (under which KLD) and found evidence for a rater effect, an effect where the ESG performance indicator is partly based on the rater's overall view of the company. This effect threatens the objectivity, and therefore reliability of the indicators. A possible solution to increase reliability could be to obtain a new indicator that is based on multiple independent ESG rating agencies. However, due to availability restrictions this paper exclusively used the MSCI ESG STATS dataset. Criticism of the Execucomp dataset has also surfaced over the years. For instance, Bebchuk and Fried (2003) argued that the data may not fully capture the complexity of executive compensation practices and that some forms of compensation might be understated or misrepresented. They also highlighted potential biases in how compensation packages are reported and the impact of corporate governance structures on these disclosures. Despite these concerns, the Execucomp dataset remains widely used and was still selected for its extensive coverage, detailed reporting and availability.

The reliance on ESG scores as the primary measure of sustainable performance introduces certain limitations. ESG scores, while comprehensive, may not capture all dimensions of sustainability, particularly those that are qualitative or context-specific. The scores aggregate diverse factors, potentially obscuring nuanced differences in performance across various sustainability aspects. For instance, environmental initiatives may be weighted differently than social or governance factors, depending on the rating agency's methodology. To achieve a more precise evaluation of sustainable performance, future research should consider incorporating additional outcome measures. Qualitative assessments, stakeholder surveys, and case studies could provide deeper insights into the effectiveness of specific sustainability initiatives. Moreover, using a combination of ESG ratings from multiple agencies and integrating other sustainability metrics, such as carbon footprints, diversity indices, and community impact assessments, could offer a more robust and holistic understanding of a firm's sustainable performance. Overall, while the datasets used in this study offer valuable insights, acknowledging their limitations is crucial for interpreting the results. The representativeness of the sample, potential biases in the datasets, and the limitations of the outcome measures all influence the external validity of the findings. Future research should address these limitations by employing more diverse samples, integrating multiple data sources, and incorporating a broader range of sustainability metrics to enhance the generalizability and robustness of the conclusions.

VI. CONCLUSION

This study investigated the impact of CEO characteristics on the sustainable performance of publicly listed firms in the United States from 2000 to 2019. Using Upper Echelon Theory as a framework, the analysis focused on CEO attributes such as age, gender, tenure, and compensation, and their relationship with MSCI ESG scores.

Initial analyses indicated a positive relationship between CEO age and gender with ESG scores, implying that older CEOs might be more inclined towards sustainability. However, this association disappeared in fixed-effects models, suggesting that firm-specific factors and potential selection biases may drive the observed relationships rather than age and gender itself. The study found a contrasting relationship between short-term and long-term compensation and sustainable performance. While OLS models showed a positive correlation with short-term compensation, fixed-effects models revealed a negative impact, suggesting that higher short-term incentives might detract from long-term sustainability goals. Conversely, long-term compensation showed a delayed positive effect on ESG scores, aligning with the hypothesis that long-term incentives foster sustainable practices, though these effects only become significant after a period of 5 years. Finally, Longer CEO tenure was initially associated with lower ESG scores, but this relationship did not hold in fixed-effects models, highlighting the potential influence of firm-specific factors. Lagged effects suggested that the impact of tenure on sustainability might take time to manifest, with positive effects emerging after extended periods.

The findings highlight the importance of firm-specific contexts when evaluating the impact of CEO characteristics on sustainable performance. It is crucial for policymakers and practitioners to exercise caution in attributing changes in sustainability solely to CEO attributes, without taking into account the broader organizational environment. Additionally, the study underscores the necessity for more comprehensive models that incorporate more firm-, industry- and geographical-specific factors to gain a clearer understanding of how leadership influences sustainability.

Future research should aim to incorporate more diverse samples to validate these findings and enhance their generalizability. Additionally, integrating qualitative data on CEO behaviour and decision-making processes could offer greater insights into the mechanisms through which CEO characteristics influence sustainable outcomes. In conclusion, while some CEO characteristics play a role in shaping sustainable performance, their impact is significantly mediated by firm-specific factors. This study contributes to the literature on corporate governance and sustainability, providing valuable insights for both academic research and practical decision-making.

VII. REFERENCES

Ameer, R., & Othman, R. (2012). Sustainability Practices and Corporate Financial Performance: A Study Based on the Top Global Corporations. *Journal of Business Ethics*, *108*(1), 61–79.

Bebchuk, L. A., & Fried, J. M. (2003). Executive compensation as an agency problem. *Journal of Economic Perspectives*, *17*(3), 71.

Belenzon, S., Shamshur, A., & Zarutskie, R. (2019). CEO's age and the performance of closely held firms. *Strategic Management Journal*, *40*(6), 917–944.

Berg, F., Kölbel, J. F., & Rigobon, R. (2022). Aggregate Confusion: The Divergence of ESG Ratings. *Review of Finance*, *26*(6), 1315–1344.

Bernard, Y., Godard, L., & Zouaoui, M. (2018). The Effect of CEOs' Turnover on the Corporate Sustainability Performance of French Firms. *Journal of Business Ethics*, *150*(4), 1049–1069.

Bertrand, M., & Schoar, A. (2003). Managing with Style: The Effect of Managers on Firm Policies. *The Quarterly Journal of Economics*, *118*(4), 1169–1208.

California Governor. (2022, November 16). "*California releases world's first plan to achieve net zero carbon pollution*". California Governor. https://www.gov.ca.gov/2022/11/16/california-releases-worlds-first-plan-to-achieve-net-zero-carbon-pollution/

Core, J., & Guay, W. (1999). The use of equity grants to manage optimal equity incentive levels. *Journal of Accounting & Economics*, *28*(2), 151–184.

Costa, P. T., Terracciano, A., & McCrae, R. R. (2001). Gender differences in personality traits across cultures: robust and surprising findings. *Journal of Personality and Social Psychology*, *81*(2), 322–331.

Davidson, D. J., & Freudenburg, W. R. (1996). Gender and Environmental Risk Concerns: A Review and Analysis of Available Research. *Environment and Behavior*, *28*(3), 302–339.

Dyllick, T., & Hockerts, K. (2002). Beyond the business case for corporate sustainability. *Business Strategy and the Environment*, *11*(2), 130–141.

Entine, J. (2003). The Myth of Social Investing: A Critique of its Practice and Consequences for Corporate Social Performance Research. *Organization & Environment*, *16*(3), 352–368.

Ghardallou, W. (2022). Corporate Sustainability and Firm Performance: The Moderating Role of CEO Education and Tenure. *Sustainability*, *14*(6), 3513.

Ghardallou, W., Borgi, H., & Alkhalifah, H. (2020). CEO Characteristics and Firm Performance: A Study of Saudi Arabia Listed Firms. *Journal of Asian Finance, Economics and Business*, *7*(11), 291–301.

Gottesman, A. A., & Morey, M. R. (2010). CEO Educational Background and Firm Financial Performance. *Journal of Applied Finance*, *20*(2), 70–82.

Graves, S. B., & Waddock, S. A. (1994). Institutional owners and corporate social performance. *Academy of Management Journal*, *37*(4), 1034.

Hambrick, D. C., & Fukutomi, G. D. S. (1991). The seasons of a CEO's tenure. *Academy of Management Review*, *16*(4), 719.

Hambrick, D. C., & Mason, P. A. (1984). Upper Echelons: The Organization as a Reflection of Its Top Managers. *Academy of Management Review*, *9*, 193–206.

Hirsh, J. B. (2010). Personality and environmental concern. *Journal of Environmental Psychology*, *30*(2), 245–248.

Hillman, A. J., & Keim, G. D. (2001). Shareholder value, stakeholder management, and social issues: what's the bottom line? *Strategic Management Journal*, *22*(2), 125–139.

Khan, T. M., Gang, B., Fareed, Z., & Yasmeen, R. (2020). The impact of CEO tenure on corporate social and environmental performance: an emerging country's analysis. *Environmental Science and Pollution Research International*, *27*(16), 19314–19326.

Mahapatra, S. (1984). Investor Reaction to a Corporate Social Accounting. *Journal of Business Finance & Accounting*, *11*(1), 29-40.

Mahoney, L. S., & Thorne, L. (2005). Corporate Social Responsibility and Long-term Compensation: Evidence from Canada. *Journal of Business Ethics*, *57*(3), 241–253.

Manner, M. H. (2010). The Impact of CEO Characteristics on Corporate Social Performance. *Journal of Business Ethics*, *93*, 53–72.

McGuire, J., Dow, S., & Argheyd, K. (2003). CEO Incentives and Corporate Social Performance. *Journal of Business Ethics*, *45*(4), 341–359.

Miller, D., & Shamsie, J. (2001). Learning across the life cycle: Experimentation and performance among the hollywood studio heads. *Strategic Management Journal*, *22*(8), 725–745.

MSCI (2019). *MSCI ESG KLD STATS: 1991-2018 Data Sets Methodology.* MSCI ESG RESEARCH INC.

Murphy, K. J. (1999). Executive compensation. *Handbook of Labor Economics, 3*(B), 2485-2563.

Oh, W. Y., Chang, Y. K., & Cheng, Z. (2016). When CEO Career Horizon Problems Matter for Corporate Social Responsibility: The Moderating Roles of Industry-Level Discretion and Blockholder Ownership. *Journal of Business Ethics*, *133*(2), 279–291.

Orlitzky, M., Schmidt, F. L., & Rynes, S. L. (2003). Corporate social and financial performance: A meta-analysis. *Organizational Studies*, *24*, 403–441.

Shoham, A., Almor, T., Lee, S. M., & Ahammad, M. F. (2017). Encouraging environmental sustainability through gender: A micro-foundational approach using linguistic gender marking. *Journal of Organizational Behavior*, *38*(9), 1356–1379.

Waddock, S. (2003). Myths and Realities of Social Investing. *Organization & Environment*, *16*(3), 369–380.

Waddock, S. A., & Graves, S. B. (1997). The corporate social performance-financial performance link. *Strategic Management Journal, 18(*4), 303–319.

Wang, Y., Hao, F., & Liu, Y. (2021). Pro-Environmental Behavior in an Aging World: Evidence from 31 Countries. *International Journal of Environmental Research and Public Health*, *18*(4).

Feng, Y., & Liu, Y. (2023). Industry Life Cycle, CEO Functional Background and Corporate Sustainable Development: Evidence from Listed Companies in China. *Sustainability*, *15*(3).

VIII. APPENDIX

Table 7. Results for the Breusch-Pagan test for both samples

	Sample 1	Sample 2
P-Value		
Age	0.000	0.000
Age^2	0.000	0.000
Tenure	0.000	0.000
Tenure^2	0.000	0.000
Female	0.000	0.000
CompST	0.000	0.000
CompLT	0.000	0.000
Total	0.000	0.000

Notes: The Breusch-Pagan test shows the correlation of the independent variables with the residuals. a significant p-value indicates the presence of heteroskedasticity. The table shows the correlation for the individual and for the complete model. A significant correlation has been found for all variables and the complete model, implying heteroskedasticity is present in both samples.