Carbon Consciousness: The Influence of CEO Ownership

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Abstract

Building on prior research on managerial ownership and firm performance, this study is the first to link CEO ownership to carbon commitment. We examine if firms led by CEOs with substantial ownership are more or less inclined to prioritise reducing carbon emissions than those without such ownership. We find that higher CEO ownership is associated with a lower carbon commitment, indicating that CEOs with more significant ownership do not prioritise carbon emissions reduction. However, we notice an inverted U-shaped relationship. Particularly, moderate CEO ownership (between 5 and 10% of total shares) has the stronger impact. The results are robust to alternative measures and approaches. The study provides empirical evidence on how CEO ownership can influence corporate carbon commitment and contribute to the global fight against climate change.

Keywords:

Carbon commitment; climate risk; managerial Ownership; CEO ownership; entrenchment effect.

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1. Introduction

Climate change is a global phenomenon that poses a grave threat to the survival of our planet. NOAA's National Centers for Environmental Information recorded 2023 as the planet's warmest year.[1] The scientific community has unequivocally identified carbon emissions from anthropogenic activities as the principal cause of this phenomenon.[2] The World Meteorological Organization acknowledges that this temperature increase is mainly due to the release of greenhouse gases (GHG), such as carbon dioxide, into the atmosphere from human activities such as burning fossil fuels and deforestation (Shahrour et al., 2023). The recent Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) finds that these anthropogenic activities increase the Earth's temperature. With the Earth's temperature already crossing 1.35°C above the pre-industrial average in 2023,[3] we are on track to exceed 1.5°C as early as 2030. Furthermore, the AR6 warns of significant discernible impacts on ecosystems, human health, and the global economy with every 0.5°C rise in temperature from current levels. The importance of decarbonisation has been increasingly recognised, prompting calls for a transformation of energy systems that could significantly reduce CO_2 emissions, and consequently, decrease the global warming (Shahbaz et al., 2023). The significance is also highlighted by the PWC's 15th Net Zero Economy Index, showing the world requires a year-on-year decarbonisation rate of 17.2% until 2050 to be able to maintain the global warming to only 1.5°C above pre-industrial levels.

From a financial perspective, the risks associated with climate change are becoming more evident.[4] A recent report by the Climate Disclosure Project found that over 1,500

[1] See: https://www.noaa.gov/news/2023-was-worlds-warmest-year-on-record-by-far
[2] See: https://blogs.worldbank.org/climatechange/scientific-evidence-human-induced-climate-change-unequivocal
[3] See: https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
[4] However, it is important to recognise that climate change also has diverse social and non-social impacts (Barnett et al., 2020). These topics, though crucial, fall outside the scope of this study and are not addressed in this paper.

companies globally could face significant financial losses due to climate-related risks, such as extreme weather events, policy changes, and technological disruptions. These risks could lead to market volatility and affect the global financial system.[5] Extant literature on climate impact on corporations has addressed issues such as the impact of climate change on asset pricing (Bolton and Kacperczyk, 2021; Choi et al., 2020; Shahrour, 2022); financial markets (Al Ayoubi and Enjolras, 2021; Ma et al., 2024; Quan et al., 2023); access to finance (Kling et al., 2021; Painter, 2020; Tang and Zhang, 2020); firms' financial outcomes (Al Ayoubi and Enjolras, 2022; Arouri and Pijourlet, 2017; Atz et al., 2023; Huang et al., 2023; Kabir et al., 2021; Kolk and Pinkse, 2004; Martinsson et al., 2024; Shui et al., 2022) and those addressing the impact of climate change from a managerial perspective (Ghafoor et al., 2023; Jung and Song, 2023; Li and Zhang, 2023; Lv and Li, 2023; Zhang et al., 2019; Zhao et al., 2022). Nevertheless, a few studies exist on the influence of managerial ownership (i.e., CEO ownership) on carbon emissions. In this study, we address this gap in research by examining the relationship between CEO ownership and carbon commitment.

To the best of our knowledge, only the studies by Zhou and Nagayasu (2023) and Shan et al. (2021) discuss ownership type. While the former examines the impact of environmental responsibility on firm value by emphasising the role of ownership type (privately owned vs. state-owned), the latter studies the impact of managerial ownership on carbon transparency (disclosure). Our study is significantly different from these two, as we consider the case of how CEO ownership is related to the firm's carbon commitment. Specifically, we aim to investigate whether companies with significant CEO ownership are more or less likely to prioritise carbon emissions reduction (i.e., carbon commitment) than those with CEOs who do not have such ownership. Our reasoning for doing so is that studies suggest CEOs play a critical role in

[5] See: https://www.cdp.net/

determining a company's environmental policies and practices (Barnhart and Rosenstein, 1998; Bhagat and Bolton, 2008; Mehran, 1995). As the top decision-makers in a corporation, CEOs have significant influence over a company's strategic direction, including its approach to environmental issues such as carbon emissions. The literature on corporate finance reveals a nuanced relationship between firm value and managerial ownership, characterised by a positive correlation up to a certain threshold, beyond which the relationship correlates inversely (Fabisik et al., 2021). Based on this phenomenon – hereafter the entrenchment effect – we argue that the impact of CEO ownership on carbon commitment could have a parabolic effect; that is, firms can realise an optimal level of influence of CEO ownership on carbon commitment, and after a certain threshold of ownership their corporate carbon commitment may turn negative/nonsignificant (i.e., an inverted U-shaped relationship).

Furthermore, our sample spans various business cycles, each influenced by distinct monetary and fiscal policies. Studying various business cycles is crucial because it allows for a comprehensive analysis of how different economic environments impact our subject of study. Each business cycle is characterised by unique conditions, such as inflation rates, interest rates, and government spending, which can influence business performance, consumer behaviour, and market dynamics in distinct ways. By examining multiple cycles, we can identify patterns and draw more robust conclusions about the underlying mechanisms at play. This approach also enhances the generalisability of our findings, ensuring they are not specific to a single economic climate but applicable across different scenarios. We introduce the policy uncertainty index as an exogenous variable to assess its impact on the relationship under study. Additionally, we differentiate between the pre-Trump and Trump presidential eras, a distinction motivated by the significant policy shift marked by the U.S. withdrawal from the Paris Agreement. This differentiation allows us to explore potential changes in corporate carbon commitment behaviour in response to altered policy landscapes.

Our study highlights the complex relationship between CEO ownership and corporate commitment to carbon reduction. Using various econometric approaches, we find that moderate levels of CEO ownership have the most significant impact on carbon reduction efforts. However, very high or very low levels of CEO ownership may not yield the same effect. Additionally, external factors, such as the policy uncertainty index and market conditions, influence how CEO ownership shapes corporate strategies. Policymakers and businesses should take these dynamics into account when designing incentives and regulations to enhance corporate contributions in the fight against climate change.

This study makes an incremental contribution to the literature investigating ownership patterns and carbon commitments (Calza et al. 2014, Mayer and Rajavuori 2017, Cohen 2023). To the best of our knowledge, this is the first study that links CEO ownership and examines the entrenchment effects concerning carbon commitment. Furthermore, we add to the growing literature on managerial ownership and climate finance by providing evidence of the impact of CEO ownership on carbon commitments in light of macro policy uncertainty shocks. In terms of theoretical contribution, the empirical evidence presented in our study, notably the entrenchment effect, demonstrates how companies strategically align their actions with societal expectations regarding carbon reduction to reinforce the company's legitimacy. Policymakers and practitioners can use this insight to design effective strategies that enhance corporate legitimacy through sustainable practices (e.g., through designing eco-labels, etc.). Our research also enriches signaling theory. By investigating the role of CEOs as signalers, we highlight how their ownership stakes influence external perceptions. Practically, this knowledge can guide investors, analysts, and other stakeholders in interpreting CEO actions as signals of commitment to environmental responsibility.

The remainder of this paper is organised as follows. Section 2 presents our conceptual framework and the development of hypotheses. Section 3 outlines the data and empirical methodology used in this study. Section 4 reports and discusses our findings. Finally, we provide a conclusion in Section 5.

2. Conceptual Framework

The relationship between CEO stock ownership and a firm's commitment to reducing carbon emissions can be understood in two distinct but interconnected ways. First, the role of CEOs in shaping the firm's strategic direction serves as the foundation. CEOs, with significant stock ownership, have their personal financial interests closely aligned with the company's long-term success (Benson and Davidson III, 2009; Tong 2008). This alignment motivates them to adopt sustainable practices that not only enhance the company's reputation but also contribute to long-term value creation, including initiatives aimed at reducing carbon emissions. Second, the influence extends through the investor base. CEOs with substantial ownership stakes are uniquely positioned to lead by example, signaling the long-term benefits of sustainable practices to investors, thus attracting a more sustainability-focused investor base, further reinforcing the company's commitment to environmental goals. Investors increasingly recognise the financial risks associated with climate change and the opportunities in sustainable business practices, making them more likely to support companies with strong carbon commitments (Bolton and Kacperczyk, 2021; Benz et al. 2020). Thus, CEO stock ownership can indirectly influence a firm's carbon commitment by shaping the expectations and composition of its investor base, creating a virtuous cycle of sustainability-driven investment and corporate practices.

As an anecdotal example, Google has been a pioneer in corporate sustainability, committing to carbon neutrality in 2007 and achieving it annually since then. In September

2020, Sundar Pichai announced an ambitious goal for Google to operate on 24/7 carbon-free energy in all its data centres and campuses worldwide by 2030. This commitment is noteworthy because it goes beyond the common practice of carbon offsetting; it involves fundamentally changing the way Google powers its operations to ensure they are always sourced from carbon-free energy sources. The link between Pichai's stock ownership and Google's carbon commitments can be understood through the lens of long-term value creation.[6] As CEO, Pichai's leadership and decision-making reflect a strategy not just for short-term profits but for sustaining Google's growth and reputation over the long term. Investments in sustainability and achieving ambitious carbon-free operations can enhance Google's brand, attract talent, and satisfy stakeholders, including environmentally conscious consumers and investors. These actions, in turn, support the company's stock value and, by extension, benefit Pichai's personal investment in Alphabet.

The relationship between responsible management and firm performance, focusing on the influence of owners in shaping firms' corporate social responsibility (CSR), can be understood notably via two theories proposed in the literature: the legitimacy theory and the signaling theory. The legitimacy theory has garnered significant attention in the CSR discourse (Jiang et al., 2023).[7] This theory posits that organisations continually strive to operate within the bounds and norms of their respective societies. It is based on the idea that an organisation's actions are perceived as legitimate when they align with the social system's values, beliefs, and definitions. Legitimacy is a generalised perception that the actions of an entity are desirable, proper, or appropriate within a socially constructed system of norms. Specifically, the theory

[6] For those interested in the most up-to-date information regarding ownership value/level, we recommend consulting the latest SEC filings and market data, which offer real-time insights into the holdings of corporate executives.

[7] The application of legitimacy theory in research on sustainability stems from the idea of organisational legitimacy. According to Suchman (1995, p. 574), "*Legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions*."

underscores the importance of maintaining social legitimacy. Companies can enhance their legitimacy by demonstrating their commitment to environmentally friendly business processes, thus gaining acceptance from the community (Shahrour et al., 2021). That is, effective socially responsible initiatives can serve as a means of legitimisation (Kautish et al., 2019; Kemper and Martin, 2010; Kim and Park, 2020; Suchman, 1995). Companies actively engage in practices that align with societal norms and expectations. In the context of carbon reduction, legitimacy theory suggests that companies strive to demonstrate their commitment to environmental responsibility to maintain legitimacy in the eyes of stakeholders. Corporate carbon commitment, therefore, becomes a strategic imperative driven by the need to be seen as a responsible and legitimate actor within the broader social and environmental landscape. Conversely, companies that neglect responsible activities may risk losing legitimacy among their stakeholders (Shahrour et al., 2022).

Signaling theory shifts the focus to individual actors, particularly CEOs. CEOs serve as key signalers, using their actions and decisions to convey information to external parties. Their behaviour sends powerful signals about the company's prospects and intentions. High CEO ownership levels may lead to specific signaling behaviours. For instance, a CEO's personal investment in company stock signals confidence in the organisation's future performance. Conversely, low CEO ownership might signal caution or uncertainty. The signaling theory suggests that companies may use carbon disclosure to signal their commitment to environmental responsibility (Bolton and Kacperczyk, 2021; Boura et al., 2020; Caby et al., 2020).[8] This theory explains how one party (the signaler) can convey information to another party (the receiver) in a way that is credible, even if their interests may not align. Signaling theory offers a compelling framework to understand the relationship between CEO stock

[8] The theory is often applied to situations where the signaler has more or better information than the receiver and needs to send a signal that credibly conveys their information or intentions.

ownership and a firm's commitment to carbon reduction. Essentially, signaling theory posits that in situations where information asymmetry exists, individuals or organisations send signals to convey their intentions, quality, or capabilities to observers, such as investors or other stakeholders.

Thus, while legitimacy theory guides overall corporate commitment, signaling theory sheds light on the CEO's role in shaping perceptions and expectations.

We argue that CEOs with considerable stock ownership are uniquely positioned to influence their company's strategic direction, including its commitment to sustainability and carbon emission reductions. This influence stems from a convergence of their personal financial interests (Eugster and Isakov, 2019; Kreinin, 1959), represented by stock ownership, and their professional commitment, encapsulated in their human capital investment in the company (Huggett and Kaplan, 2016; Regier and Rouen, 2023).

The theoretical framework suggests that such CEOs are more likely to advocate for and implement strategies that reduce carbon emissions, recognising that these initiatives mitigate future financial and regulatory risks associated with climate change and enhance the firm's long-term sustainability and reputation (Hrasky, 2011; Kim et al., 2015; Siddique et al., 2021). This approach is grounded in the premise that lower carbon emissions indicate a firm's resilience and adaptability to the growing demands for environmental stewardship, which is increasingly becoming a factor in investor decision-making (Griffin et al., 2017). Therefore, CEOs aligning their financial capital with firms prioritising low emissions signal to the market and stakeholders their commitment to sustainable practices. As proposed by the above framework, this signaling may foster a positive feedback loop, enhance the firm's brand and market position, and attract like-minded investors (Kakeu, 2017). Through the lens of signaling theory, CEO stock ownership becomes a credible signal of the firm's genuine commitment to

reducing its carbon footprint, encouraging a broader alignment of interests towards sustainability goals within and beyond the organisation, reinforcing the firm's commitment to sustainability and fostering a corporate culture that values and advances sustainability efforts.

Conversely, the relationship between CEO ownership and a firm's carbon commitment can be more complex, acting as a double-edged sword. While higher ownership stakes might align CEOs' interests with the company's long-term goals, including sustainability efforts, they also have the potential to incentivise behaviours focused predominantly on short-term financial performance (Fahlenbrach and Stulz, 2009). The focus on immediate value maximisation can lead CEOs to prioritise personal financial gains over the firm's broader, long-term values and sustainability goals; the agency issue (Chen and Steiner, 1999; Rashid, 2016). In such scenarios, investments in carbon reduction initiatives might be perceived as non-essential expenses that detract from short-term profitability. Consequently, a CEO with significant ownership might opt to eschew these initiatives, viewing them as unnecessary costs that could impede the firm's immediate financial performance (Cheng et al., 2005). This perspective underscores the potential conflict between pursuing environmental sustainability and the imperative for value maximisation, highlighting the intricate balance that CEOs must navigate between personal gain and CSR. This is not surprising, as a stream of research finds that CSR could decrease a firm's market value. For instance, Marsat and Williams (2013) find strong evidence of a negative impact of firms' responsible behaviour on corporate market value. In particular, they find that investors penalised environmental performance. From this perspective, we could expect managers to prioritise short-term gain over long-term gain, notably in terms of carbon commitments, as it could be the most costly for the firm in the ESG pillars.

In this paper, we aim to maintain an objective stance, acknowledging the compelling nature of arguments on both sides of the debate regarding CEO ownership and its impact on a firm's commitment to carbon reduction initiatives. Recognising the potential for positive and negative influences, we formulate dual opposing hypotheses to reflect the complexity of this relationship.

H1.a: *Ceteris paribus*, an increase in CEO stock ownership is positively associated with firms' commitment to carbon emission reduction initiatives.

H1.b: *Ceteris paribus*, an increase in CEO stock ownership is negatively associated with firms' commitment to carbon emission reduction initiatives.

Furthermore, building on the literature linking managerial ownership to firms behaviours/outcomes (e.g., Florackis et al. (2009)), we argue that CEO ownership can be viewed as a key factor impacting the firm's commitment to environmental practices and sustainability initiatives. CEOs with significant ownership stakes may possess enhanced decision-making power and influence within the organisation. This empowerment enables them to prioritise sustainability goals and more effectively direct resources towards carbon reduction initiatives (Shan et al., 2021). Due to their substantial personal investment in the company's long-term prosperity, CEOs holding significant ownership stakes may initially be inclined to adopt and advocate for environmentally responsible practices. This motivation stems from a desire to ensure their enterprise's sustainability and long-term success.

Nonetheless, the pursuit of personal financial gain can also influence these CEOs, leading them to prioritise actions that enhance market value in the short term. Consequently, this focus on immediate financial returns may result in the allocation of resources towards activities that boost short-term profitability (Shan et al., 2021), potentially at the expense of

investments in carbon footprint reduction. This approach focuses on the significant role of CEO ownership in driving the firm's commitment to achieving its sustainability objectives. However, beyond a certain threshold of ownership, the relationship may reverse due to potential entrenchment effects where CEOs prioritise personal gain or short-term financial outcomes over long-term environmental goals (García-Sánchez et al., 2020). Our argument posits that at higher levels of ownership, CEOs might perceive investments in sustainability as less critical compared to short-term value maximisation, possibly due to the misalignment between personal incentives and broader sustainability objectives. This perspective suggests that the impact of CEO "greenness" varies with the level of their ownership.

The literature on managerial ownership and firm value is insightful for our study. For instance, a widely recognised finding within the field of empirical corporate finance is the existence of a positive correlation between firm value and managerial ownership up to a certain threshold. Beyond this point, the relationship turns negative (Fabisik et al., 2021; Fahlenbrach and Stulz, 2009). In light of this, we acknowledge the existence of an entrenchment effect and argue that an inverted U-shape exists in the relationship between CEO ownership and carbon commitment.

H2: *Ceteris paribus*, an inverted U-shaped relationship exists between CEO ownership and firms' carbon commitment.

3. Data and Empirical Methodology

3.1. Data:

For our study, we begin with the list of S&P 500 companies for the period 2006-2021.[9] We consider this sample for the following reasons. The S&P 500 is often seen as a key indicator of the U.S. economy's health, as it includes many of the largest companies by market capitalisation from both the NYSE and NASDAQ exchanges (Papadimitriou et al., 2020). Additionally, the U.S. has shown a strong commitment to reducing carbon emissions, highlighted by the recent proposal from the SEC requiring companies to disclose specific climate-related information in their registration statements and periodic reports. We obtain the financial data associated with different control variables from the Bloomberg database for these firms. We extract the data on CEO ownership from the ExecuComp database and merge these files first with the firm-level carbon commitment scores from the Thomson Reuters (now LSEG) ESG database. Our final sample consists of 5,811 observations covering 491 unique firms. Consistent with the literature, we winsorise the data at the 1% level in each tail.

3.2. Empirical model and measures:

In this study, we employ a multivariate panel regression as defined in the baseline model (1) below, where all variables refer to firm *i* and time *t*.

$$CC_{i,t} = \alpha_0 + \beta_1 Ownserhsip_{i,t} + \sum_{j=2}^{7} \beta_j \, Controls_{i,t} + Year\ FE + Industry\ FE + \varepsilon_{i,t} \qquad (1)$$

The carbon commitment score $CC_{i,t}$ is our dependent variable, which measures a company's commitment and effectiveness towards reducing environmental emissions in the production and operational processes. This score is a subset of the environmental pillar of the ESG score, which includes resource use, emissions, and innovation. The emission score we consider in this

[9] The sample period is due to the availability of the data. ESG data is available from the year 2002. However, comprehensive CEO ownership data is available only from the year 2006. The name of the variable in the ExecuComp database is SHROWN_TOT_PCT.

study holds the highest weight in the environmental pillar and thus summarises all relevant information on carbon emissions. Our main explanatory variable is $Ownserhsip_{i,t}$ which measures the percentage of total shares outstanding held by the executive (if greater than 1%). To investigate the entrenchment effect (H2), we divide our sample based on $Ownserhsip_{i,t}$variable into three subsamples, that consist of firms with CEO ownership intervals between 0 and 5%, 5% and 10%, and higher than 10%, respectively.

To isolate the influence of firm-level and executive-level factors that could influence the examined relationship, we follow the prior literature (Fabisik et al., 2021; Shan et al., 2021; Zhou and Nagayasu, 2023) and include a set of control variables, as follows: we control for the firm size (*SIZE*) using the natural logarithm of total assets; leverage (*LEV*) using the ratio of total liabilities to total assets; firm growth (GROWTH) using the book-to-market ratio; profitability (PROF) using the return-on-assets. We also control for the CEO age (*AGE*) and gender (*GND*), besides including the year and industry fixed effects.

4. Results and Discussion

4.1. Descriptive Statistics:

Table 1 reports the summary statistics of the regression variables. The *CC* variable represents the firm's commitment to reducing their emissions, and the numbers in the table indicate that it is a significant concern for the firms in the sample. With a minimum value of 0.00 and a maximum of 99.91, the wide range of carbon emissions indicated a broad spectrum of carbon initiatives across firms. The mean value of 51.80 suggests that, on average, firms in the sample have a moderate level of commitment and effectiveness towards reducing environmental emissions. However, the median value of 57.87 indicates that more than half of the firms in the sample have higher levels of commitment and effectiveness than the average commitment (51.8). In other words, the distribution is skewed to the right. The standard deviation of 33.29

shows a wide variability in carbon emissions across the sample, with some firms emitting much more than others.

Ownership levels vary significantly as well, with a mean of 1.09 indicating that, on average, CEOs hold a modest proportion of their firms' shares. The substantial gap between the mean and the median ownership level (0.20) highlights the skewed nature of share distribution among CEOs, with a few holdings with disproportionately large stakes.

Figure 1 presents the distribution of carbon commitment within three different subsamples. The box plot reveals the highest variability in the first ownership bracket (from 0% to 5%), as evidenced by a larger interquartile range and more pronounced fractions – through looking into the whiskers in each box. This suggests that in firms where CEOs hold a smaller ownership stake, there is a greater diversity in how strongly they commit to carbon reduction initiatives. This variation may be indicative of differing strategies or motivations at lower levels of ownership. As we move into a higher ownership level, we observe that firms with CEO ownership levels between 5% and 10% exhibit a narrower interquartile range and less variability in carbon commitment compared to the lower ownership category. For firms where CEO ownership exceeds 10%, the box plot again shows an interquartile range that is comparable to that of the second level (from 5% to 10%). The preliminary conclusion for the second bracket indicates a moderate but significant relationship, supporting the entrenchment effect hypothesis, and highlighting how ownership structure might influence a firm's environmental strategy and performance.

Insert Fig.1 about here

Table 1 also reports a summary of the control variables, which indicates our sample variation (e.g., in terms of size, leverage, growth, profitability, and CEO age). For instance, firm sizes

(SIZE) range from 5.13 to 15.12, with an average size of 9.83. Leverage ratios (LEV) have a mean of 0.63, indicating moderate debt levels across firms. Growth (GROWTH) and profitability (PROF) metrics reveal variability in firms' financial performance, while the CEO age (AGE) distribution underscores the range of leadership experience within the sample.

Insert Table 1 about here

Table 2 reports the correlation coefficients between the different variables. The correlation matrix shows the dataset's pairwise correlation coefficients between *CC* and other variables. There's a slight negative correlation between *CC* and *Ownership* (-0.15), indicating that firms with higher CEO shareholding might have a marginally lower emphasis on environmental commitment. This could reflect differing priorities or strategic focuses influenced by CEO ownership stakes. In contrast, there is a moderate positive correlation between *CC* and firm size (0.46), suggesting larger firms tend to be more committed to reducing environmental emissions. The remaining control variables are also related to *CC*, at least at the 5% level.

Insert Table 2 about here

4.2. Main findings:

The multivariate panel regression analysis results show that CEO ownership, as measured by the percentage of held shares (*Ownership*), has a negative and statistically significant effect on a company's environmental commitment, as measured by *CC*. In particular, the analysis reveals that an increase in CEO ownership by one standard deviation results in a decrease of 0.72 or about 1.38% of the average *CC* score, which is statistically significant. This finding validates H1.b, rather than H1.a, suggesting that, on average, higher CEO ownership may not always align with an enhanced focus on long-term sustainability and CSR initiatives, including environmental concerns.

Insert Table 3 about here

In order to investigate whether there is an entrenchment effect or inverted U-shape relationship (H2), we divide our sample into three subsamples based on the CEO ownership level and re-examine our baseline model in Equ. (1). Table 4 reports the obtained results. In line with our expectations, our sample appears to be more concentrated in our first subsample (Sample 1), as we use the S&P 500, which is dominated by large-cap firms where CEO ownership tends to be lower. The results confirm our main findings, indicating that CEO ownership is negatively associated with *CC*, as reflected by the significant coefficient in all three subsamples. Interestingly, the coefficient estimate for *Ownership* is highest in Sample 2, where CEO ownership ranges from 5% to 10%. In the third subsample, the relationship between *Ownership* and *CC* is no longer significant. This lack of significance suggests that beyond a 10% ownership threshold, the relationship between CEO ownership and environmental commitment becomes less clear, possibly due to varying motivations or strategies at higher levels of ownership that do not uniformly affect environmental commitment. Therefore, H2 is partially validated. The control variables are consistent with our expectations and significance. However, we do not control for gender (*GND*) in the third subsample given that there is no CEO gender diversity in that sample.

Insert Table 4 about here

4.3. External shock: Policy Uncertainty Index

Next, to assess the impact of policy uncertainty during the study period, we employ an external shock to our initial model in Equ. (1) through adding the Policy Uncertainty Index (PUI) as an additional variable in our model. The PUI measures the degree of uncertainty about economic policies and their economic effects based on three components: the frequency of newspaper

articles that contain terms related to policy uncertainty, the number of federal tax code provisions set to expire in future years, and the degree of disagreement among economic forecasters about key variables such as inflation and government spending.[10] Previous studies have found that higher policy uncertainty is associated with lower economic growth, investment, employment, and trade volumes (Barnett et al., 2020; Newell and Pizer, 2004; Zhang et al., 2022). Policy uncertainty can also affect financial markets, consumer confidence, and business sentiment (Baker et al., 2015; Nicholas, 2009). Incorporating the PUI into our model appears relevant, as it allows for a better understanding of how external policy environments influence corporate sustainability strategies. Policy uncertainty can significantly impact CEOs' strategic decisions, particularly in areas sensitive to regulatory changes, such as carbon commitment. High levels of uncertainty may deter CEO owners, who typically have a long-term investment in the company, from committing to extensive carbon reduction initiatives due to the risk of future policy shifts undermining the economic rationale for such investments. Therefore, including PUI would help us isolate the direct impact of CEO ownership on carbon commitment to ensure the robustness of our results.

Table 5 reports the obtained results. The positive and statistically significant coefficient of *PUI* (0.320, $p < 0.01$) suggests that higher policy uncertainty is associated with an increase in firms' environmental commitment (*CC*). This counter-intuitive result may indicate that in times of policy uncertainty, firms potentially seek to bolster their environmental credentials as a risk management strategy, leveraging sustainability as a stable point of corporate identity amidst broader economic fluctuations. Such results are consistent with prior literature on ESG, and how it could be seen as an insurance-like protection (Godfrey et al., 2009; Kim and Park, 2020; Shahrour et al., 2021). The negative coefficient for *Ownership* (-0.239, $p < 0.05$) remains

[10] See: https://www.policyuncertainty.com/firm_pr.html

consistent with our previous findings, reaffirming the inverse relationship between CEO ownership levels and carbon commitment. This suggests that even after accounting for policy uncertainty, increased CEO ownership correlates with a decrease in carbon commitment.

Insert Table 5 about here

4.4. External shock: pre-Trump vs. Trump period

While the aforementioned discussion on policy uncertainty provides valuable context, one of the main challenges is to account for the significant policy shifts, in particular, by focusing on the distinct periods before and during Donald Trump's presidency, marked by the U.S.'s formal withdrawal from the Paris Agreement in 2017.[11] This decision could have significant implications for the behaviour of U.S. firms and their CEOs regarding their environmental commitments. The pre-trump period presumably incentivised efforts to align with the "greenness zone," reflecting a proactive stance towards carbon reduction initiatives. Conversely, the Trump era, marked by the U.S. retraction from the Paris Agreement, might have engendered a perception among CEOs that the previously binding international environmental commitments were less imperative. Consequently, we anticipate a potential shift in this era. Several studies have shown that the U.S. withdrawal from the Paris Agreement could increase global emissions and weaken international cooperation on climate action (Klaus et al., 2023). Therefore, we divided our sample into two subsamples, before and after 2017, marking the pre-Trump vs. the Trump era.

Table 6 reports the obtained results. Surprisingly, we find a significant negative relationship in the pre-Trump era, while an insignificant one in the Trump-era. During the pre-Trump era, the negative coefficient for ownership (-0.256, $p < 0.05$) suggests that higher CEO

[11] See: On the U.S. Withdrawal from the Paris Agreement - United States Department of State

ownership was somewhat associated with a lower level of environmental commitment. The results are in line with our prior findings, suggesting CEOs with higher ownerships were a bit less inclined towards environmental initiatives. This era, influenced by international agreements like the Paris Agreement, expected firms to demonstrate stronger environmental commitment, yet the slight negative tilt indicates other factors at play for firms with higher CEO ownership. The transition from the pre-Trump to the Trump era shows a shift in how CEO ownership relates to environmental commitment. During the pre-Trump era, higher CEO ownership slightly decreased environmental commitment. In the Trump era, this relationship weakened and was not statistically significant, indicating that changes in regulatory or policy priorities might influence how corporate governance structures, like CEO ownership, impact environmental strategies.

Insert Table 6 about here

4.5. Robustness:

To ensure the robustness of our findings, we examine the hypotheses above using a system of structural equations, where estimation is via three-stage least squares (3SLS). Structural equation modelling (SEM) is a statistical technique prepared for endogeneity problems, as indicated in the outstanding literature (Gregory-Smith et al., 2017; Raykov and Marcoulides, 1999). Table 7 reports the obtained results. The results confirm our previous findings, indicating a negative relationship between CEO ownership and carbon commitment. Thus, H1.b is validated. Regarding H2, within the lower ownership concentration bracket ([0 to 5%[), the significant negative coefficient for *Ownership* (-6.150, $p < 0.01$), suggests a noticeable entrenchment effect. Conversely, in the higher ownership concentration bracket ([10% < [), although the relationship between *Ownership* and the dependent variable *CC* remains significantly negative (-1.858, $p < 0.01$), the effect is less severe compared to the lower

concentration range. This pattern underscores the complex dynamic of the entrenchment effect, suggesting that while entrenchment concerns persist across varying levels of ownership concentration (except for the second subsample), their impact on firm outcomes is most acute at lower levels of concentration.

Insert Table 7 about here

As an additional approach to address potential concerns of endogeneity and reverse causality in our analysis, we employ the Arellano–Bover/Blundell–Bond GMM estimation method – which has been used in the literature (Abid, 2017; Adams and Ferreira, 2009; Bennouri et al., 2018; Fan et al., 2019), which is a dynamic panel model in which we include the lagged value of the dependent variable as an additional explanatory variable in our model.[12] Besides, we consider an alternative dependent variable to ensure our results are robust when using different measures. Our dependent variable is the carbon footprint (*Footprint*). We follow prior literature in calculating this measure by scaling the total emissions to EVIC (revenues and enterprise value including cash), which is one of the most used metrics to adjust the emissions for company size (Swinkels and Markwat, 2023). The model is presented as follows:

$$Footprint_{i,t} = \alpha_0 + \beta_1 L.Footprint_{i,t-1} + \beta_2 Ownserhsip_{i,t} + \sum_{j=3}^{8} \beta_j Controls_{i,t} + \varepsilon_{i,t} \qquad (2)$$

We retest our aforementioned hypotheses while focusing on the relationship between CEO ownership and carbon footprint, as opposed to carbon commitment. This adjustment stems from the rationale that an enhanced commitment to reducing carbon emissions inherently results in a lower carbon footprint, thereby offering a tangible and direct measure for our

[12] Pao and Tsai (2011) studied the relationship between the emissions–income and energy consumption–income and identified a strong reverse causality. That there is a strong bidirectional Granger causality between real output, energy consumption and emissions.

model's evaluation. This shift allows us to more precisely assess the impact of CEO ownership on environmental performance, underpinning our investigation with a metric that directly reflects the outcomes of corporate sustainability initiatives.

Table 8 reports the obtained results. The coefficient of *Ownership* is significantly related to the carbon footprint (-0.256, $p < 0.01$), indicating that an increase in CEO ownership is associated with an increase in carbon footprint. This finding aligns with our earlier observations, indicating that greater CEO ownership might lead to reduced emphasis on carbon reduction initiatives, thereby increasing the carbon footprint. This result supports H1.b, asserting that increased CEO ownership negatively impacts carbon commitment.

The analysis of different subsamples, particularly Sample 1 (0 to 5% ownership), where CEO ownership shows a significantly positive relationship with the carbon footprint (0.618, $p < 0.01$), underscores the variance in impact across ownership levels. However, the substantial decrease in observations, especially in Sample 2 and Sample 3, poses challenges for drawing definitive conclusions from these subsamples. The drastic reduction to 42 observations in Sample 2 underscores the potential for omitted variables bias and limits the reliability of findings in this specific segment.[13] Therefore, H2 is partially validated.

Insert Table 8 about here

In untabulated results, we conducted a quantile panel regression focusing on various levels of our dependent variable, carbon commitment (*CC*), and discovered a significant negative relationship with CEO ownership. This result aligns with our prior observations, further reinforcing the notion that increased CEO ownership is associated with a diminished

[13] The likelihood of omitted variables bias is accentuated by the significant drop in sample size when incorporating lagged variables, moving from 118 observations in the initial model to even fewer in subsequent analyses. This reduction complicates the ability to isolate the effects of CEO ownership on the carbon footprint accurately, indicating that some relevant variables may not be accounted for in the model.

commitment to carbon reduction. This consistency across different analytical approaches underscores the robustness of our results.

5. Conclusion

As we face one of the most pressing challenges of our time – climate change – it is crucial to understand how different factors can influence a company's commitment to reducing carbon emissions. Our study sheds light on the role of CEO ownership in this process, revealing significant findings. We find that higher CEO ownership is associated with a lower carbon commitment; however, we also identify the existence of an entrenchment effect. The results suggest that CEOs play a crucial role in determining a company's environmental policies and practices. CEOs significantly influence over a company's strategic direction, including its approach to environmental issues such as carbon emissions.

Our analysis thoroughly tests the robustness of our models by incorporating considerations for exogenous shocks, specifically accounting for policy uncertainty, and by contrasting the periods before and during the Trump administration. The impact of economic policy uncertainty on corporate behaviour, particularly in times of heightened uncertainty, further underscores the relevance of incorporating the policy uncertainty index into our model (Dreyer and Schulz, 2023). Additionally, through the application of various econometric methodologies and diverse measures (i.e., carbon footprint), our findings consistently demonstrate robustness.

Our study highlights the critical role of CEO ownership in addressing climate change, offering a roadmap for businesses, investors, and policymakers. This timely research adds to the growing literature on climate change and provides essential insights into the potential impact of CEO ownership on environmental sustainability. Our findings contribute to the

urgent global effort to tackle climate change, emphasising the need for sustainable practices across all industries.

Elevating corporate carbon performance to a greater extent is imperative in order to attain the global objective of regulating temperature escalation (Wojewodzki et al., 2023). By providing evidence on the entrenchment effect, businesses should foster a culture where CEOs prioritise environmental responsibility. For instance, consider setting emission reduction targets, investing in renewable energy, and adopting circular economy practices. For investors, it is recommended to engage with companies on climate-related matters, use shareholder voting rights to advocate for stronger environmental commitments, encourage companies to disclose climate risks, strategies, and progress. Integrating these factors into investment decisions can be beneficial, as companies with climate-conscious CEOs may outperform peers over the long term, as evidenced by the ESG-CFP literature. For policymakers, we recommend designing policies that incentivise CEO ownership aligned with climate goals. Tax breaks or performance-based incentives can encourage CEOs to prioritise sustainability. Additionally, setting robust disclosure standards for environmental reporting, requiring companies to disclose their carbon footprint, reduction targets, and progress can promote consistency and comparability across industries. Finally, fostering collaboration between businesses, investors, and governments through public-private partnerships can accelerate climate action. Policymakers should engage CEOs in shaping climate policies.

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6. List of Tables and Figures

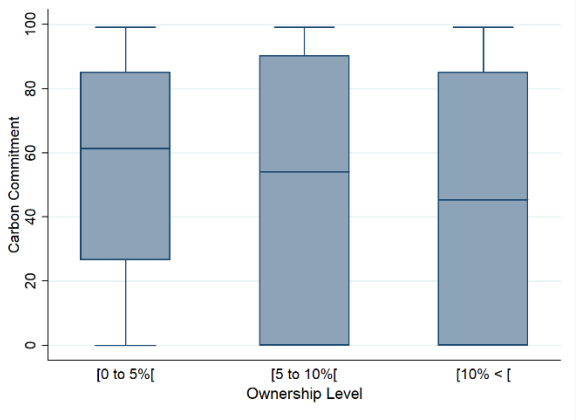

Figure 1: Carbon commitment variation per ownership level
Source: Authors' work

Table 1
Summary statistics

Variable	Min	Max	Mean	Median	SD	N
CC	0.00	99.91	51.80	57.87	33.29	5812
Ownership	0.00	19.52	1.09	0.20	2.99	5812
SIZE	5.13	15.12	9.83	9.77	1.45	5812
LEV	0.00	4.27	0.63	0.63	0.23	5812
GROWTH	-0.86	3.76	0.39	0.32	0.32	5812
PROF	-66.90	76.25	6.75	5.68	7.82	5812
AGE	28.00	86.00	57.08	57.00	6.37	5812

Table 2
Pearson pairwise correlation matrix

	CC	***Ownership***	***SIZE***	***LEV***	***GROWTH***	***PROF***	***AGE***
CC	1.00						
Ownership	**-0.15**	1.00					
SIZE	**0.46**	**-0.12**	1.00				
LEV	**0.14**	**-0.06**	**0.31**	1.00			
GROWTH	**0.04**	**-0.05**	**0.46**	**-0.04**	1.00		
PROF	**-0.03**	-0.01	**-0.28**	**-0.17**	**-0.39**	1.00	
AGE	**0.07**	**0.11**	**0.13**	**0.08**	**0.07**	-0.01	1.00

Note(s): *Coefficients in bold are significant to at least the 5% level.*

Table 3
CEO ownership vs. carbon commitment score

Variable	Equ. (1)
(Intercept)	-93.195***
	(-16.548)
Ownership	-0.239*
	(-1.915)
SIZE	13.613***
	(43.463)
LEV	0.241
	(0.139)
GROWTH	-7.946***
	(-5.263)
PROF	0.296***
	(5.834)
AGE	0.009
	(0.169)
GND	-5.001***
	(-2.936)
Industry effects	Yes
Year effects	Yes
N	5811
R^2	0.392
Adjusted R^2	0.389

Note(s): *This table reports the multivariate panel regression results from Equ. (1). The dependent variable is CC, the main explanatory variable is Ownership. SIZE, LEV, GROWTH, PROF, AGE, and GND are the control variables. The model includes industry and year effects. T-statistics are reported in parentheses. Superscripts ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 4
The entrenchment effect of CEO

Variable	Sample 1 [0 to 5%[	Sample 2 [5 to 10%[	Sample 3 [10% < [
(Intercept)	-89.074*** (-14.357)	-35.895 (-0.899)	-107.855*** (-4.687)
Ownership	-1.756*** (-3.288)	-6.346*** (-3.361)	-1.0419 (-1.443)
SIZE	13.135*** (39.163)	14.020*** (4.278)	14.926*** (8.749)
LEV	1.295 (0.733)	53.133*** (2.787)	-36.9549*** (-3.517)
GROWTH	-7.865*** (-5.081)	-23.015 (-1.606)	12.6315 (1.466)
PROF	0.294*** (5.584)	-0.072 (-0.205)	-0.5335** (-2.18)
AGE	0.001 (0.024)	0.384 (1.061)	0.8243*** (4.24)
GND	-5.080*** (-2.978)	-6.853 (-0.467)	
Industry effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
N	5518	118	175
R^2	0.387	0.781	0.619
Adjusted R^2	0.384	0.709	0.546

Note(s): *This table reports the multivariate panel regression results from Equ. (1). The dependent variable is CC, the main explanatory variable is Ownership. SIZE, LEV, GROWTH, PROF, AGE, and GND are the control variables. The model includes industry and year effects. T-statistics are reported in parentheses. Superscripts ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 5
The policy uncertainty index shock

Variable	Equ. (1) – PUI Shock
(Intercept)	-114.700***
	(-16.648)
Ownership	-0.239*
	(-1.915)
PUI	0.320***
	(10.074)
SIZE	13.610***
	(43.463)
LEV	0.241
	(0.139)
GROWTH	-7.946***
	(-5.263)
PROF	0.296***
	(5.834)
AGE	0.009
	(0.169)
GND	-5.001***
	(-2.936)
Industry effects	Yes
Year effects	Yes
N	5811
R^2	0.392
Adjusted R^2	0.389

Note(s): *This table reports the multivariate panel regression results from Equ. (1) while including PUI as an additional variable to account for policy shocks. The dependent variable is CC, the main explanatory variable is Ownership. SIZE, LEV, GROWTH, PROF, AGE, and GND are the control variables. The model includes industry and year effects. T-statistics are reported in parentheses. Superscripts ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 6
Pre-Trump vs. Trump era

Variable	Pre-Trump [2006 – 2016]	Trump Era [2017 – 2021]
(Intercept)	-106.960***	-44.320***
	(-15.001)	(-6.239)
Ownership	-0.256*	-0.152
	(-1.744)	(-0.608)
SIZE	15.000***	11.380***
	(36.472)	(23.796)
LEV	-5.190**	5.694**
	(-2.067)	(2.438)
GROWTH	-9.325***	-6.256***
	(-4.681)	(-2.731)
PROF	0.240***	0.294***
	(3.527)	(3.919)
AGE	0.057	-0.073
	(0.770)	(-0.894)
GND	-4.243*	-5.280**
	(-1.671)	(-2.399)
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	3505	2306
R^2	0.382	0.295
Adjusted R^2	0.377	0.288

Note(s): *This table reports the multivariate panel regression results from Equ. (1), after dividing our sample into two subsamples (pre-Trump vs. Trump era). The dependent variable is CC, the main explanatory variable is Ownership. SIZE, LEV, GROWTH, PROF, AGE, and GND are the control variables. The model includes industry and year effects. T-statistics are reported in parentheses. Superscripts ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 7
Structural equation modelling

Variable	Entire Sample	Sample 1 [0 to 5%[	Sample 2 [5 to 10%[	Sample 3 [10% < [
(Intercept)	-63.409***	-53.264***	-123.167***	-72.261***
	(-14.020)	(-11.130)	(-4.050)	(-3.740)
Ownership	-1.045***	-6.150***	0.900	-1.858***
	(-8.230)	(-11.510)	(0.450)	(-2.650)
SIZE	13.180***	12.120***	21.119	14.077***
	(41.460)	(35.590)	(9.770)	(8.920)
LEV	-8.099***	-7.218***	12.563	-54.432***
	(-4.600)	(-4.040)	(0.770)	(-5.140)
GROWTH	-21.943***	-20.800***	-36.811***	-9.050
	(-15.410)	(-14.260)	(-3.720)	(-1.120)
PROF	0.169***	0.195***	-0.774**	-0.416*
	(3.160)	(3.560)	(-1.980)	(-1.710)
AGE	0.142***	0.161***	-0.254	0.749***
	(2.380)	(2.450)	(-0.820)	(3.980)
GND	-9.318***	-9.105***	-10.409	
	(-5.060)	(-4.970)	(-0.590)	
N	5811	5518	118	175
R^2	0.270	0.274	0.468	0.425
RMSE	28.443	28.085	28.443	26.066

Note(s): *This table reports the structural equation modelling using three-stages least squares (3SLS). The dependent variable is CC, the main explanatory variable is Ownership. SIZE, LEV, GROWTH, PROF, AGE, and GND are the control variables. T-statistics are reported in parentheses. Superscripts ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 8
Endogeneity correction with carbon footprint

Variable	Equ. (2)	Sample 1 [0 to 5%[	Sample 2 [5 to 10%[	Sample 3 [10% < [
L.Footprint$_{t-1}$	0.319***	0.156***	52.556	1.0695***
	(81.64)	(19.44)	(1.14)	(40.17)
(Intercept)	-5.882***	-24.549***		-132.292
	(-6.4)	(-6.12)		(-0.2)
Ownership	0.285***	0.618***	-118.743	-0.102
	(59.800)	(2.740)	(-1.170)	(-0.290)
SIZE	1.214***	2.063***	199.385	1.660***
	(14.160)	(4.790)	(1.120)	(2.260)
LEV	-9.360***	-0.720	512.849	-14.720***
	(-26.420)	(-0.450)	(1.150)	(-5.930)
GROWTH	-2.997***	0.393	60.519	-1.941
	(-12.100)	(0.680)	(1.030)	(-1.040)
PROF	0.042***	0.012	-4.469	0.332***
	(8.160)	(1.220)	(-1.140)	(5.270)
AGE	-0.011***	0.001	-16.590	-0.282***
	(-2.050)	(0.020)	(-1.080)	(-2.920)
GND	-3.808***	-2.454***	0.000	138.104
	(-14.130)	(-4.440)	(0.000)	(0.210)
N	3444	2841	42	360

Note(s): *This table reports the Arellano–Bover/Blundell–Bond results as specified in Equ. (2). The dependent variable is Footprint, the main explanatory variable is Ownership. SIZE, LEV, GROWTH, PROF, AGE, and GND are the control variables. T-statistics are reported in parentheses. Superscripts ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively.*