
Exploring Policy engagement: The Impact of Public Policy and Carbon Emissions

Abstract: The complexity of governance patronage among firms, especially in relation to their policy engagement and its influence on corporate carbon emissions, presents a multifaceted challenge. This study delves into a detailed analysis of how varying levels of policy engagement influences corporate carbon emissions. Our results reveal that intensified policy engagement does not necessarily translate to a reduction in significant carbon emissions but may instead heighten symbolic carbon emissions, a phenomenon more evident in smaller firms. What's more, we find that carbon awareness reflects a significant negative moderating effect on the relationship between corporate policy engagement and substantive carbon emissions. When firms aim to reduce emissions, the effective resources generated by these policy activities will inevitably tilt towards the reduction of substantive emissions reductions. Our research underscores that while strategic policy engagement can yield advantageous outcomes for firms, its effectiveness is heavily reliant on the specific environmental strategies and conditions of each firm.

Keywords: Policy engagement, Symbolic carbon emissions, Substantive carbon emissions, Carbon Management Strategy

1. Introduction

In the past few years, climate change has emerged as a crucial socio-political issue, coinciding with increasingly proactive market responses to address this global challenge. Due to substantive variations in regulatory regimes across countries, businesses encounter diverse challenges, significantly impacting their strategies and competitiveness (Lu et al., 2022). Consequently, a growing number of

firms are turning to political intervention as a means to tackle climate-related issues (Klusak et al., 2023; Huang et al., 2022).

Extending beyond the scope of their internal operations and supply chains, firms are now actively adopting political strategies to navigate the uncertainties stemming from the regulatory landscape (Gao and McDonald, 2022; Hadani et al., 2017). This shift has transformed the partnership dynamics between governmental administrations and businesses, with corporate political activity becoming increasingly influential in shaping public policy (Liedong, 2021; Tyllström and Murray, 2021). Accordingly, there is an escalating expectation for firms to engage in long-term commitments with political activities to enhance corporate environmental quality (Haque and Ntim, 2018).

The intersection of climate change, regulatory dynamics, and policy engagement is reshaping how businesses approach sustainability and collaborate with governments to address this pressing global issue through political channels. Climate change imposes significant pressures, compelling governments to more comprehensively address environmental issues in public policy (Chai et al., 2020). In regions like Europe and North America, companies are increasingly adopting proactive stances by aligning with public policies **targeted at curbing** the impact of climate change on their operations (Setzer and Higham, 2021). As awareness of climate change intensifies, the public and investors are increasingly holding firms accountable for their actions concerning climate change, scrutinizing their political activism, affiliations with trade groups, and involvement in political strategies (De Angelis et al., 2022; Garel and Petit-Romec, 2021). Thus, **public policies serve as a linchpin in shaping corporate behavior**, offering incentives or imposing constraints. Government interventions through these policies can directly affect firm interests, both positively and negatively. Scholars have observed that the **character of the interplay between firms**, political actors, regulators, and government bureaucrats can directly influence firm performance (Van Den Broek, 2022; Yan and Chang, 2018). Hence, enhanced engagement with political processes allows firms to leverage these

activities to their advantage.

Recent evidence suggests that public policy has a significant influence on firm performance. As a policy engagement behavior of firms, lobbying activities can accumulate political capital to enhance firm's value (Anderson et al. 2023; Vadakkepatt et al. 2022). As a vital component of the zero-sum political game, it is important to point out that corporate lobbying activities primarily advance their own interests, which may not always align with societal expectations (Ongis and Davidai 2022; Baumgartner et al. 2009). Just as firms join trade associations, although these trade associations are responsible for self-regulation and regulating member behavior (Barnett and King, 2008), firms may also use the pooled resources of trade associations primarily to serve their individual interests, rather than the collective interests of the association's membership (Brühler and Downey, 2022; Williams et al., 2022). Especially in larger firms, due to disparities in resources, they exert control over trade association agendas for their specific interests (Barnett, 2013). Technological development has also become a strategic focus for businesses in addressing environmental degradation and externalities (Mullen and Marcus 2019). The firm's own R&D necessitates substantial capital costs and entails greater risks. However, funding research institutions can effectively alleviate the financial pressures associated with R&D (He et al. 2021, Lee and Min 2015). In this way, multiple firms can also develop collaboratively and benefit from technological advancements. Therefore, given the pivotal function of corporate policy participation in responding to climate change, this paper seeks to explore the influence of corporate policy engagement on their carbon emission strategies and dissect the key contingent factors on which this process depends.

Our study aims to make several additions to the scholarly corpus. First, we bridge a void in empirical research by investigating the relationship between policy engagement and corporate carbon

emissions. While some prior studies, such as Rajwani et al. (2015), have touched upon the influence of trade associations on firms and highlighted their theoretical and practical importance, **empirical inquiry into this topic remains strikingly scarce. Similarly, Delmas et al. (2016) explored the effect of corporate policy engagement on carbon emissions, but their focus was solely on lobbying. In our empirical analysis, we comprehensively explore the impact of diversified policy engagement on carbon emissions, thereby enriching the existing literature theoretically.**

Second, we delineate the boundary conditions governing the relationship between corporate policy engagement and corporate carbon emissions. This includes examining whether corporate carbon awareness and sustainable carbon practices moderate the relationship between policy engagement and carbon emissions. By investigating these moderating effects, we provide deeper insights into the dynamics of corporate policy engagement and **its influence on carbon emissions.**

Lastly, our study provides a novel lens by applying institutional theory to our research. This approach enables us to gain fresh insights into policy behavior and its implications for firms' carbon emissions. By extending the application of institutional theory to interpret corporate policy engagement, we present novel theoretical contributions to the existing literature and provide empirical evidence that can facilitate the continued development of institutional theory.

Overall, through empirical research, examination of boundary conditions, and the application of institutional theory, **our study brings substantive academic merit and deepens our insight into the complex interplay between policy processes,** corporate behavior, and carbon emissions. We hope that our contributions will inspire further research and policy development in pursuit of sustainable and environmentally responsible practices within the corporate sector.

The article proceeds as follows: Section 2 sets forth an overview of previous studies, along with

the theoretical background supporting the study. Then, we present the formulation of hypotheses grounded in the information gathered in the preceding sections. Section 3 outlines the data sources utilized in the research and describes the research methodology. Section 4 lists the empirical results obtained from the data analysis and provides a comprehensive analysis of these findings. Lastly, Section 5 concludes the paper, boiling down the key findings, examining their implications, and proposing future research directions.

2. Theoretical framework, previous studies, and hypothesis development

2.1 Institutional theory

Institutional theory serves as a powerful lens to examine the influence of societal norms, values, and practices on organizations and individuals (Meyer and Rowan, 1977). This theory explores how formal and informal rules and routines guide behaviour, with a particular emphasis on environmental considerations. It highlights how institutions bring stability, confer legitimacy, and maintain social order, shaping organizational actions towards environmental stewardship.

In the environmental context, institutional theory can be viewed from several aspects. Firstly, there's the impact of regulatory pressures. Environmental regulations imposed by governments and international bodies compel organizations to adopt sustainable practices and invest in climate-friendly technologies, not only for compliance but also to avoid penalties or reputational risks. Secondly, normative expectations from society play a critical role (Tolbert and Zucker, 1983, 1996; DiMaggio, 1988). These societal norms and values about environmental responsibility deeply influence organizational behaviour, driving them towards adopting eco-friendly practices, sometimes even in the absence of stringent regulations. What's more, the theory also underscores the influence of key stakeholders, ranging from customers, investors, and employees to environmental advocacy groups,

on shaping organizational environmental strategies. The preferences and demands of these stakeholders can influence a firm's environmental practices, as they seek to align with societal values and expectations. Whereas stakeholders' expectations often lead organizations to mimic the sustainable practices and initiatives of successful peers or industry leaders, this behavior—known as mimetic isomorphism—is more focused on legitimacy and competitiveness than mere compliance. Additionally, institutional theory explores the diversity in organizational approaches towards environmental responsibility, termed as 'institutional logics'. This diversity results in different prioritizations, ranging from firms focusing on immediate profit maximization to those emphasizing long-term environmental and social responsibilities. The theory also highlights the role of 'institutional entrepreneurs' - like environmental activists and non-governmental organizations - who challenge existing norms and advocate for sustainable practices and stricter regulations.

In summary, institutional theory elucidates our results not as mere economic calculations, but as strategic maneuvers within an institutional field. Firms navigate policy engagement, stakeholder expectations, and internal cognitive shifts to construct and maintain legitimacy, resulting in the complex pattern of symbolic and substantive carbon emissions.

2.2 Overview of public policy engagement status related to climate change

Figure 1 describes the graphical representation of sample firms' instances and the degree of public policy engagement in the US over the period from 2012 to 2019, there has been a consistent upward trend in firms' engagement with public policy regarding climate change. The count of firms exhibiting various levels of engagement with public policy demonstrates a year-on-year increase. Notably, the degree of firm public policy engagement varied from 305 in 2012 to 841 in 2019. The trend of

increasing corporate policy activity on climate issues signifies a field-level institutionalization of climate change as a critical arena for corporate policy strategy.

[INSERT FIGURE 1 HERE]

2.3 Policy engagement and Carbon Emission Dynamics

Policy engagement in environmental policy is an intricate institutional outcome, influenced by a dynamic interplay of forces involving citizens, firms, and governments. These entities are critical decision-makers in the policy process, with each group holding varying degrees of influence and authority. Governments, with their exclusive legislative power, are central in this matrix, while firms and citizens actively shape policies through their engagements. This dynamic is crucial for managers representing firms, as they must navigate this complex landscape to implement policies effectively, aligning with the broader intentions of decision-makers (Hill and Hupe, 2005). In this context, firms hold both a moral and legal imperative to be proactive in policy engagements, influencing policy formulation rather than merely reacting to it (Werner, 2015).

Although scholars have done some empirical research on policy engagement and corporate carbon emissions, the results are not uniform and depend on the design, implementation of policies and the commitment levels of the firms involved. Some studies propose that policy engagement **has active effect on firms' competitive strategy and performance** (Richter, 2011; Delmas and Montes-Sancho, 2010). Engaging with environmental policies keeps firms abreast of regulatory developments and emission reduction targets set by governments. Compliance with these policies enables firms to mitigate their carbon footprint, thereby avoiding potential penalties and reputational harm. High-polluting firms are active in political tactics to reduce their policy pressures (Cho et al., 2006). Some scholars have further found that not only high-polluting companies but also greener

companies are competing for political influence, as stricter environmental standards can give green companies an advantage over their competitors (Delmas et al., 2016). Some policies offer incentives for adopting green practices and reducing emissions, such as tax benefits, grants, or subsidies. These incentives encourage firms to adopt emission reduction measures. Additionally, through policy engagement, firms gain access to valuable resources, including research, expertise, and funding, which are instrumental in implementing innovative technologies and sustainable practices for lower emissions. Furthermore, policy engagement bolsters a firm's environmental reputation, enhancing its standing among stakeholders, customers, and investors who prioritize sustainability. Engagement in policy discussions also aligns firms with the growing emphasis on low-carbon technologies and green markets, enabling them to leverage emerging market opportunities tied to sustainable products and services. In essence, policy engagement aligns firm strategies with global climate initiatives, **fostering enduring organizational resilience and viability in a changing regulatory landscape**. However, there are also companies affected by carbon emission measures that try to lobby to delay the development of treaties and legislation (Beder, 2014). **Quite a few organizations believe that economic competitiveness must take precedence over climate goals**. To avoid the resulting economic disadvantage, they acted as quiet reactionaries, lobbying here becomes a means of delaying climate policy (Vesa et al., 2020). Given this, we argue that proactive engagement with policymakers sometimes aims to align public policies with firms' developmental needs, potentially influencing policy outcomes to suit their interests. Firms may engage in lobbying to shape regulations and policies favoring their immediate interests and profit goals, possibly overlooking significant carbon emissions reductions. Therefore, we propose the following hypotheses:

H1(i): Policy engagement increases a firm's substantive carbon emissions.

H1(ii): Policy engagement increases a firm's symbolic carbon emissions.

2.4 Carbon Awareness, Policy engagement, and Carbon Emissions

Corporate carbon awareness, a critical aspect of broader environmental consciousness, reflects a firm's ability to proactively recognize and address carbon-related opportunities and risks. This awareness guides the importance placed on carbon management strategies and directs business operations. Firms highly aware of carbon implications are better positioned to implement proactive strategies against climate change risks (UNEP, 2006), enhancing shareholder value and securing competitive advantages. For example, Centrica's integration of carbon trading into its strategy illustrates proactive adaptation to carbon regulations and market conditions. Recognizing the significance of government regulations, litigation risks, and reputation, firms engage with political policies not only as a compliance strategy but also to influence and shape regulations in line with their business interests and sustainability commitments (Jung et al., 2018).

Companies with elevated carbon awareness are expected to not only support but also actively advance substantive carbon reductions. Their insight into carbon risks and opportunities motivates them to engage with political policies, seeking policy support to foster favorable business environments and aligning policy influence with sustainability goals. Therefore, as firms' carbon awareness heightens, they tend to favor real and meaningful efforts to reduce emissions over merely symbolic actions. Based on these observations, we propose:

H2 (i): Carbon awareness weakens the active relationship between policy engagement and substantive carbon emissions.

H2 (ii): Carbon awareness weakens the active relationship between policy engagement and symbolic carbon emissions.

2.5 Intensity Targets, Policy engagement, and Carbon Emissions

Firms are increasingly emphasizing their commitment to sustainability by reporting greenhouse gas (GHG) reduction targets in their Global Reporting Initiative (GRI) reports and/or through carbon disclosure projects (CDP). According to a survey of U.S. firms, 40% have published sustainability reports, with 80% of these reports listing carbon dioxide reduction targets (Price Waterhouse Cooper 2013). Establishing carbon reduction targets has become a "must-do" for firms (Byrd et al. 2014), signaling a growing awareness of their responsibility to address climate change. These targets play a crucial role in triggering cognitive and motivational processes within firms, driving changed behaviors and encouraging a focus on emissions reduction (Locke and Latham 2009, Zhang and Jia 2013). Firms setting emission reduction targets demonstrate greater ambition for emissions reductions and commit to longer-term efforts, leading to significant reductions in their carbon emissions. Indeed, these targets genuinely reflect substantive intentions to reduce emissions (Dahlmann et al. 2019). By using intensity targets, firms can promote public policy engagement that goes beyond merely pursuing profit, with a stronger emphasis on substantive emissions reductions. Intensity targets offer a balanced approach, showcasing firms' active efforts in emissions reduction while avoiding potential suppression of firm growth. When a firm adopts intensity targets, it is generally committing to reducing its carbon emissions per unit of output, which aligns with meaningful efforts to combat climate change. The focus on actual emissions reductions, driven by intensity targets, **should not result in a growth in symbolic carbon emissions**, as the aim is to make real progress in carbon footprint reduction. Consequently, we hypothesize:

H3(i): Intensity targets weaken the active relationship between policy engagement and substantive carbon emissions.

H3(ii): Intensity targets weaken the active relationship between policy engagement and symbolic carbon emissions.

2.6 Voluntary Disclosure, Policy engagement, and Carbon Emissions

Voluntary environmental disclosures are strategic actions undertaken by firms to share both quantitative and qualitative nonfinancial data related to environmental aspects. This transparency initiative bridges a knowledge imbalance between a firm and external stakeholders involved in its activities, enhancing stakeholder understanding and trust (Adhikari and Zhou, 2022). Consistent with economic theories, firms often voluntarily disclose favorable environmental information while being more reticent about less favorable data. This selective disclosure serves as a reputational management tool and fulfills the firm's need for legitimacy (Luo, 2019). On one hand, the disclosure process enables the assimilation of stakeholder norms and expectations, driving performance improvements (Kurnia et al., 2020). Additionally, voluntary disclosure minimizes potential regulatory interference (De Villiers and Van Staden, 2006; Blacconiere and Patten, 1994). Firms engaged in voluntary disclosure typically face less resistance in public policy interactions, allowing them a more influential role in shaping policy discussions. Moreover, carbon disclosure reflects managers' concerns about sharing carbon-related information, which, in turn, encourages companies to proactively cut emissions and enhance carbon performance (Burritt and Schaltegger, 2010). We contend that increased attention to carbon-related issues steers firm policies toward more substantive emission reduction initiatives. Voluntary disclosure thus emerges as a catalyst for firms to bolster their environmental performance, especially in contexts involving public policy engagement. In practice, voluntary disclosure often stems from a firm's desire to polish its corporate image, address stakeholder calls for transparency, and showcase its commitment to sustainability. Through such disclosures, firms frequently highlight

their carbon emission reduction efforts, renewable energy initiatives, carbon offset programs, and other climate-friendly endeavors. Symbolic carbon emissions are actions taken by firm sthat represent actions that may superficially address climate change, often motivated by public relations or image-enhancing goals. While Voluntary disclosure can create positive publicity and enhance a firm's image, it does not directly influence the level of symbolic carbon emissions. Consequently, we propose the following hypotheses:

H4(i): Voluntary disclosure weakens the active relationship between policy engagement and substantive carbon emissions.

H4(ii): Voluntary disclosure weakens the active relationship between policy engagement and symbolic carbon emissions.

Figure 2 in our conceptual framework visualizes the dual research aspects: the impact of firm engagement with **various policy approaches** on carbon emissions and the efficacy of these policies in varying corporate contexts. Our hypotheses inform the depicted interrelationships within this framework. Additionally, Figure 2 illustrates the moderating role of policy engagement on carbon emissions.

[INSERT FIGURE 2 HERE]

3. Methodology

3.1 Data descriptions and source

We utilize data related to carbon emissions from the CDP report. Founded in the United Kingdom in 2002, CDP obliges the world's largest enterprises to disclose details regarding their carbon emissions and measures they are implementing to address climate change. Over time, CDP has not only become the standard for carbon emission disclosure methodology but also a crucial database for scholars

studying how firms respond to climate change.

The CDP report comprises fourteen sections (CDP, 2019), several of which are pertinent to this research. The first section introduces the firms, providing information about their names and industries. The third section focuses on firms' identification of opportunities and risks from climate change, providing insights into climate change awareness. The fifth section pertains to firms' targets and performance in addressing climate change, offering data on intensity targets and symbolic carbon emissions. The seventh section presents detailed information about the firm's accounting **for carbon emissions, including Scope 1, 2, and 3 emissions** for listed firms. The twelfth section provides carbon prices, furnishing information on whether firms are regulated by carbon emission trading schemes. The thirteenth section gives comprehensive information about the firm's engagement, including details on the policy selection of firms, specific policies they engage with, and voluntary disclosures.

To gather control variable-related data, we use the Compustat database. The study employs unbalanced panel data from 2012 to 2019, covering 601 U.S.-listed firms. After meticulously matching the two databases based on firm names and eliminating missing data, we obtain a total of 2,987 observations.

3.2 Dependent variables

Substantive carbon emissions (CE). The GHG Protocol defines the range of each firm's GHG emissions, including **Scope 1, 2, and 3 emissions** (Ranganathan et al., 2004). Scope 1 and Scope 2 **stand for** GHGs emitted directly and indirectly by firms, respectively. To measure the substantive carbon emissions, we use the sum of **Scope 1 and 2 emissions**.

Symbolic carbon emissions (SCE). SCE refers to the environmental management and institutional reforms implemented by firms in response to environmental policies, and without involving specific

upgrades to production processes (Zhang et al., 2024). *SCE* is measured by adding 12 dummy variables proxying for enterprises' level of involvement in emission reduction activities. An elevated index value signifies a higher degree of symbolic carbon emissions for an enterprise, as shown in Table 1. Consequently, an enterprise's *SCE* score spans from 0 (signifying no or zero carbon emission reduction measures implemented) to 12 (indicating the full, 100% adoption of carbon mitigation initiatives).

[INSERT TABLE 1 HERE]

3.3 Independent variable

The degree of policy engagement (PED). We create a continuous variable to represent the company's level of engagement with policy related to climate change. The data for this variable were obtained from a question in the CDP report, which asks: "Do you engage in activities that could either directly or indirectly influence public policy on climate-related issues through any of the following?" The answers are shown in Table 2, and based on these responses, we calculate a score ranging from 0 to 3.

[INSERT TABLE 2 HERE]

Policy selection (PS). A dummy variable that, if firms engage with any public policies on climate change, has a value of "1", otherwise "0".

3.4 Moderating variables

Carbon awareness (Regulation). A binary variable coded as "1" if a firm recognizes any climate change risks and opportunities, and "0" otherwise.

Intensity targets (Intensity). A dummy variable that, if firms have intensity targets for emissions reduction, has a value of "1", otherwise "0".

Voluntary disclosure (Voluntary) A binary variable that takes the value of “1” if a firm publicly discloses information regarding its climate change response and carbon emissions performance through channels other than its CDP submission, otherwise “0”.

3.5 Control variables

Firm size (*Fsize*) is considered to account for firm characteristics related to size (Kolk and Pinkse, 2004). Additionally, firms’ awareness of engagement with public policy might be influenced by previous state-level politics and regulations, where climate change legislation in different states can cause considerable variations in firm actions. Thus, we incorporated two binary variables indicating whether a firm’s headquarters is a member of the Regional Greenhouse Gas Initiative (*RGGI*) and whether the firm participates in any emission-trading schemes (*ETS*). Furthermore, Carbon sensitivity (*Carbon*) is a binary variable that judges whether the firms belong to carbon-sensitive sectors. Carbon-sensitive firms face more requirements of environmental regulations (Finnerty et al., 2018) and also often have the capacity to shape policies and political processes (Vieira et al., 2023). Additionally, several financial variables are included. We consider that less leveraged firms are likely to possess more discretionary resources to engage with public policy, making the Leverage ratio (*Lev*) a relevant control variable. We use the net return on assets (*ROE*) and the market-to-book value (*M/B*) as proxies for firm performance. To account for variations in available cash, we also include Cash holdings (*Cash*). For further details on variable operationalization and summary statistics, please refer to Table 3.

[INSERT TABLE 3 HERE]

3.5 Empirical models

We adopt the Hausman test for selecting between fixed and random effects models, and the test outcome rejects the presence of systematic differences in coefficients ($p=0.000$). Accordingly, we proceed with the panel fixed effects model to examine the association between a company's degree of policy engagement and carbon emissions.

$$Y_{i,t} = \alpha + \beta_1 PED_{i,t} + \delta' X_{i,t} + \gamma T_t + \theta F_i + \varepsilon_{i,t} \quad (1)$$

where $Y_{i,t}$ represents the enterprise's carbon emissions. It includes substantive carbon emissions and a symbolic carbon emissions reduction. $PED_{i,t}$ denotes the degree of policy engagement. $X_{i,t}$ consists of a sequence of vectors representing the control variables. T_t is the year dummy variable, used to control for secular temporal trends. F_i is the firm dummy variable, introduced to control for differences across firms. $\varepsilon_{i,t}$ denotes the error term.

Furthermore, we explore the potential moderating effect of the firm's degree of engagement with public policy on climate change and carbon emissions.

$$Y_{i,t} = \alpha + \beta_1 PED_{i,t} + \beta_2 PED_{i,t} \times Regulations + \delta' X_{i,t} + \gamma T_t + \theta F_i + \varepsilon_{i,t} \quad (2)$$

$$Y_{i,t} = \alpha + \beta_1 PED_{i,t} + \beta_2 PED_{i,t} \times Intensity + \delta' X_{i,t} + \gamma T_t + \theta F_i + \varepsilon_{i,t} \quad (3)$$

$$Y_{i,t} = \alpha + \beta_1 PED_{i,t} + \beta_2 PED_{i,t} \times Voluntary + \delta' X_{i,t} + \gamma T_t + \theta F_i + \varepsilon_{i,t} \quad (4)$$

where $Regulations_{i,t}$ is climate change awareness, $Intensity_{i,t}$ is intensity targets, and $Voluntary_{i,t}$ is voluntary disclosure.

4. Results and discussion

4.1 Descriptive statistics

Table 4 displays the descriptive statistics for the main variables. CE spans from 0 to 18.81, featuring a mean of 12.55 and a standard deviation (S.D.) of 3.238. As for SCE , spanning from 0 to 11, featuring

a mean of 3.007 and a S.D. of 1.948. The average value of *PS* is 0.646, with a S.D. of 0.478, indicating that more than half of the firms tend to engage with public policy. Furthermore, the variable *PED* ranges from 0 to 3, featuring a mean of 1.201 and a S.D. of 1.087. This suggests that although firms engage with public policy, the implementation is not strong.

[INSERT TABLE 4 HERE]

The Pearson correlation coefficient is suitable for continuous data that follow a normal distribution, but many of the variables in our dataset are dummy variables (De Winter et al., 2016). Therefore, to measure the association of discrete variables, we use the Spearman rank correlation coefficient (Mesfioui et al., 2018). Both the results of the correlation coefficient are simultaneously listed in Table 5. Before conducting the regression tests, it was important to perform multivariate analysis to examine the relationships among the variables. The maximum variance inflation factor is 3.06, which falls significantly below the widely recognized threshold of 10 and even beneath the stricter cutoff of 5 (Jeng, 2023). This suggests that the variables do not suffer from any serious issues of multicollinearity.

[INSERT TABLE 5 HERE]

4.2 Baseline regression results

Table 6 reports the impact of policy engagement and control variables on carbon emissions. We find that policy engagement is positively associated with a firm's symbolic carbon emissions ($\beta_{SCE} = 0.4173$, $p_{SCE} < 0.01$; $\beta_{SCE} = 0.2776$, $p_{SCE} < 0.01$), but instead of leading to a reduction, it actually results in an increase in substantive carbon emissions ($\beta_{CE} = 0.2236$, $p_{CE} < 0.1$; $\beta_{SCE} = 0.1235$, $p_{CE} < 0.01$). It indicates that for every S.D. increase in *PED*, *CE* will increase by about 4.1%, while the *SCER* will increase significantly by about 15.5%. Firms show obvious symbolic management

tendencies in policy engagement, and the response intensity of their symbolic behaviors is about three times that of substantive emission reduction behaviors.

For control variables, the positive coefficient for *Fsize* indicates that large firms have a greater need for carbon emissions than do small firms ($\beta_{CE} = 0.3364, p_{CE} < 0.05$; $\beta_{CE} = 0.3383, p_{CE} < 0.05$) but also need to achieve greater reduction in symbolic carbon emission compared to small firms ($\beta_{SCE} = 0.3157, p_{SCE} < 0.01$; $\beta_{SCE} = 0.3155, p_{SCE} < 0.01$). The negative coefficient for *M/B* on *CE* suggests greater firm market performance corresponds to a lower level of substantive carbon emissions ($\beta_{CE} = -0.4818, p_{CE} < 0.01$; $\beta_{CE} = -0.4857, p_{CE} < 0.01$) and a lower level of symbolic carbon emissions ($\beta_{SCE} = -0.3265, p_{SCE} < 0.01$; $\beta_{SCE} = 0.3346, p_{SCE} < 0.01$). It is worth noting that a firm's emissions liability may result in a decline in the book value of long-term assets and adversely affect cash flow ($\beta_{CE} = -1.5583, p_{CE} < 0.05$; $\beta_{CE} = -1.5564, p_{CE} < 0.05$). This is consistent with Yongqing et al. (2013). Furthermore, the negative coefficient for *Rggi* on *SCE* indicates that becoming a member of the RGGI effectively constrains the symbolic carbon emissions of firms ($\beta_{SCE} = -1.2692, p_{SCE} < 0.01$; $\beta_{SCE} = -1.2699, p_{SCE} < 0.01$).

[INSERT TABLE 6 HERE]

4.3 Robustness test

Since the sample comprises only firms that voluntarily report their carbon emissions, there is a high risk of selectivity bias. To address this issue, our robustness tests are conducted through three different regression approaches.

First, we employ the two-step Heckman selection model. In the initial step, the probit model is employed to estimate the propensity of all firms to voluntarily disclose carbon emissions. In the second step, we incorporate the estimated dummy variable into the OLS model to alleviate selectivity

bias and calculate the regression parameters. Table 8, Panel A displays the results for the Heckman model, with the following covariates: (i) Emission trading schemes (*ETS*), indicating whether firms participate in any emission trading schemes; (ii) Internal carbon price (*ICP*), indicating whether firms adopt internal carbon price mechanisms; (iii) Voluntary disclosure (*Voluntary*), indicating whether firms disclose details regarding their climate change response measures and emission performance outside their CDP response; (iv) Avoid third-party emissions (*Thirty*), indicating whether the goods and/or services used by firms directly enable third parties to avoid emissions, and (v) Research and development (*R&D*), indicating the amount of R&D invested by firms in the year. In columns (1) and (2), all covariates are found to be statistically significant, and the effect of policy engagement (*PED*) on carbon emissions (*CE*) remains significant without selectivity bias ($\beta_{CE} = 0.7448$, $p_{CE} < 0.01$).

Second, the causal relationship between the degree of policy engagement and carbon emissions is complex to determine. Corporate carbon emissions can influence their inclination to engage with public policy, as larger-emitting firms may seek governance patronage through such engagement. We argue that firms' engagement with public policy can impact future carbon emissions, while the degree of policy engagement in the current year does not directly influence carbon emissions from the prior year. To address this endogeneity issue, we utilize the degree of policy engagement lagged by one year as the instrumental variable in a two-stage least squares regression, with the results displayed in Table 8, Panel B. In column (3), the model passes the Hansen test ($\beta = 3.062$), supporting the baseline results ($\beta_{CE} = 0.033$, $p_{CE} < 0.1$).

Third, the dynamic two-step system Generalized Method of Moments (GMM) is commonly adopted to handle potential endogeneity issues (Blundell and Bond, 1998; Arellano and Bond, 1991). In GMM regression, we consider *PED* as an endogenous variable, and its first lag is utilized as an

instrument. **Table 8, Panel C, displays the results.** Notably, in column (4), we observe that *PED* exhibits a statistically significant positive effect on *CE*, with robust results ($\beta_{CE} = 0.4163, p_{CE} < 0.01$).

We present the robustness test results for *CE* here, while the robustness test results for *SCE* are provided in Appendix A. **Findings from Table 7 and Appendix A** are consistent with our findings from Table 6 in the previous section. Greater policy engagement by firms does not lead to a decrease in substantive carbon emissions; rather, it decreases symbolic carbon emissions (i.e., positively associated to symbolic carbon emissions (*SCE*)).

[INSERT TABLE 7 HERE]

4.4 Additional analysis

4.4.1 The impact of firm size and carbon sensitivity on the association between policy engagement and carbon emissions

Our analysis encompasses all firms and industries, and we further categorize them based on their size and carbon sensitivity. By conducting a comparative analysis of large and small firms, **as well as carbon-sensitive and non-carbon-sensitive firms, we explore the effect of a firm's policy engagement on both substantive and symbolic carbon emissions,** considering these two firm characteristics. To categorize firms by size, we use the mean firm size, defining firms above the mean as large firms and those below the mean as small firms. Subsequently, we adopt the classification of carbon-intensive industries provided by Zhou et al. (2018), **wherein transportation, gas and electrical utilities, chemicals, oil and gas, coal mining, steel, and pipelines are categorized as part of the carbon-sensitive sector.** The regression results for these analyses are presented in Table 8.

In columns (1) to (4), we investigate the impact of policy engagement (*PED*) on carbon emissions (*CE*), considering various firm sizes and carbon sensitivities. **We observe that *PED* only**

exerts a positive effect on the *CE* of carbon-sensitive firms (i.e., increases substantive carbon emissions) ($\beta_{CE} = 0.1356, p_{CE} < 0.05$), and this positive impact is more pronounced in small firms compared to large firms ($\beta_{CE} = 0.1201, p_{CE} < 0.1$; $\beta_{CE} = 0.1249, p_{CE} < 0.05$). In columns (5) to (8), we further investigate the effects of policy engagement (*PED*) on symbolic carbon emissions (*SCE*) under distinct firm sizes and carbon sensitivities. The results show a strong and positive impact of *PED* on *SCE* (i.e., increase symbolic carbon emission), particularly in carbon-sensitive firms and small firms ($\beta_{SCE} = 0.3533, p_{SCE} < 0.01$; $\beta_{SCE} = 0.3118, p_{SCE} < 0.01$). We also find evidence that *M/B* have negative impacts on *CE* or *SCE* in columns (2), (4), (5), (7), and (8) ($\beta_{CE} = -0.4445, p_{CE} < 0.05$; $\beta_{CE} = -0.4649, p_{CE} < 0.05$; $\beta_{SCE} = -0.5309, p_{SCE} < 0.05$; $\beta_{SCE} = -0.7504, p_{SCE} < 0.01$; $-\beta_{SCE} = 0.3206, p_{SCE} < 0.05$ correspondingly).

As such, greater policy engagement by firms is linked to an increase in substantive carbon emissions while resulting in a growth in symbolic carbon emissions. These effects are particularly pronounced for small and carbon-sensitive firms. Further, evidence shows that a greater firm market performance is related to a lower level of both substantive and symbolic carbon emissions. Investors show less inclination to allocate investment to firms with elevated levels of substantive and symbolic carbon emissions.

[INSERT TABLE 8 HERE]

4.4.2 The **impact** of a firm's carbon tendency on policy engagement and carbon emissions

Through our above research, we have discovered that firm engagement with public policy does not lead to a decrease in substantive carbon emissions; rather, it appears to increase symbolic carbon emissions. To better understand these results, we investigate boundary mechanisms that influence this relationship. We chose carbon tendency as the moderator and studied three dimensions of carbon

tendency: carbon awareness, intensity targets, and voluntary disclosure. We further explore the effect of policy engagement (*PED*) on *CE* through the moderating effect of carbon tendency. We find that when the moderator is not included in the model, both *PS* and *PED* show a positive effect on *CE*, suggesting that firm engagement with public policy may not effectively decrease substantive carbon emissions.

In columns (1) and (2) of Table 9, we introduce the moderating variable *Regulation* (proxy for carbon awareness) into the model. The interaction terms of $PS \times Regulation$ and $PED \times Regulation$ exhibit a negative effect on *CE* ($\beta_{CE} = -0.5067, p_{CE} < 0.1$; $\beta_{CE} = -0.2393, p_{CE} < 0.1$). Similarly, in columns (3) and (4), we include the moderating variable *Intensity* (proxy for intensity targets) in the model, and the interaction terms of $PS \times Intensity$ and $PED \times Intensity$ also show negative effects ($\beta_{CE} = -0.0831, p_{CE} < 0.1$; $\beta_{CE} = -0.0879, p_{CE} < 0.05$). Furthermore, in columns (5) and (6), we add the moderating variable *Voluntary* (proxy for voluntary disclosure) into the model, and the interaction terms of $PS \times Voluntary$ and $PED \times Voluntary$ are found to be statistically significant and negative at the level of 1 % ($\beta_{CE} = -0.4349, p_{CE} < 0.01$; $\beta_{CE} = -0.1950, p_{CE} < 0.01$). These results indicate that carbon tendency encourages firm engagement, while *PED* policy leads to a decrease in *CE*. We also find strong evidence that *M/B* have negative impacts on *CE* in all columns from (1) to (6) ($\beta_{CE} = -0.4682, p_{CE} < 0.01$; $\beta_{CE} = -0.4757, p_{CE} < 0.01$; $\beta_{CE} = -0.0971, p_{CE} < 0.05$; $\beta_{CE} = -0.4852, p_{CE} < 0.01$; $\beta_{CE} = -0.4644, p_{CE} < 0.01$; $\beta_{CE} = -0.4611, p_{CE} < 0.05$). In other words, companies that have higher substantive carbon emissions have weaker market performance. Investors are less likely to invest in firms that have high substantive carbon emissions. Next, we examine the moderating role of carbon tendency in the association between policy engagement and *SCE*. Our results indicate that carbon tendency does not moderate this relationship. In other words, the effect of policy engagement on symbolic carbon

emissions is the same for firms with high carbon tendency and firms with low carbon tendency. We also find that firm market performance is negatively affected by *SCE*. This suggests that firms may be engaging in symbolic carbon emission in order to improve their reputation. Full results can be provided in Appendix B.

[INSERT TABLE 9 HERE]

5. Conclusion

Policy engagement has emerged as a crucial avenue for firms to effectively combat climate change through political activities. By analyzing unbalanced panel data from 2012-2019 encompassing 601 U.S.-listed firms, we investigate how *PED* impacts *CE* and *SCE*. Grasping the link between policy engagement and carbon emissions is vital for enterprises to formulate effective strategies for mitigating climate change. Overall, we find that greater policy engagement by firms does not lead to a decrease in substantive carbon emissions, and it increases symbolic carbon emissions. The growing concern over climate change has posed notable political challenges for firms, compelling them to engage in political activities. Previous research has suggested that such heightened policy engagement can potentially have adverse effects on a firm's profitability, as politically active firms often oppose environmental regulations (Meckling, 2015). However, we present a different perspective. According to the existing literature, firms are the beneficiaries of policy maximization (Brunell, 2005), and the motivation for firms to participate in policy is to obtain preferential treatment from the government (Kim and Zhang, 2016). Consistent with the view proposed by Muttakin et al. (2021), companies are using policy engagement as a strategic approach to mitigate the business risks that may arise from carbon emissions. Thus, a firm's emphasis on political activity depends on whether such engagement aligns with the firm's overall strategy to improve

performance concerning climate-related issues. Our study not only supports the findings of Delmas et al. (2016) but also delves deeper into the question of whether firms' political activity genuinely translates into tangible improvements in firm performance.

With in-depth research on policy engagement, we find that carbon-sensitive firms and small firms benefit the most from their degree of policy engagement in terms of reducing substantive carbon emissions. Small firms will take more action to improve their environmental performance to avoid increased energy costs (Bradford and Fraser, 2008). Unlike large firms that prefer incentive programs, they tend to be reluctant to go beyond regulatory compliance and prefer a relatively level playing field brought about by mandatory regulations (Conway, 2015). Whereas, carbon-sensitive firms maintain their vested interests through policy participation as a core strategy to delay the low-carbon transition (Okereke and Russel, 2010), and this compensatory policy also serves as the support for firms to consolidate their interests.

In further research, we consider the boundary effect of corporate public policy participation on carbon emission dynamics under the action of multiple mechanisms. Carbon awareness, intensity targets, and voluntary disclosure are chosen as the three different dimensions for measuring carbon tendency. We find that carbon awareness, intensity targets, and voluntary disclosure have a negative effect on the relationship of firm engagement with public policy and carbon emission dynamics. This indicates that policy initiatives can play a pivotal role in facilitating carbon reduction efforts, particularly for firms that are inherently more attuned to environmental concerns. Existing research explores the antecedents of reducing corporate carbon emissions and focuses on management preferences on how to reduce corporate carbon emissions (Li et al., 2025). Although our study finds no consistent antecedents for direct effects, we validate the feasibility of indirect effects. After the

enterprise has a clear propensity to **decrease emissions**, the political activities of the firm help create potential resources to achieve the corporate goals (Najaf and Najaf, 2021). We argue that carbon awareness can alleviate the opportunism that firms gain from policy engagement and effectively curb their tendency to use policy resources for justifying their high-carbon behaviors.

The results underscore the significance of accounting for a firm's carbon sensitivity and size when assessing the impact of policy engagement on carbon emissions. These findings enrich the burgeoning literature regarding corporate climate action and deliver actionable insights for policymakers, enterprises, and other stakeholders committed to achieving sustainability.

5.1 Theoretical contributions

Our research explores a pivotal distinction between substantive and symbolic carbon emissions. The fact that heightened policy engagement is associated with increased symbolic emissions, but not with reductions in substantive emissions, **may be interpreted as a strategic initiative to address institutional pressures**. Firms, especially smaller ones seeking stability and resources, may engage politically to gain socio-political legitimacy. This engagement provides a license to operate and can create a form of implicit political patronage, reducing the immediate regulatory and social pressure for genuine environmental reform. Consequently, firms prioritize visible, symbolic gestures that signal conformity to environmental norms over costlier substantive changes. The role of carbon awareness emerges as a critical moderating variable, aligning with the theory's emphasis on cognitive institutions. Carbon awareness reflects the internalization of environmental norms within the organization's decision-making logic. When carbon awareness is high, it counteracts the legitimizing shield of political patronage, strengthening the internal normative pressure for substantive action and thus negatively moderating the link between policy engagement and substantive emissions. Thus, a firm's

emphasis on policy activity depends on whether such engagement aligns with the firm's overall strategy to improve performance concerning climate-related issues. Our study not only supports Delmas et al.'s (2016) findings about the link between lobbying and carbon emissions, but also delves deeper into the question of whether firms' policy activity genuinely translates into tangible improvements in firm environmental actions. This study not only offers valuable insights into the complexities of firm engagement with policies concerning climate change and its influence on firm market performance, but also provides an understanding of how firms can navigate the political landscape to achieve favorable performance outcomes amidst environmental challenges from multiple mechanisms.

5.2 Practical contributions

Corporate policy engagement plays a complex role in carbon emission governance, but it is not a panacea for emission reduction. Managers often display inconsistency in their focus on policy strategy (Drutman, 2015), and factors like poor political stickiness and policy uncertainty can lead them to be skeptical about the true impact of their political efforts. Because the available research shows that many companies do not seem to derive significant benefits from policy engagement. However, this study presents a different perspective by proposing that firm's policy engagement can indeed enhance firm performance. Whether it is aimed at reducing substantive carbon emissions or increasing symbolic carbon emissions, policy activities (including [direct engagement with policy makers, trade associations and funding research organizations](#)) are deemed necessary. While existing research tends to conclude that substantive carbon emissions have a negative impact, as they do not substantively decrease a firm's overall emissions value, we suggest that symbolic carbon emissions is also a manifestation of the company's active carbon management behavior. Just like a hospital requires not

only skilled surgeons but also doctors who are adept at public relations to represent the hospital in the media, the promotion and reputation of firms are crucial for their development. Nonetheless, it is important to acknowledge that being skilled at public relations does not necessarily imply that the doctor is less competent than their counterparts who may not excel in media representation. In essence, this study advocates that firm's policy engagement can lead to tangible benefits and improved performance. Considering both substantive and symbolic carbon emissions can **enhance a firm's reputation** and overall success. It underscores the importance of strategic and consistent political efforts for firm managers, highlighting the potential positive impact on their organizations.

Whether corporate policy engagement can become a boost to climate governance depends on whether it can form a synergy with the enterprise's internal carbon management dynamics. For managers, **using political resources strategically and integrating policy engagement into the company's overall climate strategy deeply is crucial**. Management should focus on improving transparency in carbon management, turning external pressure into internal innovation drivers by setting ambitious carbon intensity targets and improving carbon disclosure, and avoiding short-term behavior of political resources being used to circumvent regulation. For policymakers, it is necessary to create a fair and incentive institutional environment for innovation and design a refined policy system. Targeted low-carbon technology subsidies and tax incentives for carbon-sensitive enterprises and SMEs need to be prevented from being used by large corporations to hinder climate policy progress. Investors need to play their capital-oriented and supervisory role, and deepen the evaluation of corporate political behavior in investment decision-making, not only to look at the scale of political expenditure, but also to analyze whether it is linked to verifiable emission reduction performance.

5.3 Limitations

While our research has shed light on important aspects of firm engagement with public policy and its impact on carbon emissions, we acknowledge certain limitations that open up **directions for further investigations**. Firstly, **our paper explores** specific moderating mechanisms of firm engagement with public policy that influence carbon emissions, but does not explore the evolving role of such engagement. Future research could further analyze how a firm's policy engagement can lead to enhanced firm performance and reduced carbon emissions. Secondly, our analysis of the impacts of policy activities on carbon emissions was somewhat limited in scope. Future research can conduct a more comprehensive examination, exploring the distinctions and variations in the effects of different policy activities on carbon emissions. By doing so, researchers can identify the most suitable public policies for different types of firms to maximize their effectiveness in reducing carbon emissions.

References

- Adhikari, A., Zhou, H., 2022. Voluntary disclosure and information asymmetry: do investors in US capital markets care about carbon emission? *Sustainability Accounting, Management and Policy Journal* 13, 195–220. doi:10.1108/SAMPJ-02-2020-0046
- Alam, Md.S., Atif, M., Chien-Chi, C., Soytaş, U., 2019. Does corporate R&D investment affect firm environmental performance? Evidence from G-6 countries. *Energy Economics* 78, 401–411. doi:10.1016/j.eneco.2018.11.031
- Anderson, J.E., Lee, R.P., Tofighi, M., Anderson, S.T., 2023. Lobbying as a potent political marketing tool for product diversification: an examination of firm-government interaction. *Journal of Strategic Marketing* 31, 235–253. doi:10.1080/0965254X.2021.1896568
- Arellano, M., Bond, S., 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies* 58, 277. doi:10.2307/2297968

-
- Barnett, M.L., 2013. One Voice, But Whose Voice? Exploring What Drives Trade Association Activity. *Business & Society* 52, 213–244. doi:10.1177/0007650309350211
- Barnett, M.L., King, A.A., 2008. Good Fences Make Good Neighbors: A Longitudinal Analysis of an Industry Self-Regulatory Institution. *Academy of Management Journal* 51, 1150–1170. doi:10.5465/amj.2008.35732609
- Baumgartner, F.R., Berry, J.M., Hojnacki, M., Leech, B.L., Kimball, D.C., 2009. Lobbying and policy change: Who wins, who loses, and why. University of Chicago Press.
- Beder, S. 2014. Lobbying, greenwash and deliberate confusion: how vested interests undermine climate change. In M. C-T. Huang and R. R-C. Huang (Eds.), *Green Thoughts and Environmental Politics: Green Trends and Environmental Politics* (pp. 297-328). Taipei, Taiwan: Asia-seok Digital Technology.
- Blacconiere, W.G., Patten, D.M., 1994. Environmental disclosures, regulatory costs, and changes in firm value. *Journal of Accounting and Economics* 18, 357–377. doi:10.1016/0165-4101(94)90026-4
- Blanes I Vidal, J., Draca, M., Fons-Rosen, C., 2012. Revolving Door Lobbyists. *American Economic Review* 102, 3731–3748. doi:10.1257/aer.102.7.3731
- Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics* 87, 115–143.
- Bol  at, M., 2003. Managing Trade Associations. London: Trade Association Forum.
- Boubakri, N., Cosset, J.-C., Saffar, W., 2012. The impact of political connections on firm’s operating performance and financing decisions. *Journal of Financial Research* 35, 397–423. doi:10.1111/j.1475-6803.2012.01322.x
- Bradford, J., & Fraser, E. D. 2008. Local authorities, climate change and small and medium enterprises: identifying effective policy instruments to reduce energy use and carbon emissions. *Corporate Social Responsibility and Environmental Management*, 15, 156-172. doi: 10.1177/10659129050580041
- Bradley, D., Pantzalis, C., Yuan, X., 2016. Policy risk, corporate political strategies, and the cost of debt. *Journal of Corporate Finance* 40, 254–275.

-
- Brulle, R., Downie, C., 2022. Following the money: trade associations, political activity and climate change. *Climatic Change* 175, 11. doi:10.1007/s10584-022-03466-0
- Brulle, R.J., 2018. The climate lobby: a sectoral analysis of lobbying spending on climate change in the USA, 2000 to 2016. *Climatic Change* 149, 289–303. doi:10.1007/s10584-018-2241-z
- Brunell, T. L. 2005. The relationship between political parties and interest groups: Explaining patterns of PAC contributions to candidates for congress. *Political Research Quarterly*, 58, 681–688. doi:10.1002/csr.151
- Burritt, R.L., Schaltegger, S., 2010. Sustainability accounting and reporting: fad or trend? *Accounting, Auditing & Accountability Journal* 23, 829–846. doi:10.1108/09513571011080144
- Byrd, J., Cooperman, E.S., Bettenhausen, K., 2014. Determinants of corporate carbon reduction targets. *Interdisciplinary Environmental Review* 15, 271–289.
- CDP, 2019. CDP North America Annual Report ([EB/OL]). Carbon Disclosure Project, London.
- Chai, S., Zhang, Z., Ge, J., 2020. Evolution of environmental policy for China's rare earths: Comparing central and local government policies. *Resources Policy* 68, 101786. doi:10.1016/j.resourpol.2020.101786
- Chen, H., Parsley, D., Yang, Y.-W., 2015. Corporate Lobbying and Firm Performance. *Journal of Business Finance & Accounting* 42, 444–481. doi:10.1111/jbfa.12109
- Cho, C. H., Patten, D. M., & Roberts, R. W. 2006. Corporate political strategy: An examination of the relation between political expenditures, environmental performance, and environmental disclosure. *Journal of business ethics*, 139-154. doi:10.1007/s10551-006-9019-3
- Conway, E. 2015. Engaging small and medium-sized enterprises (SMEs) in the low carbon agenda. *Energy, Sustainability and Society*, 5, 32. doi:10.1186/s13705-015-0060-x
- Crable, R.E., Vibbert, S.L., 1985. Managing issues and influencing public policy. *Public Relations Review* 11, 3–16. doi:10.1016/S0363-8111(82)80114-8
- Dahlmann, F., Branicki, L., Brammer, S., 2019. Managing Carbon Aspirations: The Influence of Corporate Climate Change Targets on Environmental Performance. *Journal of Business Ethics* 158, 1–24. doi:10.1007/s10551-017-3731-z
- De Angelis, T., Tankov, P., Zerbib, O.D., 2022. Climate Impact Investing. *Management Science*

mnsc.2022.4472. doi:10.1287/mnsc.2022.4472

- De Villiers, C., Van Staden, C.J., 2006. Can less environmental disclosure have a legitimising effect? Evidence from Africa. *Accounting, Organizations and Society* 31, 763–781. doi:10.1016/j.aos.2006.03.001
- De Winter, J. C., Gosling, S. D., & Potter, J. 2016. Comparing the Pearson and Spearman correlation coefficients across distributions and sample sizes: A tutorial using simulations and empirical data. *Psychological methods*, 21, 273. doi:10.48550/arXiv.2408.15979
- Delmas, M., Lim, J., Nairn-Birch, N., 2016. Corporate Environmental Performance and Lobbying. *Academy of Management Discoveries* 2, 175–197. doi:10.5465/amd.2014.0065
- Delmas, M. A., & Montes - Sancho, M. J. 2010. Voluntary agreements to improve environmental quality: Symbolic and substantive cooperation. *Strategic Management Journal*, 31, 575-601. doi:10.1002/smj.826
- DiMaggio, P.J., 1988. In L. G. Zucker (Ed.), *Institutional patterns and organizations*, in: *Interest and Agency in Institutional Theory*. Ballinger, Cambridge, MA, pp. 3–22.
- Drutman, L., 2015. *The Business of America is Lobbying: How corporations became politicized and politics became more corporate*. Oxford University Press.
- Finnerty, N., Sterling, R., Contreras, S., Coakley, D., & Keane, M. M. 2018. Defining corporate energy policy and strategy to achieve carbon emissions reduction targets via energy management in non-energy intensive multi-site manufacturing organisations. *Energy*, 151, 913-929. doi:10.1016/j.energy.2018.03.070
- Gao, C., McDonald, R., 2022. Shaping Nascent Industries: Innovation Strategy and Regulatory Uncertainty in Personal Genomics. *Administrative Science Quarterly* 67, 915–967. doi:10.1177/00018392221112641
- Garel, A., Petit-Romec, A., 2021. Investor rewards to environmental responsibility: Evidence from the COVID-19 crisis. *Journal of Corporate Finance* 68, 101948. doi:10.1016/j.jcorpfin.2021.101948
- Goldman, E., Rocholl, J., So, J., n.d. *Politically Connected Boards of Directors and The Allocation of Procurement Contracts*.

-
- Gounopoulos, D., Kallias, A., Kallias, K., Tzeremes, P.G., 2017. Political money contributions of U.S. IPOs. *Journal of Corporate Finance* 43, 19–38. doi:10.1016/j.jcorpfin.2016.12.011
- Grossmann, M., 2014. *Artists of the possible*. Oxford University Press, New York.
- Hadani, M., Bonardi, J.-P., Dahan, N.M., 2017. Corporate political activity, public policy uncertainty, and firm outcomes: A meta-analysis. *Strategic Organization* 15, 338–366. doi:10.1177/1476127016651001
- Haque, F., Ntim, C.G., 2018. Environmental Policy, Sustainable Development, Governance Mechanisms and Environmental Performance: Environmental Policy, Corporate Governance and Environmental Performance. *Business Strategy and the Environment* 27, 415–435. doi:10.1002/bse.2007
- He, Y., Fu, F., Liao, N., 2021. Exploring the path of carbon emissions reduction in China's industrial sector through energy efficiency enhancement induced by R&D investment. *Energy* 225, 120208. doi:10.1016/j.energy.2021.120208
- Hill, M., Hupe, P., 2005. *Implementing public policy: Governance in theory and in practice*. SAGE, London, Thousand Oaks, New Delhi.
- Houque, M. N., Opore, S., Zahir-ul-Hassan, M. K., & Ahmed, K. 2022. The effects of carbon emissions and agency costs on firm performance. *Journal of Risk and Financial Management*, 15, 152 doi:10.3390/jrfm15040152
- Huang, H.H., Kerstein, J., Wang, C., Wu, F. (Harry), 2022. Firm climate risk, risk management, and bank loan financing. *Strategic Management Journal* 43, 2849–2880. doi:10.1002/smj.3437
- Jeng, C. C. 2023. Why a variance inflation factor of 10 is not an ideal cutoff for multicollinearity diagnostics. *Journal of Education Studies*, 57, 67-93. doi:10.53106/199044282023105702004
- Jung, J., Herbohn, K., Clarkson, P., 2018. Carbon Risk, Carbon Risk Awareness and the Cost of Debt Financing. *Journal of Business Ethics* 150, 1151–1171. doi:10.1007/s10551-016-3207-6
- Kim, C., & Zhang, L. 2016. Corporate political connections and tax aggressiveness. *Contemporary Accounting Research*, 331, 78–114. doi:10.1111/1911-3846.12150
- Klusak, P., Agarwala, M., Burke, M., Kraemer, M., Mohaddes, K., 2023. Rising Temperatures, Falling Ratings: The Effect of Climate Change on Sovereign Creditworthiness. *Management Science*

-
- mnsc.2023.4869. doi:10.1287/mnsc.2023.4869
- Kolk, A., Pinkse, J., 2004. Market Strategies for Climate Change. *European Management Journal* 22, 304–314. doi:10.1016/j.emj.2004.04.011
- Kurnia, P., Darlis, E., Putr, A.A., 2020. Carbon Emission Disclosure, Good Corporate Governance, Financial Performance, and Firm Value. *The Journal of Asian Finance, Economics and Business* 7, 223–231. doi:10.13106/JAFEB.2020.VOL7.NO12.223
- Lee, K.-H., Min, B., 2015. Green R&D for eco-innovation and its impact on carbon emissions and firm performance. *Journal of Cleaner Production* 108, 534–542. doi:10.1016/j.jclepro.2015.05.114
- Lenox, M.J., Nash, J., 2003. Industry self-regulation and adverse selection: a comparison across four trade association programs. *Business Strategy and the Environment* 12, 343–356. doi:10.1002/bse.380
- Li, W., Xu, Q., & Zhu, Q. 2025. CEO hometown preference in corporate environmental policies. *Management Science*, 71, 8783-8806. doi:10.1287/mnsc.2022.02560
- Liedong, T.A., 2021. Responsible Firm Behaviour in Political Markets: Judging the Ethicality of Corporate Political Activity in Weak Institutional Environments. *Journal of Business Ethics* 172, 325–345. doi:10.1007/s10551-020-04503-7
- Liu, C., Cheong, C.S., Zurbruegg, R., 2020. Rhetoric, Reality, and Reputation: Do CSR and Political Lobbying Protect Shareholder Wealth against Environmental Lawsuits? *Journal of Financial and Quantitative Analysis* 55, 679–706. doi:10.1017/S0022109019000073
- Locke, E.A., Latham, G.P., 2009. Has Goal Setting Gone Wild, or Have Its Attackers Abandoned Good Scholarship? *Academy of Management Perspectives* 23, 17–23. doi:10.5465/amp.2009.37008000
- Lu, S., Li, S., Zhou, W., & Yang, W. 2022. Network herding of energy funds in the post-Carbon-Peak Policy era: Does it benefit profitability and stability?. *Energy Economics*, 109, 105948. doi:10.1016/j.eneco.2022.105948
- Luo, L., 2019. The influence of institutional contexts on the relationship between voluntary carbon disclosure and carbon emission performance. *Accounting & Finance* 59, 1235–1264.

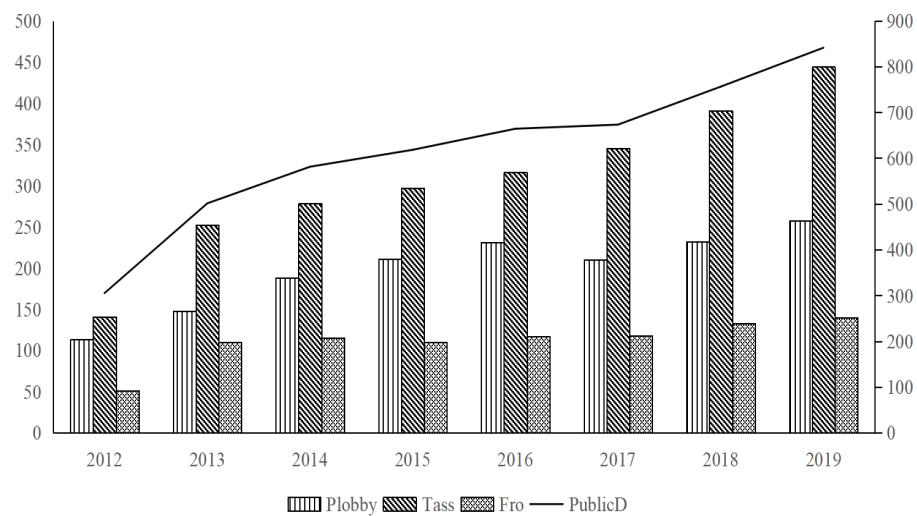
doi:10.1111/acfi.12267

- Luo, L., Tang, Q., 2021. Corporate governance and carbon performance: role of carbon strategy and awareness of climate risk. *Accounting & Finance* 61, 2891–2934. doi:10.1111/acfi.12687
- Malen, J., Marcus, A.A., 2019. Environmental Externalities and Weak Appropriability: Influences on Firm Pollution Reduction Technology Development. *Business & Society* 58, 1599–1633.
- Meckling, J. 2015. Oppose, support, or hedge? Distributional effects, regulatory pressure, and business strategy in environmental politics. *Global Environmental Politics*, 15, 19-37. doi:10.1162/GLEP_a_00296
- Mesfioui, M., Trufin, J., & Zuyderhoff, P. 2022. Bounds on Spearman's rho when at least one random variable is discrete. *European Actuarial Journal*, 12, 321-348. doi.org/10.1007/s13385-021-00289-8
- Meyer, J.W., Rowan, B., 1977. Institutionalized Organizations: Formal Structure as Myth and Ceremony. *American Journal of Sociology* 83, 340–363.
- Muttakin, M. B., Mihret, D. G., & Rana, T. 2021. Electoral system, corporate political donation, and carbon emission intensity: Cross-country evidence. *Business Strategy and the Environment*, 30, 1767-1779. doi:10.1002/bse.2714
- Najaf, R., & Najaf, K. 2021. Political ties and corporate performance: why efficiency matters?. *Journal of Business and Socio-Economic Development*, 1, 182-196. doi:10.1108/JBSED-03-2021-0023
- Okereke, C., & Russel, D. 2010. Regulatory pressure and competitive dynamics: Carbon management strategies of UK energy-intensive companies. *California Management Review*, 52, 100-124. doi:10.1525/CMR.2010.52.4.100
- Ongis, M., Davidai, S., 2022. Personal relative deprivation and the belief that economic success is zero-sum. *Journal of Experimental Psychology: General* 151, 1666–1680. doi:10.1037/xge0001144
- Price Waterhouse Cooper, 2013. CSR Trends. 2010 [WWW Document]. URL <https://www.pwc.com/ca/en/sustainability/csr-trends-report.jhtml>
- Rajwani, T., Lawton, T., Phillips, N., 2015. The “Voice of Industry”: Why management researchers

-
- should pay more attention to trade associations. *Strategic Organization* 13, 224–232. doi:10.1177/1476127015590963
- Schaefer, A., Kerrigan, F., 2008. Trade associations and corporate social responsibility: evidence from the UK water and film industries. *Business Ethics: A European Review* 17, 171–195. doi:10.1111/j.1467-8608.2008.00530.x
- Setzer, J., Higham, C., 2021. Global trends in climate change litigation: 2021 snapshot (Policy Report). The Centre for Climate Change Economics and Policy (CCCEP).
- Tolbert, P.S., Zucker, L.G., 1996. In S. R. Clegg, C. Hardy, & W. R. Nord (Eds.), *Handbook of organization studies*, in: *The Institutionalization of Institutional Theory*. SAGE, Thousand Oaks, CA, pp. 175–190.
- Tolbert, P.S., Zucker, L.G., 1983. Institutional Sources of Change in the Formal Structure of Organizations: The Diffusion of Civil Service Reform, 1880-1935. *Administrative Science Quarterly* 28, 22. doi:10.2307/2392383
- Tyllström, A., Murray, J., 2021. Lobbying the Client: The role of policy intermediaries in corporate political activity. *Organization Studies* 42, 971–991. doi:10.1177/0170840619866486
- UNEP, F., 2006. Global climate change: Risk to bank loans [WWW Document]. URL Retrieved from http://www.unepfifi.org/fifileadmin/documents/global_climate_change_risk.pdf
- Unsal, O., Kabir Hassan, M., Zirek, D., 2017. Corporate lobbying and labor relations: Evidence from employee-level litigations. *Journal of Corporate Finance* 46, 411–441. doi:10.1016/j.jcorpfin.2017.08.005
- Vadakkepatt, G.G., Arora, S., Martin, K.D., Paharia, N., 2022. Shedding Light on the Dark Side of Firm Lobbying: A Customer Perspective. *Journal of Marketing* 86, 79–97. doi:10.1177/00222429211023040
- Van Den Broek, O.M., 2022. How Political Actors Co - Construct CSR and its Effect on Firms' Political Access: A Discursive Institutional View. *Journal of Management Studies* joms.12871. doi:10.1111/joms.12871
- Vesa, J., Gronow, A., & Ylä-Anttila, T. 2020. The quiet opposition: How the pro-economy lobby

-
- influences climate policy. *Global Environmental Change*, 63, 102117. doi:10.1016/j.gloenvcha.2020.102117
- Vieira, L. C., Longo, M., & Mura, M. 2023. From carbon dependence to renewables: The European oil majors' strategies to face climate change. *Business Strategy and the Environment*, 32, 1248-1259. doi:10.1002/bse.3185
- Wang, X., Xu, J., 2021. Do shareholders tolerate faults in scientific and technological innovation? Evidence from Chinese listed companies. *Technology Analysis & Strategic Management* 1–13. doi:10.1080/09537325.2021.2010697
- Werner, T., 2015. Gaining Access by Doing Good: The Effect of Sociopolitical Reputation on Firm Participation in Public Policy Making. *Management Science* 61, 1989–2011. doi:10.1287/mnsc.2014.2092
- Williams, E.L., Bartone, S.A., Swanson, E.K., Stokes, L.C., 2022. The American electric utility industry's role in promoting climate denial, doubt, and delay. *Environmental Research Letters* 17, 094026. doi:10.1088/1748-9326/ac8ab3
- Yan, J.Z., Chang, S., 2018. The contingent effects of political strategies on firm performance: A political network perspective. *Strategic Management Journal* 39, 2152–2177. doi:10.1002/smj.2908
- Yongqing, L., Eddie, I., Jinghui, L., 2013. The Impact of Carbon Emissions on Asset Values and Operating Cash Flows: Evidence From Australian Listed Companies. *Journal of Modern Accounting and Auditing* 9, 94–111.
- Zhang, Y., Deng, Y., Yang, O., Xia, D., & Liu, H. 2024. Substantive or symbolic? The strategic choice of sustainable environmental strategy for enterprises induced by the new environmental protection law. *Sustainable Development*, 32, 7461-7481. doi:10.1002/sd.3100
- Zhang, Z., Jia, M., 2013. How can companies decrease the disruptive effects of stretch goals? The moderating role of interpersonal- and informational- justice climates. *Human Relations* 66, 993–1020. doi:10.1177/0018726713483630
- Zhou, Z., Zhang, T., Wen, K., Zeng, H., Chen, X., 2018. Carbon risk, cost of debt financing and the moderation effect of media attention: Evidence from Chinese companies operating in

FIGURE.1. The number and the degree of public policy engagement of sample firms



Source: Compiled by the authors according to CDP 2012-2019.

FIGURE.2. Conceptual framework

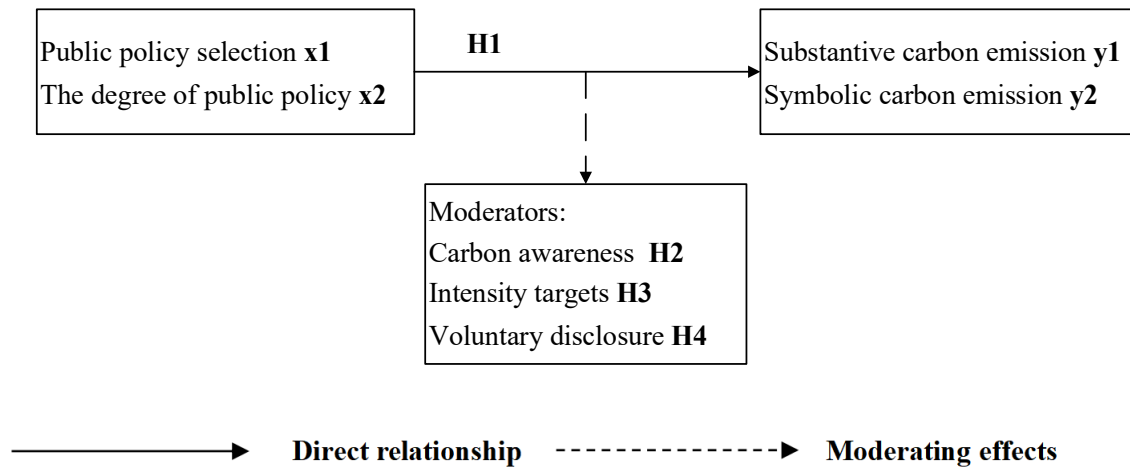


TABLE 1. Symbolic carbon emission reduction (*SCER*)

N0	What methods do you use to drive investment in emissions reduction activities?	Score	Source
1	Compliance with regulatory requirements/standards	0 or 1	CDP database
2	Dedicated budget for energy efficiency	0 or 1	
3	Dedicated budget for low-carbon product R&D	0 or 1	
4	Employee engagement	0 or 1	
5	Internal incentives/recognition programs	0 or 1	
6	Dedicated budget for other emissions reduction activities	0 or 1	
7	Lower return on investment (ROI) specification	0 or 1	
8	Financial optimization calculations	0 or 1	
9	Internal finance mechanisms	0 or 1	
10	Partnering with governments on technology development	0 or 1	
11	Internal price on carbon	0 or 1	
12	Marginal abatement cost curve	0 or 1	
Possible total score		0 - 12	

TABLE 2. A firm's degree of engagement with public policy (*PublicD*)

N0	Do you engage in activities that could either directly or indirectly influence public policy on climate-related issues through any of the following?	Score	Source
1	Direct engagement with policy makers	0 or 1	CDP database
2	Trade associations	0 or 1	
3	Funding research organizations	0 or 1	
Possible total score		0 - 3	

TABLE 3. A firm's degree of engagement with climate lobbying (*Plobby*)

N0	On what issues have you been engaging directly with policy makers? - Focus of legislation	Score	Source
1	Adaptation resiliency	0 or 1	CDP database
2	Cap and trade	0 or 1	
3	Carbon tax	0 or 1	
4	Clean energy generation	0 or 1	
5	Climate finance	0 or 1	
6	Energy efficiency	0 or 1	
7	Mandatory carbon reporting	0 or 1	
Possible total score		0 - 7	

TABLE 4. Operationalization and summary of variables

Variables	Symbols	Definition	Source
Substantial carbon emissions	<i>CE</i>	The sum of the organization's emissions of Scope 1 and Scope 2 in metric tons CO ₂ e.	CDP
Symbolic carbon emissions reduction	<i>SCER</i>	<i>SCER</i> is calculated by adding 12 dummy variables that measure the firm's degree of engagement with emissions-reduction activities, with a higher index value indicating greater symbolic carbon emissions reduction of a firm.	CDP
Public policy selection	<i>Public</i>	A dummy variable that if firms engage with public policy has a value of "1", otherwise "0".	CDP
Public policy engagement	<i>PublicD</i>	A score ranging from 0 to 3 adding three dummy variables that measure the firm degree of public policy engagement as in Table 2.	CDP
Political lobbying selection	<i>Political lobbying selection</i>	A dummy variable that if firms engage with public policy on climate change through direct engagement with policy makers has a value of "1", otherwise "0".	
The degree of political lobbying	<i>Plobby</i>	A score ranging from 0 to 7 adding seven dummy variables that measure the firm degree of political lobbying as in Table 3.	CDP
Trade associations	<i>Tass</i>	A dummy variable that if firms engage with public policy on climate change through trade associations.	CDP
Funding research organizations	<i>Fro</i>	Firm engagement with public policy on climate change through funding research organizations has a value of "1", otherwise "0".	CDP
Carbon awareness	<i>Regulation</i>	A dummy variable that if firms identify any climate change risks and opportunities a value of "1", otherwise "0".	CDP
Intensity targets	<i>Intensity</i>	A dummy variable that if firms have intensity targets for emissions reduction has a value of "1", otherwise "0".	CDP
Voluntary disclosure	<i>Voluntary</i>	A dummy variable that if firms publish information about organization's response to climate change and GHG emissions performance in places other than in CDP response has a value of "1", otherwise "0".	CDP
Firm size	<i>Fsize</i>	Natural logarithm of total assets that represents firm size.	Compustat
Market to book value	<i>M/B</i>	Natural logarithm of the market value of assets over the book value of assets.	Compustat
Cash holdings	<i>Cash</i>	Natural logarithm of current assets over total assets.	Compustat
Leverage ratio	<i>Lev</i>	Natural logarithm of all debt over total assets.	Compustat
Net return on assets	<i>Roe</i>	Natural logarithm of net return over total assets.	Compustat
Regional Greenhouse Gas Initiative	<i>Rggi</i>	A dummy variable that if a firm is headquartered in a state participating in Regional Greenhouse Gas Initiative has a value of "1", otherwise "0".	Company Website
Carbon sensitive	<i>Carbon</i>	A dummy variable that if firms belong to carbon sensitive sectors has a value of "1", otherwise "0".	CDP
Emission trading schemes	<i>Ets</i>	A dummy variable that if firms participate in any emission trading schemes has a value of "1", otherwise "0".	CDP

TABLES 5. Descriptive Statistics of Variables

Variable	N	Mean	S.D	Min	Max
<i>CE</i>	2,987	12.55	3.238	0	18.81
<i>SCER</i>	2,987	3.007	1.948	0	11
<i>Public</i>	2,987	0.646	0.478	0	1
<i>PublicD</i>	2,987	1.201	1.087	0	3
<i>Plobby</i>	2,987	1.273	1.706	0	7
<i>Tass</i>	2,987	0.702	0.457	0	1
<i>Fro</i>	2,987	0.265	0.442	0	1
<i>Regulation</i>	2,987	0.822	0.382	0	1
<i>Intensity</i>	2,987	0.487	0.500	0	1
<i>Voluntary</i>	2,987	0.646	0.478	0	1
<i>Fsize</i>	2,987	3.021	1.521	-6.215	7.741
<i>M/B</i>	2,987	0.968	0.436	0	2.806
<i>Cash</i>	2,987	0.249	0.168	0	0.653
<i>Lev</i>	2,987	0.704	1.046	-5.458	6.898
<i>Roe</i>	2,987	0.0736	0.0853	-1.305	0.537
<i>Rggi</i>	2,987	0.211	0.408	0	1
<i>Carbon</i>	2,987	0.231	0.421	0	1
<i>Ets</i>	2,987	0.315	0.465	0	1

Notes: Total number of observed firms $N=2987$. *SD* is the value of standard deviation. *Min* is the value of minimum. *Max* is the value of maximum.

TABLE 6. Pearson and Spearman rank correlation coefficient.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) <i>CE</i>	1	0.305***	0.279***	0.390***	0.267***	0.394***	0.342***	0.395***	-0.058***	-0.208***	0.123***	0.072***	-0.074***	0.307***	0.432***
(2) <i>SCER</i>	0.319***	1	0.165***	0.245***	0.234***	0.256***	0.260***	0.204***	-0.035*	-0.094***	0.046**	-0.012	0.001	0.032*	0.233***
(3) <i>Public</i>	0.289***	0.150***	1	0.864***	0.107***	0.454***	0.213***	0.085***	0.002	-0.039**	-0.012	0.084***	-0.039**	0.038**	0.178***
(4) <i>PublicD</i>	0.375***	0.242***	0.819***	1	0.296***	0.464***	0.469***	0.107***	-0.036**	-0.113***	0.024	0.049***	-0.035*	0.089***	0.265***
(5) <i>Plobby</i>	0.252***	0.260***	0.117***	0.307***	1	0.270***	0.297***	0.054***	-0.023	-0.079***	0.011	-0.036**	-0.038**	0.216***	0.273***
(6) <i>Tass</i>	0.401***	0.238***	0.454***	0.452***	0.223***	1	0.293***	0.062***	-0.010	-0.083***	0.022	0.069***	-0.003	0.143***	0.233***
(7) <i>Fro</i>	0.306***	0.252***	0.213***	0.507***	0.314***	0.293***	1	0.095***	-0.057***	-0.178***	0.111***	-0.026	0.017	0.102***	0.201***
(8) <i>Fsize</i>	0.335***	0.199***	0.083***	0.103***	0.084***	0.063***	0.096***	1	0.047***	0.086***	0.206***	0.145***	-0.046**	-0.141***	0.219***
(9) <i>M/B</i>	-0.024	-0.027	0.016	-0.009	0.015	-0.000	-0.025	0.077***	1	0.478***	-0.229***	0.726***	0.004	-0.075***	-0.017
(10) <i>Cash</i>	-0.155***	-0.083***	-0.042**	-0.124***	-0.070***	-0.084***	-0.175***	0.110***	0.470***	1	-0.279***	0.390***	-0.108***	-0.064***	-0.108***
(11) <i>Lev</i>	0.073***	0.039**	-0.028	-0.007	-0.030	-0.009	0.080***	0.257***	-0.180***	-0.230***	1	-0.198***	0.058***	-0.029	0.049***
(12) <i>Roe</i>	0.035*	-0.001	0.065***	0.025	-0.013	0.036**	-0.011	0.153***	0.562***	0.288***	-0.108***	1	-0.007	-0.034*	0.035*
(13) <i>Rggi</i>	-0.036*	-0.007	-0.039**	-0.031*	-0.059***	-0.003	0.017	-0.039**	-0.027	-0.105***	0.060***	-0.006	1	-0.086***	0.010
(14) <i>Carbon</i>	0.239***	0.048***	0.038**	0.098***	0.162***	0.143***	0.102***	-0.127***	-0.010	-0.059***	-0.054***	-0.071***	-0.086***	1	0.133***
(15) <i>Ets</i>	0.345***	0.244***	0.178***	0.272***	0.245***	0.233***	0.201***	0.200***	0.002	-0.107***	0.036**	0.014	0.010	0.133***	1

Notes: *** p<0.01, ** p<0.05, * p<0.1

TABLE 7. Fixed-Effects Regression of the relationship between Public Policy and Carbon Emissions.

	<i>CE</i>		<i>SCER</i>	
	(1)	(2)	(3)	(4)
<i>Public</i>	0.2236* (0.1255)		0.4173*** (0.0895)	
<i>PublicD</i>		0.1235*** (0.0415)		0.2776*** (0.0453)
<i>Fsize</i>	0.3364** (0.1514)	0.3383** (0.1509)	0.3157*** (0.0870)	0.3155*** (0.0867)
<i>M/B</i>	-0.4818*** (0.1796)	-0.4857*** (0.1801)	-0.3265*** (0.1180)	-0.3346*** (0.1164)
<i>Cash</i>	-1.5583** (0.7116)	-1.5564** (0.7120)	0.1617 (0.7067)	0.1958 (0.7096)
<i>Lev</i>	0.0499 (0.0457)	0.0531 (0.0453)	0.0151 (0.0491)	0.0226 (0.0489)
<i>Roe</i>	0.1253 (0.3847)	0.1104 (0.3866)	0.2581 (0.3783)	0.2285 (0.3696)
<i>Rggi</i>	-0.4103 (0.3315)	-0.4163 (0.3200)	-1.2692*** (0.3887)	-1.2699*** (0.4401)
<i>Carbon</i>	-0.1831 (0.1210)	-0.1761 (0.1205)	0.1913 (0.1670)	0.2087 (0.1679)
<i>Ets</i>	-0.0596 (0.0578)	-0.0609 (0.0569)	0.0640 (0.1350)	0.0571 (0.1342)
<i>Cons</i>	12.2075*** (0.5335)	12.2113*** (0.5192)	2.0488*** (0.3572)	1.9965*** (0.3552)
<i>N</i>	2954	2954	2954	2954
<i>R</i> ²	0.0277	0.0292	0.0678	0.0792
<i>F</i>	2.3482	2.4259	6.2821	7.3015

Notes: This Table presents the impact of public policy selection (*Public*) and public policy engagement (*PublicD*) on carbon emissions using our baseline model (1). Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

TABLE 8. The results of the robustness test regressions with dependent variable is substantial carbon emission (CE)

	Panel A Heckman test		Panel B IV	Panel C GMM
	(1) First stage	(2) Second stage	(3)	(4)
<i>PublicD</i>		0.7448*** (0.0635)	0.0330* (1.68)	0.4163*** (0.1199)
<i>Fsize</i>		0.4559*** (0.0342)	0.3860** (0.1509)	0.1936 (0.8634)
<i>M/B</i>		0.3802** (0.1547)	-0.4405*** (0.1357)	1.7737 (3.1479)
<i>Cash</i>		-3.1789*** (0.3427)	-0.2296** (0.1019)	-26.0362** (11.0138)
<i>Lev</i>		-0.0644 (0.0477)	0.0643 (0.0484)	-1.5500* (0.8535)
<i>Roe</i>		-0.3360 (0.6476)	0.0503 (0.3440)	4.7032 (10.1401)
<i>Rggi</i>		-0.3478*** (0.1168)	-0.4236 (0.4450)	-5.1622 (4.1904)
<i>Carbon</i>		1.9020*** (0.1154)	-0.1259 (0.0882)	0.6141 (2.2052)
<i>Ets</i>	0.5842*** (0.0581)	0.9595*** (0.1275)	-0.0371 (0.0470)	0.6084 (3.6944)
<i>Icp</i>	-0.9340*** (0.0828)			
<i>Voluntary</i>	0.1638*** (0.0515)			
<i>Thirty</i>	0.4814*** (0.0509)			
<i>R&D</i>	0.0138* (0.0081)			
<i>Cons</i>	-0.1343** (0.0563)	10.4298*** (0.2822)		19.3096*** (5.0945)
<i>N</i>		2956	2202	2289
<i>lambda</i>		0.0758 (0.2773)		
<i>AR (1)</i>				-2.09 (0.037)
<i>AR (2)</i>				-1.61 (0.107)
Hansen			3.062* (0.082)	0.222

Notes: This Table presents the results of robustness tests conducted through three different regression approaches. Panel A employs a two-step Heckman selection model. In the first step (column 1), we estimate the propensity of all firms to voluntarily disclose carbon emissions using the probit model. In the second step (column 2), the estimated dummy variable is incorporated into the ordinary least squares model to mitigate selectivity bias and estimate the regression parameters. Panel B (column 3) utilize the degree of public policy engagement lagged by one year as the

instrumental variable in a two-stage least squares regression model. Panel C (column 4) presents the dynamic two-step system Generalized Method of Moments (GMM) regression model. The dependent variable is *CE*. All variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

TABLE 9. The effect of firm size and carbon sensitivity on the relationship between public policy and carbon emissions

	<i>CE</i>				<i>SCER</i>			
	Carbon sensitive	Non-carb on sensitive	Large firms	Small firms	Carbon sensitive	Non-car bon sensitive	Large firms	Small firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>PublicD</i>	0.1356** (0.0581)	0.0294 (0.0526)	0.1201* (0.0652)	0.1249** (0.0510)	0.3533*** (0.0859)	0.1667*** (0.0546)	0.2149** (0.0845)	0.3118*** (0.0534)
<i>Fsize</i>	0.1705 (0.1205)	0.3410 (0.2773)			0.2300** (0.1043)	0.2771 (0.2248)		
<i>M/B</i>	-0.3298 (0.2440)	-0.4445** (0.1798)	-0.4984 (0.3643)	-0.4649** (0.2014)	-0.5309** (0.2368)	-0.1713 (0.1198)	-0.7504*** (0.2520)	-0.3206** (0.1322)
<i>Cash</i>	-2.7946 (1.7661)	-0.9271 (0.6594)	-0.6608 (0.6975)	-1.9553** (0.9447)	1.1643 (1.2175)	-0.2674 (0.9845)	-0.4514 (1.8615)	0.1904 (0.7949)
<i>Lev</i>	-0.0216 (0.0414)	-0.0050 (0.0591)	-0.0170 (0.0634)	0.1166* (0.0652)	0.0133 (0.0904)	-0.0286 (0.0576)	0.0058 (0.0908)	0.0581 (0.0592)
<i>Roe</i>	0.1328 (0.3526)	-0.0689 (0.9173)	-1.0546 (1.0736)	0.1240 (0.4229)	0.0979 (0.4540)	0.1119 (0.4598)	-0.1977 (1.6821)	0.1721 (0.4019)
<i>Rggi</i>	0.4576 (0.6915)	0.0620 (0.5012)	0.0000 (.)	-0.0142 (0.2024)	-1.0801 (0.6988)	-0.1868 (0.3931)	0.0000 (.)	-1.3101*** (0.3813)
<i>Carbon</i>			0.0517 (0.1231)	-0.2138 (0.1570)			0.1746 (0.5187)	0.1655 (0.1634)
<i>Ets</i>	-0.0596 (0.1027)	-0.0675 (0.1226)	0.0793 (0.0885)	-0.0769 (0.0730)	0.5448** (0.2735)	-0.0799 (0.1906)	-0.0937 (0.2994)	0.1060 (0.1419)
<i>Cons</i>	13.0184*** (0.5295)	11.7938*** (1.1114)	14.2061* (0.3457)	12.7771*** (0.3105)	2.0902*** (0.4124)	2.0574** (0.9198)	4.2653*** (0.5735)	2.5930*** (0.2831)
<i>N</i>	1270	1684	760	2227	1270	1684	760	2227
<i>R²</i>	0.0363	0.0200	0.0270	0.0250	0.0977	0.0472	0.0341	0.1065
<i>F</i>	1.4174	.	1.4216	1.8471	5.6272	.	2.0407	7.7165

Notes: This Table presents the effect of firm size and carbon sensitivity on the relationship between public policy and carbon emissions. We categorize all firms according to their size and carbon sensitivity. We define firms above the mean as large firms, and below the mean as small firms. Following Zhou et al. (2018), we define chemicals, gas and electrical utilities, oil and gas, coal mining, pipelines, steel, and transportation as belonging to the carbon sensitive sector. Columns (1) to (4) investigate the influence of Public Policy engagement (*PublicD*) on substantial carbon emissions (*CE*), while column (5) to (8) analyze the impact of Public Policy (*PublicD*) on symbolic carbon emissions reduction (*SCER*). Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

TABLE 10. Moderating effect of carbon tendency on the relationship between public policy engagement and substantial carbon emissions (CE)

	CE					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Public</i>	0.5689** (0.2872)		0.0779* (0.0448)		0.5263*** (0.1956)	
<i>Public</i> × <i>Regulation</i>	-0.5067* (0.2869)					
<i>Public</i> × <i>Intensity</i>			-0.0831* (0.0424)			
<i>Public</i> × <i>Voluntary</i>					-0.4349*** (0.1638)	
<i>PublicD</i>		0.3106** (0.1295)		0.1695*** (0.0534)		0.2552*** (0.0603)
<i>PublicD</i> × <i>Regulation</i>		-0.2393* (0.1300)				
<i>PublicD</i> × <i>Intensity</i>				-0.0879** (0.0383)		
<i>PublicD</i> × <i>Voluntary</i>						-0.1950*** (0.0559)
<i>Regulation</i>	0.6520** (0.3098)	0.5727** (0.2738)				
<i>Intensity</i>			0.0595 (0.0406)	0.2007** (0.1021)		
<i>Voluntary</i>					0.5881*** (0.1689)	0.5566*** (0.1472)
<i>Fsize</i>	0.3372** (0.1514)	0.3369** (0.1504)	0.0042*** (0.0007)	0.3294** (0.1508)	0.3611** (0.1529)	0.3653** (0.1528)
<i>M/B</i>	-0.4682*** (0.1751)	-0.4757*** (0.1769)	-0.0971** (0.0399)	-0.4852*** (0.1798)	-0.4644*** (0.1796)	-0.4611** (0.1812)
<i>Cash</i>	-1.5046** (0.6930)	-1.5043** (0.6965)	-0.7263*** (0.2442)	-1.5722** (0.7129)	-1.3587* (0.7184)	-1.3595* (0.7172)
<i>Lev</i>	0.0500 (0.0457)	0.0543 (0.0453)	0.0132 (0.0126)	0.0551 (0.0453)	0.0572 (0.0466)	0.0592 (0.0459)
<i>Roe</i>	0.1062 (0.3773)	0.0807 (0.3799)	-0.0428 (0.1002)	0.1131 (0.3856)	0.0386 (0.3778)	0.0296 (0.3799)
<i>Rggi</i>	-0.4003 (0.3295)	-0.4112 (0.3191)	-0.1230 (0.1194)	-0.4546 (0.3325)	-0.4065 (0.3724)	-0.4139 (0.3558)
<i>Carbon</i>	-0.1855 (0.1191)	-0.1811 (0.1186)	-0.0090 (0.0638)	-0.1641 (0.1199)	-0.2028* (0.1218)	-0.1903 (0.1207)
<i>Ets</i>	-0.0622 (0.0576)	-0.0568 (0.0559)	0.0215 (0.0439)	-0.0555 (0.0554)	-0.0623 (0.0585)	-0.0595 (0.0575)
<i>Cons</i>	11.7382*** (0.5724)	11.7779*** (0.5524)	13.0308*** (0.0985)	12.1549*** (0.5203)	11.6303*** (0.5499)	11.6432*** (0.5420)
<i>N</i>	2954	2954	2888	2954	2954	2954
<i>R</i> ²	0.0367	0.0375	0.0609	0.0311	0.0437	0.0459
<i>F</i>	2.1600	2.3828	5.6307	2.2618	2.7322	2.9823

Notes: This Table examines the impact of public policy engagement on carbon emission under the moderating effect of carbon tendency across three dimensions: carbon awareness, intensity targets, and voluntary disclosure. In column (1) & (2) we introduce the moderating variable *Regulation* (proxy for carbon awareness). In columns (3) & (4), we include the moderating variable *Intensity* (proxy for intensity targets). In columns (5) & (6), we add the moderating variable *Voluntary* (proxy for voluntary disclosure). The dependent variable is *CE*. Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, **, and *** indicate statistical significance at 10%, 5%,

and 1% levels, respectively.

TABLE 11. The regression results of the relationship between political lobbying and carbon emissions.

	<i>CE</i>			<i>SCER</i>		
	ALL	Carbon sensitive	Non-carbon sensitive	ALL	Carbon sensitive	Non-carbon sensitive
<i>Plobby</i>	0.0065 (0.0128)	0.0117 (0.0179)	-0.0189 (0.0144)	0.0590** (0.0272)	0.1114** (0.0552)	0.0196 (0.0273)
<i>Fsize</i>	0.3477** (0.1568)	0.1801 (0.1268)	0.3464 (0.2767)	0.3329*** (0.0879)	0.1411 (0.1278)	0.2824 (0.2248)
<i>M/B</i>	-0.4831*** (0.1814)	-0.3403 (0.2486)	-0.4439** (0.1771)	-0.3266*** (0.1196)	-0.2351 (0.5738)	-0.1500 (0.1211)
<i>Cash</i>	-1.6334** (0.7245)	-2.8857 (1.7793)	-0.9663 (0.6377)	0.0434 (0.7093)	0.7654 (1.4001)	-0.4281 (0.9868)
<i>Lev</i>	0.0503 (0.0449)	-0.0298 (0.0423)	-0.0058 (0.0592)	0.0210 (0.0493)	0.2380* (0.1405)	-0.0307 (0.0579)
<i>Roe</i>	0.1165 (0.3855)	0.1653 (0.3536)	-0.0653 (0.9190)	0.2520 (0.3861)	0.7582 (0.5332)	0.0920 (0.4706)
<i>Rggi</i>	-0.4383 (0.3507)	0.4579 (0.7139)	0.0478 (0.5126)	-1.2842*** (0.3684)	-0.9050 (0.8027)	-0.2347 (0.3989)
<i>Carbon</i>	-0.1879 (0.1211)			0.1770 (0.1660)		
<i>Ets</i>	-0.0504 (0.0566)	-0.0478 (0.1058)	-0.0627 (0.1196)	0.0738 (0.1340)	0.7427** (0.3022)	-0.0622 (0.1914)
<i>Cons</i>	12.3601*** (0.5527)	13.2315*** (0.5604)	11.8388*** (1.1361)	2.2854*** (0.3557)	2.2840*** (0.5516)	2.2567** (0.9241)
<i>N</i>	2954	1270	1684	2954	1270	1684
<i>R²</i>	0.0249	0.0289	0.0200	0.0611	0.0642	0.0369
<i>F</i>	2.2561	1.5671	.	5.0879	3.5054	.

Notes: This Table presents the regression results of the relationship between political lobbying and carbon emissions. We also conduct two separate analyses for carbon-sensitive and non-carbon-sensitive sectors. Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

TABLE 12. The regression results of the relationship between trade associations and carbon emissions.

	<i>CE</i>			<i>SCER</i>		
	ALL	Carbon sensitive	Non-carbon sensitive	ALL	Carbon sensitive	Non-carbon sensitive
<i>Tass</i>	0.1445 (0.1000)	0.6209** (0.3048)	-0.0030 (0.1029)	0.2913*** (0.0980)	1.0316*** (0.2306)	0.1183 (0.1008)
<i>Fsize</i>	0.3416** (0.1563)	0.0017 (0.0018)	0.3426 (0.2767)	0.3245*** (0.0890)	0.2365** (0.0993)	0.2845 (0.2241)
<i>M/B</i>	-0.4762*** (0.1797)	-0.2016 (0.1735)	-0.4412** (0.1765)	-0.3150*** (0.1200)	-0.5817** (0.2508)	-0.1540 (0.1203)
<i>Cash</i>	-1.5734** (0.7192)	-3.8103* (1.9596)	-0.9588 (0.6286)	0.1430 (0.7137)	1.1724 (1.2042)	-0.3728 (0.9789)
<i>Lev</i>	0.0517 (0.0456)	-0.0080 (0.0427)	-0.0055 (0.0609)	0.0189 (0.0490)	-0.0219 (0.0983)	-0.0261 (0.0584)
<i>Roe</i>	0.1075 (0.3861)	0.1775 (0.3618)	-0.0714 (0.9197)	0.2236 (0.3801)	0.0543 (0.4615)	0.1006 (0.4714)
<i>Rggi</i>	-0.4422 (0.3462)	0.6370 (0.6407)	0.0522 (0.5152)	-1.3284*** (0.3717)	-1.1585* (0.6013)	-0.2213 (0.3959)
<i>Carbon</i>	-0.1875 (0.1215)			0.1830 (0.1678)		
<i>Ets</i>	-0.0572 (0.0573)	-0.0760 (0.1201)	-0.0640 (0.1194)	0.0674 (0.1356)	0.5598** (0.2772)	-0.0623 (0.1919)
<i>Cons</i>	12.2733*** (0.5498)	13.9274*** (0.4747)	11.8328*** (1.1465)	2.1574*** (0.3645)	2.0460*** (0.4171)	2.1747** (0.9152)
<i>N</i>	2954	1270	1684	2954	1270	1684
<i>R²</i>	0.0259	0.0471	0.0198	0.0624	0.0933	0.0377
<i>F</i>	2.2924	2.1728	.	5.2266	5.9846	.

Notes: This Table presents the regression results of the relationship between political lobbying and carbon emissions. Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

TABLE 13. The regression results of the relationship between funding research organizations and carbon emissions

	<i>CE</i>			<i>SCER</i>		
	ALL	Carbon sensitive	Non-carbon sensitive	ALL	Carbon sensitive	Non-carbon sensitive
<i>Fro</i>	0.0898 (0.0806)	0.2779 (0.2084)	-0.0930** (0.0454)	0.2445* (0.1415)	0.3946 (0.2991)	0.1216 (0.1497)
<i>Fsize</i>	0.3466** (0.1552)	0.1738 (0.1222)	0.3482 (0.2779)	0.3335*** (0.0880)	0.2614*** (0.0944)	0.2790 (0.2257)
<i>M/B</i>	-0.4852*** (0.1814)	-0.3400 (0.2484)	-0.4382** (0.1765)	-0.3344*** (0.1184)	-0.5573** (0.2455)	-0.1567 (0.1212)
<i>Cash</i>	-1.6588** (0.7258)	-2.8829 (1.7849)	-0.9260 (0.6374)	-0.0451 (0.7126)	0.9198 (1.2334)	-0.4783 (0.9976)
<i>Lev</i>	0.0510 (0.0452)	-0.0185 (0.0338)	-0.0070 (0.0593)	0.0185 (0.0490)	-0.0431 (0.0956)	-0.0290 (0.0579)
<i>Roe</i>	0.1112 (0.3864)	0.1463 (0.3615)	-0.0606 (0.9185)	0.2285 (0.3758)	0.1539 (0.4522)	0.0842 (0.4725)
<i>Rggi</i>	-0.4436 (0.3470)	0.4632 (0.7070)	0.0528 (0.5124)	-1.3314*** (0.3647)	-1.0964* (0.6318)	-0.2400 (0.3995)
<i>Carbon</i>	-0.1842 (0.1208)			0.1918 (0.1688)		
<i>Ets</i>	-0.0451 (0.0561)	-0.0470 (0.1057)	-0.0714 (0.1201)	0.0947 (0.1348)	0.5757** (0.2794)	-0.0512 (0.1904)
<i>Cons</i>	12.3554*** (0.5435)	13.1725*** (0.5627)	11.8222*** (1.1366)	2.3149*** (0.3554)	2.5799*** (0.4095)	2.2761** (0.9292)
<i>N</i>	2954	1270	1684	2954	1270	1684
<i>R²</i>	0.0252	0.0311	0.0202	0.0606	0.0749	0.0374
<i>F</i>	2.2651	1.3722	.	4.9555	4.3550	.

Notes: This Table presents the regression results of the relationship between funding research organizations and carbon emissions. Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

APPENDIX A. The regression of the robustness test with dependent variable is symbolic carbon emission (*SCER*)

	Panel A Heckman test		Panel B IV	Panel C GMM
	(1) First stage	(2) Second stage	(3)	(4)
<i>PublicD</i>		0.5142*** (9.10)	0.256** (0.10)	0.2625** (0.1269)
<i>Fsize</i>		0.1892*** (6.26)	0.415*** (0.09)	0.9032 (1.1462)
<i>M/B</i>		-0.1495 (-1.09)	-0.293* (0.15)	-2.5469 (2.8004)
<i>Cash</i>		-0.0059 (-0.02)	-1.203* (0.73)	-0.8134 (1.1255)
<i>Lev</i>		-0.0368 (-0.87)	-0.029 (0.06)	0.8922 (0.6222)
<i>Roe</i>		-0.1050 (-0.18)	0.570 (0.55)	-0.0451 (0.5510)
<i>Rggi</i>		0.0467 (0.45)	-1.505*** (0.58)	-6.9821 (4.4248)
<i>Carbon</i>		-0.1126 (-1.09)	0.180 (0.13)	-0.2968 (1.2933)
<i>Ets</i>	0.5842*** (10.06)	0.9941*** (8.27)	0.090 (0.14)	-1.5819 (1.9804)
<i>Icp</i>	-0.9340*** (-11.29)			
<i>Voluntary</i>	0.1638*** (3.18)			
<i>Thirty</i>	0.4814*** (9.47)			
<i>R&D</i>	0.0138* (1.70)			
<i>Cons</i>	-0.1343** (-2.38)	1.0401*** (4.05)		1.6038 (4.7363)
<i>N</i>		2956	2202	2289
<i>lambda</i>		1.2840*** (4.99)		
<i>AR (1)</i>				-2.15(0.031)
<i>AR (2)</i>				-1.21(0.225)
<i>Hansen</i>			7.707*** (0.006)	0.269

Notes: This Table presents the results of robustness tests conducted through three different regression approaches with dependent variable being *SCER*. Panel A employs a two-step Heckman selection model. In the first step (column 1), we estimate the propensity of all firms to voluntarily disclose carbon emissions using the probit model. In the second step (column 2), the estimated dummy variable is incorporated into the ordinary least squares model to mitigate selectivity bias and estimate the regression parameters. Panel B (column 3) utilize the degree of public policy engagement lagged by one year as the instrumental variable in a two-stage least squares regression model. Panel C (column 4) presents the dynamic two-step system Generalized Method of Moments (GMM) regression model. Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

APPENDIX B. Moderating effect of carbon tendency on the relationship between public policy engagement and symbolic carbon emissions (*SCER*)

	<i>SCER</i>					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Public</i>	0.2967* (0.1583)		0.3404*** (0.1090)		0.3239** (0.1471)	
<i>Public</i> × <i>Regulation</i>	0.1270 (0.1802)					
<i>Public</i> × <i>Intensity</i>			0.1667 (0.1593)			
<i>Public</i> × <i>Voluntary</i>					0.1298 (0.1557)	
<i>PublicD</i>		0.2803*** (0.0834)		0.2531*** (0.0543)		0.2449*** (0.0655)
<i>PublicD</i> × <i>Regulation</i>		-0.0157 (0.0870)				
<i>PublicD</i> × <i>Intensity</i>				0.0469 (0.0635)		
<i>PublicD</i> × <i>Voluntary</i>						0.0484 (0.0601)
<i>Regulation</i>	0.1777 (0.1523)	0.2531* (0.1396)				
<i>Intensity</i>			-0.0839 (0.1590)	-0.0314 (0.1300)		
<i>Voluntary</i>					-0.0799 (0.1403)	-0.0504 (0.1167)
<i>Fsize</i>	0.3141*** (0.0865)	0.3141*** (0.0863)	0.3229*** (0.0873)	0.3200*** (0.0867)	0.3111*** (0.0871)	0.3111*** (0.0870)
<i>M/B</i>	-0.3292*** (0.1182)	-0.3332*** (0.1164)	-0.3298*** (0.1181)	-0.3377*** (0.1164)	-0.3287*** (0.1178)	-0.3379*** (0.1160)
<i>Cash</i>	0.2286 (0.7032)	0.2513 (0.7066)	0.1428 (0.7084)	0.1881 (0.7110)	0.1452 (0.7078)	0.1874 (0.7121)
<i>Lev</i>	0.0157 (0.0486)	0.0228 (0.0487)	0.0136 (0.0488)	0.0219 (0.0485)	0.0161 (0.0493)	0.0240 (0.0492)
<i>Roe</i>	0.2437 (0.3774)	0.2158 (0.3716)	0.2652 (0.3835)	0.2290 (0.3728)	0.2572 (0.3769)	0.2241 (0.3690)
<i>Rggi</i>	-1.2633*** (0.3955)	-1.2632*** (0.4449)	-1.2512*** (0.3989)	-1.2586*** (0.4469)	-1.2764*** (0.3925)	-1.2757*** (0.4449)
<i>Carbon</i>	0.1959 (0.1665)	0.2104 (0.1677)	0.1868 (0.1674)	0.2073 (0.1687)	0.1915 (0.1661)	0.2070 (0.1674)
<i>Ets</i>	0.0662 (0.1353)	0.0583 (0.1344)	0.0660 (0.1343)	0.0585 (0.1335)	0.0660 (0.1355)	0.0578 (0.1345)
<i>Cons</i>	1.9013*** (0.3753)	1.7973*** (0.3741)	2.0618*** (0.3609)	1.9986*** (0.3587)	2.1186*** (0.3736)	2.0417*** (0.3719)
<i>N</i>	2954	2954	2954	2954	2954	2954
<i>R</i> ²	0.0711	0.0818	0.0687	0.0796	0.0683	0.0796
<i>F</i>	6.4082	7.2671	5.5519	6.5276	5.6247	6.6722

Notes: This Table examines the impact of public policy engagement on symbolic carbon emission reduction under the moderating effect of carbon tendency across three dimensions: carbon awareness, intensity targets, and voluntary disclosure. In column (1) & (2) we introduce the moderating variable *Regulation* (proxy for carbon awareness). In columns (3) & (4), we include the moderating variable *Intensity* (proxy for intensity targets). In columns (5) & (6), we add the moderating variable *Voluntary* (proxy for voluntary disclosure). The dependent variable is SEC. Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard

errors are shown in parentheses and clustered at the firm level for the model. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

APPENDIX C. The regression results of the relationship between political lobbying selection and carbon emission

	<i>CE</i>			<i>SCER</i>		
	ALL	Carbon sensitive	Non-carbon sensitive	ALL	Carbon sensitive	Non-carbon sensitive
<i>Political lobbying selection</i>	0.0719 (0.1276)	-0.0123 (0.1489)	0.1440 (0.1830)	0.1257 (0.0982)	0.5573* (0.2992)	-0.0878 (0.0985)
<i>Fsize</i>	0.3485** (0.1575)	0.1798 (0.1265)	0.3510 (0.2680)	0.3383*** (0.0884)	0.2413** (0.1043)	0.2813 (0.2249)
<i>M/B</i>	-0.4856*** (0.1825)	-0.3403 (0.2480)	-0.4478** (0.1817)	-0.3333*** (0.1189)	-0.5783** (0.2471)	-0.1487 (0.1212)
<i>Cash</i>	-1.6431** (0.7301)	-2.8659 (1.7747)	-0.9414 (0.6396)	0.0042 (0.7140)	1.1115 (1.2556)	-0.4472 (0.9910)
<i>Lev</i>	0.0514 (0.0441)	-0.0314 (0.0426)	-0.0030 (0.0589)	0.0177 (0.0491)	-0.0090 (0.0919)	-0.0326 (0.0579)
<i>Roe</i>	0.1265 (0.3829)	0.1618 (0.3537)	-0.0362 (0.9079)	0.2589 (0.3838)	0.2061 (0.4818)	0.0768 (0.4707)
<i>Rggi</i>	-0.4333 (0.3581)	0.4476 (0.7156)	0.0121 (0.5540)	-1.3133*** (0.3683)	-0.9788 (0.6461)	-0.2150 (0.3989)
<i>Carbon</i>	-0.1849 (0.1207)			0.1876 (0.1678)		
<i>Ets</i>	-0.0505 (0.0565)	-0.0470 (0.1062)	-0.0690 (0.1226)	0.0812 (0.1351)	0.5678** (0.2733)	-0.0577 (0.1923)
<i>Cons</i>	12.3414*** (0.5470)	13.2501*** (0.5575)	11.7677*** (1.0648)	2.3016*** (0.3622)	2.5130*** (0.3949)	2.3036** (0.9266)
<i>N</i>	2954	1270	1684	2954	1270	1684
<i>R²</i>	0.0251	0.0287	0.0210	0.0591	0.0785	0.0372
<i>F</i>	2.3861	1.4289	.	4.7959	4.1878	.

Notes: This Table reports the results of regression analysis of the relationship between political lobbying selection and carbon emission. We use dummy variables for political lobbying selection that takes value of 1 if the firm engages in political lobbying and 0 if it does not. All other variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

APPENDIX D. Table 1 The regression results of the relationship between political lobbying and carbon emission under different firm size

	<i>CE</i>		<i>SCER</i>	
	Large firms	Small firms	Large firms	Small firms
<i>Plobby</i>	-0.0155 (0.0175)	0.0194 (0.0205)	-0.0239 (0.0252)	0.1109*** (0.0369)
<i>M/B</i>	-0.5336 (0.3803)	-0.4551** (0.2021)	-0.8134*** (0.2567)	-0.2912** (0.1367)
<i>Cash</i>	-0.7275 (0.7111)	-2.0537** (0.9602)	-0.5672 (1.8705)	-0.0335 (0.8063)
<i>Lev</i>	-0.0222 (0.0643)	0.1142* (0.0644)	-0.0028 (0.0920)	0.0562 (0.0602)
<i>Roe</i>	-0.8332 (0.9913)	0.1188 (0.4225)	0.2000 (1.6997)	0.1723 (0.4247)
<i>Rggi</i>	0.0000 (.)	-0.0027 (0.2419)	0.0000 (.)	-1.2399*** (0.2850)
<i>Carbon</i>	0.0498 (0.1216)	-0.2284 (0.1574)	0.1710 (0.5140)	0.1208 (0.1575)
<i>Ets</i>	0.1113 (0.0820)	-0.0664 (0.0735)	-0.0381 (0.3003)	0.1278 (0.1398)
<i>Cons</i>	14.4232*** (0.4372)	12.9335*** (0.3307)	4.6483*** (0.5779)	2.9141*** (0.2761)
<i>N</i>	760	2227	760	2227
<i>R²</i>	0.0220	0.0212	0.0233	0.0880
<i>F</i>	1.4237	1.7238	1.3403	5.9829

Notes: This Table presents the regression results of the relationship between political lobbying and carbon emission under different firm size. Variables are defined in Table 4. Firm and year dummy variables included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for model. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

APPENDIX D. Table 2 The regression results of the relationship between political lobbying selection and carbon emission under different firm size

	<i>CE</i>		<i>SCER</i>	
	Large firms	Small firms	Large firms	Small firms
Political lobbying selection	0.4235 (0.3901)	-0.0302 (0.1089)	-0.0994 (0.2126)	0.2148* (0.1118)
<i>M/B</i>	-0.5915 (0.4159)	-0.4566** (0.2022)	-0.8004*** (0.2598)	-0.2998** (0.1355)
<i>Cash</i>	-0.6195 (0.7216)	-2.0565** (0.9670)	-0.5672 (1.8497)	-0.0991 (0.8046)
<i>Lev</i>	-0.0140 (0.0594)	0.1117* (0.0630)	0.0001 (0.0927)	0.0581 (0.0590)
<i>Roe</i>	-0.9996 (1.1145)	0.1090 (0.4218)	0.2508 (1.6742)	0.1898 (0.4187)
<i>Rggi</i>	0.0000 (.)	-0.0213 (0.2428)	0.0000 (.)	-1.2728*** (0.2805)
<i>Carbon</i>	0.0899 (0.1015)	-0.2265 (0.1574)	0.1600 (0.5085)	0.1390 (0.1638)
<i>Ets</i>	0.1014 (0.0870)	-0.0641 (0.0737)	-0.0493 (0.3002)	0.1291 (0.1428)
<i>Cons</i>	14.2676*** (0.3429)	12.9659*** (0.3205)	4.6442*** (0.5833)	2.9589*** (0.2753)
<i>N</i>	760	2227	760	2227
<i>R</i> ²	0.0338	0.0210	0.0231	0.0825
<i>F</i>	1.2793	1.8339	1.2672	5.6008

Notes: This Table presents the regression results of the relationship between political lobbying selection and carbon emission under different firm size. We use dummy variables for political lobbying selection that takes value of 1 if the firm engages in political lobbying and 0 if it does not. Variables are defined in Table 4. Firm and year dummy variables are included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for the model. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively

APPENDIX D Table 3 The regression results of the relationship between trade associations and carbon emission under different firm size

	<i>CE</i>		<i>SCER</i>	
	Large firms	Small firms	Large firms	Small firms
<i>Tass</i>	0.0576 (0.1530)	0.1818 (0.1276)	0.0936 (0.2247)	0.4175*** (0.1097)
<i>M/B</i>	-0.5355 (0.3788)	-0.4477** (0.1992)	-0.8164*** (0.2598)	-0.2793** (0.1370)
<i>Cash</i>	-0.6975 (0.6833)	-1.9435** (0.9614)	-0.5196 (1.8675)	0.1966 (0.8051)
<i>Lev</i>	-0.0195 (0.0639)	0.1171* (0.0657)	0.0014 (0.0924)	0.0586 (0.0586)
<i>Roe</i>	-0.8025 (1.0150)	0.1022 (0.4240)	0.2494 (1.7305)	0.1201 (0.4131)
<i>Rggi</i>	0.0000 (.)	-0.0142 (0.2324)	0.0000 (.)	-1.3105*** (0.2875)
<i>Carbon</i>	0.0472 (0.1203)	-0.2267 (0.1583)	0.1667 (0.5172)	0.1333 (0.1627)
<i>Ets</i>	0.0966 (0.0772)	-0.0710 (0.0745)	-0.0614 (0.3057)	0.1219 (0.1424)
<i>Cons</i>	14.3611*** (0.4642)	12.8023*** (0.3404)	4.5491*** (0.6244)	2.6864*** (0.2899)
<i>N</i>	760	2227	760	2227
<i>R²</i>	0.0217	0.0225	0.0230	0.0888
<i>F</i>	1.4340	1.7669	1.2514	6.6239

Notes: This Table presents the regression results of the relationship between trade associations and carbon emission under different firm size. Variables are defined in Table 4. Firm and year dummy variables included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for model. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively

APPENDIX D Table 4. The regression results of the relationship between funding research organizations and carbon emission under different firm size

	<i>CE</i>		<i>SCER</i>	
	Large firms	Small firms	Large firms	Small firms
<i>Fro</i>	-0.0087 (0.0731)	0.1555 (0.1132)	0.0600 (0.1934)	0.3458* (0.1853)
<i>M/B</i>	-0.5330 (0.3818)	-0.4565** (0.2023)	-0.8203*** (0.2642)	-0.2995** (0.1360)
<i>Cash</i>	-0.7150 (0.7069)	-2.1195** (0.9681)	-0.5334 (1.8474)	-0.2032 (0.8063)
<i>Lev</i>	-0.0197 (0.0636)	0.1149* (0.0651)	0.0026 (0.0932)	0.0535 (0.0594)
<i>Roe</i>	-0.8298 (0.9876)	0.1033 (0.4236)	0.2321 (1.7083)	0.1234 (0.4046)
<i>Rggi</i>	0.0000 (.)	-0.0334 (0.2426)	0.0000 (.)	-1.3532*** (0.2797)
<i>Carbon</i>	0.0485 (0.1206)	-0.2195 (0.1571)	0.1729 (0.5160)	0.1494 (0.1675)
<i>Ets</i>	0.1027 (0.0796)	-0.0639 (0.0736)	-0.0424 (0.3092)	0.1381 (0.1427)
<i>Cons</i>	14.4040*** (0.4299)	12.9417*** (0.3366)	4.5885*** (0.5724)	3.0075*** (0.2727)
<i>N</i>	760	2227	760	2227
<i>R²</i>	0.0215	0.0218	0.0228	0.0843
<i>F</i>	1.5180	1.7500	1.2520	5.6311

Notes: This Table presents the regression results of the relationship between funding research organizations and carbon emission under different firm size. Variables are defined in Table 4. Firm and year dummy variables included in the models. Bootstrap standard errors are shown in parentheses and clustered at the firm level for model. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.