Corporate Lobbying for Environmental Performance

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Abstract

This paper focuses on how corporate political strategies at the industry level influence salient political issues. In the context of recent climate change policy debates of the United States, I investigate the impact of lobbying on climate change. The theoretical model develops the claim that lobbying expenditures and activities of the clean industry has a negative impact on CO_2 emissions, while that of the polluting industry have a positive impact. I test the hypothesis in the whole industry, which shows that lobbying expenditures and activities have a negative impact on CO_2 emissions. I use a panel data regression to analyze CO_2 emissions in the U.S. at the state-level from 2006 to 2017. The results are consistent with my hypothesis, suggesting that clean industries have a stronger negative lobbying effects on CO_2 emissions than dirty ones.

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1. Introduction

The "Paris Agreement", which was adopted at the Paris Climate Change Conference on December 12, 2015, aims to limit the rise of the global average temperature within 2 Celsius degrees in this century and to keep the rise in global temperature within 1.5 degrees Celsius above the pre-industrial level. By June 29, 2016, 178 countries had signed the "Paris Agreement". The United States was on the list. However, Donald Trump announced that the United States would withdraw from the Paris climate agreement in June 2017.[1] He claimed that the Paris Agreement would reduce U.S. gross domestic product by 3 trillion U.S. dollars and it would cut 6.5 million jobs. This announcement immediately brought about an avalanche of protests and discussions. Chuck Schumer, the Democratic leader of the Senate, said that this was "one of the worst decisions of the 21st century," and "it has caused tremendous damage to the US economic, environmental, and geopolitical stance." However, the U.S. Republican congressional leaders and the U.S. coal industry expressed their support for Trump's decision. Mitch McConnell, the Republican Senate Majority Leader, supported Trump's decision as well. He also called it "another major blow to the policy about domestic energy production and employment published by the Obama administration."

Climate change issues involve multiple industries and affect business decisions on a daily basis. Companies are under increasing pressure. They are actively formulating and implementing environmental protection policies in the hope of reducing their carbon emissions. Zito (2002) points out that lobbying policies have a significant influence on environmental protection policies and that lobbying costs of different companies and individual groups have different effect on environmental policy decisions.

Case 1: Southern Company and Pacific Gas and Electric Co

Since the U.S. legislative branch had started an argument on climate change in 2008, Electric Utilities Southern Company and Pacific Gas and Electric Company spent a significant amount of money on lobbying activities; Southern Co. spent $13 million and Pacific Gas and Electric Co. publicly supporting cap-and-trade legislation, and spent $25

[1] The process of withdrawal will take four years.

million on lobbying activities. However, Pacific carbon footprint was 40 times smaller than that of the Southern.

The two power companies have similar positions on the question of global warming. They both reflect the trend of lobbying for climate change. Both "dirty" and "clean" companies are active in lobbying. Dirty firms prefer lobbying to maintain the status quo, while green firms believe that strengthening environmental regulation is an opportunity to gain market share at the company level (Delmas et al., 2016).

However, their incentives to lobby are different. For companies with high CO_2 emissions, the implementation of global warming policies will decrease their profit margins. This type of business usually chooses to spend money on lobbying relevant lawmakers to implement a loose environmental policy, thus damaging the protection of the environment. By contrast, the clean companies adopt lobbying policy as a way to increase their market share.

Many environmental policymakers say that "when there seems to be a conflict between the economy and the environment, the environment always fails." However, there are also many exceptions to this rule.

Case 2: European six oil companies

Firms with high carbon emissions lobby at different levels for complex climate change scenarios. Six big oil and gas companies in Europe (BG, BP, Eni, shell, Norway's national oil company and Total) informed the UN in 2015 that they needed a global carbon price alliance. They said this alliance would help them to reduce carbon emissions and increase their production of cleaner natural gas. However, there was another motive for their move: these firms used the UN to increase their market share by reducing the share of the coal industry. Grey (2018, p.24) points out that "Coal is their biggest competitor, with around 30% of the global energy supply market."

Case 3: DuPont

The ozone layer was severely damaged in the 1980s. Environmental regulators tried to establish a global rule calling on companies to invest in environment-friendly products instead of ozone-depleting CFCs. However, by the end of this decade, major ozone polluters had opposed the environmental policy and had successfully used their economic status to restrict the protection of the ozone layer. DuPont, a typical ozone polluter, had

been campaigning against such regulatory lobbying and had warned that the restrictions published by the U.S. Senate on the production of CFCs would create enormous economic dislocation. However, DuPont suddenly announced that they supported regulation and wanted to put an end to the production of CFCs in the world in 1988. Barrett (2003) says that DuPont's new political support for regulation is widely seen as a critical turning point in the ozone story. Smith (1998) gives a detailed discussion of DuPont's potential motive, in which he points out that DuPont's regulatory lobbying may be in *its economic interest*. Because they have already made some investments in cleaner production technologies, they may gain market share through their lobbying.

In this paper I consider the research question of how corporate lobbying performance affects climate change. For this purpose, I use lobbying expenditures as the dependent variable and lobbying activities as the main explanatory variables to analyze the relationship among CO_2 emissions, an important factor affecting global warming, and political activity (lobbying). I use the panel data on lobbying produced by the National Institute on Money in State Politics (NIMSP), which consists of two groups: lobbying expenditures and activities, between 2006 and 2017. CO_2 emissions as the dependent variable describe the climate change performance among different industries. The data of the dependent variable is taken from the United States Energy Information Administration (EIA) at the state level. My results illustrate that dirty and clean companies are both engaged in active lobbying. Clean companies consider environmental protection as an opportunity to gain market share. This has an adverse effect on CO_2 emissions. Dirty companies lobby to maintain the status quo, which positively affects CO_2 emissions. The results suggest that the clean industries have a stronger negative lobbying effect on CO2 emissions than dirty industries.

2. Literature review

The following literature review presents theoretical and empirical research on the political economy of environmental regulation and performance.

2.1 Theoretical Literature

Grossman and Helpman (1994) were the first to apply the common agency model of Bernheim and Whinston (1986) to the lobbying field. In their model, authors assume that

special-interest groups influence the government's trade choices by means of political contributions. This model has become a standard method for studying lobbying-related issues.

Aidt (1998) and Fredriksson (1997) apply the agency model to environmental policy. Their papers present the characteristics of endogenous environmental policies by enhancing the typical agency model and pointing out that competition among lobbying groups is a vital source of externality internalization[2]. The process of political competition and the facts illustrate some lobbying groups adjust their economic goals to reflect environmental issues which contribute to political internalization. They also demonstrate that the influence of environmental lobbying groups can offset the effect of polluters' lobbying and achieve the goal of environmental protection.

Damania and Fredriksson (2000) build a lobbying model that extends the menu-auction model of Grossman and Helpman (1994). This paper proposes two research elements: collusion and collusive profits. These two factors affect the ability to overcome the free-rider problem. The authors build an induced three-staged game to explain the lobbying expense tap between dirty and clean firms. Finally, they conclude that more polluting industries and companies with higher collision have a higher motivation to form and contribute to a lobbying group. They use lobbying policies to obtain a lower pollution tax and maximize their profits.

The above works have a standard feature that polluting firms always have an incentive to organize a lobbying group against environmental protection. Their models aim to explain how environmental protection can be achieved under the effect of a polluting firm's lobbying group. However, these theoretical papers do not study the question that polluting companies may also support environmental protection.

Grey (2018) gives two specific examples: The DuPont and Paris agreements, both of which show that polluting companies may support environmental protection policies to compete for market share from competitors. The basic model is a three-stage game as in my paper. The model successfully demonstrates that at a fixed level of emission tax,

[2] Externality internalization： Because of the fierce lobbying competition of enterprises, a firm usually purchases his polluted land. This process is called an externality internalization, which eliminates externality influence and makes the economy operating at a Pareto optimal state.

companies use lobbying to support environmental protection policies, which in turn raise their market share.

Hillman and Hitt (1999) believe that firms, like other interest groups, participate in the political process because they seek policies or policy results that are beneficial to them. The government policies have a significant influence on a firm's opportunity set. They suggest that many companies choose to shape government policies to build their influence in the market. Hillman and Hitt (1999) develop and present a theoretical model called "decision-tree model", which made remarkable progress in explaining the rationale of the firm in developing political strategies.

Hillman et al. (2004) review articles related to corporate political activity (CPA) on management, political science, economics and sociology. They establish the causal model of CPA and attempt to study the relationship between the characteristics of firms related to a contested political issue and issue salience[3]. The model shows the impact of different types of public CPAs on policy and company performance. The results show that the changes in political activities at the corporate level are determined by organizational factors like age, firm size, or formal structure. However, these factors do not adequately explain the relationship between corporate strategy and the characteristics of specific problems[4].

Considering the significant expansion of environmental laws and regulations over the past few decades and the increase in the political influence of environmental groups, Kamieniecki (2006) revisits a constant problem in U.S. politics and U.S. environmental policy: what is corporate influence over federal environmental regulation. He mainly analyzes the ability and scope of the company's influence on the formulation of policies and regulations in the environmental protection and natural areas of the federal government. He studies the above issues in a carefully selected manner across government departments, selecting cases from environmental protection and natural resources.[5] However, he does not give a simple answer but draws a seemingly contradictory conclusions. He finds that there is little evidence that companies can directly achieve their interests through Capitol

[3] Issue salience was firstly referred by Vogel (1996). Issue salience is about whether the policy will affect an industry or a group of industries, and the extent to which this impact is related to the impact of other issues.
[4] Specific problems: environmental governance and performance.
[5] Natural resources include PCB contamination on the Hudson River, acid rain, climate change, surface mining, forestry and wetland restoration.

Hill legislation, agency rulemaking, or court rulings. However, at the same time, he also finds that there are ongoing political lobbying phenomena in each industry sector. In the last section of the paper, Kamieniecki's work gives subsequent scholars a view that the environmental policy is an essential context in studying the determinants of political activity.

2.2 Empirical Literature

There are empirical papers which study the effect of political activities on environmental performance. These papers adopt a panel-analysis approach.

Cho et al. (2006) study theoretical papers related to the public policy strategies and corporate relationships and find that these papers repeatedly refer to two fundamental business ethics issues (compliance and governance issues). They state that the two fundamental business ethics issues influence business decisions on public policies and protection of the natural environment. Therefore, he proposes the following three questions: (1) will companies with poor environmental performance spend more on political activities than companies with better performance? (2) Does the company's expenditure on political activities have any correlation with companies' profit? (3) How is the environmental disclosure of its financial report? To solve these three problems, the author uses a sample data from 119 U.S. environmentally sensitive companies during the 2001-2002 election period. These sample data are obtained from the corporate level of Conservation Reserve Program (CRP) database and the environmental performance of KLD Research & Analytics, Inc. (KLD)[6]. To control for the impact of specific industries and the size of the company, the article uses multiple regressions to analyze the relationship between the two. Their findings are consistent with a large number of facts and reveal the critical inverse relationship between corporate environmental performance and political spending. In other words, U.S. companies with relatively poor records of environmental performance have a stronger desire to participate in corporate activities. They also take political activities as part of their strategic management. The article also reveals that environmental disclosure and political expenditure are complementary strategies to reduce public policy pressures.

[6] KLD Research & Analytics, Inc. is an independent data disclosure company, providing environmental, social and governance research data for institutional investors. A large number of articles adopt and confirm their data, which is reliable.

The relationship between corporate political activity and climate change policies has been previously assessed only to a very limited extent; there are very few papers devoted to this subject. Clark et al. (2012) analyze the environmental performance of companies in corporate political activity. Authors put forward two perspectives on corporate lobbying which are as follow: economic theory claims that superior firms have more significant incentive to disclose lobbying reports. Conversely, the sociopolitical perspective claims that poor-performing firms spend more money on lobbying. The authors propose their own four hypotheses. Firstly, firms with poor performance in the environment may be fully involved in the constituency-building (CB) and the financial-incentive (FI) tactics. Secondly, good-performing firms may be fully involved in both the CB and the FI tactics. Thirdly, non-starters, who lack environmental records, may not participate in the CB tactic, but only participate in the FI tactic. Lastly, the authors define mixed bags as an intersection view of the above two opposite perspectives. Mixed bags may only be covered in CB and FI tactics. To verify these hypotheses, the authors choose the CDP's survey of 500 firms including 385 investors "signatory" members. The dependent variables of this regression equation are CB and FI. The explanatory variable is environmental performance. The results show that there is a statistically significant relationship between environmental performance and political activities (economic incentives), but no other (constituency building). Furthermore, the paper emphasizes the importance of shareholders in their model and mentions that intermediary companies try to shape government policies positively.

I found only one empirical paper, Delmas et al. (2016), which analyzes lobbying activity and environmental performance. This scarcity of research can be explained; lobbying information can only be obtained after the Law Disclosure Act, which was revised in 2007. Delmas et al. (2016) propose that the energy and natural resources sector in the U.S. need to spend more money every year on political lobbying. The energy and natural resource sector’s primary purpose is to gain the profit for its own companies and groups by influencing legislation. This paper mainly studies how performance on environmental issues affects corporate political strategy at the firm-level. In their paper, they choose the recently controversial government policy—climate change policy as the primary variable affecting corporate behavior. They assume that greenhouse gas (GHG) emissions and lobbying expenditures have a U-shaped relationship. To verify their hypothesis, they select

leverages original data at the firm level. GHG emissions coming from Truscot[7] can be regarded as the independent variable data of their regression equations. They select the lobbying data, which belongs to climate change legislation from CRP, as the dependent variable Finally, they verified the success of the hypothesis and obtained a study of different types of lobbying regarding climate change cost.

3. The Model

In this section, to obtain testable hypotheses, I use the model of Grey (2018) with slight modifications. Grey's model uses the approach of Grossman and Helpman (1994). There are two firms and a government who play a three-stage game. Firms try to increase their market share by lobbying the government over the level of an emissions tax.

3.1 Assumptions and basic set-up

Firms. I index firms by j∈ {1,2}. Each firm j produces a single homogeneous good q_j. Firms have convex production cost, $\frac{1}{2}aq_j^2$. Firm j chooses its technology $f_j \in \{C, D\}$, where C is presented the *clean* production technology and D is presented the *dirty* production technology. Each firm has emissions per unit of output e_j. The emission of a firm who chooses $f_j = C$ is zero.

$$e_j(f_j) = \begin{cases} 0 & if\ f_j = C \\ 1 & if\ f_j = D \end{cases} \quad (1)$$

The firm will spend $t>0$ on investment if it chooses the new clean technology. Alternatively, the firm does not need to undertake any other extra costs on the old dirty technology; the firm keeps the original marginal cost, and the cost structure of the firm does not change. However, investments in clean technology lead to lower marginal costs.

Each firm pays an emissions tax α, resulting in a tax bill of $\alpha e_j q_j$. Each firm j chooses output q_j to maximize profits, given by:

$$\pi_j(q_j|\alpha, f) = pq_j - \frac{1}{4}q_j^2 - \alpha e_j q_j \quad (2)$$

[7] Trucost is a reliable data site, which provides a range of environmental performance data for the investment community and is increasingly used for peer-reviewed academic research.

$$q = 1 - bp \tag{3}$$

where $q = q_1 + q_2$, and $b \geq 0$. It should be noted that demand is inelastic and equal to 1 when $b=0$.

Market. There are two product market assumptions.

a. The demand is linear, which helps in understanding how competition for market share drives the key results.
b. Firms are price takers, which ensures the model's focus on the strategic interactions between the investment and lobbying stages.

Government. The government sets the emission tax τ to maximize the social welfare S and to earn political donations from lobbyists. Social welfare equals the utility of firms minus environmental damage ($\varphi \sum e_j q_j$), given by

$$S(q, \tau, f) = \frac{1}{b}\left(q - \frac{1}{2}q^2\right) + \sum \pi_j - pq + \tau \sum e_j q_j - \varphi \sum e_j q_j. \tag{4}$$

It should be noted that the quasilinear utility of firms is $U(q, w) = \frac{1}{b}\left(q - \frac{1}{2}q^2\right) + w$, where wealth w is equal to total profits $(\pi_1 + \pi_2)$, minus costs $q(pq)$, plus emissions tax revenue $\tau \sum e_j q_j$. The government cares about political contribution g_1 and g_2 coming from the two firms when they lobby the government.

I use the contribution function $G_J(\tau)$ to define how much firm j pays to the government. The government maximizes $W(\tau)+\theta(G_1(\tau) + G_2(\tau))$.[8]

3.2 The timing of the game

The game has three-stages:

Stage 1: Investment

Firms simultaneously choose production technology $f_j \in \{C, D\}, j = 1,2$.

Stage 2: Lobbying

Firms simultaneously choose contribution functions $G_J(\tau), j = 1,2$. The government chooses the emissions tax $\tau \in R$.

Stage 3: Production

[8] θ is the openness index to the lobbying on the government. The model focuses on the case where θ is close to 0.

Prices are taken as given and the market clears. Each firm j earns profits π_j. Final payoffs are

$$U_{gov}=S+\theta(g_1+g_2) \quad (5)$$

$$U_j=\pi_j-q_j-i(1-e_j) \quad (6)$$

3.3 Equilibria and conclusions

Equilibria. I focus on a subgame-perfect Nash equilibrium in pure strategies. In stage 3, there are three choices for the two firms: $f \in \{(C,C),(C,D),(D,D)\}$. In the first case, the emissions tax does not affect the two firms. The output of the two firms is high and the same. In the second case, total benefits increase in the emission tax. In other words, the clean firms will benefit more than the dirty firms if the emission tax increases. In the third case, both output and profits decrease as the government increases the emission tax if $b=0$. The tax has no influence on firms if $b>0$.

In stage 2, firms seek for the best emission tax for themselves, while the government maximizes social welfare.

In stage 1, the equilibria of the game are *(C, D)* and *(C, C)*.

Lemma 1 (Grey, 2018). No-deviation conditions for the two firms are:

$$i \leq \pi_c^*(C,D)-\pi_d^*(D,D)-g_c^*(C,D)+g_d^*(D,D) \quad (7)$$

$$i \geq \pi_c^*(C,C)-\pi_d^*(C,D)+g_d^*(C,D) \quad (8)$$

Let I be the set of investment costs that satisfy conditions (7) and (8): $I = \{i \in \mathcal{R}: inequalities\ (7)\ and\ (8)\ hold\}$. I' is the set of investment costs produced when *(D, D)* transits to *(C, D)*. *Y* is the set of investment costs for which *(C, D)* is preferred to *(D, D)*. Then, the theoretical model provides four propositions (based on Grey, 2018)):

Proposition 1. (existence of *(C, D)* equilibrium). For φ large enough, and b very close to 0:

(1) The *(C, D)* equilibrium exists, that is, *I* is not empty.

(2) $\frac{d}{d\theta}|I|>0$, When the government becomes more open to lobbying

Proposition 2. **(**Welfare of lobbying-induced transitions to (*C, D)*). For b sufficiently close to 0, any lobbying-induced transition from *(D, D)* to *(C, D)* is socially preferable, that is $I' \subset Y$. For the (C, C) equilibrium, *Q* is the set of investment costs that lead to *(C, C)* in

equilibrium. Q' is the set of investment costs that result in *(C, C)* when openness to lobbying is θ. Z is the investment cost for which *(C, C)* is preferred to *(C, D)*.

Proposition 3. (Lobbying-induced transitions to *(C, C)*). For any φ and *b* is very close to 0, there exist investment costs *i* such that:

(1) It is only because of lobbying that the economy is in equilibrium at *(C, C)*, that is, Q' is non-empty.

(2) A lobbying-induced transition from *(C, D)* to *(C, C)* when the government becomes more open to lobbying, that is $\frac{d}{d\theta}|Q'| > 0$

Proposition 4. (Welfare of lobbying-induced transitions to (*C, C*). For *b* sufficiently close to 0, any lobbying-induced transition from *(D, D)* to *(C, D)* is socially preferable, that is $Q' \subset Z$.

Conclusion. Based on the model**,** I conclude that the equilibrium *(C, D)* leads to market distortions in output. Moving from *(C, D)* to *(C, C)* can efficiently solve this problem.

I build an empirical model to test the following hypothesis.

Hypothesis: The clean industry sector has a more significant effect on environmental performance than the polluting industry sector. The clean industry sector decreases CO_2 emissions while the polluting industry sector increases CO_2 emissions.

4. Empirical Methodology

In this section, I describe the used data and methods to test the hypothesis, and use lobbying activities and expenditures to represent the political activity. Environmental performance is investigated in the context of climate change and measured through CO_2 emissions.

4.1 Data

CO_2 emissions data are gathered from the U.S. Energy Information Administration (EIA). The EIA is the primary agency of the US Federal Statistical System, which collects, analyzes, and disseminates energy information to promote sound policy development, efficient markets, and public understanding of energy (Stephenson et al, 2011). EIA programs conduct a comprehensive coal emissions data. EIA's products are considered independent. The data covers the period 2016 -2017.

I obtain lobbying data from the National Institute on Money in State Politics (NIMSP). Since lobbyists must quarterly report their lobbying activity after the lobbying disclosure act was published, the NIMSP collects political funding information from government disclosure agencies. The Institute advocates stricter regulation of political contributions, including increased disclosure of political expenditures (Suderman et al., 2014). The Institute provides a great amount of lobbying expenditures and lobbying reports given by independent political spenders at the state level. I search the specific lobbying data in the NIMSP by entering several keywords, which helps us classify data by industrial sectors, business types, time, and administrative areas.

Based on Delmas et al. (2016), I divide the lobbying data into two parts: polluting and clean industry sectors. The polluting industry sectors are energy and natural resources, communications and electronics. The clean industry sectors are construction, agriculture, finance, healthcare and single issues such as tax issues, liberal policy organizations, and consumer groups etc. I adopt twelve years of lobbying data, from 2006 to 2017. At this time, our analysis covers the lobbying behaviors before the financial crisis and during the peak of climate lobbying. These two time points have a significant impact on the behaviors of lobbying on climate change.

To eliminate the vast differences in lobbying activities, which are caused by the different number of people and companies in each state, I use the annual state population data and state revenue data from the U.S. Census Bureau website to build the lobbying intensity[9]. The Census Bureau conducts the state data from the U.S. Census every ten years. The U.S. Census data is responsible for political parties in the country and is closely related to financial and economic strategies. Even though local political strategies have different impacts on federal, state, and public investment in specific demographic areas, the U.S. Census states that the data they use effectively avoid political interference (Stern,1982). The source of data also is different from the local censuses conducted in individual states or local jurisdictions. These areas are groups of states that should not be interpreted as necessary grouping due to any geographical, historical or cultural ties, which suggests that

[9] Chen et al. (2015) define the Lobbying intensity as how much the corporations get involved in the lobbying activities.

the source of data is fair and stable. I use the same period consistent with the above, from 2006 to 2017, classified by 50 states.

The data used to build control variables are obtained from the Compustat database: publicly available data on the state-environment regulations. Compustat is a database of financial, statistical and market information at the global firm-level starting from 1962. The database is updated monthly and provides real and reliable information products for many university researchers, bankers, and corporate investors. However, the type and the time spans of these data are scattered, some of which are only described in the text. I integrate these fragmented data and convert the text information into digital data by classifying the information. Finally, I divide the data into four data sets corresponding to four control variables (see the Explanatory Variables section for details).

4.2 The Econometric Model

This study uses three models to estimate the CO_2 emissions. Because of the different characteristics of the 50 states in our sample, I avoid the potential heteroscedasticity problems in the following regressions by applying the robust standard error in all regressions. In the main regression equation, marked as specification (i), each state is indexed by *j*, and *t* indexes the year:

$$G_{j,t} = \alpha_0 + L_{j,t}\alpha_l + X_{j,t}\alpha_x + \varepsilon_{j,t}. \quad \text{(i)}$$

In this regression $G_{j,t}$ is CO_2 emissions in state *j* for year *t*; $L_{j,t}$ is a vector of lobbying variables in state *j* for year *t*, whose components are lobbying money ratio and lobbying number ratio. $X_{j,t}$ is a vector of other explanatory variables in state *j* of year *t*, including California, RGGI, RPS and lobbying relation strength. $\varepsilon_{j,t}$ is the error term which represents the unexplained component of the equation. The following model, marked as specification (ii), is:

$$G_{j,t} = \alpha_0' + L_{j,t}\alpha_l' + L_{j,t}^2\alpha_{l2}' + X_{j,t}\alpha_x' + \varepsilon_{j,t}' \quad \text{(ii)}$$

where $L_{j,t}^2$ is an additional set of lobbying variables in quadratic form.

The third model addresses the problem of simultaneity. To mitigate this problem, I add a lobbying lag effect term. I mark the following model as specification (iii):

$$G_{j,t} = \alpha_0'' + L_{j,t-1}\alpha_l'' + L_{j,t-1}\alpha_l'' + X_{j,t}\alpha_x' + \varepsilon_{j,t}'' \quad \text{(iii)}$$

where $L_{j,t-1}$ represents a vector of lobbying variables in state *j* for year *t-1*.

4.3 Variables Description

Dependent Variables. I analyze climate change and use the level of CO_2 emissions gathered from the United States Energy Information Administration (EIA) to represent it. EIA reveals that 2005 emissions of greenhouses gases are associated with human activity which produced totaling 7.1 billion tons of carbon dioxide. CO_2 represented 84% of US greenhouse-gas emissions in 2005. I consider the CO_2 emissions as the primary greenhouse gas (GHG) which mainly affect climate change.

Independent Variables. Because bigger states experience more prominent lobbying activities (size effect problem), I present the primary independent variables as two lobbying intensity ratios terms: lobbying dollar ratio and lobbying number ratio. Lobbying dollar ratio is equal to the total amount of state lobbying divided by local state income. Lobbying number ratio is equal to the number of state lobbying reports divided by the state population. Those two variables can effectively mitigate the size effect problem.

$$lobbying\ dollar\ ratio = \frac{dollar\ amount\ of\ lobbying}{state\ revenue \Big/ average\ state\ revenue}$$

$$lobbying\ number\ ratio = \frac{number\ of\ lobbying\ activity}{state\ population \Big/ average\ state\ population}$$

In the second empirical model, a second variable vector is generated by squaring the lobbying intensity ratios terms. In the third empirical model, I delay the existing lobbying variable for one year.

Control Variables. I also control other factors that affect CO_2 emissions. Regarding the setting of the control variable, I refer to Delmas et al. (2016), where the scholars point out that there is a sizeable causal relationship between corporate political behavior and state-level political supervision (Reid & Toffel, 2009). Indeed, this is particularly relevant to climate change policies since states have substantially different perspectives on this environmental regulation issue (Cragg et al., 2012). To explain the heterogeneity of state regulation, I add three binary variables to the empirical model, whether the industry in the

state (a) has passed climate change legislation[10] (CCL); (b) is the regional greenhouse gas initiative (RGGI) Member[11] (GGL); (c) has published a Renewable Energy Portfolio Standard (RS).

I also create a variable that describes whether the industry sector engaged in lobbying in the previous year. This variable indicates whether the industry sector has a relationship with legislators and lobbyists. I define the variable as lobbying relation strength.

Table 1 Descriptive statistics

Variable	Variable description	Mean	S. d.	Min	Max
CO_2 emission	CO_2 emissions directly emitted by a firm	165.9	154.8	5.470	661.6
lobbying dollar ratio	Total climate change of lobbying expenditure	427306	1.529e+06	0.00	3.430e+07
lobbying number ratio	Total climate change of the number of lobbying activities	194.6	1101	0.00	65221
lobbying relation strength	Industry sector lobbied on any issue in the previous year(dummy)	1.826	2.029	0	12
CCL	Industry sector headquartered in California(dummy)	0.0269	0.162	0	1
GGI	Industry sector headquartered in a state participated in RGGI(dummy)	0.128	0.334	0	1
RS	Industry sector headquartered in a state which has RPS legislation(dummy)	0.0789	0.270	0	1

Note: number of observations=157,122

Source: U.S. Energy Information Administration, National Institute of Money in State Politics, U.S. Census Bureau, Compustat

[10] Only one state (California) passed the climate change legislation.

[11] The regional greenhouse gas initiative members are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont.

Descriptive Statistics. Table 1 shows the means, standard deviations, minimum, and maximum for all seven variables used in both sample periods.[12] The average state CO_2 emission is 165.9 million metric tons with a standard deviation of 154.8. The lobbying dollar ratio has an average of $4.27 million with a standard deviation of $1.529e+0.6 million at the state level. The lobbying number ratio averages 194.6 times of lobbying activities with a standard deviation of 1101 times at the state level. According to lobbying relation strength, each industry sector has done approximately two times lobbying activities on legislation sectors. The final three variables are dummy variables, so their minimum value is 0, and the maximum value is 1. The CCL variable calculates the percentage of the number of California's industrial sectors in the total number of sectors in all states, which causes a low mean 0.0269 with a standard deviation of 0.162. The GGI variable takes an average of 8.127 and a standard deviation of 0.334. The RS counts the number of industry sector headquartered in a state which has RPS legislation. Its mean is 0.0789 with the standard deviation of 0.27. There are 157122 observations in total in the original sample.

6. Results

In this section, I discuss the results of the empirical models, possible econometric problems and the lobbying lag effect. The empirical model will only present the results of stage 3 in our theoretical model. The reasons are the following: our paper focuses on how different industry sectors affect CO_2 emissions, which rarely correlate with firm's choice in the first and second stage. However, the first and second stage of the theoretical model provides a necessary preliminary step for the empirical model. Also, Delmas et al. (2016) use the similar model and find that lobbying factors have a positive effect on a firm's choice to lobby in the first and second stage.

6.1 Main Results

Figure 1 shows the average effect of lobbying activities on CO_2 emissions of all states during 2006-2017. The average dollar of lobbying expenditure illustrates similar patterns as the average number of lobbying activities with slight variations over time. The figure also verifies that the frequency of lobbying activities is higher during the year of U.S.

[12] The one additional lag term uses the same data as the lobbying intensity ratio variables, which are summarized in Table 1.

Presidential elections (Fu, 2013). In 2014, lobbying dollar amount reached a peak of around $1 million per state. Lobbying activities amount got the highest point in 2016. In the previous year of 2007, lobbying activities and dollar amount on CO_2 emissions dropped to the bottom with less than $ 0.1 million and 50 per state. Similar curve trends indicate that the lobbying dollar ratio and the lobbying activities ratio have an isotropic effect[13] on CO_2 emissions.

Figure 1 Lobbying Activities between 2006-2017

Source: National Institute on Money in State Politics Database

Variable correlations are illustrated in Table 2. As expected, the most significant positive correlations with lobbying expenditure come from CCL and CO_2 emissions. The

[13] Isotropic effect refers to that the physical and chemical properties of an object do not change due to the direction, that is, the performance values measured in different directions are the same.

presence of RS is also relatively highly correlated with the dependent variable. Lobbying number ratio shows a most significant negative correlation with CO_2 emissions. The maximum correlation between the proportion of lobbying and CO_2 emissions is not very high, consistent with the conclusions of the first and second stage of Grey's analysis. To sum up, no correlation is high enough to cause collinearity concerns.

Table 2 Correlation Matrix

	CO_2 emission	lobbying dollar ratio	lobbying number ratio	Quadratic lobbying dollar ratio	Quadratic lobbying number ratio	L.lobbying money ratio	L.lobbying number ratio	lobbying relation strength	CCL	GGI	RS
CO_2 emission	1										
Lobbying dollar ratio	-0.00840	1									
Lobbying number ratio	-0.0234	0.184	1								
Quadratic lobbying dollar ratio	0.00320	0.880	0.131	1							
Quadratic lobbying number ratio	-0.00950	0.0184	0.805	0.0124	1						
L.lobbying dollar ratio	-0.00840	0.184	0.0270	0.129	0.00190	1					
L.lobbying number ratio	-0.0234	0.0276	0.228	0.0128	0.147	0.184	1				
lobbying relation strength	-0.0790	0.0776	0.0291	0.0342	0.0166	0.0776	0.0291	1			
CCL	-0.226	0.0299	-0.0188	0.00890	-0.00780	0.0299	-0.0188	0.144	1		
GGI	-0.238	-0.0292	0.0210	-0.0259	-0.00440	-0.0292	0.0210	-0.0954	-0.0846	1	
RS	-0.159	0.0490	0.0459	0.0141	0.0386	0.0491	0.0460	0.256	0.652	-0.130	1

Source: National Institute on Money in State Politics Database and U.S Energy Information Administration

Table 3 presents the regression results of specification (i), which is defined in section 4. An additional $1,000,000 of lobbying contributions reduces CO_2 emissions by 1.14%. An additional 1000 times of lobbying activities reduces the CO_2 emissions by 1.57%. Both relationships are significant. Both estimated coefficients are economically significant as well. Around 1% reduction in the CO_2 emissions per ten thousand dollars is economically meaningful. The results also prove that lobbying activities hurt the CO_2 emissions. Therefore, in a competitive market, industry lobbying activities and expenditures have

negative effects on CO_2 emissions[14], corresponding with our hypothesis 2. To further verify my hypothesis, I divide the industry sector into clean and polluting industry sectors and perform an analysis of variance. The variance results show a significant difference between the clean sector and the polluting sector (Prob>F is 0.0000)[15].

Table 3 Main Regression Results

	(1)
	M1
Lobbying dollar ratio	-0.00000114***
	(-4.20)
Lobbying number ratio	-0.00157***
	(-4.22)
Lobbying relation strength	-13.89***
	(-55.71)
CCL	166.9***
	(66.00)
GGI	-116.9***
	(-95.85)
RS	16.78***
	(9.32)
Constant	248.8***
	(281.66)
N	157122
R^2	0.117

Note: *t* statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The coefficient on lobbying relation strength is negative and significant. Since lobbying relation strength measures the relation between the legislation sector and the lobbying industry, I conclude that industry produces less CO_2 emissions when the industry has closer relationship with legislation. The CCL, GGI, and RS variables are negative and significant at 1% level for all general industry sectors. These results indicate that existing regulation at the state level has significant impacts on an industry's lobbying behavior. It matches the theoretical expectation (see results in appendix).

The results using the restricted sample space are displayed in Table 4, which gives the more precise explanation of the relationship between lobbying and CO_2 emissions among different industrial sectors. To support my hypothesis, the lobbying dollar ratio in

[14] One thing should be explained is that the lobbying influence is analyzed at the state level.
[15] See the detailed result table in the Appendix.

the clean industry sector has a significant adverse effect on CO_2 emissions. The result illustrates that firms in the clean industry may protect their benefits from running a cleaner production process. However, the lobbying number ratio in the clean industry sector has a positive but not very significant effect on CO_2 emissions. In contrast, an additional 1000 times of lobbying activities reduces the CO_2 emissions by 1.52% in the dirty industry sector. The result is not consistent with my hypothesis. It can be explained that (1) there are lobbying activities which may not be successful, but still are added into the lobbying report; (2) since the lobbying number ratio accounts for all types of lobbying and a large amount of lobbying contributions is not in lobbying climate changing, which would lead to the inaccuracy of lobbying ratio. To illustrate the lobbying relation strength in the clean industry sector: the CO_2 emissions will decrease by 16.49 % if the clean industry did lobbying in the last years. Compared with the result in the clean industrial sector, the CO_2 emissions will decrease by only 8.37% if the firms in the dirty industrial sector do lobbying in the last year. These results are consistent with the literature showing that clean firms steal market share by encouraging a greener environmental policy (Cordano & Frieze, 2000).

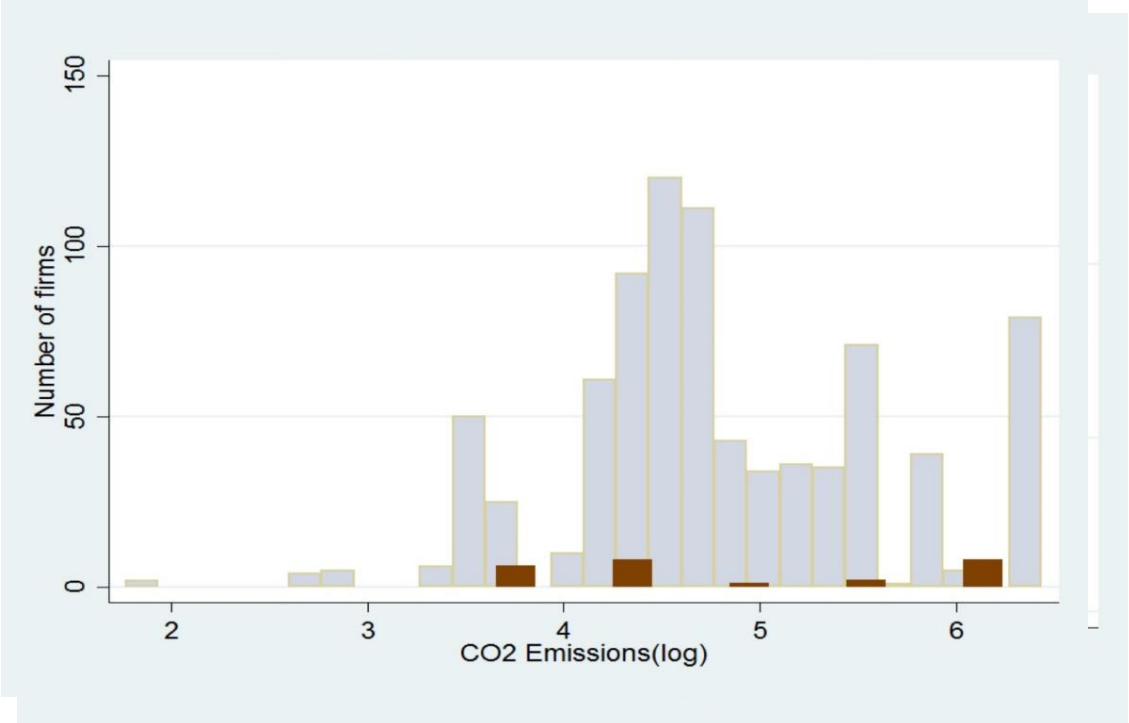
Table 4 Main Results for Different Industry Sectors

	(1) Clean industrial sector	(2) Dirty industrial sector
Lobbying dollar ratio	-0.0115***	0.00527***
	(-24.20)	(17.52)
Lobbying number ratio	0.00216*	-0.00152***
	(2.32)	(-4.12)
Lobbying relation strength	-16.49***	-8.377***
	(-55.62)	(-18.62)
CCL	-166.9***	-179.7***
	(56.52)	(37.90)
GGI	-115.3***	-115.3***
	(-78.72)	(-54.52)
RS	-17.96***	-19.65***
	(8.43)	(6.04)
Constant	265.9***	208.1***
	(248.73)	(139.44)
N	119277	37845
R^2	0.117	0.156

Note: t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To better analyze the relationship between lobbying and CO_2 emissions in different industrial sectors, the distribution CO_2 emissions among industry sectors for the state-years are shown in Figure 2. Firms are divided into polluting and clean sector. The dark area represents firms in the polluting sector. The light area shows firms in the clean sector. The distribution for the clean sector looks approximately normal. Most firms in the clean sector produced CO_2 at a medium level. Due to the small size of the polluting sector, the distribution looks more fragmented. However, it still illustrates that firm in the polluting sector generally produce higher levels of CO_2.

Figure 2 Histogram of CO_2 Emissions



Source: National Institute on Money in State Politics Database and U.S Energy Information Administration

Table 5 Test Results for Specification (i)

Tests	Statistics Value	P-value
White's test	58.39	0.0000
Breusch-Pagan-Godfrey	6.06	0.0138

Table 5 presents the test results for specification (i). The White's test tests the normality of error distribution. The value of the Chi-square statistic is 58.39, which

suggests that I cannot reject the null hypothesis of normality at a 1% level of significance. Thus, the residuals are normally distributed. I also include the Breusch-Pagan-Godfrey test for the existence of heteroscedasticity. The F-statistics value is 6.06 rejecting the null hypothesis of homoscedasticity at the 5% level.[16] The problem suggests that more state feature variables need to be introduced to improve the empirical model. Since the primary concern is the impact of lobbying, the use of heterogeneous consistent standard errors (robust options in Stata) will alleviate the heterogeneity problem.

In Table 6, I run the Variance Inflation Factor test (VIF test) to judge whether there are any collinearity relationships for the independent variables because of the low R-square in the first regression (R^2= 0.117). A low R-square means that there is a high probability of existing omitted variables in specification (i). The *VIF* statistics value is 1.3, which is far less than 10, indicating that there is no multicollinearity relationship.

Table 6 VIF Test for Specification (i)

Variable	VIF	1/VIF
CCL	1.750	0.572
Lobbying relation strength	1.080	0.926
RS	1.850	0.542
GGI	1.020	0.978
Mean	1.300	0.769

6.2 Results for Specification (ii)

Then, I want to fix and improve specification (i) since there are some heteroscedasticity problems. I generate two new variables to expect a higher R-square and test the curvilinear relationship. The definitions of the two variables are as follows:

$$lobbying\ dollar\ square = (lobbying\ dollar\ ratio)\text{^}2$$
$$lobbying\ number\ square = (lobbying\ number\ ratio)\text{^}2$$

[16] Even if the value of F-statistics cannot reject the null hypothesis at 1% significant level, I prefer to be econometrically conservative.

Table 7 Test Results for Specification (ii)

Tests	Statistic Value	P-value
White's test	70.44	0.0005
Breusch-Pagan	6.30	0.0121

I do again the White normality and Breusch-Pagan test which allows us to investigate whether specification (ii) has problems of normality of error distribution and the existence of heteroscedasticity. The results in Table 7 show that new residuals in specification (ii) follow a normal distribution. According to the results of the Breusch-Pagan-Godfrey test, heteroscedasticity still exists, but the level of heteroscedasticity decreases. The problem of heteroscedasticity does not affect the reliability of our test.

Table 8 Main Regression Results

	(2) M2
Lobbying dollar ratio	-0.00562***
	(-9.73)
Lobbying number ratio	-0.00121
	(-1.86)
Lobby dollar ratio^2	3.60e-13***
	(8.91)
Lobby number ratio ^2	6.12e-09
	(0.29)
Lobbying relation strength	-13.76***
	(-55.11)
CCL	166.9***
	(66.02)
GGI	-116.8***
	(-95.71)
RS	17.29***
	(9.60)
Constant	249.3***
	(281.46)
N	157122
R^2	0.218

Note: t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8 presents the new regression results with specification (ii). The results still show that the complete effect of lobbying expenditures and activities on CO_2 emission includes a negative linear term (t=-9.73, -1.86). The coefficient of lobbying dollar ratio effectively becomes more substantial than in specification (i), which is -0.00562. The

significance of the squared variable of lobbying expenditure indicates that the lobbying contribution not only affects the emissions of CO_2 in a linear form. Large lobbying expenditures can also have additional impact in a secondary manner. The meaning of the quadratic variables is simple. The cumulative lobbying impact is measured by continuing lobbying activities and reasonable contributions. However, the effect of the lobbying number ratio becomes insignificant and less than in specification (i), which is -0.00121. Additionally, the effect of quadratic lobbying number ratio is also insignificant. The results further illustrate that the new quadratic lobbying variables have a positive sign, which goes against the underlying hypothesis. To explain the results, I do again the VIF test to check whether there is high collinearity between the lobbying number ratio and the quadratic lobbying number ratio or not.

The results are showed in Table 9. The value of VIF increases to 2.60, however, it is still small enough to prove that there is no multicollinearity in the specification (ii). Then, I explore the following reasons that possibly explain these results. Firstly, there exists a cancel-out effect on lobbying impacts from dirty industry sectors and clean industry sectors. Dirty industry tends to encourage the legislation sector to make slack environmental policy. However, the clean industry wants to steal their market share through strict environmental policy. Secondly, since the study in this area is fresh, a wrong functional form with limited data might be the culprint. Better data and further modelling studies at the state level may help solve this problem. Furthermore, the R-square increases to 22% in the specification (ii), which improve the interpretation of our empirical model.

Table 9 VIF Test for Specification (ii)

Variable	VIF	1/VIF
Lobbying dollar ratio^2	4.500	0.222
Lobbying number ratio ^2	3.020	0.331
RS	1.850	0.541
CCL	1.750	0.572
Lobbying relation strength	1.080	0.922
GGI	1.020	0.976
Mean	2.640	0.379

6.3 Results for Specification (iii)

Looking at the third stage of the Grey analysis in specification (iii), I examine the lobbying lag effect by analyzing whether the previous year's lobbying activities affect the CO_2 emissions among states. As an additional robustness test, the high negative coefficients of these two lag terms (see Table 10) indicate that the previous-year lobbying activities are good predictors. The lobbying activities of the previous year have a substantial impact on whether a company would continue lobbying on climate change issues. This conclusion is consistent with the previous theoretical literature. (Kerr et al, 2014).

In summary, the results confirm the hypothesis I proposed. Under other identical conditions, CO_2 emissions will be diminished as lobbying efforts increase. The clean industry has a negative impact on CO_2 emissions, while the polluting industry has a positive impact on the CO_2 emissions. The result is consistent with previous research that high-polluting firms and low-polluting firms are both politically active to affect environmental policy. However, high-polluting firms aim to avoid costly regulation, while low-polluting firms are politically active to gain market share (Reid & Toffel, 2009).

Table 10 Lobbying Lag Effect Regression Results

	(3) M3
Lobbying dollar ratio	-0.000979***
	(-3.55)
Lobbying number ratio	-0.00130***
	(-3.38)
Lag lobbying dollar ratio	-0.000986***
	(-3.57)
Lag lobbying number ratio	-0.00129***
	(-3.37)
Lobbying relation strength	-13.84***
	(-55.40)
CCL	166.4***
	(65.71)
GGI	-116.9***
	(-95.78)
RS	17.26***
	(9.57)
Constant	249.2***
	(281.34)
N	157049
R^2	0.227

Note: *t* statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

7. Conclusion

My paper studies environmental lobbying, a political strategy that has attracted little attention in the empirical corporate political strategy literature. More specifically, this paper chooses environmental performance as the central political aspect of corporate lobbying influence and studies the relationship between CO_2 emissions and lobbying. I created and analyzed a data set that combines CO_2 emissions with lobbying expenditure and activities of 50 states in the U.S. throughout 11 years.

Empirical work indicates that lobbying expenditures and activities have a negative relationship with CO_2 emissions. Under the more rigid environmental policy, cleaner industries gain more market share and profits from their competitors. My paper, using novel data on lobbying, illustrates that industry with better or worse performance invests more money to influence the outcome of a controversial environmental policy issue. An additional $1,000,000 of lobbying expenditure or 1,000 times of lobbying activities decrease the CO_2 emissions by around 1%. The findings also suggest that cleaner firms are active for more stringent environmental regulations, while dirtier firms play a politically active role in relaxing the restriction of environmental regulation.

Future research should incorporate a discussion of the endogenous nature of lobbying data and use instrumental variables to address the simultaneity issues.

The findings can be extended to other issues. For example, a company that relies heavily on minimum-wage employee may object to raising the minimum wage, in contrast to competitors paying higher wages, who may seek to raise the minimum wage, which will give them a competitive advantage. Meanwhile, other research questions can help us better understand the influence of lobbying on environmental performance in different regions. Recent research has shown that corporate political investments are negatively correlated with market performance, while cumulative political investment exacerbates market and accounting performance (Hadani & Schuler, 2013). Checking these differences can be interesting.

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Appendix

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	4.0722e+15	1	4.0722e+15	1761.16	0.0000
Within groups	3.6586e+17	158227	2.3122e+12		
Total	3.6993e+17	158228	.467551367		

Bartlett's test for equal variances: chi2(1) = 4.9e+04 Prob>chi2 = 0.000

The above table is the analysis of variance. The variance results show that there is a significant difference between the clean sector and the polluting sector. Prob > F is 0.0000, rejecting the null hypothesis. The variance is considered as unequal, indicating that the lobbying expenditure is significant in the two different sectors.