

10-9-2012

Policy Influence and Private Returns from Lobbying in the Energy Sector

Karam Kang

Carnegie Mellon University, kangk@andrew.cmu.edu

Follow this and additional works at: <http://repository.cmu.edu/tepper>



Part of the [Business Commons](#)

Recommended Citation

Kang, Karam, "Policy Influence and Private Returns from Lobbying in the Energy Sector" (2012). *Tepper School of Business*. Paper 1437.

<http://repository.cmu.edu/tepper/1437>

This Working Paper is brought to you for free and open access by Research Showcase. It has been accepted for inclusion in Tepper School of Business by an authorized administrator of Research Showcase. For more information, please contact research-showcase@andrew.cmu.edu.

Policy Influence and Private Returns from Lobbying in the Energy Sector*

Karam Kang[†]

October 9, 2012

Abstract

Firms lobby the U.S. Congress to influence policy-making. This paper quantifies the extent to which lobbying expenditures affect policy enactment. First, I construct a novel dataset comprised of federal energy legislation and lobbying activities by the energy sector during the 110th Congress. Second, I develop and estimate a game-theoretic model where heterogeneous players choose lobbying expenditures to affect the probability that a policy is enacted. I find that the effect of lobbying expenditures on a policy's equilibrium enactment probability is very small. However, the average returns from lobbying expenditures are estimated to be over 140%.

1 Introduction

Government policies often benefit certain firms at the expense of others. Environmental regulations, for example, may give a competitive advantage to firms with cleaner production technologies. Hence, many firms actively engage in lobbying activities to influence the policy-making process. At the same time, most policies affect not only firms' profitability but also

*This paper is based on my Ph.D. dissertation at the University of Pennsylvania. Previous versions circulated under the title "Lobbying for Power: A Structural Model of Lobbying in the Energy Sector." I am greatly indebted to my advisor, Antonio Merlo, and to Kenneth I. Wolpin, Hanming Fang, and Flávio Cunha for their guidance, support, and insight. I have greatly benefited from discussions with Xu Cheng, Dennis Eppler, Camilo García-Jimeno, Robert Miller, Áureo de Paula, Holger Sieg, Xun Tang, and Petra Todd. I thank the seminar participants at Carnegie Mellon University, Cornell University, New York University, the University of Pennsylvania, Washington University in St. Louis, and Yale University (SOM). I also thank John Chwat of Chwat & Company and the staff in the Center for Responsive Politics, especially Jihan Andoni. Lastly, I thank Douglas Hanley for computerizing policy identification and also thank Mahuhu Attenoukon, Audrey Boles, Eric Sun, Jennifer Sun, and Yi Yi for providing excellent research assistance for data collection. The research reported here was supported by the National Science Foundation through Grant SES-1023855. All errors are mine.

[†]Tepper School of Business, Carnegie Mellon University. E-mail: kangk@andrew.cmu.edu

the general public. Therefore, the issue of political influence by private interests is of great concern to any democratic society. This raises the central question addressed in this paper: To what extent does lobbying influence public policy?

In this paper, I study lobbying activities by firms that have heterogeneous and often competing interests in public policies. The main goal of the paper is to quantify the extent to which lobbying expenditures affect policy enactment in the U.S. Congress. To achieve this goal, I construct a novel dataset that contains detailed information on policy enactment and lobbying activities in the 110th Congress (2007–2008). I then specify a game-theoretic model of lobbying and estimate it using this dataset.

To focus the analysis, I restrict attention to energy policies. The energy sector is a crucial component of the U.S. economy, and energy is a major issue in elections. Also, the energy sector is heavily involved in lobbying. For example, in recent years, lobbying expenditures by energy firms account for about 12% of total lobbying expenditures. Moreover, energy policies generally have well-defined winners and losers among energy firms. At the same time, they often address issues of great concern to the general public (e.g. environmental quality). While the empirical results of this study may be specific to energy policies, the method I propose in this paper is general, and can be readily applied to any types of policies.

A novel feature of this study is that *policies*, not entire pieces of legislation (bills), are the unit of analysis. I define a policy as part of a bill that addresses one unique issue. Most existing studies on the influence of interest groups on legislation have focused on bills as the fundamental unit of analysis. However, a bill usually contains multiple policies, which may or may not be related to each other, and the same policy may appear in multiple bills. Consider, for example, a bill that was introduced for consideration by Congress in 2008 to promote domestic energy production (H.R. 6566). This bill contained several different policies (e.g. allowing natural gas production in the outer Continental Shelf and extending the solar energy property tax credit) and was not enacted. However, the solar energy tax provision was later inserted into the financial industry bailout bill (H.R. 1424), which *was* enacted. If a researcher were to focus only on the fate of the energy bill, she would potentially mismeasure the effect of lobbying by ignoring the fact that the solar energy tax policy was ultimately enacted as part of the financial industry bill. More importantly, energy firms care about the enactment of the tax policy, not in which bill it was included.

I construct a unique dataset of 539 distinct energy policies appearing in 445 bills. This represents the universe of all energy policies considered by the 110th Congress. Among these policies, 293 of them (54%) appear in more than one bill. By tracking each policy's movement through bills, I determine whether the policy was enacted or not. There are 45 policies that were ultimately enacted, 40 of which also appear in bills that failed to pass.

For each policy, I collect information on lobbying activities. The data are sourced from the lobbying reports mandated by the Lobbying Disclosure Act of 1995. This act stipulates that for every contract with a client, a lobbyist must submit a periodical report that records the total amount of income or expenses related to lobbying activities and disclose which issues were lobbied, such as bills or bill sections.¹ I group the energy firms and trade associations in the data into multiple lobbying coalitions based on their interests with respect to energy policies. For each lobbying coalition and each policy, I determine whether the coalition lobbied for or against the policy or did not lobby at all based on the lobbying reports and other auxiliary sources of information. Though I do not observe policy-specific lobbying expenditures, I observe the total expenditures over all policies for each lobbying coalition.

The lobbying coalitions are the players in the lobbying game I specify and estimate. For each policy, players know the initial level of support in the legislature in the absence of lobbying and the values to all players. They have heterogeneous valuations of a policy, which determines their position on the policy. For each policy, players simultaneously decide whether to lobby or not and incur an entry cost if they do. Then the participants simultaneously decide the amount of lobbying expenditures. The lobbying expenditures by each player and the initial probability of enactment determine the equilibrium probability that the policy is enacted. The expected payoff of a player who lobbies the legislature on a policy is the value of the policy multiplied by the equilibrium enactment probability minus total lobbying costs.

There are three fundamental components of the model that I estimate: (i) the enactment production function; (ii) the distribution of the initial enactment probability; and (iii) the distribution of the value of a policy to each player. There are two main empirical challenges to identifying the structural parameters of the model from the data. First, the initial enactment probability is not observed, and theory implies that it is correlated with the lobbying decisions of players. Second, only total lobbying expenditures are observed in the data, rather than policy-specific expenditures. I overcome both of these challenges by exploiting both the structure of the model and exclusion restrictions. The model has a unique equilibrium in lobbying expenditures given any observed lobbying participation profile. Therefore, the unobserved, policy-specific lobbying expenditures can be expressed as a function of the exogenous variables in the model and the observed lobbying participation profile. In addition, exclusion restrictions and the fact that total expenditures are observed help separately identify the level of the policy valuations and the effectiveness of lobbying expenditures.

¹The lobbying reports were retrieved from the website of the U.S. Senate (www.senate.gov/legislative/Public_Disclosure/LDA_reports.htm). The frequency of reporting was initially semi-annual but was amended to be quarterly in 2007.

I find that the average difference between the final enactment probability and the initial probability is estimated to be less than 0.04 percentage points. This finding is the result of two effects. First, the effect of lobbying expenditures on the policy enactment probability is very small. For example, I estimate it would cost \$3 million or more for one lobby to change the enactment probability by 1.2 percentage points if no one else lobbied. Second, the effects of expenditures by both supporting and opposing lobbies partially cancel each other out. I find that 18% of the direct effects of lobbying are canceled out by competing lobbies. However, the average returns to lobbying expenditures are estimated to be 140%–156%. Because the average value of a policy is estimated to be over \$600 million, even a small change in its enactment probability can lead to large private returns.

The remainder of the paper is organized as follows. The next section describes the main features and construction of the dataset. Section 3 describes the model. Section 4 discusses the identification and estimation strategy. Section 5 contains the results of the empirical analysis. Section 6 concludes.

1.1 Related Literature

This study contributes to a large empirical literature regarding the influence of interest groups on policy-makers. A strand of this literature focuses on the effect of campaign contributions on the voting behavior of individual legislators on bills. Ansolabehere et al. (2003) provides a good survey of these studies, and they conclude that the evidence that campaign contributions lead to a substantial influence on votes is rather thin. However, it is difficult to generalize the results to understand the political influence of interest groups because their scope of analysis is limited to the policies that reach the voting stages of the legislative process. Moreover, interest groups may affect the content of a voted bill, not only the result of the votes.² In this paper, the scope of the analysis is expanded to policies that are not even seriously considered in committees.

With respect to the scope and the unit of the analysis, Baumgartner et al. (2009) is similar to this paper. These political scientists study 98 randomly selected policy issues in which interest groups were involved and then followed those issues across two Congresses (1999–2002). For each issue, they conducted detailed interviews of lobbyists and government officials, and supplemented them with extensive document searches. They find that a comparative lobbying resource advantage can help status-quo defenders prevent policy change, while the effect is weaker for challengers of the status quo. However, the findings are based

²In a similar vein, Hall and Wayman (1990) consider the behavior of legislators in committees. They find that the interest groups influence the participation of committee members, using the data drawn from staff interviews and markup records of three House committees on three bills.

on the statistical models where potential endogeneity of lobbying resources by both defenders and challengers is not considered.

Pioneered by the theoretical work of Grossman and Helpman (1994), there are studies that estimate the political influence by special interests across industries on the level of trade protection. Most studies use campaign contributions to determine whether or not an industry is politically organized, and they find that the government’s policy choices are affected by monetary contributions from interest groups.³ A recent study by Facchini et al. (2011) focuses on immigration policy, using the lobbying disclosure data. They also find that interest groups play a statistically significant role in shaping immigration policy across sectors. Unlike these studies, the focus of the paper is on the extent to which lobbying affects whether or not a proposed policy replaces the status quo policy.

This paper also contributes to a burgeoning literature on the private returns from lobbying expenditures. Some studies look at how lobbying expenditures affect financial performance of firms, and they find that the effect is positive.⁴ Their approach may give suggestive evidence on the returns from lobbying expenditures, without showing specific benefits of policy choices by the government. In a similar study to my paper, de Figueiredo and Silverman (2006) estimate the elasticities of lobbying expenditures by universities with respect to academic earmarks. They find that the elasticity can be as large as 0.35, depending on whether or not a university has representation on the House or Senate Appropriations Committee. My approach differs from theirs in two aspects. First, they do not account for competition among multiple players. Second, their analysis does not extend to environments where the private values of specific policies to individual players are unobserved.

A recent empirical literature uses the lobbying disclosure data to address a variety of issues. For example, Tripathi et al. (2002) establish the relationship between lobbying expenditures and campaign contributions by individual interest groups. Bombardini and Trebbi (2009) explore the determinants of political organization across U.S. industries, and (Bertrand et al., 2011) assess the relative importance of issue expertise and connections in lobbying.

2 Background and Data

I construct a dataset on energy policies considered in the 110th Congress and the lobbying activities targeting these policies by energy firms and trade associations. The main dataset is based on lobbying reports mandated by the Lobbying Disclosure Act (1995), which are

³See e.g. Goldberg and Maggi (1999), Gawande and Bandyopadhyay (2000), and Gawande et al. (2005).

⁴See e.g. Chen et al. (2010) and Kim (2008).

available at the Senate Office of Public Records, and on legislative information available in the Library of Congress. I describe the main features of the construction of the dataset and show summary statistics of the key variables.

2.1 Bills vs. Policies

I define a *policy* as the smallest self-contained part of a bill or a joint resolution that addresses one unique issue.⁵ Existing studies have focused on legislative bills as the fundamental unit of analysis. However, it is more reasonable to consider that the objective of a lobbying entity is to help or block the passage of a certain part of a bill rather than the entire bill. A bill often addresses multiple issues; this is especially the case for omnibus legislation, which is more likely to pass than other types of legislation. Furthermore, some parts of a bill can be dropped from the bill or inserted into another bill over the course of the legislative process.

The approach of having a policy as the unit of the analysis has a unique advantage in that the outcome of lobbying—i.e., success or failure to enact a policy—is measured accurately. To obtain the enactment information of the policy, I track each policy across bills by taking the following procedures. First, I divide bills into bill sections as defined in the text. Second, I use vector space model to represent the sections by the corresponding vectors based on word frequency and measure the distance between the vectors by calculating the cosine of the angle between them.⁶ Third, I group the bill sections based on the measured distances. Here, the focus in this step is to minimize the probability of categorizing two bill sections that are different in content into one group. Lastly, I combine some groups into one to account for the following two issues: a bill section is not always self-contained; and the effect of lobbying on a policy may not be independent from that on another policy. In order to systematically handle these issues, I adopt a set of rules to combine different groups into one group, which are described in detail in Appendix. Each group of bill sections represents a policy in the analysis. In the dataset, a policy appears, on average, in 3 different bills.

The dataset covers all policies that were both considered in the 110th Congress (2007–2008) and that create, modify, or repeal a federal financial intervention or regulation whose main statutory subjects are coal, oil, nuclear or renewable energy companies, or electric and gas utilities. Examples are tax incentives for renewable energy sources, loan guarantees to construct energy-efficient power lines, and regulation of mercury emission from coal-fired power

⁵There are four types of legislation: bills, joint resolutions, concurrent resolutions, and simple resolutions. Bills and joint resolutions require the approval of both the House and the Senate and the signature of the president to be enacted into law. Concurrent resolutions and simple resolutions are not submitted to the president and therefore do not have the force of law.

⁶Vector space model is used in information filtering, information retrieval, indexing and relevancy rankings. For references, see Salton et al. (1975) and Raghavan and Wong (1986).

Table 1: The Final Status of Policies in the Data

Final Status	Number of Observations
Not Reported	388 (71.99%)
Reported, Not Enacted	106 (19.66%)
Enacted	45 (8.35%)
Total	539

plants. Note that not all policies that affect the energy sector are included in the analysis because their statutory subject might be a different sector. For example, a policy to enhance competition in the railroad industry affects the coal mining industry and the electric utilities that mainly use coal to generate electricity, but it is not in the sample because the statutory subjects are the firms in the railroad industry. In the dataset, there are 539 policies which are included in 445 bills.

A policy is considered to have been enacted if the policy is included in the final version of an enacted bill. By this definition, 45 policies (8.35%) were enacted into law.⁷ Table 1 shows the final the status of the policies. Over 70% of the policies died even before being sent to the floor of the House or the Senate (denoted as ‘Not Reported’ in the table), and about 20% of the policies reached the floor, but were not enacted into law (denoted as ‘Reported, Not Enacted’ in the table).

2.2 Lobbying Disclosure Data

Lobbyists can be categorized into two groups by their professional arrangement: in-house (or internal) lobbyists and external lobbyists.⁸ In-house lobbyists are hired by a firm, a trade association, or a citizens’ group as an employee. External lobbyists have a contract with a client and often work for multiple clients simultaneously. Most lobbyists, whether in-house or external, are required to register and file a report to disclose their lobbying activities by the Lobbying Disclosure Act of 1995.

This act mandates that any lobbyist or lobbying firm whose lobbying income (for external lobbyists) or expenditure (for self-lobbying entities) exceeds a certain threshold during the filing period must file a report.⁹ The content of the report includes: (i) all relevant lobbyists’

⁷Note that the average enactment rate of all bills and joint resolutions in the 110th Congress is 4.10%. The enactment rate of a policy in the dataset is higher than that of a bill because an enacted bill includes more policies than a rejected bill on average. Out of 445 bills that included the policies in the dataset, only 5 bills (1.12%) were enacted.

⁸According to Bertrand et al. (2011), about 40% of registered lobbyists are in-house lobbyists.

⁹The cutoff amount is \$5,000 for external lobbyists and \$20,000 for self-lobbying entities. The frequency of filings was originally semi-annual, and after the Honest Leadership and Open Government Act (2007)

name, address, and previous official position; (ii) the client’s name, address, and general business description; (iii) the total amount of income or expenditures related to lobbying activities; (iv) a list of general issue areas (such as Agriculture, Energy, etc.); (iv) a list of the specific issues including a list of bill numbers and references to specific executive branch actions; and (vi) a list of contacted houses of Congress or federal agencies. I have obtained the original disclosure reports from the website of the Senate Office of Public Records.

2.3 Lobbying Coalitions by Energy Sub-sectors

In total, there are 559 firms and associations in the energy sector which filed at least one lobbying report in 2007–2008.¹⁰ The total amount of their lobbying expenditures during this period is about \$607.9 million. The distribution of individual firm or trade association’s lobbying expenditures is very skewed; the median amount of lobbying expenditures is \$160,000, while the average is over \$1,087,000. When ranked by lobbying expenditures, the top 10% of firms and trade associations in this sector—55 entities in total—spent about \$462.7 million. This accounts for 76.11% of the total amount of lobbying expenditures by the sector.

The energy sub-sectors are often politically organized. Among these top 55 lobbying spenders, there are 8 trade associations that represent energy sub-sectors.¹¹ For example, the American Petroleum Institute represents the U.S. oil and natural gas industry and has members including major oil and natural gas companies such as Exxon Mobil, BP, and Chevron. All energy companies among the top lobbying spenders are a member of at least one trade associations.

I categorize energy firms and trade associations in the dataset into 4 groups: (i) the coal mining industry and investor-owned electric utilities that mainly use coal for power generation; (ii) the oil and natural gas industry, (iii) the nuclear industry and investor-owned electric utilities that mainly use nuclear energy for power generation; and (iv) the renewable energy industry (such as bio, solar, wind, geothermal, and hydro-kinetic) and investor-owned electric utilities that mainly use renewable energy for power generation.

I designate certain firms and trade associations as *strategic* or *major* in lobbying the

was enacted, it became quarterly. This amendment also strengthened the registration criteria and the enforcement rules.

¹⁰See Appendix for a detailed description on identifying these 559 entities from in the lobbying disclosure reports.

¹¹This is the list of the trade associations which are among the top 55 lobbying spenders in the energy sector: (1) National Mining Association (coal mining industry); (2) American Coalition for Clean Coal Electricity (coal industry and electric utilities that mainly use coal to generate electricity); (3) American Petroleum Institute (oil and natural gas industry); (4) Nuclear Energy Institute (nuclear industry and electric utilities that mainly use nuclear energy to generate electricity); (5) Edison Electric Institute (investor-owned electric utilities); (6) American Wind Energy Association (wind energy industry); (7) Solar Energy Industries Association (solar energy industry); and (8) National Biodiesel Board (biodiesel industry).

legislature on the energy policies in the dataset.¹² I assume that these strategic firms and trade associations lobby cooperatively according to the 4 groups mentioned above. In the model, these *lobbying coalitions* are the players of a lobbying game. Entities are selected as strategic based on the fraction of their individual lobbying expenditures to the total lobbying expenditures by the group to which they belong. The threshold for inclusion is 2.5% for all groups except for that of renewable energy, whose threshold is 1.5%.^{13,14} Based on the criterion, 42 firms and trade associations are considered as strategic, with 8 to 12 belonging to each group.¹⁵ The total amount of lobbying expenditures by these strategic entities accounts for 66.01% of that of the energy sector as a whole.

Table 2 shows some descriptive statistics of the lobbying coalitions. The second and third columns show the number of associations and firms that are included in each coalition respectively. The fourth column shows the sum of the asset value of each firm within the coalition at the end of 2007 and the fifth column is for the sum of the revenue of each firm within the coalition in the same year.¹⁶ It can be seen that the oil and natural gas lobbying coalition consists of much larger firms in terms of total asset and sales compared to other coalitions. However, the lobbying expenditures are not necessarily proportional to the size of the coalition. In the last column of the table, the total lobbying expenditures in 2007–2008 by each coalition are listed, and the rest of the lobbying coalitions spend in lobbying activities much more in proportion to their size than the oil and natural gas lobbying coalition.

2.4 Lobbying Participation and Position

For each firm or trade association in each lobbying coalition, I extract from lobbying reports and other auxiliary sources the following information for each policy: (i) whether or not the entity lobbied the legislature on the policy and (ii) whether the entity supports or opposes it. I assume that when a bill is listed as a lobbying target in the report, all energy policies in the bill are lobbied on by the respective entity. The position of a firm or a trade association on a

¹²In this paper, environmental groups are not considered as *strategic* or *major* in energy policy lobbying. It is because their lobbying spending is very small compared to that by the energy sector. During the period of this study, they spent \$35.2 million dollars in total, which is 6% of the total lobbying expenditures by the energy sector. Moreover, much of their lobbying is focused on issues outside the energy sector.

¹³There are two reasons why only large and active firms and trade associations are included in the analysis. First, small firms and large firms may take different positions on a policy even though they belong to the same industry. They are often treated differently in public policies. The goal is to have a coalition consisting of homogenous interests. Second, small firms are more likely to lobby private policies such as an earmark for a specific product.

¹⁴The renewable energy group is relatively more heterogeneous than other groups. I use a lower threshold so that all major renewable energy sources are represented.

¹⁵See Appendix for the list of the 42 entities in the dataset.

¹⁶These figures are based on the Compustat dataset and they do not include information on firms that were not on the U.S. stock market at the end of 2007.

Table 2: Energy Lobbying Coalitions

	Assns	Firms	Asset	Sales	Lobbying
Coal	3	7	\$253.35b	\$71.68b	\$139.56m
Oil/Gas	1	7	\$1,116.92b	\$1,443.73b	\$160.63m
Nuclear	1	11	\$195.06b	\$87.78b	\$70.65m
Renewable	6	6	\$41.04b	\$14.69b	\$30.44m
Total	10	32	\$1,606.33b	\$1,617.88b	\$401.28m

policy is determined by exploiting a variety of sources of information. Note that the position information is needed for all relevant firms and trade associations regardless of lobbying participation. In most cases, classification is straightforward based on the business of an entity and the content of each policy.¹⁷ I also collect and use relevant documents available online to arrive at these determinations, such as the letters sent to the Congress by interest groups and statements in news articles and the groups’ own websites.

The lobbying participation and policy position of the entities within a lobbying coalition are aggregated as follows. A coalition is assumed to have lobbied the legislature on a policy if any of the strategic firms or trade associations within the coalition lobbied on the policy. The position of individual strategic firms or trade associations mostly align within a coalition, but when there are disagreements, I take the policy position of the majority of the entities in the coalition as the coalition’s position.

Table 3 shows some pattern of lobbying participation by each lobbying coalition. Lobbying participation is selective in the sense that not all policies are lobbied by all lobbying coalitions. The second column of the table shows the average frequency of lobbying participation on a policy. The oil and natural gas coalition participates the most frequently, followed by the renewable energy coalition. The renewable energy coalition participates relatively often compared to its total lobbying spending, which is less than one tenth of that of the oil and natural gas coalition. The rest columns show the correlation of lobbying participation among lobbying coalitions. It can be seen that lobbying participation is positively correlated.

2.5 Policy Passage and Lobbying

Table 4 and Table 5 show the relationship between the enactment of a policy and the lobbying activities on the policy. As can be seen in Table 4, among 539 energy policies in the dataset,

¹⁷It is possible that even if a policy is beneficial to a firm, it may not support the policy if enactment or rejection of the policy affects the enactment probability of another policy. I assume that the interaction between different policies does not exist when constructing the dataset.

Table 3: Lobbying Participation by the Energy Lobbying Coalitions

	Avg.	Coal	Oil/Gas	Nuclear	Renewable
Coal	49.54%	1.00	0.38	0.71	0.42
Oil/Gas	66.79%	-	1.00	0.45	0.34
Nuclear	48.98%	-	-	1.00	0.45
Renewable	61.97%	-	-	-	1.00

Table 4: Policy Enactment and Lobbying I

	Obs.	Enactment
Not lobbied by all	351	0.6%
Lobbied by all	188	22.9%
Supporters are dominant	122	25.4%
Opposition is dominant or equal	66	18.2%
Total	539	8.4%

351 policies were lobbied either by none of the lobbying coalitions or by some, but not all, of them. The enactment rate of these policies is less than 1%.¹⁸ On the other hand, when a policy was lobbied by all of the lobbying coalitions, the enactment rate increases to about 23%. Furthermore, when the number of supporting lobbying coalitions exceeds that of opposing lobbying coalitions, the enactment rate is greater (about 25%) than that of the opposite case (about 18%). This does not necessarily imply that lobbying is effective because lobbying participation is endogenously determined. In Table 5, it can be seen that when both supporting lobbying coalitions and opposing coalitions lobby, the enactment rate is much higher (about 14%) than when only supporting coalitions lobby (about 8%).

To quantify the effect of lobbying participation on the probability that a policy is enacted, controlling for the selection in lobbying participation is necessary. It is complicated by the fact that both the outcome variable, the enactment of a policy, and the endogenous explanatory variable, the participation in lobbying on the policy, are discrete. In this paper, I quantify the effect of lobbying *expenditures* on the enactment probability of a policy, controlling the endogeneity of lobbying decisions and exploiting the structure of the model described in the next section.

¹⁸Among the 351 policies, only 2 policies were enacted. Both of the two enacted policies were lobbied by one lobbying coalition which opposed them.

Table 5: Policy Enactment and Lobbying II

	Obs.	Enactment
Not lobbied	78	0.0%
Lobbied by supporters only	266	8.4%
Lobbied by opposition only	68	4.4%
Lobbied by both sides	167	13.8%
Total	539	8.4%

2.6 Observed Characteristics of Policies and Lobbying Coalitions

In the data, policies differ in several observed dimensions. First, the general public has different opinions on each policy. I measure the public opinion on a policy by using the polling data obtained from the Roper Center for Public Opinion Research. I include all polling questions in the polling dataset which asked about energy policy issues to U.S. national adult samples during 2007–2008, and these polling questions are matched with the policies in my dataset. Not all policies in the dataset have corresponding polling questions. Based on the polling data, I create two variables for each policy: (i) one dummy variable that indicates whether a relevant polling question exists in the polling dataset (*salience*), and (ii) the estimated fraction of supporters for the policy (*public opinion*).¹⁹

Second, each policy heterogeneously affects each of the lobbying coalitions in two observed aspects. For each coalition, one is whether the policy favors or disfavors the coalition (*pro-all*, *pro-renewable*).²⁰ The other aspect is whether or not the policy directly affects it (*relevance*). For instance, a tax credit policy for capturing and sequestering carbon dioxide from coal-fired power plants directly benefits the coal industry while it indirectly affects other energy industries.

A third way in which policies differ is the congressional committees that have jurisdiction over a policy. The members of these committees play an important role in moving the policy through the lawmaking process. When a bill is introduced, it is referred to one or multiple committees in whichever chamber of Congress it was submitted in. The receiving committees

¹⁹When a policy does not have a corresponding polling question, it may be considered that it has a missing observation for *public opinion* variable. However, I interpret this case as ‘no opinion,’ which may be due to certain characteristics of the policy, such as being too technical for the general public to form an opinion. For this reason, I construct a variable called *salience*, instead of imputing values for *public opinion* variable.

²⁰Given that there are four lobbying coalitions, there are potentially seven dummy variables regarding the identity of the coalitions that are directly favored or disfavored. However, given the small sample size, I constructed two variables. *Pro-all* variable is an indicator variable, which is 1 when all four lobbying coalitions are benefited, and is 0 otherwise. *Pro-renewable* variable is also an indicator variable, which is 1 when the renewable energy lobbying coalition is favored but there exists at least one other coalition that is disfavored.

may consider and approve the bill, with or without amendments or recommendations, and send it to the full House or Senate. The committee may also rewrite the bill entirely, reject it, or simply refuse to consider it. Most bills die in the committee action stage. In the 110th Congress, over 84.07% of bills were killed there. As Oleszek (2010) describes in detail, which committees receive what kinds of bills is determined by precedent, public laws, memoranda of understanding between committee chairs, turf battles, and the rules of the House and Senate. I determine jurisdictional committees for a particular policy based on the referrals of bills in which the policy and its similar policies appear.

For each policy and a lobbying coalition, I measure the degree of connection by the fraction of the committee members whose ex-staffers are hired by the lobbying coalition as lobbyists to the total number of committee members. In calculating the fraction, I weigh each committee differently based on the observed likelihood that it has jurisdiction over the policy. In constructing this variable (*connection*), I use the dataset on the career history of registered lobbyists from Lobbyists.info, a division of Columbia Books & Information Services.²¹ Wright (1996), Ainsworth (1997), and Hall and Deardorff (2006), amongst other papers, discuss the cooperative relationship between lobbyists and legislators. Lobbyists, particularly those who have broad access, can acquire and provide information on other legislators' positions and plans to like-minded legislators. As Wright (1996) noted, the knowledge about what legislators are planning and thinking is an important resource that can be used to shape perceptions about the viability of various policy options. Empirically, there is a recent study by Blanes i Vidal et al. (2010) examining how staffer-turned-lobbyists benefit from the personal connections acquired during public service. They find that lobbyists with experience in the office of a U.S. Senator suffer a 24% drop in generated revenue when that Senator leaves office.

Table 6 presents the summary statistics of the variables.

3 Model

There is a finite set of lobbying coalitions, denoted as \mathcal{L} . Each lobbying coalition represents a unique interest. These lobbying coalitions are the players of the lobbying game. Consider a specific policy k . In the absence of lobbying, the policy will be enacted into law with probability π_k . Each player values the policy heterogeneously, and the value of policy k to player ℓ is denoted as $v_{\ell,k}$. Some players have positive values and others have negative values from the enactment of the policy. I denote the set of players that positively value policy k as $\mathcal{L}_{f,k} \subseteq \mathcal{L}$ and those that negatively value it as $\mathcal{L}_{a,k} \subseteq \mathcal{L}$. For simplicity, it is assumed that

²¹For more details on the connection variable, see Appendix.

Table 6: Summary Statistics of Variables

	Obs.	Mean	SD	Min	Max
Policy-specific variables					
<i>Public Opinion</i>	539	0.3753	0.3555	0.0000	0.9100
<i>Salience</i>	539	0.5436	0.4986	0	1
<i>Pro-All</i>	539	0.3636	0.4815	0	1
<i>Pro-Renewable</i>	539	0.3340	0.4721	0	1
Policy-player-specific variables					
<i>Relevance (Coal)</i>	539	0.2690	0.4439	0	1
<i>Relevance (Oil/Gas)</i>	539	0.4972	0.5005	0	1
<i>Relevance (Nuclear)</i>	539	0.2022	0.4020	0	1
<i>Relevance (Renewable)</i>	539	0.4675	0.4994	0	1
<i>Connection (Coal)</i>	539	0.2319	0.0682	0.0000	0.6935
<i>Connection (Oil/Gas)</i>	539	0.1940	0.0533	0.0408	0.5410
<i>Connection (Nuclear)</i>	539	0.1378	0.0386	0.0000	0.2968
<i>Connection (Renewable)</i>	539	0.1240	0.0397	0.0000	0.3420

the legislative process regarding a policy does not interfere with that of any other policy. From now on, the subscript k is dropped for notational ease.

The model is a game of complete information, consisting of two stages.²² For each policy, players first simultaneously decide whether or not to lobby the legislature on the policy. Upon participation, a player pays an entry cost. The entry cost represents the minimal administrative or informational cost to embark on lobbying activities. Examples of such costs could include the costs of initial research and surveys on the economic, social, or environmental effects of the proposed policy as well as related existing policies. These costs may vary by both policy and player. The initial level of support for the policy in the legislature, the value of the policy to all players, and the entry costs of lobbying on the policy for all players are common knowledge. Second, knowing the identities of other participants, players simultaneously decide how much to spend in order to affect the chances that the policy will be enacted. The initial level of support for the policy in the legislature and the lobbying expenditures of each player determine the probability that the policy is enacted. This second stage game is modeled as an all-pay group contest in the sense that the lobbying expenditures are sunk costs and the rent is a public good shared amongst all groups on the same side of a policy.²³

²²This complete information assumption does not necessarily exclude the possibility that lobbying affects politicians' decisions by providing them with information.

²³By taking a rent-seeking contest approach, the mechanism through which lobbying activities affect the policy choices by the legislature is not specifically modeled. There are two types of economic models of interest group influence, and it is not easy to pick one model over another based on the data on lobbying.

The early papers on the rent-seeking behaviors, such as Tullock (1967) and Krueger (1974), have been extended in various directions (see Nitzan (1994), Konrad (2007), and Corchon (2007) for a survey) and this rent-seeking literature has studied lobbying as an application. One extension that is very relevant to my paper is that the rent is a group-specific public good.²⁴ An important modeling issue is to determine a policy enactment production function, denoted as $p(\mathbf{s}_f, \mathbf{s}_a; \pi)$. This function defines how the probability that a policy is enacted, p , is determined by the initial enactment probability, denoted as π , and a profile of supporting players' spending, $\mathbf{s}_f \equiv (s_i)_{i \in \mathcal{L}_f}$, and opposing players' spending, $\mathbf{s}_a \equiv (s_j)_{j \in \mathcal{L}_a}$. I assume the following production function:

$$p(\mathbf{s}_f, \mathbf{s}_a; \pi) = \frac{\pi + \beta_f \sum_{i \in \mathcal{L}_f} s_i^\gamma}{1 + \beta_f \sum_{i \in \mathcal{L}_f} s_i^\gamma + \beta_a \sum_{j \in \mathcal{L}_a} s_j^\gamma},$$

where $\beta_f > 0$, $\beta_a > 0$, $\gamma \in (0, 1)$. There are a few notable features in this specification. First, $p(0, 0; \pi) = \pi$, which is consistent with the definition of π . Second, this specification allows a prior advantage or disadvantage to each group such that when only supporting (opposing) group lobbies, the probability that a policy is enacted is not necessarily one (zero). This is consistent with the data, but in the literature on contests, it is often assumed that when only one player participates, his winning probability is one.²⁵ Third, by assume that $\gamma < 1$, the number of lobbying participants matters in determining the probability that the policy becomes law: if the same amount of money is spent from one side, the more participants there are, the more effective the money is.²⁶

Given the policy enactment production function specified above, the expected payoff of a player is delineated as follows. Players are assumed to be risk-neutral and without

Papers in the the first category assume that interest groups offer legislators money or resources in exchange for legislative favors (e.g. Snyder (1991) and Groseclose and Snyder (1996)). Although the lobbying expenditures may not directly benefit the legislators by law, the lobbyists often act as bundlers of campaign contributions, and they may provide other politically valuable resources. Papers in the second category assume that interest groups may affect policy outcomes by providing relevant information to the lawmaker (e.g. Austen-Smith and Wright (1996) and Bennedsen and E. Feldmann (2002)). As discussed in Bertrand et al. (2011), lobbyists may have technical expertise on specific policy issues, and/or they may act as a credible or trusted transmitter, from the view of legislators, of valuable information possessed by the firms or organizations that hire them.

²⁴See, for example, Katz et al. (1990), Nitzan (1991), Riaz et al. (1995), Dijkstra (1998), and Baik (2008).

²⁵For example, Tullock's standard contest success function is

$$p_i(s_1, s_2, \dots, s_n) = \begin{cases} \frac{s_i^\gamma}{\sum_{j=1}^n s_j^\gamma} & \text{if } \max\{s_1, \dots, s_n\} > 0, \\ \frac{1}{n} & \text{otherwise,} \end{cases}$$

for $\gamma > 0$. Note that if $s_i > 0$ and $s_j = 0$ for all $j \neq i$, then $p_i = 1$.

²⁶This assumption is data-driven. In the data, there are multiple lobbying participants from the same side. However, when the lobbying expenditures by two different players are perfect substitutes ($\gamma = 1$) and budget constraints do not exist, there is only one participant from each side.

budget constraints.²⁷ If player ℓ spends s_ℓ to lobby for a policy given other players' spending $(\mathbf{s}_{-\ell,f}, \mathbf{s}_a)$, the expected payoff is:

$$\mathbb{E}u_\ell(In, s_\ell | \pi, \mathbf{s}_{-\ell,f}, \mathbf{s}_a) = p(\mathbf{s}_f, \mathbf{s}_a; \pi)v_\ell - s_\ell - c_\ell,$$

where c_ℓ is the entry cost. Note that if the player lobbies against the policy, the expected payoff can be similarly defined. If the player does not participate,

$$\mathbb{E}u_\ell(Out | \pi, \mathbf{s}_{-\ell,f}, \mathbf{s}_a) = p(\mathbf{s}_f, \mathbf{s}_a; \pi)v_i.$$

The equilibrium concept in this game is the Subgame Perfect Nash Equilibrium.

Proposition 1. *In the second stage of the game, a pure-strategy Nash equilibrium exists and is unique.*

Proof. See Appendix. □

As a unique equilibrium in pure strategies exists in the second stage, a payoff matrix in the first stage can be uniquely determined. As a result, the first stage game boils down to a finite normal-form game. It is well-known that every finite normal-form game has a mixed-strategy equilibrium. Therefore, in the first stage, a (mixed-strategy) equilibrium exists but it may not be unique.

We do not observe the initial enactment probability, the values, and the entry costs. For each policy k , I make the following parametric assumptions. First, I assume that the initial enactment probability, π_k , depends on the sum of a linear index of \mathbf{Z}_k and an unobserved random variable ξ_k :

$$\pi_k = F(\mathbf{Z}_k\delta + \xi_k),$$

where $F(\cdot)$ is a cumulative density function of the standard normal distribution. \mathbf{Z}_k is the vector of a constant and the variables regarding the public opinion (*salience*, *public opinion*) and the identity of lobbying coalitions that are favored or disfavored (*pro-all*, *pro-renewable*).²⁸ ξ_k includes the omitted variables regarding other activities of political influence

²⁷Baik (2008) studies the rent-seeking contest with group-specific public goods when players are budget-constrained. He finds that the free-rider problem within group is alleviated compared to the base model without budget-constraints.

²⁸The initial level of support for a particular policy in Congress is related to the factors that weigh into legislators' choices of policy positions. Fenno (1973) argued that legislators are motivated by three basic goals: reelection, good public policy, and influence within the legislature. Based on his argument, prominent factors include the preferences of their constituents, their own personal policy preferences, and the preferences of their party leaders. All of these preferences are closely related to how the policy affects each energy industry.

that are not considered in this model.²⁹ Second, I assume that the log of the valuation of policy k to player ℓ , $\log |V_{\ell,k}|$, is additively separable into a linear index of $\mathbf{X}_{\ell,k}$ and an unobserved random variable $\eta_{\ell,k}$:

$$\log |V_{\ell,k}| = \mathbf{X}_{\ell,k} \alpha_\ell + \eta_{\ell,k},$$

where η_ℓ follows $N(0, \sigma_\ell)$. $\mathbf{X}_{\ell,k}$ is the vector of a constant and the direct relevance of the policy to the coalition (*relevance*). Lastly, I assume that the entry cost for player ℓ to lobby on policy k , $C_{\ell,k}$, is linear in the extent to which a lobbying coalition is connected to the members of the committees that have jurisdiction over a policy (*connection*), denoted by $R_{\ell,k}$:

$$C_{\ell,k} = \max \{ \kappa_0 + \kappa_1 R_{\ell,k}, 0 \}.$$

4 Identification and Estimation

4.1 Identification

There are two empirical challenges to identifying the structural parameters of the model from the data. First, the initial enactment probability is not observed and theory implies that it is correlated with the lobbying decisions of interest groups. Second, policy-specific lobbying expenditures are not observed. I overcome these challenges by exploiting both exclusion restrictions and functional form restrictions.

Key exclusion restrictions are twofold. First, I assume there exists a variable that affects the entry cost of one player and which can vary while the initial enactment probability, the other players' entry costs and the value of the policy to all players remain fixed. In estimation, the variable is called *connection*, and it represents the extent to which a player is connected to the members of the committees that have jurisdiction over a policy. The argument that the variable *connection* does not affect the initial enactment probability or valuations of policy is based on timing and information assumptions about hiring lobbyists. Lobbying contracts are often long-term and the formation of new contracts in the middle of a Congress (two years) is not very common.³⁰ If lobbying contracts are made before policies are proposed in Congress and firms have limited ability to anticipate policy proposals and initial

²⁹In particular, I focus on the lobbying behaviors of *strategic* or *major* energy firms, which I define in Section 2. However, other *nonstrategic* firms, trade associations, and citizens' groups also attempt to influence legislators. I assume that their activities of political influence happen before the lobbying coalitions in the dataset make lobbying decisions.

³⁰Among 1,521 lobbyist-firm or lobbyist-association pairs in my dataset, about 30% of them were formed during the middle of the 110th Congress.

support, this exclusion restriction can be justified. Second, I assume that there exist variables that affect the initial enactment probability and which can vary while other components of the initial enactment probability, valuations of policy, and entry costs of lobbying are fixed. In estimation, the variables are called *salience* and *public opinion*, and they are related to public opinion on a policy.

An important restriction from the model is that it predicts a unique profile of equilibrium lobbying expenditures given the exogenous variables and an observed profile of lobbying participation. Further, I impose an equilibrium selection rule. Specifically, when there are multiple equilibria, I select the equilibrium that maximizes the sum of the payoffs of all players.^{31,32} Lastly, I assume that $F(\cdot)$ and κ_0 are known. In estimation, I assume that F is the cumulative distribution function of the standard normal distribution. As the value for κ_0 , I take the smallest lobbying expenditure undertaken by entities that lobbied for one policy and did not hire lobbyists with connections in the data.³³

4.2 Estimation

I have the individual policy-level data (enactment and lobbying participation profile) and the aggregate player-level data (total lobbying expenditures). Both levels of data are necessary to identify the parameters in the model as discussed in the previous section. I propose and use an extremum estimator where the scalar objective function $Q_n(\theta)$ is defined as:

$$Q_n(\theta) = \sum_{k=1}^n \ln f(y_k, \mathbf{d}_k | \mathbf{w}_k; \theta) - \frac{\lambda}{n} \sum_{\ell=1}^L \left\{ 1 - \frac{\sum_{k=1}^n \varphi_{\ell}(\mathbf{w}_k; \theta)}{SS_{\ell}} \right\}^2, \quad (4.1)$$

for any given $\lambda > 0$. For notation, Y_k is a random variable that is 1 if policy k is enacted and 0 otherwise; $D_{\ell,k}$ is a random variable that is 1 if player ℓ lobbies the legislature regarding policy k and 0 otherwise; \mathbf{w}_k is a vector of the value of the observable variables for policy

³¹There is an active literature on estimating discrete-choice games that explicitly addresses this issue (Tamer 2003; Ciliberto and Tamer 2009; Bajari et al. 2010, for example). Ciliberto and Tamer (2009) do not impose an equilibrium selection rule and their inference methods are robust to non-point-identification. However, it is not practical to employ their method given the size of my dataset.

³²At the point estimate, the average number of equilibria is 1.000000 with a 95% confidence interval [0.999996, 1.000001].

³³The rationale is the following. The observed expenditure of an entity ℓ that lobbied only one policy with no connection regarding the lobbied policy is

$$S_{\ell}^o = \kappa_0 + \tilde{S}_{\ell},$$

where \tilde{S}_{ℓ} stands for the lobbying expenditures after entry. Because the support of \tilde{S}_{ℓ} is $(0, \infty)$ given the model, the lower bound of S_{ℓ}^o is κ_0 . The sensitivity analysis in Appendix shows that my findings are robust to variation in the value chosen for κ_0 .

k , $\mathbf{w}_k \equiv (\mathbf{x}_k, \mathbf{z}_k, \mathbf{r}_k)$; and ss_ℓ is the total lobbying expenditures for any $\ell = 1, \dots, L$.³⁴ The first part of the objective function is the sum of the log-likelihood of observing (y_k, \mathbf{d}_k) given \mathbf{w}_k over each policy k . The second part of the objective function is the weighted sum of the squared difference between the observed total lobbying expenditures and the model-predicted total lobbying expenditures by each player conditional on $\{\mathbf{w}_k\}_{k=1}^n$.³⁵ Note that the equilibrium objects, $\Pr(Y = 1, \mathbf{D} = \mathbf{d}_k | \mathbf{w}_k; \theta)$ and $\varphi_\ell(\mathbf{w}_k; \theta)$, do not have a closed-form solution. Therefore, I simulate in obtaining the value for $Q_n(\theta)$ for any θ .

Let $\hat{\theta}_n \in \arg \max_{\theta \in \Theta} Q_n(\theta)$ where $Q_n(\theta)$ is as defined in (4.1). Under some regularity conditions, this proposed estimator is consistent and asymptotically normally distributed.³⁶ Alternatively, one can use a GMM estimator, as suggested by Imbens and Lancaster (1994), based on the moment conditions that (i) the expectation of the first derivative of log-likelihood, or the score, is zero, and (ii) the expectation of the difference between the observed total lobbying expenditures and the model-predicted total lobbying expenditures by each player is zero. The weighting matrix of the GMM estimator can be likened to the weight of the proposed estimator in this paper, λ . While there exists a theoretical guidance for an optimal weighting matrix for the GMM estimator so that the efficiency of the estimator is guaranteed, I do not have a counterpart for the proposed estimator. Let us denote the efficient GMM estimator as $\tilde{\theta}_n$. It can be seen that the difference between the asymptotic covariance matrix of $\sqrt{n}(\tilde{\theta}_n - \theta_0)$, denoted as $\tilde{\Sigma}_n$, and the asymptotic covariance matrix of

³⁴Specifically, ss_ℓ is the sum of lobbying expenditures by player ℓ on all energy policies. In the data, I observe the sum of lobbying expenditures on *all* policies for each player. Therefore, it is crucial to determine the energy lobbying expenditures from the total lobbying expenditures for each player. In doing so, I use the information on lobbying participation at the bill level. First, for each entity that belongs to a player, I multiply its total lobbying expenditures by the ratio of the number of the energy bills that the entity lobbied to the total number of the bills that it lobbied. Then, I sum the obtained energy lobbying expenditures over all entities that belong to the player.

³⁵Specifically, $\varphi_\ell(\mathbf{w}_k; \theta)$ can be defined as:

$$\begin{aligned} \varphi_\ell(\mathbf{w}_k; \theta) = & \int \sum_{\mathbf{d}'} (\phi_\ell(\mathbf{w}_k, \xi, \eta, \mathbf{d}'; \theta) + (\kappa_0 + \kappa_1 r_{\ell,k}) d'_\ell) \\ & \cdot \Pr(\mathbf{D} = \mathbf{d}' | \mathbf{w}_k, \xi, \eta, \theta) dH(\xi, \eta; \theta). \end{aligned}$$

where $\phi_\ell(\mathbf{w}, \xi, \{\eta_\ell\}_{\ell \in \mathcal{L}}, \mathbf{d})$ denotes the one-to-one mapping from $(\mathbf{w}, \xi, \{\eta_\ell\}_{\ell \in \mathcal{L}}, \mathbf{d})$ to the equilibrium lobbying spending by player ℓ .

³⁶One can show that under regularity conditions as described in Theorem 4.1.3 in Amemiya (1985), $\sqrt{n}(\hat{\theta}_n - \theta_0) \rightarrow N(0, B(\theta_0)^{-1} A(\theta_0) B(\theta_0)^{-1})$, where

$$\begin{aligned} A(\theta_0) &= \mathbb{E} \left(\frac{\partial \ln f(y_k, \mathbf{d}_k | \mathbf{w}_k; \theta_0)}{\partial \theta} \cdot \frac{\partial \ln f(y_k, \mathbf{d}_k | \mathbf{w}_k; \theta_0)}{\partial \theta'} \right), \\ B(\theta_0) &= -A(\theta_0) - 2\lambda \sum_{\ell=1}^L \frac{1}{\mathbb{E}(ss_{\ell,k})} \mathbb{E} \left(\frac{\partial \varphi_\ell(\mathbf{w}_k; \theta_0)}{\partial \theta} \right) \mathbb{E} \left(\frac{\partial \varphi_\ell(\mathbf{w}_k; \theta_0)}{\partial \theta'} \right). \end{aligned}$$

Table 7: Estimation Results

Parameter	Estimate	Parameter	Estimate
β_f	4.30E-6*** (7.16E-7)	$\alpha_0(Nuclear)$	18.4415*** (0.8276)
β_a	1.63E-4*** (5.45E-5)	$\alpha_0(Renewable)$	18.8061*** (0.4214)
γ	0.2895*** (0.0111)	$\alpha_1(Coal)$	1.5090 (1.0995)
δ_0	-1.9696*** (0.2333)	$\alpha_1(Oil/Gas)$	1.0809** (0.4452)
$\delta_1(Opinion)$	0.8734 (9.6797)	$\alpha_1(Nuclear)$	1.5155 (1.5240)
$\delta_2(Salience)$	-0.4191 (4.4478)	$\alpha_1(Renewable)$	1.0540** (0.5010)
$\delta_3(Pro-All)$	0.2237 (0.1608)	$\sigma_\eta(Coal)$	1.9925*** (0.3530)
$\delta_4(Pro-Ren.)$	0.0746 ** (0.0371)	$\sigma_\eta(Oil/Gas)$	1.5779*** (0.5277)
σ_ξ	1.2517*** (0.3993)	$\sigma_\eta(Nuclear)$	1.6469*** (0.3576)
$\alpha_0(Coal)$	17.9953*** (0.5447)	$\sigma_\eta(Renewable)$	1.4203*** (0.2461)
$\alpha_0(Oil/Gas)$	18.7945*** (0.7264)	$\kappa_1(Connection)$	-12,980.6*** (2,502.8)

* The asterisks marks represent the statistical significance: * (10%), ** (5%), and *** (1%).

$\sqrt{n}(\hat{\theta}_n(\lambda) - \theta_0)$, denoted as $\hat{\Sigma}_n(\lambda)$, is positive-definite for any choice of $\lambda > 0$. Therefore, the issue is whether a researcher can find a weight λ such that $\hat{\Sigma}_n(\lambda)$ is close enough to $\tilde{\Sigma}_n$ so that the information in the data is fully used for making statistical inferences. As can be seen in the following section, the key parameters of the model are estimated with a high degree of precision. Further, compared to this GMM estimator, the proposed estimator in this paper is computationally less intensive.

5 Empirical Results

Table 7 shows the parameter estimates. The asymptotic standard errors are provided in parentheses.³⁷

5.1 Model Fit

Using the estimated parameters, I simulate the data and calculate the following moments displayed in Table 8. The overall fit of the simulated data to the actual data is good in both the level and the trend. The table shows both the actual and the predicted moments regarding policy enactment, lobbying participation, and total lobbying expenditures. Using the estimated parameters, I calculate the moments via simulation.

One way to validate my estimates is to compare the estimated value distribution to

³⁷The reported standard errors of the parameters are based on the asymptotic variance matrix defined in footnote 36. The parameters are estimated at $\lambda = 50$. The sensitivity analysis in Appendix shows that the results in Table 7 and 8 are robust to a wide range of values of λ .

Table 8: Model Fit

	Observed	Predicted
Policy Enactment (%)		
All	8.35	7.79
Participation (%)		
Coal	49.54	51.04
Oil/Gas	66.79	65.48
Nuclear	48.98	50.37
Renewable	61.97	62.33
Total Spending (\$ million)		
Coal	77.85	77.61
Oil/Gas	73.21	75.29
Nuclear	33.91	33.33
Renewable	22.11	22.09

the actual value distribution. However, the private valuation of a specific policy to each lobbying coalition is mostly unavailable, and therefore it is not included in the estimation. In particular, the economic impact of an environmental or market regulation on the targeted industry, as well as non-targeted industries which may be indirectly affected, is very hard to measure. In my dataset, there are 27 policies in which the federal government directly spends money for private entities and the authorized amount of money to be appropriated is listed. Among these policies, 22 of them are grants, R&D subsidies or loan or loan guarantees for bio and other renewable energy industries, and the rest are directed towards new nuclear power plants, coal-to-liquid projects, etc. The average government spending authorized by these policies is \$736 million and the standard deviation is \$579 million. The average value of a policy which is specific to the renewable energy lobbying coalition is estimated to be \$757 million with a 95% confidence interval [\$372.67, \$3,225.30] million.

5.2 Effect of Lobbying Expenditures on Policy Enactment

Based on the estimates, I find that the effect of lobbying expenditures on the equilibrium policy enactment probability is very small. This assessment is based on the following exercise. First, I simulate the equilibrium enactment probability and the initial enactment probability for each policy conditional on the observed participation profile and observable characteristics of the policy and lobbying coalitions. Second, I calculate the difference between the two probabilities. If lobbying were not allowed, the initial enactment probability would be the final enactment probability. Therefore, the difference in these two probabilities is due to

Table 9: Effect of Lobbying Expenditures on Policy Enactment

(unit: percentage points)	Average Effect
All	0.041 [0.021,0.280]
Enacted policies	0.060 [0.032,0.289]
Not enacted policies	0.033 [0.017,0.237]

* The numbers in brackets are 95% confidence intervals.

lobbying expenditures by both supporting and opposing lobbying coalitions. This measure of the effect of lobbying expenditures on the enactment probability for policy k conditional on the participation profile \mathbf{d}_k and observable characteristics \mathbf{w}_k can be mathematically expressed as:

$$E \left[\frac{F(\mathbf{z}_k \delta + \xi_k) + \beta_f \sum_{i \in \mathcal{L}_f} \phi_i(\mathbf{w}_k, \xi, \eta, \mathbf{d}_k; \theta)^\gamma}{1 + \sum_{j \in \mathcal{L}} \beta_j \phi_j(\mathbf{w}_k, \xi, \eta, \mathbf{d}_k; \theta)^\gamma} - F(\mathbf{z}_k \delta + \xi_k) | \mathbf{d}_k, \mathbf{w}_k \right].$$

Based on this measure, I find that the difference is on average 0.041 percentage points and with a 95% confidence interval [0.021, 0.280] percentage points. As can be seen in 9, both enacted and not enacted policies were not largely affected by lobbying expenditures on average. The finding that lobbying expenditures hardly affect policy-making results from the following two channels. First, the estimated enactment production function is such that the marginal effect of lobbying expenditures on the policy enactment probability is very small. Second, the effects of lobbying expenditures by competing interests partially cancel each other out. I discuss these two channels in detail.

5.2.1 The Enactment Production Function

Based on the estimates of β and γ , I conclude that the marginal effect of lobbying expenditures on the policy enactment probability is very small. To illustrate this point, I calculate the effect of additional lobbying expenditure (Δs_ℓ) by lobbying coalition ℓ on the probability that a policy is enacted, assuming ℓ is the only coalition which is interested in the policy. If the lobbying coalition favors the policy, the effect, or the change in the enactment probability, can be mathematically represented as:

$$\Delta Pr(Enactment | \Delta s_\ell, s_\ell, \pi, \ell \in \mathcal{L}_f, \mathbf{s}_{-\ell} = \mathbf{0}) = \frac{\pi + \beta_f(s_\ell + \Delta s_\ell)^\gamma}{1 + \beta_f(s_\ell + \Delta s_\ell)^\gamma} - \frac{\pi + \beta_f s_\ell^\gamma}{1 + \beta_f s_\ell^\gamma},$$

where π is the initial enactment probability and $\mathbf{s}_{-\ell}$ is the vector of lobbying expenditures by all other lobbying coalitions. Similarly, if ℓ opposes the policy, the effect can be represented

Table 10: Change in Enactment Probability as Lobbying Spending Changes

Δs_ℓ	$\Delta Pr(Enactment)$	
	ℓ in Support	ℓ in Opposition
	$(\pi = 0, s_\ell = 0, \mathbf{s}_{-\ell} = \mathbf{0})$	$(\pi = 1, s_\ell = 0, \mathbf{s}_{-\ell} = \mathbf{0})$
\$1,000	0.003 [0.002,0.004]	-0.120 [-0.199,-0.041]
\$66,000	0.011 [0.007,0.015]	-0.403 [-0.674,-0.133]
\$3,000,000	0.032 [0.019,0.046]	-1.208 [-2.043,-0.373]

* The unit is in percentage points and the numbers in brackets are 95% confidence intervals.

as:

$$\Delta Pr(Enactment|\Delta s_\ell, s_\ell, \pi, \ell \in \mathcal{L}_a, \mathbf{s}_{-\ell} = \mathbf{0}) = \frac{\pi}{1 + \beta_a(s_\ell + \Delta s_\ell)^\gamma} - \frac{\pi}{1 + \beta_a s_\ell^\gamma}.$$

Note that this effect, regardless of the position of the lobbying coalition ℓ , depends on s_ℓ and π . First, in both cases, the smaller s_ℓ is, the larger the change in the enactment probability is given Δs . Second, if ℓ lobbies the government for the policy, the change in the enactment probability is the largest when $\pi = 0$. On the other hand, if ℓ is in opposition of the policy, the change in the enactment probability is the largest when $\pi = 1$.

In Table 10, the changes in the enactment probability are shown when the sole lobbying player either supports or opposes the policy, as a function of the change in lobbying spending by player ℓ (Δs_ℓ). As discussed earlier, the change in the enactment probability depends on s_ℓ and π , and I set s_ℓ and π such that the effect of the additional lobbying expenditures is the largest. The choices of Δs_ℓ are closely related to the data: \$66,000 is the average per-policy lobbying expenditure by the renewable energy lobbying coalition, and \$3 million is over ten times as much as the average per policy lobbying expenditures by the coal lobbying coalition. There are two notable trends in the results: first, the effect of lobbying expenditures is fairly small even when only one player lobbies and spends large amount of money such as \$3 million; and second, the effect of lobbying expenditures is much larger when the player lobbies in opposition than when it lobbies in favor. The second point is broadly consistent with the empirical results by Baumgartner et al. (2009), who find that there is a bias towards the status quo.

5.2.2 Competing Interests

The average difference between the equilibrium enactment probability and the initial enactment probability conditional on the observed participation profile and observable characteristics of the policy and lobbying coalitions is 0.041 percentage points for those policies on

Table 11: Average Effect of Lobbying Expenditures by Lobbying Positions

Lobbied by	Enactment	Effect by Supporters	Effect by Opposition
Supporters Only	8.4%	0.015 [0.003,0.031]	-
Opposition Only	4.4%	-	-0.033 [-0.342,-0.019]
Both	13.8%	0.011 [0.004, 0.023]	-0.085 [-0.645,-0.031]

* The unit is in percentage points and the numbers in brackets are 95% confidence intervals.

which at least one of the lobbying coalitions lobbied. Out of 539 policies in the dataset, 461 policies were lobbied by at least one of the lobbying coalitions. Table 11 shows the effect of lobbying expenditures on the equilibrium enactment probability conditional on the following cases: (i) when only the supporting lobbying coalitions lobbied; (ii) when only the opposing lobbying coalitions lobbied; and (iii) when both sides lobbied. The third and the fourth columns show the effect of lobbying by supporting groups and opposing groups respectively, and each effect is calculated by simulating the expectation of the difference in the enactment probability due to the supporting (or opposing) lobbying expenditures conditional on the observed participation profile and observable characteristics of the policy and lobbying coalitions. Specifically, for 167 policies in the dataset, both supporting and opposing lobbying occurred and the lobbying efforts by both sides partially canceled each other out. One measure of the canceled-out effect is the ratio of twice the minimum of these two effects by each side to the sum of them. Based on this measure, I find that about 18.19% of the effect of lobbying expenditures by both sides canceled each other out when both sides lobbied, with a 95% confidence interval [9.93, 21.32]%.

5.3 Average Returns to Lobbying

I define the conditional expectation of the returns to lobbying coalition ℓ from lobbying on policy k as:

$$\mathbb{E} \left(\frac{u_{\ell,k}(d_{k,\ell} = 1 | \mathbf{d}_{p,-\ell}) - u_{\ell,k}(d_{k,\ell} = 0 | \mathbf{d}_{p,-\ell})}{s_{\ell,k}} | \mathbf{w}_k \right).$$

In words, the return from lobbying on the policy is the ratio of the difference in the equilibrium payoffs with and without lobbying, given other lobbying coalitions' strategies, to the coalition's lobbying expenditures on the policy. Because the policy-specific value to a lobbying coalition and its lobbying expenditures on the policy are not observed, I take the expectation conditional on the observed lobbying participation profile and observable characteristics of the policy and the lobbying coalitions. For each lobbying coalition, I calculate the expected average returns from lobbying on a policy, conditional on participation. As

Table 12: Average Returns from Lobbying Expenditures

	Returns to Lobbying (unit: %)
Coal	154.47 [76.70, 184.11]
Oil/Gas	156.10 [63.37, 189.05]
Nuclear	139.65 [67.06, 167.16]
Renewable	142.25 [56.09, 161.76]

* The numbers in brackets are 95% confidence intervals.

can be seen in Table 5.3, I find that the returns to lobbying are similar among the lobbying coalitions and are above 100%.

Ansolabehere et al. (2003) discuss the puzzle described by Tullock (1972). The amount of campaign contributions by interest groups is relatively very small compared to the extremely large costs and benefits that are levied and granted by government. Ansolabehere et al. (2003) provide their perspective that campaign contributions should be viewed primarily as a type of consumption good rather than as a market for buying political benefits. In my paper, lobbying expenditures are assumed to be made as an economic investment. However, analogously, the average lobbying expenditures in the data are very small compared to the estimated value of policies. This is because the marginal effect of lobbying expenditures on the policy enactment probability is very small.

6 Conclusion

In this paper, I have presented a novel approach to the empirical analysis of political influence by interest groups based on the specification and estimation of an all-pay contest with heterogeneous interest groups over policies considered in the U.S. Congress. One of the main contributions of this paper is that I provide a novel unit of analysis: policies, which are parts of bills, rather than bills themselves as in previous works. This is particularly relevant for studying lobbying behaviors because the content of a bill can and often does change throughout the whole legislative process. Using a newly constructed dataset that contains information on policies and lobbying activities, I have quantified the effect of lobbying expenditures on the probability that a policy is enacted, and estimated the average returns to lobbying expenditures for or against a policy. In this study, I focus on energy policies and lobbying activities targeting these policies by energy firms. It remains to be seen whether the results for lobbying in the energy sector will extend to lobbying in other domains. The findings for the energy sector are interesting in their own right, however, given that lobbying

expenditures by the sector comprise 12% of all lobbying expenditures. Moreover, the approach developed in this paper can be applied to study the effects of lobbying in other policy domains.

While the analysis extends the existing empirical literature on the study of political influence, there are several important issues I have neglected to address in this paper which represent possible directions for future research. One issue is that lobbying expenditures can be a long-term investment which may only bear fruit after several congressional sessions. Since this study uses a dataset collected from only one congressional session, progress on incorporating this issue critically hinges on the collection of new data on the multiple Congresses. Another important issue concerns the mechanism through which lobbying influences policy-making. An extension of my model, which incorporates this issue, could be used to address the welfare implication of the regulation of lobbying.

References

- AINSWORTH, S. H. (1997): “The Role of Legislators in the Determination of Interest Group Influence,” *Legislative Studies Quarterly*, 22, 517–533.
- AMEMIYA, T. (1985): *Advanced Econometrics*, Harvard University Press.
- ANSOLABEHERE, S., J. M. D. FIGUEIREDO, AND J. M. S. JR. (2003): “Why Is There so Little Money in U.S. Politics?” *The Journal of Economic Perspectives*, 17, 105–130.
- AUSTEN-SMITH, D. AND J. R. WRIGHT (1996): “Theory and Evidence for Counteractive Lobbying,” *American Journal of Political Science*, 40, 543–564.
- BAIK, K. H. (2008): “Contests with Group-specific Public-good Prizes,” *Social Choice and Welfare*, 30, 103–117.
- BAJARI, P., H. HONG, AND S. P. RYAN (2010): “Identification and Estimation of a Discrete Game of Complete Information,” *Econometrica*, 78, pp. 1,529–1,568.
- BAUMGARTNER, F. R., J. M. BERRY, M. HOJNACKI, D. C. KIMBALL, AND B. L. LEECH (2009): *Lobbying and Policy Change : Who Wins, Who Loses, and Why*, The University of Chicago Press.
- BENNEDSEN, M. AND S. E. FELDMANN (2002): “Lobbying Legislatures,” *Journal of Political Economy*, 110, pp. 919–946.

- BERTRAND, M., M. BOMBARDINI, AND F. TREBBI (2011): “Is It Whom You Know or What You Know? An Empirical Assessment of the Lobbying Process,” Working Paper 16765, National Bureau of Economic Research.
- BLANES I VIDAL, J., M. DRACA, AND C. FONS-ROSEN (2010): “Revolving Door Lobbyists,” *SSRN eLibrary*.
- BOMBARDINI, M. AND F. TREBBI (2009): “Competition and Political Organization: Together or Alone in Lobbying for Trade Policy?” Working Paper 14771, National Bureau of Economic Research.
- CHEN, H., D. C. PARSLEY, AND Y.-W. YANG (2010): “Corporate Lobbying and Financial Performance,” *SSRN eLibrary*.
- CILIBERTO, F. AND E. TAMER (2009): “Market Structure and Multiple Equilibria in Airline Markets,” *Econometrica*, 77, 1791–1828.
- CORCHON, L. (2007): “The Theory of Contests: a Survey,” *Review of Economic Design*, 11, 69–100.
- DE FIGUEIREDO, J. M. AND B. S. SILVERMAN (2006): “Academic Earmarks and the Returns to Lobbying,” *The Journal of Law and Economics*, 49, 597–625.
- DIJKSTRA, B. R. (1998): “Cooperation by Way of Support in a Rent Seeking Contest for a Public Good,” *European Journal of Political Economy*, 14, 703–725.
- FACCHINI, G., A. M. MAYDA, AND P. MISHRA (2011): “Do Interest Groups Affect US Immigration Policy?” *Journal of International Economics*, 85, 114–128.
- FENNO, R. F. (1973): *Congressmen in Committees*, Study of Congress series, Little, Brown.
- GAWANDE, K. AND U. BANDYOPADHYAY (2000): “Is Protection for Sale? Evidence on the Grossman-Helpman Theory of Endogenous Protection,” *The Review of Economics and Statistics*, 82, 139–152.
- GAWANDE, K., P. KRISHNA, AND M. OLARREAGA (2005): “Lobbying Competition Over Trade Policy,” Working Paper 11371, National Bureau of Economic Research.
- GOLDBERG, P. K. AND G. MAGGI (1999): “Protection for Sale: An Empirical Investigation,” *The American Economic Review*, 89, 1135–1155.
- GROSECLOSE, T. AND J. SNYDER, JAMES M. (1996): “Buying Supermajorities,” *The American Political Science Review*, 90, pp. 303–315.

- GROSSMAN, G. M. AND E. HELPMAN (1994): "Protection for Sale," *The American Economic Review*, 84, 833–850.
- HALL, R. L. AND A. V. DEARDORFF (2006): "Lobbying as Legislative Subsidy," *American Political Science Review*, 100, 69–84.
- HALL, R. L. AND F. W. WAYMAN (1990): "Buying Time: Moneyed Interests and the Mobilization of Bias in Congressional Committees," *The American Political Science Review*, 84, 797–820.
- IMBENS, G. W. AND T. LANCASTER (1994): "Combining Micro and Macro Data in Microeconomic Models," *The Review of Economic Studies*, 61, pp. 655–680.
- KATZ, E., S. NITZAN, AND J. ROSENBERG (1990): "Rent-Seeking for Pure Public Goods," *Public Choice*, 65, 49–60.
- KIM, J.-H. (2008): "Corporate Lobbying Revisited," *Business and Politics*, 10.
- KONRAD, K. A. (2007): "Strategy in Contests - An Introduction," *SSRN eLibrary*.
- KRUEGER, A. O. (1974): "The Political Economy of the Rent-Seeking Society," *The American Economic Review*, 64, 291–303.
- NITZAN, S. (1991): "Collective Rent Dissipation," *The Economic Journal*, 101, 1522–1534.
- (1994): "Modelling Rent-Seeking Contests," *European Journal of Political Economy*, 10, 41–60.
- OLESZEK, W. J. (2010): *Congressional Procedures and the Policy Process*, CQ Press.
- RAGHAVAN, V. V. AND S. K. M. WONG (1986): "A Critical Analysis of Vector Space Model for Information Retrieval," *Journal of the American Society for Information Science*, 37, 279–287.
- RIAZ, K., J. F. SHOGREN, AND S. R. JOHNSON (1995): "A General Model of Rent Seeking for Public Goods," *Public Choice*, 82, 243–259.
- SALTON, G., A. WONG, AND C. S. YANG (1975): "A Vector Space Model for Automatic Indexing," *Communications of the ACM*, 18, 613–620.
- SNYDER, J. M. (1991): "On Buying Legislatures," *Economics & Politics*, 3, 93–109.

- SZIDAROVSKY, F. AND K. OKUGUCHI (1997): “On the Existence and Uniqueness of Pure Nash Equilibrium in Rent-Seeking Games,” *Games and Economic Behavior*, 18, 135–140.
- TAMER, E. (2003): “Incomplete Simultaneous Discrete Response Model with Multiple Equilibria,” *The Review of Economic Studies*, 70, 147–165.
- TRIPATHI, M., J. M. SNYDER, AND S. ANSOLABEHERE (2002): “Are PAC Contributions and Lobbying Linked? New Evidence from the 1995 Lobby Disclosure Act,” *Business and Politics*, 4, 131–155.
- TULLOCK, G. (1967): “The Welfare Costs of Tariffs, Monopolies, and Theft,” *Economic Inquiry*, 5, 224–232.
- (1972): “The Purchase of Politicians,” *Western Economic Journal*, 10, 354–355.
- WRIGHT, J. R. (1996): *Interest groups and Congress: Lobbying, Contributions, and Influence*, Allyn and Bacon.

Appendix 1: Data Construction

A1.1. Sample Selection Rule

The dataset covers all bill sections that create, modify, or repeal a federal financial intervention or regulation whose main statutory subjects are coal, oil, nuclear or renewable energy companies, or electric and gas utilities. The challenge is to effectively winnow all relevant bill sections from the pool of over 11,000 bills and joint resolutions that were introduced during the 110th Congress. By employing the following procedure, I select 2,279 bill sections that are contained in 445 bills and joint resolutions.

First, I divide all versions of bills and joint resolutions into sections as defined in the text.³⁸ Then, I select 9,613 bill sections based on the words in the title of the bill section. By using a computer code, I check for each section if its title includes at least a word related to the energy industry. The number of the words I use is over 500 and these words are related to various energy sources (coal, oil, natural gas, nuclear, and renewable energy), electricity, and environmental regulations. Lastly, I read each section in order to exclude the sections whose main statutory subjects are not coal, oil, nuclear or renewable energy companies, or electric and gas utilities. For example, a bill section regarding energy-efficient government buildings may include a word 'energy-efficient', but it is not directly related to the energy industry that I study in this paper.

A1.2. Bill Sections vs. Policies

I define a *policy* as the smallest self-contained part of a bill or a joint resolution that addresses one unique issue. A natural candidate for a policy is a bill section as defined in the text. However, there are two major challenges in considering the bill sections as distinct policies: first, some bill sections are exactly the same or very similar among one another; and second, some bill sections are not self-contained in the sense that multiple sections in a bill jointly address one unique issue. To handle these challenges, I use the following method.

First, based on vector space model, I represent the sections by the corresponding vectors based on word frequency and measure the distance between the vectors by calculating the cosine of the angle between them. When the cosine measure is 0, the sections have no similarity because it means that there are no words that exist in both sections. On the other hand, when the measure is 1, the sections are equal because it means that all words used in one section are also used in the other section with the same frequency. Although the

³⁸The text of each version of a bill or a joint resolution is available on the website of the Government Printing Office. Note that a bill or a joint resolution may have multiple versions as it goes through the legislative process.

ordering of the words may be different, it is of less concern because bill language is written in a formulaic manner.

Then, I group the bill sections based on the measured distances. I considered two texts whose distance is greater than or equal to 0.985 as the same, or *connected*, as defined in the graph theory. With this cutoff, it is reasonable to consider that the two connected texts are essentially the same. Then, using a Matlab routine to find connected components in graph (graphconncomp.m), I group the 2,279 bill sections into 962 components. On average, 2.4 bill sections are considered to be the same based on the metric. For example, creating a production tax credit for electricity produced from marine renewable resources appear 32 different bill sections in the exact same terms. The distribution of the number of bill sections that are categorized as one component is shown in Figure 6.1.

Lastly, I combine some components by reading each bill section representing each component. The combining criteria for multiple different components are (i) they, as a whole, represent a idea to change or retain the status quo, or (ii) they are similar in the sense that their statutory subjects and the law that they aim to change are the same. For example, a proposal to create an organization for carbon storage research consisted of multiple sections to specify their function, administration, and organization structure, to name a few. These sections are considered as one. This rule is to take into account that bill sections are not always self-sustained. Note that the sections which were considered as one policy may be slightly different from each other to a certain degree. The sections to extend a special tax rule to implement electricity market restructuring, for example, were different from each other in terms of the specific expiration year or by the degree of other modifications upon extension. Despite the differences, they were considered as the same to maintain the assumption that the effect of lobbying a policy is confined to the policy only. To maintain consistency of the dataset, I sometimes divided a section into multiple policies when it consisted of subsections on proposals that affect different entities. After this procedure, the 962 components are re-grouped into 539 groups, and each group represents a policy in the analysis. On average, one policy appear in about 2.7 different bill versions. The distribution of the number of bill sections that are categorized as one policy is shown in Figure 6.1.

A1.3. Energy Firms in the Lobbying Disclosure Data

In total, there are 559 firms and associations in the energy sector which filed at least one lobbying report in 2007–2008.³⁹ In identifying firms or associations in the energy sector,

³⁹I exclude the following firms and associations which can be considered as in the energy sector in the analysis: (i) community-owned electric utilities, rural electric cooperatives and public power districts (93 entities), (ii) foreign energy companies (9 entities), (iii) independent power providers (26 entities), and (iv)

Figure 6.1: Bill Sections vs. Policies

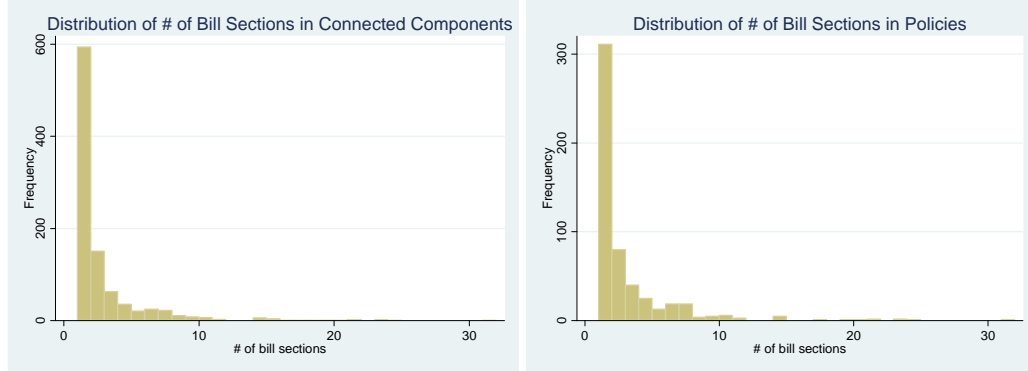


Table 13: List of of Entities in the Energy Lobbying Coalitions

Lobbying Coalition	List of Entities
Coal (10)	Ameren Corp, American Coalition for Clean Coal Electricity, American Electric Power, Duke Energy, Edison Electric Institute, Energy Future Holdings Corp, National Mining Association, Peabody Energy, Southern Co, Xcel Energy
Oil/Gas (8)	American Petroleum Institute, BP, Chevron Corp, Conocophillips, Exxon Mobil, Koch Industries, Marathon Oil, Shell Oil
Nuclear (12)	Areva Group, Constellation Energy, Dominion Resources, Energysolutions Inc., Entergy Corp, Exelon Corp, FPL Group (now NextEra Energy), General Atomics, Nuclear Energy Institute, Pinnacle West Capital, Public Service Enterprise Group, USEC Inc.
Renewable Energy (12)	American Wind Energy Association, Archer Daniels Midland, Climatemaster Inc., Covanta Energy Corp, Farmers Educational Cooperative Union (known as National Farmers Union), National Biodiesel Board, National Hydropower Association, New Generation Biofuels, PG&E Corp, Poet LLC, Renewable Fuels Association, Solar Energy Industries Association

one of the main challenges is that there is no identifier for company or organization. To overcome this challenge, I merge my dataset with the dataset compiled and cleaned by the Center for Responsive Politics (CRP) to determine the industry in which a lobbying client is involved and to figure out parent-subsidiary relationships and the changes in the name of a company, for example, due to mergers and acquisitions. I also did my own research on firms and trade associations by checking their website and the website of *Bloomberg Businessweek* (investing.businessweek.com) when the information in the CRP dataset is not sufficient.

In the analysis, I select certain firms and trade associations as *strategic* or *major* in lobbying the legislature on the energy policies and assume that they lobby cooperatively as *lobbying coalitions*. The members of lobbying coalitions are listed in Table 13.

A1.4. Connection Variable

To construct this variable, I use four sources of data: (i) the committee assignment records for each bill, available in the Library of Congress website (<http://thomas.loc.gov>); (ii) the committee assignment records for each House Representative and Senator, available in the Center for Responsive Politics website (<http://www.opensecrets.org>); (iii) the list of lobbyists hired by each firm or trade association, constructed using the lobbying reports; and (iv) the data on the career history of registered lobbyists from Lobbyists.info, a division of Columbia Books & Information Services. Note that there is no identifier for registered lobbyists, so the name of a lobbyist and his/her current employer are the major source of information to merge the third and the fourth datasets. In my dataset, there are 1,025 lobbyists who are hired by the firm or the trade association that is categorized into one of the lobbying coalitions (42 entities), and 116 of them are a ex-staffer to a member of the 110th Congress.

There are two challenges in constructing the variable. One challenge is that I infer the jurisdiction of committees on a specific issue based on the committee assignments on bills. Sometimes, a bill is divided into multiple parts and each part is assigned to a respective committee, but this information is not often available. To infer the jurisdiction of committees on a specific issue, I categorize policies in the dataset into 100 issue groups. Then, for each issue, I gather all bills in the dataset that include at least one policy that is related to the issue. Then, for each committee, I calculate the ratio of the number of these bills' assignments to the committee and the total number of the committee assignments in the respective chamber of Congress. I assume this ratio as the likelihood that the committee has jurisdiction over the issue. The other challenge is that I aggregate the connection information at the level of a firm or a trade association into the level of a lobbying coalition. I assume

firms that are only involved electric transmission (10 entities).

that if a firm or a trade association hires an ex-staffer to a certain member of Congress as a lobbyist, then the respective lobbying coalition has a connection to the member.

Based on the two assumptions, the definition of the degree of connection of a lobbying coalition ℓ regarding a policy k , denoted as $R_{\ell,k}$, is as follows:

$$R_{\ell,k} = \min \left\{ \sum_{c \in C^H} Ratio_{c,k} \times \frac{\sum_{m \in M_c} Con_{\ell,m}}{|M_c|}, \sum_{c' \in C^S} Ratio_{c',k} \times \frac{\sum_{m \in M_{c'}} Con_{\ell,m}}{|M_{c'}|} \right\},$$

where $C^H(C^S)$ is the set of the committees of the House (the Senate) and M_c is the set of the members of committee c . $Ratio_{c,k}$ is the observed likelihood that committee c has jurisdiction over policy k , and $Con_{\ell,m}$ is an indicator variable that is 1 when lobbying coalition ℓ is connected to member m and is 0 otherwise.

Appendix 2: Existence and Uniqueness of Pure-strategy Equilibrium in the 2nd Stage

Proof. The proof is constructive and is similar to the arguments in Szidarovszky and Okuguchi (1997). Suppose the set of the participants are given in the first stage: $\mathcal{L}_f^E \subset \mathcal{L}_f$ and $\mathcal{L}_a^E \subset \mathcal{L}_a$. Let me define the following variables: $y_i \equiv \begin{cases} \beta_f s_i^\gamma & \text{if } i \in \mathcal{L}_f^E \\ \beta_a s_i^\gamma & \text{if } i \in \mathcal{L}_a^E \end{cases}$, $Y_f \equiv \sum_{j \in \mathcal{L}_f^E} y_j$, $Y_a \equiv \sum_{j \in \mathcal{L}_a^E} y_j$, and $Y_{-i,f} \equiv \sum_{j \in \mathcal{L}_f^E - \{i\}} y_j$. Suppose player i lobbies for a policy. The player solves the following maximization problem given $\{\pi, Y_{-i,f}, Y_a\}$:

$$\max_{y_i} \frac{\pi + y_i + Y_{-i,f}}{1 + y_i + Y_{-i,f} + Y_a} v_i - \left(\frac{1}{\beta} y_i \right)^{\frac{1}{\gamma}}.$$

If y_i^* maximizes player i 's expected payoff, y_i^* must satisfy the first order condition:

$$\frac{1 - \pi + Y_a^*}{(1 + Y_f^* + Y_a^*)^2} |v_i| - \frac{1}{\beta_f \gamma} \left(\frac{1}{\beta_f} y_i^* \right)^{\frac{1-\gamma}{\gamma}} = 0, \quad (6.1)$$

where Y_f^* and Y_a^* are equilibrium outcomes. Using the definition that $Y_f^* \equiv \sum_{j \in \mathcal{L}_f^E} y_j^*$ and (6.1), we can derive the following equation:

$$Y_f^* = \sum_{i \in \mathcal{L}_f^E} \beta_f \left(\frac{\beta_f \gamma |v_i| (1 - \pi + Y_a^*)}{(1 + Y_f^* + Y_a^*)^2} \right)^{\frac{\gamma}{1-\gamma}}. \quad (6.2)$$

Similarly, using the first order condition of opposing players, we can derive the following equation:

$$Y_a^* = \sum_{j \in \mathcal{L}_f^E} \beta_a \left(\frac{\beta_a \gamma |v_i| (\pi + Y_f^*)}{(1 + Y_f^* + Y_a^*)^2} \right)^{\frac{\gamma}{1-\gamma}}. \quad (6.3)$$

Note that the payoff functions are concave, so the first order conditions are sufficient and necessary for optimality.

Now, let S^* denote $Y_f^* + Y_a^*$. Then equations (6.2) and (6.3) can be rewritten as:

$$S^* - Y_a^* = c_f \left(\frac{1 - \pi + Y_a^*}{(1 + S^*)^2} \right)^{\frac{\gamma}{1-\gamma}}, \quad (6.4)$$

$$S^* - Y_f^* = c_a \left(\frac{\pi + Y_f^*}{(1 + S^*)^2} \right)^{\frac{\gamma}{1-\gamma}}, \quad (6.5)$$

where $c_f \equiv \sum_{i \in \mathcal{L}_f} \beta_f (\beta_f \gamma |v_i|)^{\frac{\gamma}{1-\gamma}}$ and $c_a \equiv \sum_{j \in \mathcal{L}_a} \beta_a (\beta_a \gamma |v_j|)^{\frac{\gamma}{1-\gamma}}$. Based on equation (6.4), we can derive Y_a^* as a function of S^* , denoted as $\psi_a(S^*)$. Similarly, based on equation (6.5), we can derive Y_f^* as a function of S^* , denoted as $\psi_f(S^*)$. Note that $0 \leq \psi_f(S) \leq S$ if and only if $S \geq S_{0f}$ where S_{0f} satisfies $S_{0f}(1 + S_{0f})^{\frac{2\gamma}{1-\gamma}} = \pi^{\frac{\gamma}{1-\gamma}} c_a$. Similarly, $0 \leq \psi_a(S) \leq S$ if and only if $S \geq S_{0a}$ where S_{0a} satisfies $S_{0a}(1 + S_{0a})^{\frac{2\gamma}{1-\gamma}} = (1 - \pi)^{\frac{\gamma}{1-\gamma}} c_f$. Let me define the following function $\Psi(S)$:

$$\Psi(S) \equiv \psi_f(S) + \psi_a(S) - S. \quad (6.6)$$

Note that the proof is done if $\Psi(S) = 0$ has a unique solution. By differentiating equations (6.4) and (6.5) with respect to S , we obtain

$$\begin{aligned} \psi_f'(S) &= \left(1 + \frac{2\gamma}{1-\gamma} \frac{S - Y_f}{\pi + Y_f} \right) / \left(1 + \frac{\gamma}{1-\gamma} \frac{S - Y_f}{\pi + Y_f} \right), \\ \psi_a'(S) &= \left(1 + \frac{2\gamma}{1-\gamma} \frac{S - Y_a}{1 + S} \right) / \left(1 + \frac{\gamma}{1-\gamma} \frac{S - Y_a}{1 + \pi + Y_a} \right). \end{aligned}$$

Note that $\psi_f'(S) \geq 0$ and $\psi_a'(S) \geq 0$ as long as $S \geq S_0 \equiv \max\{S_{0f}, S_{0a}\}$. Note also that $\psi_f'(S) \geq 1$ if and only if $\frac{\pi + Y_f}{1 + S} \geq \frac{1}{2}$; and $\psi_a'(S) \geq 1$ if and only if $\frac{1 - \pi + Y_a}{1 + S} \geq \frac{1}{2}$. Therefore, $\psi_f'(S) \geq 1$ if and only if $S \geq S_f$ where $\psi_f(S_f) = \frac{1}{2}S_f - \pi + \frac{1}{2}$. Similarly, $\psi_a'(S) \geq 1$ if and only if $S \geq S_a$ where $\psi_a(S_a) = \frac{1}{2}S_a + \pi - \frac{1}{2}$. Without loss of generality, let us assume that $S_f \leq S_a$. Now there are three possible cases: (Case I) $S_f \leq S_0 \leq S_a$, (Case II) $S_0 \leq S_f \leq S_a$, and (Case III) $S_f \leq S_a \leq S_0$. I show that in each case, a unique solution S^* exists. In (Case I), $S^* \in [S_0, S_a]$. First, if $S < S_0$, then either $\psi_f(S)$ or $\psi_a(S)$ is negative. Second, $\Psi(S_0)$ is $\psi_f(S_0) - S_0$ if $S_0 = S_{0a}$, and is $\psi_a(S_0) - S_0$ if $S_0 = S_{0f}$. In either case, $\Psi(S_0) \leq 0$. As for

$\Psi(S_a)$,

$$\begin{aligned}\Psi(S_a) &= \psi_f(S_a) + \psi_a(S_a) - S_a \\ &= \psi_f(S_a) + \left(\frac{1}{2}S_a + \pi - \frac{1}{2}\right) - S_a \\ &\geq \left(\frac{1}{2}S_a - \pi + \frac{1}{2}\right) + \left(\frac{1}{2}S_a + \pi - \frac{1}{2}\right) - S_a = 0.\end{aligned}$$

The second equality results from the definition of S_a , and the third equality results from the fact that $S_f \leq S_a$. Third, for any $S \geq S_0$, $\Psi(S)$ is strictly increasing because $\psi_f(S) \geq 1$ and $\psi_a(S) > 0$. Note also that if $S > S_a$, then $\Psi(S) > \Psi(S_a) \geq 0$. In (Case II), $S^* \in [S_0, S_f]$, and the argument is similar. In the last case, (Case III), $S^* \geq S_0$ because $\Psi(S_0) \leq 0$ and $\Psi(S)$ is strictly increasing in $S \geq S_0$ as $\psi'_f(S) \geq 1$ and $\psi'_a(S) \geq 1$. \square

Appendix 3: Robustness of the Results

A3.1 Weight in the Objective Function

As discussed earlier, the estimator $\hat{\theta}_n$ maximizes the following objective function, $Q_n(\theta)$:

$$Q_n(\theta) = \sum_{k=1}^n \ln f(y_k, \mathbf{d}_k | \mathbf{w}_k; \theta) - \frac{\lambda}{n} \sum_{\ell=1}^L \left\{ 1 - \frac{\sum_{k=1}^n \varphi_\ell(\mathbf{w}_k; \theta)}{ss_\ell} \right\}^2.$$

$\hat{\theta}_n$ is consistent for any choice of $\lambda > 0$. With a finite sample, the choice of λ does affect the results, and the following table shows the estimation results for $\lambda = (1, 1000)$. The estimation results shown in the main text are based on $\lambda = 50$.

In Table 14, I show the estimation results under λ being 1, 50, and 1,000. At $\lambda = 1$, the log-likelihood is higher but the predicted total lobbying expenditures are further away from the observed total lobbying expenditures compared to $\lambda = 50$. However, the parameter estimates and the findings under $\lambda = 1$ or $\lambda = 1,000$ are within 95% confidence regions of those under $\lambda = 50$.

A3.2 Entry Cost Parameter

I assume that κ_0 is known. In estimation, I plug in the smallest lobbying expenditures undertaken by entities that lobbied the Congress regarding one policy and did not hire lobbyists with connections in the data, which is \$5,000. This estimate of κ_0 , the maximum of the entry costs per policy, may not be a consistent estimate for a couple of reasons.

Table 14: Results under Different Values of λ

λ	50 (Base)	1	1,000
Parameter Estimates			
β_f	4.300E-6*** (7.160E-7)	4.400E-6*** (6.289E-7)	4.400E-6*** (1.280E-6)
β_a	1.630E-4*** (5.446E-5)	1.570E-4*** (3.052E-5)	1.570E-4 (2.713E-4)
γ	0.2895*** (0.0111)	0.2894*** (0.0197)	0.2895*** (0.0318)
Effect of Lobbying (pp)	0.041 [0.021, 0.280]	0.030	0.040
Returns to Lobbying (%)			
Coal	154.47 [76.70, 184.11]	126.81	154.20
Oil/Gas	156.10 [63.37, 189.05]	156.30	156.46
Nuclear	139.65 [67.06, 167.16]	97.70	140.12
Renewable	142.25 [56.09, 161.76]	143.01	141.94
Avg. Log-likelihood	-2.760755	-2.739249	-2.760747
Objective Function	-2.760858	-2.742240	-2.760807
Total Lobbying Expenditures: Observed - Predicted (\$ million)			
Coal	0.2451	70.9515	0.1922
Oil/Gas	-2.074	0.8428	-0.1489
Nuclear	0.5858	29.9781	0.1042
Renewable	0.0214	-0.5727	0.0783

* The numbers in parentheses are asymptotic standard errors, and those in brackets are 95% confidence intervals.

First, the data is potentially truncated because an entity with small lobbying expenditures or revenues is not subject to register and report to the government if certain conditions are met. However, this problem is mitigated by the fact that once registered, an entity is supposed to report its lobbying activities regardless of the amount of its total lobbying cost or revenue. Second, the maximum of the lobbying entry cost for a player in the analysis may be different from that of an entity. For these reasons, I show how the results may change as I change the value of κ_0 .

In Table 15, I show the estimation results under κ_0 being \$1,000, \$5,000, and \$50,000. First, the estimates of the parameters of the enactment production function are larger as κ_0 is set to have larger values. This is an expected result because to maintain the same participation rate given larger entry costs, the marginal benefit of lobbying should be larger. Second, the coal and the oil/natural gas coalitions have on average lower entry costs than other lobbying coalitions because they are better connected. Third, the average effect of lobbying expenditures on the enactment probability of a policy is very small in all cases, while higher κ_0 leads to higher effects on average. Note that the average per policy lobbying expenditures by the renewable energy lobbying coalition is \$66,000, which is close to \$50,000. Therefore, one could conclude that the major result of this paper that the effect of lobbying expenditures on the policy enactment probability is very small is pretty robust to the choice of κ_0 . Lastly, the returns of lobbying expenditures to all lobbying coalitions are around 100% or more, while higher κ_0 is related to lower returns.

A3.3 Policy Enactment Production Function

I make specific parametric assumptions on the enactment production function. To understand how sensitive the results are to the assumptions, I estimate the model with a different specification of the enactment production function. The following specification of a policy enactment production function is based on an idea that the difference of lobbying efforts by both sides determines the probability that a policy is enacted: policy k is enacted if

$$\mathbf{Z}_k\delta + \xi_k + \beta_f \sum_{i \in \mathcal{L}_{\mathcal{F},k}} s_{i,k}^\gamma - \beta_a \sum_{j \in \mathcal{L}_{\mathcal{A},k}} s_{j,k}^\gamma - \epsilon_k > 0,$$

where the random variable ϵ_k follows a cumulative density function F_ϵ .⁴⁰ This randomness in the outcome of lobbying represents unexpected changes in the environment, such as economic and electoral conditions, that could affect the legislators' votes. $\mathbf{Z}_k\delta + \xi_k$ summarizes the initial level of support for policy k in the legislature, and hence $F_\epsilon(\mathbf{Z}_k\delta + \xi_k)$ is the probability

⁴⁰This specification was considered and estimated in the earlier versions of this paper.

Table 15: Results under Different Values of κ_0

κ_0	\$5,000 (Base)	\$1,000	\$50,000
Parameter Estimates			
β_f	4.300E-6*** (7.160E-7)	2.600E-6** (1.086E-6)	1.740E-5*** (1.280E-6)
β_a	1.630E-4*** (5.446E-5)	1.571E-4* (9.004E-5)	3.807E-4*** (4.996E-5)
γ	0.2895*** (0.0111)	0.2189*** (0.0324)	0.2893** (0.014)
Avg. Entry Costs (\$)			
Coal	1,990	465	21,484
Oil/Gas	2,481	552	26,135
Nuclear	3,211	682	30,054
Renewable	3,390	714	34,744
Effect of Lobbying (pp)	0.041 [0.021, 0.280]	0.014	0.113
Returns to Lobbying (%)			
Coal	154.47 [76.70, 184.11]	228.50	130.84
Oil/Gas	156.10 [63.37, 189.05]	235.10	125.97
Nuclear	139.65 [67.06, 167.16]	214.46	94.88
Renewable	142.25 [56.09, 161.76]	224.00	75.96
Avg. Log-likelihood	-2.760755	-2.768769	-2.765831
Objective Function	-2.760858	-2.768896	-2.769619

* The numbers in parentheses are asymptotic standard errors, and those in brackets are 95% confidence intervals.

Table 16: Results under Different Enactment Production Function

	Base	Alternative
Parameter Estimates		
β_f	4.300E-6*** (7.160E-7)	7.020E-6** (1.560E-6)
β_a	1.630E-4*** (5.446E-5)	8.020E-6* (1.806E-6)
γ	0.2895*** (0.0111)	0.3797*** (0.0325)
Effect of Lobbying (pp)	0.041 [0.021,0.280]	0.036
Returns to Lobbying		
(%)		
Coal	154.47 [76.70, 184.11]	113.24
Oil/Gas	156.10 [63.37, 189.05]	116.16
Nuclear	139.65 [67.06, 167.16]	102.20
Renewable	142.25 [56.09, 161.76]	103.20
Avg. Log-likelihood	-2.760755	-2.417518
Objective Function	-2.760858	-2.419170

* The numbers in parentheses are asymptotic standard errors, and those in brackets are 95% confidence intervals.

that the policy is enacted in the absence of lobbying.

The distribution of ϵ_k determines how the marginal benefit of one's lobbying spending depends on the initial enactment probability. If the probability density function f_ϵ is single-peaked, then the marginal benefit of lobbying is also single-peaked. In the specification considered in the main text, the marginal benefit of lobbying is monotone in the initial enactment probability. Here, I assume that ϵ_k follows the Triangular distribution with the finite support of (λ_L, λ_U) with a unique mode of $\lambda_0 \in (\lambda_L, \lambda_U)$.⁴¹ In Table 15, the estimation results based on both specification are shown respectively. As can be seen in the table, the results are very similar.

⁴¹Both scale and location normalizations are necessary. When estimating the model, I normalize λ_0 to be 0 and $|\lambda_U - \lambda_L|$ to be 2. In addition, I assume that ϵ_k is distributed symmetrically around λ_0 . As a result, I estimate the parameters of the model under the assumption that $(\lambda_L, \lambda_0, \lambda_U)$ is $(-1, 0, 1)$.