Firms' Support for Climate Change Legislation: Industry Competition and the Emergence of Green Lobbies

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Abstract

Legislative efforts to curb carbon emissions are projected to increase production costs across the board. Yet a broad-based coalition of firms has emerged in support of both domestic legislation and international cooperation on mitigation efforts. Why do firms lobby in support of environmental policies that directly increase their costs of production? I argue that by imposing differential costs on market participants, policies designed to mitigate carbon emissions shift market share towards more energy-efficient firms. This shift in market share increases profitability, compensating for the policy's direct costs. I model climate change policy making in the presence of market competition and show how heterogeneity in adjustment costs induces a preference for regulation among low cost firms. Nonetheless supportive lobbying emerges only under favorable political conditions. Increasing heterogeneity between firms leads to a greater likelihood of climate change mitigation by fostering political demand for regulation.

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1 Introduction

How does competition between firms shape political behavior and preferences over international cooperation? Existing studies in international political economy often explain domestic support or opposition to cooperative policies, such as trade liberalization or capital controls, through reference to their distributional impact across industries.[1] More recent work though highlights how firm-level characteristics can lead to heterogeneous preferences *within* as well as across industries.[2] The current study builds on this work by arguing that firms support cooperative policies that impose costs on their industry competitors.

I develop this argument in the context of global climate change cooperation. Efforts to mitigate carbon emissions through regulation are projected to impose significant economic costs. Yet a growing number of firms have been outspoken advocates of climate change cooperation and domestic regulation. Why would firms lend support to a policy designed to increase the costs of production and transportation across the board? I argue that firms do so in order to put their competitors at a disadvantage. I develop a formal model of firm competition and show how firms can increase their market share by lobbying in favor of legislation which imposes costs on other firms. The analysis demonstrates the importance of a favorable political environment to the emergence of such lobbying behavior. Additionally, I show that increasing heterogeneity between firms leads to a greater increase in equilibrium regulation than does reducing costs across the board.

In the final section of the paper I endogenize firms' adjustment costs by allowing for the possiblity that firms can pay a cost *ex ante* to invest in energy efficiency or other technologies expected to reduce *ex post* adjustment costs. Comparing outcomes in the model to a baseline case in which climate change regulation is exogenously imposed, I show that the potential for

[1] See Scheve and Slaughter, 2001; Frieden, 1988; Frieden, 1991; Hiscox, 2002; Leblang, Fitzgerard, and Teets, 2007 among others. For a survey of this work see Lake, 2009.

[2] See Osgood et al. forthcoming or Kim et al. 2016.

competitive lobbying leads to strictly greater investments for firms facing high adjustment costs. Since these firms bear not only high adjustment costs but also the costs of lobbying in order to keep regulation low, investments in efficiency become relatively more cost effective in the presence of lobbying.

2 The Emerging Green Lobby

The past decade has witnessed the emergence of a new coalition of firms calling for aggressive action to mitigate the disastrous consequences of global climate change. Support for mitigation policies can now be found across a range of industries, from transportation and eletronics to cement production and finance. Even within the oil and gas industry, infamous for its historically trenchant opposition to climate action, major players such as BP and Shell have come out in favor of policies designed to reduce carbon emissions.

This private sector support for climate change initiatives is apparent at both the international and domestic levels. At COP21 climate negotiations in Paris, firms played a high profile role in urging action. Companies including Kellogs, NRG Energy, the International Post Corporation, Coca Cola and many more went beyond calls for action to make specific commitments themselves, in consultation with the UN Global Compact, to reduce carbon emissions with or without government action. Table (1) lists a selection of firms who have made such commitments.

Within U.S. domestic politics as well members of the private sector have played a growing role in lobbying policy makers to adopt comprehensive climate change legislation. When the Democratic Party, enjoying new majorities in the House and Senate, launched a new push for legislation in early 2009, CEO after CEO testified before Congress to offer support for the initiative as well as their industry expertise. The bill which was eventually passed by the

Table 1: Firms Announcing Specific Commitments at COP21

Bank Australia	LG Life Sciences
BNP Paribas	L'Oreal
Carrefour	MetLife, Inc.
China Steel Corporation	Motorola Solutions
Colgate Palmolive	National Express Group
Daimler AG	Nissan Motor Co.
GlaxoSmithKline	Novo Nordisk
Hewlett Packard	Philip Morris
Honda Motor Company	PepsiCo. Inc
ING	Xerox Corporation

House (the so-called Waxman-Markey bill) was heavily influenced by earlier draft legislation published by the U.S. Climate Action Partnership, an industry group counting BP, Alcoa, and Caterpillar among its members.

To be sure, private sector opposition to climate action remains. In 2016 the U.S. Chamber of Commerce listed opposing EPA efforts to regulate carbon emissions as a key policy priority. Working with electric utility Southern Company and other opponents, it also secured an immediate stay from the Supreme Court of the EPA's Clean Power Plan, designed to limit carbon emissions from power generation. During the 2009 Waxman-Markey debate, the American Petroleum Institute funded public protests around the country in an attempt to pressure lawmakers into rejecting the bill.[3]

In fact a key feature of industry's response to climate change policy has been its divisiveness within industries. While BP promoted the 2009 cap and trade bill as a member of U.S. CAP, Exxon Mobil infamously denied the threat of climate change until a change in leadership brought grudging acknowledgement in April 2014. One of BP's partners in U.S. CAP, Alcoa has long been another outspoken advocate of agressive climate change policy. Yet its com-

[3]Critics of "greenwashing" have also called into quetion the sincerity of many firms' claims to sustainability. In a recent court case in California, consumers sued Fiji Water Company for falsely advertising its bottled water as "environmentally friendly and superior" alleging that in the course of its operations the firm uses more than "46 million gallons of fossil fuel, producing approximately 216,000,000 billion pounds of greenhouse gases per year," on par with, if not exceeding, similar figures from its industry competitors (Forbes, 2012).

petitor, Noranda Aluminum publicly threatened to relocate to Mexico if Waxman-Markey became law and lobbied lawmakers to oppose ("Blunt's visit..." 2009). Major agricultural groups including the National Farmers Union supported the cap and trade bill while the American Farm Bureau and others lobbied furiously against. These divisions within the agricultural lobby led one commentator to remark that the legislation had "succeeded in doing something neither the nation's environmental groups or the Bush administration could do: Create fault lines in the farm bloc" (Delta Farm Press, 2009).

As I argue in the following section, this emergence of private sector support for effective carbon emissions reduction has the potential to re-shape the domestic and international politics of climate change.

3 Firms and the Politics of Global Climate Change

The challenge of addressing global climate change represents a severe collective action problem. Economic activity produces greenhouse gases which, if unchecked, may lead to devastating ecological consequences. Yet policies designed to mitigate carbon emissions necessarily impose painful adjustment costs on the domestic economy. The benefits of such policies are non-excludable, creating incentives for states to free-ride on the mitigation efforts of others. States' ability to overcome this collective action problem depends on the distribution of domestic adjustment costs. This distribution depends crucially on the behavior of firms. Most directly, the greater firms' *ex ante* investments in energy efficiency, the lower the *ex post* economic costs of climate change mitigation.

Yet from the perspective of policy makers, the costs of climate change mitigation are not only economic, but also political. Here too firms play a large role in determining the political costs of mitigation. While the benefits of climate change are diffuse for individual citizens,

its costs are highly concentrated in particular sectors. Standard models of political economy thus suggest that, all else equal, firms that oppose mitigation should be better able to organize politically in order to obstruct any new policy. Firms that wish to impose costs on policy makers for pursuing climate change legislation may do so either by witholding campaign contributions or providing contributions to a candidate's opponent. Leaders also rely on firms for information about the likely costs and feasibility of any proposed climate policy, creating an additional source of leverage.

This makes firms and their policy preferences a key feature of the politics of global climate change, an analysis that is in line with traditional models of IPE in which the preferences of domestic economic actors play a prominant role (Lake, 2009; Frieden, 1999). An extensive literature has explored the economic determinants of individual or firm preferences over policies related to international trade, foreign direct investment, international bailouts and the like. A growing body of work also explores the distribution of citizens' preferences, and willingness to pay, for climate change mitigation. Yet fewer studies have explored the preferences and political behavior of *firms* in the context of mitigation, in spite of their prominance in the political process.[4]

4 Firms, Competition, and Political Behavior

I argue that competition for market share drives firms to support climate change policies in order to impose costs on industry competitors. While policies to combat climate change impose costs on all firms within the economy, these costs vary significantly across firms. Thus while climate change policy increases costs across the board it also leads to shifts in market share which benefit relatively low cost firms. This argument follows well-established results from the field of industrial organization. In particular, models of Cournot competition, in

[4]For exceptions see...

which firms strategically choose how much of a good to produce in response to production choices of others, demonstrate the importance of relative costs in determining market share (Tirole, 1989).

There are several reasons why firms might anticipate lower adjustment costs relative to their competitors. First, cost advantages may arise due to variation in firms' *ex ante* capital stock. Increasing the energy efficiency of production becomes more expensive the older a firm's machinery and equipment currently in use. Second, adjustment costs may vary due with the location of firms' production facilities. Within the United States, regions vary in the mix of fuels commonly used for electricity generation. Those regions that rely more intensively on coal in particular tend to emit high levels of green house gases. The costs of emissions reduction in these areas are thus anticipated to be much higher relative to regions that rely on cleaner sources of fuel. These anticipated costs affect not only utility companies themselves, but are also passed on to electricity consumers including manufacturers and other energy intensive industries. Third, asymmetric adjustment costs may reflect endogenous firm strategies. When presented with the opportunity, firms may choose to invest resources in energy efficiency or green technology in order to position themselves advantageously in anticipation of climate change legislation.

In the following sections I develop a theory of asymmetric adjustment costs and political support for climate change legislation. In the baseline model firms have the opportunity to participate in policy making before competing in Cournot competition. In a subsequent extension, I endogenize firms investment choices: prior to participating in the political process firms may pay a cost to increase their "green capital." While the model is generalizeable to many forms of green capital, I take as a leading example investments in equipment to increase energy efficiency thereby reducing the adjustment costs imposed by combatting climate change. Before introducing the model, I first provide some preliminary evidence in support of the basic mechanism described above. Appendix A also contains a brief case

study of Colorado's largest utility company, Xcel Energy, which illustrates how competitive dynamics can drive firm support for climate change legislation.

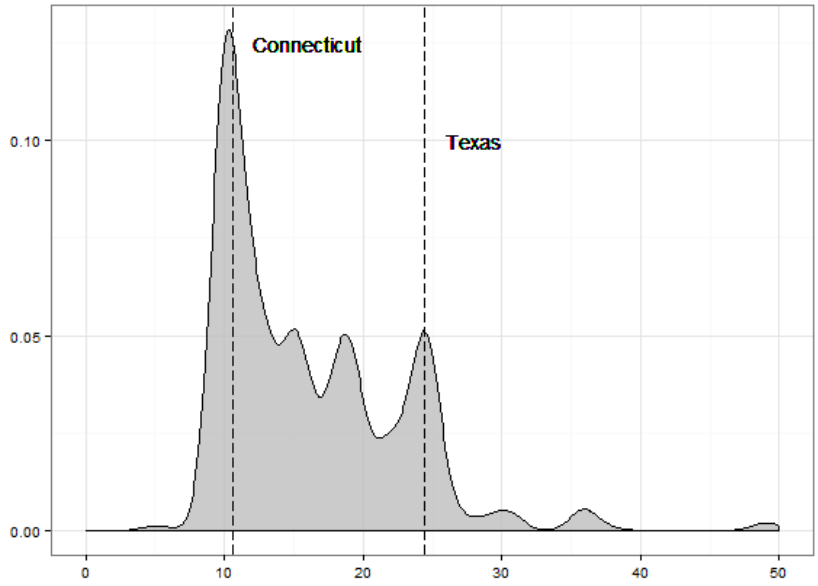
5 Preliminary Evidence

To establish the plausibility of the argument laid out above, I construct a dataset of firm lobbying in support of H.R.2454, the American Clean Energy and Security Act (ACES). Passed by the U.S. House of Representatives on June 26, 2009, the ACES called for a nationwide "cap and trade" system to reduce emissions of carbon dioxide and other greenhouse gases. By placing a cap on the total amount of emissions permitted in the course of energy generation, the bill was projected to increase energy costs nationwide. The private sector would be especially hard hit due to the intensity of energy use in many production activities. According to a Heritage Foundation estimate, profits from U.S. agriculture alone would drop by 28 percent within two years and by 57 percent within 25 years under the proposed allocations (Lieberman, 2009).

Beginning with the universe of publicly-traded firms, I code support for the ACES using federally mandated lobby disclosure reports, compiled by the Center for Responsive Politics, and a range of public sources including press releases, media coverage, and firm annual reports. To proxy anticipated competitor adjustment costs I leverage geographic variation in the carbon-intensity of electricity generation. States where electricity generation is highly reliant on coal were projected to face much greater increases in energy costs. Concerns about regional variation in adjustment costs were widely discussed at the time.

In an open letter to the Congressional Budget Office, Senator James Inhofe (R-OK) criticized CBO estimates of the bill's impact for downplaying these regional impacts, noting "electricity consumers in relatively less populated Midwestern and Southern states that rely primarily

Figure 1: Carbon Emissions per Capita (Million Metric Tons)

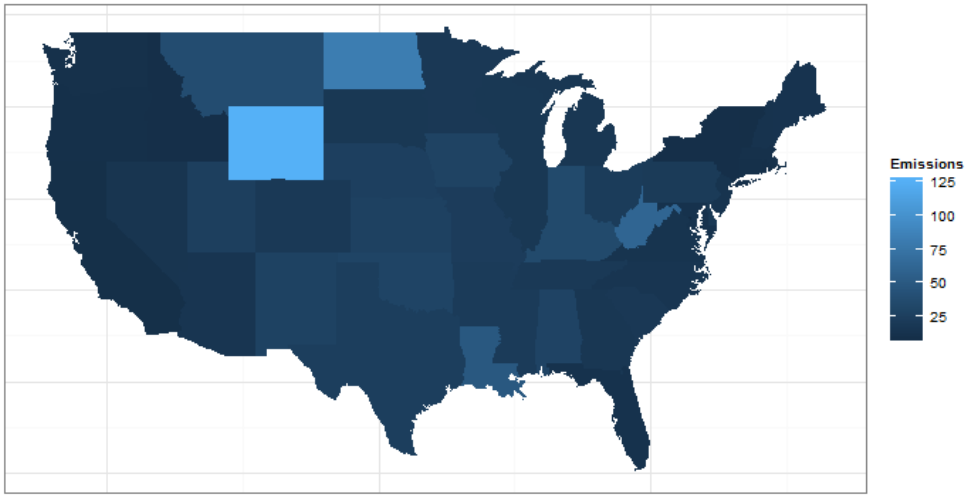


Density of carbon emissions from electricity generation per capita for U.S. states.

upon coal to generate electricity will suffer greater harships from the program than consumers in populous, natural gas burning and hydro-powered states on the West Coast and the Northeast" (Inhofe, 2009). Thus firms whose main competitors are located in these areas could reasonably expect the ACES to impose significant costs, controlling for the firm's own geographic location. I operationalize my measure by calculating the share of competitor firms located within the top quartile of states by per capita carbon emissions from electricity generation. Figure (1) displays the distribution of carbon intensity across the fifty U.S. states. Figure (2) displays the spatial distribution of carbon intensity.

Regression analysis confirms the existence of a positive and statistically significant relationship between the measure of competitor adjustment costs and a firm's proponsity to lobby in favor of cap and trade legislation. Appendix C contains additional description of the data, model specifications, and robustness of these results.

Figure 2: Heat Map of Carbon Emissions per Capita



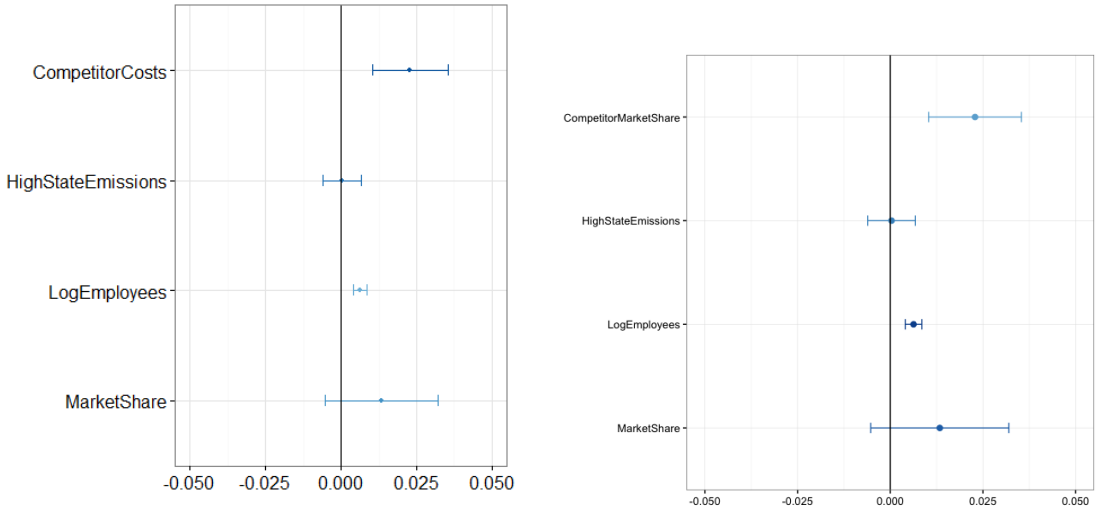
Carbon emissions from electricity generation per capita, by U.S. state. Darker states indicate more efficient electricity production. Lighter states represent more carbon intensive electricity production.

6 A Model of Competition and Political Influence

In this section I develop a theory of political participation in which preferences over policy are induced by competition between firms. In the model below, political participation takes the form of campaign contributions promised in exchange for the adoption of particular policies. Nevertheless this approach is also consistent with the idea that lobbying takes the form of information provision to lawmakers. In this interpretation information provision can be thought of as a subsidy to the policy maker's legislative resources.

Let there be two firms, $i = 1, 2$, each producing a single homogenous good at a constant marginal cost. Marginal costs depend on both the regulatory regime, r, and a parameter indexing each firm's "green capital," F_i. In the baseline case this green capital represents any geographic or firm-level characteristic which provides advantage in the case that climate change legislation is adopted. Thus a low F_i may reflect the location of production facilities in regions expected to be hard hit by legislation or may reflect frictions in increasing the

Figure 3: Marginal Effects



Logistic regression. Dependent variable is support for H.R. 5424 The American Clean Energy and Security Act of 2009

energy efficiency of a firm's capital stock. Higher values of F_i indicate that firms hold a competitive advantage in coping with climate change legislation. Accordingly, assume that costs are increasing in the stringency of the regulatory regime and decreasing in a firm's green capital. In particular, let marginal costs take the form:

$$c_i(F_i, r) = \frac{r}{F_i} \tag{1}$$

In the first stage, firms can choose to participate in the policy making process. I model lobbying as a first price menu auction (Bernheim and Whinston, 1986; Grossman and Helpman, 2001). Firms simultaneously announce schedules of campaign contributions, $s_i : \mathbb{R}^+ \to \mathbb{R}^+$. Firm i's schedule maps policy choices, $r \in \mathbb{R}^+$ to the contribution firm i intends to make in the event that that policy is selected. The policy is then chosen by a unitary policy maker, maximizing a weighted sum of campaign contributions and her own preferred policy. The policy maker has quasilinear preferences that are single peaked over policy outcomes with ideal point r^{PM}.

Her objective function is:

$$g(r|s_1(\cdot), s_2(\cdot), r^{PM}) = -\lambda(r^{PM} - r)^2 + (1 - \lambda)(s_1(r) + s_2(r))$$

where λ is the weight the policy maker attaches to her own policy preferences. While I take the policy maker's ideal point as exogenous, it can be thought of as reflecting the social value of regulation, weighted by the policy maker's beliefs about the dangers of climate change. Considerable empirical evidence suggests that these beliefs covary with political orientation. Thus conservative, climate skeptic politicians should have a relatively low, or zero, ideal point, while progressive policy makers should have a relatively high and strictly positive ideal point.

In the analysis below I restrict attention to truthful or "compensating" strategies in the lobbying stage (Grossman and Helpman, 2001). That is, suppose that in some equilibrium the policy choice is r and $\tilde{r}$ is any other feasible policy alternative. Then firms campaign contributions for each possible $\tilde{r}$ are equal to their marginal gain from switching from the equilibrium choice, r, to $\tilde{r}$. Restricting attention to truthful strategies is a relatively weak refinement: Bernheim and Winston (1986) show that a truthful strategy must form part of any best response set for both players. Additionally, restricting attention to truthful strategies ensures that an efficient solution will be selected in equilibrium.

Following selection of the regulatory framework, r, the firms engage in market competition. For each unit it produces, firm i incurs a constant marginal cost as described earlier. Consumers are indifferent between the good produced by either firm so can substitute costlessly between them. Let the quantity produced by each firm be denoted q_1 and q_2. Finally, let

the per unit price of the good be given by the (linear) inverse demand function:

$$p(q_i, q_j) = \begin{cases} \alpha - q_i - q_j & \text{if } q_i + q_j \leq \alpha \\ 0 & \text{if } q_i + q_j > \alpha \end{cases} \tag{2}$$

for some $\alpha > 0$. Profits are defined by total revenue less total costs, or:

$$\pi_i(q_i, q_j, F_i) = \begin{cases} q_i \left[\alpha - c(F_i, r) - q_i - q_j\right] & \text{if } q_i + q_j \leq \alpha \\ -c(F_i, r) q_i & \text{if } q_i + q_j > \alpha \end{cases} \tag{3}$$

for $i = 1, 2$. In the final stage, firms select their level of output, q_i, to maximize profits, given their competitors' output. Taking into account the costs of investment and lobbying, firm i's objective function is:

$$u_i(F_i, s_i, q_i | q_j, r, \hat{F}_i) = \pi_i(q_i, q_j, F_i, r) - s_i(r) - h(F_i, \hat{F}_i)$$

A strategy for each firm is a pair $\sigma_i = (s_i(\cdot), q_i(\cdot))$ corresponding to its choices of contribution schedule and its output level. A strategy for the policy maker is $r : \mathbb{R}^+ \times \mathbb{R}^+ \to \mathbb{R}^+$ mapping campaign contributions into its choice of policy.

7 Analysis of the Baseline Model

The game is solved via backwards induction, beginning in the market competition stage. If firm i produces $q_i > 0$ in the last stage of the game, he solves:

$$\underset{q_i}{Max} \quad q_i \left(\alpha - q_i - q_j - \frac{r}{F_i}\right) \tag{4}$$

Taking the first order condition and re-arranging yields i's best response as a function of q_j:

$$q_i(q_j) = \frac{1}{2}\left(\alpha - q_j - \frac{r}{F_i}\right) \tag{5}$$

Plugging in for j's best response, we obtain i's equilibrium output and profits. Letting $\gamma_i = \frac{1}{F_j} - \frac{2}{F_i}$:

$$q_i^* = max\left\{\frac{1}{3}\left(\alpha + r\gamma_i\right), 0\right\} \tag{6}$$

$$\pi_i(q_i^*) = \begin{cases} \frac{1}{9}\left(\alpha + r\gamma_i\right)^2 & \text{if } q_i^* > 0 \\ 0 & \text{if } q_i^* = 0 \end{cases} \tag{7}$$

Thus firm i produces $q_i > 0$ as long as $\alpha > -r\gamma_i$. Next we consider the legislative stage of the game. The policy maker solves:

$$\underset{r}{Max} \quad -\lambda(r^{PM} - r)^2 + (1-\lambda)(s_1(r) + s_2(r)) \tag{8}$$

Taking the first order condition and rearranging, we have:

$$r^* = r^{PM} + \frac{1-\lambda}{2\lambda}\left(\frac{ds_1}{dr} + \frac{ds_2}{dr}\right) \tag{9}$$

Given the assumption of differentiable contribution schedules, in the neighborhood of the equilibrium it must be that each firm's marginal contribution is equivalent to its marginal rate of substitution between policy and money (Grossman and Helpman, 2001). Quasilinearity of the firms' utility then implies that in any equilibrium $ds_i/dr = d\pi_i/dr$. Taking the derivative of equation (7) with respect to r and plugging in gives the policy maker's best

response. Letting $\beta = \frac{1}{9} \cdot \frac{1-\lambda}{\lambda}$ this is,

$$r^* = \max \left\{ \frac{\left(r^{PM} + \alpha\beta(\gamma_i + \gamma_j)\right)}{1 - \beta(\gamma_i^2 + \gamma_j^2)}, 0 \right\} \tag{10}$$

As regulation cannot be negative r^* is bounded below by zero. Next we identify the schedule of equilibrium campaign contributions. Given the assumption of compensating contribution schedules, i's schedule takes the form:

$$s_i(r) = max \left\{ \pi_i(r) - \pi_i(r^*) + s_i(r^*), 0 \right\} \tag{11}$$

where r^* is the equilibrium policy outcome. Thus the schedule is completely pinned down by $s_i(r^*)$. To calculate $s_i(r^*)$ consider the policy maker's optimal choice if firm i chose not to compete, i.e. if $s_i(r) = 0$ for all $r \in \mathbb{R}^+$. The policy maker then solves:

$$\underset{r}{Max} \quad -\lambda(r^{PM} - r)^2 + (1 - \lambda)(s_j(r)) \tag{12}$$

yielding policy choice:

$$r^j = \frac{r^{PM} + \alpha\beta\gamma_j}{1 - \beta\gamma_j^2}$$

Thus if i does not compete, conditional on j's contribution schedule, the policy maker chooses r^j, yielding utility $g(r^j)$. Given that the policy maker can attain $g(r^j)$ by ignoring firm i and choosing r^j, it must be that if she chooses r^* in equilibrium, she is at least as well off. Thus i's contribution in equilibrium must compensate for any utility loss induced by switching from r^j to r^*. This utility loss will reflect both losses with respect to her own policy preferences and to the campaign contribution received from firm j. Note that i will never provide any amount greater than what is necessary in order to achieve this indifference since this makes

i strictly worse off. Firm i's contribution is then given by the following equality:

$$-\lambda(r^{PM} - r^*)^2 + (1-\lambda)(s_i(r^*) + s_j(r^*)) = -\lambda(r^{PM} - r^j)^2 + (1-\lambda)s_j(r^j) \tag{13}$$

Re-arranging and plugging in $s_j(r^j)$ using j's contribution schedule (defined similarly to (11)) yields:

$$s_i(r^*) = \frac{\lambda}{1-\lambda}[(r^{PM} - r^*)^2 - (r^{PM} - r^j)^2] + \big(\pi_j(r_j) - \pi_j(r^*)\big) \tag{14}$$

Equations (11) and (14) jointly characterize firm i's equilibrium contribution schedule.

Note that in any equilibrium, firm i offers positive contributions in exchange for policies that improve its welfare, relative to r^*, and zero for policies which leave it worse off. From here on we say that firm i lobbies *in favor* of regulation if $s_i(r) > s_i(r^*)$ for all $r > r^*$, and firm i lobbies *against* regulation if $s_i(r) > s_i(r^*)$ for all $r < r^*$.

The analysis so far is summarized in Proposition 1.

Proposition 1 (Characterization of Equilibrium). The following strategy profile is the unique pure strategy subgame perfect equilibrium of the lobbying game:

(a) In the final stage of the game, firms $i = 1, 2$ choose production levels:

$$q_i^* = max\left\{\frac{1}{3}(\alpha + r\gamma_i), 0\right\} \tag{15}$$

where $\gamma_i = \frac{1}{F_j} - \frac{2}{F_i}$ and r^* is as defined below.

(b) In the policy making stage, the legislator selects $r = r^*$ where,

$$r^* = max\left\{\frac{r^{PM} + \alpha\beta(\gamma_i + \gamma_j)}{1 - \beta(\gamma_i^2 + \gamma_j^2)}, 0\right\} \tag{16}$$

(c) Prior to the announcement of policy, firms announce contribution schedules:

$$s_i(r) = max\left\{\pi_i(r) - \pi_i(r^*) + s_i(r^*), 0\right\} \tag{17}$$

where $s_i(r^*) = \frac{\lambda}{1-\lambda}\left[(r^{PM} - r^*)^2 - (r^{PM} - r^j)^2\right] + \pi_j(r^j) - \pi_j(r^*)$.

8 Results

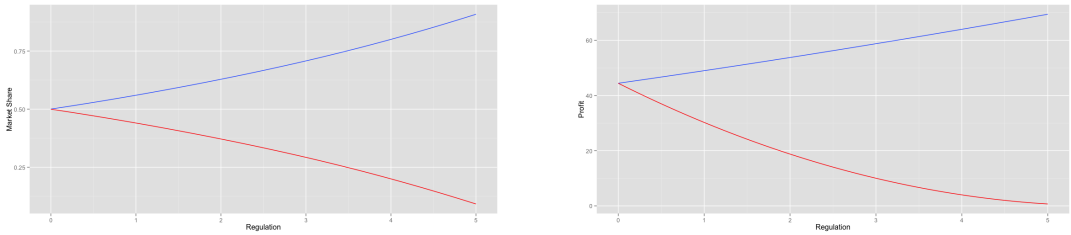
The first result establishes the argument that firms with relatively lower adjustment costs gain market share following the imposition of regulation and thus have incentive to lobby in favor of climate change policy.

Proposition 2. Let $\gamma_i > 0$. Then firm i's profits are increasing in r, and firm j's profits are decreasing. Accordingly, i lobbies in favor of legislation while j lobbies against.

The proof along with all subsequent proofs are included in Appendix C. Recalling the definition of γ_i, the first condition of Proposition 2 requires that firm i have twice the level of green capital as firm j. That is $F_i > 2F_j$. Thus competitive lobby emerges only if there is a significant difference in firms' anticipated adjustment costs. This reflects the fact that climate change legislation imposes both a direct and an indirect effect on firm profits. The direct effect of regulation is that of increasing each firm's production cost. The indirect effect is that of shifting market share towards the low cost firm. If firms are relatively close in terms of their adjustment costs, the former will dominate the latter since the shift in market share will be small. As heterogeneity in adjustment cost grows, the impact of regulation on market share grows, eventually overtaking the direct effect of increasing costs.

Figure (4) depicts market share and profits for each firm as the level of regulation increases for the case in which $\gamma_i >$, that is, in which firm i is more than twice as efficient as firm j.

Figure 4: Effect of Regulation on Market Competition



(a) (b)

Effect of an increase in r on equilibrium market share and profits when $\alpha = 20$, $r^{PM} = 5$, and $F_j = 0.5$. Blue indicates the more competitive firm while red indicates the less competitive firm.

Since market share sums to one, in panel (a) a decrease in firm j's market share is exactly matched by an increase to firm i. However, as shown in panel (b), the corresponding gain to firm i in terms of profit is less than the loss to firm j. This reflects the overall (economic) inefficiency of regulation. Since regulation increases costs across the board, overall economic surplus decreases in r.[5]

Above I provide empirical evidence of competitive lobbying in the U.S. Congress during the Obama administration. Yet as noted the emergence of green lobbies represents a relatively new phenomena. For example, consider climate change politics during the Bush administration the vast majority of which was carried out exclusively by firms opposed to U.S. participation in the Kyoto Protocol. The next result provides insight into these dynamics and by implication an important scope condition for the emergence of competitive lobbying.

Proposition 3. There exists a $\bar{\gamma} > 0$ such that if $\gamma_i \in (0, \bar{\gamma}_i)$ the following is the unique equilibrium outcome: firm j lobbies against regulation, firm i does not lobby at all, and the policy maker chooses, $r^* = 0$.

Proposition 3 applies in the case where regulation is economically inefficient. That is overall economic profits are decreasing in r. Given γ_i we know that i profits are increasing in r.

[5]Regulation need not always be inefficient thus there exist equilibria in which the reverse conclusion would hold: firm i's gain in profits would increase more rapidly than firm j's loss.

Thus it must be that the corresponding loss to firm j strictly outweighs firm i's gain from any positive level of regulation. Recall that in equilibrium, each firm offers the policy maker a contribution exactly equal to its marginal gain or loss from changing policy. Since j's loss always exceeds i's gain from regulation this means that j can always outbid i. This gives firm j an advantage in the competition for influence, an advantage which can be offset only by the policy maker's own bias. In effect, if the policy maker's prefers greater regulation this reduces the cost of higher policies to firm i and increases the cost of low policies to firm j re-balancing the scales in favor of the more efficient firm.

Finally, I consider the effects of a possible policy intervention on lobbying behavior and subsequent regulatory outcomes. In particular, I consider the effects of an exogenous increase in either firm's endowment of green capital. Before presenting the result it is important to note that such an increase, holding all else constant, has implications for relative adjustment costs between firms. Increasing F_i holding F_j constant leads to greater heterogeneity in adjustment costs while increasing F_j leads to the reverse. Given that firm j's marginal costs of regulation are larger than firm i's it seems tempting to conclude that the most efficient use of resources would be to increase j's green capital, loosening this constraint on policy making. The following result demonstrates that this is not necessarily the case. While equilibrium regulation is increasing in either firm's green capital, there exist equilibria in which the increase is strictly greater for firm i.

Proposition 4. There exists an equilibrium with endowments, $(F_i,\ F_j)$ such that the following is true. Denote r' the policy which would result from increasing F_i by $\delta > 0$ and r'' the policy which would result from instead increasing F_j by the same amount. Then $r' > r''$. That is, increasing inequality between the two firms leads to higher levels of equilibrium regulation.

Proposition 4 suggests that increasing the distance between firms' adjustment costs may lead to higher levels of equilibrium regulation. This reflects the fact that firm i's incentive

to lobby in favor of regulation is increasing in its cost advantage: the greater the advantage, the greater the shift in market share and thus profits. Increasing firm i's green capital, via subsidy or other means, bolsters the political constituency for climate change policy. The reverse is true of an increase to firm j's green capital. Increasing j's green capital reduces the cost advantage of firm i, undermining political demand for regulation.

9 Investments in Energy Efficiency

Next, I consider an extension of the model in which firms endogenously choose whether and how much to invest in reducing future investment costs. In particular, I assume that firms' green capital is equivalent to investments in energy efficiency. Climate change legislation is designed to reduce carbon emissions by increasing the cost of energy. Thus firms with a more energy efficient capital stock face lower adjustment costs than their competitors who invest fewer resources in efficiency. This interpretation of adjustment costs is not without loss of generality since I also assume that increasing energy efficiency reduces marginal production costs, holding all else equal. Thus firms benefit from their investments regardless of the regulatory outcome.

To incorporate investments in energy efficiency I assume that each firm may now choose to invest resources prior to engaging in market competition. Investment is costly *ex ante* but leads to lower marginal costs during the subsequent competition stage. The cost of investment is given by $h(\cdot)$ assumed to be convex so that marginal costs are increasing. At the beginning of the game firms hold intitial endowment of green capital $\hat{F}_i$. Thus to achieve green capital of F_i costs the firm $h(F_i) - h(\hat{F})$. Firms pay no cost in order to maintain their initial level of efficiency (i.e. there is no depreciation cost). Once investments have been made, firms have the opportunity to participate in the political process and engage in market competition as before. The sequence of play and all other parameters of the model

remain the same as in the baseline case. Appendix D analyzes equilibrium behavior with endogenous investment choices.

To investigate the effects of political competition I compare the equilibrium in the extended game with a benchmark in which policy, r is exogenously fixed at the same level as would obtain in equilibrium. Holding the policy regime constant I then investigate how the presence of political competition alters firms' incentives to invest. Proposition 5 describes the results of this analysis. The proof is included in Appendix D.

Proposition 5. Firm j's investment in energy efficiency is strictly greater in the presence of political competition. Firm i's investments may be greater or smaller.

10 Conclusion

I have argued that firms use non-market strategies in order to gain advantage over their industry competitors. In particular, firms at times support costly legislation if they believe it will impose a greater disadvantage on the competition. The pattern of firm lobbying in support of the American Clean Energy and Security Act of 2009 is consistent with this argument. This work has implications for the literature on firms' preferences over international cooperation and the domestic politics of global climate change.

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Appendix A: Exel Case Study

In 2004, Colorado voters approved a state-wide renewable energy portfolio standard in spite of opposition from local utility companies. The standard required all retail utilities to generate a specified percentage of their electricity using renewable sources. The percentage specified varies across utility types and is scheduled to gradually increase over time. Initially, investor owned utilities (IOUs) were required to generate 10% of their electricity from renewable sources by 2015 (Peterson et al. 2011). While it initially opposed the RES, Colorado's largest electricity provider, Xcel Energy quickly discovered that it was on track to meet its renewable energy targets ahead of the deadline. A few years later the utility did an about-face lobbying hard in favor of an even stricter renewable energy standard. The new standard passed in 2007, increasing the required threshold of electricity generated from renewable sources to 20% by 2020. Additionally, the new measure adopted a renewable energy standard of 10% for smaller utilities, many of whom compete directly with Xcel (Kenworthy, 2009).

This was not the only time that Xcel supported green policy initiatives which imposed costs on both itself and its market competitors. The company has also supported the Waxman-Markey cap and trade bill, referenced above, and has argued in favor of a direct tax on carbon. As one commentator notes:

> One of Xcel's priorities is winning market share from independent power producers on the wholesale electricity market. Older natural gas plants are Xcel's fiercest competitors, because they have already paid off their capital costs, so they can bid electricity prices relatively low. The $20/ton carbon tax eliminates this advantage, because new plants are more efficient than older plants. It tilts the playing field to Xcel's favor (Yeatman, 2011).

More recently, Xcel lobbied in favor of legislation incentivizing utilities to reduce emissions

from coal plants by upgrading to more efficient technologies or switching to alternative sources of fuel. In particular, Xcel pushed for provisions which support the construction of entirely new natural gas plants, to the dismay of both existing natural gas providers, who view Xcel's plans to contrust new plants as a direct threat to market share, and other coal-reliant utilities, who argued in favor of extending the life of coal-fired plants through pollution controls. While the law required Xcel itself to contruct new electricity generation facilities, these costs could be largely passed on to consumers rather than borne by Xcel. Thus the legislation in its final form imposed relatively low costs on Xcel while worsening the market share of its industry competitors. Commenting on Xcel's lobbying strategy, one former Colorado utility commissioner noted, "There is nothing pretty about utility regulation...It is just a bunch of rent seekers at the trough" (quoted in Denver Post, 2010).

Finally, the case of Xcel Energy highlights another important dynamic of the interaction between firms and policy makers in the realm of climate change policy. In 2010 Xcel petitioned local authorities for permission to cancel plans for a 250 megawatt solar power plant it had promised to build. In its petition, Xcel cited "changed circumstances" in particular "the expectation that carbon legislation won't be enacted for several years." Xcel claimed that the failure of national climate change legislation made such investments in energy efficiency economically unappealing (Hill, 2010, cited in Yeatman, 2011). Thus, even for firms predisposed to support climate change legislation, willingness to invest in energy efficiency is conditioned by the political environment. In the model below I explore both sides of this dual relationship: the effect of firm preferences on policy and the effect of the policy environment on firm investments.

Appendix B: Additional Details of Empirical Analysis

To construct a dataset of firm lobbying in support of H.R.2454, the American Clean Energy and Security Act (ACES) I first identified all firms lobbying on the ACES using federally-mandated lobby disclosure reports compiled by the Center for Responsive Politics. Figure 5 depicts the distribution of these firms across industries for the top thirty most active industries. In order to leverage firm-level financial data I restrict attention to the subset of these firms which are publicly-traded. I identified 211 publicly-traded firms which disclosed lobbying activity related to H.R. 2454. Restricting attention to publicly traded firms enables me to match lobbying behavior with firm-level financial data from which I draw my key independent variables. This restriction should not bias the results below provided that publicly-traded firms and non-traded firms do not differ systematically in ways that correlate with both the dependent variable (lobbying in favor of cap and trade) and the independent variables (location of rival firms and productivity). Thus while this restriction may overstate the extent of lobbying amongst firms more broadly, it is not obvious that it would bias the parameter estimates below.

Next, I used public sources, including Congressional testimony, press releases, and annual reports, to code the direction of lobbying.[6] For example, in a press release dated June 26, 2009, Louisiana-based electric utility Entergy states: "We support the Waxman-Markey bill's market-based cap-and-trade system as it is a major step forward in solving the biggest challenge of our time" (Entergy, 2009). Another press release, from Puget Sound Energy, quotes CEO Stephen P. Reynolds saying:

> PSE is committed to keeping energy costs reasonable for its customers, and the mechanisms in ACES are well-designed for cutting carbon emissions but balancing customer needs, in particular those who are low-income are in energy

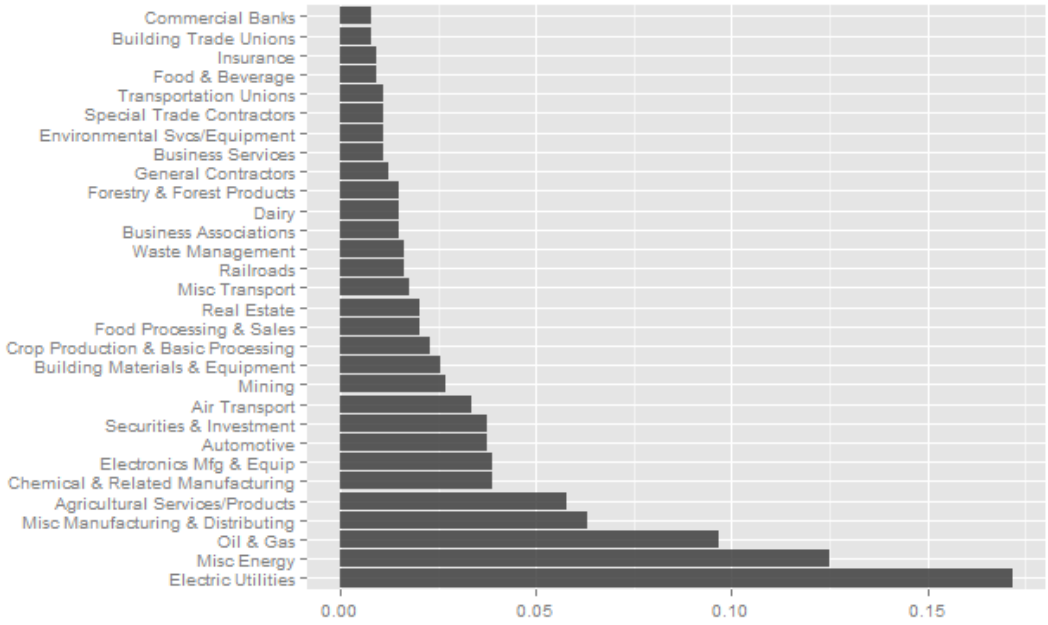
[6]Lobby disclosure reports typically describe the firm engaged in lobbying activity as well as the specific bill lobbied, but contain little information about the direction of lobbying.

> intensive industries...The American Clean Energy and Security Act puts us on track to reduce greenhouse gas emissions while also investing in the smart grid infrastructure and other technologies for greater energy efficiency (PSE, 2009).

Relying on these and other sources I was able to code the direction of lobbying for 101 firms. In particular, I identified 71 instances of favorable lobbying and 30 instances of opposition to the proposed legislation. Given that I was able to identify the positions of only a subset of firms lobbying on the ACES, the data clearly underestimate the true amount of lobbying in both directions. Again in order to bias the results it would have to be the case that this unobservability correlates with both firms' willingness to support cap and trade legislation and the geographic location of its largest rivals. The first condition is plausible. Firms lobbying in favor of the ACES should have incentive to publicize their support in order to curry favor among socially conscious consumers thus it seems likely that the majority of uncoded firms were lobbying against, rather than in favor of the legislation. Yet there seems to be no reason to expect that this unobservability would also correlate with the independent variables of interest.

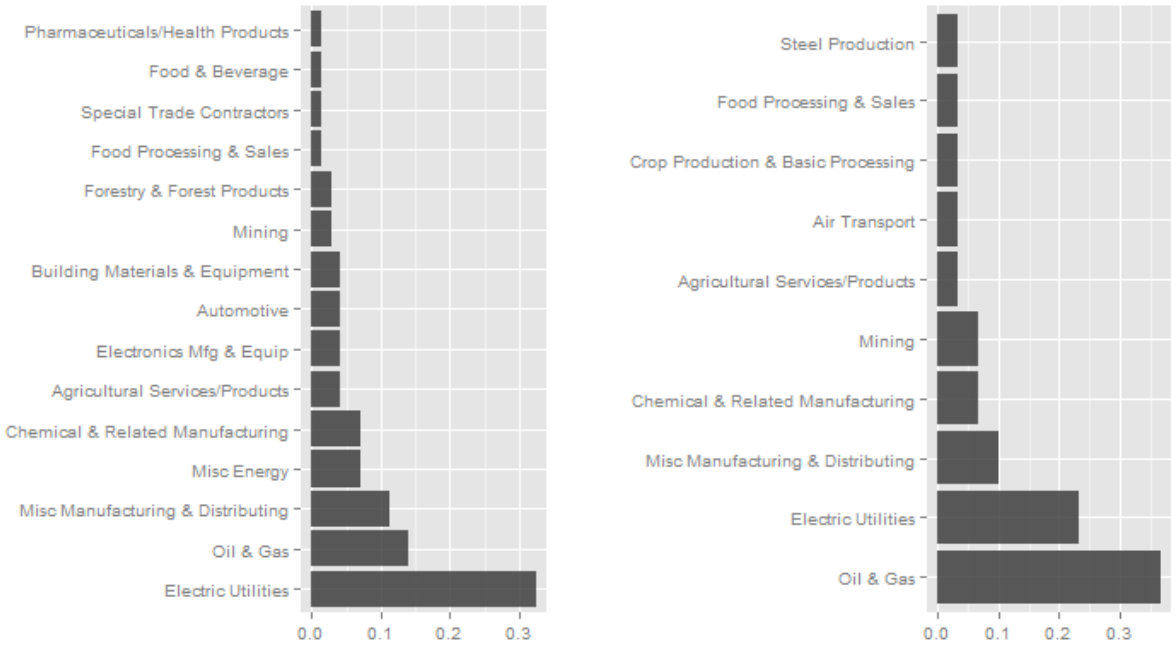
Taking these concerns into account the data nonetheless reveal a striking amount of support for cap and trade legislation from the private sector. I estimate that, at a minimum, nearly 35% of firms lobbying on the bill supported its passage in one form or another. Also striking is the amount of support for cap and trade legislation among electric utilities themselves. 23 of the 71 firms lobbying in favor of cap and trade are electric utilities or around 32%. Figure 6 displays the distribution of this lobbying by industry. The panel on the left displays the distribution of firms lobbying in favor of the ACES while the panel on the right displays firms lobbying in opposition (though again, given the logic above, the panel on the right likely significantly underestimates the true amount of lobbying in opposition to H.R. 2454 and should be interpreted with caution).

Figure 5



Distribution of firms by industry lobbying on cap and trade (top thirty industries only).

Figure 6



Distribution of firms by industry lobbying in favor (left) and against (right) the American Clean Energy and Security Act.

I matched this data on lobbying behavior with balance sheet data for the universe of public firms.[7] I use each firm's profit margin as a measure of productivity. To measure the perceived costs of legislation to each firm's competitors, I first obtained data on the (per capita) carbon intensity of electricity production for each state. Data on energy-related carbon emissions come from the U.S. Energy Information Administration. State population data is taken from the U.S. census.

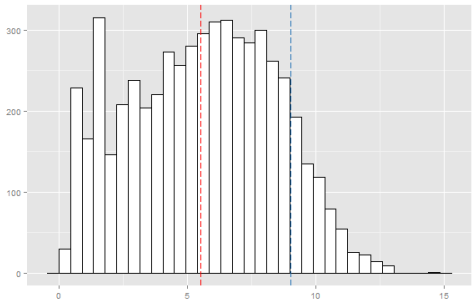
I define a high emitting state as any state whose per capita emissions are greater than the median.[8] I construct a dummy variable, $HighEmittingState$, equal to 1 for any firm located in a high emitting state and use this to proxy for each firm's anticipated costs of legislation. I use the same definition of high emitting states to construct three measures of competitor costs. $CompetitorShare$ measures the proportion of within-industry competitors located in high emitting states. $MarketShareHS$, measures the market share held by competitors located in high emitting states. Finally, $BiggestCompetitorHS$ is a dummy variable equal to 1 if a firm's biggest competitor (measured in terms of total sales) is located in a high emitting state.

In addition to these variables, I include a several firm-level covariates in the analysis below. Existing literature on firm lobbying behavior highlights the systematic differences between firms who engage in lobbying and those who do not (citation). These findings suggest that larger, richer firms are far more likely to engage in the political process. To account for this, covariates include each firm's profit margin, number of employees, net property, plant, and equipment, and total assets. I log employees and total assets, but choose to scale net PP&E by total assets in line with existing approaches in the literature (another citation). Figure 7 depicts the distribution of each of these (logged) balance sheet variables. In each figure, the vertical blue line represents the mean of that variable for firms lobbying in support of

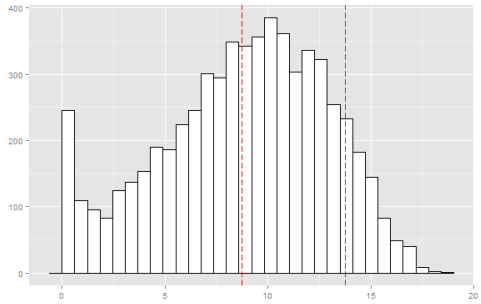
[7] I obtain the balance sheet data from Osiris.

[8] The median emitting state is Illinois where electricity generation produces 18.54 million metric tons of carbon per capita.

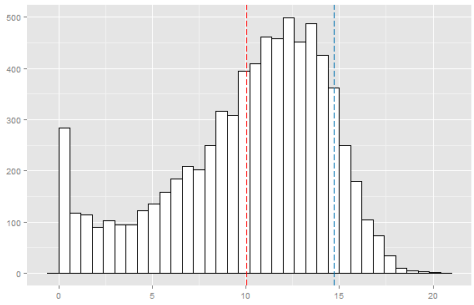
Figure 7: Distribution of Firm-Level Variables



(a) Employees (Logged)



(b) Net PP&E (Logged)



(c) Total Assets (Logged)

Distribution of logged balance sheet variables. Blue line represents mean for each variable among firms lobbying in support of H.R. 2454. Red line represents corresponding mean for all other firms.

cap and trade legislation. The red line represents the corresponding mean for all other firms in the sample. Consistent with expectations, the firms who lobbied in support of cap and trade legislation seem to be larger and posses greater resources on average than those that did not. Altogether, the dataset comprises 2704 complete observations.

Supportive lobbying is a relatively rare event in the data: I observe supportive lobbying in only 53 out of 2704 observations, yielding an incidence rate of just 1.9%. King and Zheng (2001) demonstrate that logistic regression can dramatically underestimate the probability of an event when positive outcomes are observed in less than 5% of cases. Thus I employ their correction for rare events logistic regression in the analysis below. To begin, I first regress $ProfitMargin$ on $Support$, including covariates for $HighEmissionsState$, $MarketShare$, and $LogEmployees$. The results are presented in column 1 of Table 1. As predicted, a

higher profit margin is associated with a greater propensity to lobby in favor of cap and trade legislation.

Table 2

	Model 1	Model 2	Model 3	Model 4
(Intercept)	-8.42^{**}	-9.56^{**}	-8.97^{**}	-8.82^{**}
	(0.74)	(0.87)	(0.82)	(0.78)
ProfitMargin	0.02^{*}	0.03^{**}	0.03^{**}	0.03^{**}
	(0.01)	(0.01)	(0.01)	(0.01)
HighEmitting	0.25	0.09	0.10	0.14
	(0.30)	(0.32)	(0.31)	(0.30)
MarketShare	0.50	0.31	1.23	0.67
	(0.63)	(0.72)	(0.75)	(0.63)
LogEmployees	0.51^{**}	0.53^{**}	0.50^{**}	0.50^{**}
	(0.08)	(0.08)	(0.08)	(0.08)
CompetitorShare		2.09^{**}		
		(0.78)		
MarketShare			$1.17^{\dagger}$	
			(0.62)	
BiggestCompetitor				0.87^{**}
				(0.33)
N	2772	2755	2772	2772
AIC	463.6	447.8	461.7	457.4

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$

Next, I introduce each competition variable one by one. Both the share of competitor firms located in high emissions states and the dummy for the largest competitor located in a high emissions state are positively associated with supportive lobbying and statistically significant at conventional levels. The market share held by competitor firms located in high emissions states is also positively associated with supportive lobbying though this relationship is significant at only the 10% level. Across each of these models, the coefficient for $ProfitMargin$ remains positive and statistically significant. The estimated coefficients for $HighEmissionsState$, $MarketShare$ and $LogEmployees$ are positive across all four models, though only the last is statistically significant.

The regressions above do not take into account the potential for unobserved industry-level

confounder. Given that the models are estimated via maximum likelihood, fixed effects cannot be introduced due to the incidental parameter problem (Lancaster, 2000). An alternative is to employ a random effects model, yet given the rarity of supportive lobbying this approach seems inefficient. While lobbying is observed in 31 unique sectors, in 26 of these I observe only one lobbying event. Nevertheless, to address concerns that the results are driven entirely by variation across sectors I perform several robustness checks, presented in Table 2. Mode; 1 of Table 2 recreates the preferred specification (Model 2 of Table 1). Models 2 and 3 display the results of adding dummy variables for first the Electric Services industry (the industry with the greatest number of lobbying events) and second the Electric and Other Services industry (the industry with the second largest number of lobbying events). While the level of statistical significance of $ProfitMargin$ drops to 10% in Model 3, $CompetitorShare$ retains its significance in both models. Model 4 recreates Model 1, but is estimated only on the subset of observations from industries for which at least one lobbying event is observed. Again, the coefficients for both variables of interest remain positive and statistically significant. As an additional check, I re-run the preferred specification, dropping each industry in the sample one at a time. The coefficients for both $ProfitMargin$ and $CompetitorShare$ are estimated to be positive and statistically significant in all but one of these models. Clustering standard errors at the industry level also has little effect on the results.

Tables 3 and 4 display the results of additional robustness checks (the first column of each reproduces my preferred specification for comparison). In particular, in Table 3 I replace $LogEmployees$ with alternative covariates intended to capture firm size and resources: $ScaledPPE$ and $LogTotalAssets$. In Table 4, I re-construct the competition variables defining a high emissions state as one which is in the top quartile of states (rather than simply above the median). The results remain consistent across most of these specifications. Overall, the empirical analysis provides support for the hypotheses that firms which are more productive or which expect their competitors to bear greater costs from climate change

Table 3

	Model 1	Model 2	Model 3	Model 4
(Intercept)	-9.56^{**}	-9.95^{**}	-10.08^{**}	-8.63^{**}
	(0.87)	(0.95)	(1.00)	(0.88)
ProfitMargin	0.03^{**}	0.03^{*}	$0.02^{\dagger}$	0.02^{*}
	(0.01)	(0.01)	(0.01)	(0.01)
CompetitorShare	2.09^{**}	2.21^{**}	2.15^{*}	1.63^{*}
	(0.78)	(0.85)	(0.89)	(0.82)
HighEmitting	0.09	0.01	0.06	0.07
	(0.32)	(0.33)	(0.33)	(0.33)
MarketShare	0.31	0.68	1.23	1.54^{*}
	(0.72)	(0.72)	(0.72)	(0.74)
LogEmployees	0.53^{**}	0.54^{**}	0.53^{**}	0.50^{**}
	(0.08)	(0.09)	(0.09)	(0.08)
ElectricService		3.30^{**}	3.50^{**}	
		(0.46)	(0.46)	
ElectricAndOther			2.54^{**}	
			(0.52)	
N	2755	2755	2755	1698
AIC	447.8	411.2	396.9	393.47

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$

legislation, are more likely to lobby in favor of cap and trade.

Appendix C: Proofs

Proof of Proposition 2. The marginal effect of r on firm i's profits is:

$$\frac{d\pi_i}{dr} = \frac{2}{9}(\alpha + r\gamma_i)\gamma_i \tag{18}$$

This is positive when $\gamma_i > 0$. Also if $d\pi_i/d_r > 0$ it must be that firm i's production is non-zero. Thus $\alpha > -r\gamma_i$. But then $d\pi_i/dr > 0$ implies $\gamma_i > 0$.

Table 4

	Model 1	Model 2	Model 3
(Intercept)	-9.56^{**}	-5.50^{**}	-11.56^{**}
	(0.87)	(0.41)	(1.21)
ProfitMargin	0.03^{**}	0.01^{*}	0.01
	(0.01)	(0.01)	(0.01)
CompetitorShare	2.09^{**}	$1.34^{\dagger}$	1.90^{*}
	(0.78)	(0.71)	(0.76)
HighEmitting	0.09	0.02	0.08
	(0.32)	(0.31)	(0.32)
MarketShare	0.31	2.34^{**}	0.58
	(0.72)	(0.55)	(0.71)
LogEmployees	0.53^{**}		
	(0.08)		
ScaledPPE		1.50^{**}	
		(0.50)	
LogTotalAssets			0.47^{**}
			(0.08)
N	2755	2995	3115
AIC	447.8	471.3	481.3

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$

For the second part, recall firm i's equilibrium contribution schedule:

$$s_i(r) = max\left\{\pi_i(r) - \pi_i(r^*) + s_i(r^*), 0\right\}$$

Suppose $\gamma_i > 0$. By Lemma 1, $\pi_i(r) > \pi_i(r^*)$ for any $r > r^*$. This implies $s_i(r) > s_i(r^*)$ for all $r > r^*$. Thus firm i offers greater contributions for higher levels of regulation and lesser contributions for lower levels of regulation. Since $\gamma_j < 0$ when $\gamma_i > 0$ the reverse is true for firm j. ■

Proof of Proposition 3.

If $r^{PM} = 0$ then $r^* = \frac{1-\lambda}{2\lambda}\left(\frac{d\Pi}{dr}\right)$, where $\Pi = \pi_i + \pi_j$ represents total producer surplus. Given $\gamma_i < \bar{\gamma}_i$ this surplus is strictly decreasing in r. Thus $r^* = 0$. Note that if i does not contribute at all the outcome would be the same, $r^j = 0$. Thus firm i's optimal contribution

Table 5

	Model 1	Model 2	Model 3	Model 4
(Intercept)	-8.42^{**}	-9.26^{**}	-8.89^{**}	-8.45^{**}
	(0.74)	(0.82)	(0.78)	(0.74)
ProfitMargin	0.02^{*}	0.03^{*}	0.02^{*}	0.02^{*}
	(0.01)	(0.01)	(0.01)	(0.01)
HighEmitting	0.25	0.12	0.12	0.22
	(0.30)	(0.32)	(0.30)	(0.30)
MarketShare	0.50	0.31	1.01	0.51
	(0.63)	(0.73)	(0.67)	(0.63)
LogEmployees	0.51^{**}	0.54^{**}	0.52^{**}	0.51^{**}
	(0.08)	(0.08)	(0.08)	(0.08)
CompetitorShare		2.21^{**}		
		(0.73)		
MarketShare			1.50^{**}	
			(0.57)	
BiggestCompetitor				0.25
				(0.31)
N	2772	2755	2772	2772
AIC	463.6	446.8	459.3	465.1

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$

in equilibrium is 0. The same is not true for firm j. If j does not participate the policy maker chooses:

$$r^i = \frac{1-\lambda}{2\lambda}\left(\frac{d\pi_i}{dr}\right) \tag{19}$$

$$= \beta(\alpha + r\gamma_i)\gamma_i \tag{20}$$

$$> 0 \tag{21}$$

Thus it must be that $s_j(0) > 0$. ■

Proof of Proposition 4. The partial derivatives of r^* with respect to F_i and F_j are:

$$\frac{\partial r^*}{\partial F_i} = \frac{1}{F_i^2}\left[\frac{\alpha\beta + 2r^*\beta(2\gamma_i - \gamma_j)}{1 - \beta(\gamma_i^2 + \gamma_j^2)}\right]$$
$$\frac{\partial r^*}{\partial F_j} = \frac{1}{F_j^2}\left[\frac{\alpha\beta + 2r^*\beta(2\gamma_j - \gamma_i)}{1 - \beta(\gamma_j^2 + \gamma_i^2)}\right]$$

r^* will increase more quickly in F_i than in F_j if:

$$\frac{F_j^2}{F_i^2}\big(\alpha + 2r^*(2\gamma_i - \gamma_j)\big) > \big(\alpha + 2r^*(2\gamma_j - \gamma_i)\big)$$

The left hand side is strictly positive, while the right hand side will be negative whenever $\alpha < 2r^*(\gamma_i - 2\gamma_j)$. Thus an equilibrium exists in which policy is increasing more quickly in F_i than in F_j.

Appendix D: Equilibrium with Endogenous Investments

Define firm i's profits in terms of the following function:

$$\tilde{\pi}_i(q_i^*(F_i), r^*(F_i), F_i)$$

and equilibrium campaign contribution in terms of the function:

$$s_i^*(r^*(F_i), r^j(F_i)$$

When choosing it's optimal level of investment, firm i solves,

$$\underset{F_i}{Max} \quad \tilde{\pi}_i(q_i^*(F_i), r^*(F_i), F_i) - s_i^*(r^*(F_i), r^j(F_i) - h(F_i) + h(\hat{F}_i)$$

and likewise for firm j. Applying the envelope theorem, the first order conditions yield a system of equations,

$$h'(F_i) = \frac{\partial \tilde{\pi}_i(q_i^*(F_i), r^*(F_i), F_i)}{\partial r^*(F_i)} \cdot \frac{dr^*(F_i)}{dF_i} + \frac{\partial \tilde{\pi}_i(q_i^*(F_i), r^*(F_i), F_i)}{\partial F_i} - \frac{ds_i^*(r^*(F_i), r^j(F_i)}{dF_i}$$
$$h'(F_j) = \frac{\partial \tilde{\pi}_j(q_j^*(F_j), r^*(F_j), F_j)}{\partial r^*(F_j)} \cdot \frac{dr^*(F_j)}{dF_j} + \frac{\partial \tilde{\pi}_j(q_j^*(F_j), r^*(F_j), F_j)}{\partial F_j} - \frac{ds_j^*(r^*(F_j), r^j(F_j)}{dF_j}$$

Proof of Proposition 5

Let the pair (F_i^*, F_j^*) denote the optimal investment levels for each firm, defined as the solution to the above equations. We consider how these investment levels change when the lobbying phase is removed and r^* is exogenously imposed.

In this case, firm i solves

$$\underset{F_i}{Max} \quad \hat{\pi}_i(q_i^*(F_i), r^*, F_i) - h(F_i) + h(\hat{F}_i)$$

where r^* is now an exogenous parameter. The first order conditions are now:

$$h'(F_i) = \frac{\partial \hat{\pi}_i(q_i^*(F_i), r^*, F_i)}{\partial F_i}$$
$$h'(F_j) = \frac{\partial \hat{\pi}_j(q_j^*(F_j), r^*, F_j)}{\partial F_j}$$

Denote the solution to this system, i.e. optimal investment levels when r is set exogenously, by (F_i', F_j'). How do these compare to the levels identified before (F_i^*, F_j^*)? Note that by convexity of $h(\cdot)$, $F_i' > F_i^*$ if $h'(F_i') > h'(F_i^*)$. Additionally, it must be that $\frac{\partial \hat{\pi}_i(q_i^*(F_i), r^*, F_i)}{\partial F_i} = \frac{\partial \tilde{\pi}_i(q_i^*(F_i), r^*(F_i), F_i)}{\partial F_i}$ since r^* is held fixed in both. Thus we can write:

$$h'(F_i') > h'(F_i^*)$$
$$0 > \frac{\partial \tilde{\pi}_i(q_i^*(F_i), r^*(F_i), F_i)}{\partial r^*(F_i)} \cdot \frac{dr^*(F_i)}{dF_i} - \frac{\partial s_i^*(r^*(F_i), r^j(F_i))}{\partial r^*(F_i)} \cdot \frac{dr^*(F_i)}{dF_i} - \frac{s_i^*(r^*(F_i), r^j(F_i)}{\partial r^j(F_i)} \cdot \frac{dr^j(F_i)}{dF_i}$$

Recall that in equilibrium, $\frac{\partial \tilde{\pi}_i(q_i^*(F_i), r^*(F_i), F_i)}{\partial r^*(F_i)} = \frac{\partial s_i^*(r^*(F_i), r^j(F_i))}{\partial r^*(F_i)}$. Thus the first two terms cancel out leaving:

$$\frac{s_i^*(r^*(F_i), r^j(F_i)}{\partial r^j(F_i)} \cdot \frac{dr^j(F_i)}{dF_i} > 0$$

As r^j increases, it moves towards r^*. Thus the change induced in the policy maker's utility by moving to r^* must be strictly decreasing. This reasoning implies that i contribution must also be decreasing in r^j. Thus the above condition will hold if and only if $0 > \frac{dr^j(F_i)}{dF_i}$ or $\alpha > -2r^j\gamma_j$. In this case investment for firm i is strictly higher in the absence of lobbying. If the reverse condition holds, firm i's investment is higher in the presence of political competition.

Firm j's investment will be higher in the presence of lobbying if:

$$0 > \frac{s_j^*(r^*(F_j), r^j(F_j)}{\partial r^i(F_j)} \cdot \frac{dr^i(F_j)}{dF_j}$$

Since $r^i > r^*$ it must be that firm j's contribution is increasing in r^i. But $\frac{dr^i(F_j)}{dF_j}$ is strictly negative. Thus the condition will always be true. Firm j's investment is increases in the presence of political competition. ■