Firm Responses to Climate Change: Exit and Voice*

Alexander F. Gazmararian† Helen V. Milner‡

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Abstract

Firms wield considerable influence over government responses to climate change. When and how do firms respond to their climate change vulnerability? We argue that companies update their beliefs about the immediacy of climate change in response to direct experiences such as extreme heat. These updated beliefs lead firms facing future damages to engage in economic and political strategies of exit or voice to minimize climate change risks. To test these claims, we construct a novel firm-level measure of vulnerability to global warming using data on 6.6 million establishments and a spatial economic assessment model of climate change. After firms experience extreme heat, those facing future global warming damages lobby more on climate-related issues, exercising their voice. The effect is strongest among firms with fewer exit options. There is limited evidence of delayed economic adaptation. Our findings point to the importance of firm geography for understanding business influence in politics, and help to explain how global warming will reshape political coalitions as its material effects are increasingly felt.

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†PhD Candidate, Department of Politics, Princeton University. Email: afg2@princeton.edu. Web: www.alexgaz.org

‡B.C. Forbes Professor of Politics and International Affairs, Princeton School of Public & International Affairs. Email: hmilner@princeton.edu. Web: hvmilner.scholar.princeton.edu

Companies are responsible for greenhouse gas emissions that cause climate change and exert considerable influence over policymaking responses to global warming. Firms also vary in their exposure to physical damages from climate change, their ability to adapt, and whether they gain or lose from environmental policies. This implies that companies should have different preferences about government responses to global warming. Yet, there is uncertainty about when the effects of climate change will be felt. So, it is not automatic that companies will respond to their latent climate vulnerability. How do firms change their beliefs about when they will be affected by climate change? In turn, how do these updated beliefs shape the political and economic strategies of firms?

Previous studies of firms focus on lobbying as the outcome and the relative costs and benefits from regulations as predicting firm policy preferences (Cory, Lerner, and Osgood 2021; Genovese 2019; Kennard 2020; Meckling 2011; Vogel 1995). However, firms have strategies beyond lobbying, such as relocating their establishments and investing in new technologies. Green et al. (2022) and Meckling (2015), for example, demonstrate the value of considering political and economic strategies simultaneously, showing how some companies are hedging against decarbonization risks.

There are also factors beyond the costs of compliance with regulations that should affect firm strategies: companies face physical damage from global warming (Krueger, Sautner, and Starks 2020). These physical effects of climate change are in the future but should affect the political and economic responses of firms (Sprinz and Vaahtoranta 1994). However, there is little theory about how firms learn about their exposure to climate change and how this affects their corporate strategies. While Colgan, Green, and Hale (2021) propose a valuable framework where companies learn about global warming as the value of their assets changes, absent an economic assessment model of climate change, their theory does not generate testable predictions. Further, challenges measuring firm vulnerability to global warming inhibit research on how businesses respond to climate change.

Building on research about the role of experience in decision-making under risk (Weber

2006), we argue that as firms experience climate change, they will update their beliefs about how soon they will be affected by global warming. In turn, companies facing physical damage from climate change in the future will pursue actions to minimize their climate vulnerability. Following a political strategy of exercising voice, companies should increase lobbying to support policies that minimize planet-warming emissions and provide private rents. Following an economic strategy of exit, firms might also relocate their establishments and switch suppliers to reduce exposure to higher temperatures. In contrast, firms anticipating possible benefits should be less supportive of mitigation policies and see little need to relocate.

Central to our argument is the prediction that firms will have conflicting preferences about responses to climate change depending on their underlying vulnerability to physical climate risks. In deriving firm preferences, our theory departs from Colgan, Green, and Hale (2021) by focusing on location rather than assets because the firms with same assets will face differential effects from global warming depending on where they are located. For example, agricultural producers will face worse impacts in southern areas of the United States than in northern regions, which might even see benefits (Hsiang et al. 2017). By accounting for the heterogeneity of global warming's effects across space, our theory can better predict how firms will mobilize in response to climate change. Firms that hold similar assets may exhibit diverging responses depending on where they are located.

Geography is not destiny since some companies are mobile. Thus, we expect that firms with highly specific assets to a location, such as those with considerable investments in property, plants, and equipment, should be most motivated to engage in political activity. This prediction stems from Hirschman's (1970) insight that when exit from a group is not possible, people turn to exercise their voice. We hypothesize that the same process should occur for firms. Our idea of asset specificity as tied to geography also differs from Colgan, Green, and Hale (2021), who focus on the convertibility of carbon-intensive assets to less polluting alternatives.

We test our theory by constructing a new measure of firm climate exposure from data on 6.6 million establishments in the United States, which we pair with economic assessment models of global warming (Hsiang et al. 2017) and geospatial data on extreme heat. We use panel data on 1,650 publicly-traded firms from 1999 to 2022 to estimate whether climate-vulnerable firms respond to extreme heat with increased lobbying on climate-related legislation (Kim 2018), and relocate their establishments away from damage.

We find that extreme heat experience causes only firms facing future climate damages to exercise their voice by increasing lobbying expenditures on climate-related issues. Consistent with Hirschman's (1970) proposition about exit options, it is the firms with the most highly specific assets that are more likely to mobilize politically. There is little sign in our data of short-run economic adaptation where firms relocate to safer locations, but there is suggestive evidence of a lagged response, possibly an indication of the costliness of adapting to climate change.

We validate our interpretation of the results as evidence of firms updating their beliefs about the immediacy of global warming by conducting placebo tests that assess the effect of extreme heat on non-environmental lobbying. These tests show that lobbying on non-climate issues like alcohol or Medicaid does not increase after extreme heat. Thus, we can be more confident that it is changing expectations of global warming's timing that drives these results.

Our paper makes three contributions that the conclusion elaborates upon. First, political economy theories typically assume businesses understand with certainty how they are affected by public policies (Lake 2009), but this assumption is often unrealistic in scientific domains where uncertainty abounds about when the effects of an externality like climate change will be felt. Our theory helps to explain how firms formulate and change their strategies as they become more certain about how their material interests are affected by public policy (or its absence).

Second, we contribute to the climate politics literature by incorporating economic assessment models of global warming to understand the political responses of firms. By modeling the heterogeneous effects of global warming, we generate new predictions about how firms will have contrasting responses to the climate crisis—not just because of the regulatory costs they face—but because their business footprints face differential exposure to the damages and possible benefits of higher temperatures. We also explore outcomes beyond lobbying, such as economic adaptation, which is seldom done simultaneously.

Our finding that firm experience with climate change increases lobbying also invites research on how these lobbying activities affect policy outcomes. While the size of the effect of extreme heat on lobbying is meaningful, we do not think these political activities are yet a sufficient counterweight to incumbent fossil fuel interest groups.

Lastly, we develop a novel measurement strategy to capture business exposure to climate change based on granular establishment-level data, which also points to new directions for the study of business in politics. Companies have a geographic footprint, often not considered in deriving their policy preferences. However, it could be consequential for understanding who gains and loses from public policies with uneven geographic consequences. Beyond climate change, the effects of globalization often fall on particular regions (Rickard 2020), which could influence the responses of firms given the local economic spillovers even if their business activities are not directly affected by trade policy. We advance the study of firms in politics by demonstrating and quantifying the role of geography and, in doing so, help to explain the contours of corporate influence in response to the climate crisis.

Business Influence on Climate Policy

Businesses exert considerable influence on policymaking processes. On climate and environmental issues alone, companies spent over $2 billion on lobbying between 2000 and 2016 (Brulle 2018). These lobbying activities work to influence what gets put on or kept off the agenda, how policymakers think about the issues and the implementation of laws. Understanding the policy preferences of firms is critical.

The influence of corporations has led scholars to frame climate politics as a distributive conflict between the owners of assets that cause climate change and the owners of assets vulnerable to global warming (Colgan, Green, and Hale 2021; Mildenberger 2020; Meckling 2011). Since the costs of policies to reduce planet-warming emissions concentrate on specific firms, industries, and sectors, those affected have powerful incentives to engage in collective action (Olson 1965). These firms engage in political activities such as lobbying lawmakers (Cheon and Urpelainen 2013; Cory, Lerner, and Osgood 2021; Brulle 2018; Kennard 2020; Stokes 2020; Baehr, Bare, and Heddesheimer 2023), funding "grassroots" opposition (Skocpol 2013), and casting doubt on established climate science (Oreskes and Conway 2011). While one resolution would be to strike a bargain over climate policy that includes side payments for firms facing losses, credible commitment problems stand in the way (Gazmararian and Tingley 2023).

Previous studies focus predominantly on political responses to climate change, focusing on explanations for firm lobbying. The typical political economy approach examines the expected costs and benefits from emissions mitigation for firms, industries, or sectors. Certain companies have business models heavily dependent on fossil fuels. Absent readily available less polluting alternatives, these firms face an "existential threat" from mitigation policy (Colgan, Green, and Hale 2021; Green et al. 2022). Measuring regulatory costs is a challenging endeavor because they can matter in absolute and relative terms (Kennard 2020). Multiple factors moderate the costs of mitigation such as trade exposure (Genovese 2019; Aklin 2016; Peters et al. 2011), the timeline of a policy's implementation (Genovese and Tvinnereim 2019), or how early a firm adopted an environmental standard or technology (Vogel 1995). Variation in regulatory costs can also emerge because companies differ in their ability to convert polluting assets to less carbon-intensive alternatives (Colgan, Green, and Hale 2021; Kelsey 2018).

Firms also differ in whether they benefit from policies to lower temperatures. Prior research focuses on the immediate economic beneficiaries, such as renewable energy companies that receive subsidies (Aklin and Urpelainen 2013; Kim, Urpelainen, and Yang 2016). This has led to work examining how to broaden reform coalitions by giving sectoral interests an economic stake in green energy (Meckling et al. 2015).

Beyond the immediate economic benefits of legislation, firms with vulnerability to physical climate risks also stand to gain in the long run from climate mitigation policy.[1] These benefits may have been less emphasized because these were presumed to be temporally distant for firms. There is some evidence of a relationship between firms mentioning physical climate change risks in their shareholder communications and lobbying on climate issues (Baehr, Bare, and Heddesheimer 2023). Firms have also started to disclose climate risks despite not yet having a legal obligation to do so. However, it is unclear why some firms but not others mention climate risks, despite having the same underlying vulnerability. As firms increasingly feel the effects of global warming, they may start to change their decision-making.

Yet, there are theoretical and empirical challenges in accounting for how the physical effects of climate change affect firm preferences over policy responses to global warming. First, any theory must specify how firms learn about how climate change will affect their business operations. Previous studies suggest that firms start to act on climate change in response to consumers (Prakash 2002), corporate board members learning from experiences at other firms (Lerner and Osgood 2022), or shareholder and regulatory threats (Reid and Toffel 2009). While these might explain some instances of firm attention to climate change risks, they do not amount to a general theory. The closest to a general theoretical model is Colgan, Green, and Hale (2021), who hypothesize that as the value of firms' assets changes in response to global warming, their preferred policies will evolve. However, some companies might not wait until their assets devalue and instead act in anticipation.

The other challenge that has impeded the study of firm exposure to climate change is mea-

[1]Cross-pressures from policy and climate vulnerability matter for citizen's policy preferences (Gaikwad, Genovese, and Tingley 2022).

surement. The ideal measure should have broad longitudinal and sectoral coverage; a transparent methodology; differentiate firms in the same industry; and use objective features independent of firms' strategic behavior, such as messaging. However, previous attempts have used indirect measures of a company's exposure to climate change, such as financing terms for debt (Huang et al. 2022), home country climate vulnerability (Kling et al. 2021; Huang, Kerstein, and Wang 2018), shareholder communications (Sautner et al. 2023), and equity markets (Bansal, Kiku, and Ochoa 2016). Other studies have created more precise models for individual industries like automobiles (Castro-Vincenzi 2022), but this does not permit comparisons across industries. There are proprietary efforts by consultants with blackboxed methodologies, such as Four Twenty Seven from Moody's ESG Solutions Group (Ginglinger and Moreau 2019; Acharya et al. 2022), but these present challenges for reproducible research and also lack longitudinal coverage. Researchers also examine the geographic distribution of firms, but many of these efforts only look at the address of a company's headquarters (Pankratz, Bauer, and Derwall 2023), which does not reflect a firm's climate vulnerability; in the United States, this approach would indicate that most companies have the same climate vulnerability as Delaware. Longitudinal, transparent, and objective measures of firm exposure to physical climate risks are needed to understand the effects of global warming on business strategies.

Theorizing Firm Responses to Climate Change

Our theory aims to explain how firms learn they are affected by climate change and how this influences their political and economic responses to minimize their climate vulnerability. We assume that firms select their strategies by conducting a cost-benefit calculation of the expected return of political expenditures and economic adaptation. For political responses, inputs into this calculation include the expected costs of a regulation, which could include required technological upgrades, higher taxes, or lost market share. The benefits of climate policy include avoiding future damage from global warming, funds to help adapt to climate change, or tax breaks for making green investments. In terms of economic responses, firm leaders must consider such factors as the liquidity of their assets and availability of skilled labor in new locations. The assumption that firms make intentional calculations is reasonable, given their focus on profit maximization.

When considering political responses, we hold constant the role of regulatory costs to focus on the expected benefits of climate action from reduced physical vulnerability. The opposition to climate mitigation policies stemming from the adjustment costs faced by carbon-intensive industries has already been well-documented (Cory, Lerner, and Osgood 2021; Mildenberger 2020; Stokes 2020). We examine how changing beliefs about firm climate vulnerability shape their corporate strategies in response to global warming.

A fundamental assumption in our theory is that the effects of global warming differ across locations, so we should expect firms to have differing responses to global warming. A large body of empirical and theoretical research finds substantial heterogeneity within and across countries in global warming's consequences for various economic outcomes: amenities and productivities (Cruz and Rossi-Hansberg 2023; Moore and Diaz 2015), gross domestic product (GDP) (Burke, Hsiang, and Miguel 2015; Burke, Davis, and Diffenbaugh 2018; Callahan and Mankin 2022; Desmet et al. 2021; Kotz et al. 2021), agriculture (Conte et al. 2021), manufacturing (Desmet and Rossi-Hansberg 2015), energy consumption (Rode et al. 2021), crime, coastal storms, labor (Hsiang et al. 2017), and human mortality (Carleton et al. 2022). There are two mechanisms behind this asymmetry. First, higher temperatures in places that are presently cool may enhance productivity up to a limit (Burke, Hsiang, and Miguel 2015; Conte et al. 2021), decrease mortality (Carleton et al. 2022; Hsiang et al. 2017), and ease energy consumption (Rode et al. 2021; Hsiang et al. 2017). In contrast, higher temperatures in areas currently warm degrade productivity, increase mortality and heighten energy consumption. Second, temperature changes lead individuals and firms to adapt by trading with new partners, migrating to safer locations, and investing in local technology. These changes will redistribute economic activity across countries and within nations, deepening inequality (Cruz and Rossi-Hansberg 2023) and giving rise to new political cleavages (Gazmararian and Milner 2023).

Firms, in particular, face different effects from global warming depending on the assets they hold (Colgan, Green, and Hale 2021). The insurance industry is exposed to more systematic risks from extreme weather events, though there will still be variation depending on the geographic footprint of where firms insure. Just as there are heterogeneities in the effects of global warming on agricultural output across nations (Conte et al. 2021), firms in the agricultural industry will experience different consequences depending on their location.

Thus, companies with differing business footprints should exhibit heterogeneous responses as they update their beliefs about when the impacts of climate change will be felt. Firms in places facing future climate change damage should be more likely to engage in economic and political responses: changing their organizational structure to be less exposed and lobbying governments to reduce future climate damage.

By contrast, firms in places that may experience benefits or anticipate being better off than their competitors may be less incentivized to engage in political lobbying or economic responses. This might change if the benefits become more certain and tangible. However, since the firms benefit from the status quo, they may not see a need to increase lobbying and can free-ride on incumbent fossil fuel interest groups that are already mobilized.

We argue that in response to climate change experiences, firms update their beliefs about how soon they will be affected by global warming. Companies likely have a sense of how they are vulnerable to global warming *in theory*, but this may not affect their behavior until they experience the effects of global warming first-hand. Initially, firms may be uncertain about when the effects of climate change will be felt. The level of scientific certainty about climate change has evolved, and while the science is solid, firms may have questions about when the effects of global warming will be felt.

Climate change experiences send costly signals to vulnerable firms that the effects of climate change are being felt today and the organization needs to change its strategies. Studies of industrial organization find that climate change events like extreme weather are costly for firms. Extreme heat raises energy costs and reduces productivity (Ponticelli, Xu, and Zeume 2023; Lai et al. 2023). There are persistent wage declines at businesses affected by natural disasters (Indaco, Ortega, and Taşpınar 2021; Barrot and Sauvagnat 2016). Firms shift their global supply chains when suppliers are affected by climate shocks (Pankratz and Schiller 2021). Weather-related disruptions from climate change alter the spatial organization of firms (Pankratz and Schiller 2021; Castro-Vincenzi 2022).

Experience with climate change demonstrates that the costs of climate change are not a distant, abstract phenomenon but are immediate and concrete. Direct experience is also more salient for decision-makers who are less likely to act on analytical information alone (Marx et al. 2007; Weber 2006). Organizational learning theories indicate that change in corporate strategy is more likely to occur when the organization's economic environment evolves (Linnenluecke, Griffiths, and Winn 2012). This model of belief updating builds from our earlier work about how individuals learn about the timing of climate impacts (Gazmararian and Milner 2023). The model also relates to the asset re-evaluation framework proposed by Colgan, Green, and Hale (2021), which contends that as climate change alters the value of a firm's assets, companies with vulnerable assets will increasingly mobilize to pressure governments to act on climate change. However, it is unclear in their framework the process firms use to learn about the effects of climate change. The economic models of climate change cited above also indicate that companies, even with the same assets, will exhibit different responses to climate change because their business footprints vary in their vulnerability to global warming.

Firms have economic and political responses they can pursue to minimize their climate vulnerability. First, companies could engage in economic adaptation by relocating their supply chains to safer locations (Linnenluecke, Stathakis, and Griffiths 2011), investing in technologies to enhance their resilience to higher temperatures like air conditioning, or reimagining their business models entirely. These economic responses to climate change are costly but provide private benefits to firms. Some of these benefits, like installing air conditioning, may be immediate, while others are long-term, like investing in green innovation (Rahman et al. 2023). Efforts to relocate firm establishments to be less exposed to climate change may be an even longer-term process (Leduc and Wilson 2023).

Companies can also engage in political responses, such as lobbying on climate issues. Companies facing future damages from global warming may seek to affect policymaking by pushing for emissions mitigation, which will reduce firm exposure in the long run, but also by attempting to extract private rents, which will have short-term benefits. Mitigation efforts could include a carbon pricing system, while private rents could entail subsidies to help adjust to the effects of global warming. The overall aim is to influence policymaking to help the firm minimize its exposure to climate change's physical effects, a complex process to observe but one that is crucial to understand.

Firms with highly specific assets should be more likely to mobilize politically since economic adaptation via relocation is a less feasible alternative. This idea builds on Hirschman (1970), who explains why groups facing high costs of exit are more likely to exercise their voice. For example, companies with significant investments in manufacturing plants and established local supply chains may find it harder to relocate to an area less vulnerable to global warming. Thus, the firms turn to political mobilization instead to help minimize their future climate damage exposure.

There are already examples of firms choosing between exit and voice, or a combination of the two, in response to global warming.[2] Firms closely guard their lobbying strategies, so one cannot automatically infer their intentions, but there are patterns consistent with what our theory suggests. Microsoft, for example, has begun to face increased costs of cooling data centers due to extreme heat, which has led the firm to explore how to build submersible data

[2]For all examples, our measures described below show these firms face climate damages, have been exposed to extreme heat, and lobbied on environmental issues.

centers in northern climates (Stokel-Walker 2022). The company has also begun to lobby in support of sustainability and climate change issues (Geman 2020). Microsoft voiced its support for a federal carbon tax (Worland 2019), opposed the rollback of the Clean Power Plan (Roberts 2020), condemned President Trump's decision to exit the Paris Agreement (Moss 2017), and supported the Inflation Reduction Act (IRA) (Weihl 2022).

FMC Corporation, an agricultural firm, is another example of companies responding to climate change experiences with lobbying. The firm's public communications discuss how the firm is "keenly aware of the impact of climate change...Persistent temperature change in geographies with significant cultural lands may impact growers through land use change, crops suitable to cultivate, and pest presence" (FMC Corp 2023). According to OpenSecrets, a public lobbying database, the company has spent $804,283 since 2010 on lobbying, including on environmental issues. The firm is cross-pressured in certain respects because regulations could increase the costs of energy used in fertilizer. However, the firm has made a net-zero commitment, including disclosures to the CDP.

To summarize, we have the following hypotheses.

> **Hypothesis 1:** In response to climate change experiences, firms facing future damage from global warming should be more likely to mobilize politically on climate-related issues.

> **Hypothesis 2:** The effects of climate change experiences on firm mobilization on climate-related issues should be strongest for companies with more highly specific assets.

> **Hypothesis 3:** In response to climate change experiences, firms facing future damage from global warming may adapt economically by relocating their operations away from climate-vulnerable locations.

For the last hypothesis, we anticipate this might be hard to observe in the short run because relocation is a slow-moving and costly procedure. Finally, while the models we cite above indicate there are potential benefits from climate change, we do not expect anticipation of benefits to affect political mobilization in the near term. These benefits may be uncertain, and companies can free-ride on the obstruction by incumbent fossil fuel interest groups, so they have fewer incentives to act.

Research Design

Data and Measurement

Firm Exposure to Climate Change's Economic Effects

We develop a novel establishment-level measure of firm exposure to climate change to test our hypotheses. We pair our measure with geospatial data on extreme heat and firm lobbying activities. Four goals motivate our establishment-level approach: coverage, transparency, differentiation, and objectivity. An ideal measure should, first, have broad longitudinal and sectoral coverage. Second, it should be transparent in that it is clear what factors make certain firms more vulnerable than others, which is not always true for proprietary measures. Third, the measure should allow for the differentiation of firms within the same industry rather than broadly categorizing specific sectors or assets as more or less vulnerable. Lastly, the ideal measure should be derived from objective features that are hard for firms to quickly change without high costs rather than being dependent on the possible strategic behavior of firms, such as in their messaging documents.

Our measurement strategy satisfies these four objectives. We use data on the establishments (E) of firms (i), which we pair with the results from a spatial assessment model of climate change's effects (D) on counties (j) in the United States. Establishments are physical locations where business activities occur, such as manufacturing plants and sales offices. We calculate the number of establishments a firm has in each county, which we then use to create an establishment-weighted damage estimate for a firm's overall exposure to the economic effects of global warming.

$$D_i = \sum_{j=1}^{N} \frac{E_{j(i)}}{\sum_{i=1}^{N} E_i} D_j \tag{1}$$

In equation 1, D_i represents the firm-level effects of climate change on economic activity across the location of its establishments. This estimate comes from using the share of establishments a firm has in a county as weights for the economic impact of climate change in that county as measured by a model, denoted D_j.

To help visualize how this measurement strategy works in practice, consider hypothetical ABC Inc. The firm has 3 establishments in DeKalb County, 1 in Mercer County, and 1 in Costilla County. If a climate model indicated that climate change would reduce economic activity by 4.7% in DeKalb, 1.9% in Mercer, and increase it by 7.7% in Costilla, to calculate a firm's average establishment-level exposure to climate change, we compute $0.6 \times 4.7 + 0.2 \times 1.9 - 0.2 \times 7.7$. So, overall, ABC Corp's establishments would be operating in localities that will likely experience a 1.66% decline in economic activity due to climate change.

This measurement strategy achieves broad coverage, given appropriate longitudinal data on firm establishments. The model is also transparent by using open-source estimates for climate damages; it is clear which firm establishments are contributing to the overall estimate. Crucially, the measure is specific to each firm, which can capture variation within the same industry and sector. Lastly, the measure is derived from the costly decisions of firms to locate in particular places, which cannot be automatically changed, so it is more objective than measuring their climate vulnerability from sources that could be influenced by strategic messaging.

A fundamental assumption is that the geographic footprint of a firm matters for its exposure to the effects of climate change. Studies on the impact of climate change on firms support this assumption. Establishment-level research documents how extreme heat raises energy costs and reduces productivity for firms (Ponticelli, Xu, and Zeume 2023; Pankratz, Bauer, and Derwall 2023). Studies of municipalities also find that counties with greater climate risks have worse terms of borrowing, which suggests that markets are pricing in geographic-based climate risks (Painter 2020). There is increasing research about how firms learn from experiences at different establishments (Gumpert, Steimer, and Antoni 2022) and how economic shocks can propagate through a firm's network of establishments (Giroud and Mueller 2019).

Another advantage of our measure is that it, by construction, accounts for the differential vulnerability of firms to climate change as mediated by their organizational structure. An important finding in industrial organization research is that larger firms are better able to adapt to global warming because they can build more and larger establishments that are more resilient to climate-related disruptions (Castro-Vincenzi 2022; Ponticelli, Xu, and Zeume 2023; Zivin and Kahn 2016). Our measurement strategy captures the greater resilience of larger firms by weighting climate damages by their overall number of establishments.

A limitation is that there are features of industries and business models independent from geography that affect firm vulnerability to climate change. For example, the insurance industry may be systematically more exposed to climate risks. However, many insurers have physical businesses in the locations where they operate, though the overlap may not be perfect. To address variation that could stem from industry-specific exposure to climate change, our models include firm fixed effects that account for time-invariant features of the industry within which a firm operates.[3] Another limitation is that the measure does not capture international exposure to climate change for firms with global supply chains. The political effects of climate change on global supply chains present a promising avenue for future study. Research on international organizations, for example, indicates how bureaucrats learn from their experiences in other countries (Clark and Zucker 2023), which could similarly occur for global firms.

To operationalize our measure, we use establishment-level data from Data Axle on firms

[3] We also examine models with industry fixed effects.

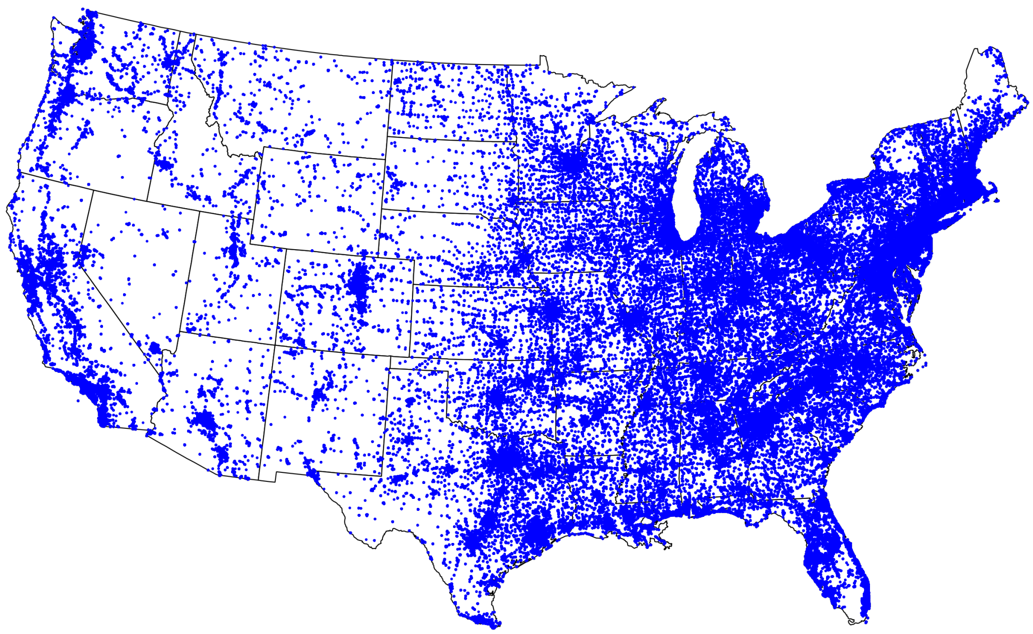

Figure 1: Publicly-traded firm establishments, 1997-2022. $N = 6{,}603{,}104$

in the US. These data include annual, geo-coded records on 226 million American businesses from 1997 to 2022. The organization gathers these data from public sources, such as local yellow pages, and verifies them with more than 25 million verification phone calls each year. While the data have good coverage of establishments, the information about establishment sales and store categories is less reliable, so we leverage these data for the primary goal of locating the business footprint of firms.

Since Data Axle does not provide a historical company identification key that could link the data with other databases, we conduct a fuzzy matching procedure to connect the establishment data to Compustat's database of firms. Since this process involved matching the names of 226 million business establishments, we leveraged high-powered computing clusters to accelerate this computationally intensive task. Figure 1 displays the geographic coverage of the 6.6 million firm establishments with matches in the Compustat data, which serve as our source of information on firm financials.

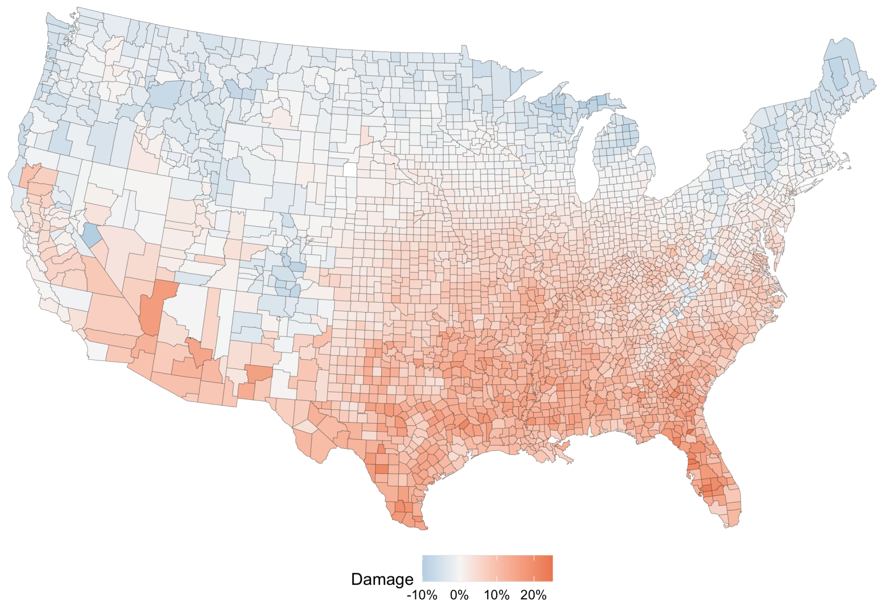

Figure 2: Future climate change damage to county GDP. Red denotes potential climate damages, while blue denotes potential climate benefits.

Then, we pair the locations of firm establishments with county-level estimates of climate change damages from Hsiang et al. (2017). Their model estimates the value of market and non-market damages from higher temperatures in agriculture, crime, coastal storms, energy, human mortality, and labor. They find substantial spatial heterogeneity in the economic effects of higher temperatures, consistent with other expert models (e.g., Cruz and Rossi-Hansberg 2023). Another recent study projects that climate change will cause substantial reallocations of people and jobs across the US, where hotter Sunbelt counties lose population and employment, while the North and Mountain West see gains (Leduc and Wilson 2023). As Figure 2 visualizes, parts of the North and West of the US experience potential gains in terms of GDP, while the South incurs large losses.

To assess the face validity of our measure, we explored the firms facing the most considerable future climate damages and potential benefits. Among the firms facing the most extensive climate damages is Tarpon Coast Bancorp, a bank in Port Charlotte, Florida, that services customers in an area with considerable exposure to sea level rise and extreme heat. Another company facing sizeable climate damage is SFL Corporation, an international shipping company with significant shoreline investments, which might lose value as the sea level rises. Regarding firms facing potential benefits, Mackinac Financial Corporation, a financial holding company in the upper peninsula of Michigan, faces gains as its location may benefit from the northward relocation of economic activity. Another company that faces potential benefits is Keweenaw Land Association, a forest land management and subsurface mining company also located in Northern Michigan. These firms and the nature of their climate vulnerability match our intuition of what types of companies are most and least exposed to global warming, which builds confidence in the measurement strategy.

While previous work to derive firm preferences has focused on the industry and sector levels, our measure emphasizes variation among firms in their exposure to climate change. To demonstrate that a firm-level analysis is meaningful, Figure 3 plots the distribution of firm climate vulnerability within industries in our sample.[4] The taller the vertical blue area, the more firms in that industry face similar levels of future climate damages. The wider the horizontal blue area, the greater dispersion within industries in climate vulnerability. The figure shows that while the average firm across all industries faces future climate damages, there is considerable variation within industries in whether companies stand to lose or benefit from climate change's effects on their establishments. This motivates our focus on the firm as the unit of analysis.

[4]Industries are defined at the 2-digit NAICS level.

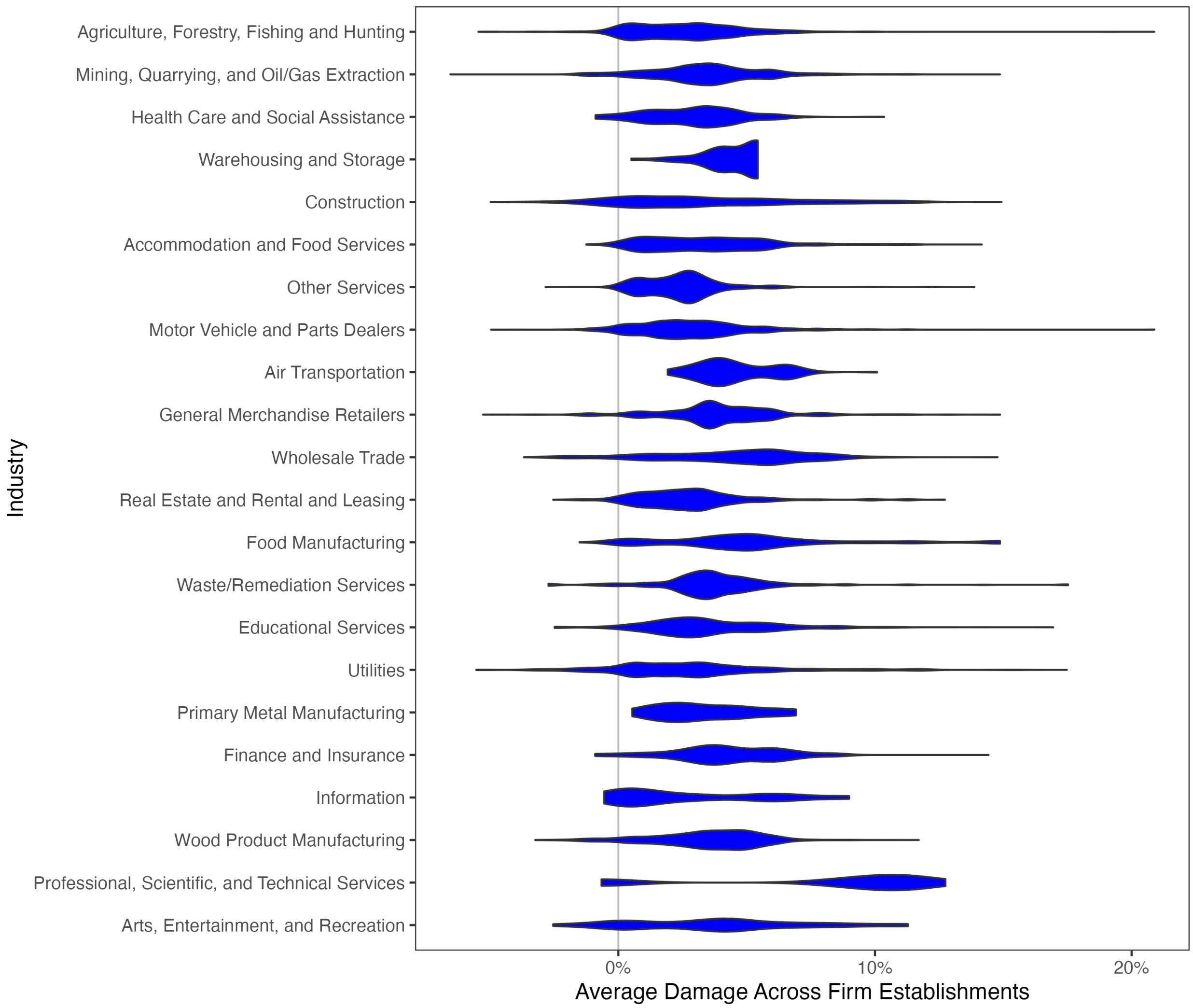

Figure 3: Within-industry variation in a firm's average change in future economic activity because of climate change across its establishments. The vertical width of each curve is a rotated kernel density plot that shows the distribution of all data in the corresponding industry for 1,650 publically traded firms in the United States.

Firm Experience with Climate Change

We measure firm experience with climate change using data on establishment exposure to extreme heat. Extreme heat is defined by the number of days with temperatures over 90°F.[5] There is extensive literature in economics documenting the economic effects of heat (e.g., Dell, Jones, and Olken 2012). For firms in particular, extreme heat can cause visible disruptions by raising energy costs and reducing productivity (Ponticelli, Xu, and Zeume 2023; Pankratz, Bauer, and Derwall 2023).[6] We examine heat at the establishment level, following studies in economics and matching the unit of analysis from which we constructed our measure of firm climate vulnerability.

Temperature data come from the National Oceanic and Atmospheric Administration (NOAA). These geospatial data cover gridded cells for the contiguous United States from 1951 to the present at daily intervals. We map these data to the county level, the unit of analysis we use to construct the establishment-level measure of firm climate vulnerability. Then, we use the same weighting approach to calculate the number of extreme heat days a company's establishments experience in a year. This approach tallies the number of extreme heat days in each county, then sums these days, weighted by the company's share of establishments in each county. This approach maintains consistency between the measurement of climate vulnerability and exposure to global warming.

Outcomes

Voice The primary outcome is political mobilization on climate issues by firms. We measure this political response using firm lobbying expenditures. Data come from LobbyView, which covers the universe of lobbying reports filed by interest groups under the Lobbying Disclosure Act of 1995 (Kim 2018). We focus on firm-level lobbying expenditures as opposed

[5] https://www.ready.gov/heat

[6] But see Addoum, Ng, and Ortiz-Bobea (2020).

to coalition membership since firms join coalitions for unobserved strategic reasons, such as attempting to shape outcomes (Grumbach 2015).

Issue codes allow us to identify climate-related lobbying. The reports require that the filer categorize the general issue areas in which they engaged in political activities during a reporting period. We use the issue codes associated with the environment, energy, and fuels to classify climate-related lobbying. While there is no climate change code, actions to respond to global warming fall within these issue areas, making them an appropriate approximation of climate lobbying. This coding likely includes some spending unrelated to climate policies while excluding other relevant expenditures under different issue codes. This will likely contribute to non-systematic measurement error, which should make estimates less precise but not bias the results.

Since the reports do not indicate the position of the firms, a question is how to interpret an increase in lobbying expenditures. This challenge confronts all studies of lobbying. However, since we have a model of how firms should respond to climate change exposure based on their underlying vulnerability to future global warming, we have a theoretical basis to infer the directionality of their lobbying behavior. There would be a threat to our interpretation if there were an equivalent interpretation of our model where firms mobilize *against* climate mitigation action in response to experiencing extreme heat, but we are unaware of substantiated arguments that could support such a chain of reasoning. Thus, we interpret companies' increased spending on these issues as political mobilization to mitigate climate change or receive private benefits to help minimize a firm's climate vulnerability.

When presenting the results, we also take three steps to validate our interpretation of increased lobbying expenditures as reflecting greater concern about climate change. First, the estimation strategy examines changes in lobbying expenditure within the same firm. So, the empirical model corresponds to the theorized process, which increases confidence in relying on theory to interpret the change in lobbying behavior. Second, we conduct placebo tests examining whether spending on non-climate issues increases and find that global warming experience only induces political mobilization on climate-related issues. Third, we consider a model specification that tests whether the more fossil fuel-dependent firms increase lobbying after extreme heat exposure since these are the likely opponents of climate action. However, we find that these firms do not spend more on climate lobbying after exposure to the treatment. The match between our theoretical model and estimation strategy, placebo tests, and interpretation checks instill confidence that our research design captures political mobilization motivated by global warming concerns.

Exit We also examine whether firms engage in economic adaptation after climate change experiences. Our theory implies that in addition to political responses to climate damage, firms should take steps, such as relocating vulnerable establishments, to reduce their future global warming exposure. To test this hypothesis, we examine whether a firm's level of climate vulnerability declines over time in response to experience with extreme heat. Since this process may take time, we examine several lags of past climate change exposure as the explanatory variable.

Asset Specificity

We predict that firms with more specific assets—those that are harder to liquidate—should be more likely to exercise voice in response to climate-related experiences. Following the literature, we measure asset specificity by dividing the net value of a firm's property, plant, and equipment (PP&E) by its total assets in a year (Acharya, Bharath, and Srinivasan 2007; Berger, Ofek, and Swary 1996; James and Kizilaslan 2014). The logic is that PP&E are long-term, tangible assets that are not easily converted into cash. To the extent that a company's overall value is composed of these assets, it should face more significant barriers to adapting to climate change by selling its assets and relocating its establishments.

Firm Financials

Our data on firm financials, such as PP&E, comes from Compustat. Our statistical approach below leads us to analyze a balanced panel of firms from 1999 to 2022. The balanced panel provides for greater internal validity, though the trade-off is that these companies present in all data periods may be more likely to be larger, more productive firms. This invites future research about how new, smaller businesses react to climate change experiences. Smaller firms might have fewer resources to engage in political or economic responses to climate change, so they are more likely to die. New entrants might also select different strategies since they can be more circumspect in deciding where they set up shop to avoid climate vulnerability.

Estimation and Assumptions for Causality

We used a two-way fixed effects regression model to estimate the effect of extreme heat experiences on climate lobbying by firms, conditional on whether they face future global warming damages. The estimation strategy examines variation in lobbying and climate change experience *within* the same firm instead of analyzing cross-sectional differences. Specifically, we estimated the following model,

$$Y_{it} = \beta_1 D_{it} + \beta_2 G_{it} + \beta_3 (D_{it} \times G_{it}) + \beta_4 \mathbf{X}_{it} + \lambda_i + \eta_t + \epsilon_{it}, \tag{2}$$

where Y is annual climate-related lobbying expenditures, D is the level of future climate damages a firm faces in a year, G is the number of extreme heat days a firm experiences, $\mathbf{X}$ is a matrix of time-varying covariates discussed below, and λ and η are firm and year fixed effects. The main coefficient of interest is β_3, which represents the differential effect of extreme heat on firms facing future climate damages, which we expect to be positive. For interpretation, we standardized all variables using their variation at the firm-level (Mummolo and Peterson 2018). We employed heteroskedastic-robust standard errors clustered by firm and industry to account for autocorrelation. As with most studies of firms, there is some missing data, which we handled using 100 imputations (King et al. 2001).

The primary challenge for causal identification is that the occurrence of extreme heat and a firm's vulnerability to future climate damages may not be exogenous to factors that could, instead, explain changes in lobbying expenditures. For example, fossil fuel companies along the Gulf Coast might be more vulnerable to future climate damage and increase lobbying expenditures to fight climate action over time while extreme heat days also become more frequent. Failing to account for variables that predict the incidence of extreme heat, climate vulnerability, and lobbying expenditures would confound inference.

We took several steps to satisfy this exogeneity assumption. First, our estimation strategy included firm and year fixed effects, which remove potential confounding from time-invariant variables. This is important because several firm-specific and temporal factors could bias the results. Since their inception, some companies have been larger, more productive, and lobbied actively, which the firm fixed effects address.[7] The firm fixed effect also accounts for the industry in which the company operates, which could influence its propensity to lobby on environmental issues. The firm fixed effects also account for geographic features, such as companies being located in fossil fuel regions. The year fixed effects help by accounting for potential factors like how, in certain years, there are more items on the legislative agenda that create a need for greater lobbying expenditures.

Second, we included time-varying controls to account for potential omitted variable bias not absorbed by the fixed effects. We controlled for the share of electricity from fossil fuels in the states where a firm has establishments.[8] This measure captures changes in the costs of adjusting to environmental regulations, which should be higher when local electricity markets must make more extensive adjustments to move away from fossil fuels (Kennard 2020). We

[7]One study finds that firms with more organizational resources and capabilities are likely to engage in the climate policymaking process (Kim 2022).

[8]These data come from the EIA.

also included an indicator for if a firm lobbied in the past year to account for a possible path dependence in lobbying expenditures that increases because a company mobilized politically in an unrelated issue area. Finally, we also controlled for the asset specificity of a firm in a year, which could influence a company's propensity to lobby more generally because of its exposure to government policies beyond those motivated by environmental concerns.

After accounting for firm and year fixed effects, the remaining threat to inference would be if there were an omitted time-varying confounder orthogonal to the control variables. We are unaware of a reasonable candidate for a confounder that is positively correlated with changes in extreme heat exposure, establishment climate vulnerability, and lobbying expenditures. We conducted a sensitivity analysis using the methodology developed by Cinelli and Hazlett (2020) to formally assess how large such an omitted variable would have to be to change our conclusions. Based on this analysis, such an extreme confounder would be unlikely to bias the results (Appendix B).

Results

Voice: Political Responses to Climate Change

Table 1 reports estimates of the effect of extreme heat exposure on climate-related lobbying expenditures by firms, conditional on the extent of their future global warming damages. Across all model specifications, the interaction of future climate damages and extreme heat is positive, indicating that climate change experiences increase lobbying only for firms with business footprints facing future global warming harm. The substantive size of this effect is appreciable; a one-standard deviation in extreme heat causes a firm facing future global warming damages to spend $44,300 more on climate-related lobbying in a year. This is about equivalent to the quarterly lobbying expenditures of EQT Corp in 2017, a major oil and gas extraction company.

Figure 4 illustrates the main result, plotting the average marginal effect of a standard

Table 1: Linear regression of firm climate lobbying expenditures on the interaction of extreme heat days and future climate change vulnerability, 1999–2022

	Outcome: Lobbying ($1000s)			
	(1)	(2)	(3)	(4)
Potential Damage × Extreme Heat	22.9**	26.6**	26.2**	24.1**
	(11.4)	(12.7)	(12.3)	(10.8)
Potential Damage	−24.7	−23.7	−23.9	−26.1
	(25.4)	(27.6)	(27.5)	(28.8)
Extreme Heat	17.4	17.7	17.3	20.9
	(13.2)	(14.0)	(14.0)	(13.9)
Extreme Heat × Specificity			−2.4	
			(9.4)	
Potential Damage × Extreme Heat × Specificity			27.6*	
			(16.7)	
Extreme Heat × Carbon Intensity				26.3
				(16.9)
Potential Damage × Extreme Heat × Carbon Intensity				−12.4
				(11.8)
Specificity		−20.1	−24.3	−20.1
		(20.2)	(22.3)	(20.2)
Carbon Intensity		22.7**	23.0**	23.5**
		(10.8)	(10.8)	(11.5)
Lobbied_{t-1}		243.3***	244.4***	239.8***
		(45.5)	(45.8)	(44.6)
N	39600	37950	37950	37950
Adjusted R^2	0.620	0.630	0.630	0.630
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: Heteroskedasticity-robust standard errors clustered by firm and industry. Missing data are handled using 100 multiple imputations. *$p < 0.1$; **$p < 0.05$; and ***$p < 0.01$.

deviation increase in extreme heat at different levels of climate damage, using the binning estimator proposed by (Hainmueller, Mummolo, and Xu 2019). At low and moderate levels of climate damage, extreme heat does not affect lobbying, but a one standard deviation increase in future climate damages causes the extreme heat exposure treatment to increase climate-related lobbying. The figure also shows that a linear functional form well-approximates the moderating relationship of future climate damage on extreme heat, an assumption behind the multiplicative interactive effect. There is also common support of the moderator across relevant levels of extreme heat.

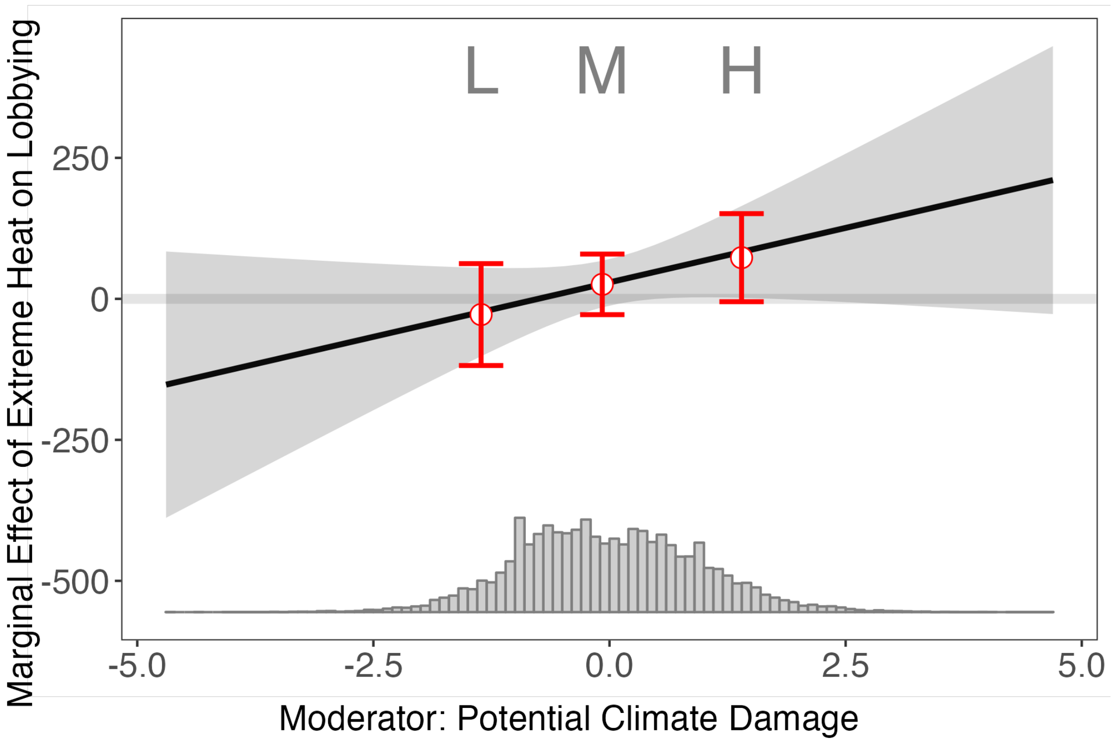

Figure 4: Average marginal effect of a standard deviation increase in firm extreme heat exposure at different levels of potential future damages, 1999-2022. Red bars denote 95% confidence intervals around bins corresponding with standard deviation changes in potential damage exposure. Extreme heat exposure only affects lobbying for the firms facing the greatest future climate damages ($p < 0.067$). The model list-wise deletes missing observations due to programming constraints.

The covariates in the model also have their expected signs, though we do not grant them a causal interpretation since they are only included for identification. Firms with business footprints in states with more carbon-intensive electricity are more likely to lobby on environmental issues. However, when we interact carbon intensity with our treatment and moderator in model 4, the coefficient lacks statistical significance at conventional levels. This indicates that the increased lobbying expenditures caused by extreme heat and climate vulnerability are driven by a motivation that is independent of concerns about the costs of regulation for fossil fuel-reliant firms. This instills greater confidence in our interpretation of the lobbying expenditures as motivated by concern about the immediacy of climate change.

To test the hypothesis about asset specificity, we interacted the measure of asset specificity with extreme heat and future climate damages. Model 3 in Table 1 shows that the effect of climate change experience and future global warming vulnerability is strongest for companies with more specific assets. This lends support to Hirschman's (1970) proposition that for firms where exit is not an option, they are more likely to engage in voice.

These results are robust when list-wise deleting missing data instead of imputing it (Table C1), including industry fixed effects (Table C2), and using alternative definitions of extreme heat (Table C3).

Placebo Tests We conducted placebo tests to probe the hypothesized mechanism that updated beliefs about climate change's timing increased lobbying expenditures. If lobbying activities also increased in areas unrelated to the environment, this would signal that some unrelated mechanism causes the change in political spending. However, to the extent that we only observe an increase in lobbying on climate-related issues, that would be more consistent with our interpretation that increasing concern about global warming's future damages explains the change in firms' political activities.

Our placebo tests examine whether lobbying expenditures on non-climate-related issues increase due to extreme heat exposure. We selected a broad range of lobbying codes: alcohol and drug abuse (ALC), the constitution (CON), Medicare and Medicaid (MMM), and veterans (VET). The criterion for inclusion was that the issue was unrelated to climate change, so it would be implausible to have an indirect effect of global warming experience that could lead to a false positive when conducting the placebo test.

Table 2 presents the results of estimating the effect of extreme heat and future climate damages on the placebo. Across the board, there is no effect. This is consistent with our interpretation of the increased lobbying expenditures as due to growing concern about global warming. Not only is the size of the coefficients small compared to the estimates in Table 1, none achieves conventional levels of statistical significance.

Table 2: Linear regression of non-climate lobbying expenditures (placebos) on the interaction of firm-level extreme heat days and climate vulnerability, 1999–2022

	Outcome: Lobbying ($1000s)			
	ALC	MMM	VET	CON
Potential Damage × Extreme Heat	−0.3	3.0	3.4	0.7
	(0.8)	(5.0)	(2.6)	(0.5)
Potential Damage	−1.2	−3.3	−4.7	−1.8
	(0.8)	(6.9)	(3.0)	(1.7)
Extreme Heat	0.6	−1.7	−1.3	0.3
	(1.0)	(2.7)	(1.9)	(0.7)
Specificity	0.2	−2.4	−6.4**	0.5
	(1.1)	(3.1)	(3.2)	(0.7)
Carbon Intensity	0.6	1.3	2.8	0.0
	(1.5)	(4.3)	(2.2)	(0.4)
Lobbied_{t-1}	7.6	78.9**	16.3**	3.0
	(5.9)	(31.6)	(7.1)	(2.7)
N	37950	37950	37950	37950
Adjusted R^2	0.150	0.420	0.130	0.100
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: ALC stands for alcohol, MMM is Medicare/Medicaid, VET is veterans, and CON is the constitution. Heteroskedasticity-robust standard errors clustered by firm and industry. Missing data are handled using 100 multiple imputations. *$p < 0.1$; **$p < 0.05$; and ***$p < 0.01$.

Exit: Economic Responses to Climate Change

We also assessed whether firms adapt economically in response to extreme heat, engaging in exit instead of voice. Table D1 shows that in the first and second years after experiencing extreme heat, there is no observable change in the locations of firm establishments away from climate-vulnerable places. However, there is suggestive evidence that extreme heat experiences cause firms facing future global warming damages to be more likely to move their establishments to avoid climate-vulnerable locations three years later. This result underscores that economic adaptation to climate change is a long-term process. In contrast, companies may face fewer barriers to engaging in political responses to global warming in the short run. However, we urge caution in interpreting these results since the effects are small and imprecise.

Conclusion

Firms exert considerable influence over government responses to the climate crisis. Our paper helps to explain when companies become concerned about global warming and their strategic responses to minimize these risks. To do so, we bring together economic assessment models of global warming with models of politics to generate new predictions about how companies will respond to climate-related experiences like extreme heat.

We predict that firms will have divergent responses because they face vast differences in their future exposure to climate change: some confront significant losses, while others may benefit. Indeed, we show, using a novel measure of firm climate vulnerability and geospatial data on extreme heat, how only companies facing future losses from global warming respond to extreme heat with political mobilization on climate issues. Companies with highly specific assets constraining their ability to adapt to extreme weather are even more likely to exercise their voice since they lack exit options. These results suggest that as firms increasingly feel the effects of global warming, new political coalitions may emerge, defined by the underlying climate vulnerability of corporations.

There are two primary limitations of our study that should inspire new lines of research. First, while we garner considerable empirical traction by focusing on geographic vulnerability to climate change, there could be residual variation in lobbying explained by other forms of vulnerability. Scholars should search for parsimonious ways to measure the exposure of assets to climate change over time, which would complement our results and help to nuance our predictions about firm responses to climate change.

Second, scholars need new data to better understand the directionality of firm lobbying behavior. We go to great lengths with our estimation strategy, placebo tests, and interpretation checks to instill confidence in our interpretation of political spending as evidence of mobilization in response to climate vulnerability. Future studies should explore the content of these lobbying activities to learn the types of demands companies make and how they shape the climate policymaking process. While there is some impressive work about the coalitions firms join (Cory, Lerner, and Osgood 2021), a natural next step is to examine the activities companies take individually.

Our paper makes three contributions. First, our model of how firms learn about the timing of global warming provides a template that could be used to understand the political activities of companies under conditions of uncertainty. Many political economy models, such as the Open Economy Politics approach (Lake 2009), assume that firms understand with certainty how they are affected by public policies or their absence. However, this assumption is often unrealistic. In technological, scientific, and environmental domains, uncertainty abounds. Our theory helps to explain how firms formulate and change their strategies as they learn about how their material interests are affected by public policy. For example, our model could be extended to assess how firms respond to artificial intelligence, where what is currently a technology with distant effects could become more concrete as companies experiment with it.

Our second contribution is to advance the climate politics literature by conducting the first study of how companies update their beliefs about when they are affected by global warming and how that influences their economic and political responses. Previous work has focused on incumbent interest groups, an appropriate emphasis given the not-yet-widespread impacts of global warming. However, the climate vulnerability of companies is becoming more and more relevant as the effects of global warming manifest. International investors are increasingly worried about climate vulnerability (Krueger, Sautner, and Starks 2020). Our study shows how as firms learn about the timing of global warming damages, it causes them to mobilize politically. We focused on this phenomenon in the United States, but future work should see if these effects obtain in other institutional contexts.

We also explored strategies firms have beyond lobbying, such as economic adaptation.

This is crucial since politics is only one outlet through which companies pursue their goals. We take up the call from earlier work on the multi-pronged strategies of firms (Green et al. 2022), extending it to focus on responses to climate vulnerability, as opposed to regulatory risk as has been the focus in previous work (Meckling 2015).

Finally, we developed a novel measurement strategy to capture business exposure to climate change, which opens new avenues for research on climate politics. For example, our measure could be used to analyze how physical global warming risks affect other aspects of firm climate behavior, such as the disclosure of emissions to nongovernmental or international organizations (Prakash 2002). The measure is also valuable for economists interested in understanding the effects of global warming on the industrial organization of firms.

The measure's conceptual approach also points in new directions for the study of business in politics. Identifying the preferred policies of businesses is a building block of political economy research. However, the geographic footprint of companies is often not considered in deriving firm policy preferences. Yet, it is consequential for understanding who gains and loses from public policies with uneven distributive effects across geography. For example, globalization has differential effects across industrial regions (Rickard 2020). Establishments may also help explain why lawmakers are more responsive to requests from some firms than others. Our findings demonstrate the value of incorporating the role of geography into firm policy preferences, and in doing so, we help to explain the changing role of corporate influence in response to global climate change.

References

Acharya, Viral V., Sreedhar T. Bharath, and Anand Srinivasan. 2007. "Does Industry-Wide Distress Affect Defaulted Firms? Evidence from Creditor Recoveries." *Journal of Financial Economics* 85 (3): 787–821.

Acharya, Viral V., et al. 2022. "Is Physical Climate Risk Priced? Evidence from Regional Variation in Exposure to Heat Stress." Preprint, Working Paper. https://doi.org/10.3386/w30445. National Bureau of Economic Research: 30445.

Addoum, Jawad M, David T Ng, and Ariel Ortiz-Bobea. 2020. "Temperature Shocks and Establishment Sales." *The Review of Financial Studies* 33 (3): 1331–1366.

Aklin, Michaël. 2016. "Re-Exploring the Trade and Environment Nexus Through the Diffusion of Pollution." *Environmental and Resource Economics* 64 (4): 663–682.

Aklin, Michaël, and Johannes Urpelainen. 2013. "Political Competition, Path Dependence, and the Strategy of Sustainable Energy Transitions." *American Journal of Political Science* 57 (3): 643–658.

Baehr, Christian, Fiona Bare, and Vincent Heddesheimer. 2023. "Climate Exposure Drives Firm Political Behavior: Evidence from Earnings Calls and Lobbying Data." Unpublished Manuscript, 2023.

Bansal, Ravi, Dana Kiku, and Marcelo Ochoa. 2016. "Price of Long-Run Temperature Shifts in Capital Markets." Preprint, Working Paper. https://doi.org/10.3386/w22529. National Bureau of Economic Research: 22529.

Barrot, Jean-Noël, and Julien Sauvagnat. 2016. "Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks." *Quarterly Journal of Economics* 131 (3): 1543–1592.

Berger, Philip G., Eli Ofek, and Itzhak Swary. 1996. "Investor Valuation of the Abandonment Option." *Journal of Financial Economics* 42 (2): 259–287.

Brulle, Robert J. 2018. "The Climate Lobby: A Sectoral Analysis of Lobbying Spending on Climate Change in the USA, 2000 to 2016." *Climatic Change* 149 (3-4): 289–303.

Burke, Marshall, Matthew Davis, and Noah Diffenbaugh. 2018. "Large Potential Reduction in Economic Damages under UN Mitigation Targets." *Nature* 557 (7706): 549–553.

Burke, Marshall, Solomon Hsiang, and Edward Miguel. 2015. "Global Non-Linear Effect of Temperature on Economic Production." *Nature* 527 (7577): 235–239.

Callahan, Christopher, and Justin Mankin. 2022. "Globally Unequal Effect of Extreme Heat on Economic Growth." *Science Advances* 8 (43): eadd3726.

Carleton, Tamma, et al. 2022. "Valuing the Global Mortality Consequences of Climate Change Accounting for Adaptation Costs and Benefits." *Quarterly Journal of Economics* 137 (4): 2037–2105.

Castro-Vincenzi, Juanma. 2022. "Climate Hazards and Resilience in the Global Car Industry." Unpublished Manuscript, 2022.

Cheon, Andrew, and Johannes Urpelainen. 2013. "How Do Competing Interest Groups Influence Environmental Policy? The Case of Renewable Electricity in Industrialized Democracies, 1989–2007." *Political Studies* 61 (4): 874–897.

Cinelli, Carlos, and Chad Hazlett. 2020. "Making Sense of Sensitivity: Extending Omitted Variable Bias." *Journal of the Royal Statistical Society Series B* 82 (1): 39–67.

Clark, Richard, and Noah Zucker. 2023. "Climate Cascades: IOs and the Prioritization of Climate Action." *American Journal of Political Science* Forthcoming.

Colgan, Jeff, Jessica Green, and Thomas Hale. 2021. "Asset Revaluation and the Existential Politics of Climate Change." *International Organization* 75 (2): 586–610.

Conte, Bruno, et al. 2021. "Local Sectoral Specialization in a Warming World." *Journal of Economic Geography* 21 (4): 493–530.

Cory, Jared, Michael Lerner, and Iain Osgood. 2021. "Supply Chain Linkages and the Extended Carbon Coalition." *American Journal of Political Science* 65 (1): 69–87.

Cruz, José-Luis, and Esteban Rossi-Hansberg. 2023. "The Economic Geography of Global Warming." *Review of Economic Studies* rdad042.

Dell, Melissa, Benjamin F Jones, and Benjamin A Olken. 2012. "Temperature Shocks and Economic Growth: Evidence from the Last Half Century." *American Economic Journal: Macroeconomics* 4 (3): 66–95.

Desmet, Klaus, and Esteban Rossi-Hansberg. 2015. "On the Spatial Economic Impact of Global Warming." *Journal of Urban Economics* 88:16–37.

Desmet, Klaus, et al. 2021. "Evaluating the Economic Cost of Coastal Flooding." *American Economic Journal: Macroeconomics* 13 (2): 444–486.

FMC Corp. 2023. "Our Care for the Planet — FMC Corp." Accessed August 20, 2023. https://www.fmc.com/en/sustainability/climate-change-statement.

Gaikwad, Nikhar, Federica Genovese, and Dustin Tingley. 2022. "Creating Climate Coalitions: Mass Preferences for Compensating Vulnerability in the World's Two Largest Democracies." *American Political Science Review* 116 (4): 1165–1183.

Gazmararian, Alexander F., and Helen V. Milner. 2023. "Political Cleavages and Changing Exposure to Global Warming." Unpublished Manuscript.

Gazmararian, Alexander F., and Dustin Tingley. 2023. *Uncertain Futures: How to Unlock the Climate Impasse.* Cambridge University Press.

Geman, Ben. 2020. "Microsoft's next Phase of Climate Lobbying." Axios, 2020. Accessed August 16, 2023. https://www.axios.com/2020/11/20/microsoft-climate-change-lobbying.

Genovese, Federica. 2019. "Sectors, Pollution, and Trade: How Industrial Interests Shape Domestic Positions on Global Climate Agreements." *International Studies Quarterly* 63 (4): 819–836.

Genovese, Federica, and Endre Tvinnereim. 2019. "Who Opposes Climate Regulation? Business Preferences for the European Emission Trading Scheme." *The Review of International Organizations* 14 (3): 511–542.

Ginglinger, Edith, and Quentin Moreau. 2019. "Climate Risk and Capital Structure." Preprint, SSRN.

Giroud, Xavier, and Holger M. Mueller. 2019. "Firms' Internal Networks and Local Economic Shocks." *American Economic Review* 109 (10): 3617–3649.

Green, Jessica, et al. 2022. "Transition, Hedge, or Resist? Understanding Political and Economic Behavior toward Decarbonization in the Oil and Gas Industry." *Review of International Political Economy* 29, no. 6 (2022): 2036–2063.

Grumbach, Jacob M. 2015. "Polluting Industries as Climate Protagonists: Cap and Trade and the Problem of Business Preferences." *Business and Politics* 17 (4): 633–659.

Gumpert, Anna, Henrike Steimer, and Manfred Antoni. 2022. "Firm Organization with Multiple Establishments." *The Quarterly Journal of Economics* 137 (2): 1091–1138.

Hainmueller, Jens, Jonathan Mummolo, and Yiqing Xu. 2019. "How Much Should We Trust Estimates from Multiplicative Interaction Models? Simple Tools to Improve Empirical Practice." *Political Analysis* 27 (2): 163–192.

Hirschman, Albert O. 1970. *Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States.* Harvard University Press.

Hsiang, Solomon, et al. 2017. "Estimating Economic Damage from Climate Change in the United States." *Science* 356 (6345): 1362–1369.

Huang, Henry He, Joseph Kerstein, and Chong Wang. 2018. "The Impact of Climate Risk on Firm Performance and Financing Choices: An International Comparison." *Journal of International Business Studies* 49 (5): 633–656.

Huang, Henry He, et al. 2022. "Firm Climate Risk, Risk Management, and Bank Loan Financing." *Strategic Management Journal* 43 (13): 2849–2880.

Indaco, Agustín, Francesc Ortega, and and Süleyman Taṣpınar. 2021. "Hurricanes, Flood Risk and the Economic Adaptation of Businesses." *Journal of Economic Geography* 21 (4): 557–591.

James, Christopher, and Atay Kizilaslan. 2014. "Asset Specificity, Industry-Driven Recovery Risk, and Loan Pricing." *Journal of Financial and Quantitative Analysis* 49 (3): 599–631.

Kelsey, Nina. 2018. "Industry Type and Environmental Policy: Industry Characteristics Shape the Potential for Policymaking Success in Energy and the Environment." *Business and Politics* 20 (4): 615–642.

Kennard, Amanda. 2020. "The Enemy of My Enemy: When Firms Support Climate Change Regulation." *International Organization* 74 (2): 187–221.

Kim, In Song. 2018. "LobbyView: Firm-level Lobbying & Congressional Bills Database." Working Paper.

Kim, Sung Eun, Johannes Urpelainen, and Joonseok Yang. 2016. "Electric Utilities and American Climate Policy: Lobbying by Expected Winners and Losers." *Journal of Public Policy* 36 (2): 251–275.

Kim, Younsung. 2022. "Integrated Market and Nonmarket Strategies: Empirical Evidence from the S&P 500 Firms' Climate Strategies." *Business and Politics* 24 (1): 57–78.

King, Gary, et al. 2001. "Analyzing Incomplete Political Science Data: An Alternative Algorithm for Multiple Imputation." *American Political Science Review* 95 (1): 49–69.

Kling, Gerhard, et al. 2021. "The Impact of Climate Vulnerability on Firms' Cost of Capital and Access to Finance." *World Development* 137 (2021): 105131.

Kotz, Maximilian, et al. 2021. "Day-to-Day Temperature Variability Reduces Economic Growth." *Nature Climate Change* 11:319–325.

Krueger, Philipp, Zacharias Sautner, and Laura T Starks. 2020. "The Importance of Climate Risks for Institutional Investors." *Review of Financial Studies* 33 (3): 1067–1111.

Lai, Wangyang, et al. 2023. "The Effects of Temperature on Labor Productivity." *Annual Review of Resource Economics* 15:11.1–11.20.

Lake, David A. 2009. "Open Economy Politics: A Critical Review." *The Review of International Organizations* 4 (3): 219–244.

Leduc, Sylvain, and Daniel J. Wilson. 2023. *Climate Change and the Geography of the U.S. Economy.* 2023-17. Federal Reserve Bank of San Francisco, 2023.

Lerner, Michael, and Iain Osgood. 2022. "Across the Boards: Explaining Firm Support for Climate Policy." *British Journal of Political Science* (2022): 1–24.

Linnenluecke, Martina K., Andrew Griffiths, and Monika Winn. 2012. "Extreme Weather Events and the Critical Importance of Anticipatory Adaptation and Organizational Resilience in Responding to Impacts." *Business Strategy and the Environment* 21 (1): 17–32.

Linnenluecke, Martina K., Alexander Stathakis, and Andrew Griffiths. 2011. "Firm Relocation as Adaptive Response to Climate Change and Weather Extremes." *Global Environmental Change* 21 (1): 123–133.

Marx, Sabine M., et al. 2007. "Communication and Mental Processes: Experiential and Analytic Processing of Uncertain Climate Information." *Global Environmental Change* 17 (1): 47–58.

Meckling, Jonas. 2011. *Carbon Coalitions: Business, Climate Politics, and the Rise of Emissions Trading.* MIT Press.

———. 2015. "Oppose, Support, or Hedge? Distributional Effects, Regulatory Pressure, and Business Strategy in Environmental Politics." *Global Environmental Politics* 15 (2): 19–37.

Meckling, Jonas, et al. 2015. "Winning Coalitions for Climate Policy." *Science* 349 (6253): 1170–1171.

Mildenberger, Matto. 2020. *Carbon Captured: How Business and Labor Control Climate Politics.* MIT Press.

Moore, Frances, and Delavane Diaz. 2015. "Temperature Impacts on Economic Growth Warrant Stringent Mitigation Policy." *Nature Climate Change* 5 (2): 127–131.

Moss, Sebastian. 2017. "Tech, Data Center Firms Increase US Lobbying Spend," 2017. Accessed August 20, 2023. https://www.datacenterdynamics.com/en/analysis/tech-data-center-firms-increase-us-lobbying-spend/.

Mummolo, Jonathan, and Erik Peterson. 2018. "Improving the Interpretation of Fixed Effects Regression Results." *Political Science Research and Methods* 6 (4): 829–835.

Olson, Mancur. 1965. *The Logic of Collective Action.* Harvard University Press.

Oreskes, Naomi, and Erik M. Conway. 2011. *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming.* Bloomsbury Press.

Painter, Marcus. 2020. "An Inconvenient Cost: The Effects of Climate Change on Municipal Bonds." *Journal of Financial Economics* 135 (2): 468–482.

Pankratz, Nora, Rob Bauer, and Jeroen Derwall. 2023. "Climate Change, Firm Performance, and Investor Surprises." *Management Science,* mnsc.2023.4685.

Pankratz, Nora M. C., and Christoph Schiller. 2021. "Climate Change and Adaptation in Global Supply-Chain Networks." Preprint, SSRN Scholarly Paper.

Peters, Glen P., et al. 2011. "Growth in Emission Transfers via International Trade from 1990 to 2008." *Proceedings of the National Academy of Sciences* 108 (21): 8903–8908.

Ponticelli, Jacopo, Qiping Xu, and Stefan Zeume. 2023. "Temperature and Local Industry Concentration." Preprint, Working Paper. https://doi.org/10.3386/w31533.

Prakash, Aseem. 2002. "Green Marketing, Public Policy and Managerial Strategies." *Business Strategy and the Environment* 11 (5): 285–297.

Rahman, Sohanur, et al. 2023. "Environment-specific Political Risk Mitigation: Political Lobbying versus Green Innovation." *Journal of Business Finance & Accounting,* jbfa.12740.

Reid, Erin M., and Michael W. Toffel. 2009. "Responding to Public and Private Politics: Corporate Disclosure of Climate Change Strategies." *Strategic Management Journal* 30 (11): 1157–1178.

Rickard, Stephanie. 2020. "Economic Geography, Politics, and Policy." *Annual Review of Political Science* 23 (1): 187–202.

Roberts, avid. 2020. "Microsoft's Astonishing Climate Change Goals, Explained - Vox," 2020. Accessed August 20, 2023. https://www.vox.com/energy-and-environment/2020/7/30/21336777/microsoft-climate-change-goals-negative-emissions-technologies.

Rode, Ashwin, et al. 2021. "Estimating a Social Cost of Carbon for Global Energy Consumption." *Nature* 598:308–314.

Sautner, Zacharias, et al. 2023. "Firm-Level Climate Change Exposure." *The Journal of Finance* 78 (3): 1449–1498.

Skocpol, Theda. 2013. "Naming the Problem: What It Will Take to Counter Extremism and Engage Americans in the Fight against Global Warming."

Sprinz, Detlef, and Tapani Vaahtoranta. 1994. "The Interest-Based Explanation of International Environmental Policy." *International Organization* 48 (1): 77–105.

Stokel-Walker, Chris. 2022. "Data Centers Are Facing a Climate Crisis." *Wired,* 2022.

Stokes, Leah. 2020. *Short Circuiting Policy: Interest Groups and the Battle Over Clean Energy and Climate Policy in the American States.* Oxford University Press.

Vogel, David. 1995. *Trading up: Consumer and Environmental Regulation in a Global Economy.* Cambridge, Mass: Harvard University Press.

Weber, Elke. 2006. "Experience-Based and Description-Based Perceptions of Long-Term Risk: Why Global Warming Does Not Scare Us (Yet)." *Climatic Change* 77 (1-2): 103–120.

Weihl, Bill. 2022. "Why Microsoft Is a Company to Watch on Climate Policy," 2022. Accessed August 20, 2023. https://www.greenbiz.com/article/why-microsoft-company-watch-climate-policy.

Worland, Justin. 2019. "Microsoft Is the Latest Major U.S. Company to Back a Carbon Tax. Here's Why." Time, 2019, 8:46 p.m. Accessed August 20, 2023. https://time.com/5570982/microsoft-carbon-tax-corporate-backing/.

Zivin, Joshua Graff, and Matthew E. Kahn. 2016. "Industrial Productivity in a Hotter World: The Aggregate Implications of Heterogeneous Firm Investment in Air Conditioning." Preprint, Working Paper. https://doi.org/10.3386/w22962.

Online Appendix
Firm Responses to Climate Change

A Summary Statistics

Table A1: Summary Statistics

	Mean	SD	Min	Max	N	NA
Climate Lobbying	333.44	3786.62	0.00	262 002.00	39600	0
Extreme Heat Days	0.96	3.41	0.00	66.00	35305	4295
Potential Climate Damage	3.18	2.82	−6.55	20.89	35305	4295
Alcohol Lobbying (Placebo)	2.66	155.04	0.00	18 160.00	39600	0
Constitution Lobbying (Placebo)	6.35	596.03	0.00	100 380.00	39600	0
Medicare/Medicaid Lobbying (Placebo)	68.89	1268.59	0.00	144 396.00	39600	0
Veterans Lobbying (Placebo)	15.98	518.57	0.00	85 190.00	39600	0
Carbon Intensity	0.33	0.15	0.00	1.00	35305	4295
Asset Specificity	25.08	25.58	0.00	100.00	38081	1519

B Sensitivity Analysis

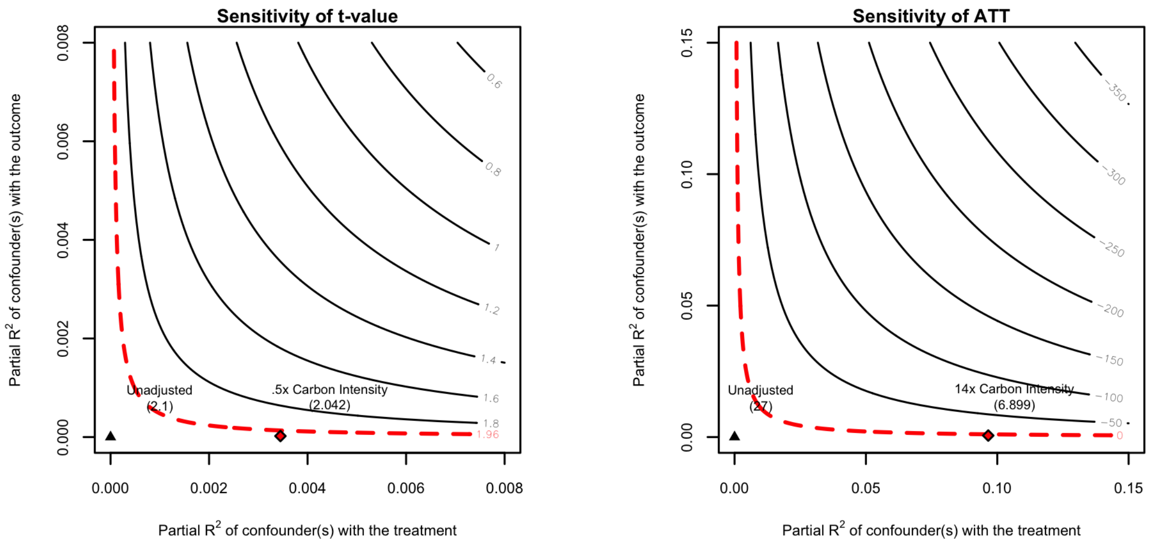

Figure B1: Sensitivity analysis of the interaction term in model 2 of Table 1 to omitted variable bias.

C Robustness

C.1 List-Wise Deletion

Table C1 presents the results when list-wise deleting instead of using multiple imputation to handle missing data. We urge caution in interpreting these estimates given the consensus that list-wise deletion introduces considerable selection bias and reduces statistical power (e.g., King et al. 2001). Table C1 shows that for the interaction of potential damage and extreme heat, the coefficient is positive across all specifications. Unsurprisingly, the standard error increases, given the efficiency losses from list-wise deletion. The sign of the triple interaction with specificity remains positive, though its standard error grows, which is also predictable given the statistical power needed to estimate a triple interaction. Table C1 shows qualitatively consisent results, despite the list-wise deletion method being widely considered to be inappropriate.

Table C1: Linear regression of firm climate lobbying expenditures on the interaction of extreme heat days and future climate change vulnerability, 1999–2022

	Outcome: Lobbying ($1000s)			
	(1)	(2)	(3)	(4)
Potential Damage × Extreme Heat	31.9*	38.6*	37.4*	33.5*
	(16.6)	(20.9)	(19.8)	(16.5)
Potential Damage	−34.3	−33.9	−34.3	−37.3
	(34.8)	(40.6)	(40.7)	(42.8)
Extreme Heat	27.1	29.2	28.8	35.4
	(20.0)	(22.2)	(22.3)	(22.2)
Extreme Heat × Specificity			−1.5	
			(13.5)	
Potential Damage × Extreme Heat × Specificity			39.4	
			(26.4)	
Extreme Heat × Carbon Intensity				30.6
				(23.1)
Potential Damage × Extreme Heat × Carbon Intensity				−15.4
				(14.9)
Specificity		−15.4	−23.0	−15.7
		(27.0)	(31.3)	(27.2)
Carbon Intensity		37.3**	37.7**	39.4*
		(17.8)	(17.6)	(19.6)
Lobbied$_{t-1}$		258.9***	260.4***	255.3***
		(55.5)	(55.7)	(54.3)
N	28 279	26 021	26 021	26 021
Adjusted R^2	0.624	0.630	0.630	0.630
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: Heteroskedasticity-robust standard errors clustered by firm and industry. Missing data are list-wise deleted. *$p < 0.1$; **$p < 0.05$; and ***$p < 0.01$.

C.2 Industry Fixed Effects

Table C2: Linear regression of firm climate lobbying expenditures on the interaction of extreme heat days and future climate change vulnerability, 1999–2022

	Outcome: Lobbying ($1000s)			
	(1)	(2)	(3)	(4)
Potential Damage × Extreme Heat	22.1**	25.6**	25.7**	23.3**
	(11.3)	(12.5)	(12.6)	(10.8)
Potential Damage	−25.6	−24.6	−24.9	−27.0
	(25.4)	(27.6)	(27.6)	(28.9)
Extreme Heat	18.1	18.5	18.1	21.5
	(13.2)	(14.1)	(14.1)	(13.9)
Extreme Heat × Specificity			−2.7	
			(9.5)	
Potential Damage × Extreme Heat × Specificity			28.5*	
			(17.4)	
Extreme Heat × Carbon Intensity				26.5
				(17.2)
Potential Damage × Extreme Heat × Carbon Intensity				−12.7
				(11.8)
Specificity		−20.1	−24.5	−20.1
		(20.2)	(22.4)	(20.2)
Carbon Intensity		22.3**	22.6**	23.1**
		(10.6)	(10.6)	(11.4)
Lobbied_{t-1}		243.4***	244.5***	239.8***
		(45.6)	(45.9)	(44.6)
N	39600	37950	37950	37950
Adjusted R^2	0.620	0.630	0.630	0.630
Firm Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: Heteroskedasticity-robust standard errors clustered by firm and industry. Missing data are list-wise deleted. $^{*}p < 0.1$; $^{**}p < 0.05$; and $^{***}p < 0.01$.

C.3 Temperature Thresholds

Table C3: Linear regression of firm climate lobbying expenditures on the interaction of extreme heat days with different thresholds and future climate change vulnerability, 1999–2022

	Extreme Heat Threhsold (°C)				
	32.2	−1.0	+1.0	+2.0	+3.0
Potential Damage × Extreme Heat	25.6**	16.0*	23.1**	13.0**	15.6**
	(12.5)	(9.6)	(9.7)	(6.7)	(7.5)
Potential Damage	−24.6	−27.2	−23.2	−23.3	−22.4
	(27.6)	(28.9)	(27.4)	(27.2)	(27.4)
Extreme Heat	18.5	31.1**	12.2	18.3	13.5
	(14.1)	(15.2)	(13.6)	(11.1)	(8.5)
Specificity	−20.1	−20.0	−20.1	−20.1	−20.2
	(20.2)	(20.2)	(20.2)	(20.2)	(20.2)
Carbon Intensity	22.3**	23.4**	21.8**	21.0**	21.2**
	(10.6)	(10.9)	(10.3)	(9.9)	(10.2)
Lobbied_{t-1}	243.4***	243.6***	242.6***	242.2***	241.8***
	(45.6)	(45.7)	(45.5)	(45.4)	(45.2)
N	37950	37950	37950	37950	37950
Adjusted R^2	0.630	0.630	0.630	0.630	0.630
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes

Notes: Heteroskedasticity-robust standard errors clustered by firm and industry. Missing data are handled using 100 multiple imputations. $^{*}p < 0.1$; $^{**}p < 0.05$; and $^{***}p < 0.01$.

D Economic Adaptation

Table D1: Linear regression of firm potential climate damage on the interaction of lagged extreme heat days and climate change vulnerability, 1999–2022

	Lags					
	1	1	2	2	3	3
Potential Damage × Extreme Heat	−0.008	−0.008	−0.005	−0.005	−0.011**	−0.010**
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)
Potential Damage	0.492***	0.492***	0.285***	0.284***	0.154***	0.154***
	(0.009)	(0.009)	(0.007)	(0.008)	(0.006)	(0.006)
Extreme Heat	0.004	0.004	0.001	0.001	0.007	0.006
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Potential Damage × Specificity		0.009*		0.022***		0.020***
		(0.006)		(0.006)		(0.007)
Extreme Heat × Specificity		−0.005		−0.005		0.002
		(0.005)		(0.007)		(0.006)
Potential Damage × Extreme Heat × Specificity		0.003		0.003		0.003
		(0.006)		(0.006)		(0.007)
Profit	0.006**	0.006**	0.004	0.005	0.004	0.004
	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)	(0.006)
N	37950	37950	36300	36300	34650	34650
Adjusted R^2	0.260	0.260	0.110	0.110	0.060	0.060

Notes: Heteroskedasticity-robust standard errors clustered by firm and industry. Missing data are handled using 100 multiple imputations. $^{*}p < 0.1$; $^{**}p < 0.05$; and $^{***}p < 0.01$.

References

King, Gary, et al. 2001. “Analyzing Incomplete Political Science Data: An Alternative Algorithm for Multiple Imputation.” *American Political Science Review* 95 (1): 49–69.