Responsible Demand: Irresponsible Lobbying?*

Olimpia Cutinelli Rendina †

Sonja Dobkowitz ‡

Antoine Mayerowitz §

February 28, 2023

Abstract

How do firms respond to rising environmental concerns of consumers? We investigate this question for the automobile industry in the US using a shift-share instrumental variable approach. Our findings suggest that firms not only innovate cleaner but also increase their lobbying on environmental topics. A one standard deviation increase in our measure of household environmental concerns raises the average lobbying firm's spending on environmental lobbying by a factor of 3. Simultaneously, the value of new clean patents grows by a factor of 2.4. We argue that the results are best understood as a demand-driven mechanism: when households lower demand for dirty goods due to environmental concerns, investment in clean R&D becomes especially important. Firms' eagerness to protect profits in order to finance more clean research increases. We conjecture that environmental lobbying helps firms finance the transition to cleaner production.

JEL classification: D70, O3, Q55

*We thanks Philippe Aghion, and Francis Bloch for their thoughtful comments. We thank Siméon Campos, Paul Chagnaud, and particularly Corentin Lafitte for excellent research assistance.

†Collège de France and Paris School of Economics

‡University of Bonn

§Collège de France and Paris School of Economics

1 Introduction

Households' environmental concerns are rising eventually shifting demand towards environmentally friendly products.[1] How do firms react to such a shift in demand? On the one hand, firms' incentives to innovate clean increase (Aghion, Bénabou, et al., 2021). On the other hand, lower demand for dirty goods diminishes firms' profits thereby reducing their ability to invest in clean R&D. As a result, firms have an increased incentive to protect their profits. Lobbying qualifies as a potential measure. In this paper, we investigate whether a rise in green consumer preferences also implies an increase in environmental lobbying.

To this end, we compile a novel dataset linking natural catastrophes, environmental preferences, and firm-level data on lobbying and patents in the automobile industry. Our measure of household environmental awareness is based on Google Trends data allowing for a high-frequency and geographically disaggregated measure. We find robust and significant evidence that automotive producers adjust in two dimensions in response to a rise in environmental concerns. First, in line with the literature, the average lobbying firm's value of novel clean patents rises and decreases for dirty ones. Second, this shift in innovation activity is accompanied by an increase in lobbying expenditures on environmental topics. A one standard deviation increase in environmental concerns implies a rise in environmental lobbying expenditures by a factor of 3 and in clean innovation by a factor of 2.4 on average.

Using variation in environmental preferences induced by natural catastrophes and controlling for federal policy changes, we interpret our results as identifying a demand-led mechanism. As firms face more clean demand, they innovate cleaner technologies. At the same time, the shift in demand reduces profits of dirtier firms. Fixed costs of research or convex returns to clean innovation render marginal profits more valuable. At its extreme, preventing a further reduction in profits may be vital for the firm to survive the transition toward green production. Then, environmental lobbying emerges as a tool to ensure the

[1] Recently, the phenomenon of an intrinsic willingness to pay for the avoidance of negative externalities has spurred interest in the economics literature; for instance: Bénabou et al., 2010; Bartling et al., 2015; Aghion, Bénabou, et al., 2021.

survival of the firm.

The analysis focuses on the US over the period from 2006 to 2019. We connect several datasets to employ a shift-share instrumental variable approach. First, we construct a novel proxy for household environmental preferences from Google Trends data. Google Trends measures the relative frequency with which certain terms, e.g. *Climate Change*, are searched. In contrast to available survey data, Google Trends comes at a high frequency and fine geographic variation which allows us to build a panel dataset on the state level at a quarterly frequency.[2]

Second, we combine our proxy for green preferences with vehicle registration data of the automobile industry to construct a measure of firm exposure to green consumer preferences.[3] While environmental awareness has increased everywhere, there is significant heterogeneity across the consumers of different firms; both in terms of the speed and the timing of the change.

Third, green preferences are most likely shaped by political and economic surroundings. For instance, exposure to green supply or policies may increase environmental awareness. To rule out that we measure firm responses to confounding factors, we use exogenous variation in green preferences induced by natural catastrophes. Therefore, we construct a novel dataset of state exposure to wildfires using satellite data from NASA. We argue that our instrument is valid to capture the effect of green preferences due to, first, geographic differences in firms' sales and production markets. Second, we include control variables to capture political adjustments in response to natural catastrophes.

We find that firms increase their spending on lobbying on environmental topics as green preferences increase. A one standard deviation increase in environmental aware-

[2]On the downside, the data does not provide information on the intention with which a term is searched so that the search data does not express concerns. However, we observe similar trends comparing Google Trends data to survey data.

[3]We focus on the automotive industry for several reasons. First, the industry produces highly heterogeneous goods in terms of pollution standards, that are easily identifiable (through the distinction between electric, hybrid, and fuel cars). This allows us both to identify whether green demand pushes specifically green innovation in this context and to study the relevance of path dependency in lobbying strategies. Second, the United States is the country with the highest level of expenditures in both lobbying and innovation, therefore, enabling us to study the trade-off between these two strategies.

ness causes an increase in the average firm's environmental lobbying expenditures by a factor of 3. Simultaneously, patenting increases for clean and declines for dirty technologies.

Taken together, these results suggest that, on the one hand, greener household preferences urge firms to innovate cleaner technologies. On the other hand, however, firms' returns to lobbying on environmental issues increase. Protecting profits seems to become vital as firms need to finance more clean innovation while returns to dirtier goods decline. A possible explanation is that R&D investment becomes more important when profits are low due to fixed costs of innovation. Another may be first-mover advantages in particular in a market for durable goods.

Interpretation of our results as a response to demand hinges upon the assumption that it is not a shift in policies driving our results: greener household preferences may urge policymakers to discuss greener laws at the state level. Clearly, this provides the opportunity for firms to increase their spending on environmental lobbying. However, our measure of lobbying consists of expenses targeted at federal institutions only. Our empirical set-up allows us to control for a rise in environmental regulations on the federal level by including time fixed effects. In addition, we find that firms also increase their lobbying expenditures on other topics which constitute margins to protect profits, such as trade and manufacturing, which presumably do not become more important politically in response to a shock in environmental preferences. This observation, thus, lends support to the narrative that protecting profits becomes more vital to firms and it is not an increase in environmental regulations being discussed. Finally, including controls for policy amendments leaves our point estimates unchanged thereby affirming our exclusion restriction.

More generally, next to the instrumental variable approach we employ a variety of strategies to alleviate concerns that our patterns arise from omitted factors or through reverse causality. First, the analysis is carried out on first differences within firms in order to identify variations that are not driven by firm-specific fixed observed or unobserved characteristics, such as size or main geographic areas of operation of the firm. Second, we control for period and firm fixed effects, which are to be interpreted as controls for time trends in a linear specification. Thirdly, we control in our first stage for factors potentially affecting state-level policies and corporate strategies, such as demographics, political preferences, transportation habits, local infrastructure, and local investments in the energy transition of transports.

Literature This paper brings together two strands of literature: the literature on the relationship between competition, innovation, and lobbying and the literature on households' willingness to pay to avoid negative externalities.

The first literature developed around the seminal paper by Aghion, Bloom, et al., 2005 which discusses the relation between competition and innovation. Aghion, Blundell, et al., 2009 use a Schumpeterian model to show that firms that are able to innovate to differentiate from competition will do so when competitive pressures reach certain levels. Empirical validation thus far focuses on trade shocks to investigate firm responses to increased competition (Bloom et al., 2016; Bombardini, 2008; Brandt et al., 2017; Hombert et al., 2018).

Autor et al., 2020 find that many firms do not have the possibility to innovate after a competition shock. Based on the intuition that other escape avenues exist in response to competitive pressures, Bombardini et al., 2021 provide evidence that U.S. firms use innovation and lobbying as two alternative strategies to deal with a trade shock. Akcigit et al., 2022 present opposed firm-level correlations on the relationship between market dominance, innovation, and political connections in the framework of Italian firms, further confirming this intuition. In contrast, we focus our analysis on firm responses to a demand shock. Furthermore, our results point to an aggregate complementarity of clean innovation and lobbying: both, clean innovation and lobbying expenditures rise in response to increased competition in one market fragment. Going forward, we aim to study firm characteristics shaping the decision in order to make a statement on the complementarity of these adjustment margins on the firm level.

Within this literature, more precisely, our project connects to studies on firm capacities to modify environmental regulations through political influence. This literature at-tests high social costs and individual gains from anti-environmental lobbying (Kang, 2016; Meng et al., 2019).[4] Adverse environmental lobbying is particularly effective because the strength of lobbying is multiplied when targeted at maintaining the status-quo (McKay, 2012), dirty firms tend to organize more than clean firms resulting in a higher impact on policies (S. E. Kim et al., 2016), and environmental organizations lobby less than what would be considered rational (Gullberg, 2008). We contribute by investigating motives for environmental lobbying. In more detail, in the framework of the automotive industry, we show that while firms increase their environmental lobbying expenditures in reaction to the shift in green preferences, they also engage in a technological transition through clean innovation.

The second connected literature explores *individual social responsibility* (see, for instance, Bénabou et al., 2010; Bartling et al., 2015; Falk et al., 2021). While the phenomenon of social responsibility has been studied in the behavioral economics literature, analyses of the effectiveness of social responsibility to affect market outcomes is scarce. Aghion, Bénabou, et al., 2021 show that clean innovation is one way to escape competition in conventional, non-green markets. Stronger environmental consumer preferences accelerate the mechanism. Other contributions highlight obstacles for social responsibility to impact actual allocations. Income inequality (Vona et al., 2011; Dobkowitz, 2022), for instance, may keep low-income households from consuming clean products. A perceived quality advantage of conventional goods, a low availability (Vermeir et al., 2006), or a lack of trust in sustainability claims (Meis-Harris et al., 2021) are other reasons why demand and environmental attitudes diverge. We add to answer the question of whether households can shape the allocation of resources across sectors by focusing on a barrier on the producers' side: lobbying. Another contribution of this paper is to construct a new measure of consumer environmental concerns highly disaggregated both at the geographic and temporal levels.

[4] A remarkable study shedding light on the positive impact of lobbying on the discrepancy between voters and legislature decisions is Giger et al., 2016 in the context of Swiss referenda.

Outline The remainder of the paper is structured as follows. Section 2 outlines our data followed by a description of the empirical strategy in Section 3. In Section 4 we present and discuss our results. Section 5 concludes.

2 Data and Summary Statistics

In this section, we describe the data sources, define our sample of interest, and present summary statistics.

2.1 Data Construction

Vehicle sales: S&P Global. The data on new vehicle registrations is sourced from *S&P Global* covering the years 2006 through 2019.[5] This comprehensive dataset provides quarterly registration details for each US state including information on the make, model, and engine type of each vehicle. We consider registrations in a given state to be equivalent to a sale to a resident of that state.[6] Using this dataset, we can determine the market share of each vehicle make at the state level which we use to assess a make's exposure to green consumer preferences.

Environmental preferences: Google Trends. To proxy consumers' awareness of environmental issues at the state level, we revert to Google Trends data. Google Trends is a free tool that provides time-series indices of search queries made in a certain area. Specifically, it quantifies the percentage of all searches that use a given term. To build our index, we use Google Trends queries on topics related to environmental issues and aggregate them using factor analysis. The selected keywords are *"Electric car"*, *"Recycling"* and *"Climate Change"*. Google Trends normalizes the index by the highest value observed within the time period and areas included in the query. However, Google Trends only allows comparing a maximum of five locations per search so that reference points of normalization

[5] `https://www.spglobal.com/mobility/en/products/automotive-market-data-analysis.html`

[6] It's generally forbidden to register a vehicle in another state than the state of residency in the United States. Exceptions exists for citizen that are living in multiple states, or working in another state.

vary. To solve this issue, we include the national US index in each query and sequentially normalize each state by the maximum value of the US.[7]. Finally, we build a composite index with principal component analysis (PCA).[8]

Previous work highlights the usefulness of Google Trends to predict near-term economic indicators (Choi et al., 2012; Stephens-Davidowitz et al., 2014). Vosen et al., 2011 show in the context of private consumption that Google Trends outperforms survey-based indicators in forecasts.

Fires: FIRMS. We measure exogenous shocks to environmental preferences through wildfires. Data on fires comes from the Fire Information for Resource Management System (FIRMS) of the US NASA. In particular, the data divides the United States into cells of one square kilometer and documents several times a day whether there is a fire in this cell.[9] We apply the following procedure to obtain a map of all fires in the US for each week of the period of analysis. First, we collapse this highly disaggregated data at the week level, considering that a cell is alight if a fire was declared in the cell at least once over the week. Second, we determine clusters of fires using the algorithm *dbscan* algorithm (Ester et al., 1996).[10] Third, we draw a convex polygon around each cluster to determine the area of the fire.

Finally, we compute our measure of consumers' exposure to fires at the state level by summing over all the fires f the of a state l:

$$Fire\ Exposure_l = \log\left(\sum_f \text{intensity}_i * \text{surface}_f / \text{distance}^2_{f,l}\right)$$

where the intensity is proxied by the fire radiative power (in Megawatts) and the size of the fire is measured by its surface. Our measure of fire exposure is divided by the square

[7]See West, 2020 for an extensive discussion of this issue

[8]We extract the first component which accounts for 53% of the total variance.

[9]We focus on "presumed vegetation fire" and drop the other types of fires.

[10]We focus on clusters to exclude fires that are too small to impact environmental preferences. We choose eps=0.25 and minpts=5 as parameters for the algorithm, that is clusters are composed of at least 5 points at a maximum normalized distance of 0.25.

of the distance between the fire and the population to ensure that close populations are exponentially affected.[11]

Lobbying: LobbyView. Following the Lobbying Disclosure Act of 1995, all lobbyists ought to register their lobbying activity with the U.S. Senate Office of Public Records. In particular, they need to declare their client, the amount spent on lobbying, the topics lobbied, and the entity targeted by the lobbying activity. Although this information is publicly available at the Senate Office of Public Records, we use the clean version *LobbyView* provided by I. S. Kim, 2018, where firms are matched to standard identifiers, such as the *gvkey* identifier for the Compustat database. In particular, we focus on clients that are firms from the automotive industry.

Using this dataset, we derive information on the topic firms lobby on by dividing lobbying expenditures into the nine groups of issues receiving the most expenditures. These groups of issues are manufacturing, trade, tax, labor, environment, consumer safety, trade, finance, innovation, and public expenditures. Last, we deduce information on the targeted entity. We create a variable for the log expenditures targeted at one of the eight institutions subject to the most lobbying (House of Representatives, Senate, White House, Department of Commerce, Environmental Protection Agency, Department of Energy, National Highway Traffic Safety Administration, and Trade Representative). We also aggregate entities following two criteria: first, political institutions versus agencies and, second, according to whether the institution's main mandate is towards environmental questions.[12]

Innovation: Patentsview. We measure innovation through granted patents at the United States Patent and Trademark Office (USPTO). Patents are dated by their year of application to precisely represent the year of their invention. We match patents with firms in our sample using the assignee disambiguation method of PatentsView and manual inspection.[13]

[11] The distance is computed between the center of gravity of the fire and the one of the state.

[12] We define political institutions (in opposition to independent agencies) as institutions where representatives are elected. The list of targets and their classifications can be found in the appendix.

[13] `https://patentsview.org/disambiguation`

Following Aghion, Dechezleprêtre, et al., 2016 we categorize patents using their Cooperative Patent Classification (CPC) into *clean*, *dirty*, and *grey* technologies. However, the number of patent applications may not reflect actual investment in R&D. To bypass this issue, we weight patent applications with an estimation of its private economic value from Kogan et al., 2017 updated until 2020. Finally, following Hall, 2005 and Bloom et al., 2016, we compute a measure of *knowledge stock*, K_{ist}, according to the recursive identity:

$$K_{ist} = (1 - \delta)K_{i,s,t-1} + R_{ist}$$

Where R_{ist} represents the economical market value of new patents from firm i in technology s. Following the literature on depreciation of R&D (Li et al., 2020), we set $\delta = 0.2$. [14]

State-level controls. We control for a series of state trends that may affect corporate strategies responding to shocks to consumer preferences. In particular, we control for local transportation habits (through the percentage of the population commuting by personal car, by public transportation, and by bike and the percentage of the population working remotely), local investments in the energy transition of transports (number of alternative fueling stations). We also control for demographic information such as the share of active in the labor market and young persons in the population; the share of the rural population, and the average income. Finally, we control major political preferences by using the share of votes for Republicans in the past presidential election.[15]

[14] Note that setting the standard annual rate $\delta = 0.15$ does not affect our results. Moreover, using the perpetual inventory method to compute the knowledge stock allows us to not rely on the $ln(1 + \text{Patents})$ that may bias our results.

[15] Data on transportation habits, local infrastructure, investment in local infrastructure, and alternative fueling stations come from the Bureau of Transportation Statistics. Demographic data comes from the Census and the share of the rural population comes from the Decennial Census. Personal income per capita comes from the Bureau of Economic Analysis. Last, election data comes from the MIT Election Data and Science Lab.

2.2 Summary Statistics

Having specified all main variables of interest, we now present a brief discussion of our sample and main variables.

Innovation and Lobbying. Our dataset is composed of 17 groups, which are the main groups of the automotive sector offering private cars.[16] We focus on groups, which are aggregates of makes because we observe in the data that both lobbying and innovation are most often set at the group level.[17] Table 1 reports the distributions of our main outcome variables. Table 3 reports average make characteristics.

We document that green technologies represent 57% of patent applications in our period of analysis, grey technologies around 28%, and dirty technologies account for only 16% of applications. Figure 9 depicts the trends in the different types of patenting since 1976. There is an exponential increase in the number of patents since the late 1990s' which was mainly driven by green applications. The number of clean patents rose by a factor of five during the period.[18] The level of dirty patenting remains stable over the period with a peak around the year 2000. Grey patenting follows similar but milder trends than green patenting until 2010. Then the number of applications plateaued at an intermediate level between green and dirty applications.[19]

There is high heterogeneity in the mix of technologies patented by firms, with makes such as Mazda or Isuzu innovating mainly in grey technologies, and others focusing on green technologies. However, all firms—with the exception of Tesla—innovate in all types of technologies. When studying the heterogeneity in response to consumers' environmental awareness we, therefore, do not compare *green* to *dirty* firms but use a continuous scale

[16] We remove from the sample groups with less than 30,000 registered cars over the whole period and truck-only companies.

[17] The group BMW, for instance, includes the makes BMW, Mini and Rolls-Royce. Similarly, the group General Motors includes the makes Oldsmobile, Hummer, GMC, Buick, Chevrolet, Saturn, Cadillac, and Pontiac. The whole list of groups and makes can be found in the appendix.

[18] In our dataset we only observe patent applications that were accepted by the USPTO. The application process takes a few years, so all applications after 2018 have not been accepted yet. This explains the sharp decrease in patenting we observe in the last quarter.

[19] These trends are congruent with trends presented in Aghion, Dechezleprêtre, et al., 2016; Aghion, Bénabou, et al., 2021.

of *greenness*.

15 out of the 17 firms in our sample lobby, and lobbying expenditures are substantial.[20] The average expenditure is US$683,000 with a maximal expenditure of more than US$6,3 million.[21] Splitting lobbying expenditures according to targeted topics on the firm level, we observe that on average 13% of lobbying expenditures are directed toward environmental topics. The largest firms in terms of market shares are also the largest spender in lobbying, with General Motors spending around US$503,000 by quarter and Ford spending on average US$320,000 per quarter. Interestingly, the highest share of lobbying expenditures going to environmental topics are from BMW (32% of total expenditure) and Tesla (30% of total expenditures); in comparison, both General Motors and Ford allocate 18% of their lobbying to environmental issues.

Variation in shock exposure. Figure 6 compares market shares across makes over the U.S. A more bluish color, for instance, means that the area represents a more important market for a given make than for other makes. There is important heterogeneity between companies: some are unexceptionably exposed to demand across the US (Ford, Toyota, and Jeep, for instance), while others are more exposed than the average make to some regions. To Tesla, for instance, the West and Washington DC are of superior importance, New England and the West Coast are highly important to BMW, and General Motors is highly exposed to demand in the Midwest and the South. These variations in the importance of specific states for firms are at the heart of our empirical strategy. In the next step, we discuss the second crucial variation: changes in environmental attitudes across states and time.

Trends in environmental awareness and fires. Our standard index of environmental attitudes toward the environment is presented in Figure 1. It is characterized by a positive trend over the first years followed by a drastic U-shape. While the decrease in environmen-

[20]The two groups that do not lobby are Suzuki and Isuzu.

[21]The order of magnitude surpasses by far campaign contributions or other political influence tools. We conjecture that adding other political influence tools would only increase the significance and magnitude of our results.

tal concerns is only somewhat discussed in the literature, our trends are congruent with the stark decline in environmental awareness presented in Aghion, Bénabou, et al., 2021 and the trends of the Gallup survey. In our sample, we observe that the decrease started around 2008, one candidate explanation is then the drop in the salience of climate issues as a consequence of the financial crisis. Importantly for us, there is significant variation at the state level and over time.

Exposure to wildfires. Because some confounders could affect consumer preferences and firm behavior, we instrument the index of environmental awareness by the exposure of populations to fires. Figure 7 pictures our index of fire exposure through time. The index is centered with respect to a yearly linear trend and state-quarter fixed effects, similar to our main regression. We observe a high heterogeneity both between states and across years.

3 Empirical Strategy

In this section, we introduce a quasi-experimental shift-share design to estimate the causal effects of changes in consumer environmental attitudes on firm decisions to lobby and invest in clean and dirty innovation.

3.1 Research Design

To estimate the causal effect of environmental attitudes on lobbying and innovation, the ideal experiment would change firms' consumer attitudes toward environmental issues. However, consumer preferences are an endogenous object. To approximate the ideal experiment using a shift-share IV design, we leverage two components: localized shocks to environmental concerns and pre-determined exposure shares to local markets.

Treatment. We seek to estimate the effect of a change in consumer preferences on a firm i. Using changes in our environmental preferences index build using Google Trends ENV_{lt}^{GT}, we measure the firm-level shock ΔENV_{it}^{GT} as the state-exposure weighted shock:

$$\Delta ENV_{it}^{GT} = \sum_{l}^{L} s_{ilt} \Delta ENV_{lt}^{GT} \tag{1}$$

Where weights $s_{ilt} = \frac{N_{ilt}}{N_{it}}$, $l \in L$ are the shares of state l in i total sales.

Instrument. To capture a purely demand-led mechanism, we instrument the change in environmental preferences. As discussed in Section 2, exogenous shocks are obtained through the identification of wildfires in the US. Those shocks are aggregated at the state level l to match observed firm market shares. We measure the shocks as changes in state exposure to wildfires over a period of 2 years (8 quarters).

$$g_{lt} = Fire\ Exposure_t - Fire\ Exposure_{t-8} \tag{2}$$

The shift-share design combines this set of local shocks with variations in exposure to local markets. The exposure shares $s_{i,l,t-h}$ are computed as the share of sales in state l in total sales of firm i lagged by h quarters. Because contemporaneous shares are likely to be subject to reverse causality, we use lagged shares, measured 4 years behind. Finally, the shift-share instrument is built by combining the shocks and exposure shares. [22]

$$Z_{it} = \sum_{l}^{L} s_{il,t-h} g_{lt} \tag{3}$$

Specification Outcomes are measured as log change over two years (or eight quarters) and our endogenous variable is the standardized index of environmental attitudes toward the environment. We then estimate by 2SLS

$$\Delta y_{it} = \lambda_t + \alpha_i + \beta_{it} \Delta ENV_{it}^{GT} + \gamma X_{it} + \varepsilon_{it} \tag{4}$$

[22] Firms may strategically change their exposure to markets given the shocks, and shocks may affect a firm's market share. By using lagged exposure, we make sure to capture variation that comes only from the shocks.

Where λ_t is a time fixed effect, α_i is a parameter capturing firm trends in the outcome variable, and X_{it} is a set of controls. Our coefficient of interest is β which captures the semi-elasticity of a change in the index of green environmental preferences, conditional on a set of controls X_{it}. We instrument the change in environmental preferences ΔENV_{it}^{GT} with the weighted change in wildfire Z_{it}.

3.2 Identification

The instrument used in this study is a combination of lagged exposure shares and local shocks. Previous studies on shift-share instruments have identified two possible sources of identification in this research design. The first source, as discussed by Goldsmith-Pinkham et al., 2020, is identification when the shares are exogenous. The second source, as shown by Borusyak et al., 2022, is when the instrumental variable (IV) identification assumption can be met through quasi-random assignment of shocks. In this paper, we argue that our study belongs to the latter category. In this section, we discuss the necessary conditions for identification:

Quasi-random shock assignment. This condition requires that $\mathbf{E}[g_{lt}|\bar{\varepsilon}_{lt}, \tilde{X}_l t s_{t-h}] = \tilde{X}_{lt}' \cdot \mu$. This implies that shocks are quasi-randomly assigned conditional on shock-level unobservable $\bar{\varepsilon}$, average lagged exposure s_{t-h}, and shock-level observables $\tilde{X}_{lt}$. In our design, it means that shocks are randomly assigned, conditional on state-level characteristics and period fixed effects.

Many uncorrelated shocks. This condition states that shocks should not be concentrated in few observations and that average exposure converges to 0 as observations increases. To effective number of shocks leveraged by this research design can be estimated by the inverse of the Herfindhal index HHI of the weights $\hat{s}_{l,t-h}$ where $\hat{s}_{l,t-h} = \frac{1}{N}\sum_i s_{il,t-h}$. We report the related statistics in Table 4. Our effective sample size is large (above 700) and our largest importance weight s_{lt} is below 1%.[23]

Relevance Condition. The relevance condition states that the instrument has power, that

[23]Note that even if we have relatively few treatment groups (50 states), we leverage the quarterly frequency in our data to reach consistency.

is $\mathbf{E}[\Delta Y_{it} \cdot Z_{it}|X_{it}] \neq 0$. This can be checked by computing the first-stage F-statistic which we report in our tables of results. Figure 2 visualizes the first-stage revealing a strong positive correlation between exposure to wildfires and environmental attitudes. This finding is in line with the literature which establishes that natural disasters strongly affect local public opinion on climate change (Bergquist et al., 2019).

All results are clustered at the state level, which allows for correlated shocks within a state across time. For example, California especially may expect numerous wildfires throughout our period of analysis. In a shift-share IV design, observation cannot be treated as i.i.d. We thus follow Adao et al., 2019 and Borusyak et al., 2022 to correct standard errors and the first-stage F-statistic.

4 Results

This section details our main results and additional analyses.

4.1 Main results

Our main results are shown in Table 5. The first two panels report results for variables capturing lobbying expenditures as the dependent variable: lobbying expenditures on environmental topics, and total lobbying expenditures.[24] The following three panels use the change in the stock of clean, dirty, and grey patents, respectively, in a firm measured as the knowledge stock detailed in Section 2. All outcomes are in two-year log difference and include year-quarter fixed effects, firm fixed effect, and the lagged market share at the firm level.

Table 5 separates into an OLS regression, columns 1 to 4, and our preferred IV estimates, columns 5 to 8. We first turn to the OLS estimates. The first column applies a bare-bone specification that includes no covariates beyond the change in environmental awareness,

[24] We focus on the intensive margin of lobbying. Lobbying activity has inherent fixed costs rendering it extremely persistent. We thus do not have enough heterogeneity in the extensive margin to measure the impact of environmental concerns on it. Details on how lobbying expenditures are aggregated between issues and institutions can be found in the appendix.

the specific fixed effects, and the lagged market shares. The estimates of column 1 suggest no significant correlation between the change in consumers' environmental awareness and our dependent variables, with the exception of a negative correlation with grey innovation. In column 2, we augment the long difference model with a set of demographic controls, such as population and income per capita, which test robustness and potentially eliminate confounders. This specification presents a positive correlation between the increase in environmental concerns and lobbying expenditures targeted at environmental institutions. In the third column, we add controls for transportation habits (the share of the population commuting by personal car and state-level investments in transportation infrastructures). Finally, we control for the score for Republicans in the last presidential elections in column 4. These specifications further address the concern that firms might respond differently to different populations depending on their demographics and income level and the concern that the response of firms runs primarily through public policies and not demand. In all three specifications, the controls leave the results of similar magnitude and significance.

The following four columns repeat the same specifications instrumenting the change in the environmental attitudes index by the change in exposure to wildfires. This allows us to exclude confounding factors affecting both the demand and supply sides. Consider column 5. We don't observe a significant impact of consumer awareness on total lobbying expenditures. However, lobbying on environmental topics increased as a consequence of environmental concerns. This suggests a reallocation of the lobbying activity within topics. Also, clean patenting responded positively to contemporaneous exposure to greener consumers, while dirty patenting decreased, and grey patenting didn't react significantly.[25] The results are of the same magnitude after the inclusion of demographic, transportation, and political controls. In five out of six models, the IV estimates are larger than their OLS counterparts suggesting that the instrumentation purges the potential effect of confounders shocks or measurement error (or both).

The results are economically meaningful. A one standard deviation increase in envi-

[25]These results are in line with Aghion, Bénabou, et al., 2021 who find that exposure to greener attitudes fosters clean innovation.

ronmental concerns implies a rise in environmental lobbying expenditures by a factor of 3. Moreover, the last two panels suggest that a one standard deviation increase in environmental awareness spurs green innovation on average by a factor of 2.4 and slows down dirty innovation by a factor of 1.1.

Taken together, these results suggest that, on the one hand, greener household preferences urge firms to innovate cleaner technologies. On the other hand, however, firms' returns to lobbying on environmental issues increase. Protecting profits seems to become vital as firms need to finance more clean innovation while returns to dirtier goods decline. A possible explanation is that R&D investment becomes more important when profits are low due to fixed costs of innovation. Another may be first-mover advantages in particular in a market for durable goods.

To ensure that our results capture the period-specific effects of exposure to consumers' environmental awareness, and not some long-run common causal factor behind both the rise in awareness and technological change or lobbying, we conduct a falsification exercise by regressing past changes in innovation and lobbying expenditures on future changes in environmental awareness. The results of the pre-trend falsification tests are presented in Table 8, where the first two panels focus on lobbying activity and the three following panels on patenting, similarly to our main table of results. Across all five specifications, we cannot reject that there is no relationship between the shocks and our lagged dependent variables on lobbying expenditures and innovation. These results lend credibility to a causal interpretation of these estimates.

4.2 Additional analysis

Topics lobbied. Our results suggest that while total lobbying expenditures do not increase at the firm level, there is a reallocation within issues and institutional targets towards green topics. To further understand how firms react to environmental concerns, we repeat in this section our empirical strategy of dividing lobbying expenditures into different groups of issues - that is the topic on which firms lobby - and targets - which are the institutions lobbied.

Table 6 presents the results for the different issues, where the dependent variable is successively the lobbying expenditures targeted environmental topics, taxation, trade, innovation, finance, manufacturing, labor, and public expenditures. Apart from environmental topics, the issues toward which there is a clear reallocation in lobbying expenditures are trade and manufacturing. The estimates suggest that a one standard deviation increase in environmental topics results in an increase in lobbying expenditures, respectively, by a factor of 6.5 and 7. The magnitude is economically significant and twice as large as the one on environmental lobbying. These two topics receive a significant share of total lobbying and represent 12% and 38% of total expenditures.

The increase in lobbying is therefore not concentrated solely on environmental topics. This further suggests that lobbying can be viewed as an escape-competition avenue, for those firms for which clean innovation is particularly expensive. We note that we do not observe a significant decrease in the expenditures allocated to other topics, indicating that there is a high heterogeneity in the topics from which firms reallocate expenditures.

Institutions lobbied. Similarly, Table 7 presents the results of the main specification where the dependent variable is the amount of lobbying expenditures targeted at a specific institution. There are over eighty institutions targeted by lobbying from the automotive sector. We first group the institutions into two main categories and then focus on the eight institutions targeted by the largest number of firms. All our results are interpreted taking into account the absence of effect of our shocks on the *total* amount of lobbying expenditures.

The first panel gathers expenditures at all the targets whose main mandate is related to environmental issues.[26] The second panel focuses on political institutions - that is institutions where representatives are elected - in opposition to independent agencies.[27] The

[26]These targets are the Environmental Protection Agency, the Department of Energy, the Council on Environmental Quality, and the Federal Energy Regulatory Commission. For simplicity, we refer to this group of targets as environmental institutions in the rest of the paper.

[27]The list of political institutions can be found in the appendix.

following panels focus, respectively, on expenditures targeted at the Department of Energy, the Environmental Protection Agency (EPA), the National Highway Traffic Safety, the Department of Commerce, the Trade Representative, the House of Representatives, the Senate, and the White House.

Panel 1 presents a positive causal relationship between environmental concerns and lobbying expenditures on environmental institutions. This result is in line with the previous results on environmental topics. However, we note that the estimates are twice as large, implying that a one standard deviation increase in environmental awareness results in an increase in lobbying expenditures on these targets by a factor of 7.5. Decomposing, we find a modest causal effect of consumers' attitudes on expenditures targeted at the Department of Energy (panel 3) and no effect on expenditures targeted at the EPA (panel 4). These results could be explained by a sample effect or the fact that lobbying expenditures on each individual issue are too noisy to measure the impact of our shocks.

Panel 2 focuses on lobbying targeted at political institutions. Changes in consumers' environmental concerns can be understood as changes in public opinion, and therefore as changes in the salience of environmental issues for voters. Politicians therefore have incentives to adapt to new concerns. On the contrary, independent agencies do not rely on public support and do not see their incentives shift with public opinion. Interestingly, our estimate suggests that lobbying on political institutions responded positively to contemporaneous exposure to greener consumers. This confirms the intuition that firms are concerned with new environmental regulations, after the shift of our index of environmental attitudes toward the environment. The political institutions targeted the most by lobbyists are the House of Representatives, the Senate, and the White House. Surprisingly, we observe no simultaneous effect on the expenditures targeted at the first two. The causal impact of environmental attitudes on lobbying on the White House is positive, statistically significant, and of meaningful magnitude.

Last, Panel 7 exhibits a positive effect of environmental concerns on lobbying expenditures targeted at the Trade Representative, in line with our results of Table 6. This result highlights one more time lobbying as an escape-competition avenue, and the necessity for firms to protect their profits in view of a technology transition.

5 Conclusion

Households' environmental concerns are rising presumably lowering demand for dirty goods. How do firms react to an increase in green preferences? The literature points to the innovation of cleaner technologies as a response (Aghion, Bénabou, et al., 2021). We show that there exists another margin of adjustment: environmental lobbying.

More precisely, We examine firm responses in the automotive industry to exogenous changes in household concerns about the environment in the US from 2005 to 2020. Our findings suggest that automotive firms not only innovate cleaner technologies but also increase their lobbying on environmental topics. We argue that the eagerness to innovate clean plus the reduction in profits from dirty goods makes environmental lobbying more valuable to firms. As firms' profits decline, the ability to invest in R&D reduces. Protecting remaining profits becomes especially important for firms to survive a transition to green production. We interpret lobbying on environmental topics as a measure to protect profits and finance research on clean technologies.

In a next step, we plan to scrutinize more closely the heterogeneity of firm responses. We seek to test the hypothesis that the rise in environmental lobbying is driven by firms with a dirtier stock of technologies. Dirtier firms have an increased incentive to prevent stricter environmental regulations in a response to a shift in demand toward clean products. First, those firms are affected more adversely by the shift in demand. Second, these firms need to innovate clean to not lag behind cleaner firms and eventually survive a green transition of the economy. Finally, dirtier firms are hit more by stricter environmental regulation.

Relatedly, we intend to investigate the complementarity and dynamics behind the two dimensions of firm response to a demand shock: clean innovation and lobbying. We expect the initial sizable response in lobbying expenses to decay over time as firms' stock of clean innovation rises. We would then think of lobbying as a means to generate profits in the short run until the firm transitioned to green means of production.

We argue that our results are best explained by a demand channel and not a change in policies. To mitigate concerns that it is in fact a change in regulations on the state level which drives our results, we plan to construct a variable capturing environmental state-level policy changes using public information on state environmental regulations.[28] This dataset will then be available for future research on environmental policies.

[28] Information on state-level policies are collected here: `https://www.epa.gov/aboutepa/health-and-environmental-agencies-us-states-and-territories`.

References

Adao, Rodrigo, Michal Kolesár, and Eduardo Morales (2019). "Shift-share designs: Theory and inference". In: *The Quarterly Journal of Economics* 134.4, pp. 1949–2010.

Aghion, Philippe, Roland Bénabou, Ralf Martin, et al. (2021). "Environmental Preferences and Technological Choices: Is Market Competition Clean or Dirty?"

Aghion, Philippe, Nicholas Bloom, Richard Blundell, et al. (2005). "Competition and Innovation: an Inverted-U Relationship". In: *The Quarterly Journal of Economics* 120.2, pp. 701–728.

Aghion, Philippe, Richard Blundell, Rachel Griffith, et al. (2009). "The Effects of Entry on Incumbent Innovation and Productivity". In: *The Review of Economics and Statistics* 91.1, pp. 20–32.

Aghion, Philippe, Antoine Dechezleprêtre, David Hémous, et al. (2016). "Carbon Taxes, Path Dependency, and Directed Technical Change: Evidence from the Auto Industry". In: *Journal of Political Economy* 124.1, pp. 1–51.

Akcigit, Ufuk, Salomé Baslandze, and Francesca Lotti (2022). *Connecting to power: political connections, innovation, and firm dynamics*. Temi di discussione (Economic working papers) 1376. Bank of Italy, Economic Research and International Relations Area.

Autor, David, David Dorn, Gordon H. Hanson, et al. (2020). "Foreign Competition and Domestic Innovation: Evidence from US Patents". In: *American Economic Review: Insights* 2.3, pp. 357–74.

Bartling, Björn, Roberto A. Weber, and Lan Yao (2015). "Do markets erode social responsibility?" In: *Quarterly Journal of Economics* 130.1, pp. 219–266. ISSN: 15314650.

Bénabou, Roland and Jean Tirole (2010). "Individual and corporate social responsibility". In: *Economica* 77.305, pp. 1–19. ISSN: 00130427.

Bergquist, Magnus, Andreas Nilsson, and P. Wesley Schultz (2019). "Experiencing a Severe Weather Event Increases Concern About Climate Change". In: *Frontiers in Psychology* 10. ISSN: 1664-1078.

Bloom, Nicholas, Mirko Draca, and John van Reenen (2016). "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity". In: *The Review of Economic Studies* 83.1, pp. 87–117. ISSN: 00346527, 1467937X.

Bombardini, Matilde (2008). "Firm heterogeneity and lobby participation". In: *Journal of International Economics* 75.2, pp. 329–348.

Bombardini, Matilde, Olimpia Cutinelli-Rendina, and Francesco Trebbi (2021). *Lobbying Behind the Frontier*. CEPR Discussion Paper DP16390.

Borusyak, Kirill, Peter Hull, and Xavier Jaravel (2022). "Quasi-experimental shift-share research designs". In: *The Review of Economic Studies* 89.1, pp. 181–213.

Brandt, Loren, Johannes Van Biesebroeck, Luhang Wang, et al. (2017). "WTO Accession and Performance of Chinese Manufacturing Firms". In: *American Economic Review* 107.9, pp. 2784–2820.

Choi, Hyunyoung and Hal Varian (2012). "Predicting the present with Google Trends". In: *Economic record* 88, pp. 2–9.

Dobkowitz, Sonja (2022). "Redistribution, Demand, and Sustainable Production".

Ester, Martin, Hans-Peter Kriegel, Jörg Sander, et al. (1996). "A density-based algorithm for discovering clusters in large spatial databases with noise." In: *kdd*. Vol. 96. 34, pp. 226–231.

Falk, Armin, Peter Andre, Teodora Boneva, et al. (2021). *Fighting Climate Change: The Role of Norms, Preferences, and Moral Values*. Tech. rep.

Giger, Nathalie and Heike Klüver (2016). "Voting Against Your Constituents? How Lobbying Affects Representation ." In: *American Journak of Political Science* 1, pp. 190–205.

Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift (2020). "Bartik instruments: What, when, why, and how". In: *American Economic Review* 110.8, pp. 2586–2624.

Gullberg, Anne Therese (2008). "Rational lobbying and EU climate policy." In: *International Environmental Agreements: Politics, Law and Economics* 8, pp. 161–178.

Hall, Bronwyn H (2005). "Measuring the Returns to R&D: The Depreciation Problem". In: *Annales d'Économie et de Statistique*, pp. 341–381.

Hombert, Johan and Adrien Matray (2018). “Can Innovation Help U.S. Manufacturing Firms Escape Import Competition from China?” In: *Journal of Finance* 73.5, pp. 2003–2039.

Kang, Karam (2016). “Policy influence and private returns from lobbying in the energy sector”. In: *Review of Economic Studies* 83.1, pp. 269–305.

Kim, In Song (2018). *Lobbyview: Firm-level lobbying & congressional bills database*. Tech. rep. *Unpublished manuscript, MIT, Cambridge, MA. A. http://web. mit. edu/insong/www/pdf/lobbyview. pdf Google Scholar Article Location*.

Kim, Sung Eun, Johannes Urpelainen, and Joonseok Yang (2016). “Electric utilities and American climate policy: lobbying by expected winners and losers.” In: *Journal of Public Policy* 36.2, pp. 251–275.

Kogan, Leonid, Dimitris Papanikolaou, Amit Seru, et al. (2017). “Technological innovation, resource allocation, and growth”. In: *The Quarterly Journal of Economics* 132.2, pp. 665–712.

Li, Wendy CY and Bronwyn H Hall (2020). “Depreciation of business R&D capital”. In: *Review of Income and Wealth* 66.1, pp. 161–180.

McKay, Amy (2012). “Negative Lobbying and Policy Outcomes.” In: *American Politics Research* 1, pp. 116–146.

Meis-Harris, Julia, Celine Klemm, Stefan Kaufman, et al. (2021). “What is the role of eco-labels for a circular economy? A rapid review of the literature”. In: *Journal of Cleaner Production* 306, p. 127134.

Meng, Kyle C. and Ashwin Rode (2019). “The social cost of lobbying over climate policy/”. In: *Natural Climate Change* 9, pp. 472–476.

Stephens-Davidowitz, Seth and Hal Varian (2014). “A hands-on guide to Google data”. In: *further details on the construction can be found on the Google Trends page*.

Vermeir, Iris and Wim Verbeke (2006). “Sustainable food consumption: Exploring the consumer ”attitude - Behavioral intention” gap”. In: *Journal of Agricultural and Environmental Ethics* 19.2, pp. 169–194. ISSN: 11877863.

Vona, Francesco and Fabrizio Patriarca (2011). “Income inequality and the development of environmental technologies”. In: *Ecological Economics* 70.11, pp. 2201–2213. ISSN: 09218009.

Vosen, Simeon and Torsten Schmidt (2011). “Forecasting private consumption: survey-based indicators vs. Google trends”. In: *Journal of Forecasting* 30.6, pp. 565–578.

West, Robert (2020). “Calibration of Google Trends time series”. In: *Proceedings of the 29th ACM International Conference on Information & Knowledge Management*, pp. 2257–2260.

Appendix

A Tables

Table 1: Summary statistics of the outcomes

	Mean	SD	P25	P50	P75	P95
$\Delta ln(Lobby)$ (Env. topics)	-0.03	0.82	-0.41	0.00	0.34	1.34
$\Delta ln(Lobby)$ (Total)	0.07	1.19	-0.19	0.02	0.28	1.15
$\Delta ln\ K_{clean}$	-0.65	1.14	-1.83	-0.49	0.08	1.63
$\Delta ln\ K_{dirty}$	-0.91	1.51	-1.83	-1.83	-0.23	0.54
$\Delta ln\ K_{grey}$	-0.82	2.12	-1.83	-1.83	-0.17	0.79

Notes: The table summarizes the main outcomes in our analysis. Data is observed quarterly and outcomes are computed as a 2 year change. The first line is log change in lobbying targeted to environmental topics. Second line is log change in total lobbying expenses. The last three rows are change in patents stock for clean, dirty, and grey innovations. See section 2 for a description of the dataset.

Table 2: Firm lobbying expenditures by target

	Mean	SD	P25	P50	P75	Max
Lobbying	683.92	842.94	38.01	380.00	1040.01	6380.00
- Political Group	555.15	729.38	30.00	261.67	742.51	5224.97
– Senate	253.25	298.55	13.33	136.60	405.14	1725.81
– White House	16.55	41.62	0.00	0.00	5.00	514.61
– House of Representatives	255.33	299.22	13.12	144.93	415.75	1725.81
– Dpt. of Commerce	11.23	23.23	0.00	0.00	10.02	140.91
– Dpt. of Energy	16.33	42.43	0.00	0.00	6.17	531.61
- Agencies	123.03	217.59	0.00	24.44	145.63	1374.44
– EPA	18.61	35.95	0.00	0.00	27.20	431.31
– NHTSA	14.36	30.72	0.00	0.00	10.00	205.86
– USTR	12.38	25.23	0.00	0.00	17.05	347.98

Notes: The table summarizes the distribution of quarterly lobbying expenses for a list of target in thousand of dollars. The first row report the total lobbying. On average, makes spend 684k$ on lobbying each quarter.

Table 3: Summary Statistics by Make (Quarterly, 2006-2019)

Make	Clean Patents	Dirty Patents	Grey Patents	Lobbying (k$)	Market Share (avg,%)
BMW	10.71	2.52	3.02	131.45	2.32
Daimler	5.12	0.92	2.29	438.45	2.09
FCA	4.46	1.15	1.90	1271.57	11.61
Ford	63.58	25.17	47.96	1786.18	15.03
Geely Automobile Hld.	3.19	0.88	1.83	334.69	0.52
General Motors	47.40	15.48	30.56	2773.49	19.61
Honda	41.50	16.02	11.35	769.56	9.82
Hyundai Kia Automotive Group	79.77	15.35	26.31	437.90	7.01
Isuzu	0.42	0.59	3.76	0.00	0.03
Mazda Motors Gr.	2.00	2.46	9.15	35.57	1.85
Renault-Nissan-Mitsubishi	33.79	6.35	12.58	1115.96	8.46
Subaru Gr.	4.00	0.38	1.00	2.50	2.45
Suzuki	3.69	2.28	0.79	0.00	0.38
Tata Gr.	4.56	0.68	1.26	127.92	0.45
Tesla	3.21			161.07	0.10
Toyota Group	116.10	19.15	43.31	1577.17	15.00
Volkswagen	21.77	3.46	6.67	381.64	3.34

Notes: The table summarizes patenting activity, lobbying, and market share for the make group that we observe in our sample. First three columns are the average number of patent applications per quarter that are categorized as clean, dirty, and grey. Lobbying is the average lobbying expenses per quarter. The last column reports the average market share of the firm over all quarters such that the column may not sum to one.

Table 4: Shocks and Shares Summary Statistics

Panel A: Shocks Summary Statistics

	Mean	Std. dev.	p5	p95
g_{lt}	−0.04	0.01	−0.02	0.03
g_{lt} (w. period FE)	0.00	0.01	−0.01	0.01

Panel B: Shares Summary Statistics

	Mean	Max
$1/HHI$	719.56	719.56
s_{lt} (pct)	0.05	0.44
Treatment Groups	50.00	50.00

Notes: Panel A summarize the distribution of the instrument (change in wildfire intensity exposure) across states. All statistics are weighted by the average state exposure share $s_{l,t}$. Panel B reports the *effective sample size* computed as the inverse of the Herfindahl index of the average state exposure share $s_{l,t}$. the second line reports exposures statistics in percent. Our largest average exposure share is less than 1 percent. Finally, we report the number of treatment groups, which are the 50 states (excluding DC).

Table 5: Regression estimates: effect of environmental preferences on firms outcome

	OLS				IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta_8 ln(lobby) Lobbying$ *(Environment Topics)*								
$\Delta_8 ENV^{GT}$	0.34	0.36	0.29	0.27	3.10***	3.08***	3.06***	3.09***
	(0.51)	(0.56)	(0.57)	(0.57)	(0.83)	(0.82)	(0.81)	(0.80)
$\Delta_8 ln(lobby)$ *(Total)*								
$\Delta_8 ENV^{GT}$	-0.28	-0.60	-0.74*	-0.74*	0.67	0.66	0.70	0.70
	(0.31)	(0.40)	(0.42)	(0.43)	(0.81)	(0.85)	(0.84)	(0.83)
Δ_8 *Clean Knowledge Capital*								
$\Delta_8 ENV^{GT}$	0.29	0.78	0.93	0.91	2.27***	2.37***	2.33***	2.36***
	(0.39)	(0.62)	(0.57)	(0.56)	(0.71)	(0.65)	(0.66)	(0.64)
Δ_8 *Dirty Knowledge Capital*								
$\Delta_8 ENV^{GT}$	0.23	0.18	0.13	0.13	-1.09***	-1.11***	-1.09***	-1.08**
	(0.20)	(0.22)	(0.22)	(0.22)	(0.39)	(0.39)	(0.40)	(0.41)
Δ_8 *Grey Knowledge Capital*								
$\Delta_8 ENV^{GT}$	-1.04***	-0.27**	-0.14	-0.14	0.79	0.77	0.70	0.70
	(0.19)	(0.11)	(0.09)	(0.09)	(0.92)	(0.74)	(0.71)	(0.72)
FE: year-quarter	X	X	X	X	X	X	X	X
Firm Trend	X	X	X	X	X	X	X	X
Lagged Firm Controls	X	X	X	X	X	X	X	X
Lagged Demographic Controls		X	X	X		X	X	X
Lagged Transportation Controls			X	X			X	X
Lagged Political Controls				X				X
N (states - periods)	2000	2000	2000	2000	2000	2000	2000	2000
First-Stage F					46	49	50	50

Signif. codes: ***: 1%, **: 5%, *: 10%
Notes: Column (1) to (4) are OLS, (5) to (6) are Shift-Share IV. Standard errors clustered at the state level are in parentheses. all changes are in 2 years differences (8 quarters). ΔENV^{GT} represent the 8 quarters difference in the environmental awareness index that is constructed in section 2. In columns (5) to (8), it is instrumented by the change exposure to wildfire computed using satellite data from NASA's FIRMS dataset. Each line-column is the result of a different regression. Each line report the result for a different outcome. First three rows are related to change in lobbying expenditures. Last three are net investment in innovation using patent valuation. The unit of analysis are US automotive groups. Outcomes are extensively described in the 2 section.

Table 6: OLS and Shift Share IV of Firms Lobbying by Topic

	OLS				IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta_8 ln(Lobby)$ $(Environment)$								
$\Delta_8 ENV^{GT}$	0.34	0.36	0.29	0.27	3.10***	3.08***	3.06***	3.09***
	(0.51)	(0.56)	(0.57)	(0.57)	(0.83)	(0.82)	(0.81)	(0.80)
$\Delta_8 ln(Lobby)$ $(Taxation)$								
$\Delta_8 ENV^{GT}$	-0.93**	-0.84*	-0.87*	-0.88*	1.74*	1.77*	1.81*	1.82*
	(0.45)	(0.43)	(0.45)	(0.46)	(1.00)	(0.97)	(0.94)	(0.94)
$\Delta_8 ln(Lobby)$ $(Trade)$								
$\Delta_8 ENV^{GT}$	0.67***	0.68**	0.67**	0.67**	6.46***	6.50***	6.49***	6.48***
	(0.25)	(0.28)	(0.29)	(0.29)	(2.04)	(2.02)	(2.02)	(2.03)
$\Delta_8 ln(Lobby)$ $(Innovation)$								
$\Delta_8 ENV^{GT}$	-0.20***	-0.20***	-0.21***	-0.21***	-0.27	-0.27	-0.27	-0.27
	(0.05)	(0.05)	(0.06)	(0.06)	(0.21)	(0.21)	(0.21)	(0.21)
$\Delta_8 ln(Lobby)$ $(Finance)$								
$\Delta_8 ENV^{GT}$	0.02	0.02	0.02	0.02	1.09*	1.10*	1.11*	1.11*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.58)	(0.57)	(0.58)	(0.58)
$\Delta_8 ln(Lobby)$ $(Manufacturing)$								
$\Delta_8 ENV^{GT}$	0.10	0.08	0.08	0.09	6.95***	6.99***	6.95***	6.94***
	(0.13)	(0.11)	(0.09)	(0.09)	(1.54)	(1.52)	(1.53)	(1.53)
$\Delta_8 ln(Lobby)$ $(Labor)$								
$\Delta_8 ENV^{GT}$	-0.67***	-0.65***	-0.64***	-0.64***	0.65	0.67	0.66	0.65
	(0.19)	(0.18)	(0.19)	(0.18)	(0.48)	(0.48)	(0.47)	(0.47)
$\Delta_8 ln(Lobby)$ $(Public\ Expenses)$								
$\Delta_8 ENV^{GT}$	-0.12	-0.08	-0.05	-0.05	-0.16	-0.16	-0.16	-0.17
	(0.08)	(0.08)	(0.07)	(0.07)	(0.22)	(0.23)	(0.23)	(0.23)
FE: year-quarter	X	X	X	X	X	X	X	X
Firm Trend	X	X	X	X	X	X	X	X
Lagged Firm Controls	X	X	X	X	X	X	X	X
Lagged Demographic Controls		X	X	X		X	X	X
Lagged Transportation Controls			X	X			X	X
Lagged Political Controls				X				X
N (states - periods)	2000	2000	2000	2000	2000	2000	2000	2000
First-Stage F					46	49	50	50

Signif. codes: ***: 1%, **: 5%, *: 10%
Notes: The table reports results of our regression on log change in lobbying expenses categorized by topic. Column (1) to (4) are OLS, (5) to (6) are Shift-Share IV. Standard errors clustered at the state level are in parentheses. all changes are in 2 years differences (8 quarters). ΔENV^{GT} represent the 8 quarters difference in the environmental awareness index that is constructed in section 2. In columns (5) to (8), it is instrumented by the change exposure to wildfire computed using satellite data from NASA's FIRMS dataset. Each line-column is the result of a different regression. Each line report the result for a different outcome. First three rows are related to change in lobbying expenditures. Last three are net investment in innovation using patent valuation. The unit of analysis are US automotive groups. Outcomes are extensively described in the 2 section.

Table 7: OLS and Shift Share IV of Firms Lobbying by Targeted Agency

	OLS				IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta_8 ln(Lobby)$ (*All env. Targets*)								
$\Delta_8 ENV^{GT}$	0.18*	0.24**	0.30**	0.31**	7.47***	7.53***	7.49***	7.47***
	(0.10)	(0.12)	(0.12)	(0.12)	(2.04)	(1.98)	(2.00)	(2.00)
$\Delta_8 ln(Lobby)$ (*All Political Inst.*)								
$\Delta_8 ENV^{GT}$	0.10	0.16	0.14	0.13	2.18***	2.19***	2.18***	2.18***
	(0.22)	(0.23)	(0.23)	(0.23)	(0.46)	(0.47)	(0.48)	(0.48)
$\Delta_8 ln(Lobby)$ (*Dpt. of Energy*)								
$\Delta_8 ENV^{GT}$	-0.01	-0.01	0.00	0.00	0.40**	0.41**	0.41**	0.41**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.16)	(0.16)	(0.16)	(0.16)
$\Delta_8 ln(Lobby)$ (*EPA*)								
$\Delta_8 ENV^{GT}$	-0.14*	-0.10	-0.08	-0.08	0.62	0.63	0.64	0.64
	(0.08)	(0.08)	(0.07)	(0.07)	(0.50)	(0.50)	(0.51)	(0.51)
$\Delta_8 ln(Lobby)$ (*NHTS*)								
$\Delta_8 ENV^{GT}$	0.26***	0.35***	0.40***	0.39***	0.20	0.19	0.20	0.20
	(0.07)	(0.08)	(0.07)	(0.07)	(0.61)	(0.60)	(0.61)	(0.62)
$\Delta_8 ln(Lobby)$ (*Dpt. of Commerce*)								
$\Delta_8 ENV^{GT}$	-0.15**	-0.17**	-0.17**	-0.17**	1.19**	1.20**	1.21**	1.21**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.50)	(0.50)	(0.49)	(0.49)
$\Delta_8 ln(Lobby)$ (*Trade Representative*)								
$\Delta_8 ENV^{GT}$	0.07	0.07	0.07	0.07	2.55***	2.57***	2.56***	2.55***
	(0.10)	(0.11)	(0.12)	(0.12)	(0.72)	(0.71)	(0.71)	(0.71)
$\Delta_8 ln(Lobby)$ (*House of Representatives*)								
$\Delta_8 ENV^{GT}$	0.08	0.05	0.00	0.00	2.20***	2.21***	2.21***	2.22***
	(0.15)	(0.16)	(0.15)	(0.15)	(0.68)	(0.70)	(0.71)	(0.71)
$\Delta_8 ln(Lobby)$ (*Senate*)								
$\Delta_8 ENV^{GT}$	-0.10	-0.13	-0.17	-0.17	0.61	0.61	0.61	0.61
	(0.18)	(0.18)	(0.17)	(0.17)	(0.60)	(0.61)	(0.62)	(0.63)
$\Delta_8 ln(Lobby)$ (*White House*)								
$\Delta_8 ENV^{GT}$	0.24	0.24	0.23	0.23	3.20***	3.22***	3.20***	3.20***
	(0.15)	(0.16)	(0.16)	(0.16)	(1.00)	(1.00)	(1.01)	(1.01)
FE: year-quarter	X	X	X	X	X	X	X	X
Firm Trend	X	X	X	X	X	X	X	X
Lagged Firm Controls	X	X	X	X	X	X	X	X
Lagged Demographic Controls		X	X	X		X	X	X
Lagged Transportation Controls			X	X			X	X
Lagged Political Controls				X				X
N (states - periods)	2000	2000	2000	2000	2000	2000	2000	2000
First-Stage F					46	49	50	50

Signif. codes: ***: 1%, **: 5%, *: 10%
Notes: Regression on log change in lobbying expenses categorized by target. (1) to (4) are OLS, (5) to (6) are Shift-Share IV. Standard errors clustered at the state level are in parentheses. Independent variable is th change in environmental preferences instrumented in columncs (5) to (8) by the change in exposure to wildfire computed using NASA's FIRMS dataset. Each line-column is the result of a different regression.

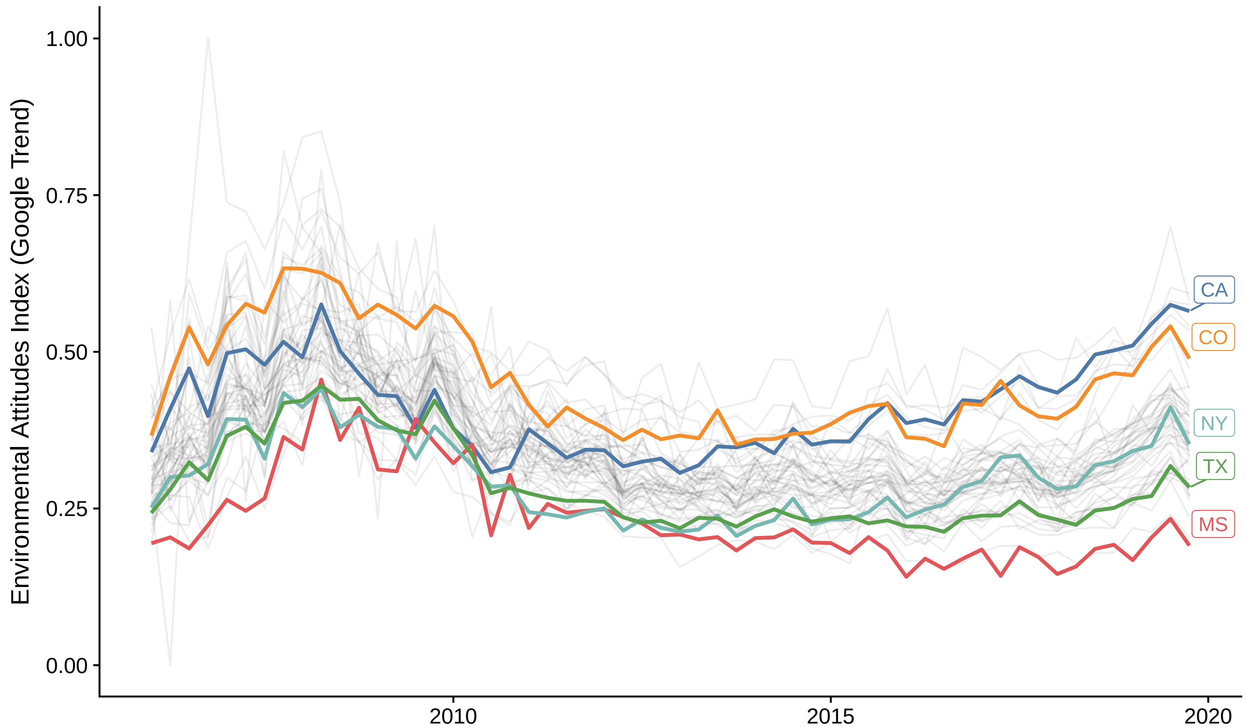
Table 8: Falsification test for the IV regression on lagged Patents

	(1)	(2)	(3)	(4)
Lagged $\Delta_8 ln(lobby) Lobbying$ (*Environment Topics*)				
$\Delta_8 ENV^{GT}$	0.61	0.18	-0.27	-0.26
	(0.92)	(0.91)	(1.06)	(1.07)
Lagged $\Delta_8 ln(lobby)$ (*Total*)				
$\Delta_8 ENV^{GT}$	0.78	-0.11	-0.45	-0.44
	(0.49)	(0.74)	(0.63)	(0.64)
Lagged Δ_8 *Clean Knowledge Capital*				
$\Delta_8 ENV^{GT}$	0.24	0.54	0.69	0.66
	(0.46)	(0.54)	(0.60)	(0.60)
Lagged Δ_8 *Dirty Knowledge Capital*				
$\Delta_8 ENV^{GT}$	0.84*	0.72	0.58	0.57
	(0.42)	(0.49)	(0.51)	(0.51)
Lagged Δ_8 *Grey Knowledge Capital*				
$\Delta_8 ENV^{GT}$	-1.95***	-0.66	-0.46	-0.49
	(0.64)	(0.89)	(0.84)	(0.84)
FE: year-quarter	X	X	X	X
Firm Trend	X	X	X	X
Lagged Firm Controls	X	X	X	X
Lagged Demographic Controls		X	X	X
Lagged Transportation Controls			X	X
Lagged Political Controls				X
First-Stage F	58	53	47	47
N (states - periods)	1500	1500	1500	1500

Signif. codes: ***: 1%, **: 5%, *: 10%
Notes: The table reports coefficients from the shift-share IV falsification tests. We regress the two-year change in the environmental preferences index on lagged changed in outcome. The change in environmental preferences index is instrumented with the change in wildfire intensity computed from NASA's FIRMS dataset. Clustered standard errors at the state level are in parentheses.

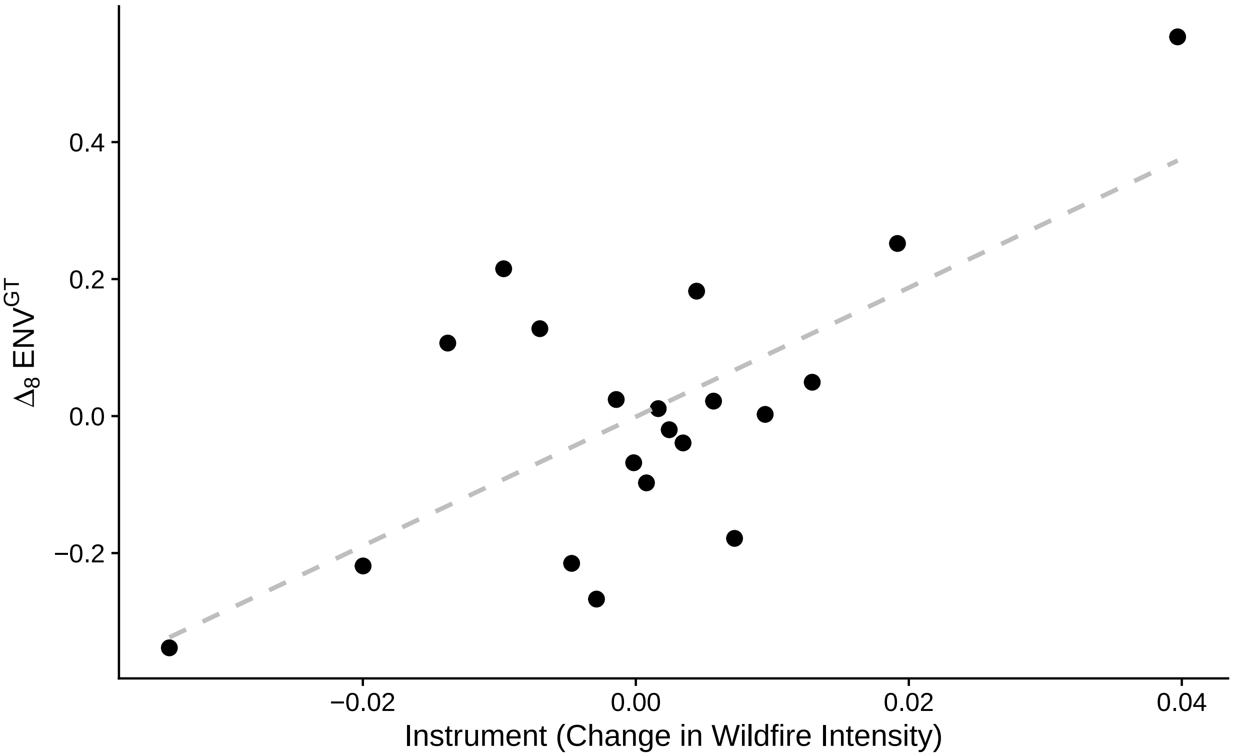
B Figures

Figure 1: Environmental Preferences Index



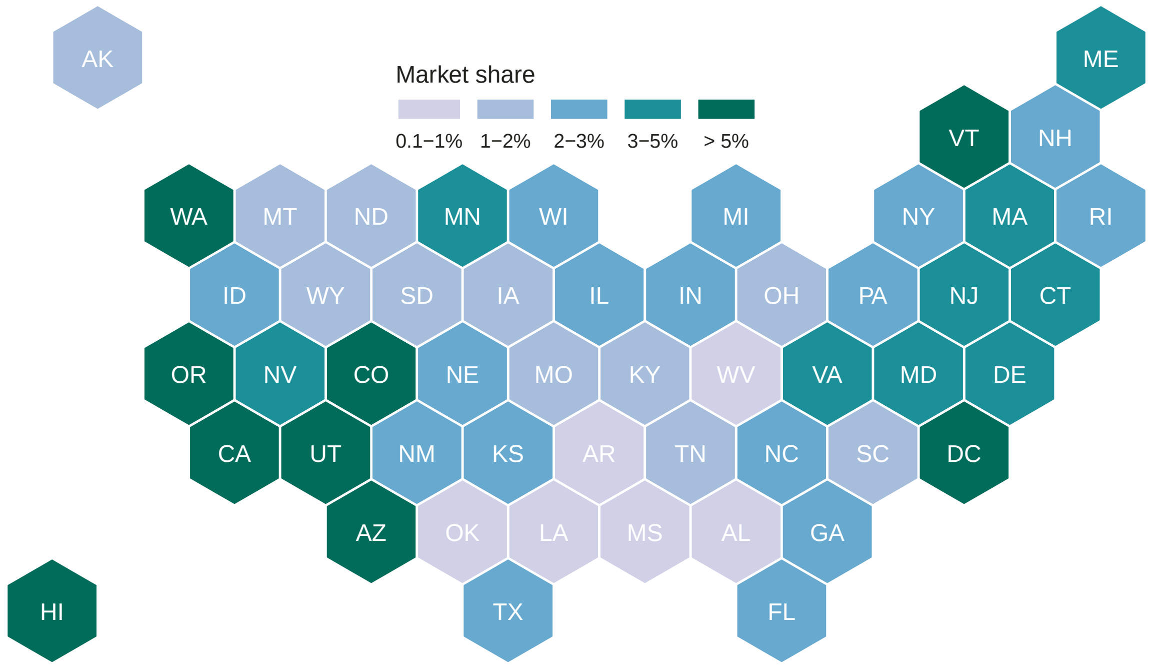
Notes: This figure shows the our measure of environmental preferences build with Google Trends series at the state level discussed in section 2. The index is a composite of research popularity for terms related to popular keywords related to environment. Those keywords are 'Climate Change', 'Recycling', and 'Electric Car'. Series are combined using the first component of a principal component analysis. y axis is normalized between 0 and 1 for aesthetic purposes.

Figure 2: First-stage estimation, shift-share IV



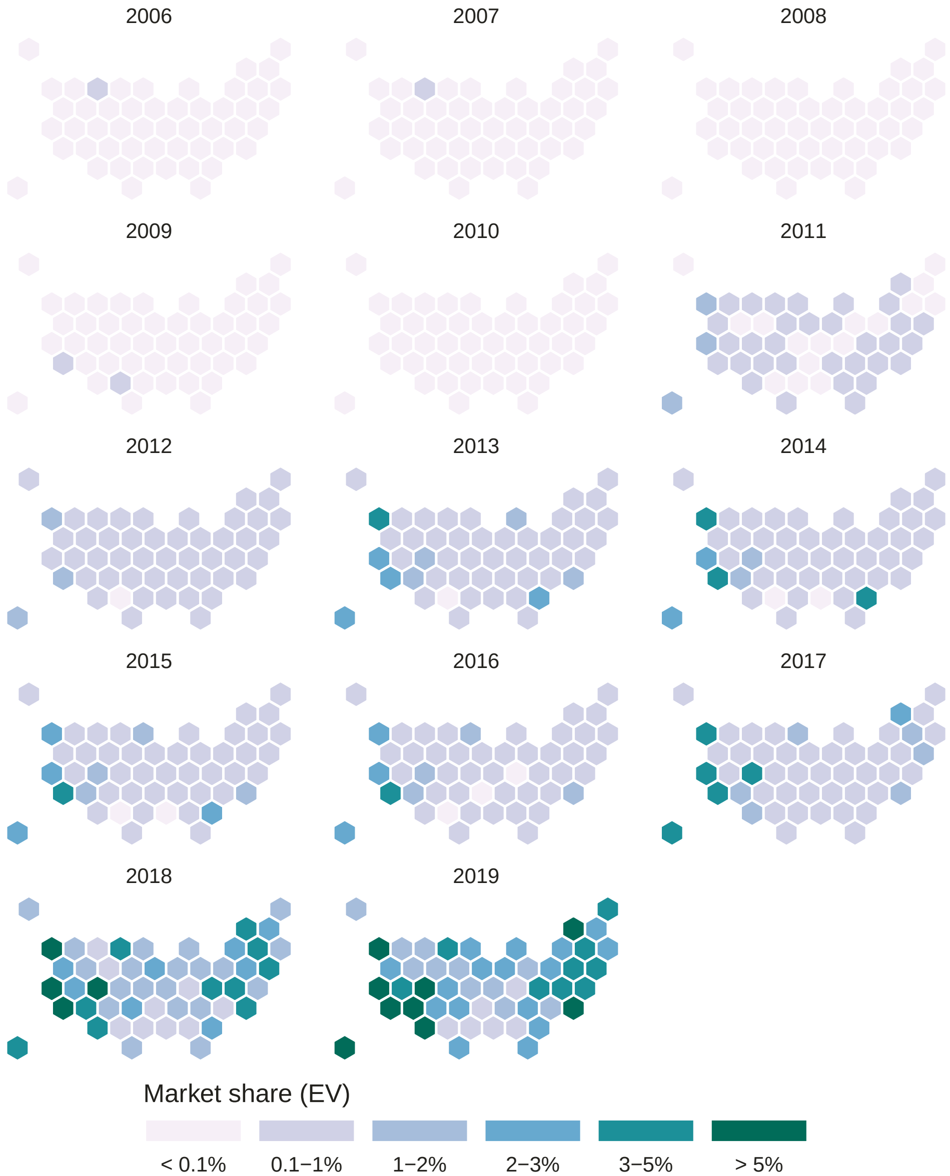
Notes: The figure plots the reduced-form relationship underlying our shift-share IV design. It plots the correlation between our instrument (in x-axis) and change in the environmental preferences index (in y-axis). Each point accounts for 1% of the data. The data is first residualized on a set of firm controls and period fixed-effects. Observation are weighted by the average treatment group exposure share s_{lt}.

Figure 3: Market Share of Electric Vehicles in 2019



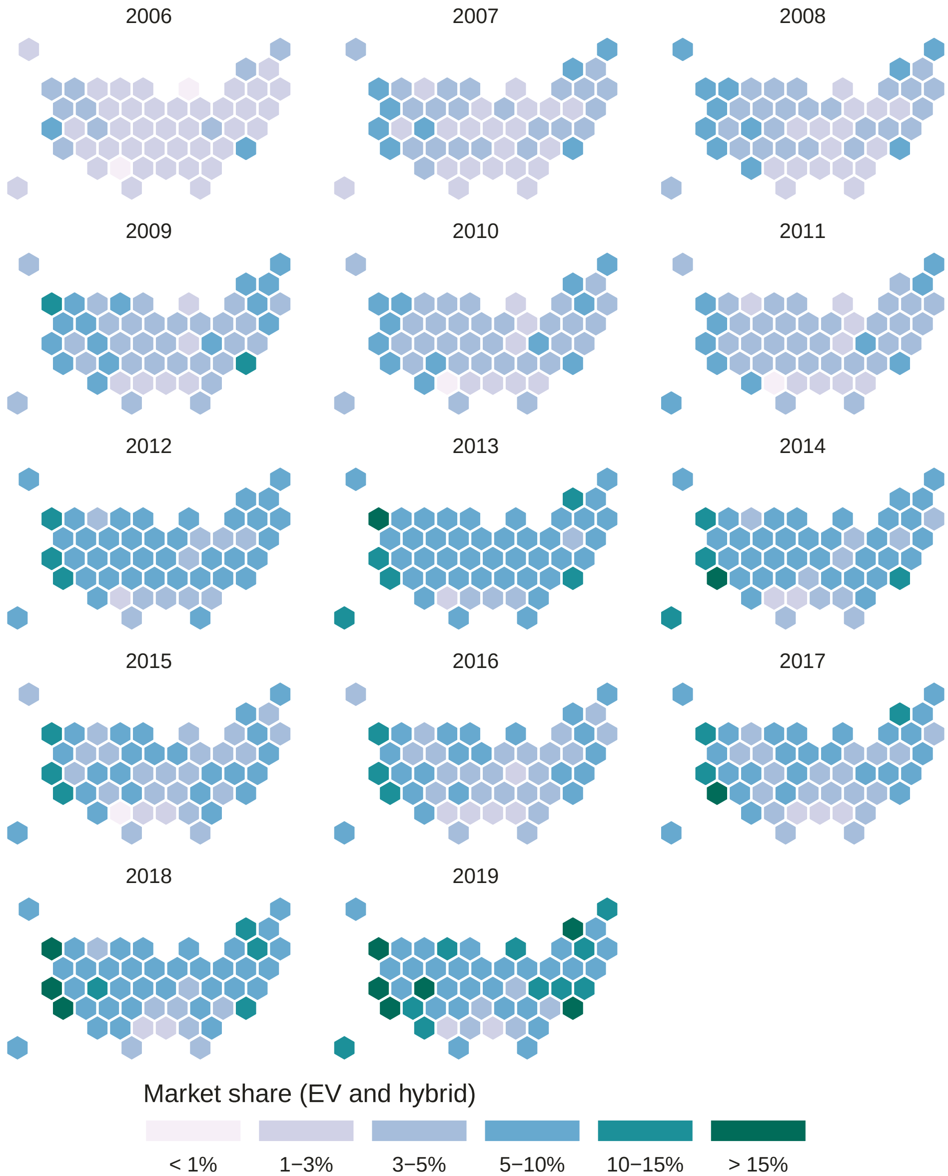
Notes: The figure show the market share of electric vehicles in each US states for vehicle registrations in 2019. The market shares are computed as the fraction of clean passenger cars registered over total passenger cars registrations in the state.
Source: S&P Global, author's calculation.

Figure 4: Market Share of Electric Vehicles



Notes: The figures shows the market share of electric vehicles in each US states between 2006 and 2019. The market shares are computed as the fraction of clean passenger cars registered over total passenger cars registrations in the state.
Source: S&P Global, author's calculation.

Figure 5: Market Share of Low Emission Vehicles

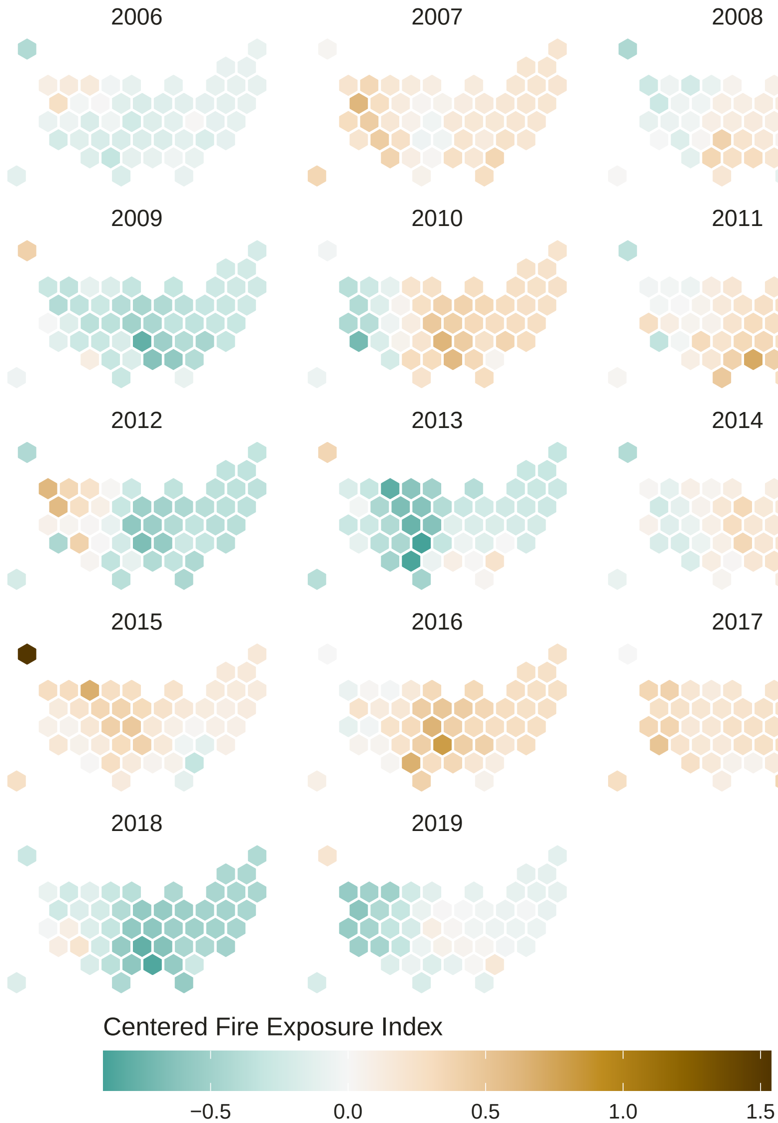


Notes: The figures shows the market share of low emissions vehicles in each US states between 2006 and 2019. The market shares are computed as the fraction of clean passenger cars registered over total passenger cars registrations in the state.
Source: S&P Global, author's calculation.

Figure 6: Relative Market Shares (log Odds-Ratio)

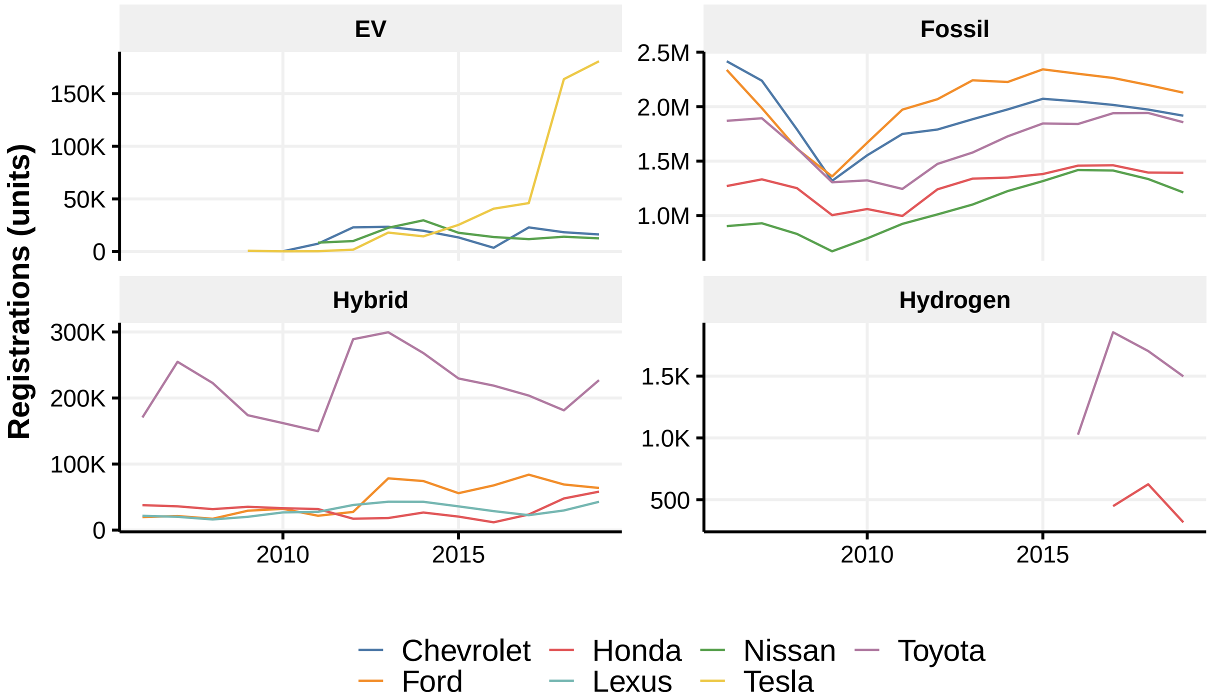
Notes: The figures show the relative market share compared to all the other make. We define $p_{il} = P(l|i)$ the proportion of vehicle registered in state l for a make i, and $p_{0l} = P(l|\neg i)$ the proportion of vehicles – not made by i – registered in state l. Then the log odds-ratio is $r_{li} = log\left(\frac{p_{il}/(1-p_{il})}{p_{0l}/(1-p_{0l})}\right)$. The ratio is positive for makes that are over-represented in a state l and negative if under-represented in the state.
Source: S&P Global, author's calculation

Figure 7: Centered Fire Exposure Index (yearly average)



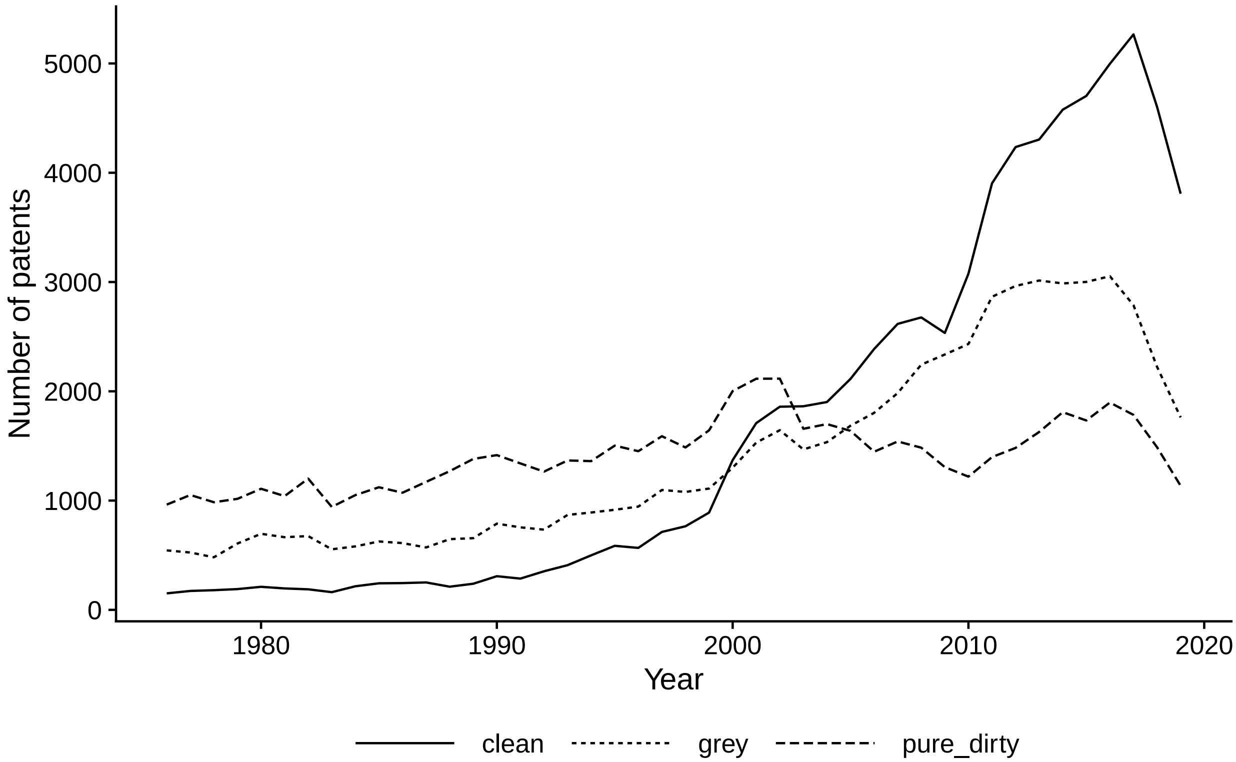
Notes: The figures shows the centered wildfire measure. The measure is centered with respect to a yearly linear trend and state×quarter fixed effects. We report annual average for each state. Brown shade indicates over-exposure. Blue shades indicates under exposure.
Source: NASA's FIRMS, author's calculation.

Figure 8: Number of vehicle registrations in the US for makes with at least 5% market share in a segment.



Notes: This figure shows the number of registered units by quarter in the US. Only makes with more than 5% market share in a engine segment are plotted. Top left are Electric Vehicles (EV), top righ are Fossil Fuel vehicles, bottom left are Hybrid, including plug-in hybrid, finally bottom right are Hydrogen.
Source: S&P Global, author's calculation

Figure 9: Number of Clean, Dirty, and Grey Patents 1976-2019



Notes: This figure illustrates the number of patent applications filed for 'clean', 'grey', and 'dirty' technologies over time in the US patent office. Dirty patents are defined as innovation related to internal combustion engine while clean innovations are related to electric, hybrid, and hydrogen vehicle patents. Grey patents are are innovation that aim to reduce emissions from fossil fuel vehicles.
Source: USPTO, author's calculation

C Additional Details on the Construction of Lobbying Variables

Lobbying Expenditures by Targeted Issue

We find a total of 79 different targets in the lobbying data. We group the relevant issues into the nine following categories:

- Manufacturing: AUT, AVI, TRA, AER, TRU, CPI, MAN.
- Trade: TRD, TAR, FOR.
- Taxes: TAX.
- Environment: ENV, ENG, CAW, FUE.
- Finance: FIN, BAN, BNK, INS.
- Labor: HCR, LBR, IMM MMM, RET.
- Public Expenditures: BUD, DEF, GOV, HOM, ROD, RRR.
- Innovation: CPT, SCI.
- Consumer, Safety Product: CSP.

Lobbying Expenditures by Targeted Branch

We split lobbying expenditures equally over all the targets present in a single report.

We first focus on the eight main targets, then separate them between political and independent, and finally, we separate them between branches focusing on environmental issues and other branches.

The eight main instituions target by lobbying are: House of Representatives, Senate, White House, Department of Commerce, Environmental Protection Agency, Department of Energy, National Highway Traffic Safety Administration, and Trade Representative

The list of political branch is the following: House Of Representatives, Senate, Department Of Transportation, Department Of Energy, Department Of Commerce, Department Of The Treasury, White House, Department of State, Department of Defense, Department of Labor, Office Of Management And Budget, Council on Environmental Quality, National Economic Council, Council on Economic Advisers, Federal Highway Administration, Department of Homeland Security, Occupational Safety And Health Administration, Federal Railroad Administration, Department of Education, National Security Agency, Department Of Agriculture, Executive Office of the President, Federal Transit Administration, Patent and Trademark Office, Internal Revenue Service, Department of Veterans Affairs, Food and Drug Administration, Transportation Security Administration, National Telecommunications and Information Administration, Army, Navy, Air Force, International Trade Administration, Customs And Border Protection, Administration for Children and Families, Technology Administration, Federal Aviation Administration, Science Office. All the other targets are considered as independent agencies.

Last, We divide lobbying expenditures depending on whether the target focuses mainly on environmental issues. The targets that do are the following: Department of Energy, Environmental Agency Protection, Council of Environmental Quality, Federal Energy Regulatory Commission.