# Teaming up with the Enemy: Firms and the Information Environment of Climate Regime*

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**Abstract**

Firms play a significant role in shaping climate change policy. In addition to directly influencing legislators via lobbying or campaign contributions, they influence the information environment of regulators. This paper studies, in particular, the ways that carbon-intensive firms join pro-climate groups to take the focus away from the most aggressive emission standards. I combine a unique dataset of policy comments on greenhouse gas emission standards, which reveal a systemic issue slant towards R&D and technology in comments by environmental groups affiliated with business interests. Strategic partnership with environmental groups is a compelling lobbying strategy by which business interests successfully translate their expertise into political influence. Not only does strategic partnership increase the quality of information, but it can alleviate regulators' uncertainty over the strategic use of information by political actors. I show that this joint effort has meaningful impact on policy amendments by quantifying political influence based on information theory.

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# Introduction

Political lobbying has been one of the significant factors that decide the fate of climate change legislation. Academics have argued (e.g., Grumbach, 2015) that extensive lobbying activities by private actors have constituted the major underlying causes that led to the failure of climate legislation. Historically, U.S. climate-related legislation has faced political resistance from polluting industries including coal, oil, and gas. For example, the Waxman-Markey Bill[1] was introduced in the 111th United States Congress to propose a cap and trade system, but the bill was faced with strong opposition from business interests. Global greenhouse gas emissions have been concentrated on a few number of corporations[2], and the expected economic costs imposed by climate legislation leads them to become the most prominent stakeholders of climate policy-making.

However, despite such firms' active engagement and influence in shaping climate policy outcomes, their informational tactics and political influence in creating environmental regulations have not been illuminated enough. Interestingly, not all firms take a clear political stance toward environmental policy. In the face of economic costs imposed by global climate change regulations, several firms have actively engaged with pro-climate groups that are in favor of domestic regulations (e.g., Kennard, 2020; Cory et al., 2021). For example, the American Council for an Energy-Efficient Economy, one of the non-profit coalitions that support action on climate, has been affiliated with Baltimore Gas and Electric Company and Dow Chemical. Baltimore Gas and Electric Company is a subsidiary of the Exelon Corporation, while Dow Chemical is ranked 39th in the Greenhouse 100 Polluters Index (2021) Report [3]. Another example is the Alliance to Save Energy, a nonprofit coalition of environmental and consumer groups founded in 1977. This coalition has partnered with Exxon Mobil, Exelon, and Duke Energy. The same index ranks Exxon Mobil as 10th, Exelon as 78th, and Duke energy as 2nd.

Why do such carbon-intensive firms partner with pro-climate coalitions despite their anti-regulation incentives? Concerning this political phenomenon, previous research on corporate behavior and environmental politics has provided the following explanations: 1) scholars have conjectured that business interests intend to green-wash their images (Vos, 2009; Zingales,

[1]Its official title is the American Clean Energy and Security Act of 2009 (ACES), under which the government would set a limit on the total amount of greenhouse gases that can be emitted.

[2]Heede (2014) finds that 90 big firms including Chevron, Exxon Mobil, BP, Exelon, or Shell are emitting two-thirds of global greenhouse gas emissions.

[3]This edition of the Greenhouse 100 ranks companies by C02-equivalent greenhouse gas emissions (including CO2, methane, nitrous oxide, and fluorinated gases, but not biogenic CO2) directly released by large facilities in the US in 2019, https://peri.umass.edu/greenhouse-100-polluters-index-current. https://peri.umass.edu/greenhouse-100-polluters-index-current, The University of Massachusetts Amherst

1998) or 2) they use environmental regulations to dominate market competitors (e.g., Kennard, 2020). However, some big firms such as Exxon Mobil are already notoriously known for being a polluter, and funding a few pro-climate coalitions may not put an impressively more agreeable face on their political interests. Moreover, given that citizens tend to be unfamiliar with coalitions and their political orientation (Druckman and Lupia, 2016), the fact that business interests are affiliated with pro-climate coalitions is unlikely to be widely known to broad consumers or voters. Next, while the market competition theory helps understand why firms engage in pro-climate actions to dominate market competitors, it stops short of explaining why individual firms join coalitions instead of lobbying alone.

Within this ongoing debate, as well as the research on corporate lobbying and their influence on the environmental regulatory regime, this work introduces a new mechanism through which business interests channel their influence by informing politicians through the partnership with pro-climate coalitions. I argue that firms influence the contents of proposals submitted by the pro-regulation camp to avoid the most aggressive clauses. These firms aim to pull potential climate legislation closer to their interests, shape future political terrain, and shift the political debate in the opposing camp in their favor. By collecting 13,129 public comments submitted in response to greenhouse gas emissions standards between 2010 and 2020, I demonstrate that comments submitted by environmentalist groups in partnership with business interests tend to take the focus away from emission standards by emphasizing research, development and technologies.

This work further suggests that the lobbying strategy of communicating their expertise through pro-climate groups further increases the chances of lobbying success. Even though corporate actors' preferences may not be fully represented, the joint effort of environmentalists and business interests leads to higher quality in both "hard" and "soft" information. Each political actor has expertise in different areas and corporate actors can increase the informational value (expertise) of their policy comments to regulators by collaborating with environmentalists. Moreover, a strategic partnership with actors with contrasting preferences makes legislators place even weight on the importance of the business interests' information. Epistemologically, the informational value of policy comments is to facilitate the choice of policies based on the maximum amount of available information and the consistency with the majority rule. However, given that information asymmetry presents opportunities for the strategic use of information by policy proposers(e.g., Fudenberg and Tirole, 1989; Gilligan and Krehbiel, 1990; Austen-Smith and Wright, 1992), the normative goal of informed decision-making may not be consistent with rational behaviors by individuals or entities whose preferences are heterogeneous. Concerning these rulemaking dynamics, policy comments jointly submitted by groups of heterogeneous political actors not only increase the

informational value of comments (hard information) but also help legislatures maximize benefits from specialized expertise and knowledge by signaling that involved actors are not exaggerating the extreme preferences (soft information).

Focusing on the dynamics in climate politics, this paper explains and quantitatively demonstrates the political influence by which business interests alter the information environment that is available for regulators. The next section further discusses the broader literature on climate politics and private actors and outlines theoretical expectations regarding the strategic partnership between business interests and environmentalists. I then describe my dataset and empirical strategies. The following section presents the findings and a series of robustness tests, followed by an analysis of the influence of joint comments on the legislative outcome. The final section discusses the implications of strategic partnership in environmental politics, as well as the contribution to broad literature on corporate lobbying.

## Climate Lobbying and Business Interests

Studies in environmental politics have assumed that corporate political preferences are structurally determined (e.g., Keohane et al., 1998; Falkner, 2017). Firms have been expected to evaluate the possible impact that regulations would have on their stakes and the competitive balance in the market. For instance, They consider the extent to which they can adapt to new environmental standards through technological innovations, product changes, and process modifications and how their competitors will be affected. They tend to oppose regulations, if the regulations impose costs on them and support them if they do not. For instance, firms generating coal generational capacity are expected to oppose action to fight climate change (e.g., Cory et al., 2021) if the firms believe that they would suffer if such climate-related legislation passed.

Indeed, a closer analysis of business strategies in climate change reveals that restrictions on greenhouse gas emissions pose a significant challenge to particular industries. Some (e.g., Shell, BP) have begun to pursue diversification into other energy sources that have a lower greenhouse effect, or no effect at all, as a strategic opinion. However, none of these alternative energy sources can provide business opportunities on the same scale as that of oil and coal production (Stokes, 2020). While placing a price on carbon emissions through a trading system or carbon taxes is considered to be the most efficient policy for reducing greenhouse gasses (Stern, 2008), the policy has been politically contested (Hess, 2014) as climate-related policy measures have an immediate impact on these corporations.

Based on inferences concerning corporate preferences, scholars have emphasized the link

between corporate political activities and climate policy outcomes (Aklin and Urpelainen, 2013; Hess, 2013; Kennard, 2020; Tvinnereim and Ivarsflaten, 2016). Firms translate their preferences into political lobbying strategies to influence a policy (e.g., Rogowski, 1990; Frieden, 1988) but they do not necessarily translate their preference explicitly into political actions. In fact, the process of reflecting business interests in policy-making is not always straightforward even when they choose to translate. Not all interests may be fully represented, and the choice of political strategy that they choose is influenced not only by the underlying preference structure but also by the political environment in which firms operate.

While the analysis of corporation preference formation has been essential to the study of the business influence on politics, the way their preferences are realized via political strategies has not been rigorously explained. There are several strategies business interests can adopt, such as engaging in direct lobbying activities to create political ties with politicians or targeting a broad audience for public persuasion (Baumgartner et al., 2009; Kraft and Kamieniecki, 2007; Layzer, 2012; Sell and Prakash, 2004). In this work, I particularly analyze a corporate lobbying strategy through which corporate actors form a joint coalition with environmental groups and influence the regulatory landscape. Through strategic partnerships with pro-climate groups, corporate actors influence issue attention given to a particular topic during the rule-making process and achieve higher information efficiency. The next section further elaborates on this mechanism and discusses the details of such political behaviors.

## Explaining Informational Lobbying in Regulatory Politics

Building on the literature on regulatory politics and the value of information during the rule-making process, I provide a business interests-centered explanation of why carbon-intensive firms partner with pro-climate groups. Namely, business interests strategically become affiliated with the pro-climate coalitions to influence the political environment where policymakers gather information. This strategy of forming a joint coalition is a compelling approach by which business interests translate their political interests into policy amendments. A joint effort by political actors with contrasting preferences increases the quality of information that policymakers seek during the legislative process, in both enhanced expertise (hard information) and reduced uncertainty (soft information). I further discuss the dynamics of information provision in the process of climate policy-making and derive observable implications for examining corporate political behaviors.

## Theory: Communicating via climate groups as an effective corporate strategy

The core of politics has focused on competition over issue selection and the issue attention given to a particular topic. It has long been recognized that allocation of issue across policy agenda agenda is fundamental to understanding the political process (e.g., Cobb and Elder, 1972; Kingdon and Stano, 1984; Schnattschneider, 1960; Romer and Rosenthal, 1978) and an important source of political power (e.g., Bachrach and Baratz, 1962). In addition to political parties or public interest groups, business interests have been emphasized as one of the primary actors influencing agenda (Kamieniecki, 2007; Acs and Coglianese, 2022). They can keep issues off the table to obviate the risk of an aggressive proposal rising to a vote, by successfully controlling the agenda or they can emphasize relatively overlooked issues to distract attention given to the aggressive clauses.

Such strategic communication by business interests exercises leverage over the federal rulemaking process. The Administrative Procedure Act (APA) of 1946 mandates the notice and comment period in which a proposed policy is open for public review. During this stage, all interested parties are invited to provide written comments regarding the content of the proposed rule. All political actors including business interests are invited to introduce the contents of the policy proposals that agencies should take into consideration, define policy problems and develop the details in the proposed government rules (Yackee, 2012; Baumgartner and Leech, 1998; Baumgartner and Jones, 2010). After reviewing the comments, the agency usually issues a final rule that is enforceable as law.

My argument is centered on firms' incentives to get affiliated with the pro-climate coalitions to open their information up to regulations. To communicate their expertise more effectively, firms strategically join pro-climate coalitions and collaborate with environmentalists. There are lots of qualitative evidence that demonstrates business actors' attempt to reframe climate policy and take the issue attention away from emission cuts by highlighting technological issues (e.g., Grumbach, 2015; Downie, 2017). To give an example, ExxonMobil highlights its contributions in climate actions with advertorials citing "our industry-leading investments in research and development," such as the Global Climate and Energy Project at Stanford University, which implies that current solar or wind technologies are inadequate (Supran and Oreskes, 2021). Likewise, business interests suggest that scientific research or technology rather than emission cutbacks would provide the key solutions that manage the long-term risk of global climate change. Therefore, I expect more coverage about R&D or technology in comments jointly written by business interests and environmentalists, as opposed to the environmentalist group with business affiliations. When pro-climate environ-

mental coalitions receive corporate money or are in partnership with business interests, they would be more likely to cover business-friendly agenda.

**Hypothesis 1** *(Motivation) Comments submitted by environmentalist groups affiliated with business interests are more likely to discuss R&D and technology compared to comments submitted by pro-climate groups without a corporation affiliation.*

This strategy of communicating via a pro-climate coalition should be differentiated from hedging. The fact that some industries (e.g., oil and gas industries) are fragile to their corporation reputations has been cited to argue that they are green-washing their image to prevent a reputational crisis. This alternative explanation assumes that firms would prefer to maintain a green image to a broad audience since they are constrained by popular opinion. The public marketing strategy to hedge against the reputation crisis is geared more toward a defensive posture that is intended to protect the corporations from possible backlash stemming from their political preferences against climate actions. However, strategic communication via pro climate groups is accompanied by a meaningful influence on environmental regulations. By collaborating with environmentalists, firms actively seek political influence that will allow them to convey information that may be useful to regulators. The next section explains why corporations choose to be in coalition with pro-climate groups in detail and further explores how such an informational lobbying strategy translates into meaningful political influence.

## Achieving higher quality of information and political influence

Studies of interest group politics and regulatory politics find that policy comments submitted by business interests are politically impactful (e.g., Yackee, 2012), and shape agency agendas by changing the way regulators allocate issue attention within the topic. However, the mechanisms of how business information translates into political influence have remained unclear. This section further explores how such a partnership between corporate actors and environmentalists connects to policy amendments.

Comments submitted by interested parties during the rulemaking process have substantial informational value to policymakers as rulemaking is one of the most resource-intensive and time-consuming activities (Kerwin and Furlong, 2018). Regulators seek to apply regulations where their success is dependent on their ability to collect or analyze information (McCarty, 2017). Information plays a particularly vital role as the development of regulation requires fine-grained, technical judgment concerning how to design these major operations

(e.g., Breyer, 1982; Hawkins and Thomas, 1989). And this is particularly true for environmental regulations which require an understanding of the options for reducing pollutants and greenhouse gas, or the economic consequences of various alternatives and regulatory standards. While business influence has been described in terms of financial resources such as hiring lobbyists or making campaign contributions, their political influence during the regulatory process comes from their expertise and specializations.

Concerning the informational value of political comments, the joint effort of business interests and environmentalists improves the quality of information that regulators collect. Private actors typically have a better understanding of which pollution control measures will be effective in their facilities, as well as the extent to which certain measures would create unintended consequences or unexpected economic costs (e.g., Wagner, 2003; Michael, 1996). Similarly, environmental groups also use similar information-based strategies that are used by firms or business associations (Vormedal, 2008).[4] They exercise leverage by communicating public demands, conveying information on the distributional consequences of regulations in communities or suggestions for developing national climate change strategies or climate change adaptation (Nachmany et al., 2014). By partnering with environmentalists, firms can improve their policy design such as information gathering and the acquisition of expertise.

**Hypothesis 2** *(Mechanism): Joint comments by business interests and environmentalists contain more informational values than that of other groups.*

Yet, while expertise is a necessary condition, it remains unclear whether specialization is a sufficient condition for achieving information efficiency due to the opportunities for strategic use of information. The political usage of information and scientific knowledge suggests that actors pick the evidence that supports their political objectives and discard information that undermines their position. (Weible, 2008; Austen-Smith and Riker, 1987). When suggesting issues or information in need of government redress, political actors intentionally portray issues in ways that will gain support for their side, all the while making it seem as though they are simply describing the facts (Stone, 1989). In other words, firms have an incentive to share self-serving information with the government, such as information regarding how likely the expected benefits of the regulations would be lower or how likely that the incurred economic costs would be huge (Quirk, 2014).

Such possibility of the strategic use of private information poses uncertainty over the trustability of information. Inference from Gilligan and Krehbiel (1989) on committee-legislature decision-making in which legislators are uncertain and information is asymmetric

[4]Environmental NGOs include research units of environmental NGOs and think tanks dedicated to influencing the policy-making process via research outputs and information provision. (Gough and Shackley, 2001)

suggests that political outcomes are imposed principally by the electoral environment. Constraints should be imposed on the tendencies of regulators to self-select high-demanders or preference outliers. To rephrase it, preferences must not be too extreme vis-a-vis those of the median voter to achieve any informational benefits from expertise and specialization.[5] Therefore, regulators cannot be induced to trust all private information delivered by interested parties, particularly since the interested parties in the rulemaking process can take advantage of information asymmetry.

Assuming that they are risk averse and choose policies under information asymmetry, regulators prefer a policy suggestion whose outcome is certain. In the presence of such uncertainty, regulators prefer a policy recommendation by coalitions that incorporate political actors with heterogeneous preferences (soft information).The joint effort of those with contrasting preferences signals that their suggestion is a consensus agreed upon by both extremes of interested parties. Therefore, joint comments by business interests and environmentalists would reduce the uncertainty that regulators face concerning the trustability of information, giving the impression that their policy proposal is not skewed to extreme preferences. Thus, business information coming through pro-climate coalitions is much more available to regulators, compared to other groups of comments by single firms or business associations.

**Hypothesis 3** *(Outcome): Comments written by the joint effort of business interests and environmentalists are more likely to influence a policy amendments than comments written by a singular firm or a group of firms.*

# Empirical Analysis

A key consideration in assessing the degree of corporate influence in the rulemaking process is to establish an objective benchmark. The benchmark refers to points within the agenda that business interests strategically emphasize to distract attention given to the risk of climate change and stringent emission standards. Regarding these considerations, I assess corporate influence by examining the coverage of research, development, and technology (R&D and technology) and the degree of issue slant towards R&D and technology. The topic of R&D and technology has obvious implications for expertise and specialization of business interests, as in most cases, businesses have better knowledge about what they produce. Since

[5]That is, holding distributional effects (private goods) constant, legislators always unanimously benefit from a reduction in the uncertainty about the consequences of a given policy.

business interests have informational supremacy based on their private knowledge of R&D as opposed to other commenter types, the information asymmetry concerning the agenda of R&D becomes worsened and the chances of the strategic use of information by corporate actors would be more prevalent as opposed to other topics.

## Data

I utilize an original dataset containing 13,129 comments officially submitted on *Greenhouse Gas Emissions Standards* from 2010 to 2020 without duplicates.[6] Under APA, the Federal Register publishes the proposed rule, and the agency requests comments from the public and other interested parties. Once the formal period for comments ends, the agency revises the rule pursuant to these comments. Once the comments are incorporated, a "final rule" is issued and eventually becomes law. To summarize, this process consists of an initial proposal, followed by an intervention in the form of public comments, and then a final rendition of the rule that is responsive to public comments.

By identifying company/organization identifiers and automated text analysis, I filter 903 comments submitted by companies, entities, or organizations, which is the basis of my analysis. Then I classify the documents by commenter types: 1) joint coalition of environmentalist and business interests, 2) environmentalist coalitions without affiliated business ties, 3) business associations (e.g., trade associations) and 4) single business proposals. Comments submitted by research institutes or universities are classified as others. The category of joint coalitions includes environmental advocacy groups that list firms or business associations as partners, that are financed by corporate actors, or that are seeking business partnership.

## Communicating via pro-climate groups focusing on R&D and technology topics

### Measuring R&D and Technology Coverage

In this section, I empirically demonstrate strategic communication by business interests exhibited in public comments. In essence, the empirical strategy has two basic components. I compare issue coverage of R&D technology by (1) environmentalists with business ties versus pro-climate coalitions without business interests and (2) across all company/organization proposals. By comparing the issue coverage of public comments, I examine the effects of

[6]Duplicates are not considered in this paper; the total number of comments after removing duplicates is 13,239.

| Commenter | Descriptions | Affiliated Business Interests |
|---|---|---|
| Sierra Club | Nonprofit environmental group | Chesapeake Energy |
| Consumer Energy Alliance | Nonprofit environmental group | Exxon Mobil<br>Chevron Corp<br>ConocoPhillips<br>BP |
| Environmental Defense Fund | Nonprofit environmental group | Walmart<br>Lyft<br>FedEx |
| American Council for an Energy-Efficient Economy | Environmental NGO | Dow Chemical Co<br>Alcoa<br>Xcel Energy |
| Climate Leadership Council | Nonprofit environmental group | Exxon Mobil<br>General Motors<br>ConocoPhillips<br>Exelon |

Table 1: Examples of public comments submitted by the joint effort of environmental groups and corporate actors

business partnerships on the issue attention allocated for the topic of R&D and technology. I define R&D and technology coverage by using two metrics: comment level, the indicator of whether a comment mentions research, development, or technology at least twice; and word level, the frequency of the occurrences of R&D words normalized by the total number of tokens of a comment. I first examine whether proposals associated with business interests are more likely to cover $R\&D$ than those that are not affiliated with business interests, using a comment-level metric.

$$Pr(Y_{it} = 1) = \Phi(\alpha + \beta_1 \text{Business Influence}_i + \tau_t)$$

where $Y_{it}$ is a binary variable that indicates a comment that mentions research, development, or technology at least twice; Business Influence$_i$ is a binary indicator for business ties coded based on commenter types; and $\tau$ is a vector of year fixed effects. For a word-level metric, I use negative binomial models rather than a Poisson or OLS because there exists overdispersion in the distribution of the dependent variable across observations and the dependent variable cannot have negative values (King, 1988). The main analysis analyzes the sample of company/organization comments to reduce the sparsity of data.

The main parameter of interest is $\beta_1$, the coefficient for business influence. Table 2 presents the estimation results with marginal effects in the main entries and standard errors in parentheses. The results suggest that proposals affiliated with business interests mention more R&D coverage; business influence appears to be positive and statistically significant at the 0.01 level in the first and second columns, and its interaction term is significant at

| Metrics | Comment-level | | | Word-level | | |
|---|---|---|---|---|---|---|
| Sample | Environmentalist | Company/Organization | | Environmentalist | Company/Organization | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Business Influence | 0.703*** | 0.282*** | 0.158 | 0.538** | 0.281** | 0.193 |
| | (0.220) | (0.104) | (0.120) | (0.258) | (0.131) | (0.153) |
| Environmentalist | | | −0.043 | | | 0.101 |
| | | | (0.131) | | | (0.162) |
| Business Influence×Environmentalist | | | 0.550** | | | 0.520* |
| | | | (0.247) | | | (0.311) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 232 | 903 | 903 | 232 | 903 | 903 |

A binary probit model is used for the comment-level R&D coverage. For word-level R&D coverage, negative binomial model is used.
*p < .1; **p < .05; ***p < .01

Table 2: Binary probit and negative binomial models estimating R&D coverage

the 0.05 level in the sample of organization/company comments (Column 3). This result is maintained when the word-level metrics are used.

### Measuring the degree of issue slant towards R&D and Technology

However, the word-count-based metrics do not convey any information concerning the context in which words are used. For instance, the analysis in the previous section does not say about the context where the 'technology' is used; the context might be the need for technological investment for alternative energy sources or might be related to carbon technology. To handle this limitation, I apply a text embedding method, allowing words to encode meaningful information about analogies. The measure constructed in this section indicates how issue attention is characterized in the languages used by commenters.

Political science research has utilized *Word2Vec* which embeds words in a low-dimensional vector space using neural network structure. This method results in a set of vectors where proximity in vector spaces implies similar meaning context-wise, while vectors distant from each other have different meanings. For instance, "diligent" and "industrious" would be close together while "diligent" and "lazy" would be relatively distant. Based on embedding methods, I let the algorithm assign each word to a vector in a shared space during the training stage, and this creates clusters of words semantically connected. As a result, the similar the context is, the closer the two words are located in geometric space.

Built on this advance in modern natural language processing technique, I employ *Paragraph Vector* proposed by Le and Mikolov (2014), an unsupervised framework that learns continuous distributed vector representations at the comment level. In the *Paragraph Vector* framework, each document is mapped to a unique vector, and each token is also mapped to a unique vector. The paragraph vector and word vectors are averaged to predict the

next words in each sentence. Analogous to Word2Vec's continuous-bag-of-words model, this approach uses distributed memory where document vectors can be acquired by the task of predicting a word based on an average in consideration of context and full document levels. Similarly, analogous to the skip-gram model of *word2vec* model, the distributed bag of words enables us to predict a target word just from the full document's document vector. I construct a model with a window size of five and do not consider words that are observed less than ten times in the entire corpus.

As explained above, a key feature of word embeddings is that the difference between word vectors in the geometric space conveys meaning. For instance, the difference between the two vectors, $\overrightarrow{R\&D} - \overrightarrow{Emission}$, identifies an issue dimension in the space by taking the difference between the normalized vector across a set of research words and the average normalized vector across a set of emission words [7]:

$$\overrightarrow{R\&D} - \overrightarrow{Emission} = \frac{\sum_n \overrightarrow{R\&D_n}}{|N_{R\&D}|} - \frac{\sum_n \overrightarrow{Emission_n}}{|N_{Emission}|}$$

Therefore, the vector difference corresponds to the issue slant in the R&D direction and can be substantively interpreted as a degree to which a proposal is leaning toward the issue of R&D, compared to emission cuts. By the geometry of vector space, I measure the cosine of the angle between the inferred vectors of the issue slant and each document vector. The connotation of this approach is measuring the similarity of a proposal to the dimension of the issue slant towards $R\&D$ and technology. This metric for non-zero vectors, $\overrightarrow{x}$ and $\overrightarrow{y}$, is defined as

$$similarity(\overrightarrow{x}, \overrightarrow{y}) = cos(\theta) = \frac{\overrightarrow{x} * \overrightarrow{y}}{||\overrightarrow{x}||||\overrightarrow{y}||} = \frac{\sum x_i y_i}{\sqrt{\sum {x_i}^2}\sqrt{\sum {y_i}^2}}$$

where $\theta$ denotes the angle between vectors and $||*||$ indicates the 2-norm. The similarity score ranges from -1 to 1 and, a score close to 1 indicates that a document tends to emphasize R&D compared to emissions. If the score is negative, this implies that the issue slant in the emission direction.

Figure 1 reports the mapping of the issue slant score, and I provide a human-based validation to examine machine performance (Table 3). Purple dots indicate policy comments submitted by environmental groups with business affiliation, while green dots represent comments by environmental groups without any observed business affiliation. Policy comments by joint coalitions tend to be associated with positive issue slant scores and tend to cover more about technology and research. However, comments by environmental groups with-

[7] Please see the Appendix for more details

out business affiliation tend to be associated with a negative issue slant score and discuss emission reductions.

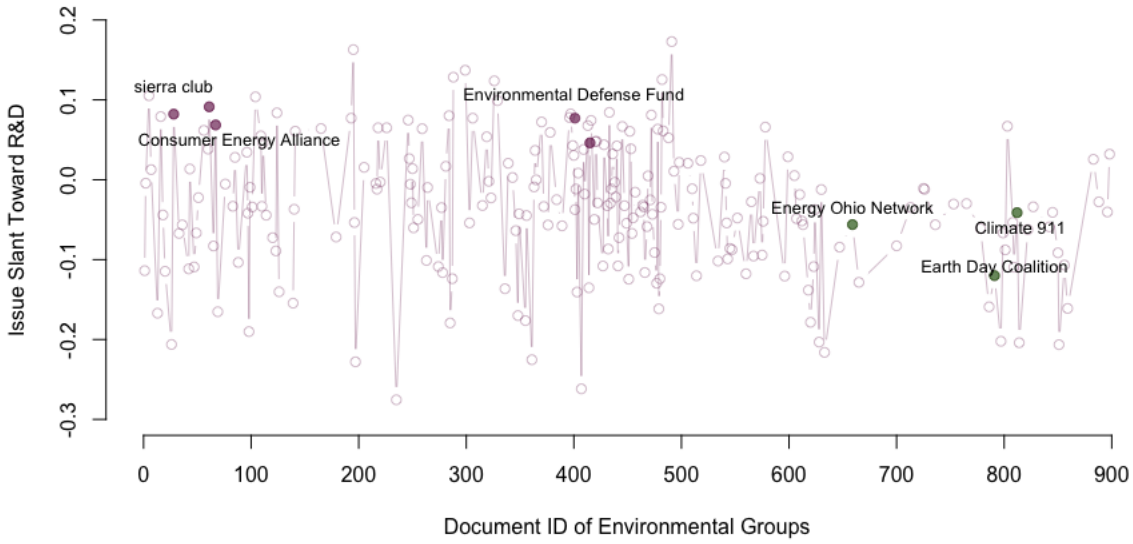


Figure 1: The mapping of issue slant score

| Sample | Environmentalist | Company/Organization Comments | |
|---|---|---|---|
| | (1) | (2) | (3) |
| business | 0.027** | 0.028** | −0.009 |
| | (0.013) | (0.012) | (0.014) |
| Environmentalist | | | −0.008 |
| | | | (0.015) |
| Business×Environmentalist | | | 0.037* |
| | | | (0.019) |
| Year FE | Yes | Yes | Yes |
| N | 232 | 903 | 903 |

*p < .1; **p < .05; ***p < .01

Table 3: OLS estimating the degree of issue slant towards R&D and technology

I use the score for each comment as a dependent variable and run an ordinary least squares regression to analyze the issue slant of joint comments versus other types of groups. If corporate actors communicate via pro climate groups, we would find that business influence leads to increased issue slant toward R&D and technology direction. Table 3 shows the positive relationship between business ties and issue slant in the *R&D* directions, and the

finding is statistically significant at the 0.01 level (Columns 1 and 2). Overall, comments by coalitions with business affiliations are more likely to be slanted to R&D and technology, as opposed to emissions, and its positive relationship is stronger than the relationship between general proposals and issue slant. The regression analysis based on a measure of issue slant toward R&D supports the claim that business interests can successfully take the focus away from emission cuts by highlighting R&D and technology.

| Commenter | Comments | Business Influence |
|---|---|---|
| Sierra Club | ".....requirements should satisfy the statutory mandate that standards be based on reasonably available control technology and is likewise supported by substantial scientific and technical evidence..." | ✓ |
| Consumer Energy Alliance | ".... long-term research and development of cleaner burning natural gas will ultimately advance the United States' goal of a more sustainable energy future.... The oil and gas industry has proven its ability to develop and implement environmentally friendly practices and technology...." | ✓ |
| Environmental Defense Fund | "EPA's unsupported practical concerns about "buffering" technology supply could only justify this departure from the existing standard....." | ✓ |
| Climate 911 | "....we are facing a very large gap between the emissions reductions required to accomplish this and the sum of the commitments offered by the international community....." | × |
| Earth Day Coalition | "...new fuel economy standards proposed by EPA represent an opportunity to reduce fuel consumption and reduce emissions.." | × |
| Energy Ohio Network | "....the sector makes up 70 percent of all oil consumption in the United States and accounts for almost 30 percent of the nation's greenhouse gas emissions..." | × |

Table 4: Policy comments submitted by environmental groups in Figure 1

## Measuring the quality of information

The previous section empirically demonstrates the positive associations between corporate ties and issue slant toward R&D within a sample of environmental groups. This section further explores why the strategic partnership with environmentalists is a compelling political strategy for business interests. In the course of rule-making, a key question is the informativeness of the comments that are written by the joint effort of environmentalists and businesses. Related to this information quality story, this section examines the hypothesis of whether a strategic partnership of corporate actors and environmental groups further achieves a higher quality of information that informs regulators of details of policy implementation.

To construct a measure of information quality, I use NLP techniques to capture the particular semantic types such as organization (e.g., companies, agencies, institutions.), geopolitical entity (i.e. countries, cities, states), person, time, cardinality, location, percent, money, event or natural phenomenon, or jargon that may indicate technical information. This empirical strategy is called an entity recognition technique and involves extracting and identifying essential information from the text.[8] Based on this technique, I count the sum of detected entities for each comment and use this variable as a measure of information quality.[9]

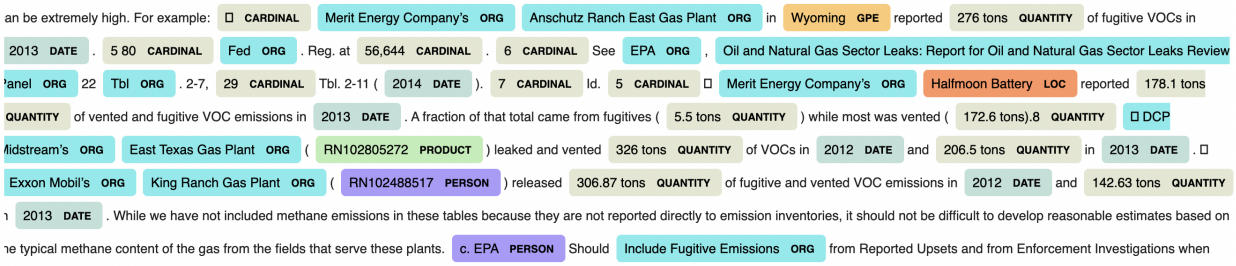


Figure 2: Example of the application of entity recognition approach (Comment submitted by Environmental Justice Health Alliance)

In this analysis, I include a measure of issue slant towards R&D and technology as a control variable as this topic tends to be accompanied by technical details. Table 5 suggests that policy comments jointly written by business interests and environmental groups have a higher quality of information compared to other comments (Columns 1 and 2); business

[8]The information that is extracted and categorized by this technique is called entity, and it can be any word or a series of words that consistently refers to the same thing. I customize entities present in policy comments- supplementary documents, figures, or tables.

[9]This measure is intended to capture the absolute amount of technical information contained in the comment so normalizing by the total count of tokens is not necessary.

| Sample | Environmentalist | | Business | | Company/Organization | Business |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Business Influence | 0.581*** | 0.570*** | | | −0.353 | |
| | (0.188) | (0.187) | | | (0.186) | |
| Environmentalist | | | 0.771*** | 0.768*** | −0.267 | |
| | | | (0.163) | (0.163) | (0.201) | |
| Business Influence×Environmentalist | | | | | 1.012*** | |
| | | | | | (0.258) | |
| Business Coalition | | | | | | 4.661*** |
| | | | | | | (0.122) |
| Joint Coalition | | | | | | 5.248*** |
| | | | | | | (0.180) |
| Issue Slant towards R&D | | 2.956*** | | 0.201 | 0.766* | 0.083 |
| | | (0.934) | | (0.533) | (0.460) | (0.532) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 232 | 232 | 665 | 665 | 903 | 665 |

The baseline for Column 6 is single firm.
*p < .1; **p < .05; ***p < .01

Table 5: Negative binomial model estimating the quality of information

comments are associated with higher quality when they are working together with environmentalist groups (Columns 3 and 4). Column 6 indicates a higher association between each group of comments and business interests, but the magnitude of the coefficient is bigger in comments submitted by the joint effort of corporate actors and environmental groups. These findings suggest that policy comments can bring more informative content to regulators when environmental groups and corporate actors work together.

Even though this paper is focused on explaining the incentives of firms in the regulatory process, this empirical analysis using a measure of information quality provides explanations as to why environmentalists allow business interests to become involved in policy discourse despite their contrasting preferences. Not only business actors but also environmental groups benefit from this partnership; environmentalists can access the business information and improve their suggestions concerning climate change adaptations based on resources corporate actors provide. As rulemaking is a process of developing technical details of regulation based on expertise, the informativeness of comments is one of the primary determinants of political influence. By investing in a joint effort, both environmental groups and firms achieve higher quality information that helps regulators develop details of regulations.

## Capturing the effectiveness of communicating via pro-climate groups

The previous analysis suggests that corporate actors strategically communicate their expertise via a joint effort with environmentalists and that a strategic partnership increases the

informativeness of comments. This section further analyzes how such informational lobbying via pro-climate coalitions connects to political influence in regulation politics. While expertise is a necessary condition, it remains unclear whether specializations are a sufficient condition for achieving information efficiency given opportunities for the strategic use of information; political actors pick the evidence that supports their political objectives and discard information that undermines their position (Weible, 2008; Austen-Smith and Riker, 1987; Stone, 1989, e.g.,). This section examines whether the joint effort of actors with conflictual policy goals relay regulators' concerns over the strategic use of information by interested parties.

### Measuring political influence via statistical distance between policy comments and final amendments

To quantify the influence of policy comments on environmental regulations, I borrow the divergence scores from information theory as relative entropy captured via divergence score denotes how close two samples are from each other. Given that the vectors in this context indicate probability distribution, the cosine angle is inappropriate as its similarity fits for vector space modeling. Therefore, I use divergence scores as metrics for capturing statistical distance. I further tailor this technique so that it can be applied to our context of analyzing political influence via texts. The intuition behind this approach is to examine how likely is it that two groups of proposals and the finalized policy come from the same distribution. If a policy amendment is likely to be from the same distribution of pro-coalition proposals, we can infer that agenda-setting strategies by business interests have political leverage over environmental regulations. In this section, I suggest an approach combining hypothesis testing with distribution similarity.

The procedure is as follows. I collapse the comments of each group and adopt the notion of the bag-of-words model which represents a document as a set of the count. Equivalently, a cluster of proposals is represented as a multinomial probability distribution over words. Figure 2 shows the Kernel density of each distribution. $P$ denotes the proposals submitted by business interests while $O$ indicates final amendments. Again, each of them is represented as multinomial distribution. $P$ is a multinomial distribution of $(p_1, p_2, ....., p_n)$ and $O$ is a multinomial distribution of $(o_1, o_2, o_3, ...., o_n)$. n is the total number of tokens in the entire text. $p_i$ is defined as the $\frac{count(word_i, proposals)}{length(proposals)}$ and $o_i$ is defined as the $\frac{count(word_i, finalizedrule)}{length(finalizedrule)}$.

As distance metrics, I employ Kullback-Leibler (KL) divergence. KL divergence has already been widely used in advanced social science research as a similarity measure of sparse data. The KL divergence metric is defined as follows.

$$D(P||O) = \sum_i P_i log(\frac{P_i}{O_i})$$

where the expectation value of the log difference between the two probability distribution computed with weights of $P_i$.

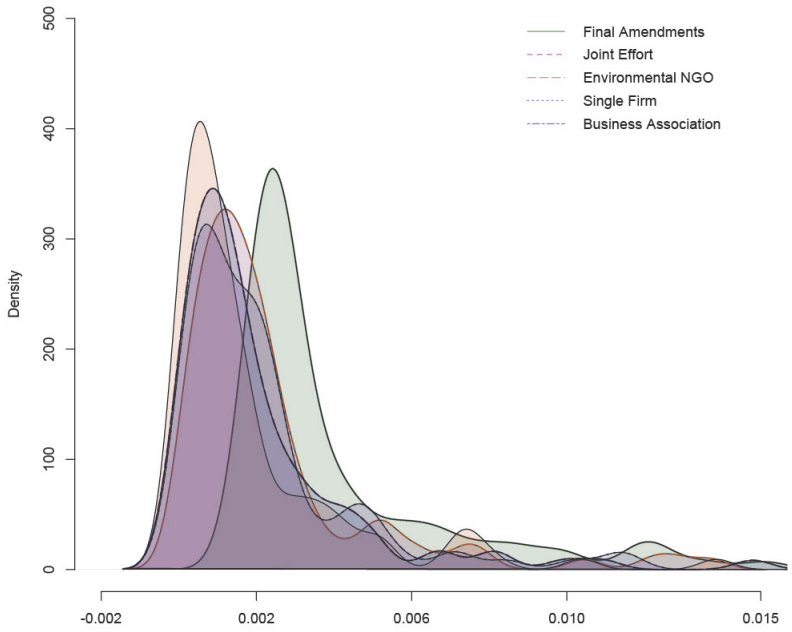


Figure 3: Kernel density estimate for each cluster of proposals

However, the KL divergence is an asymmetric measure, and calculating the divergence score for A and B results in different scores for B to A. For a more rigorous inference, I combine the metric of statistical similarity with hypothesis testing to handle this problem. The null hypothesis in this context is that each element of $P$ is equivalent to each element of $O$ while the alternative hypothesis is the opposite of the null hypothesis (e.g., at least one mismatch in elements). The test statistics used in this approach are inferred from Jensen-Shannon (JS) divergence. Following Wolpert (1995) and entropy approximation, the test statistic below is derived.[10], which is approximated by the JS divergence. JS divergence is a symmetric distance and smoothed version of the KL divergence as a test statistic. For both metrics, the lower divergence scores near zero indicate the closer statistical distance between

[10]Detailed proofs are provided in Appendix.

the two distributions. JS divergence is defined as

$$J(P||O)) = \frac{1}{2}(D(P||M) + D(O||M))$$

where $M = \frac{1}{2}(P + O)$ is a mean distribution.

A final amendment is a collection of updated clauses of regulations after the notice and comment period. Estimating the influence of policy comments on the entire policy would underestimate the regulatory influence of comments; a finalized policy is an approximately 900-page-long document and policy comments tend to focus on a few provisions of a proposed policy. Therefore, I construct a document, a set of clauses updated after regulators collect comments. Table 6 reports the KL and JS divergence scores that measure the statistical proximity between each cluster of comments and the finalized policy. At all measurements, policy comments submitted by environmental groups affiliated with business interests have the closest statistical distance to final amendments, compared to other groups' policy comments.

| Commenter Types | JS divergence scores | KL divergence scores |
|---|---|---|
| Joint Coalitions* (with business affiliations) | 0.3191772 | 1.324716 |
| Environmental NGOs | 0.4171314 | 1.886226 |
| Single Firm | 0.3557707 | 1.523774 |
| Business Associations | 0.3246622 | 1.603456 |

* Joint Coalitions include Environmental NGOs 1) receiving corporate money, 2) working with corporate partners and 3) seeking for corporate partnership.

Table 6: KL and JS divergence scores for each cluster of policy comments & final amendments

There might be some concerns that this analysis would end up capturing linguistic similarity or legal formalism between comments and policies, rather than their influence on policy changes. In response to this concern, I repeat the same analysis using a proposed policy published before the notice and comment period, instead of final amendments. We can infer that linguistic properties do not dominate analysis outcomes if the ordering of the statistical distance between an initial policy and comments is different from that of the distance between finalized policy and comments. The analysis outcome is presented below. Table 7 indicates that policy comments submitted by business associations have the closest distance from a proposed policy, followed by single firms and joint coalitions. Therefore, we conclude that the influence of policy comments on final amendments is not driven by the

linguistic similarities of texts.

| Commenter Types | JS divergence scores | KL divergence scores |
|---|---|---|
| Joint Coalitions* (with business affiliations) | 0.3536187 | 1.589078 |
| Environmental NGOs | 0.4112866 | 1.827071 |
| Single Firm | 0.3557707 | 1.550576 |
| Business Associations | 0.3463794 | 1.517257 |

* Joint Coalitions include Environmental NGOs 1) receiving corporate money, 2) working with corporate partners and 3) seeking for corporate partnership.

Table 7: KL and JS divergence scores for each cluster of policy comments & a proposed policy

As a robustness check, I repeat the analysis using Latent Dirichlet allocation (LDA). I take the harmonic mean of a set of samples generated by the Gibbs sampler to approximate the marginal corpus likelihood and find that 14 is the optimal number of topics for comments data. LDA results in the probabilistic distribution over topics for each comment and I calculate the statistical similarity between distributions for each category. Another exercise for robustness check includes calculating divergence scores for each comment and running a regression analysis. Results are presented in Appendix and are consistent with the analysis outcome based on multinomial distributions.

This finding is aligned with Yackee and Yackee (2006)'s argument that business comments are more frequently associated with changes that tend to make rules less stringent. Moreover, this empirical evidence is consistent with theoretical predictions in policy-making literature (e.g., McCarty, 2019; Hirsch and Shotts, 2012), which argues that joint effort by involved actors can increase the quality of information and provide more efficient conditions for legislators to make the most out of them. Uncovering a causal effect of business influence on politics would require a comprehensive analysis that incorporates contact information (e.g., lobbying expenditures, campaign contributions, or communication between lobbyists and legislators). My examination particularly focuses on the delivery of expertise and specialization by corporate actors which is valuable for regulators. The analysis based on the rulemaking process provides evidence that communicating through pro-climate coalitions is an effective lobbying strategy by which firms negotiate the details of policy implementation with regulators.

# Conclusion

This paper explores corporate influences on the rulemaking process. Focusing on joint coalitions of environmental groups and firms, this paper shows 1) how firms attempt to shift issue attention in environmental regulations by strategically discussing R&D technology and 2) how a such strategic partnership with environmental groups and firms translates into political influence in information environment where regulators develop a policy. The advantage of forming a partnership is substantial: firms achieve a higher quality of information and their joint comments exercise significant leverage over final amendments than other groups of comments. Drawing on recent development in machine learning techniques, this paper develops a new measure of issue slant and a new measure of information quality to test this mechanism.

The paper's empirical analysis pertains to the growing literature demonstrating the understanding of the business influence on environmental politics. Despite the high salience of climate change and heated discourse on environmental regulations, the US produced more than 6 billion metric tons of carbon dioxide equivalent greenhouse gas emissions in 2019 and has been ranked second in total greenhouse gas emissions worldwide. This paper provides an analysis of how firms influence the rulemaking process of greenhouse gas emission standards by strategically partnering with environmental groups. Even though the analysis is focused on business interests-centric explanations, this paper provides a piece of suggestive evidence on why some environmental groups partner with firms: they benefit from business information and exercise significant influence on climate policy conversation based on competitive advantage in information than other environmental groups without business affiliation. This suggests that the formation of joint coalitions is motivated by the strategic needs of both environmental groups and corporate actors.

My results contribute to a contemporary debate, both conceptual and practical. By highlighting an overlooked channel of political influence, I contribute to efforts in estimating business influence on politics. Most scholars have focused on money expenditures measured by PAC and lobbying expenditures to capture firms' influence on the legislative process. However, there are more invisible channels, and we can better capture corporate influence on politics when considering the broader set of political instruments available to firms. In this regard, my findings highlight the challenges in identifying the full set of instruments employed by special interest groups in environmental politics. Lack of consideration of the various channels of influence can lead to substantial bias in the assessment of corporate influence.

# References


Acs, A. and C. Coglianese (2022). Influence by intimidation: Business lobbying in the regulatory process. *The Journal of Law, Economics, and Organization*.

Aklin, M. and J. Urpelainen (2013). Political competition, path dependence, and the strategy of sustainable energy transitions. *American Journal of Political Science 57*(3), 643–658.

Austen-Smith, D. and W. H. Riker (1987). Asymmetric information and the coherence of legislation. *American Political Science Review 81*(3), 897–918.

Austen-Smith, D. and J. R. Wright (1992). Competitive lobbying for a legislator's vote. *Social choice and Welfare 9*(3), 229–257.

Bachrach, P. and M. Baratz (1962). Two faces of power, in "american political science review", 56.

Baumgartner, F. R., J. M. Berry, M. Hojnacki, B. L. Leech, and D. C. Kimball (2009). *Lobbying and policy change: Who wins, who loses, and why*. University of Chicago Press.

Baumgartner, F. R. and B. D. Jones (2010). *Agendas and instability in American politics*. University of Chicago Press.

Baumgartner, F. R. and B. L. Leech (1998). *Basic interests: The importance of groups in politics and in political science*. Princeton University Press.

Breyer, S. G. (1982). Regulation and its reform. In *Regulation and Its Reform*. Harvard University Press.

Cobb, R. and C. Elder (1972). Participation in american politics: The dynamics of agenda-building. boston: Allyn and bacon.

Cory, J., M. Lerner, and I. Osgood (2021). Supply chain linkages and the extended carbon coalition. *American Journal of Political Science 65*(1), 69–87.

Downie, C. (2017). Business actors, political resistance, and strategies for policymakers. *Energy Policy 108*, 583–592.

Druckman, J. N. and A. Lupia (2016). Preference change in competitive political environments. *Annual Review of political science 19*.

Falkner, R. (2017). *Business power and conflict in international environmental politics*. Springer.

Frieden, J. (1988). Sectoral conflict and foreign economic policy, 1914–1940. *International Organization 42*(1), 59–90.

Fudenberg, D. and J. Tirole (1989). Noncooperative game theory for industrial organization: an introduction and overview. *Handbook of industrial Organization 1*, 259–327.

Gilligan, T. W. and K. Krehbiel (1989). Asymmetric information and legislative rules with a heterogeneous committee. *American journal of political science*, 459–490.

Gilligan, T. W. and K. Krehbiel (1990). Organization of informative committees by a rational legislature. *American Journal of Political Science*, 531–564.

Gough, C. and S. Shackley (2001). The respectable politics of climate change: the epistemic communities and ngos. *International affairs 77*(2), 329–346.

Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: journal of the Econometric Society*, 424–438.

Grumbach, J. M. (2015). Polluting industries as climate protagonists: Cap and trade and the problem of business preferences. *Business and Politics 17*(4), 633–659.

Hawkins, K. and J. M. Thomas (1989). Making policy in regulatory bureaucracies. *Making Regulatory Policy*, 3–30.

Heede, R. (2014). Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010. *Climatic change 122*(1), 229–241.

Hess, D. J. (2013). Industrial fields and countervailing power: The transformation of distributed solar energy in the united states. *Global environmental change 23*(5), 847–855.

Hess, D. J. (2014). Sustainability transitions: A political coalition perspective. *Research Policy 43*(2), 278–283.

Hirsch, A. V. and K. W. Shotts (2012). Policy-specific information and informal agenda power. *American Journal of Political Science 56*(1), 67–83.

Kamieniecki, M. E. K. S. (2007). *Business and environmental policy: Corporate interests in the American political system*. MIT Press.

Kennard, A. (2020). The enemy of my enemy: When firms support climate change regulation. *International Organization 74*(2), 187–221.

Keohane, N. O., R. L. Revesz, and R. N. Stavins (1998). The choice of regulatory instruments in environmental policy. *Harv. Envtl. L. Rev. 22*, 313.

Kerwin, C. M. and S. R. Furlong (2018). *Rulemaking: How government agencies write law and make policy*. Cq Press.

King, G. (1988). Statistical models for political science event counts: Bias in conventional procedures and evidence for the exponential poisson regression model. *American Journal of Political Science*, 838–863.

Kingdon, J. W. and E. Stano (1984). *Agendas, alternatives, and public policies*, Volume 45. Little, Brown Boston.

Kraft, M. E. and S. Kamieniecki (2007). Analyzing the role of business in environmental policy. *Business and environmental policy. Corporate interests in the American political system*, 3–31.

Layzer, J. A. (2012). *Open for business: Conservatives' opposition to environmental regulation*. MIT Press.

Le, Q. and T. Mikolov (2014). Distributed representations of sentences and documents. In *International conference on machine learning*, pp. 1188–1196. PMLR.

McCarty, N. (2017). The regulation and self-regulation of a complex industry. *The Journal of Politics 79*(4), 1220–1236.

McCarty, N. (2019). Team policy production. *Available at SSRN 3505655*.

Michael, D. C. (1996). Cooperative implementation of federal regulations. *Yale J. on Reg. 13*, 535.

Nachmany, M., S. Fankhauser, T. Townshend, M. Collins, T. Landesman, A. Matthews, C. Pavese, K. Rietig, P. Schleifer, and J. Setzer (2014). The globe climate legislation study: a review of climate change legislation in 66 countries.

Quirk, P. J. (2014). *Industry influence in federal regulatory agencies*, Volume 84. Princeton University Press.

Rogowski, R. (1990). *Commerce and coalitions: How trade affects domestic political alignments*. Princeton University Press.

Romer, T. and H. Rosenthal (1978). Political resource allocation, controlled agendas, and the status quo. *Public choice*, 27–43.

Schnattschneider, E. (1960). The semi-sovereign people. *New York: Holt, Reinhart and Winston*.

Sell, S. K. and A. Prakash (2004). Using ideas strategically: The contest between business and ngo networks in intellectual property rights. *International Studies Quarterly 48*.

Stern, N. (2008). The economics of climate change. *American Economic Review 98*(2), 1–37.

Stokes, L. C. (2020). *Short circuiting policy: Interest groups and the battle over clean energy and climate policy in the American States*. Oxford University Press, USA.

Stone, D. A. (1989). Causal stories and the formation of policy agendas. *Political science quarterly 104*(2), 281–300.

Supran, G. and N. Oreskes (2021). Rhetoric and frame analysis of exxonmobil's climate change communications. *One Earth 4*(5), 696–719.

Tvinnereim, E. and E. Ivarsflaten (2016). Fossil fuels, employment, and support for climate policies. *Energy Policy 96*, 364–371.

Vormedal, I. (2008). The influence of business and industry ngos in the negotiation of the kyoto mechanisms: the case of carbon capture and storage in the cdm. *Global environmental politics 8*(4), 36–65.

Vos, J. (2009). Actions speak louder than words: Greenwashing in corporate america. *Notre Dame JL Ethics & Pub. Pol'y 23*, 673.

Wagner, W. E. (2003). Commons ignorance: the failure of environmental law to produce needed information on health and the environment. *Duke LJ 53*, 1619.

Weible, C. M. (2008). Expert-based information and policy subsystems: a review and synthesis. *Policy Studies Journal 36*(4), 615–635.

Yackee, J. W. and S. W. Yackee (2006). A bias towards business? assessing interest group influence on the us bureaucracy. *The Journal of Politics 68*(1), 128–139.

Yackee, S. W. (2012). The politics of ex parte lobbying: Pre-proposal agenda building and blocking during agency rulemaking. *Journal of Public Administration Research and Theory 22*(2), 373–393.

Zingales, F. (1998). What's a company's reputation worth?'. *Global Finance 12*(2), 1.

# Appendix

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# A Strategic use of the topic of R&D and technology by business interests

### Correlation

In this section, I empirically test the qualitative evidence that business actors strategically mention more about R&D and technology to take attention away from emission standards. I compare the salience of issues focused on research and development, with indicators that reflect the firms' demand for regulation intensity and test the hypothesis that the proposed coverage of research and development is intended to distract the attention away from stringent emission cuts. I first perform an initial and simplistic study of this agenda-setting strategy. I define *R&D* coverage following the comparative agendas project and added specific conditions that mention research and development at least twice. I show in Figure 1 the proportion of proposals discussing *R&D*. I found a strong positive correlation ($\gamma_1$= 0.8722452 for Carbon Dioxide emission, $\gamma_2$ =0.913333 for Methane emission); this suggests that mentions of research or development increase as emission increase. This positive correlation indicates the possibility of strategic use of agenda-setting by business interests.

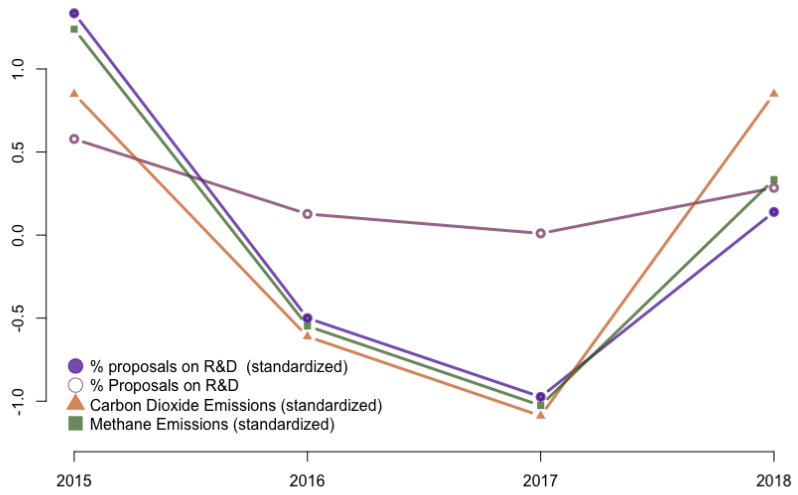



Figure 4: Proportion of regulatory proposals by business interests groups that mention research, technology and development at least twice and emission (Yearly emission data is from EPA)

Next, I extend these preliminary results in various ways. First I redefine the definition of *R&D* coverage by using two metrics: proposal-level, the number of articles that mention

research, development, or technology at least twice, normalized by the total number of proposals in the time slice; and word level, the frequency of the occurrences of the research and development topics normalized by the total count of words in the time slice. Next, I refine the time resolution and use year and month levels of analysis. For monthly analysis, I use monthly average-emission data measured at ESRL Global Monitoring Laboratory.

Table 1 describes the correlation between metrics of R&D coverages and climate change indicators at year and month levels. At all levels, there exist correlations between the proportion of agenda focused on research and development and CO2 emissions.

| Levels | Proposal-level | Word-level |
|---|---|---|
| U.S. Atmospheric CO2 (Global Monitoring Laboratory, Monthly Averages)* | 0.3723696 | 0.3364334 |
| CO2 Emissions (EPA, Yearly)** | 0.3328969 | 0.4501426 |

* CO2 measurements from flask-air samples scaled by National Oceanic and Atmospheric Administration (NOAA)
** Emissions are expressed in million metric tons of carbon dioxide equivalents.

Table 8: Pearson's correlation between proposal coverage of the Research and Development and emission indicators

### Granular Analysis of Granger Causality

Next, I hypothesize that these correlations are directed in fact: Greenhouse gas emissions are followed by business interests' coverage of research and development. To scrutinize this conjecture, I combine Granger Causality test (Granger, 1969) with measures based on textual analysis. The crux of Granger causality is that we can identify if cause precedes effects. Therefore, a time series X is said to Granger-cause a time series values Y if past values $x_{t-i}$ are a statistically significant indicator in predicting $y_i$.

The analysis for Granger Causality is as follows. 1) I calculate the metrics at the proposal level and word-level to implement a weekly-level granular analysis from 2015 to 2018. I use the U.S. weekly mean CO2 data from Global Monitoring Laboratory. Next, Granger causality between word-metric and CO2 molfrac (ppm) is computed by fitting a linear regression model with m-lag and n-lag. CO2 emissions Granger-cause the coverage of $R\&D$ if

the analysis finds that $\beta$ is different from zero with statistical significance.

$$\text{Word-level metric}_t = \sum_{i=1}^{m} \alpha_i(\text{Word-level metric}_{t-1}) + \sum_{j=1}^{n} \beta_j(\text{CO2 molfrac (ppm)}_{t-1})$$

| | Proposal-level | | Word-level | |
|---|---|---|---|---|
| | **1-Lag** | **2-Lag** | **1-Lag** | **2-Lag** |
| R&D Coverage$_{t-1}$ | 0.800** | 0.202*** | 0.003 | 0.002 |
| | (0.353) | (0.073) | (0.072) | (0.072) |
| R&D Coverage$_{t-2}$ | | −0.073 | | 0.051 |
| | | (0.072) | | (0.072) |
| Mean carbon dioxide$_{t-1}$ | 0.115*** | 0.044 | 0.00002*** | −0.001 |
| | (0.036) | (0.038) | (0.00000) | (0.001) |
| Mean carbon dioxide$_{t-2}$ | | 0.070* | | 0.001 |
| | | (0.038) | | (0.001) |
| N | 190 | 190 | 190 | 190 |
| Adj. R-squared | 0.1079 | 0.117 | 0.127 | 0.122 |

***p < .01; **p < .05; *p < .1

Table 9: Granger Causality between CO2 molfrac (ppm) and the coverage of *R&D*

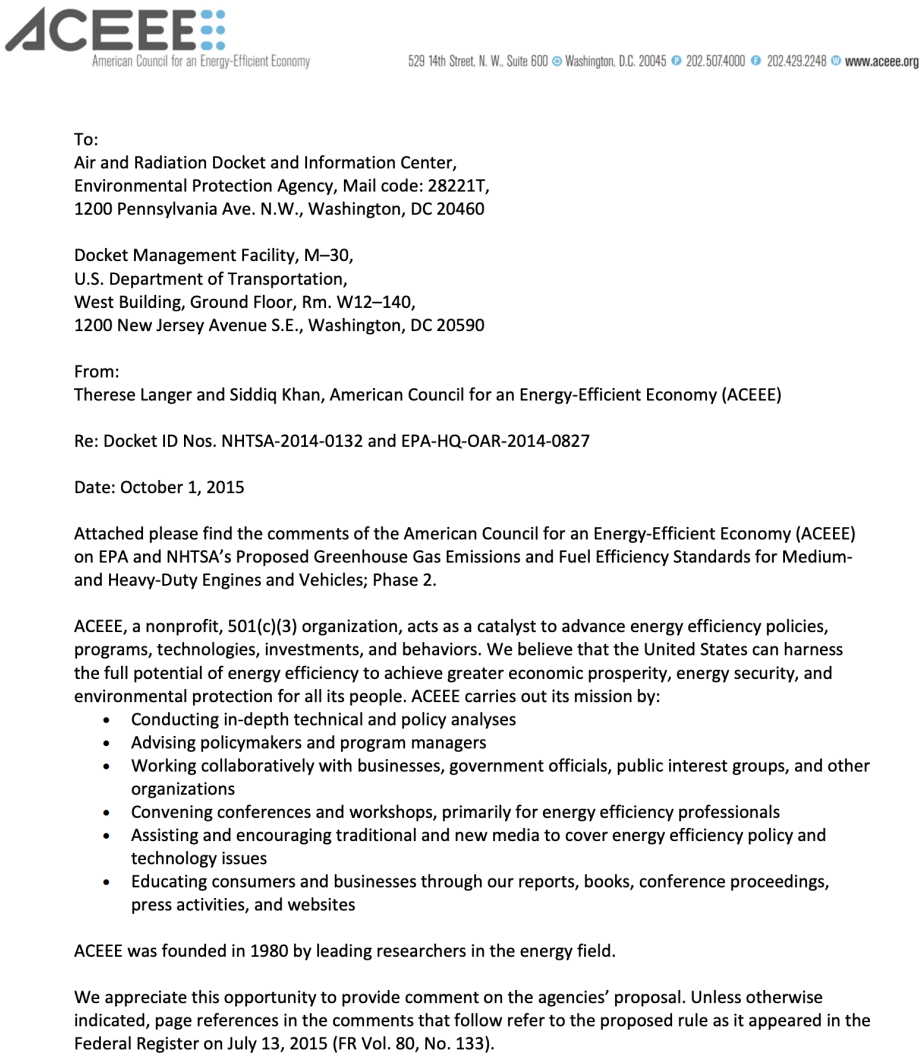
Table 2 indicates the analysis results. I found 1-lag mean Carbon Dioxide values Granger-cause coverage of *R&D* agenda at both proposal-level and word-level metrics. Remarkably, the coefficients for Greenhouse gas emission are positive, which indicates that the increase in the emission is followed by an increase in R&D coverage. In the 2-lag analysis, the $p$-value at the proposal-level is less than 0.1 but it is not statistically significant at the word-level. To rule out the likelihood of reverse causality, I compute Grange causality in opposite direction, and the analysis does not return statistically meaningful results. The Granger Causality Tests in the reverse direction are presented below. These findings implies that corporate actors discuss the topic of R&D when air pollusion increases.

| | Proposal-level | | Word-level | |
|---|---|---|---|---|
| | **1-Lag** | **2-Lag** | **1-Lag** | **2-Lag** |
| Mean carbon dioxide$_{t-1}$ | 1.000*** | 0.728*** | 0.002*** | 0.001*** |
| | (0.0002) | (0.069) | (0.084) | (0.092) |
| Mean carbon dioxide$_{t-2}$ | | 0.272*** | | 0.089*** |
| | | (0.069) | | (0.071) |
| R&D Coverage$_{t-1}$ | 1.767 | 1.601 | 1.0004 | 1.001 |
| | (3.804) | (3.677) | (0.509) | (0.704) |
| R&D Coverage$_{t-2}$ | | 1.602 | | 0.007 |
| | | (3.681) | | (2.001) |
| N | 190 | 190 | 190 | 190 |
| Adj. R-squared | 0.1079 | 0.117 | 0.137 | 0.112 |

***p < .01; **p < .05; *p < .1

Table 10: Granger Causality between CO2 molfrac (ppm) and the coverage of *R&D* (Reverse Direction)

# B Example of Regulatory proposals



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To:
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1200 New Jersey Avenue S.E., Washington, DC 20590

From:
Therese Langer and Siddiq Khan, American Council for an Energy-Efficient Economy (ACEEE)

Re: Docket ID Nos. NHTSA-2014-0132 and EPA-HQ-OAR-2014-0827

Date: October 1, 2015

Attached please find the comments of the American Council for an Energy-Efficient Economy (ACEEE) on EPA and NHTSA's Proposed Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles; Phase 2.

ACEEE, a nonprofit, 501(c)(3) organization, acts as a catalyst to advance energy efficiency policies, programs, technologies, investments, and behaviors. We believe that the United States can harness the full potential of energy efficiency to achieve greater economic prosperity, energy security, and environmental protection for all its people. ACEEE carries out its mission by:

- Conducting in-depth technical and policy analyses
- Advising policymakers and program managers
- Working collaboratively with businesses, government officials, public interest groups, and other organizations
- Convening conferences and workshops, primarily for energy efficiency professionals
- Assisting and encouraging traditional and new media to cover energy efficiency policy and technology issues
- Educating consumers and businesses through our reports, books, conference proceedings, press activities, and websites

ACEEE was founded in 1980 by leading researchers in the energy field.

We appreciate this opportunity to provide comment on the agencies' proposal. Unless otherwise indicated, page references in the comments that follow refer to the proposed rule as it appeared in the Federal Register on July 13, 2015 (FR Vol. 80, No. 133).

Figure 5: A Proposal submitted by Siddiq Khan, Senior Researcher and Lead, Heavy-Duty Vehicle Work, American Council for an Energy-Efficient Economy (ACEEE)

# C Descriptive visusalization of public comments

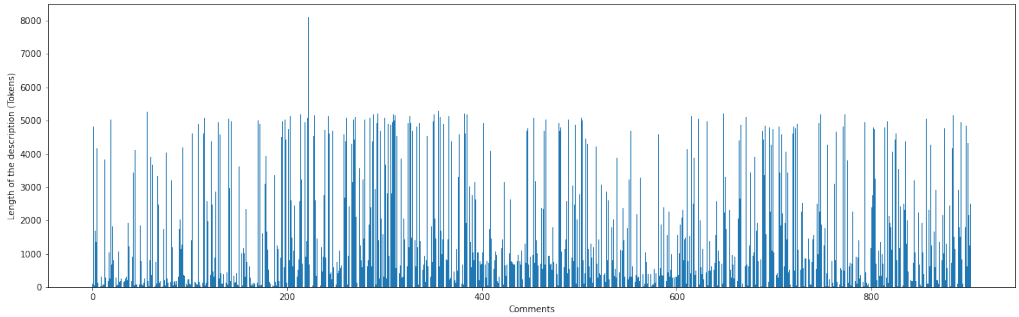


Figure 6: Length of comments in the company/organization sample

# D Word Embeddings Evaluations

I evaluate the model with examples by showing the closest words to the words research, development and technology to make sure that training a neural network makes sense substantively. The table below indicates the words used for constructing a global issue slant vector. For robustness check, I adjust the number of words 3,5 and 7 for each topic and the results are still consistent.

| | |
|---|---|
| Research<br>Development, Technology | firm, funded, stakeholder, engineering, literature<br>development, advanced, adoption, improvements, cost-effectively |
| Emission ** | GHG, criteria, gases, greenhouse,requirements,<br>pollutant, requiring, applicable, engines, control |

* The table reports ten most frequent words that are most likely to be associated with each keywords.

Table 11: The Word Sets of the Most Frequent Words

# E Harmonic Mean Method

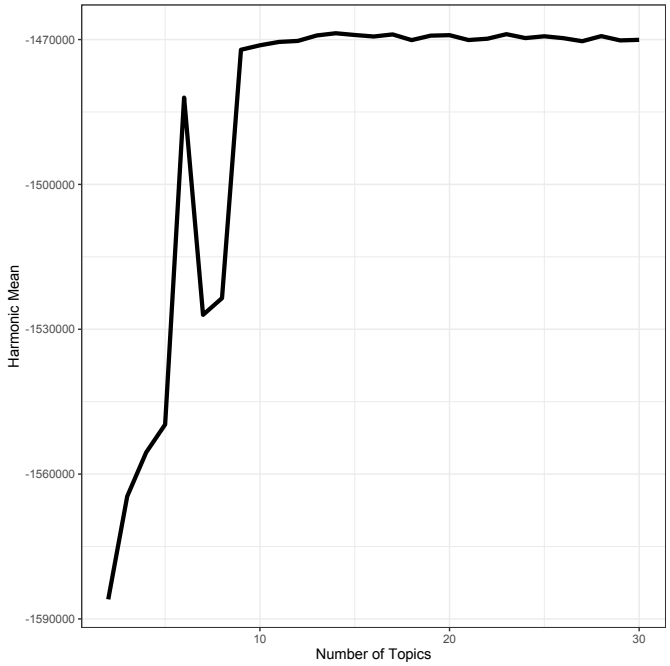


Figure 7: Optimal number of topics for Latent Dirichlet Allocation

# F Statistical proximity based on Latent Dirichlet Allocation (LDA)

| Commenter Types | JS divergence scores | KL divergence scores |
|---|---|---|
| Joint Coalitions* (with business affiliations) | 0.5297128 | 3.21294 |
| Environmental NGOs | 0.7117782 | 5.251285 |
| Single Firm | 0.5822825 | 4.025009 |
| Business Associations | 0.5325079 | 5.042943 |

* Joint Coalitions include Environmental NGOs 1) receiving corporate money, 2) working with corporate partners and 3) seeking for corporate partnership.

Table 12: KL and JS divergence scores for each cluster of policy comments & final amendments based on LDA

# G Regression analysis using divergence scores for each comment

| | *Dependent variable: JS divergence score* | | | |
|---|---|---|---|---|
| Sample | Company/Organization | Environmentalist | Business | Company/Organization |
| Joint Coalition | $-0.066^{***}$ | $-0.101^{***}$ | $-0.071^{***}$ | $-0.073^{***}$ |
| | (0.011) | (0.018) | (0.012) | (0.020) |
| Environmentalists | | | | $0.034^{**}$ |
| | | | | (0.015) |
| Business Coalition | | | | $-0.002$ |
| | | | | (0.021) |
| Single Firm | | | | $0.036^{***}$ |
| | | | | (0.012) |
| Constant | $0.804^{***}$ | $0.760^{***}$ | $0.812^{***}$ | $0.766^{***}$ |
| | (0.013) | (0.020) | (0.016) | (0.014) |
| Observations | 903 | 232 | 665 | 903 |
| Year FE | Yes | Yes | Yes | Yes |

*Note:* $^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01

# H Proof: Comparing Multinomial Distributions

Let x be a discrete variable, and the set of probability distribution x is parameterized by a vector p where p(x=k)= $p_k$.

$$p(x|p) = \prod_{k=1}^{K} p_k \tag{1}$$

where $\delta(x = k)$ is an indicator function. Therefore, the joint probability of N IID samples X can be expressed as

$$p(X|P) = \prod_{k=1} K p_k \tag{2}$$

$$N_k = \sum_k \delta(x_k = k) \tag{3}$$

A conjugate prior for p is the Dirichlet distribution:

$$p(p|\alpha) \sim D(\alpha_1, ....., \alpha_k) = \frac{\Gamma(\sum_k \alpha_k)}{\pi_k \Gamma(\alpha_k)} \prod_k {}^{k-1}_{k} \tag{4}$$

$$\sum_k p_k = 1 \tag{5}$$

In above equations, $\alpha_k$ is the hyper-parameter, a virtual count for value k. Large $\alpha$ is equivalent to prior knowledge about the distribution. The Dirichlet distribution has the properties of

$$p(p_1|\alpha) \sim D(\alpha_1, \alpha_2 + ....., +\alpha_k) \tag{6}$$

$$E[p_1] = \frac{\alpha_1}{\sum_k \alpha_k} \tag{7}$$

$$E[logp_1] = \psi(\alpha_1) - \psi(\sum_k \alpha_k) \tag{8}$$

, where $\psi(x) = \frac{\Gamma'(x)}{\Gamma(x)}$. The maximum of its density is at $p_k = (\alpha_k - 1)/((\sum_k \alpha_k) - k)$. Given Dirichlet prior, the joint distribution of a set of samples X and p is

$$p(X,p|\alpha) = \frac{\Gamma(\sum_k \alpha_k)}{\prod_k \Gamma(\alpha_k)} \prod_k p_k^{N_k+\alpha_k-1} \tag{9}$$

and the posterior is reduced to $p(p|X,\alpha) \sim D(N_k + \alpha_k)$

Therefore, the probability that data all come from one multinomial distribution can be indicated as;

$$p(X|\alpha) = \int_p p(X,p|\alpha) \tag{10}$$

$$= \frac{\Gamma_k \alpha_k \prod_k \Gamma(N_k+\alpha_k)}{\prod_k \Gamma(\alpha_k)\Gamma(\sum_k N_k + \alpha_k)} \int_p D(p; N_k + \alpha_k) \tag{11}$$

$$= \frac{\Gamma(\sum_k \alpha_k)}{\Gamma(N + \sum_k \alpha_k)} \prod_k \frac{\Gamma(N_k+\alpha_k)}{\Gamma(\alpha_k)} \tag{12}$$

# I Proof: Jenson-Shannon divergence as a test statistic

Our primary concern is the probability that finalized rule (= Y) and proposals (=X) are from the same probabilistic distribution. Based on information-theoretic quantity of mutual information, I connect distribution similarity to hypothesis testing. This is a problem related to homogeneity and I examine if two samples X and Y are from the same multinomial distribution or different distribution. Therefore, I am interested in

$$P(same|X,Y) = \frac{P(X|Y|same)p(same)}{p(X,Y|same)p(same) + p(X,Y|different)p(different)} \tag{13}$$

$$= \frac{1}{1 + \frac{P(X,Y|different))}{P(X,Y|same)} \frac{P(different)}{P(same)}} \tag{14}$$

The quantity of $\frac{p(X,Y|different)}{p(X,Y|same)}$ is the ratio in favor of difference as shown below by Wolpert (1995)

$$\frac{p(X|\alpha)p(Y|\alpha)}{p(X,Y|\alpha)} = \frac{\Gamma(\sum_k \alpha_k \Gamma(M+N+\sum_k k)}{\Gamma(M+\sum_k \alpha_k)\Gamma(N+\sum_k k)} \prod_k \frac{\Gamma(M_k+\alpha_k)\Gamma(N_k+\alpha_k)}{\Gamma(\alpha_k)\Gamma(M_k+N_k+\alpha_k)} \tag{15}$$

By entropy approximation, the logarithm of this ratio is equal to

$$log\frac{p(X|\alpha)p(Y|\alpha)}{p(X,Y|\alpha)} \approx -MH(\frac{M_k}{M}) - NH(\frac{N_k}{N}) + (M+N)H\frac{M_k+N_k}{M+N}) \tag{16}$$

$$= MD(\frac{M_k}{M}||\frac{M_k+N_k}{M+N}) + ND(\frac{N_k}{N}||\frac{M_k+N_k}{M+N}) \tag{17}$$

$$\text{where } D(p||q) = \sum_k p_k log\frac{p_k}{q_k} \tag{18}$$

The equation 19 is equal to the average divergence to the mean, which is known to be Jensen-Shannon divergence.

Note: Entropy Approximation

$$\frac{\gamma(K)}{\Gamma(N+K)} \approx \frac{\Gamma(K)}{\Gamma(N+1)N^{K-1}} \approx \frac{1}{\Gamma(N+1)} \tag{19}$$

$$logp(X|\alpha=1) \approx -NlogN + N + \sum_k (N_k logN_k - N_k) \tag{20}$$

$$= \sum_k N_k log\frac{N_k}{N} \tag{21}$$

$$= -NH(N_k/N) \tag{22}$$