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“Environmental Regulation Informed by Biased Stakeholders”

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Environmental regulation informed by biased stakeholders *

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Abstract

Public consultations are widely used in regulatory processes, allowing stakeholders to present their viewpoints despite their inherent biases. Some stakeholders, such as firms, are known to be pro-business, while others, such as environmental NGOs, are pro-environment. Other such as national authorities have unknown bias. We develop a framework to analyze how a regulator processes information provided by biased stakeholders. We show that the regulator follows the advice that runs counter to a stakeholder's typical bias: to regulate if firms so advise and not to regulate if environmental organizations so advise. Without such advice, she prioritizes the comments from stakeholders with unknown biases. We then contrast our theoretical results with the regulation of chemicals in the European Union. Consistent with the model's predictions, support for regulation is more strongly associated with regulatory outcomes when it comes from firms than from NGOs or environmental organizations. We also find that regulatory decisions are more strongly correlated with comments from national authorities than from other stakeholders, both in terms of participation and relative support.

Keywords: environmental policy, incomplete information, cheap talk, biased expertise, private politics, chemicals, REACH.

JEL codes: D21, H23, L51, Q48, Q58.

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1 Introduction

Many public policies involve some public consultation process. From urban planing to infrastructure investment or product safety, stakeholders are asked to report their views in publicly available comments to the authorities in charge of the decision. In Europe, the Commission's 2001 White Paper on European Governance established public consultations as a key tool to increase the openness and representativeness of policy decisions covering diverse domains such as financial regulation, aviation safety, and chemical authorization. To fulfill their informational needs regarding the sectors they regulate, public administrations are required to consult stakeholders and the public (see e.g., Beyers and Arras 2020).

This paper investigates regulatory decision-making in public consultations with biased and informed stakeholders. It addresses how regulators can navigate biased information reported by diverse stakeholders to improve the accuracy of regulatory decisions. We develop a framework to analyze stakeholders' commenting strategies and the regulator's optimal response to comments received. We then bring theory to data in the context of chemical regulation in Europe. Conflicts surrounding chemical risk and safety involve a variety of stakeholders with competing positions, making this a particularly suitable case for our study. The EU's extensive and transparent consultation process allows us to gather stakeholder input and connect it to regulatory outcomes, offering valuable insights into how biases shape policy decisions.

We model a consultation game in which a regulator receives input from stakeholders with different biases about whether to authorize or ban a product. Using a Bayesian Nash Equilibrium (BNE) framework, we analyze how the regulator updates her beliefs based on the recommendations. The model accounts for scenarios with two key stakeholders—a firm and an environmental organization—where the regulator gains insights based on whether their recommendations align or conflict. We further extend the model by introducing a third stakeholder with uncertain or unknown bias, such as a national authority, whose input helps resolve conflicting information. Additionally, we explore the role of multiple stakeholders of each type and analyze how the presence of differing recommendations within a group provides information to improve the decision-making process.

We propose several hypotheses regarding how biased input from stakeholders is related to regulatory outcomes, including the role of firms in opposing regulation and the importance of national authorities in resolving conflicting input. We apply our framework to EU chemical regulation using comprehensive data from public consultations.

Our empirical analysis examines how patterns of stakeholder participation and expressed support relate to subsequent regulatory outcomes. Stakeholder comments are endogenous, since both the decision to comment and the regulatory outcome are jointly influenced by underlying characteristics of chemical substances. Accordingly, the empirical analysis is not interpreted causally. Rather, it documents correlations that help assess whether observed regulatory decisions align with the model's predictions about the relative informational content of comments from different stakeholder types. Consistent with these predictions, regulatory decisions are more strongly associated with firms' comments—particularly when firms support regulation—and with comments from national authorities when stakeholder opinions are divided.

Our findings offer practical implications for policymakers by providing strategies to handle biased input more effectively and improve the accuracy of their decisions. While our framework focuses on environmental regulation, the insights are broadly applicable to decision-making in various policy domains influenced by stakeholder bias. We contribute to the literature by examining how biased information affects the likelihood of regulation and provide suggestive evidence on the extent to which stakeholder input influences regulatory outcomes in practice.

Contribution to the literature. Political science has documented that more powerful stakeholders can capture public consultations by raising public awareness of their concerns and thereby influencing policymaking. Despite efforts to diversify the set of stakeholders consulted, studies have shown that business groups often dominate the process due to their superior political and technical resources (Furlong and Kerwin 2005; Beyers and Arras 2020). In contrast, non-business interests, such as environmental NGOs and consumer advocates, tend to participate less due to the higher costs associated with acquiring sufficient expertise to engage effectively (Bunea 2017; Dür and De Bièvre 2007). Regulatory capture occurs when policies systematically favor industry interests at the expense of the broader public good. Regulatory capture is particularly likely when industry messages are strong and unified, while countervailing voices, such as NGOs, are less mobilized (Chalmers 2020). Furthermore, industries may supply information that serves their specific interests, even if it means withholding knowledge of environmental or public health risks (Dunlop et al. 2020). We complement this literature by modeling the process of information disclosure, focusing on the incentives to misreport the truth. The stakeholder's regulatory capture occurs through strategically distorting the comments sent in the public consultation process. To the best of our knowledge, our paper is the first to perform an economic analysis of public consultation processes in which insights are empirically investigated in a case study.

Our model is built on the literature on cheap-talk and persuasion games, which examines how biased players communicate information to decision-makers (Crawford and Sobel 1982; Milgrom and Roberts 1986; Grossman and Helpman, 2001, Krishna and Morgan 2001, 2008, Dessein 2002; Bhattacharya and Mukherjee 2013). These models typically explore how players with private information strategically disclose or conceal information to influence the decision-maker's choice, depending on their own preferences. Unlike in persuasion games, our work extends this literature by considering a binary decision space (authorize or ban) and introducing both known and unknown biases among stakeholders. Our model differs from traditional cheap-talk games, where players can choose to partially disclose information, revealing only certain aspects that serve their interests while withholding others. By contrast, our model focuses on regulatory decisions where partial disclosure is not an option. Stakeholders must either fully support or fully oppose the regulation, with no opportunity to selectively share favorable information while hiding unfavorable details. This binary setup simplifies the equilibrium analysis. We are able to characterize a BNE with pure strategies.[1] Additionally, we show how the presence of stakeholders with unknown biases can mitigate the inefficiencies arising from strategic lying by other biased stakeholders. By doing so, we expand the cheap-talk framework to a real-world regulatory setting, providing practical implications for how regulators can better handle biased input.

Our approach is related to three main strands of literature in economics: (1) the political economy of environmental regulation, where we explore how regulatory decisions are shaped by the input of stakeholders with conflicting interests; (2) private politics, as we analyze how firms and NGOs engage in influencing regulatory outcomes; and (3) chemical regulation, focusing on how stakeholder input affects regulatory decisions specifically in the context of chemical safety.

We contribute to the line of research that investigates how public policies emerge and which specific policies are ultimately formulated or designed. In the political econ-

[1] Equilibria in cheap-talk games are multiple and in mixed strategies since the privately-informed players send random messages with a uniform probability distribution on a partition of the strategy space (Crawford and Sobel, 1982). Among them, the "babbling equilibrium" does not convey any information to the decision maker since the support of the message is uniform among all the strategy space. In our simplified framework, a similar 'babbling equilibrium" exists in which the stakeholder's messages are not informative (e.g., always oppose regulation for a firm and always favor regulation for an NGO), and the regulator ignores the stakeholder's message. The babbling equilibrium is not robust to a coalition deviation by stakeholders: they have a joint interest in sending informative messages, in which case the regulator should not ignore the message sent. Furthermore, the babbling equilibrium is Pareto-dominated. It also induces more type I and II errors (see Proposition 4).

omy approach, environmental policies are modeled as the result of collective decision-making processes, often using frameworks such as probabilistic electoral competition or the median-voter model (Cremer et al. 2008; Besley and Persson 2023; Oates and Schwab 1988; Ambec and De Donder 2021). These models typically assume that voters or decision-makers have specific preferences, which may lead to suboptimal policies due to misalignment between individual interests and societal welfare. Our paper contributes to this literature by endogenizing the policy decision process through a formal consultation mechanism involving biased stakeholders. In contrast to existing political economy models that treat the policy-making process as exogenous, we analyze how the regulator, confronted with biased input from stakeholders, can improve the decision-making process. Our framework shows that, when stakeholders with opposing biases agree or when advice runs counter to their known bias, the regulator can be confident in making optimal decisions, ensuring the best possible outcome. This contribution highlights how decision-making can be improved when stakeholders' biases are directly incorporated into the regulatory process.

Our paper also contributes to the literature on private politics, which focuses on how stakeholders, such as firms and NGOs, influence policy through lobbying, protests, and other costly activities (Baron 2003; Egorov and Harstad 2017; and Daubanes and Rochet 2019). In these models, stakeholders' influence is typically proportional to the resources they invest, which affects their bargaining power in shaping policy outcomes. In contrast, our consultation game models a costless communication process where stakeholders submit comments without directly incurring costs to influence regulation. However, we incorporate strategic information manipulation, as seen in Lyon and Maxwell (2004), Bramoullé and Orset (2018) and Chiroleu-Assouline and Lyon (2020). These authors show that firms have incentive to pay interest groups not to communicate on certain issues or to send false reports. They also invest resources to undermine the credibility of scientific evidence, thus reducing public support for regulation. While our model includes the possibility of firms manipulating information by hiding or distorting evidence not aligned with their interests, our consultation framework differs in that this manipulation does not affect how other stakeholders (such as think tanks, NGOs, or environmental agencies) communicate with the regulator. All stakeholders can freely and transparently declare whether they support or oppose the regulation to the regulator.

Finally, our paper also contributes to the literature on chemical regulation by analyzing the role of biased stakeholders in influencing regulatory decisions. A key theme in this literature is the dominance of business interests in regulatory consultations, where regulatory agencies rely heavily on industry information due to the technical complexity of chemical products (Beyers and Arras 2020; Legg et al. 2021). Our paper examines the roles of firms, NGOs, and national authorities in the consultation process and shows that regulatory outcomes are more strongly associated with comments from firms than with those from NGOs or environmental agencies. Additionally, we document that national authorities with unknown biases are particularly important in cases where stakeholders with opposing interests disagree. Our analysis of EU chemical regulation provides empirical support for the theoretical framework and offers insights into the interaction between stakeholders and regulators in this highly contested policy area.

This paper is organized as follows. Section 2 introduces our theoretical model and examines how stakeholder input is associated with regulatory outcomes in the model. Section 3 examines how the model's implications align with EU chemical regulation. Section 4 concludes the paper.

2 The public consultation game with biased stakeholders

2.1 The model

We analyze the regulation of a potentially harmful product or technology when the decision is influenced by information provided by different stakeholders. The regulator relies on advice given by stakeholders. Communication is primarily science-based in the context of EU chemical regulation; however, it may incorporate any opinion reported by stakeholders that is relevant for regulatory decision-making. Importantly, the comments sent to the regulator can be distorted by stakeholders' self-interests. Such distortions may arise because of bounded rationality on the regulator's side (i.e., regulators cannot fully process scientific knowledge and therefore rely on experts' interpretations), or because stakeholders actively influence the interpretation of evidence, for instance by creating uncertainty about the scientific case for regulation.[2]

Importantly, stakeholder comments need not be interpreted as purely informational

[2] One common strategy for creating doubt is to attack the credibility of science-based organizations by accusing them of political bias. Another is to put forward competing scientific evidence whose findings oppose those supporting policy action; see, e.g., Chiroleu-Assouline and Lyon (2020).

signals. They may also reflect economic stakes, political pressures, or strategic positioning. The regulator's problem is therefore to assess the relative informativeness of these signals given known or partially known stakeholder biases.

A regulator R has to decide whether or not to regulate a product that generates an expected gain V (economic benefits) and an expected loss D (environmental and expected health damages). The product should be regulated if $V < D$ and not otherwise. The welfare from regulating the product is normalized to 0. For simplicity, we refer to the decision to regulate as a ban. However, regulation encompasses other forms of control of production and product use that reduce both the economic value of the product and its harm to health and the environment. Both V and D are unknown by the regulator.

There are three kinds of stakeholders: firms F, public authorities G, and organizations O (NGOs, environmental, and health agencies). All stakeholders are biased about the outcome of the regulation. The type-T stakeholder's preference is represented by its payoff $V - \alpha_T D$ if the product is authorized and 0 if it is banned, for $T \in \{F, G, O\}$. Stakeholder T aligns more with the social interest when α_T is close to 1.

It is common knowledge that $\alpha_F < 1 < \alpha_O$: firms put more weight on the economic value and less weight on health or environmental damages, while the reverse holds for organizations. In the baseline model, we assume that the regulator knows both the direction and the magnitude of these biases, i.e., the values of α_F and α_O are common knowledge.

As for public authorities G, they can be either pro-business or pro-environment. Their bias parameter α_G is uncertain. It can be higher or lower than 1 with positive probability. Both the direction and the magnitude of this bias are unknown to the regulator.

Note that the parameter α_T might also capture the stakeholder's misperception of economic value and harms, rather than solely reflecting biased preferences. Firms may underestimate the harmful impacts of their products, while organizations may undervalue economic benefits. Stakeholders' expertise may also shape this discrepancy, as firms primarily prioritize generating economic value over accurately estimating environmental damages.[3]

[3]For instance, under REACH's Authorization Program, the use of substances of very high concern is allowed if the socio-economic benefits from the use of the substance are shown to outweigh the risks connected with its use and there are no suitable alternative substances or technologies that are economically and technically viable. In 2017, the European Chemical Agency compared the firms' assessment of social benefits and social costs of continued use to those of technical experts. The aggregate benefit-cost ratio calculated by the firms was 100:1, whilst the aggregate benefit-cost ratio

Working with the product's expected social return defined by $r \equiv \dfrac{V}{D}$ is convenient. The product should be authorized if $r \geq 1$ and banned if $r < 1$. Without advice from stakeholders, R decides based on expected return: the product is authorized if $E[r] \geq 1$ and banned if $E[r] < 1$.

Stakeholder bias can be linked to the expected return in a simple way. Stakeholder T would like the product to be authorized if $V - \alpha_T D \geq 0$ – that is, if $r \geq \alpha_T$. It would like the product to be banned if $r < \alpha_T$. Hence, a firm would rather authorize a product that should be regulated whenever $1 > r \geq \alpha_F$. Symmetrically, an organization would like the product to be banned if $V - \alpha_O D \leq 0$ – that is, if $r < \alpha_O$. Hence, the organization would ban a product that should be authorized whenever $\alpha_O > r > 1$.

The consultation process provides stakeholders with the opportunity to make comments about the product. The comment recommends authorizing or banning the product. We denote by m_T the comment from stakeholder $T = F, G, O$. The comment $m_T = A$ recommends authorizing the product, while $m_T = B$ recommends banning the product. The regulator bases her decision on the comments received. We denote the decision $d(\boldsymbol{m})$, where $\boldsymbol{m}$ are the comments received, and $d(\boldsymbol{m}) = A$ means authorizing the product while $d(\boldsymbol{m}) = B$ means banning it.

The timing of the consultation process is as follow:

1. A product with return $r = \dfrac{V}{D}$ is drawn from $[\underline{r}, \overline{r}]$ with distribution f with $\underline{r} < 1 < \overline{r}$.

2. Stakeholders (but not the regulator) observe V and D.

3. Each stakeholder T sends a comment $m_T \in \{A, B\}$.

4. The regulator decides $d(\boldsymbol{m}) \in \{A, B\}$.

We first analyze the decision-making process with one firm and one organization before introducing public authorities into the game.

per continued use based on the assessment of technical experts was 15:1. The substantial difference between these ratios suggests that firms overestimate the benefits to society from their use of hazardous chemicals and underestimate the negative impacts on workers and the general public. It is difficult to conclude whether such biases are strategically made or due to a lack of skills in assessing risks and benefits; see Georgiou et. al. (2018).

2.2 Consultation with one or two stakeholders with opposite bias

Assume first that the regulator is informed by at most two stakeholders, a firm and an organization, with known bias $\alpha_F < 1 < \alpha_O$. As explained before, each stakeholder's comment is guided by its own preferences represented by its payoff – that is, $V - \alpha_T D$ or 0 – depending on whether the product is authorized $d(\boldsymbol{m}) = A$ or not $d(\boldsymbol{m}) = B$. The comment sent by a stakeholder of type $T = F$ or O is:

$$m_T = \begin{cases} A & \text{if} \quad r \geq \alpha_T, \\ B & \text{if} \quad r < \alpha_T, \end{cases} \tag{1}$$

The optimal decision and the comments sent by each stakeholder are represented in Figure 1 below.

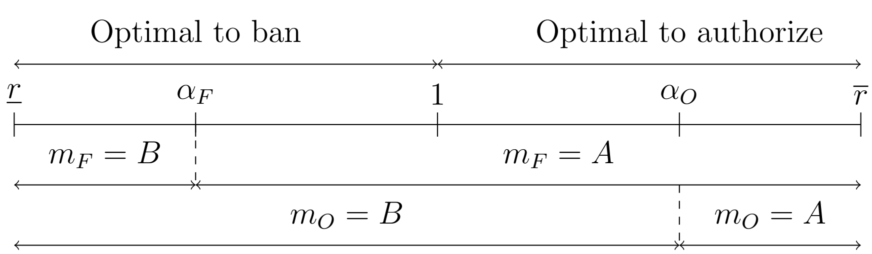

Figure 1: Return, biases and reports with two stakeholders: a firm and an organization

The stakeholders truthfully report their information by advising the optimal decision only for extreme values of the return: if it is low enough for the firm ($r < \alpha_F$) or high enough for the organization $r \geq \alpha_O$. For intermediary values $\alpha_F \leq r < \alpha_O$, the firms will untruthfully comment positively on the product by advising the regulator to authorize it, while the organization will untruthfully comment negatively by recommending banning it.

For extreme values of r, both stakeholders send the same comment: $m_F = m_O = B$ when $r < \alpha_F$, or $m_F = m_O = A$ when $r \geq \alpha_O$. In these cases, they agree on the recommended decision, and the regulator correctly follows their advice. If $r < \alpha_F$, the firm advises banning the product despite valuing the economic benefit over the environmental or health damages. Because $\alpha_F \leq 1$, a comment recommending a ban from the firm implies $r < 1$, which guarantees that the regulator is making the right decision by banning the product. Symmetrically, if $r \geq \alpha_O$, the organization advises authorizing the product, even though it typically prioritizes the potential harms over the economic benefits. Because $\alpha_O \geq 1$, a comment recommending authorizing the product from an organization implies $r \geq 1$, ensuring that the regulator makes the correct decision by authorizing the product. Overall, the regulator makes the right decision when both stakeholders send the same comment, whether they recommend authorization or a ban.

A "naive" regulator who literally follows the stakeholders' prescription would be right for extreme values of r, i.e., when $r < \alpha_F$ or $r \geq \alpha_O$. For intermediary values $\alpha_F \leq r < \alpha_O$, the naive regulator would often be wrong when following the advice of one of the two stakeholders. She should ban the product when the firm advises authorizing it when $\alpha_F \leq r < 1$, or authorize it when the organization advises banning it when $1 \geq r > \alpha_O$. The regulator can do better by considering the stakeholders' biases when making decisions. We now explain how she should do it.

When $\alpha_F \leq r < \alpha_O$, the regulator receives opposite comments: a positive one from the firm and a negative one from the organization, i.e., $m_F = A$ and $m_O = B$. A "sophisticated" regulator who is aware of the stakeholders' bias should infer that $r \geq \alpha_F$ and $r < \alpha_O$. She should base her decision on her updated beliefs on the distribution of r by computing $E[r|\alpha_F \leq r < \alpha_O]$. She should authorize the product if $E[r|\alpha_F \leq r < \alpha_O] \geq 1$ and ban it otherwise. Her decision is based on more accurate expectations than if she receives a comment from one stakeholder only or no comment at all. Hence, even if the stakeholders disagree in their comments, the public consultation process helps improve regulations. Nevertheless, the regulator would sometimes be wrong; this would be the case if $r < 1$ while $E[r|\alpha_F \leq r < \alpha_O] \geq 1$ (by authorizing a product that should be banned) or if $r \geq 1$ while $E[r|\alpha_F \leq r < \alpha_O] < 1$ (by banning a product that should be authorized).

Following the above reasoning, we can define the regulator's decision strategy as a function of the comments sent $\boldsymbol{m} = (m_F, m_O)$, where $m_T = \emptyset$ means no comment was sent by stakeholder $T = F$ or O, as follows.[4]

- Decision strategy if only receiving a comment from F.

$$\begin{aligned} d(A, \emptyset) &= \begin{cases} A \text{ if } E[r|r \geq \alpha_F] \geq 1 \\ B \text{ if } E[r|r \geq \alpha_F] < 1 \end{cases} \qquad (2) \\ d(B, \emptyset) &= B \end{aligned}$$

[4]Note that with the stakeholders' reporting strategy defined in (1), one outcome will never happen in equilibrium: the firm recommending banning the product and the organization recommending authorizing it, i.e., $m_F = B$ and $m_O = A$. In this out-of-equilibrium case, we assume that the regulator has "passive beliefs": she bases her expectation on the a priori distribution of r. We use the concept of the BNE under passive beliefs (Fudenberg and Tirole, 1991).

- Decision strategy if only receiving a comment from O.

$$\begin{aligned} d(\emptyset, A) &= A \\ d(\emptyset, B) &= \begin{cases} A \text{ if } E[r|r < \alpha_O] \geq 1 \\ B \text{ if } E[r|r < \alpha_O] < 1 \end{cases} \end{aligned} \tag{3}$$

- Decision strategy if receiving comments both F and O.

$$\begin{aligned} d(A, A) &= A \\ d(B, B) &= B \\ d(A, B) &= \begin{cases} A \text{ if } E[r|\alpha_F \leq r < \alpha_O] \geq 1 \\ B \text{ if } E[r|\alpha_F \leq r < \alpha_O] < 1 \end{cases} \\ d(B, A) &= \begin{cases} A \text{ if } E[r] \geq 1 \\ B \text{ if } E[r] < 1 \end{cases} \end{aligned} \tag{4}$$

In Appendix A, we prove the following proposition.

Proposition 1 *The strategies defined in (1), (2), (3) and (4) are a BNE of the consultation game with F only, O only, and both F and O.*

Proposition 1 implies the regulator will ban a product if F advises doing so. It will authorize the product if O advises doing so. She is always right to act this way – that is, to follow the recommendation sent by the stakeholder who is less likely to make such a recommendation. If the firm recommends a ban, then there is no doubt that the product should be banned. Symmetrically, if the organization recommends authorization, the product should be authorized.

For technical convenience, the baseline analysis assumes that the regulator knows not only the direction but also the magnitude of the biases α_F and α_O. This assumption is not essential for our main results. If instead the regulator held beliefs over α_F and α_O, then the expected return when stakeholders send contradictory comments $m_F = A$ and $m_O = B$ (as in the equilibrium decision rule $d(A, B)$ in (4)) would be computed using expected biases rather than known values, without affecting the qualitative implications of the model.

Proposition 1 implies the following corollary about the regulator's decision.

Corollary 1 *The regulator should ban a product if a firm recommends doing so, and should authorize a product if an organization recommends doing so.*

We now examine the extent to which decision-making is improved when there are two stakeholders with opposite biases, rather than only one stakeholder. To do so, we focus on the likelihood of error of type I or type II. The type of error depends on whose perspective is favored in the consultation process. Not banning a bad product (false positive) is referred to as a type I error, while banning a good product is a type II error (false negative).[5] Minimizing both types of errors is part of the mandate of environmental regulatory authorities. For instance, this objective is explicitly stated in the toxicity testing guidelines published by the Environmental Protection Agency in the United States (US Environmental Protection Agency 2000). In our framework, decision errors arise because the regulator maximizes expected welfare under imperfect information; reducing the probability of such errors therefore improves the implementation of the welfare-maximizing policy. [6]

Below are the errors that may occur depending on the stakeholders involved in the consultation process.

- With only F's comment, type I error occurs (authorizing a bad product) if $\alpha_F < r < 1$ and $E[r|r \geq \alpha_F] \geq 1$
- With only O's comment, type II error occurs (banning a good product) if $1 \leq r < \alpha_O$ and $E[r|r < \alpha_O] < 1$
- With both F's and O's comments:
  - type I occurs if $\alpha_F < r < 1$ and $E[r|\alpha_F \leq r < \alpha_O] \geq 1$
  - type II occurs if $1 \leq r < \alpha_O$ and $E[r|\alpha_F \leq r < \alpha_O] < 1$

Because $E[r|r \geq \alpha_F] > E[r|\alpha_F \leq r < \alpha_O]$, type I error is more likely with only F than with both F and O. Similarly, because $E[r|\alpha_F \leq r < \alpha_O] > E[r|r < \alpha_O]$, type II error is more likely with only O than with both F and O. Hence, we conclude the following.

[5]Under the premise that the consultation process is carried out because the product is suspected to be harmful, we define the null hypothesis that the product should be banned. This is without loss of generality; under the alternative null hypothesis that the product should be authorized, type I becomes type II and vice-versa.

[6]This interpretation is in line with the decision-theoretic approach to policy evaluation in Kitagawa and Tetenov (2018), who formalize welfare losses arising when policy choices made under imperfect information deviate from the full-information welfare-optimal rule. Improving information and reducing the likelihood of choosing the wrong policy action therefore improves the implementation of welfare-maximizing policies.

Proposition 2 *Errors in decision-making are reduced when the regulator considers the comments of two stakeholders with opposite biases rather than only one. Moreover, there is no error when consensus is achieved.*

Proposition 2 highlights that the informational value of a public consultation depends not on the volume of participation per se, but on the presence of stakeholders with systematically different preferences. When the regulator observes input from stakeholders with opposing and well-understood biases, disagreement becomes informative and reduces decision errors. Moreover, when such stakeholders converge on the same recommendation, that agreement is fully informative in the model and eliminates decision errors altogether.

Furthermore, Proposition 2 provides a rationale for strategies aimed at increasing participation in public consultations. The intuition is that participation by relevant stakeholders with opposing biases can enhance decision quality by reducing errors in both directions. Note, however, that with two stakeholders both types of errors are possible, whereas with only one stakeholder only one type of error can occur (type I with F or type II with O). Therefore, if the regulator wishes to prioritize avoiding one type of error over the other, she may optimally rely on a single stakeholder or selectively involve particular stakeholders in the decision-making process.[7]

Finally, Proposition 2 also sheds light on the value of consensus in policy decisions. The literature on evidence-based policymaking emphasizes that consensus increases the likelihood that evidence influences decisions by serving as a heuristic for informational reliability (see Ding et al. 2011; Lewandowsky et al. 2013). Our analysis aligns with this view by showing that, when stakeholders with opposing biases agree, the regulator can be confident in the correctness of her decision. In the model, however, such consensus arises only in extreme cases.

2.3 Adding a stakeholder with uncertain bias

We now investigate the consultation game with a third type of stakeholder: a public authority (e.g., a member State of the European Union) denoted G (for government) and referred as "authority". Unlike firms or organizations, the authority bias α_G is

[7] In the same vein, because the level of bias affects the likelihood of errors, the regulator might prioritize the input of a stakeholder perceived as less biased. For instance, if O's bias is small (i.e., α_O is close to 1), the range $1 \geq r > \alpha_O$ is narrow, making type II errors unlikely when relying only on O. Conversely, if F's bias is large (i.e., α_F close to zero), the range $\alpha_F \leq r < 1$ is wide, increasing the likelihood of type I errors when relying only on F. At the limit, when $\alpha_F = 0$, the firm's comment is completely uninformative, since $m_F = A$ regardless of r.

unknown by the regulator, and α_G can be lower or higher than 1 (i.e., the authority may undervalue the damage as firms do, or overvalue it as organizations do). The regulator's a priori belief about α_G is denoted by the density function g and the cumulative G. It is such that $P[\alpha_G \leq 1] = G(1) > 0$ and $P[\alpha_G > 1] = 1 - G(1) > 0$, implying that the authority can be pro-business or pro-environment with some probability. Let us denote the expectation operator on α_G with the underscript g, e.g. $E_g[\alpha_G]$.

We investigate the BNE of the consultation game with three players: a firm F, a public authority G, and an organization O. Stakeholder's commenting strategies are defined as before by (1): each stakeholder T recommends the decision that maximizes its payoff. It gives the opinion $m_T = A$ if it would like the product to be authorized and $m_T = B$ if it prefers it to be banned. Stakeholder T gives the opinion $m_T = A$ if $V - \alpha_T D \geq 0$ or, equivalently, $r \geq \alpha_T$; and $m_T = B$ if $V - \alpha_T D < 0$ or, equivalently, $r < \alpha_T$.

The regulator's decision strategy as a function of all comments $\boldsymbol{m} = (m_F, m_G, m_O)$ is now:

$$
\begin{aligned}
d(A,A,A) &= d(A,B,A) = A, \\
d(B,B,B) &= d(B,A,B) = B, \\
d(A,A,B) &= \begin{cases} A \text{ if } E_g[E[r|\alpha_G \leq r < \alpha_O]] \geq 1 \\ B \text{ if } E_g[E[r|\alpha_G \leq r < \alpha_O]] < 1 \end{cases} \\
d(A,B,B) &= \begin{cases} A \text{ if } E_g[E[r|\alpha_F \leq r < \alpha_G]] \geq 1 \\ B \text{ if } E_g[E[r|\alpha_F \leq r < \alpha_G]] < 1 \end{cases} \\
d(B,m_G,A) &= \begin{cases} A \text{ if } E[r] \geq 1 \\ B \text{ if } E[r] < 1 \end{cases} \text{ for } m_G = A, B.
\end{aligned} \tag{5}
$$

In Appendix B, we prove the following proposition.[8]

Proposition 3 *The strategies defined in (1) and (5) are a BNE of the consultation game with three stakeholders F, G and O.*

Likewise in Proposition 1, in the BNE with the three types of stakeholders described in Proposition 3, the regulator follows the recommendation of the stakeholder with known biases (the firm or the organization) if the comment runs counter to the bias. She

[8]Note that, as in Proposition 1, we assume out-of-equilibrium passive beliefs. This implies that the regulator decides based on the ex ante expected return $E[r]$ if the firm recommends to ban and the organization recommends to authorize, that is for $d(B, m_G, A)$ for $m_G = A, B$.

authorizes if the organization recommends doing so and bans if the firm recommends banning. In both cases, the regulator disregards the authority's comments because she is sure to make the right decision.

The regulator's decision is consistent with the comments when there is a consensus between the firm and the organization. In contrast, when the firm and the organization disagree (the firm recommends authorizing the product, $m_F = A$, while the organization recommends banning it, $m_O = B$), the regulator updates her belief about the product's expected return based on the authority's comment. From the comments sent by the firm and by the organization, she knows that $r \geq \alpha_F$ and $r < \alpha_O$. From the comment sent by the authority, she knows that $r \geq \alpha_G$ if $m_G = A$ and $r < \alpha_G$ if $m_G = B$. Even if she does not know the direction of the bias (whether α_G is lower or higher of 1), this information helps the regulator make a better decision.

Further, we analyze the role of public authorities with unknown bias in the specific case where their bias is always lower than that of the firm or the organization. The motivation is that, unlike firms or NGOs that advocate narrow objectives, public authorities represent a broad and heterogeneous set of interests and may therefore adopt less extreme positions.[9] More precisely, we assume that it is common knowledge that the realized value of α_G is such that $\alpha_F < \alpha_G < \alpha_O$. Under such an assumption, following G's comment when F and O disagree on their comment reduces errors of type I or II.

We focus on two specific strategies that are not BNE strategies. The regulator can just follow the authority's recommendation by deciding $d(A, m_G, B) = m_G$. Alternatively, it might simply ignore the authority. The decision is thus $d(A, m_G, B) = A$ if $E[r|\alpha_F \leq r < \alpha_O] \geq 1$, and $d(m_G) = B$ if $E[r|\alpha_F \leq r < \alpha_O] < 1$ for $m_G = A, B$. Under the assumption that r is symmetrically distributed around 1, the regulator follows G's comment rather than ignoring it. The proof is in Appendix C.

Proposition 4 *If r is symmetrically distributed around* 1 *and the public authority's bias is lower than that of the firm or the organization, then the probability of making errors is minimized by following the public authority's comment rather than ignoring it.*

Proposition 4 extends the logic of Proposition 2 to settings with multiple stakehold-

[9] Public authorities are institutionally tasked with aggregating a broader and more heterogeneous set of interests than most firms or single-issue NGOs, and that diversity of organized interests can counter certain biases, especially dominance by a single actor type. See e.g., Flöthe and Rasmussen (2019)

ers and unknown biases. Aggregating information from stakeholders whose preferences reflect a broader range of interests improves the regulator's ability to interpret recommendations and reduces decision errors in expectation. In this sense, the proposition provides a theoretical rationale for why input from stakeholders such as national authorities—whose biases are less predictable and likely less extreme than those of firms or organizations—can be particularly informative in public consultations.

To see how this result operates in the model, consider how the probability and type of errors depend on the authority's bias relative to the optimal decision. Suppose that $\alpha_G < 1$. If the regulator's prior-based decision is to authorize the product (i.e., $E[r \mid \alpha_F \leq r < \alpha_O] \geq 1$), ignoring G's comment leads to a type I error whenever $\alpha_F < r < 1$. Because $\alpha_F < \alpha_G$, this error occurs over a wider range of r than when the regulator follows G's advice.

By contrast, if the regulator's prior-based decision is to ban the product (i.e., $E[r \mid \alpha_F \leq r < \alpha_O] < 1$), ignoring G's comment leads to a type II error whenever $1 \leq r < \alpha_O$. Under the assumption that r is symmetrically distributed around 1 and since $\alpha_G < \alpha_O$, this interval is larger than the range in which following G would generate an error.

Thus, regardless of whether the regulator's prior favors authorization or banning, ignoring the authority's comment increases the likelihood of type I error in the former case and type II error in the latter.

2.4 Multiple stakeholders

We now extend our results to multiple stakeholders under asymmetric information about the magnitude of the bias parameter α_T for $T \in \{F, G, O\}$. In this extension, we relax the baseline assumption that the regulator knows the exact magnitudes of firms' and organizations' biases. Instead, the regulator knows the direction of bias for firms and organizations (pro-business for firms and pro-environment/health for organizations), but not its magnitude. That is, she knows that firms place relatively more weight on V and less on D, and that organizations place relatively more weight on D than on V, without knowing the exact bias parameters.

Let us denote the set of firms and organizations by $N = \{1, ...n\}$ and $M = \{1, ...m\}$ respectively. They are ranked according to their bias: $\alpha_F^1 \leq \alpha_F^1 \leq .... \leq \alpha_F^n$ and $\alpha_O^1 \leq \alpha_O^2 \leq .... \leq \alpha_O^m$. The regulator knows that $\alpha_F^i < 1 < \alpha_O^j$ for every $i \in N$ and $j \in M$. However, she does not know the ranking of α_F^i or α_O^j nor their exact values.

The return and biases can be visualized in the below figure below.

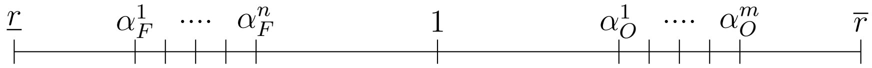

Figure 2: Firms' and organizations' biases.

As before, if all stakeholders with opposite bias (firms and organizations) agree, the decision is obvious and correct. If they all recommend banning with $m_T^i = B$ for all i and $T = O, F$, the regulator knows for sure that $r < \min_i \alpha_F^i \equiv \alpha_F^1$. Because $\alpha_F^1 < 1$, the product should be banned. Conversely, if all firms and organizations recommend authorizing the product with $m_T^i = A$ for all i and $T = O, F$, then the regulator infers that $r \geq \max_i \alpha_O^i \equiv \alpha_O^m$. Because $\alpha_O^m > 1$, the product should be authorized.

A new feature of our multiple stakeholders extension is that stakeholders of the same type might send contradicting comments. For instance, if r is such that $\alpha_F^i \leq r < \alpha_F^{i+1}$ for one firm $i < n$, firms $j < i$ send $m_F^j = A$ while firms with $j \geq i$ send $m_F^j = B$. Symmetrically, for r such that $\alpha_O^i \leq r < \alpha_O^{i+1}$ for one organization i, organizations $j < i$ send $m_O^j = A$ and organizations $j \geq i$ send $m_O^j = B$.

In case of a disagreement among stakeholders of the same type, what matters is if a firm advises a ban or if an organization recommends authorization. The decision is obvious and correct. If at least one firm i sends $m_F^i = B$, by equation (1) it holds that $r < \alpha_F^i$. Because it is common knowledge that $\alpha_F^i < 1$, the regulator knows for sure that $r < 1$. Hence, she always makes the right decision by banning the product. Similarly, if at least one organization j sends $m_O^j = A$, by equation (1) one can infer that $r \geq \alpha_O^j$. Because $\alpha_O^1 > 1$, the regulator knows that $r \geq 1$. Hence, she is always right if she authorizes the product.

From the above reasoning, we conclude that the presence of several firms and organizations in the public consultation game modifies the regulator's equilibrium decision strategy (defined by (5)) by replacing the first two lines with

$$d(\boldsymbol{m}) \quad = \quad \begin{cases} A \text{ if } \exists i \in F \text{ such that } m_F^i = A \\ B \text{ if } \exists j \in O \text{ such that } m_O^j = B \end{cases}$$

In case of disagreement among stakeholders of different types, the decision process proceeds as before. In equilibrium, firms send positive comments $m_F^i = A$ for all i, while organizations send negative comments $m_O^i = B$ for all i. The regulator knows that the return is above $\max_i \alpha_F^i = \alpha_F^n$ and below $\min_i \alpha_O^i = \alpha_O^1$. She updates her beliefs accordingly. She relies on the comments sent by authorities to get a more accurate estimation of the expected return. Her decision is based on her estimation of the expected return given the comments received, as in (5), with updated believes on $\max_i \alpha_F^i$ and $\min_i \alpha_O^i$ as a lower and a upper bound on r respectively. When computing the expected return, she aggregates the comments sent by several authorities. We show that the decision process is such that a product that receives more positive comments from authorities is more likely to be authorized. Symmetrically, a product receiving more negative comments is more likely to be banned.

Consider two products, 1 and 2, with respective returns r^1 and r^2. Assume that authorities sent more comments in favor of authorizing product 1 than product 2. This implies that at least one stakeholder k must have submitted comment $m_G^k = A$ for product 1 and one stakeholder must have submitted $m_G^k = B$ for product 2. By equation (1), it should be the case that $r^1 \geq \alpha_G^k$ and $r^2 < \alpha_G^k$. Even if the regulator does not know α_G^k, she can infer that $r^1 > r^2$.[10] She should incorporate this information when updating her belief. The expected return of product 1 with updated beliefs should be higher that the expected return of product 2, regardless of the distribution of α_G^k. Hence, product 1 is more likely to be authorized than product 2.

In summary, just as with only one stakeholder of each type, comments from authorities are more influential when firms and organizations disagree. Not only does each authority's comment carry more weight, but the number of authorities sharing the same recommendation also matters. The more authorities that recommend authorization, the more likely the product is to be authorized. Our analysis leads to the following corollary.

Corollary 2 *Support for a ban by one firm is enough to ban a product; support for authorization by one organization is enough to authorize a product. The share of stakeholders supporting a decision does not matter for firms and organizations, but it matters for public authorities; the more authorities that support a ban, the more likely it is that the product will be banned.*

2.5 Costly Communication and Strategic Silence

We conclude the theoretical analysis by discussing how our results extend to a setting in which communication is costly. Allowing for communication costs introduces the possibility that some stakeholders remain silent. We show that this does not alter the

[10] Note that this argument hold even if authorities are potentially more biased than firms or organizations. We do not need to assume $\alpha_F^i < \alpha_G^k < \alpha_O^j$ for every i, j, k as in Proposition 4. We can have $\alpha_G^k < \min_i \alpha_F^i$ and/or $\alpha_G^k > \max_i \alpha_O^i$ with some positive probability.

regulator's decision rule in a qualitative sense. Instead, silence arises endogenously in equilibrium precisely when messages would be predictable and therefore uninformative.

When sending a comment entails a cost, a stakeholder communicates only if its message is pivotal, in the sense that it can change the regulatory decision. This logic applies both in the baseline two-stakeholder setting and in the richer environment with multiple stakeholders and national authorities.

Consider first the case in which firms and organizations hold opposing views, that is, when $\alpha_F^i \leq r < \alpha_O^j$ for all firms i and organizations j. Any message sent by firms in favor of authorization or by organizations in favor of banning would then be fully aligned with their known biases and thus convey no new information to the regulator. In this case, both types optimally remain silent to avoid incurring communication costs. If no comments are received, the regulator bases her decision on her prior belief $E[r]$. This outcome mirrors the logic of the costless-communication benchmark: silence replaces predictable messages without affecting the information available to the regulator.

Next, consider the case of disagreement within a stakeholder type. This occurs when there exists a firm i such that $\alpha_F^i > r$, or an organization j such that $\alpha_O^j \leq r$. In such situations, a stakeholder may find it optimal to communicate by sending a recommendation that runs counter to the group's typical bias. Because this message is somehow unexpected, it is informative and can be decisive for the regulator's choice. In equilibrium, at most one stakeholder of a given type communicates.[11] Additional messages would be redundant and would not change the outcome, so other stakeholders optimally remain silent.

National authorities play a distinctive role in this environment. When firms and organizations remain silent because their predictable biases make communication uninformative, national authorities may still find it optimal to communicate if they expect their advice to be pivotal. In that case, the regulator updates her beliefs based on their comments exactly as in the baseline model. Thus, allowing for costly communication does not undermine the informational role of national authorities; rather, it clarifies the circumstances under which their input is most likely to be observed and most informative.

Overall, when communication is costly, equilibrium participation is selective. Stakeholders speak only when their message is informative and potentially decisive, while

[11]We assume that the communication cost c is not too high, so that the stakeholder prefers to incur the cost of sending a comment rather than accept an unfavorable regulatory outcome; formally, for organizations this requires $r - \frac{c}{D} \geq \alpha_O^j$, with an analogous condition for firms.

silence arises when preferences align with known biases and therefore convey little additional information. This extension reconciles the theoretical framework with the extensive-margin participation patterns observed in public consultations, without altering the core informational mechanisms emphasized in the baseline model.

3 Empirical Analysis of the EU's public consultation process on chemicals

We now investigate the extent to which the decision-making characterized in the public consultation game is consistent with our data on chemical regulation in the EU. From our theoretical analysis, we make the following predictions.

(i) **Prediction 1**: For a given economic value and potential harm of a chemical, firms tend to oppose its regulation and organizations tend to support the regulation.

(ii) **Prediction 2**: Support for regulation is more strongly associated with the probability of regulation when it comes from a firm, while opposition to regulation is more strongly associated with the probability of regulation when it comes from an organization.

(ii) **Prediction 3**: Support from public authorities matters when firms oppose regulation and organizations support it.

Prediction 1 follows from the stakeholder's equilibrium strategies defined in (1), Prediction 2 is implied by Corollary 1, and Prediction 3 is supported by Proposition 3 and Corollary 2.

In this section, we first describe our data. Second, we examine prediction (i) by relating firms' and organizations' comments with two proxies for expected economic value V and expected environmental harm D. Third, we examine predictions (ii) and (iii) by relating the regulatory decision to the relative support by firms, national authorities, NGOs, and environmental organizations.

Stakeholder comments in public consultations are not exogenous messages to the regulator. As documented below, chemicals that are more hazardous or more economically relevant attract systematically different patterns of participation and support from firms, NGOs, and national authorities, and these same characteristics also affect the likelihood of regulation. For these reasons, the empirical analysis does not identify causal effects of comments on regulatory outcomes. Rather, it documents conditional associations that allow us to assess whether regulatory decisions are more strongly aligned with the types of comments that, according to the model, carry greater informational content—such as advice that runs counter to a stakeholder's typical bias or advice from stakeholders with smaller but uncertain bias.

3.1 The regulation of chemicals in the European Union

In the European Union, the use and production of chemicals are governed by the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulation. In the European Union, the use and production of chemicals are governed by the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulation. Under REACH's Authorization program, industrial chemicals classified as substances of very high concern (SVHCs)—those with potentially serious effects on human health and the environment—are subject to authorization requirements and, in some cases, strict limitations, including prohibitions (see, e.g., Coria 2018; Coria et al. 2022). SVHCs are identified based on intrinsic hazardous properties, including being carcinogenic, mutagenic, or toxic for reproduction (CMRs); persistent and bioaccumulative in the environment (PBTs and vPvBs); or exhibiting other properties of equivalent concern (ECs).

The process of regulating SVHCs involves two stages. First, substances are proposed for inclusion in the Candidate List by Member States or the European Chemicals Agency (ECHA) and are added to the list through a decision by the Member States. Second, ECHA prioritizes substances from the Candidate List for inclusion in the Authorization List by considering additional factors such as usage volume, exposure data, and risks to specific populations. The European Commission ultimately decides which substances are included in the Authorization List, taking into account the information gathered during public consultations (see, e.g., Klika 2015). Substances included in the Authorization List require explicit authorization from the European Commission before they can be used in industrial processes.

By February 2022, ECHA had proposed 202 chemicals for inclusion on the Authorization List, of which 120 were ultimately included. Comments from different stakeholders were received for 201 of these chemicals. Our analysis is based on 4,939 comments submitted to the European Commission (EC) by 1,245 stakeholders during public consultations on substances recommended by ECHA for inclusion on the Authorization List. We define regulation as a decision to add a chemical to the Authorization List and subject it to binding requirements.

Comments in the public consultation process are written submissions from stakeholders such as industry representatives, national authorities, and non-governmental organizations (NGOs). For each comment, we identify the type of submitter—firms and industrial organizations; competent authorities or national organizations; and NGOs and environmental organizations—and whether the comment supports or opposes regulation. Support is defined as advocating inclusion of the substance on either the Candidate List or the Authorization List.

The categorization of comments was conducted manually. For the large majority of comments, classification was straightforward because they explicitly expressed support or opposition to the proposed regulatory action. Supportive comments typically endorsed stricter regulation and emphasized the hazardous properties of the substance, such as carcinogenicity or environmental persistence. For example, one supportive comment stated: 'We support the nomination of this chemical to the Candidate List and believe it is important, given its properties, for it to be as strictly controlled as possible'. Opposing comments, by contrast, often questioned the sufficiency or interpretation of the available evidence, argued that regulation was unnecessary, or emphasized potential economic or operational costs—particularly in submissions from industry stakeholders. For instance, one opposing comment noted: 'Without additional evidence, a guideline oral carcinogenicity study alone may not give assessable results. A listing of [this substance] in the Authorization List is a severe decision and should be based on adequate scientific evidence'. In a smaller number of cases, comments did not explicitly endorse or oppose regulation but provided technical critiques or additional data. In these instances, classification was based on the overall tone, context, and implications of the arguments presented, applying the same criteria across all comments to ensure consistency.

Table 1 summarizes the comments by submitter type and the frequency of supportive comments. Firms/industrial organizations account for 3,610 comments submitted by 1,164 stakeholders, and only about 3.0% of these comments support regulation. NGOs and environmental organizations are much more supportive of regulation (90% of their comments support regulation), but their participation is more limited in relative terms (13.3% of the 4,939 comments and 5.2% of the 1,245 stakeholders). National authorities account for 13.6% of all comments and are also highly supportive (81% of their comments support regulation). Notably, national authorities exhibit substantially greater within-group variation in support across chemicals than firms or NGOs/environmental organizations, as reflected in the within standard deviation reported in Table 1.

By	Total			
	# N	# C	Support	Std.Dev.
Firms/Industry	1,164	3,610	0.03	0.05
National Authorities	26	671	0.81	0.27
NGOs/Env.Org.	65	658	0.90	0.04
All	1,245	4,939	0.25	0.08

Table 1: Comments under Public Consultations

Notes: Table 1 reports the number of distinct stakeholders commenting (# N), the number of comments (# C), the percentage of comments per stakeholder that supports regulation (Support), and the within standard deviation of the comments by stakeholders in each group (Std. Dev).

Figure 3 plots the number of comments by type of submitter and identifies the stakeholders most active in public consultations. As shown in the figure, individual companies in EU countries with substantial chemical production—such as Germany, France, and the United Kingdom—participate actively. National authorities in countries such as Norway, Germany, and Sweden, as well as NGOs including the Health and Environment Alliance, the International Chemical Secretariat (Chemsec), the World Wide Fund for Nature (WWF), and the Chemicals, Health and Environmental Monitoring Trust (CHEM Trust), are also among the most active participants.

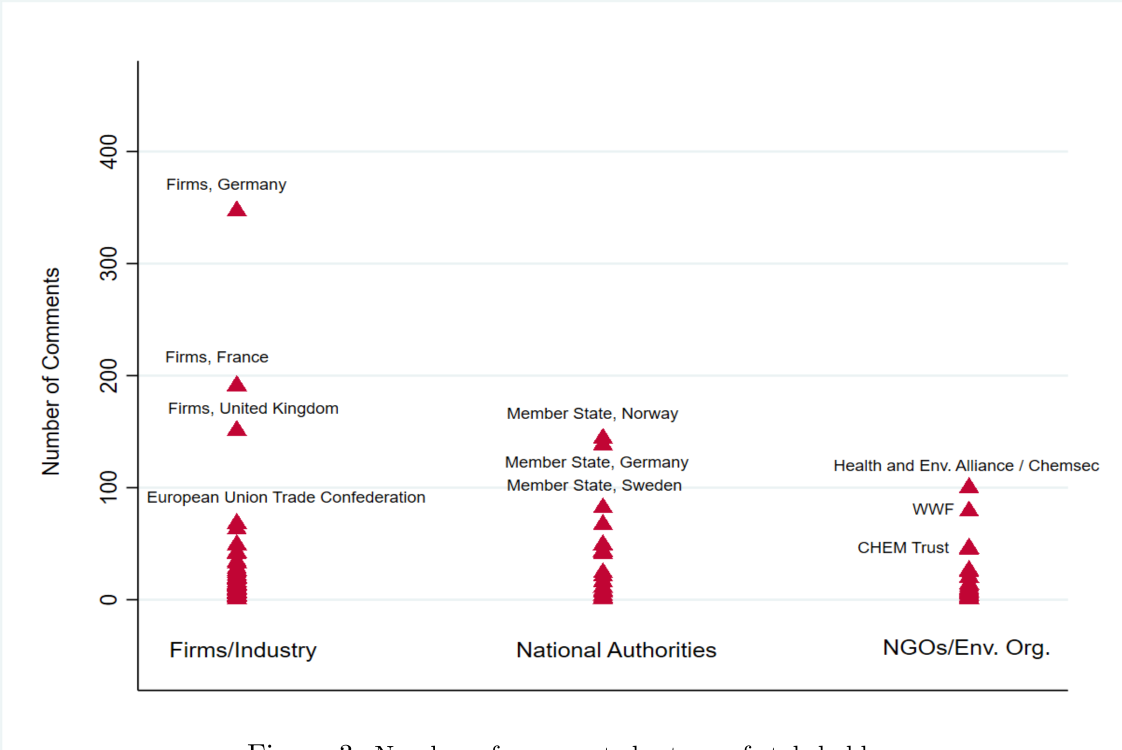

Figure 3: Number of comments by type of stakeholder.

Notes: Figure 3 displays the number of comments by firms/industry versus National Authorities and NGOs/Env. Org.

We aggregate the information described in Table 1 (i.e., number of comments and support for regulation by different stakeholders) by chemical. This data is complemented with information about the intrinsic properties of the chemicals and the number of countries with firms actively producing or using the chemicals (active registrants), collected by Coria et al. (2022). In particular, we use their CMR Score, which proxies for the intensity of carcinogenic (C), mutagenic (M), and reprotoxic (R) properties. The score is based on the share of firms within the European Economic Area that label the chemical with codes related to CMR properties under the European Classification, Labelling and Packaging Regulation; higher values indicate that the chemical is classified as hazardous across a broader range of potential uses.

3.2 Descriptive Analysis

The analysis of the properties of the chemicals for which comments have been provided, and of how those comments are associated with inclusion on the Authorization List, yields three main findings.

Firm comments focus on high-value chemicals; NGOs and environmental organizations comment on high-damage chemicals

Figure 4 displays the properties of the chemicals that predominantly received comments from firms, national authorities, and NGOs/environmental organizations. In relative terms, chemicals for which firms provide the majority of comments account for 88% of all comments, whereas chemicals for which NGOs and environmental organizations are the primary senders of comments account for 6%. As shown in the figure, chemicals receiving most comments from firms are, on average, produced or used by a larger number of EU countries than those primarily commented on by national authorities or NGOs/environmental organizations. By contrast, NGOs and environmental organizations concentrate their comments on chemicals with higher damage, as measured by the CMR score, while no clear pattern emerges for national authorities.[12]

Overall, Figure 4 highlights systematic differences in the types of chemicals on which stakeholders comment: firms tend to focus on chemicals with higher economic relevance, NGOs and environmental organizations on more hazardous substances, and national authorities exhibit no clear bias along these dimensions.

[12]The differences in CMR Score and the percentage of EU countries with active registrants are statistically significant when comparing cases where firms provide most of the comments to cases where NGOs/environmental organizations provide most of the comments (p-values of 4% and 2%, respectively).

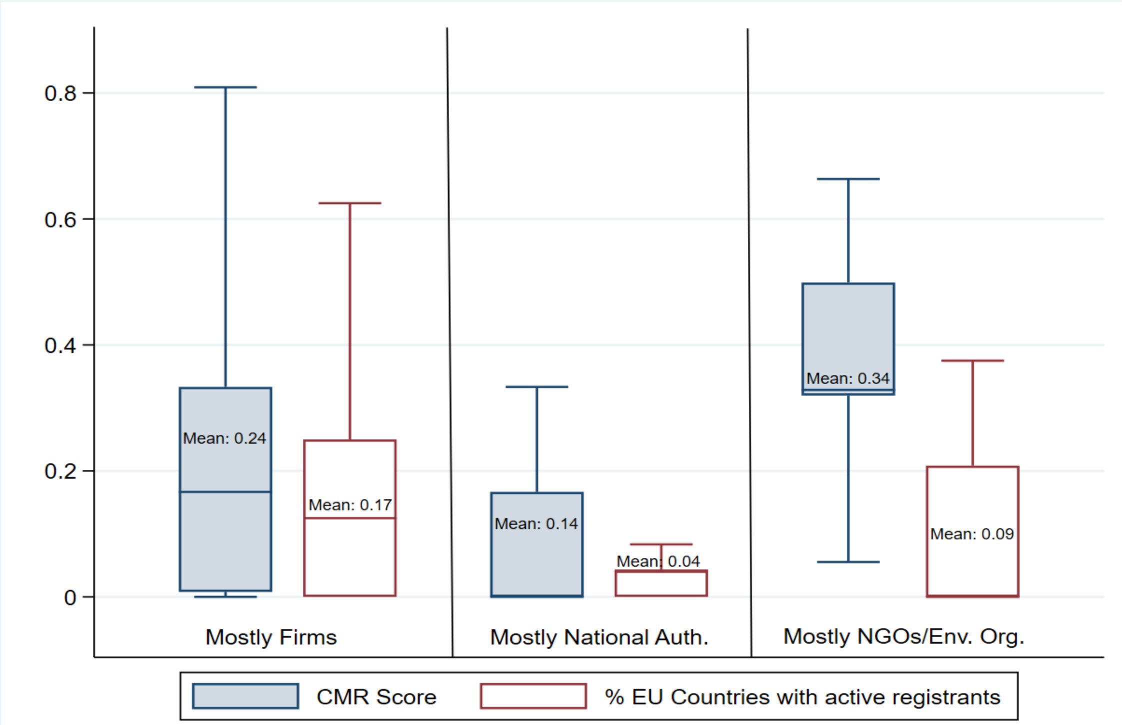

Figure 4: Properties of the chemicals proposed for regulation and stakeholder comments.

Notes: Figure 4 displays the distribution of the CMR Score and the percentage of EU with active registrants of the chemicals proposed for regulation. We distinguish among those chemicals based on whether the most comments came from firms and industrial organizations (i.e., mostly firms, n= 131 chemicals and 59.75 total comments on average), from national authorities (i.e., mostly National Auth., n= 39 chemicals and 12.23 total comments on average), or from NGOs and environmental organizations (i.e., mostly NGOs/Env. Org., n= 31 chemicals and 11.45 total comments on average). "Mostly Firms" indicates that the number of comments from firms is larger than the number of comments from national authorities, as well as larger than the number of comments from NGOs and environmental organizations. The same logic applies to the categories "Mostly National Authorities" and "Mostly NGOs/Env.Org".

Relative support for regulation by firms, National Authorities, and NGOs and environmental organizations varies with the properties of the chemicals

Figure 5 shows how relative support for regulation by firms, national authorities, and NGOs/environmental organizations varies with the properties of the chemicals. Panel (a) distinguishes chemicals for which all firms commenting oppose regulation from those for which at least one firm supports regulation. Panel (b) distinguishes chemicals for which all national authorities support regulation from those for which at least one national authority opposes it. Panel (c) distinguishes chemicals for which all

NGOs/environmental organizations support regulation from those for which at least one organization opposes regulation.

Across panels, relative support for regulation varies systematically with chemical properties. In Panel (a), firms are more likely to support regulation for chemicals with higher damage, as chemicals receiving some firm support are, on average, more hazardous than those whose regulation is unanimously opposed by firms. In Panel (c), NGO and environmental organization support is nearly unanimous. The few cases of opposition concern chemicals with greater economic relevance, even though these chemicals are, on average, more hazardous. Panel (b) shows that chemicals unanimously supported by national authorities tend to be more hazardous and less widely used than those for which some national authorities oppose regulation.

Overall, these patterns are consistent with the theoretical prediction that relative support for regulation increases with chemical hazard and decreases with economic relevance, with firms, NGOs/environmental organizations, and national authorities placing different weights on these dimensions.

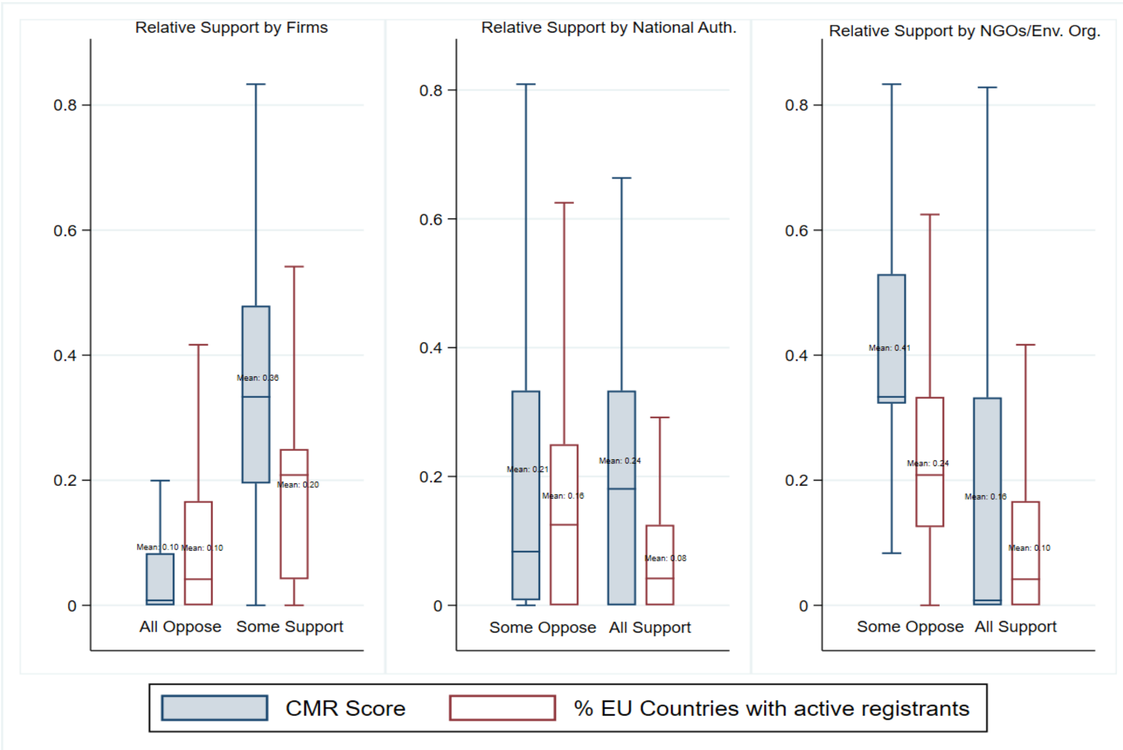

Figure 5: Properties of the chemicals proposed for regulation and support by different stakeholders

Notes: Figure 5 displays the distribution of the CMR Score and the percentage of the EU with active registrants of the chemicals proposed for regulation. Panel (a) distinguishes between chemicals where all firms commenting oppose regulation (n= 91 observations) and chemicals where some firms support regulation (n= 81 observations). Panel (b) distinguishes between chemicals where all national authorities commenting support regulation (n= 66 observations) and chemicals where some national authorities oppose regulation (n= 132 observations). Panel (c) distinguishes between chemicals where all NGOs/Env.Org. commenting support regulation (n= 149 observations) and chemicals where some NGOs/Env.Org. oppose regulation (n= 52 observations).

Support from firms and national authorities is more strongly associated with regulatory outcomes

Figure 6 displays the distribution of relative support for regulation by firms, national authorities, and NGOs/environmental organizations, comparing chemicals that were ultimately included in the Authorization List (YES) with those that were not (NO). Relative support is measured, for each group, as the share of that group's comments favoring regulation among all comments submitted by the same group for a given chemical. The figure reports cumulative distributions of relative support, with quantile lines indicating the 25th, 50th (median), and 75th percentiles and horizontal lines marking mean support levels.

On average, overall relative support is higher for regulated chemicals (55%) than for unregulated ones (48%), although this difference is only weakly statistically significant.[13] Differences in mean support are statistically significant for firms and national authorities, but not for NGOs/environmental organizations. Firms exhibit mean support of 11% for regulated chemicals and 4% for unregulated chemicals, while national authorities exhibit mean support of 90% and 78%, respectively. By contrast, support from NGOs/environmental organizations is high in both cases (94% versus 92%), with no statistically significant difference.[14]

These patterns are also evident in the distributions shown in Figure 6. For firms and national authorities, regulated chemicals are associated with higher relative support and a wider distribution than unregulated chemicals. By contrast, the distributions for NGOs/environmental organizations are nearly identical across regulated and unregulated chemicals.

Our theoretical analysis highlights the potential role of outliers—cases in which at least one firm supports regulation while at least one NGO/environmental organization opposes it. In Figure 6, firm outliers correspond to cases with strictly positive relative support from firms, while NGO/environmental organization outliers correspond to cases with relative support below one. We observe a weakly statistically significant lower prevalence of firm outliers among regulated chemicals compared to unregulated ones (40% versus 52%). By contrast, the prevalence of NGO/environmental organization outliers does not differ significantly between regulated and unregulated chemicals (25% versus 27%).[15]

Economic considerations may help explain the lower prevalence of firm outliers among regulated chemicals. Chemicals with higher economic relevance are more likely to attract unified opposition to bans from firms, as fewer firms have incentives to support their regulation. In addition, the set of firms submitting comments may be more narrowly composed of those directly affected by the proposed regulation, leading to more cohesive positions and reducing the likelihood of outlying support within this group.

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[13]Overall relative support is calculated as the total number of comments favoring regulation divided by the total number of comments across all stakeholder groups for a given chemical. The p-value for the difference in means is 0.067.

[14]p-values for differences in mean support: firms = 0.01; national authorities $<$ 0.01; NGOs/environmental organizations = 0.21.

[15]p-values for differences in the prevalence of outliers: firms = 0.08; NGOs/environmental organizations = 0.65.

More generally, the absence of a clear relationship between outliers and regulatory outcomes may reflect the fact that regulatory decisions are associated more closely with the overall stance of stakeholder groups than with isolated dissenting comments. For example, even when one firm supports regulation, if most firms oppose it, the broader opposition may dominate. Similarly, when NGOs and environmental organizations overwhelmingly support regulation, the opposition of one or a few organizations may not be sufficient to affect the final decision.

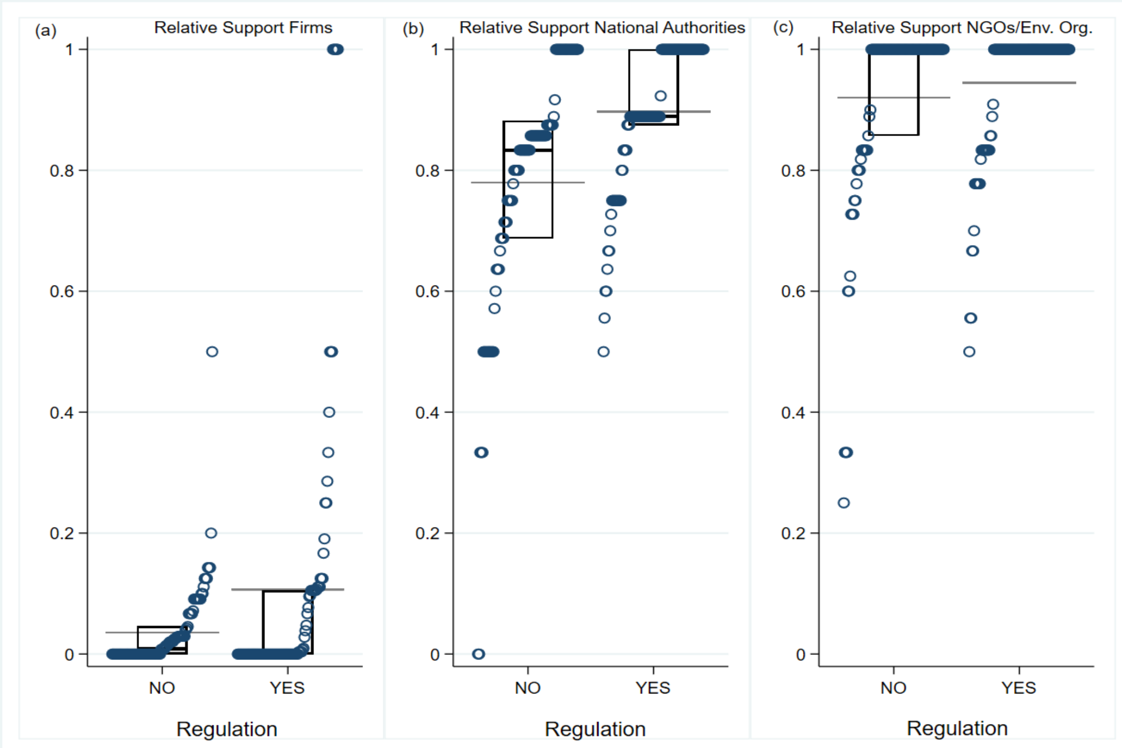

Figure 6: Relative Support by Firms, National Authorities, and NGOs/Env. Org. and regulation of the chemicals

Notes: Figure 6 shows the cumulative distribution of relative support for regulation by firms, national authorities, and NGOs/environmental organizations across chemicals. Each panel compares chemicals that were ultimately regulated (YES) and those that were not regulated (NO). The points display the relative support for each chemical, ordered vertically to reflect the cumulative distribution of support levels. Superimposed quantile lines indicate the 25th, 50th (median), and 75th percentiles, summarizing key distribution characteristics. Horizontal reference lines represent the mean relative support for each group. In Panel (a), the figure presents the distributions of relative support by firms for regulated (n = 101) and unregulated chemicals (n = 81). Panel (b) presents the distributions of relative support by national authorities for regulated (n = 106) and unregulated chemicals (n = 92). Panel (c) presents the distributions of relative support by NGOs/Env.Org. for regulated (n = 106) and unregulated chemicals (n = 95).

3.3 Regression Analysis

In this section, we examine how the number of comments and the level of support expressed by different stakeholders are associated with the likelihood that a chemical is added to the Authorization List. We estimate probit regressions in which the probability of regulation is related to stakeholder participation, stakeholder support, and chemical characteristics (see Appendix D for summary statistics).

Table 2 reports the main results. In column (1), regulation is explained by the square root of the number of comments submitted by firms, national authorities, and NGOs/environmental organizations, together with overall relative support for regulation.[16] Column (2) adds controls for chemical characteristics, including CMR and other hazardous properties and the share of EU countries with active registrants, while column (3) further controls for whether the regulatory proposal concerns a single chemical or a group of chemicals. Columns (4)–(6) mirror these specifications but replace overall relative support with group-specific relative support from firms, national authorities, and NGOs/environmental organizations.

The results in columns (1)–(3) show that the number of comments submitted by national authorities and overall relative support for regulation are positively and statistically significantly associated with inclusion in the Authorization List, even after controlling for chemical characteristics. Columns (4)–(6) indicate that relative support from firms and national authorities is statistically significantly associated with a higher probability of regulation, whereas relative support from NGOs and environmental organizations is not.

These findings are consistent with the theoretical predictions for firms and national authorities, but not for NGOs/environmental organizations. Prediction 2 suggests that support from firms and opposition from NGOs/environmental organizations should matter for the regulator's decision. Empirically, we find that support from firms is strongly and statistically significantly associated with inclusion in the Authorization List, while support from NGOs/environmental organizations is not.

As documented in Table 1, firms predominantly oppose regulation, whereas NGOs/ environmental organizations overwhelmingly support it. Given this asymmetry in baseline positions, the empirical results show that, despite being relatively rare, variation in firm support is systematically associated with inclusion in the Authorization List. By contrast, because support from NGOs and environmental organizations is nearly universal across chemicals, it exhibits little cross-chemical variation and provides limited incremental information for distinguishing inclusion decisions, resulting in no statistically significant association. National authorities, which display greater heterogeneity in their positions, also exhibit a strong association between support and inclusion in the Authorization List.

[16]Using the square root transformation mitigates skewness in the distribution of comments while retaining observations with zero comments, unlike a logarithmic transformation.

National authorities differ from firms and NGOs in their institutional role within the consultation process. In some cases, they are the only public authority commenting on behalf of a country, while in others they submit comments alongside additional national stakeholders (see Table 5 in Appendix E). This institutional variation allows us to examine whether the informational content of authority comments depends on the context in which they are provided.

In our theoretical framework, the key distinction between stakeholder types is not the strength of their preferences, but their predictability. For firms and NGOs, the regulator knows the direction of bias ex ante, which limits the informational content of their recommendations unless they run counter to those interests. By contrast, the regulator does not know whether a national authority's bias favors or opposes regulation. As a result, authority comments always shift beliefs about the underlying trade-off between economic benefits and damages and are informative in equilibrium.

Table 3 explores whether the empirical association between authority comments and regulatory outcomes varies with whether national authorities act alone or alongside other national stakeholders. We find that the association between the number of authority comments and the probability of regulation is weaker when authorities act as the sole national public actor. While the model does not make a sharp prediction along this institutional dimension, this pattern is consistent with the idea that authority comments are more informative when they are perceived as reflecting a broader set of national considerations rather than more idiosyncratic positions. By contrast, the interaction between relative support and sole commentary is not statistically significant, reflecting the fact that support from national authorities is high both when they act alone and when they comment alongside other national stakeholders.

Appendix E reports robustness checks. We first examine whether the presence of outliers—cases in which at least one firm supports regulation while at least one NGO or environmental organization opposes it—is associated with inclusion in the Authorization List. Consistent with the descriptive evidence, we find no statistically significant association between outlier presence and inclusion decisions. By contrast, relative support from firms remains statistically significant.

One possible explanation for the lack of a statistically significant association between outliers and inclusion decisions lies in the heterogeneity of firms' motivations for supporting regulation. While relative support captures the overall stance of the group, outliers may reflect firm-specific or strategic considerations that do not generalize across firms, such as efforts to restrict entry, raise rivals' costs, or address specific occupational risks. Similarly, the rare cases in which NGOs or environmental organizations oppose regulation may reflect context-specific concerns rather than a systematic position. As a result, relative support provides a clearer summary of group-level positions to the regulator than few individual comments that differ from the majority position

Finally, Appendix E also examines whether the number of countries commenting and the share of countries in which a majority of commenters support regulation are associated with regulatory outcomes. Neither variable is statistically significant, and their inclusion does not affect the main results. This suggests that stakeholder type and the content of comments are more closely associated with regulatory outcomes than country-level participation or majority support.

In sum, the empirical analysis shows that regulatory outcomes are more closely associated with comments that, according to the model, are most informative: firm support that deviates from firms' typical opposition, and advice from national authorities whose biases are less predictable. By contrast, near-unanimous NGO support provides little additional information and is not statistically associated with inclusion decisions. Overall, the results support the model's central mechanism: regulatory decisions are more closely aligned with comments that convey new information relative to predictable stakeholder positions—such as support from firms that departs from their usual opposition, and advice from national authorities whose bias is less predictable.

	(1)	(2)	(3)	(4)	(5)	(6)
No. Comments Firms	0.02	0.08	0.09	-0.03	0.03	0.03
	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)
	[0.61]	[0.17]	[0.10]	[0.43]	[0.45]	[0.43]
No. Comments NAs	1.43***	1.46***	1.46***	1.30***	1.49***	1.49***
	(0.27)	(0.29)	(0.29)	(0.28)	(0.39)	(0.40)
	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]
No. Comments NGOs/Env. Org.	-0.28	-0.06	-0.10	-0.22	-0.34	-0.35
	(0.26)	(0.39)	(0.40)	(0.31)	(0.43)	(0.42)
	[0.29]	[0.89]	[0.81]	[0.48]	[0.42]	[0.42]
Relative Support (RS)	2.36***	1.85**	1.90**			
	(0.76)	(0.89)	(0.88)			
	[<0.01]	[0.04]	[0.03]			
RS Firms				2.24**	2.78*	2.75*
				(1.07)	(1.60)	(1.56)
				[0.04]	[0.08]	[0.08]
RS NAs				3.54***	3.13*	3.14*
				(1.12)	(1.64)	(1.63)
				[<0.01]	[0.06]	[0.06]
RS NGOs/Env. Org.				0.99	2.38	2.38
				(1.00)	(1.57)	(1.37)
				[0.32]	[0.13]	[0.13]
Control CMR Properties		X	X		X	X
Control Other Hazardous Properties		X	X		X	X
Control % EU Countries AR		X	X		X	X
Control # Chemicals in the Proposal			X			X
R^2	0.21	0.39	0.40	0.26	0.45	0.45
N	201	193	193	198	191	191

Table 2: Stakeholder Comments and Probability of Inclusion in the Authorization List.

Notes: Table 2 reports the estimates of probit regressions where regulation is explained as a function of the square root of the number of comments by firms, national authorities, and NGOs/environmental organizations; their relative support for the regulations; and controls for the hazardous properties of the chemicals, the percentage of EU countries with active registrants, and the number of chemicals discussed in the same regulatory proposal (i.e., a dummy variable accounting for whether the proposal concerns a single chemical or a group of chemicals). The dependent variable is a binary variable that takes a value equal to one for chemicals included in the Authorization List, and zero otherwise. Robust standard errors in parentheses, and p-values in brackets. *p-value<0.1, ** p-value<0.05, *** p-value<0.01.

	(1)	(2)	(3)	(4)	(5)	(6)
No. Comments Firms	0.01	0.04	0.05	-0.03	-0.00	-0.00
	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)
	[0.77]	[0.52]	[0.35]	[0.54]	[0.93]	[0.94]
No. Comments NAs	1.51***	1.85***	1.93***	1.30***	1.48***	1.49***
	(0.31)	(0.43)	(0.43)	(0.29)	(0.40)	(0.40)
	[<0.01]	[<0.01]	[<0.01]]	[<0.01]	[<0.01]	[0.01]
No. Comments NAs * Share NASC	-0.17	-0.78**	-0.86**			
	(0.26)	(0.34)	(0.35)			
	[0.52]	[0.02]	[0.01]			
No. Comments NGOs/ Env. Org.	-0.32	-0.18	-0.28	-0.22	-0.48	-0.49
	(0.26)	(0.40)	(0.41)	(0.34)	(0.44)	(0.44)
	[0.23]	[0.65]	[0.50]	[0.51]	[0.27]	[0.27]
Relative Support (RS)	2.46***	2.40**	2.51**			
	(0.77)	(1.07)	(1.04)			
	[<0.01]	[0.03]	[0.02]			
RS Firms				2.23**	2.68**	2.60**
				(1.07)	(1.32)	(1.27)
				[0.04]	[0.04]	[0.04]
RS NAs				3.53***	3.56**	3.59**
				(1.11)	(1.60)	(1.57)
				[<0.01]	[0.03]	[0.02]
RS NAs * Share NASC				0.01	-1.01	-1.04
				(0.83)	(0.93)	(0.63)
				[0.99]	[0.28]	[0.27]
RS NGOs/Env. Org.				1.00	2.01	2.00
				(1.06)	(1.64)	(1.65)
				[0.35]	[0.22]	[0.23]
Control CMR Properties		X	X		X	X
Control Other Hazardous Properties		X	X		X	X
Control % EU Countries AR		X	X		X	X
Control # Chemicals in the Proposal			X			X
R^2	0.20	0.42	0.42	0.26	0.46	0.46
N	198	191	191	198	191	191

Table 3: National Authorities' Sole Commentary and Probability of Inclusion in the Authorization List.

Notes: Table 3 reports the estimates of probit regressions where regulation is explained as a function of the square root of the number of comments by firms, national authorities, and NGOs/environmental organizations; their relative support for regulation; and controls for the hazardous properties of the chemicals, the percentage of EU countries with active registrants, and the number of chemicals discussed in the same authorization proposal (i.e., a dummy variable accounting for whether the proposal concerns a single chemical or a group of chemicals). In addition to analyzing national authorities' comments and relative support, we also account for the proportion of their comments when they are the sole national stakeholder contributing input. The dependent variable is a binary variable that takes a value equal to one for chemicals included in the Authorization List, and zero otherwise. Robust standard errors in parentheses, and p-values in brackets. *p-value< 0.1, ** p-value< 0.05, *** p-value< 0.01.

4 Conclusions

In this paper, we develop a framework to analyze how biased stakeholders – firms, NGOs, and national authorities – influence regulatory decisions. By focusing on public consultations, where stakeholders submit comments to the regulator, we examine how the regulator can update her beliefs based on the biases of those providing input. We also conduct a case study focused on chemical regulation in Europe to illustrate how these dynamics play out in practice and to provide evidence supporting our theoretical predictions.

Our model generated three main predictions. First, we predict that firms are generally more likely than NGOs and environmental organizations to oppose regulation. Second, we propose that the regulator is more likely to make the correct decision when advice comes from a stakeholder who typically opposes the recommended decision, such as when a firm supports regulation. Third, in cases of conflicting views between stakeholders, the input of national authorities becomes crucial in making the right regulatory decision. Their advice is particularly valued even though their biases are not as clear as those of firms or organizations.

Our empirical analysis offers several important insights consistent with the theoretical framework. When selecting chemicals for comments, firms tend to target those with high economic value, whereas NGOs and environmental organizations focus on those with greater potential harm. In their comments, firms predominantly oppose regulation and support it only for potentially very hazardous chemicals. In contrast, NGOs and environmental organizations tend to support regulating most chemicals regardless of their economic value or potential toxicity. Finally, in line with our predictions, on the relatively rare occasions when firms do support regulation, this support is more strongly associated with the probability of regulation than support from NGOs and environmental agencies. By contrast, variation in support from NGOs and environmental organizations is not statistically significantly associated with regulatory decisions. We also find that regulatory outcomes are more strongly associated with comments from national authorities, both in the number of comments submitted and in the relative support expressed for regulation.

Our findings, though centered on chemical regulation, have implications for public consultations in many other regulatory areas. In sectors such as consumer product safety, urban planning, and large-scale infrastructure, public consultations offer regulators essential information on potential benefits, costs, and risks that quantitative assessments may not fully capture. While methods such as cost-benefit analysis and environmental impact assessments can cover a wide range of impacts, obtaining this information can be costly and time-intensive. Public consultations, by contrast, provide a practical approach for regulators to quickly identify concerns from diverse stakeholders, including indirect effects on economic activity, community acceptance, and environmental impacts.

This framework offers regulators across various fields a systematic approach to updating beliefs about the net value of policy decisions. By helping regulators refine their assessment of a policy's benefits and costs, these insights support more accurate and effective decisions in public consultations across diverse regulatory areas.

Our findings suggest several avenues for further research. One important area involves strategic interaction in information manipulation. Our model accounts for potential manipulation by firms – such as hiding or distorting evidence – when it occurs in isolation, without affecting how other stakeholders communicate with the regulator. This approach aligns with our analysis of public consultations, where stakeholders submit input directly to the regulator without interacting with each other. Future research could explore more complex strategic interactions, where stakeholders adjust their messaging in anticipation of others' arguments. Such extensions could provide deeper insights into how stakeholders shape not only the regulator's beliefs but also each other's actions.

Additionally, two areas warrant exploration. One is the analysis of continuous policy decisions influenced by biased stakeholders. Unlike our model, where stakeholder views affect the likelihood of regulation but not its stringency, stakeholders may influence both in real-world scenarios. Another promising direction is to examine how biased information interacts with decision-makers' own biases. Decision-makers often prioritize signals confirming their pre-existing beliefs – a phenomenon known as confirmation bias (see, e.g., Benabou and Tirole 2002; Charness and Dave 2017). This suggests decision-makers may weigh certain stakeholders' views more heavily if aligned with their initial beliefs. Exploring ways to structure public consultations to mitigate such biases and support robust decision-making is an important area for future work.

A Proof of Proposition 1

To prove that the strategies defined in (1), (2), (3) and (4) constitute a Bayesian Nash Equilibrium of the consultation game, we show that no player has an incentive to deviate with beliefs updated according to the Bayesian rule.

Let us first consider the consultation game with only one stakeholder, say F. We successfully investigate three cases.

Case 1: $r > \alpha_F \iff V - \alpha_F D > 0$.

The equilibrium strategies are the comment $m_F = A$ and the decision $d(A) = A$ if $E[r|r \geq \alpha_F] \geq 1$ and $d(A) = B$ if $E[r|r \geq \alpha_F] < 1$. In the first case, F obtains $V - \alpha_F D > 0$, while in the second case F's payoff is nil. In contrast, by deviating with $m_F = B$, F's payoff is always nil. The payoff thus is worse if $E[r|r \geq \alpha_F] \geq 1$.

Case 2: $r = \alpha_F \iff V - \alpha_F D = 0$.

Because $r = \frac{V}{D}$, F's payoff is $V - \alpha_F D = 0$ regardless of the regulator's decision. Hence, F cannot gain by deviating from $m_F = A$.

Case 3: $r < \alpha_F \iff V - \alpha_F D < 0$.

The equilibrium strategies are $m_F = B$ and $d(B) = B$ and F's payoff is nil. If F deviates by submitting a comment $m_F = A$, its payoff is unchanged if $E[r|r \geq \alpha_F] < 1$, while it is worse off if $E[r|r \geq \alpha_F] \geq 1$ because then $d(A) = A$ and F's payoff is $V - \alpha_F D < 0$.

Given F's strategy, the regulator has no incentive to deviate because, by definition, R's equilibrium strategy described in equation (4) maximizes her expected payoff with beliefs updated according to the Bayes rules.

The proof proceeds asymmetrically with O as the only stakeholder. It is thus omitted.

We now focus on the more interesting case where both stakeholders F and O are involved.

Consider first player F. We successfully investigate three cases.

Case 1: $r > \alpha_F \iff V - \alpha_F D > 0$.

The equilibrium strategies are $m_F = m_O = A$, $d(A, A) = A$ and the firm's payoff is $V - \alpha_F D > 0$. F cannot be better off by deviating and submitting comment $m_F = B$ instead of $m_F = A$; F is worse off in the case of $E[r] < 1$ (because then $d(B, A) = B$ so that F's payoff is 0), while its payoff is unchanged if $E[r] \geq 1$.

In the case $r < \alpha_O$, the equilibrium strategies for the stakeholders are $m_F = A$ and $m_O = B$. If $E[r|\alpha_F \leq r < \alpha_O] < 1$, then $d(A, B) = B$ and F's payoff is 0. F cannot gain by deviating with $m_F = B$ instead of $m_F = A$ because then $d(B, B) = B$ and F's payoff is 0. If $E[r|\alpha_F \le r < \alpha_O] \ge 1$, then $d(A,B) = A$ and F's payoff is $V - \alpha_F D > 0$. F cannot gain by deviating with $m_F = B$ instead of $m_F = A$ because then $d(B,B) = B$ and F's payoff is $0 < V - \alpha_F D$.

Case 2: $r = \alpha_F \iff V - \alpha_F D = 0$.
Because $r = \frac{V}{D}$, F's payoff is $V - \alpha_F D = 0$ regardless of the regulator's decision. Hence F cannot gain by deviating from $m_F = A$.

Case 3: $r < \alpha_F \iff V - \alpha_F D < 0$.
The equilibrium strategies are $m_F = m_O = B$ and $d(B,B) = B$ and F's payoff is nil. Suppose that F deviates by submitting comment $m_F = A$ instead of $m_F = B$. If $E[r|\alpha_F \le r < \alpha_O] \ge 1$, then $d(A,B) = A$, and F is worse off because its payoff is $V - \alpha_F D < 0$. In the reverse case $E[r|\alpha_F \le r < \alpha_O] < 1$, F's payoff is unchanged and equals zero.

Consider now player O. We distinguish among three cases.

Case 1: $r > \alpha_O \iff V - \alpha_O D > 0$.
The equilibrium strategies are $m_F = m_O = A = d(A,A)$, and O's payoff is $V - \alpha_O D > 0$. By deviating with $m_O = B$, O obtains the same payoff if $E[r|\alpha_F \le r < \alpha_O] > 1$ because then $d(A,B) = A$. However, O is worse off if $E[r|\alpha_F \le r < \alpha_O] < 1$ because then $d(B,A) = B$ and O's payoff is nil.

Case 2: $r = \alpha_O \iff V - \alpha_O D = 0$.
Because $r = \frac{V}{D}$, O's payoff is $V - \alpha_O D = 0$ regardless of the regulator's decision. Hence, O cannot gain by deviating from $m_O = A$.

Case 3: $r < \alpha_O \iff V - \alpha_O D < 0$.
In the case $r < \alpha_F$, the equilibrium strategies are $m_F = m_O = B = d(B,B)$. Because $d(B,A) = B$, the decision is unchanged if O deviates with $m_O = A$. In the case $r \ge \alpha_F$, the equilibrium strategies are $m_F = A$ and $m_O = B$ for the stakeholders. The decision is $d(A,B) = B$ if $E[r|\alpha_F \le r < \alpha_O] < 1$. If O deviates with $m_O = A$ instead of $m_O = B$, then $d(A,A) = A$, which makes O worse off with a payoff of $V - \alpha_O D < 0$. Alternatively, the decision is $d(A,B) = A$ if $E[r|\alpha_F \le r < \alpha_O] \ge 1$, and, by deviating with $m_O = A$, O does not change the outcome because $d(A,A) = A$. Hence, O is not better off.

Finally, consider the regulator. Given the stakeholder's strategies defined in (1), the regulator's strategy maximizes her expected payoff with her beliefs updated according to Bayes' rule.

B Proof of Proposition 3

As a preliminary to the proof, note that if $\alpha_G < \alpha_O$, for every $\alpha_F < \alpha_O$, we have

$$E[r|\alpha_G \leq r < \alpha_O] > E[r|\alpha_F \leq r < \alpha_G] \tag{6}$$

Furthermore, if $\alpha_G > \alpha_F$, for every $\alpha_O > \alpha_F$, we also have (6). Hence, taking the expectation over α_G in (6), we can conclude that if $\alpha_G < \alpha_O$ or if $\alpha_G > \alpha_F$,

$$E_g[E[r|\alpha_G \leq r < \alpha_O]] > E_g[E[r|\alpha_F \leq r < \alpha_G]]. \tag{7}$$

We first show that G cannot gain by deviating from the BNE defined in (1).

- If $m_F = A = m_O$, then the project is authorized regardless of G's comment. Hence payoffs do not change if G changes its strategy.
- If $m_F = m_O = B$, then the project is regardless of G's comment. Hence payoffs are nil regardless of G's strategy.
- If $m_F = A$ and $m_O = B$, then $\alpha_F \leq r < \alpha_O$. We consider two cases: $r > \alpha_G$ and $r < \alpha_G$ (if $r = \alpha_G$, G's payoff is zero regardless of the decision, so G cannot gain by deviating).
  - *Case* $r > \alpha_G$: G is better off if the product is authorized rather than banned. Note that we cannot have $\alpha_G \geq \alpha_O$, because then $r > \alpha_O$, which contradicts that $m_O = B$. Hence $\alpha_G < \alpha_O$ and therefore (7) holds. If G deviates with $m_G = B$ instead of $m_G = A$, then the regulator authorizes the product if $E_g[E[r|\alpha_F \leq r < \alpha_G]] \geq 1$ instead of if $E_g[E[r|\alpha_G \leq r < \alpha_O]] \geq 1$. By (7), the product is less likely to be authorized. In particular, it is banned with $m_G = B$ but not with $m_G = A$ whenever $E_g[E[r|\alpha_G \leq r < \alpha_O]] \geq 1 > E_g[E[r|\alpha_F \leq r < \alpha_G]]$. In that case, G is worse off by deviating (its payoff is nil rather than strictly positive).
  - *Case* $r < \alpha_G$: G is better off if the product is banned than authorized. Note that we cannot have $\alpha_G < \alpha_F$, because then $r < \alpha_F$, which contradicts that $m_F = A$. Hence $\alpha_G > \alpha_F$ and therefore (7) holds. If G deviates with $m_G = A$ instead of $m_G = B$, then the regulator bans the product if $E_g[E[r|\alpha_G \leq r < \alpha_O]] < 1$ instead of if $E_g[E[r|\alpha_F \leq r < \alpha_G]] < 1$. By (7), the product is less likely to be banned. In particular, it is authorized

with $m_G = A$ but not with $m_G = B$ whenever $E_g[E[r|\alpha_G \leq r < \alpha_O]] \geq 1 > E_g[E[r|\alpha_F \leq r < \alpha_G]]$. In that case, G is worse off by deviating (its payoff is negative rather than nil).

- If $m_F = B$ and $m_O = A$, since the decision does not depend on m_G, G cannot gain by deviating from its NBE strategy defined in (1).

For F and O, the proof that they cannot gain by deviating proceeds as in the proof of Proposition 1 in Appendix A.

For the regulator, her strategy defined in (5) maximizes her expected payoff with beliefs updated according to Bayes' rule. Hence, it is the best response to the stakeholder's comment strategies with updated beliefs.

C Proof of Proposition 4

Let f_u and F_u denote the regulator's updated beliefs after receiving $m_F = A$ and $m_O = B$. It is defined as follows for every $r \in (\alpha_F, \alpha_O)$:

$$f_u(r) = \frac{f(r)}{F(\alpha_O) - F(\alpha_F)}. \tag{8}$$

Assume it is symmetric: $F_u(x) = 1 - F_u(x)$ for all $x \in (\alpha_F, \alpha_O)$.

If $\alpha_G = 1$, the regulator is always right by following G's comment.

Suppose first that $\alpha_G < 1$. If the regulator follows G's comment, the only error made is of type I (authorizing a product that should be banned) whenever $\alpha_G \leq r < 1$, which occurs with probability $P[\alpha_G \leq r < 1] = F_u(1) - F_u(\alpha_G)$. If the regulator ignores G's comment, she makes an error of type I if $E[r|\alpha_F \leq r < \alpha_O] \geq 1$ and $\alpha_F \leq r < 1$, or of type II if $E[r|\alpha_F \leq r < \alpha_O] < 1$ and $1 \leq r < \alpha_O$. In the case $E[r|\alpha_F \leq r < \alpha_O] \geq 1$, the probability of making the same error is higher because $P[\alpha_F \leq r < 1] = F_u(1) > F_u(1) - F_u(\alpha_G)$, where the last inequality is due to the assumption $\alpha_F < \alpha_G < 1$. In the opposite case $E[r|\alpha_F \leq r < \alpha_O] < 1$, the probability of making the error (of type II rather than type I) is higher as well, because $P[1 \leq r < \alpha_O] = 1 - F_u(1) = F_u(1) > F_u(1) - F_u(\alpha_G)$, where the last equality is due to the symmetry of F_u.

Suppose now that $\alpha_G > 1$. The regulator makes a type II error (banning a good product) with probability $P[1 \leq r < \alpha_G] = F_u(\alpha_G) - F_u(1)$ by following G's comment. She makes the same type II error by ignoring G's comment if $E[r|\alpha_F \leq r < \alpha_O] < 1$ and

$1 \leq r < \alpha_O$. The probability of making an error is then $P[1 \leq r < \alpha_O] = 1 - F_u(1) > F_u(\alpha_G) - F_u(1)$, where the last inequality is due to the assumption $\alpha_G > 1$. It is thus higher than it would be if the regulator follows G's comment. In the opposite case $E[r|\alpha_F \leq r < \alpha_O] \geq 1$, the regulator is likely to makes an error of type I by ignoring G's comment when $\alpha_F \leq r < 1$. This happens with probability $P[\alpha_F \leq r < 1] = F_u(1) = 1 - F_u(1) > F_u(1) - F_u(\alpha_G)$, where the last equality is due to the symmetry of f_u and the inequality to the assumption $\alpha_G > 1$. Again, the probability of making an error (of type I or of type II) is higher than it would be if the regulator follows G's comment.

D Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
In Authorization List	202	0.52	0.50	0.00	1.00
No. Comments All	201	5.68	3.29	1.73	24.08
No. Comments Firms	201	4.13	3.72	0.00	23.66
No. Comments NAs	201	2.53	0.66	0.00	4.24
No. Comments NGOs/Env. Org.	201	2.28	0.45	1.41	3.61
No. Countries Commenting	201	10.90	5.00	3.00	26.00
Relative Support	201	0.52	0.27	0.03	1.00
RS Firms	201	0.07	0.19	0.00	1.00
RS NAs	198	0.84	0.18	0.00	1.00
RS NGOs/Env. Org.	201	0.93	0.14	0.25	1.00
RS Countries Commenting	201	0.49	0.28	0.04	1.00
Outliers Firms	201	0.45	0.50	0.00	1.00
Outliers NGOs/Env. Org.	201	0.26	0.44	0.00	1.00
CMR Properties	194	0.22	0.24	0.00	1.00
Other Hazardous Properties	202	0.41	0.49	0.00	1.00
% EU Countries AR	202	0.13	0.16	0.00	1.00
# Chemicals in the Proposal	202	0.54	0.50	0.00	1.00

Table 4: Summary Statistics

Notes: Table 4 reports the summary statistics of the variables included in the regression analysis. "In Authorization" List corresponds to a dummy variable equal to 1 for chemicals ultimately included in the Authorization List, and zero otherwise. "No. Comments" corresponds to the square root of the number of comments by all stakeholders, firms, national authorities, and NGOs/environmental organizations, respectively. "Outliers Firms" and "Outliers NGOs/Env. Org." are binary variables that take a value of one in case of outliers (i.e., firms or NGOs/Env. Org. provide comments that go against their expected bias), and zero otherwise.

E Robustness Checks

In this section, we introduce two robustness checks and offer a more comprehensive examination of instances involving comments from national authorities. Table 5 provides detailed insights into these instances: out of 671 occurrences where national authorities have contributed comments, they were the only national stakeholder in 43%, while they provided comments alongside other national stakeholders in the remaining 57%. Notably, we observe a tendency for national authorities to express stronger support for regulation when they are the sole national stakeholders providing input. Conversely, their support diminishes when commenting alongside firms and industrial organizations.

By	Total		
	# C	Support	Std.Dev.
NAs Solely Stakeholder	293	90.8	0.22
NAs & Other Stakeholders	378	73.8	0.30
NAs& Firms/Industry	209	63.2	0.39
NAs& NGOs/Env.Org.	82	90.2	0.16
NAs& Firms/Industry&NGOs/Env.Org.	87	83.9	0.22

Table 5: Comments under Public Consulations

In Table 6, we explore how the presence of outliers with divergent views is associated with the probability of regulation. Finally, in Table 7, we examine whether the number of countries commenting and the overall support from countries are associated with the probability of regulation.

	(1)	(2)	(3)
No. Comments Firms	-0.06	-0.02	-0.01
	(0.04)	(0.04)	(0.04)
	[0.17]	[0.65]	[0.80]
No. Comments NAs	1.22***	1.53***	1.55***
	(0.27)	(0.40)	(0.39)
	[<0.01]	[<0.01]	[<0.01]
No. Comments NGOs/ Env. Org.	0.31	-0.02	-0.04
	(0.33)	(0.36)	(0.36)
	[0.35]	[0.95]	[0.92]
Outliers Firms	-0.33	0.20	0.16
	(0.25)	(0.38)	(0.37)
	[0.19]	[0.60]	[0.66]
RS NAs	3.73***	3.09**	3.16**
	(1.13)	(1.55)	(1.52)
	[<0.01]	[<0.05]	[0.04]
Outliers NGOs/Env. Org.	-0.22	-0.73	-0.70
	(0.32)	(0.47)	(0.48)
	[0.49]	[0.13]	[0.15]
Control CMR Properties		X	X
Control Other Hazardous Properties		X	X
Control % EU Countries AR		X	X
Control # Chemicals in the Proposal			X
R^2	0.23	0.43	0.43
N	198	191	191

Table 6: Outliers and Probability of Inclusion in the Authorization List

Notes: Table 6 reports the estimates of probit regressions where regulation is explained as a function of the square root of the number of comments by firms, national authorities, and NGOs/Env. Org.; the relative support from national authorities; and the presence of outliers (firms supporting regulation and NGOs/Env. Org. opposing regulation). "Outliers Firms" and "Outliers NGOs/Env. Org." are binary variables that take a value of one in case of outliers (i.e., firms or NGOs/Env. Org. provide comments that go against their expected bias), and zero otherwise. The dependent variable is a binary variable that takes a value equal to one for chemicals included in the Authorization List, and zero otherwise. Robust standard errors in parentheses, and p-values in brackets. *p-value<0.1, ** p-value<0.05, *** p-value<0.01.

	(1)	(2)	(3)	(4)	(5)	(6)
No. Comments Firms	0.06	0.09	0.11*	-0.01	-0.02	-0.02
	(0.06)	(0.07)	(0.06)	(0.06)	(0.07)	(0.07)
	[0.32]	[0.15]	[0.07]	[0.83]	[0.80]	[0.81]
No. Comments NAs	1.52***	1.51***	1.52***	1.38***	1.37***	1.38***
	(0.31)	(0.29)	(0.29)	(0.35)	(0.43)	(0.43)
	[<0.01]	[<0.01]	[<0.01]]	[<0.01]	[<0.01]	[<0.01]
No. Comments NGOs/ Env. Org.	-0.21	-0.02	-0.06	-0.18	-0.36	-0.36
	(0.27)	(0.40)	(0.39)	(0.32)	(0.43)	(0.43)
	[0.45]	[0.95]	[0.88]	[0.57]	[0.40]	[0.40]
No. Countries Commenting	-0.05	-0.02	-0.03	-0.03	0.02	0.02
	(0.04)	(0.06)	(0.06)	(0.04)	(0.05)	(0.05)
	[0.24]	[0.68]	[0.64]	[0.45]	[0.73]	[0.74]
Relative Support (RS)	2.26***	1.87**	1.92**			
	(0.76)	(0.90)	(0.90)			
	[<0.01]	[0.04]	[0.03]			
RS Firms				2.15**	2.82*	2.78*
				(1.06)	(1.48)	(1.44)
				[0.04]	[0.06]	[0.05]
RS NAs				3.47***	3.38**	3.40**
				(1.08)	(1.66)	(1.64)
				[<0.01]	[0.04]	[0.04]
RS NGOs/Env. Org				0.81	2.61	2.61
				(1.06)	(1.72)	(1.73)
				[0.45]	[0.13]	[0.13]
RS Countries Commenting				0.08	-0.72	-0.73
				(0.69)	(0.77)	(0.76)
				[0.91]	[0.35]	[0.34]
Control CMR Properties		X	X		X	X
Control Other Hazardous Properties		X	X		X	X
Control % EU Countries AR		X	X		X	X
Control # Chemicals in the Proposal			X			X
R^2	0.21	0.39	0.40	0.26	0.46	0.46
N	201	193	193	198	191	191

Table 7: Number of Countries Commenting, Majority Support among Countries, and the Probability of Regulation in the Authorization List.

Notes: Table 7 reports the estimates of probit regressions where regulation is explained as a function of the square root of the number of comments by firms, national authorities, and NGOs/Env. Org.; their relative support for regulation; controls for the hazardous properties of the chemicals; the percentage of EU countries with active registrants; and the number of chemicals discussed in the same authorization proposal (i.e., a dummy variable accounting for whether the proposal concerns a single chemical or a group of chemicals). We also include controls for the total number of countries providing comments, as well as the proportion of these countries where the majority of stakeholders support regulation. The dependent variable is a binary variable that takes a value equal to one for chemicals included in the Authorization List, and zero otherwise. Robust standard errors in parentheses, and p-values in brackets. *p-value< 0.1, ** p-value< 0.05, *** p-value< 0.01.

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