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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. We develop a framework to analyze how a regulator should process information provided by biased stakeholders. We distinguish between stakeholders whose biases are high and known and those whose biases are small but unknown, such as national authorities. We show that the regulator should follow the advice that runs counter to a stakeholder's typical bias, i.e., to regulate if firms so advise, and not to regulate if environmental organizations so advise. Without such advice, she should prioritize the comments provided by stakeholders with smaller but unknown bias. Next, we contrast our theoretical results with the regulation of chemicals in the European Union. In line with our theory, we find that support for regulation has a strong and significant impact on the decision to regulate when the support comes from firms but not when it comes from NGOs and environmental agencies. We also find that national authorities have a stronger influence than other stakeholders in the regulation decision, both by the number of comments and the relative support.

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

JEL codes: D04, 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 influences 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 consulta-

tions, allowing us to examine the direct link between stakeholder input and regulatory outcomes. Our analysis shows that firms' comments, particularly when they support regulation, significantly impact regulatory decisions. Additionally, national authorities, especially those with unknown biases, play a critical role when stakeholder opinions are divided. These findings illustrate how regulators leverage the input from multiple biased stakeholders to improve decision-making.

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; 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 the BNE with pure strategies. 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 economy 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 Bramoullé and Orset (2018) and Chiroleu-Assouline and Lyon (2020). These authors show that firms 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. By highlighting the role of bias and information manipulation in a setting where costly political efforts are absent, our paper complements and extends the private politics literature by showing how strategic communication alone can influence regulatory outcomes.

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 role of firms, NGOs, and national authorities in the consultation process, showing that biased input from firms has a more significant impact on regulatory outcomes than input from NGOs or environmental agencies. Additionally, we document that national authorities with unknown biases play a crucial role, especially when there is conflict between stakeholders with opposing interests. Our analysis of EU chemical regulation provides empirical support for the theoretical framework, offering 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, investigating the impact of stakeholder input on regulatory outcomes. 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. Advice is science-based but can be distorted based on stakeholders' self-interests. The distortion could occur because of bounded rationality on the regulator side (i.e., regulators cannot process scientific knowledge and therefore have to rely on experts' interpretation of the results) or because stakeholders can influence the interpretation of the results (for instance, by creating uncertainty about the scientific case for regulation by undermining the credibility of scientific evidence).[1]

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.

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 $T = F, G, O$. Stakeholder T aligns more with the social interest when α_T is close to 1.

[1] One common strategy for creating doubt is to attack the character of science-based organizations, accusing them of a political bias that makes their recommendations untrustworthy. A second common strategy is to put forward competing scientific evidence whose findings are opposed to those scientific findings calling for policy action. See, e.g., Chiroleu-Assouline and Lyon 2020.

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. This is to say, the direction of the bias (i.e., economic benefits for firms and health and environmental protection for organizations) is public information. As for public authorities G, they are known to be less biased but can be pro-business or pro-environment. Their bias parameter α_G is closer to 1 compared to the bias parameter of firms or organization (i.e. $\alpha_F < \alpha_G < \alpha_O$), but it can be higher or lower than 1.

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.[2]

Working with the product's expected social return defined by $r \equiv \frac{V}{D}$ 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 $1 > r > \alpha_O$.

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

[2]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 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).

$m_T = A$ 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 $r = \frac{V}{D}$ is drawn from $[\underline{r}, \overline{r}]$ with distribution f with $\underline{r} < 1 < \overline{r}$.
2. Stakeholders 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.

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.

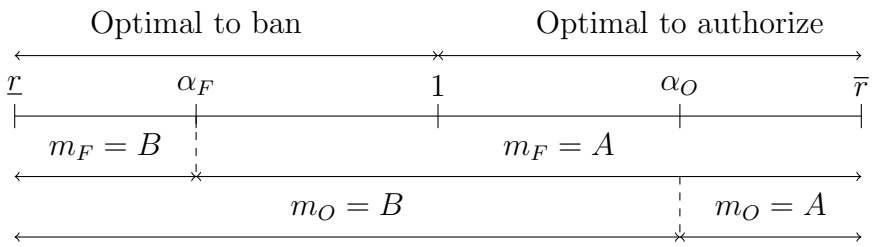

Figure 1: Return, biases and reports with two stakeholders: a firm and an organization

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.[3]

- Decision strategy if only receiving a comment from F.

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

- 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.

[3]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).

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, we assume that the regulator knows not only the direction but also the magnitude of the biases α_F and α_O. However, our main results hold if the regulator does not know the magnitude of the biases. Then, the expected return when the stakeholders send contradictory comments $m_F = A$ and $m_O = B$, as displayed in the equilibrium strategy $d(A, B)$ in (4), would be based on the expected biases rather than the known biases.

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 that, we focus on the likelihood of being wrong by making errors of types I and II. The type of error depends on whose perspective is favored in the consultation process. Not banning a bad product is referred to as a type I error, while banning a good product is a type II error.[4] Below are the errors that can happen depending on who is 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:

[4]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.

– 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.

Proposition 2 *Type I and II errors are reduced when the regulator considers the comments of two stakeholders with opposite biases rather than only one.*

Proposition 2 provides some rationale for strategies intended to increase participation in public consultations. The intuition is that inclusive participation of relevant stakeholders with opposite biases can enhance the quality of decision-making by reducing errors in both directions. Note, though, that each of the two error types is possible with two stakeholders, while only one error can occur with only one stakeholder (error I with F or error II with O). Therefore, if the regulator wants to prioritize one type of error over the other, she could consider only one comment or involve only one stakeholder in the decision-making process.[5]

Proposition 2 also sheds light on the logic behind the value of consensus in policy decisions. The literature on evidence-based policymaking suggests that consensus increases the likelihood of evidence influencing decisions, as it serves as a heuristic for assessing the accuracy of the information. Consensus acts as a signal that the conclusions are likely correct, boosting support for policy implementation and legitimizing decisions (see Ding et al. 2011 and Lewandowsky et al. 2013). Our analysis aligns with this view by showing that, when consensus is achieved, the regulator can be confident in the correctness of her decision. However, in our context, consensus is only likely in extreme cases.

Before adding the third type of stakeholder in the public consultation game, we briefly discuss how robust our conclusions are to the assumption of the costless message. If sending comments is costly, a stakeholder will only send a comment if it is pivotal in the sense that its comment changes the decision. In the BNE described in Proposition 1, for extreme values of r, the stakeholder whose comment matters turns out to be

[5]In the same vein, because the level of bias matters for the likelihood of errors, the regulator might prioritize the comment of the stakeholder that is considered to be less biased. For instance, if O's bias is low, meaning that α_O is close to 1, having $1 \geq r > \alpha_O$ is less likely, and so is the chance of having a type II error with only O's comment. Conversely, if F's bias is high, α_F is close to zero, so that $\alpha_F \leq r < 1$ is more likely, type I error is more likely to occur with only F's comment. At the limit, F's comment is not informative at all for $\alpha_F = 0$ because, in that case, $m_F = A$ regardless of r.

pivotal. If $r < \alpha_F$ and $E[r] \geq 1$, the firm is pivotal: its message $m_F = B$ matters because the product is otherwise authorized if the organization sends no comment, or if it sends a comment $m_O = B$ but $E[r|r < \alpha_O] \geq 1$. Symmetrically, if $r \geq \alpha_O$ and $E[r] \leq, r$, the organization's message $m_O = A$ matters because without comment from a firm (or with a comment $m_F = A$ when $E[r|r \geq \alpha_F] \leq r$) the product is banned. Hence, Corollary 1 holds with costly communication.

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). Due to its regulatory role and accountability to the public, it is expected to be less biased than other stakeholders. This expectation arises from its responsibility to uphold the public interest in decision-making. However, unlike firms or organizations, its bias is uncertain. It can be pro-business or pro-environment. It may undervalue the damage (as firms do) or overvalue it (as organizations do). The regulator knows that the public authority bias α_G is such that $\alpha_F < \alpha_G < \alpha_O$. However, α_G can be lower or higher than 1. The regulator's a priori belief about α_G is denoted by the density function g and the cumulative G on the range (α_F, α_O). 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:

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

In Appendix B, we prove the following proposition.[6]

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

In the BNE, the regulator's response to a comment depends on who is sending it. She always follows a recommendation to authorize a product from an organization but sometimes bans a product that a firm or an authority recommends authorizing. Similarly, the regulator always bans a product if the firm favors banning it, but she sometimes authorizes a product even if a firm or an authority advises banning it. Furthermore, the regulator's decision is consistent with the comments when there is a consensus. 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 knows that $r \geq \alpha_F$ and $r < \alpha_O$. She updates her beliefs accordingly. She also considers the authority's comment m_G when computing the expected return of r. She knows that $r \geq \alpha_G$ if $m_G = A$ and $r < \alpha_G$ if $m_G = B$. Even if the regulator does not know the value of the bias α_G, this information helps the regulator make a wiser decision.

We now provide another rationale for following G's comment when F and O disagree on their comment, based on errors of type I or II. We focus on two specific strategies that

[6]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 and the organization send the same comment (to authorize or ban) while the authority sends a different comment. The equilibrium is robust to alternative out-of-equilibrium assumptions. For instance, we could have $d(A,B,A) = d(A,A,A) = A$ and $d(B,A,B) = d(B,B,B)$, in which the regulator chooses to authorize or ban as long as both the firm and the organization advise it to do so, regardless of the authority's comment.

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, then the probability of making errors is minimized by following G's comment rather than ignoring it.*

The type of error that results depends on how the authority G is biased compared to the optimal decision. Suppose that $\alpha_G < 1$. A type I error (authorizing a bad product) is made by following G's comment when $\alpha_G \leq r < 1$. If the regulator ignores G's comment, in the case where $E[r|\alpha_F \leq r < \alpha_O] \geq 1$, she makes an error of type I if $\alpha_F < r < 1$. Because $\alpha_F < \alpha_G$ (F is more biased than G), the error happens more often than would occur if she ignored G's comment. Conversely, if $E[r|\alpha_F \leq r < \alpha_O] < 1$, she makes an error of type II (banning a good product) if she ignores G's comment in the case where $1 \leq r < \alpha_O$. Under the assumption that r is distributed symmetrically around 1, since $\alpha_G < \alpha_O$, the probability that $1 \leq r < \alpha_O$ is higher than the probability that $\alpha_G \leq r < 1$. Hence, the regulator makes errors (of type II rather than of type I) more often by ignoring G's comment. In the same vein, if $\alpha_G > 1$, the regulator makes a type II error by following G's comment if $1 \geq r > \alpha_G$. She makes an error (of type I or II) by ignoring G's comment with a wider range of r values and, therefore, with a higher probability.

An important implication of the BNE described in Proposition 3 is that the regulator is more likely to follow G's comment when F and O disagree. If they agree, G's comment is irrelevant to the decision. However, the regulator uses G's comment to update her beliefs on r if they disagree. She knows that $r \geq \alpha_G$ if $m_G = A$ and $r < \alpha_G$ if $m_G = B$. Her expectation over r is higher if she knows that $r \geq \alpha_G$ rather than $r < \alpha_G$ for any value of α_G. Hence, the regulator is more likely to authorize the product if $m_G = A$ than if $m_G = B$. It is thus more likely to follow the authority's comment. Propositions 3 and 4 imply the following corollary.

Corollary 2 *If the firm and the organization disagree, the regulator should follow the advice given by the public authority.*

Before turning to the case of multiple stakeholders of the same type, we would like to stress that Corollary 2 holds if sending comments is costly. This is because the

authority is pivotal in case of disagreement between firms and organizations. As long as the firm does not recommend to ban and the organization does not recommend to authorize, the authority's comment matters for the decision. It is so even if the other stakeholders do not send any comments. The authority should spend the cost of sending a comment even if the two other stakeholders do not.

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 $T = F, G, O$. As before, for firms and organizations, the regulator knows the bias direction (pro-business or pro-environment). She knows that firms assign more value to V and less to D but not how much. Symmetrically, she knows that organizations care more about damages D than economic benefits V but not how much.

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.

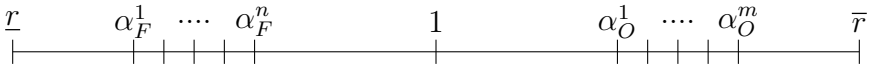

Figure 2: Firms' and organizations' biases.

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 $j \leq i$ send $m_F^j = A$. Symmetrically, for r such that $\alpha_i \leq r < \alpha_{i+1}$ for one organization i, organizations $j < i$ send positive comments and organizations $j \geq i$ send negative comments.

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 public 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). When computing the expected return, she aggregates the comments sent by several national authorities. We show that the decision process implies that a product that receives more positive comments from public 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 national 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 $r^1 \geq \alpha_F^k$ and $r^2 < \alpha_F^k$. Even if the regulator does not know α_G^k, she can infer that $r^1 > r^2$. 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_F^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 it is that the product will be authorized. Our analysis leads to the following corollary.

Corollary 3 *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 public authorities that support a ban, the more likely it is that the product will be banned.*

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 has a higher impact on the probability of regulation if it comes from a firm; opposition to regulation has a higher impact on the probability of regulation if 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 Corollaries 2 and 3.

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.

3.1 The regulation of chemicals in the European Union

In the European Union, the use and production of chemicals are governed by regulations such as the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH). Through 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—can be subject to strict limitations, including complete prohibitions (see, e.g., Coria 2018 and Coria et al. 2022).

SVHCs are identified based on their intrinsic hazardous properties, which include 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 made 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, accounting for the comments gathered during public consultations, and allowing stakeholders, including industry representatives, non-governmental organizations, and Member States, to provide input (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. This ensures that their use is controlled, limited to essential applications, and subject to strict conditions designed to minimize risks.

Public consultations are intended to enhance transparency and ensure that decisions are informed by a diverse range of perspectives. However, they have been criticized for favoring well-connected actors, such as industries and Member States with significant chemical production, raising concerns about equitable participation. [7]

By February 2022, the European Chemical Agency (ECHA) had proposed 202 chemicals for inclusion on the Authorization List, out of which 120 were ultimately included. Comments from different stakeholders were received for 201 of these chemi-

[7] For example, Persson (2007) found that, during consultations for the REACH regulation itself, industry associations and businesses far outnumbered NGOs and representatives of diffuse interests, and chemical-producing countries were better represented than others. These imbalances highlight potential challenges in ensuring fair representation in the decision-making process.

cals. 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 focus on analyzing these comments to explore their influence on the final regulatory outcome. 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). These comments typically express opinions, advocate for or against specific regulatory actions, or address the proposed classification of substances as substances of very high concern. For each comment, we can ascertain the submitter's identity – whether it was submitted by a firm or industrial organization, competent authorities or national organizations, or NGOs and environmental agencies. We also assess whether the comment expresses support or opposition to the regulation of the chemical. Support is understood as advocating for inclusion on either the Candidate or the Authorization List.

The categorization of comments was conducted manually and systematically by assessing whether the language and arguments presented supported or opposed the proposed regulatory actions. It was straightforward to evaluate the large majority of the comments because they explicitly expressed support or opposition, or they clearly provided arguments that could be categorized accordingly. For instance, supportive comments generally agreed with the proposed regulatory actions and emphasized the need for stringent regulation due to the hazards associated with the substance. These comments often cited the substance's intrinsic properties, such as carcinogenicity or environmental persistence, as justification for its inclusion on the Candidate or Authorization List. 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'.

In contrast, opposing comments often questioned the sufficiency or interpretation of the evidence presented, argued that the regulatory action was unnecessary, or proposed alternative approaches. Some also highlighted potential economic or operational challenges arising from regulation, particularly from industry stakeholders. For example, one opposing comment noted, 'Without additional evidence, a guideline oral carcinogenicity study alone may give not assessable results. A listing of [this substance] in the Authorization List is a severe decision and should be based on adequate scientific

evidence.'

In some cases, categorization was more challenging. Certain comments provided technical critiques or additional data without explicitly endorsing or opposing the proposed action. In such instances, the researchers evaluated the overall tone, context, and implications of the comment, using consistent criteria to ensure accuracy and uniformity across the manual categorization process.

Table 1 summarizes the comments in terms of the type of submitter, as well as the frequency of supporting comments. As shown in the table, 3,610 comments have been sent by 1,164 firms/industrial organizations. Only about 3.0% of comments by firms/industrial organizations have supported regulation; most such comments are from industrial entities, such as the European Trade Union Confederation. The motivations behind these comments vary but generally include the desire to diminish the occurrence of occupational diseases, the commitment to comply with international codes of practice aimed at ensuring product safety, and ongoing industry efforts to discontinue the use of the listed chemicals.

NGOs and environmental organizations are much more supportive of regulation (i.e., 90% of the comments support regulation). However, in relative terms, participation in public consultations by NGOs/Env.Org. are much more limited than participation by firms/industries, both in terms of the number of comments they provided (i.e., 13.3% of the 4,939 comments) and the number of actors commenting (5.2% of the 1,245 stakeholders commenting). Participation is also more limited by national authorities, which have provided 13.6% of all comments. National authorities are also very supportive of regulation (i.e., 81% of their comments support regulation). Notably, despite a high level of support, this is the group that shows the larger variability in responses among stakeholders. In other words, while a typical firm or NGO commenting several times will show no variability in their responses (i.e., they oppose or support the regulation of all chemicals for which they provide comments), national authorities support regulation in most cases, but still oppose the regulation of some of the chemicals. The larger variation in the advice provided in national authorities' comments suggests that – compared to firms and NGOs/Env.Org. – they might be less biased, because they are expected to represent the interests of multiple stakeholders.

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 key stakeholders that are active in the public consultations. As shown in the figure, individual companies in EU countries with a large production of chemicals (i.e., Germany, France, and the United Kingdom) have actively participated in the public consultations. National authorities in countries such as Norway, Germany, and Sweden, and NGOs such as the Health and Environment Alliance, the International Chemical Secretariat (Chemsec), the World Wide Fund for Nature (WFF), and the Chemicals, Health and Environmental Monitoring Trust (CHEM Trust) have also actively participated in public consultations.

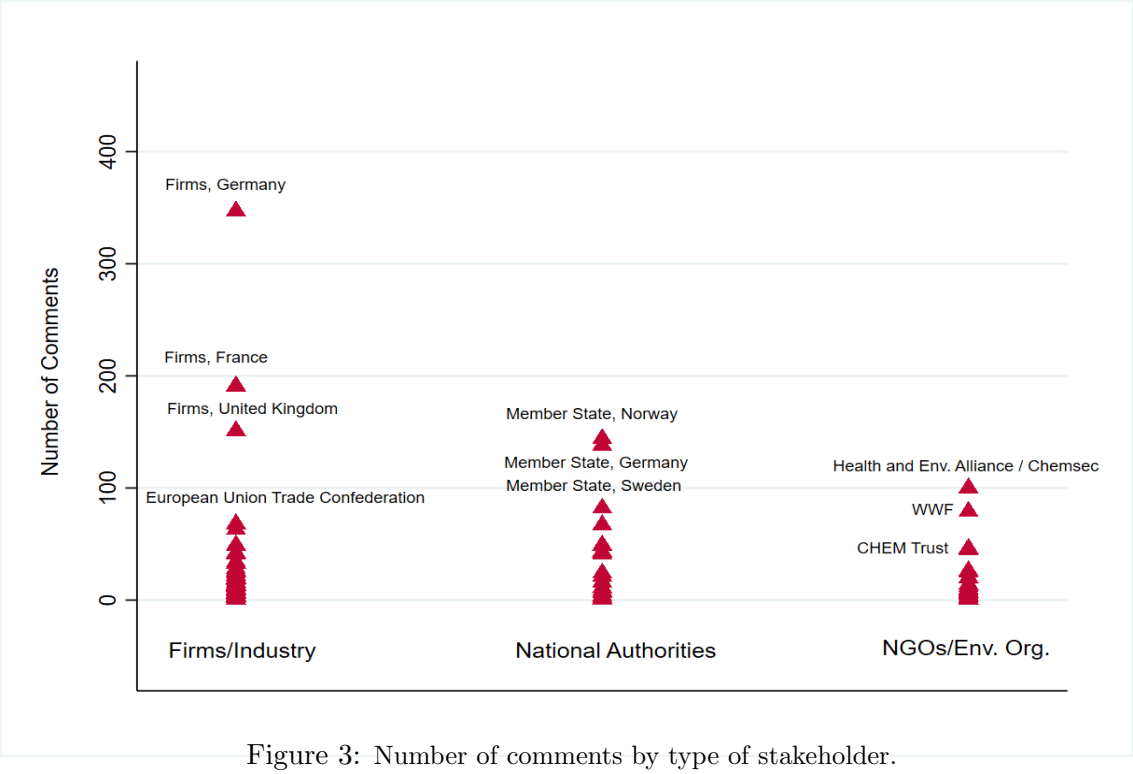

Figure 3: Number of comments by type of stakeholder.

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 was complemented with information about the intrinsic properties of the chemicals and information on the number of countries with firms actively producing or using the chemicals (active registrants). Such information has been collected by Coria et al. (2022). In our analysis, we make use of their CMR Score, which is a proxy for the intensity of carcinogenic (C), mutagenic (M) and reprotoxic (R) properties of the chemicals. This score is based on the percentage of firms supplying hazardous chemicals within the European Economic Area (i.e., manufacturers, importers and re-importers, producers of specific articles, formulators, distributors and retailers) that label the chemical with either of the codes related to CMR properties following the European Classification, Labelling and Packaging Regulation. A higher value of the score indicates that the chemical is hazardous in a broad range of potential uses, thus leading to higher risks.

3.2 Descriptive Analysis

The analysis of the properties of the chemicals for which comments have been provided and how the comments have influenced inclusion on the Authorization List provides three main findings.

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

In Figure 4, we display the properties of the chemicals that mostly received comments from firms, those that mostly received comments from national authorities, and those that mostly received comments from NGOs and environmental organizations. In relative terms, the chemicals for which the majority of the comments were provided by firms account for 88% of all comments. In contrast, those chemicals for which the majority of the comments were provided by NGOs and environmental organizations account for 6% of all comments. As shown in Figure 4, the chemicals for which most comments were provided by firms are, on average, produced/used by more EU countries than those for which most comments were provided by national authorities and NGOs and environmental organizations. In contrast, NGOs and environmental organizations have focused on chemicals with high damage, while no clear trends emerged in the case of national authorities.[8]

Thus, Figure 4 reveals distinctive patterns in stakeholders' biases regarding the types of chemicals on which they comment. Chemicals receiving the most comments from firms tend to possess higher economic value, reflecting these stakeholders' prioritization of economic considerations. Conversely, when NGOs and environmental organizations are the primary commenters, this typically involves chemicals perceived as more hazardous, as NGOs and environmental organizations prioritize environmental and public health concerns. However, when authorities lead in commenting, no clear bias emerges, potentially indicating a more balanced perspective or regulatory oversight. These patterns suggest that stakeholders' comments mirror underlying biases toward economic interests, environmental and public health considerations, or regulatory oversight, respectively.

[8]The differences in CMR Score and % EU Countries with active registrants are statistically significant for the cases when firms provide most of the comments versus those cases when NGOs/Env.Org provide most of the comments, with p values equal to 4% and 2% respectively.

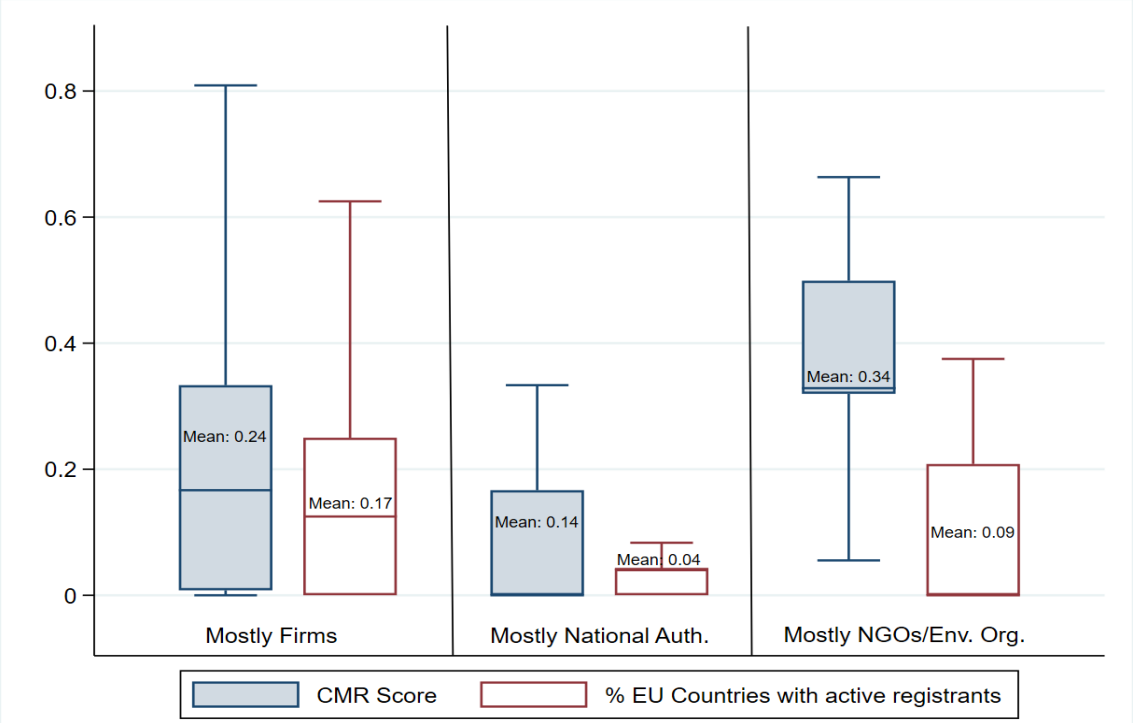

Figure 4: Properties of the chemicals proposed for regulation and stakeholder comments.

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

In Figure 5, we show how the relative support by firms, national authorities, and NGOs and environmental organizations varies with the properties of the chemicals. In Panel (a), we distinguish those chemicals where all firms commenting oppose regulation (i.e., all oppose) and those chemicals where some firms support regulation (i.e., some support). In Panel (b), we distinguish between chemicals where all national authorities commenting support regulation (i.e., all support) and those chemicals where

some national authorities oppose regulation (i.e., some oppose). Finally, in Panel (c), we distinguish between chemicals where all NGOs and environmental organizations commenting support regulation (i.e., all support) and those chemicals where some NGOs/environmental organizations oppose regulation (i.e., some oppose). Interestingly, Figure 5 corroborates the view that firms are not only concerned about the economic effects of regulations, nor are NGOs and environmental organizations only concerned about the hazardous properties of the chemicals. For instance, as shown in Panel (a), the relative support for regulation by firms increases with our proxy for damage. This is evident in that some firms support regulation of chemicals that are – on average – more hazardous than those chemicals whose regulation is fully opposed by firms. Moreover, some NGOs/environmental organizations oppose the regulation of some chemicals that are produced/used by a larger number of EU countries, even though such chemicals are (on average) more hazardous than those chemicals whose regulation receives full support from organizations. In other words, the relative support from organizations for regulation decreases with economic value. Finally, it is noteworthy that chemicals for which a ban is endorsed by all national authorities tend to exhibit higher average hazard levels and are produced/used by a fewer number of EU countries compared to those for which certain national authorities oppose regulation. This shows that, in line with our theoretical prediction, relative support for regulation increases with our proxy for damage and decreases with our proxy for economic value.

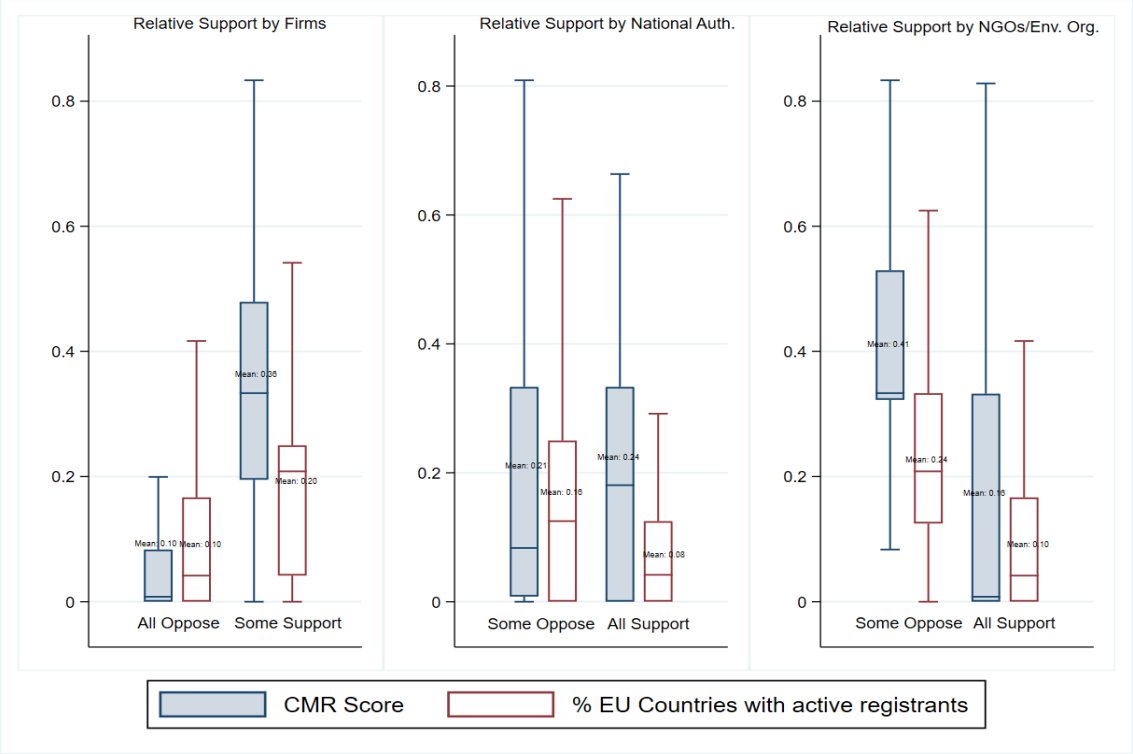

Figure 5: Properties of the chemicals proposed for regulation and support by different stakeholders

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).

Regulators prioritize support from firms and national authorities over that from NGOs and environmental organizations.

Finally, Figure 6 displays the relative support for regulation by firms, national authorities, and NGOs/Env.Org., comparing chemicals that were ultimately regulated (YES) with those that were not (NO). The figure shows cumulative distributions of relative support, with each point representing the support level for a single chemical. Quantile lines mark the 25th, 50th (median), and 75th percentiles of the distribution, while horizontal reference lines indicate the mean relative support for each group.

On average, the overall relative support for chemicals that were regulated was 55%,

compared to 48% for unregulated chemicals.[9] While this overall difference is only weakly statistically significant, the differences in mean support across regulated and unregulated chemicals are statistically significant for firms and national authorities but not for NGOs and environmental organizations. Firms showed mean support of 11% for regulated chemicals versus 4% for unregulated ones; for national authorities, mean support was 90% for regulated chemicals and 78% for unregulated ones. NGOs and environmental organizations exhibited smaller differences, with mean support of 94% for regulated chemicals and 92% for unregulated ones.[10]

Figure 6 highlights these patterns visually. For firms, relative support for unregulated chemicals is concentrated at lower values, whereas regulated chemicals show a broader spread and higher levels of support. A similar pattern is observed for national authorities, where regulated chemicals are associated with higher support levels and a wider distribution. In contrast, the distributions for NGOs/environmental organizations are nearly identical, reflecting the small and statistically insignificant difference in their support levels.

Our theoretical analysis suggests that the presence of outliers – cases where at least one firm supports regulation while at least one NGO/environmental organization opposes it – could influence the probability of regulation. Figure 6 also provides a visual indication of the presence of such outliers. For firms, outliers exist whenever the relative support for regulation is greater than zero, indicating that at least one firm supports regulation. For NGOs and environmental organizations, outliers occur whenever the relative support is less than one, signaling that at least one NGO/environmental organization opposes regulation.

Interestingly, we observe a weakly statistically significant lower presence of firm outliers among chemicals that were ultimately regulated compared to those that were not (40% versus 52%). By contrast, we find no statistically significant differences in the presence of NGOs/Env.Org. outliers between regulated and unregulated chemicals (25% versus 27%).[11]

The lack of an apparent relationship between outliers and regulatory outcomes might have several explanations. One possible explanation is that the overall influence of stakeholder groups may be determined less by a few dissenting voices (outliers) and more by the collective signal of the majority within each group. For example, even

[9] p-value for the overall difference: 0.067.

[10] p-values for differences in mean support: firms = 0.01, national authorities < 0.01, NGOs/Env.Org.= 0.21.

[11] p-values for differences in the presence of outliers: firms = 0.08, NGOs/Env.Org. = 0.65.

when one firm supports regulation, if most firms oppose it, the broader opposition may outweigh the influence of the outlier. Similarly, if NGOs/environmental organizations overwhelmingly oppose regulation, the support of one or a few organizations may not carry enough weight to affect the final decision.

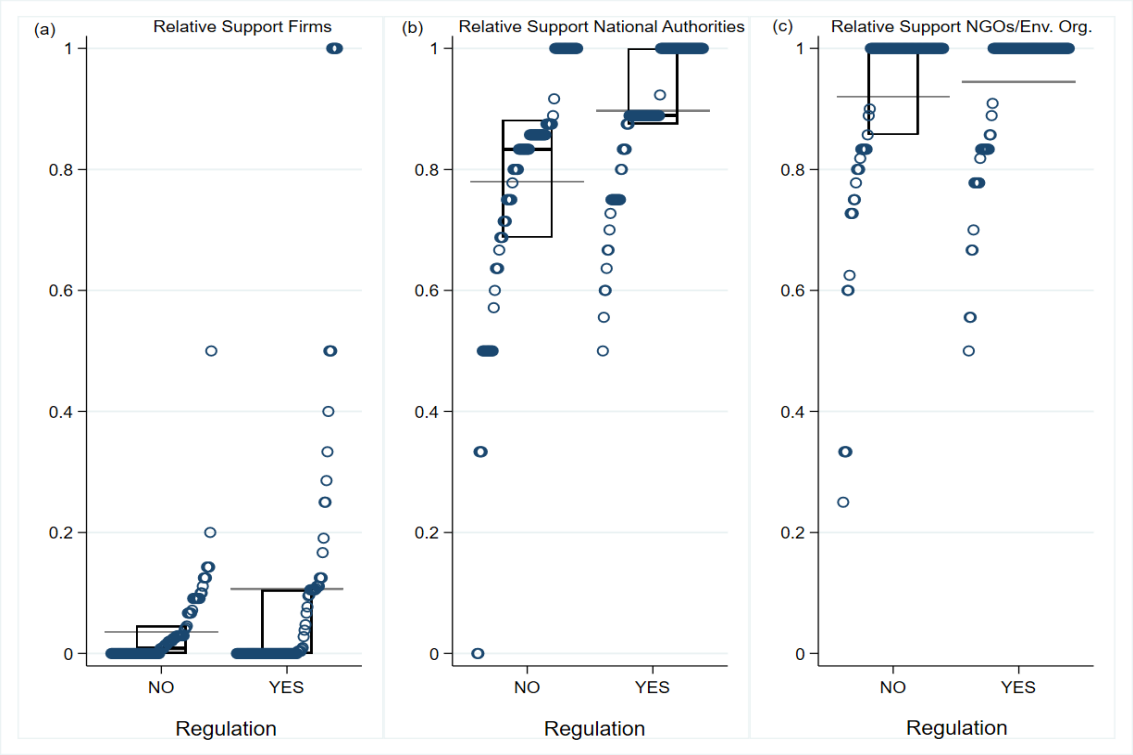

Figure 6: Relative Support by Firms, National Authorities, and NGOs/Env. Org. and regulation of the chemicals

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).

Economic considerations could also explain the lower presence of firm outliers for regulated chemicals. Chemicals with high economic relevance are likely to attract more

unified opposition to bans from firms, as fewer firms would have an incentive to support their regulation. Additionally, the pool of firms submitting comments may be more narrowly formed by those directly affected by the proposed regulation, leading to more cohesive positions and reducing the likelihood of outliers within this group.

In the next section, we further explore these dynamics through regression analysis to quantify the role of stakeholder support in determining regulatory outcomes, while controlling for the properties of the chemicals.

3.3 Regression Analysis

In this section, we examine how both the number of comments and the varying levels of support from different stakeholders influence the likelihood of chemicals being added to the Authorization List. We employ logistic regression analysis to shed light on how factors such as the number of comments, support from different stakeholder groups, and the inherent properties of the chemicals impact the probability of regulation (see Appendix D for summary statistics). In Table 2, col. (1), the probability of regulation is explained by the square root of the number of comments by firms, national authorities, and NGOs/environmental organizations and the overall relative support for regulation.[12] In col. (2), we also control for the properties of the chemicals (in particular, CMR and other hazardous properties and the share of countries with active registrants), while in col. (3) we add a control for whether the regulatory proposal concerns one chemical or a group of chemicals. Cols. (4)-(5) resemble specifications (1)-(3), but disentangle among the relative support by firms, national authorities, and NGOs/environmental organizations. The results in cols. (1)-(3) indicate that the number of comments provided by national authorities and the overall support are important determinants of the probability of regulation, even after controlling for the properties of the chemicals. Furthermore, the results in cols. (4)-(6) indicate that the relative support by firms and national authorities has a statistically significant effect on increasing the probability of regulation. On the contrary, the relative support provided by NGOs and environmental organizations does not yield a statistically significant effect.

These findings align with our theoretical framework for firms and national authorities but not for NGO/environmental organizations. According to Prediction 2,

[12] Using the square root transformation for the number of comments effectively mitigates the skewness of the data, particularly in cases where there is a right-skewed distribution with some observations having a high number of comments. Unlike the logarithm transformation, the square root transformation can handle zero values, ensuring that observations with zero comments are included in the analysis.

the support from firms and the opposition from NGO/environmental organizations should matter for the regulator's decision. We find a strong and significant impact of firms' support on the probability of inclusion in the authorization list. As for NGO/environmental organizations, the opposition should negatively impact the probability of inclusion. Since more opposition implies less support, we should also obtain that support to impact the probability of inclusion in the authorization list positively. We do not find any significant impact, which suggests that the opinions of NGOs/environmental organizations do not matter much.

As depicted in Table 1, most firms oppose regulation, while most NGOs/environmental organizations support it. This stark disparity underscores a clear divergence in stakeholders' preferences. Our results confirm the pivotal role of comments and endorsements from national authorities in such contexts. Moreover, our research identifies a noteworthy effect: the presence of firms endorsing regulation significantly influences the likelihood of implementing regulatory measures. Firms constitute a diverse and extensive group, with instances of regulatory support being rare. Conversely, organizations tend to default toward supporting regulation, rendering their endorsements potentially less informative compared to those from firms.

As previously discussed, national authorities represent a diverse group that sometimes comments alongside other national stakeholders and, at other times, acts as the sole contributor from their respective countries (see Table 5 in Appendix E for details). Our theoretical framework assumes that the direction of the bias for firms (negative) and NGOs/Env.Org. (positive) is known, while the magnitude of these biases is unknown. In contrast, the direction of the bias for national authorities is unknown. However, since they are expected to balance the interests of both firms and society, we anticipate their bias to be smaller in magnitude compared to these groups. Indeed, as shown in Appendix E, national authorities tend to express stronger support for regulation when acting alone, whereas their support diminishes when commenting alongside firms and industrial organizations.

The case most aligned with our theoretical model occurs when national authorities comment alongside other national stakeholders. In such instances, national authorities are more likely to represent a broader set of interests, reflecting their mandate to consider societal and economic considerations. As a result, their bias should be less extreme than that of firms or NGOs/environmental organizations. By contrast, when national authorities act as the sole contributors, their input may reflect narrower considerations, which introduces greater variability in the informational value of their

input.

In Table 3, we account for the share of cases where national authorities are the sole contributors from their respective countries. This measure reflects how often their input is provided independently rather than alongside other national stakeholders. To examine its effects, we interact this share with both the number of comments by national authorities and their relative support for regulation. This approach evaluates how acting alone or alongside others influences the impact of national authority comments and support on the probability of regulation.

Interestingly, the relative significance of comments from national authorities diminishes when they are the sole contributors. This finding aligns with our theoretical framework, which posits that their input may carry greater informational value when provided alongside other national stakeholders. By contrast, when they act as the sole contributors, their comments appear less impactful in shaping regulatory decisions. Moreover, the interaction between relative support and the share of cases where national authorities comment alone is not statistically significant. One possible explanation is that relative support from national authorities remains consistently high across all configurations, limiting the variability that the interaction term can capture.

Appendix E presents some robustness checks. First, rather than investigating the effects of relative support by firms and NGOs/environmental organizations, we examine whether the presence of outliers – instances where some firms support regulation and NGOs/environmental organizations oppose it – has a statistically significant effect on the probability of regulation. Despite theoretical expectations suggesting otherwise, our analysis shows no statistically significant effect of outliers. Instead, it is the relative support from these stakeholder groups that proves to be influential in determining regulatory outcomes.

A potential explanation for the significance of relative support by firms, but the lack of significance of outliers, lies in the heterogeneous nature of firms and their motivations for supporting regulation. While relative support aggregates the broader stance of the group, offering policymakers a clear and consistent signal, outliers may reflect individual firms' strategic or context-specific motivations that do not align with the general preferences of the group. Firms may support regulation for varied reasons, including genuine concerns for worker health and safety, strategic efforts to level the competitive playing field, or a desire to impose higher compliance costs on rivals. This diversity of motivations reduces the interpretability of outliers as a representative signal of a firm group's overall position, making relative support a more reliable and influential

factor in determining regulatory outcomes.

In Appendix E, we also examine whether two additional factors – the number of distinct countries commenting (i.e., the number of countries from which stakeholders sending comments originate) and the proportion of commenting countries where the majority of commenters support regulation – affect the probability of regulatory action. One might expect these variables to be relevant if decision-makers prioritize majority support among countries when determining whether to regulate a chemical. However, our analysis reveals no statistical evidence supporting this notion, as both variables are found to be statistically insignificant. Moreover, our results remain robust even with their inclusion. This suggests that the information provided by various types of biased stakeholders carries more weight in decision-making than the presence of national majorities among countries submitting comments.

	(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: Effects of the Number of Comments and Relative Support by Different Stakeholders on the Probability of Regulation.

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: Investigating the Impact of National Authorities' Sole Commentary on the Probability of Regulation.

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 reducing uncertainty; while their biases are not as clear as those of firms or organizations, they tend to be less biased because they reflect a broader range of interests.

Our empirical analysis offers several important insights that support our 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 the comments they send, firms predominantly oppose regulation; they support regulation only for potentially very hazardous chemicals. In contrast, NGOs and environmental organizations tend to support the regulation of most chemicals regardless of their economic value or potential toxicity. Finally, in line with our predictions, on the rare occasions when firms do support regulation, this support has a higher impact on the probability of regulation, compared the support of NGOs and environmental agencies. In contrast, less support from NGOs and environmental organizations does not yield statistically significant effects on the decision to regulate. Additionally, we find that national authorities play a crucial role, as both the number of comments and the relative support matters for inclusion on the Authorization List.

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 in-

formation 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 $E[r|\alpha_F \leq r < \alpha_O] \geq 1$, 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 $E[r|\alpha_F \leq r < \alpha_O] \geq 1$, then $d(A, B) = A$, and F is worse off because its payoff is $V - \alpha_F D < 0$. In the reverse case $E[r|\alpha_F \leq r < \alpha_O] < 1$, 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 $E[r|\alpha_F \leq r < \alpha_O] > 1$ because then $d(A, B) = A$. However, O is worse off if $E[r|\alpha_F \leq r < \alpha_O] < 1$ 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 $r \geq \alpha_F$, the equilibrium strategies are $m_F = A$ and $m_O = B$ for the stakeholders. The decision is $d(A, B) = B$ if $E[r|\alpha_F \leq r < \alpha_O] < 1$. 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 $E[r|\alpha_F \leq r < \alpha_O] \geq 1$, 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

Because $\alpha_F < \alpha_G < \alpha_O$, we have $E[r|\alpha_G \leq r < \alpha_O] > E[r|\alpha_F \leq r < \alpha_G]$ for any α_G and, therefore,

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

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

If $m_F = A = m_O$, then $r \geq \alpha_O$ by (1), which, together with $\alpha_G < \alpha_O$, implies $r \geq \alpha_G$. G is better off if the product is authorized than banned (its gain is positive rather than nil). This is always the case if $m_G = A$ but not if G deviates with $m_G = B$, in which case the product is banned whenever $E[r] < 1$.

Similarly, if $m_F = m_O = B$, then $r < \alpha_F$ by (1), which, together with $\alpha_G > \alpha_F$, implies $r < \alpha_G$. Then G is better off if the product is banned than if it is authorized (its gain is nil rather than negative). This always is the case if $m_G = B$ but not if G deviates with $m_G = A$, in which case the product is authorized when $E[r] \geq 1$.

If $m_F = A$ and $m_O = B$, 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). If $r > \alpha_G$, G is better off if the product is authorized rather than banned. 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 (6), 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). If $r < \alpha_G$, G is better off if the product is banned than authorized. 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 $E_g[E[r|\alpha_G \leq r < \alpha_O]] < 1$. By (6), 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 (1).

For F and O, the proof that they cannot gain by deviating proceeds as 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 stake-

holder'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 $r \in (\alpha_F, \alpha_O)$:

$$f_u(r) = \frac{f(r)}{F(\alpha_O) - F(\alpha_F)}. \tag{7}$$

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 the effects of the presence of outliers with divergent views on the probability of regulation. Finally, in Table 7, we investigate whether there is any effect of the number of countries commenting and the overall support from countries on 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: Investigating the Impact of Outliers on the Probability of Regulation.

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: Investigating the Impact of the Number of Countries Commenting and Majority Support among Countries on the Probability of Regulation.

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.

References

Ambec S. and P. De Donder (2021). Environmental Policy with Green Consumerism, *Journal of Environmental Economics and Management*, 111: 102584.

Baron, D.P. (2003), Private Politics. *Journal of Economics and Management Strategy*, 12: 31-66.

Benabou R. and Tirole J. (2002), Self-Confidence and Personal Motivation, *Quarterly Journal of Economics*, 117: 871-915.

Besley, T., and Persson, T. (2023). The political economics of green transitions. The Quarterly Journal of Economics, 138(3): 1863-1906.

Beyers J. and Arras S. (2020). Who feeds information to regulators? Stakeholder diversity in European Union regulatory agency consultations. *Journal of Public Policy*, 40(4): 573-598.

Bhattacharya, S. and Mukherjee, A. (2013). Strategic information revelation when experts compete to influence. *The RAND Journal of Economics*, 44(3): 522-544.

Bunea A (2017) Designing Stakeholder Consultations: Reinforcing or Alleviating Bias in the European Union System of Governance? *European Journal of Political Research*, 54: 46–69.

Bramoullé Y. and C. Orset (2018) Manufacturing of doubt. *Journal of Environmental Economics and Management*. 90: 119-133.

Chalmers, A. W. (2020). Unity and conflict: Explaining financial industry lobbying success in European Union public consultations. *Regulation and Governance*, 14(3): 391-408.

Charness, G. and Dave, C.(2017). Confirmation bias with motivated beliefs. *Games and Economic Behavior*, 104: 1-23.

Chiroleu-Assouline, M., and Lyon, T. P. (2020). Merchants of doubt: Corporate political action when NGO credibility is uncertain. *Journal of Economics and Management Strategy*, 29(2): 439-461.

Coria, J (2018). The Economics of Toxic Substance Control– the REACH Directive. *Review of Environmental Economics and Policy*, rey003.

Coria, J., Kristiansson, E. and Gustavsson, M. (2022). Economic interests cloud hazard reductions in the European regulation of substances of very high concern. *Nature Communications*, 13(1): 1-9.

Crawford V.P. and J. Sobel (1982). Strategic information transmission. *Econometrica*, 50(6): 1431-1451.

Cremer, H., P. De Donder, and F. Gahvari (2008). Political Competition within and between Parties: An Application to Environmental Policy. *Journal of Public Economics*, 92(3): 532-547.

Daubanes, J. and J.J. Rochet (2019). The Rise of NGO Activism. *American Economic Journal: Economic Policy*, 11(4): 183-212.

Dessein, W. (2002). Authority and Communication in Organizations. *Review of Economic Studies*, 69: 811-838.

Ding, D., Maibach, E.W., Zhao, X., Roser-Renouf, C. and Leiserowitz, A. (2011). Support for climate policy and societal action are linked to perceptions about scientific agreement. *Nature Climate Change*, 1(9): 462-466.

Dunlop, C. A., Kamkhaji, J., Radaelli, C. M., Taffoni, G., and Wagemann, C. (2020). Does consultation count for corruption? The causal relations in the EU-28. *Journal of European Public Policy*, 27(11): 1718-1741.

Dür, A., and De Bièvre, D. (2007). Inclusion without influence? NGOs in European trade policy. *Journal of Public Policy*, 27(1): 79-101.

Egorov G. and B. Harstad (2017). Private politics and regulation, *The Review of Economic Studies*, 84(4): 1652–1682.

Fudenberg D. and J. Tirole (1991) *Game Theory*, MIT Press.

Furlong, S. R., and Kerwin, C. M. (2005). Interest group participation in Rule Making: A decade of change. *Journal of Public Administration Research and Theory*, 15(3): 353-370.

Georgiou, S., Rheinberger, C. M., and Vainio, M. (2018). Benefit-cost analysis in EU chemicals legislation: Experiences from over 100 REACH applications for authorisation. *Journal of Benefit-Cost Analysis*, 9(1): 181-204.

Klika, C. (2015). The implementation of the REACH Authorisation Procedure on Chemical Substances of Concern: What kind of legitimacy? *Politics and Governance,* 3(1): 128-138.

Krishna, V. and Morgan, J. (2001). A model of expertise. *Quarterly Journal of Economics*, 116(2): 747-775.

Krishna, V. and Morgan, J. (2008). Cheap talk. The New Palgrave Dictionary of Economics, 1, pp.751-756.

Legg, T., Hatchard, J., and Gilmore, A. B. (2021). The science for profit model—how and why corporations influence science and the use of science in policy and practice. Plos One, 16(6): e0253272.

Lewandowsky, S., Gignac, G.E. and Vaughan, S. (2013). The pivotal role of perceived scientific consensus in acceptance of science. *Nature Climate Change*, 3(4): 399-404.

Milgrom, P. and Roberts, J. (1986). Relying on the information of interested parties. *The RAND Journal of Economics*, 17(1): 18-32.

Oates W.E. and R.M Schwab (1988). Economic competition among jurisdictions: efficiency enhancing or distortion inducing? *Journal of Public Economics*, 35(3): 333-354.

Persson, T. (2007). Democratizing European chemicals policy: Do consultations favour civil society participation? *Journal of Civil Society,* 3(3): 223-238.