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Demand-side climate action: engaging citizens to enhance policy acceptance

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Executive summary

This Working Paper explores the pivotal role of citizen engagement in advancing climate action and increasing the acceptance of green policies. The study examines the interplay of socioeconomic factors, self-efficacy, and peer influence on citizens' willingness to adopt and support environmental-friendly policies. By leveraging advanced agent-based modelling (ABM) –and using a new data set produced by the Elcano Royal Institute as a result of its second survey on citizens and climate change– the analysis underscores the need for inclusive and participatory strategies to strengthen public support for climate change mitigation measuress

Key findings

1. **The role of citizen engagement**:

   - Active participation in social discussions about climate change significantly boosts the acceptance of green policies.
   - Current levels of citizen engagement in Spain remain low, with approximately 40% of individuals not discussing climate-related topics in their outer social circles (friends and work colleagues).
   - Engagement amplifies the impact of peer pressure, leading to a ripple effect that increases overall societal support for climate policies.

2. **Pluralistic ignorance and spiral of silence**:

- Misperceptions about the extent to which other people support climate action perpetuate silence (ie, not expressing one's opinion for fear of it being a minority/unpopular view) and reduce collective action.
- Correcting these misperceptions can foster broader societal engagement and amplify support for green initiatives.

3. **Regional differences in policy acceptance**:

   - The acceptance of green policies varies significantly across regions.
   - Increasing citizen engagement at the regional level reduces the gap between national and regional support for climate policies.

4. **Impact of socioeconomic inequalities**:

   - Socioeconomic disparities negatively affect self-efficacy and engagement, particularly in marginalised communities.
   - Poorer regions exhibit lower green propensity under regressive policies, while progressive policies lead to a higher likelihood of climate policy acceptance in

poorer regions and a limited reduction in policy acceptance in wealthier regions compared with the national mean.

5. **Self-efficacy and policy acceptance**:

   - A citizen's perceived ability to make meaningful contributions to climate action (self-efficacy) is a critical determinant of policy support.
   - Self-efficacy is strongly influenced by income and education, creating disparities in green behaviour across different societal segments.

Policy recommendations

1. **Promote citizen engagement**:
   - Encourage open discussions on climate topics in peoples' outer social networks (friends and work colleagues) to mitigate the effects of pluralistic ignorance and boost collective climate action.

2. **Design inclusive participation mechanisms**:

   - Implement citizen assemblies, stakeholder dialogues and collaborative platforms to ensure diverse voices are represented in policymaking.

3. **Leverage technology and local initiatives**:

   - Use digital platforms to enhance communication and engagement, and support community-based sustainability projects.

4. **Address equity and regional disparities**:
   - Implement targeted interventions for marginalised communities, including economic support and locally tailored initiatives to bridge regional gaps in policy acceptance.

5. **Enhance education and awareness to increase self-efficacy**:

   - Develop public campaigns to raise awareness about climate issues and foster an understanding of individual contributions to climate mitigation.

Conclusions

This Working Paper underscores the importance of addressing heterogeneity in societal responses to climate policies. Tailored interventions that enhance self-efficacy, leverage peer influence and promote active citizen engagement are critical for fostering widespread acceptance of green policies. Policymakers are encouraged to prioritise inclusivity, equity and regional considerations in the design and implementation of climate strategies, ensuring a just and effective transition to a low-carbon future.

Graphical abstract

Research questions

1. Does citizen engagement matter to enhance support for green policies?
2. Does citizen engagement impact regions differently?
3. How does self-efficacy in a given income class affect the likelihood of climate policy acceptance?

Key findings

1. Climate policy acceptance is enhanced via *engagement, addressing misperceptions regarding support for climate actions and breaking the spiral of silence*. These issues also reduce the gap between regional and national climate policy support.
2. *Progressive policies are preferred in Spain*. They enhance policy acceptance in poorer regions and have a limited negative effect on acceptance in wealthier regions.
3. *Policy support is enhanced by self-efficacy* (a perception that one can make a meaningful contribution to climate action), which depends on socioeconomic

Policy lessons

1. *Engagement is low in Spain, which matters* for climate policy acceptance, as do the lack of information regarding climate policy support and self-censoring one's opinion for fear of it being a minority view (spiral of silence).
2. *Policies affect regions asymmetrically* according to their wealth. Citizen engagement, progressive policies and policies that benefit the middle-class garner greater support, reducing the differences in climate policy acceptance across regions.
3. *The supply of climate policies and self-efficacy* (its support and correct estimation) drive climate policy

Recommendations

1. *Promote engagement between citizens*' and their outer social networks, address misperceptions regarding climate policy support and break the spiral of silence to enhance acceptance. Strengthen public participation mechanisms. Reconvene citizens' assemblies and stakeholder dialogues. *Leverage digital platforms to enhance citizen participation*.
2. *Design and adopt progressive policies as well as policies that benefit middle classes* to limit both climate policy backlash and regional differences in acceptance. *Continue supporting regions in transition* through upskilling and reskilling programs, severance packages and the development of economic alternatives through e.g. the updated Just Transition Strategy, Just Transition Agreements, Just Renewable Transition Agreements and the Social Climate Fund.
3. *Analyse existing self-efficacy and support capacity-building initiatives, strengthening them to increase the likelihood of climate policy acceptance*. Design awareness and communication tools on climate change, climate action and just transition.

1. Introduction

Fighting climate change can be achieved through a combination of personal action (eg, switching one's behaviour to greener options) and collective action (eg, attending town-hall meetings to put pressure on politicians to support green policies). In both cases the effectiveness of these actions depends on whether large numbers of people engage in coordinated action. According to the IPCC (2014, 2022), effective climate action also requires major economic and social changes to transition to a low-carbon economy, to adapt to the changes that are already 'locked in' by previous patterns of carbon emissions and to address losses and damages.

However, to secure a broad political consensus, climate policies cannot focus solely on reducing emissions. Climate impacts and the policies to address them can affect society deeply, and climate policies must therefore aim for broader objectives. Political consensus hinges on the ability of these policies to also address economic disparities, reduce inequalities and design industrial strategies that support regions and areas facing (or at risk of) crises, while enhancing job opportunities. The absence of socially acceptable climate policies risks leaving these policies vulnerable to manipulation.

Scholarly literature recognises that interpersonal communication about topics is crucial to building public acceptance and support for social change: scientifically grounded public discussion can increase the public understanding of the problem, community engagement and foster the development of a consensus for locally appropriate mitigation and adaptation solutions (Clayton *et al*., 2015; Swim *et al*., 2014).

Citizen and civic engagement with climate change and green policies has emerged as a critical area of research in environmental economics and policymaking. For instance, the recent Draghi report for the EU highlights the importance of citizens' engagement in achieving sustainable competitiveness. Furthermore, the political guidelines of the recently re-elected President of the European Commission has called for greater citizen engagement to understand how Europe affects its citizens (von der Leyen, 2024). The interplay between public participation, policy effectiveness and environmental outcomes highlights the importance of understanding how citizens' involvement can shape and be shaped by green policies (Besley & Persson, 2022; Ulph & Ulph, 2021; Bond *et al*., 2012; Muchnik *et al*., 2013; Levine & Mattozzi, 2020; Cole *et al*., 2022). Yet involvement depends on specific social dynamics and social preferences.
There is a substantial body of literature (Ulph & Ulph, 2021; Konc *et al*., 2021; Nyborg *et al*., 2006; Allcott & Mullainathan, 2010; Allcott, 2011; Allcott & Rogers, 2014; Bolsen *et al*., 2014; Dasgupta *et al*., 2016; Nyborg *et al*., 2016; Allcott & Kessler, 2019; Andor *et al*., 2020; Szekely *et al*., 2021; Lipari *et al*., 2024) that shows how social learning and peer effects are important drivers of citizen participation in climate policymaking. Being exposed to information that comes from citizens' social circles, or other formal sources of information (such as policies, political parties, newspapers and social media) has an impact on people's intentions to act, to vote and support policies designed to mitigate climate change and its impacts. Reference groups and social positions are also considered important in forming peoples' perception of fairness regarding specific policies, such as redistribution policy (Hvidber *et al*., 2023; Boskin & Sheshinski, 1978; Meltzer & Richard, 1981; Benabou & Ok, 2001; Alesina & Angeletos, 2005). Green policies, like carbon taxes, have been criticised for their distributional effects (Andor *et*

al., 2018; Cai *et al*., 2010; Drews *et al*., 2016; Sommer *et al*., 2022; Dietz & Atkinson, 2010; Maestre-Andrés *et al*., 2019; Douenne & Fabre, 2022). Hence, understanding how perceived fairness is formed and reinforced within different social groups could provide policymakers with important insights when designing and communicating new green policies.

Lipari *et al*. (2024) show that social learning, through mechanisms such as peer pressure, increases the likelihood of accepting climate policies (be they progressive or regressive) at very mild levels of peer pressure, even when a policy is not benefiting people at the individual level. In fact, as soon as the model allowed peer pressure to increase, rich citizens were also influenced by poorer ones and by social learning dynamics. High-income classes convince themselves that progressive policies that benefit middle classes (middle green policies) benefit society, even if the policies imply higher costs (or lower benefits) for them. This result sheds light on the how perceived fairness of a green policy at the global level can be increased by capitalising on such social dynamics and network effects when designing communication strategies and policy interventions. As a consequence of the results, the authors highlighted, on the one hand, the importance of having a clear understanding of the social network in which people are embedded and, on the other hand, the relevance of complementary policy interventions, like community engagement or citizen assemblies (Luís *et al*., 2018; Teodoro *et al*., 2021), which, by using information transmission and network structures, would increase citizen support for mitigation policies.

Lipari *et al*. (2024) also showed, through a simulation model based on survey data regarding the attitudes of Spanish citizens towards climate change collected by the Elcano Royal Institute (henceforth, RIE), how the probability of supporting green-friendly policies was connected to three main factors: (a) the social information from their neighbours; (b) the formal information from policy-makers; and (c) the perception of self-efficacy that people have of their own actions.

Yet citizens being exposed to (and influenced by) the ideas of peers might represent just one significant element in explaining people's intentions to act. This is so due to the following reasons:

- First, people are not influenced in the same way: heterogeneity matters.
- Secondly, people do not have access to the same type of information, due to the heterogeneity of their social circle: ie, the diversity of information received (in terms of quality and quantity) depends on socio-economic factors such as income.
- Third, people might not be actively engaged in their social circle (this mechanism is called throughout this paper 'citizen engagement'): the diversity of information depends on the number/types of people a citizen is in contact with (ie, depending on whether one talks to family members or friends and/or colleagues about green-friendly behaviour or policies, the consequences on a citizen's ability to act in a green-friendly manner might be different).

On this third point, a new wave of data collected by the RIE (Lázaro Touza *et al*., 2024) in 2023 shows that 40% of the Spanish citizens interviewed do not talk about climate change-related topics with anyone in their social circle. Using this new piece of information, we have built a new simulation model that tries to incorporate the three above-mentioned factors (heterogeneity, self-efficacy and engagement) in the analysis of variables that enhance support for climate policies. Hence, the new model extends the authors' previous work by adding a new structural parameter able to capture both the heterogeneity and the different levels of engagement between citizens and their (outer) social circle.

In this paper the term 'engagement' is taken to mean a personal *state* of connection with the issue of climate change captured in the 2023 survey via a question regarding whether respondents talk to their outer social circle (friends and work colleagues).[1] Engagement in pro-environmental behaviour can be understood in part by considering how individuals operate as members of social communities and are influenced by them. Teodoro *et al*. (2021) show that social ties can increase learning about others' climate change perception, but it highlights that learning is dependent on the complexity and multidimensionality of the ties. The studies that employ social network analysis (SNA) frameworks and tools should account for this complexity. In our analyses we focus on how individuals operate as members of a social circle: do they talk to others?

In other words, it is not enough for people to know about climate change to be 'engaged' in the topic; they also need to care about it, be motivated, willing to talk to their outer social circle about the topic and able to act. Knowing the real engagement of individuals with their social circle is fundamental for measuring whether their perception of the green behaviour of others is accurate or not. Indeed, perceptions may be incorrect because people are not typically able to see the behaviour of others and may not engage in conversations about such behaviour. The phenomenon of the inaccurate perceptions of others' opinions is called pluralistic ignorance (Allport, 1924; Miller & McFarland, 1987; Kashima, Wilson, Lusher, Pearson, & Pearson, 2013; Allport, 1924; Miller & McFarland, 1987; Bursztyn *et al*., 2020). In the presence of pluralistic ignorance, individuals may inaccurately estimate the green engagement of their peers, which may reduce their potential support for green policies.

Capitalising on the simplified agent-based model presented in Lipari *et al*. (2024), calibrated using the results of RIE's new survey, we seek to: understand the extent to which public attitudes towards climate policies that have asymmetric impacts on the population are affected by citizen engagement, perceived self-efficacy and place of residence. The aim is to uncover ways to strengthen public support for climate-change mitigation measures, bridging the climate attitude-behaviour gap.

In the original paper (Lipari *et al*. 2024) the main research question was to understand which were the factors that impact individuals' support for green policies. To do that the paper presented an evolutionary model that used the agent-based methodology (ABM) to describe an artificial Spanish society accounting for different types of agents that exhibit bounded rationality whose preferences for mitigation policies span several

[1] This differs from engagement understood as a top-down *process* of public participation in policy making.

domains, such as the economic, social, political and subjective ones. In the original paper (*Ibid.*) both citizens and political institutions interact. Citizens, who are considered as consumers and voters, interact with each other via a peer-pressure mechanism, while the interaction between political institutions and citizens occur, on the one hand, via political endorsement (linking citizens to regional parliament seats through the voting mechanism) and, on the other, via an accountability process (linking politicians to citizens through the final policy scenario chosen by the politician). We tested different policy scenarios, from regressive (eg, carbon tax whose tax proceeds are earmarked to specific emission reduction projects) to progressive (eg, carbon tax with a compensation scheme) ones in order to study the effect that they have on citizens' policy support.

In this Working Paper, our main contribution is to shed light on the mechanisms behind the heterogeneity of individuals' climate policy support and to provide new evidence on how society understands and thinks about climate policies to reflect on how to enhance climate policy acceptance. Specifically, this paper looks at the idea of citizen engagement as an extension of the effects of peer influence and pluralistic ignorance. Regarding the former paper, we have extended the initial model in two directions. First, building on the primary data on respondents' social circle (obtained by asking them about the degree of interaction with their social network as regards climate action) we were able to construct an index of citizen engagement that measures the degree to which respondents share information about climate change-related topic with a small social circle or a more diverse one. Secondly, we run robustness checks on the initialisation (activation) of a green propensity (ie, the likelihood of climate policy acceptance). While in the original model the initial green propensity is uniformly distributed, in the new data it seems to have a more polarised distribution (that could be due to specifics of the new sample, though the data is representative of Spanish society). Thus, we check whether a heterogeneous initialisation might produce different results. Furthermore, to study the perception of the fairness of a specific policy scenario, we assume that it is modulated by all the following social network ingredients: the reference network and the degree of interaction within it can increase or depress the fairness perception and, in turn, the support for the policy.

The key results of our research can be summarised as follows. We find that socioeconomic inequalities negatively affect citizen engagement and, in turn, reduce the support of green policies. Marginalised communities often face greater barriers to participation, necessitating targeted policies to ensure inclusivity (Bullard & Wright, 2009). This also occurs at the regional level. We also find that there is an interaction between self-efficacy and engagement, suggesting that complementary interventions on both fields seem necessary to increase climate policy acceptance. Finally, we corroborate our earlier results regarding the need for policymakers to recognise that heterogeneity in every society is a fundamental source of information that can be used in favour of the green transition.

The paper also contributes to the literature that delves into the intricate process of citizen belief formation and perceptions and examines how these factors influence the demand for environmental regulation within political institutions (Douenne & Fabre, 2020; Carattini *et al.*, 2017; Heine & Black, 2019; Klenert *et al.*, 2018; Douenne & Fabre, 2022; Maestre-Andrés *et al.*, 2019; Andre *et al.*, 2024; Teodoro *et al.*, 2021; Ulph & Ulph, 2021;

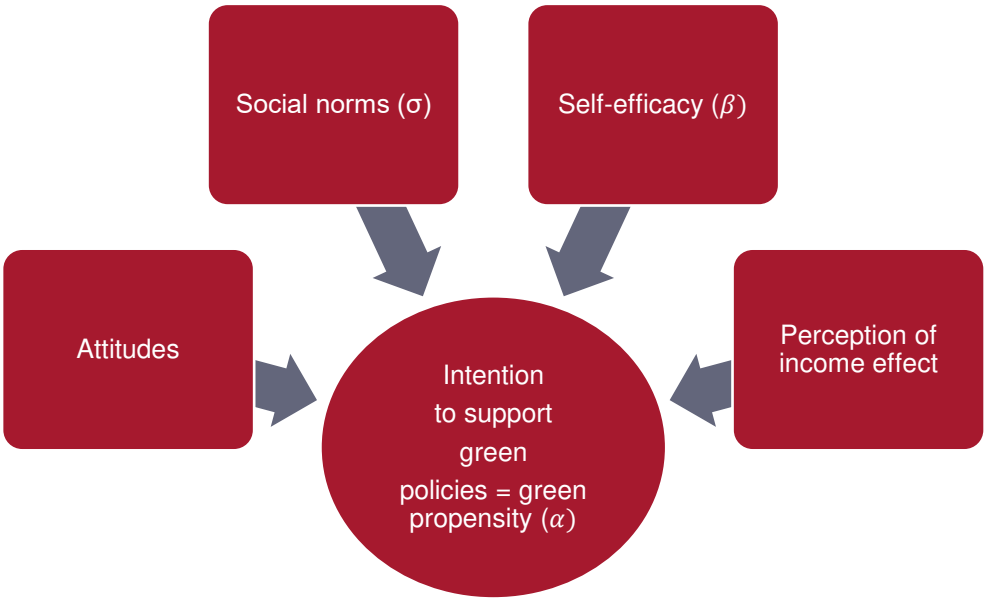
Bond *et al*., 2012; Levine & Mattozzi, 2020; Drews & Van den Bergh, 2016; Cole *et al*., 2022; Ghesla *et al*., 2020). Moreover, it contributes to the literature that uses ABM for policy design (Noeldeke *et al*., 2022; Konc *et al*., 2021; Konc *et al*., 2022; Safarzyńska & Van den Bergh, 2020, 2019; Savin *et al*., 2022; Lipari *et al*., 2024).

This Working Paper is structured as follows: Section 2 describes the conceptual framework; Section 3 introduces the strategy used for the set-up of the parameters; Section 4 presents the research questions and the model's set up; Section 5 summarises and discusses the results; and Section 6 concludes and presents the policy implications.

2. Conceptual framework

Lipari *et al*. (2024) presented as their conceptual framework a revised version of the Theory of Planned Behaviour (henceforth, TPB) (Ajzen, 1991; Fishbein & Ajzen, 2010) as shown in Figure 1.

Figure 1. Support for green policies and its determinants: original model



Source: Lipari *et al*. (2024).

Before proceeding with the new set-up, it would be useful to summarise the original models and variables. The likelihood of supporting for green policies was measured by a parameter called green propensity represented by measure α.

Such a propensity evolves over time due to four factors:

- First, individuals' attitudes towards the existence and the extent of climate change: these were measured by combining the RIE survey data on people's self-assessed knowledge about climate change, their environmental worldview (ie, the New Ecological Paradigm scale, NEP) and their beliefs about the existence of climate change.

- Second, a peer pressure mechanism is understood as the social norm governing their reference groups and an individual's sensitivity to the norms. Through a process of observation and opinion dynamics, agents learn about the behaviour of others and internalise these behaviours as social norms. This is captured through the parameter in the model called σ.

- Third, perception of self-efficacy (parameter β): the belief that citizens have material and cognitive capacity and control to understand the consequences of the policy and implement the new behaviour defined by the policy. The original paper (Lipari *et al*. 2024) assumes, moreover, that self-efficacy depends on the citizens' income class (bracket) and tests whether moving from the assumption of homogeneous self-efficacy to one of heterogeneity influences the level of support. The agents' self-efficacy is based on the Elcano data (both from 2019 and 2023) as explained in Section 3.2.

- Fourth, policy accountability measures through the evaluation of its perceived distributional impacts on lower-income households. In the model we allow agents to update their green propensity considering how much a specific policy scenario will impact their income. We have introduced a parameter $r_{p,y}$ that measures this perception.

Figure 2 shows the parameters of the model used in Lipari *et al*. (2024).

Figure 2. Parameters in the original model

Parameter	Values	Definitions
$\boldsymbol{\alpha_i}$	$\in [0;1]$	Green Propensity
$\boldsymbol{\beta}$	$\in (0;1]$	Self-efficacy
$\boldsymbol{\sigma}$	$\in [0;0.25]$	Peer pressure
$\boldsymbol{r_{p,y}}$	≥ 0	Income policy effect
$\boldsymbol{N_c}$	10,000	Citizens' population size
$\boldsymbol{N_s}$	200	Number of seats
$\boldsymbol{y_i}$	$\in [H; HM; M; ML; L]$	Agent's income class

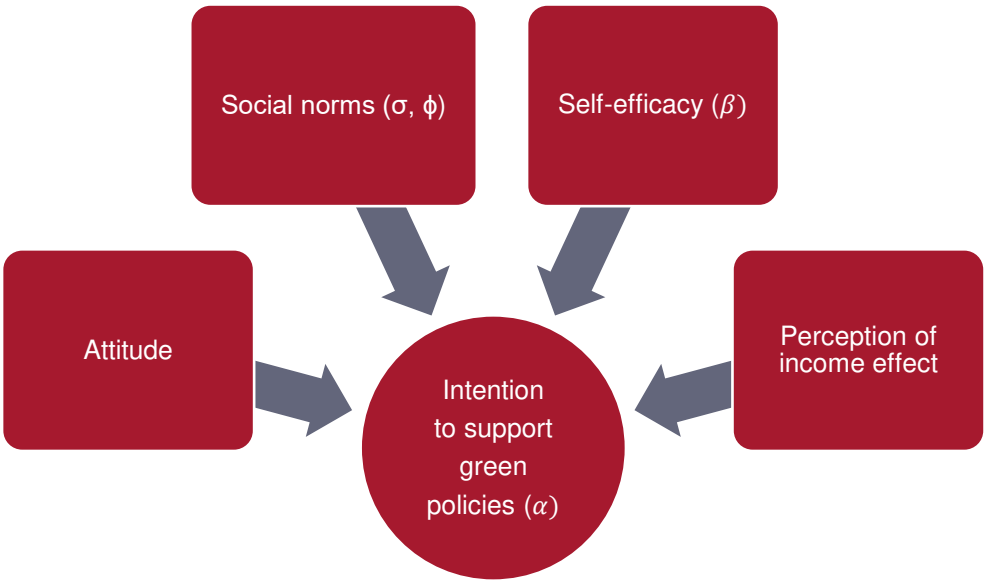
Source: Lipari *et al*. (2024).

A citizen's intention to support green policies is determined by four main factors: personal attitude; peer pressure exercised by the social norms present in the social circle; self-efficacy; and the perception of the policy's income effect. We assume that both social norms and self-efficacy depend on the reference income class (Ghesla *et al*., 2020; Hertwig & Grüne-Yanoff, 2017; McPherson *et al*., 2001; Boguna *et al*., 2004; Currarini *et al*., 2009). High (low) income individuals are more likely to interact with each other than with people outside their income class. Additionally, the higher the income of respondents the higher the perception of self-efficacy. We also assume that the

perception of the income effect of a green policy not only exists as a result of the person's reference group, which is determined by income level, but also due to place of residence, especially when regional inequality is high (Susskind *et al*., 2022; Duarte *et al*., 2022). Hence, in our model individuals interact locally according to their income class and their residential area.

Yet in the original model we assumed that every citizen would be fully engaged with all the people forming his social circle. The parameter $\sigma \in [0,1]$ measures citizens' sensitivity to peer pressure. Every agent could have the same σ, with a different social circle. From the RIE's new data we have information about the fact that not all the people interviewed discuss climate change action with their social circle. Hence, in the new model we maintain the role of σ as a measure of the intensity of peer pressure that an agent suffers, but then we add a new parameter $\phi_i \in [0,1]$ that considers whether people are talking to their neighbours or not. We call ϕ_i a measure of *citizen engagement*. Hence the new model's conceptual framework is depicted in Figure 3, while Figure 4 shows the initialisation of the new parameter ϕ, along with the previous variables.

Figure 3. Support for green policies and its determinants: extended model including 'engagement'



Source: the authors.

Figure 4. Parameters in the extended model

Parameter	Values	Definitions
$\boldsymbol{\alpha_i}$	$\in [0; 1]$	Green Propensity
$\boldsymbol{\beta}$	$\in (0; 1]$	Self-efficacy
$\boldsymbol{\sigma}$	$\in [0; 0.25]$	Peer pressure
$\boldsymbol{\phi}$	$\in [0,1]$	Citizens' engagements
$\boldsymbol{r_{p,y}}$	≥ 0	Income policy effect
$\boldsymbol{N_c}$	10,000	Citizens' population size
$\boldsymbol{N_s}$	200	Number of seats
$\boldsymbol{y_i}$	$\in [H; HM; M; ML; L]$	Agent's income class

Source: the authors.

In other words, it is not enough for people to know about climate change (whether through global or local information) in order to be engaged; they also need to care about it, be motivated enough to talk about it with people in their social circle and be able to act. Knowing the real engagement of individuals with their social circle is fundamental to measure whether their perception of people's green behaviour is accurate or not, because misperceptions of climate norms can hinder climate action. This phenomenon, that has been dubbed pluralistic ignorance (Kashima, Wilson, Lusher, Pearson & Pearson, 2013; Allport, 1924; Miller & McFarland, 1987; Bursztyn *et al.*, 2020), could trap society into a state (an equilibrium) with low climate engagement.

Pluralistic ignorance can have significant consequences for effectively addressing social issues like climate change. Sparkman *et al.* (2022) show that Americans perceive a false social reality: a near universal perception of public opinion that is the opposite of true public sentiment. Andre *et al.* (2024a, 2024b) in two surveys, first in a global survey with 130,000 individuals and then using the US population, show that the world is in a state of pluralistic ignorance whereby individuals around the globe systematically underestimate the willingness of their fellow citizens to act. The majority may privately endorse climate action but incorrectly assume that it is not endorsed by others. This incorrect belief may discourage people from acting against climate change, thereby confirming other peoples' pessimistic beliefs.

Moreover, pluralistic ignorance not only limits people's actions against climate change, but limits their willingness to talk about it with others. According to Geiger & Swim (2019) inaccurate perceptions of others' opinions (ie, *pluralistic ignorance*) contribute to self-silencing among those concerned about climate change, and misperception can limit the effort of collective action even more. Underestimating the behaviour of others regarding their climate action contributes to the so-called *spiral of silence* theory that analyses the impact of pluralistic ignorance on public discourse (Noelle-Neumann, 1993; Taylor, 1982). The spiral of silence theory suggests that people seek opinions from their social circle and are less likely to express theirs if they feel it is a minority view, especially on

controversial issues. This self-reinforcing silence occurs when others, who share the same view, also stay quiet, reinforcing the perception that their opinion is unpopular. As public support appears to decline, people become even more likely to self-censor.

Climate change might be different from other topics where the spiral of silence may be observed, because it does not (theoretically) entail morally controversial or value-laden topics, such as abortion and support for addressing racial inequality. Climate change is indeed a scientific phenomenon supported by a solid body of evidence that asserts that climate change is unequivocally anthropogenic in nature. Yet climate change has taken on a cultural significance distinct from the scientific understanding of the topic due to its politicisation. Climate change has culturally acquired a controversial, moral connotation in modern society. Hence, the spiral of silence could be the reason behind the lack of citizen engagement. Citizens might be less willing to talk about climate change when they perceive their opinions are not widely shared within their social circle. However, at the same time, this situation provides a unique opportunity to promote and accelerate climate-friendly behaviour. Correcting prevalent misperceptions can encourage climate-friendly behaviour and, according to Andre *et al*. (2004), it is a relatively simple, scalable and cost-effective intervention.

2.1. Barriers to citizen engagement

Despite the potential for citizen engagement to drive climate action, several barriers exist. We have identified at least three.

The first barrier is the limited knowledge and awareness about climate change. A lack of understanding of climate science and policy can hinder meaningful participation. Educational initiatives are crucial to bridging this gap and empowering citizens to engage effectively (Weber & Stern, 2011). The second barrier is the existence of socioeconomic inequalities. Research indicates that socioeconomic factors, such as income and education, significantly influence one's ability to engage in environmental actions. Marginalised communities often face greater barriers to participation, requiring targeted policies to ensure inclusivity (Bullard & Wright, 2009). The third barrier to citizen engagement includes political and institutional constraints. Political will and institutional capacity are critical for enabling civic engagement. In some contexts, authoritarian government structures limit the space for public participation in environmental decision-making (Newell, 2008).

In the model we capture only the first two barriers (knowledge and inequalities). Specifically, we know that knowledge and socioeconomic inequalities (also regional ones) affect peoples' self-efficacy too. So, in the model we run simulations where both self-efficacy and citizen engagement differ across income classes and regions.

The extended work we present in this Working Paper presents an evolutionary model that uses an extended version of the agent-based model used in Lipari *et al*. (2024) to describe how an artificial Spanish society deals with green policy acceptance. We do so by building on recent research that highlights the potentially productive role of social norms in fostering climate action (Nyborg *et al*., 2006; Allcott & Mullainathan, 2010; Allcott, 2011; Allcott & Rogers,2014; Bolsen *et al*., 2014; Dasgupta *et al*., 2016; Nyborg

et al., 2016; Allcott & Kessler, 2019; Andor *et al*., 2020; Szekely *et al*., 2021), on the literature of social cognitive theory (Bandura, 1997), the scholarly literature that addresses pluralistic ignorance (Kashima, Wilson, Lusher, Pearson & Pearson, 2013;Allport, 1924; Miller & McFarland, 1987; Bursztyn *et al*., 2020), the theory of planned behaviour (Ajzen, 1991; Fishbein & Ajzen, 2010) and, lastly, on the theory of multiplex networks (Boguñá *et al*., 2004; Boccaletti *et al*., 2014).

In our model both citizens and political institutions interact. Citizens, who are considered consumers and voters, interact with each other via a peer pressure mechanism, while the interaction between political institution and citizens occurs, on the one hand, via political endorsement (linking citizens to politicians) and, on the other, via accountability processes (linking politicians to citizens). Based on the RIE's data, we test three different policy scenarios, from regressive (eg, carbon tax whose proceeds are earmarked to specific emission reduction projects) to progressive (eg, carbon tax with a social cushion compensation scheme) ones in order to study the effect that they have on citizens policy support (Baranzini & Carattini, 2017; Drews & Van den Bergh, 2016; Heine & Black, 2019). Finally, we calibrate the model by using data from the survey of the RIE evaluating Spaniards' support for elements, instruments and institutions that can help implement Spain's low-carbon transition according to its Climate Change and Energy Transition Law, which was finally adopted in May 2021.

Within this framework, we address three key research questions:

(1) Does citizens' engagement matter for increasing the support of green policies?
(2) How does citizens' engagement impact differently at the regional level?

(3) How does the decrease in individual self-efficacy in a given income class affect the citizens' green propensity?

To these we add other two questions to compare the new set up with the one proposed in Lipari *et al*. (2024) and, especially, to check whether the new results are consistent with the previous ones. They are as follows:

(4) How do social and political institutions co-evolve?

(5) To what extent are public attitudes toward climate policies affected by social norms and self-efficacy?

3. Preliminary steps: parameter set-up

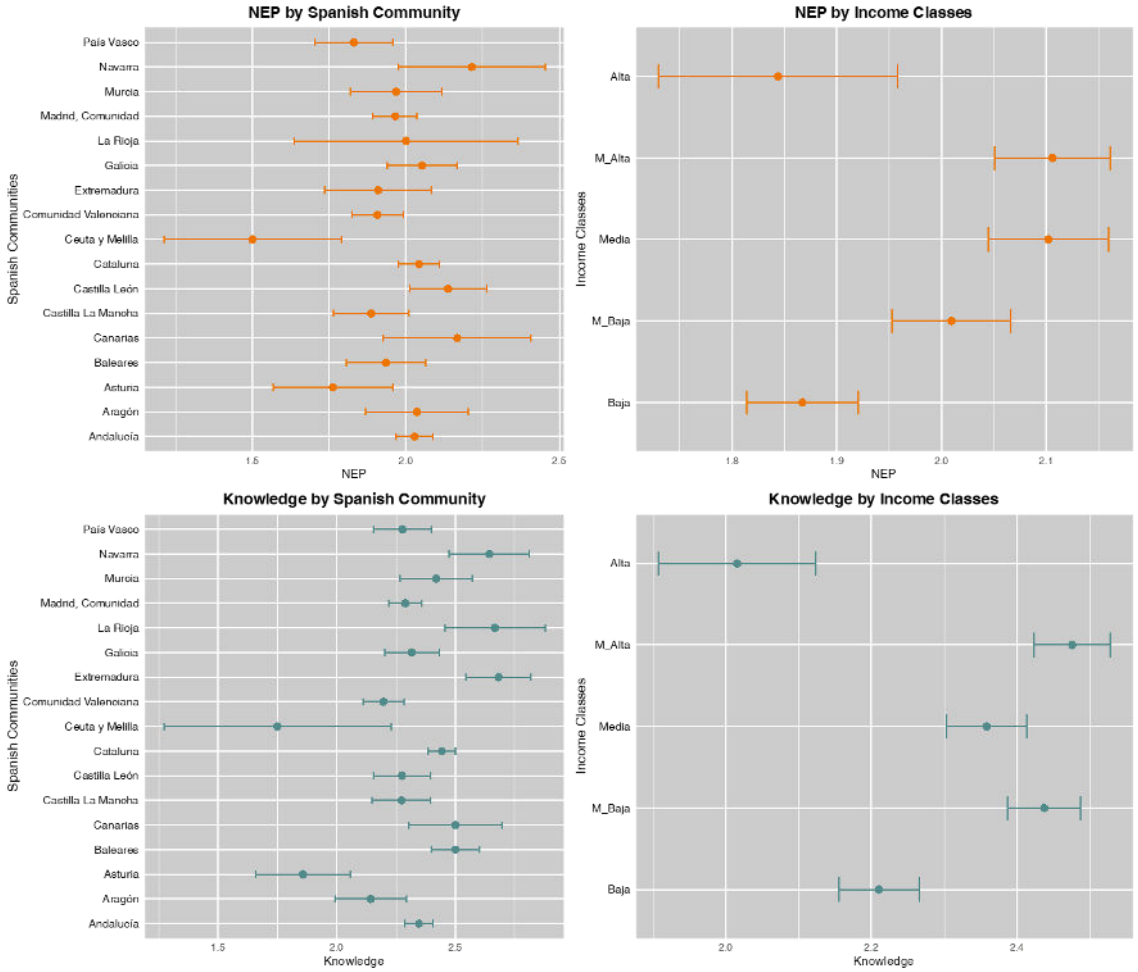
3.1. Individuals' propensity to support (likelihood of supporting) green policy, α_i, depends on their attitudes

Everyone can contribute to fight against climate change. But the personal commitment to protect the climate depends on three major factors: social-psychological factors affecting a person's perception of climate change; the perception of climate policy and its design; and contextual factors. We have revised the data from the RIE survey (Lázaro Touza *et al*., 2023) according to the three factors mentioned above.

The original data set (2019) covered only two dimensions (ie, social-psychological factors and contextual factors), hence for comparability reasons we decided to set up the parameters that were common to the two models following the original model. As we did in the previous study, Lipari *et al*. (2024), the main variables selected to build α belong mainly to the first factor, ie, the social-psychological factors and climate change perception. In the questionnaire these factors are captured by two variables: the environmental worldview (ie, measured by Dunlap *et al*., 2000, the New Ecological Paradigm or NEP); and self-assessed knowledge about climate change (ie, self-rated knowledge). These two variables were already present in the work based on the RIE survey (Lázaro Touza *et al*., 2019). In the 2023 dataset there is another psychological factor that could affect people's propensity to support green policy: the beliefs about the exposure to climate change (ie, beliefs about the impacts that climate change have on the respondent).

As shown in the following Figures, the data from 2023 depict a slightly different reality from the 2019 cohort. In 2019 the pro-ecological worldview of survey respondents, measured using the New Ecological Paradigm scale (NEP) by Dunlap (2000) and self-assessment knowledge were uniformly distributed among Spanish regions and income classes. According to the most recent data, the three previous variables are not uniformly distributed among the citizens of the survey, considering regional and income distribution. In Figures 5 and 6 the bar plots report the mean values of NEP, Green Knowledge and Exposure, along with their Standard Error bars. Overall, we can see that in the data of 2023 both NEP and Knowledge are slightly lower than the data gathered in 2019.

Figure 5. Distribution of the two main variables used to build the green propensity (α), with respect to income and regional distributions

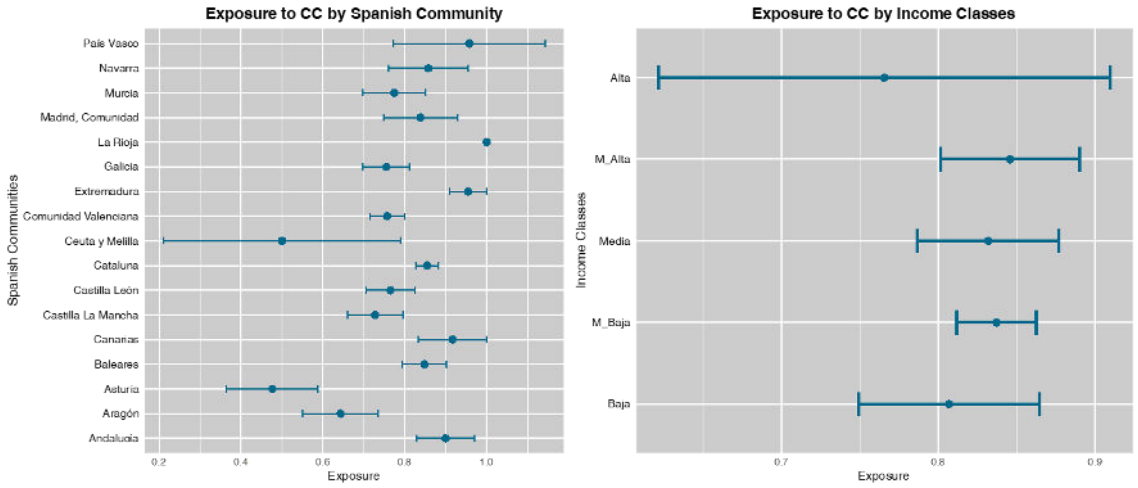


Source: the authors.

We note that these plots look somewhat different from our 2019 results. However, the statistical analysis, presented in Figure S1 in Section 1 of Appendix 1, shows that knowledge and NEP are uniformly distributed across income class and regions. The graphical difference could be due to some random differences in the sample distribution of income classes or regional distribution (though the sample, as a whole, is representative of the Spanish population). Consequently, we can maintain the assumption of a uniform distribution of initial α, but we also run a simulation with a hump-shaped α, as a robustness check.

In the following Figure we display the third variable used to build α, that is, the perception of exposure to climate change. We present the perception of exposure to climate change according to region and income classes.

Figure 6. Distribution of the third variable, used to build the green propensity (α), with respect to income and regional distributions



Source: the authors.

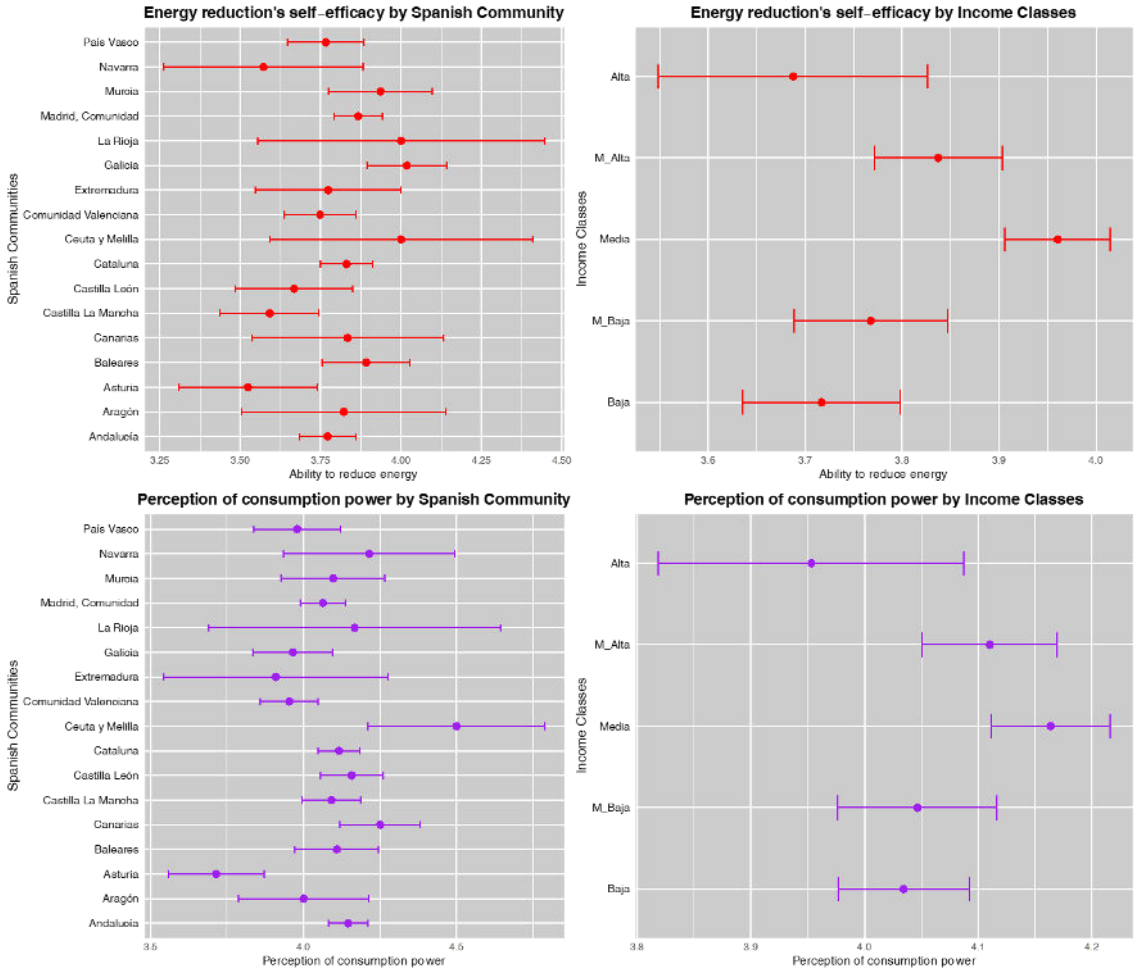
Exposure is a dichotomous variable, and it is believed to be very high regardless of income class or regional distribution.

Thus, we run the simulation considering the three variables to construct α. For initialising α, we used two types of distribution: first, uniform, and second, hump-shaped (reversed U-shaped, where high- and low-income classes have the smallest α). The overall effect of the initial distribution of α does not have an impact on the final results (see Section 2 of Appendix 1, for the hump-shaped initial α). The initial distribution of α does not have an impact on the final citizen propensity to support (likelihood of supporting) green policy, because the dynamic is powered by peer effects, self-efficacy and income effects of the proposed policies.

3.2. Individuals' self-efficacy, β, still depends on income

Citizens' self-efficacy perception, $\beta_{i,t} \in (0,1)$, is the belief that they have material and cognitive capacity and control to understand the consequences of the policy and implement the new behaviour defined by the policy. As we did in the previous work, the two variables selected to build β are: on the one hand, the perception of being able to consume less energy and, on the other, the perception that by changing consumption behaviour individuals can help climate-change mitigation. In 2023 an additional dimension of self-efficacy was recorded: whether survey respondents thought they could reduce water consumption. This was not considered in the simulation for comparability reasons, as the water consumption statement was not included in the 2019 survey. In future simulations we would like to extend self-efficacy to include other dimensions (eg, water). Figure 7 shows how the variable used to build β are distributed according to income class and region.

Figure 7. Distribution of the two main variables used to build the self-efficacy index (β), with respect to income and regional distributions



Source: the authors.

The bar plots report the mean values of energy and consumption reduction, and their Standard Error bars. Overall, we noted that in the data of 2023 both perceptions of self-efficacy are slightly lower than the data gathered in 2019 and there is more heterogeneity with respect to the income class with which respondents identify. Therefore, we run the simulation with two types of distribution for initialising β: uniform, first, and hump-shaped (reversed u-shaped, where high and low-income class have the smallest α), secondly.

3.3. Peer effect vs citizen engagement, ϕ (active links): peer pressure exists if people engage in discussion with others

Lipari *et al*. (2024) found that peer pressure (σ) was one of the main variables affecting the evolution of individuals' propensity towards a green policy (their likelihood of supporting green policies). We showed that even for $\sigma = 0.25$ (when agents are exposed to low peer pressure), in most of the scenarios the peer effect already had an impact on the acceptance of climate policies. One assumption of the model was that σ was the same for the whole population. In the 2023 data we have the possibility of diving deep into the peer effect. We have the possibility of inserting heterogeneity in peer pressure. From the data we have a variable, C5, that we will call from now on *citizen engagement*

ϕ_i, that measures how many people in the outer social circle (ie, friends and colleagues) each respondent engages with in discussions about climate action. Question C5 is formulated as follows:

'If you think about your family, friends and co-workers are there any that talk about what each of us should be doing on a day-to-day basis to slow climate change?'

If σ measures the intensity of peer pressure that an agent is exposed to, ϕ_i measures whether people are talking to their neighbours or not about climate action. The first parameter measures the potential to speak, while the second measures active speaking. Responses to question C5 shows that the majority of respondents (60%) engage in discussions related to climate action but only 40% engage with their outer circle (friends and work colleagues). This evidence shows that, even if such a majority might have a positive α, they do not engage widely with others in their outer circle (friends and colleagues) in talking about what each of us should do to address climate change, limiting the respondents' potential to change other people's minds.

We built the citizen engagement variable as $0 \leq \phi_i \leq 1$ where:

- ϕ = 0: I do not speak at all about the topic with my outer circle
- ϕ = 1: I speak with colleagues and/or friends (the outer circle of my social network)

The citizen engagement mechanism tries to measure to what degree we engage with a diverse social network: talking to family members or partner is not considered in ϕ_i, since these connections relate to strong ties, while the connections in the outer circle (ie, friends and colleagues) are considered weaker ties. In this way we implement the Granovetter's theory of weak ties as the main driver for information spreading/social influence.

Figure 8. How we implement the interaction between peer pressure and citizen engagement

	$\sigma = 0$	$\sigma = 0.25$	$\sigma = 1$
$\phi = 100\%$	Lipari *et al*. (2024)	Lipari *et al*. (2024)	Lipari *et al*. (2024)
$\phi < 100\%$	New simulation	New simulation	Not included

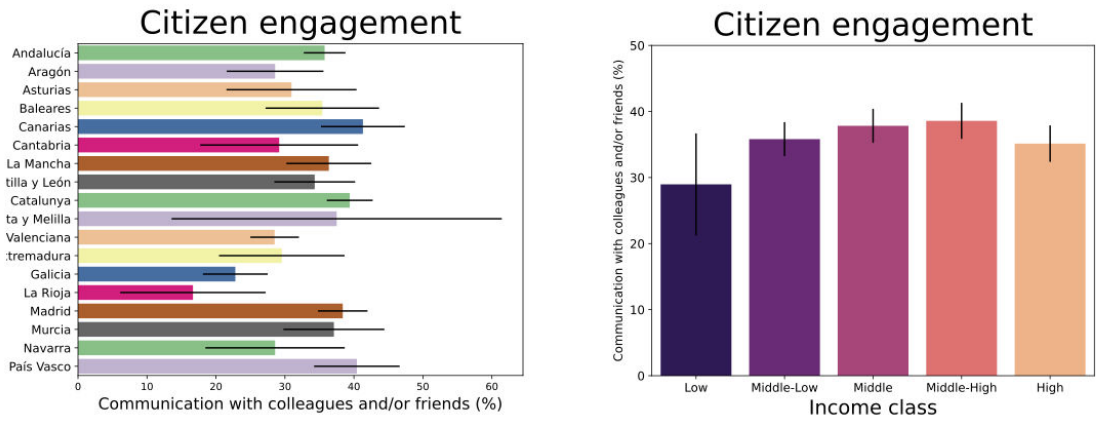
Source: the authors.

Lipari *et al*. (2024) implemented simulations with all the agents connected ($\phi = 100\%$) while changing the degree of peer pressure (σ). We have also seen that mild peer pressure, $\sigma = 0.25$, had a positive effect on policy support (ie, higher levels of σ did not significantly change policy support). Thus, in the new model we did not consider high levels of peer pressure, and we focus more on the absence of intensity, $\sigma = 0$, and on mild intensity, $\sigma = 0.25$. Of course, having $\sigma = 0$ is equivalent to saying that an agent has no active neighbours with whom to engage ($\phi = 0$).

The implementation of the *citizen engagement* mechanism requires changing the set of neighbours that each agent has in the simulation. Hence, it has an impact on the way we initialise the social layer (ie, initialise the neighbours of each agent). Structurally, the social network for each agent will change with respect to the original work. We are differentiating between agents who can have, now, active links within their social network. We assume that the entire set of neighbours of an agent is composed of a portion of active links and a portion of inactive links ($\eta_i = \eta_i^{(a)} + \eta_i^{(\mathrm{na})}$). An agent is engaged at $\phi_i, = 0.3$, meaning that agent i only has 30% of active links and hence only talks to 30% of his neighbours.

The data show that, overall, ϕ_i is on average around 0.3-0.4, very mild. This means that even though people might have a very high green propensity (likelihood of accepting climate policies), either because they are individually inclined to accept these policies or because they are mildly pressured by their peers to accept them, if their engagement with their outer circle is low, their own propensity to accept climate policies alone could have a limited impact on the global/social propensity to support (likelihood of supporting) a specific policy. Additionally, ϕ might be differently distributed among citizens. The following Figures show how ϕ_i is distributed among income classes and regions.

Figure 9. Distribution of citizen engagement (ϕ_i) with respect to income and regional distributions



Source: the authors.

Citizen engagement is not the same for the entire population. In order to show this heterogeneity, we run the chi-squared test that measures the association between ϕ_i and the two main contextual variables, regional residency and income classes. The test shows no statistically significant association (p-value = 0.88) for the regional distribution, while it shows a mild statistically significant association (at 10%, p-value 0.096) for income distribution.

Thus, the new simulations are run according to the following set-up:

First, we fix $\sigma_i = 0.25$ for the whole population[2], then we run the simulation considering such heterogeneity driven by ϕ_i. We run two types of simulations:

- ϕ_i, is the same for all agents.
- ϕ_i, is distributed differently by income class (see the results in Appendix 3).

We found that the effect of the two types of distribution does not, qualitatively, modify the final support for green policy.

3.4. Policy preference and scenarios: from regressive to progressive green policies the support changes according to geographical location and income class

This paper focuses on three main policies scenarios: regressive; progressive; and middle policies. The choice is justified by studying respondents' policy preferences as recorded in the 2023 survey (Lázaro Touza *et al*., 2024). First, with all the questions related to respondents' green policy preferences we have computed an index, the *Green Policy Index* that combines different policy measures (from command and control to regulation and fiscal measures) whose range is defined between 0 and 100%:

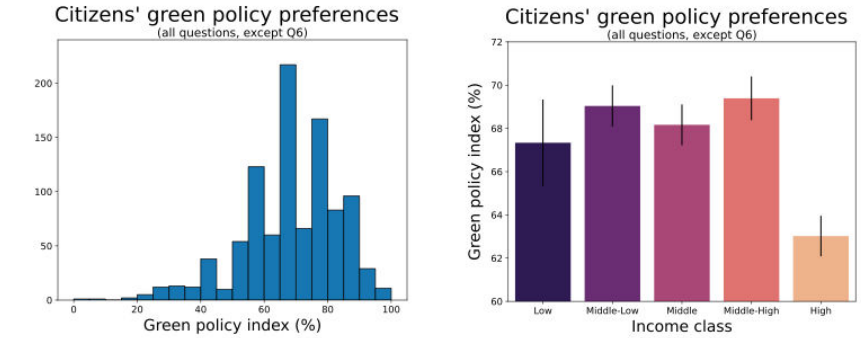
- 0= means that respondents do not support any type of measure.
- 100= means that respondents support a mix of all the policy instruments.
- Intermediate values= means that respondents support a specific combination of policy measures.

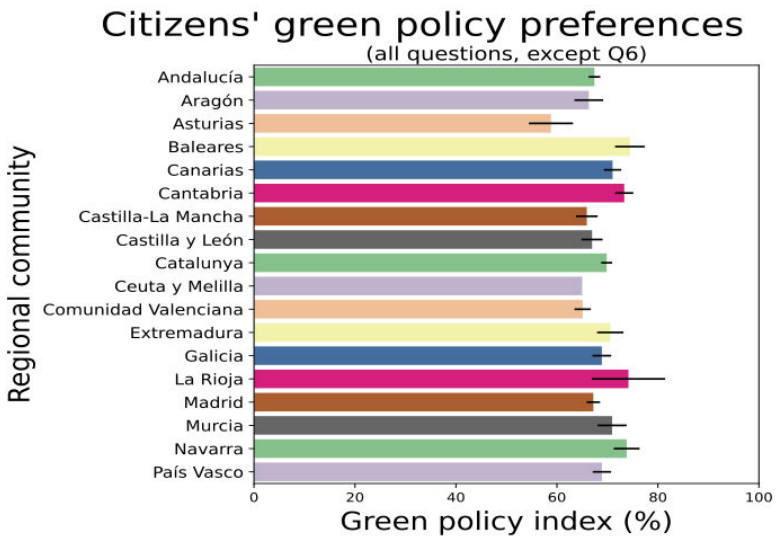
We have used the policies that had an impact of individuals' income or consumption patterns, exacerbating economic inequality (E1.1-E1.11)[3] and left out the question (E1.6) eliciting citizens' preferences about the extension of a nuclear plant under the assumption that expanding the lifetime of nuclear power plants would not significantly impact the perception of fairness. See Appendix 3 for a summary of policy preferences.

The construction of the index is internally consistent according to the Cronbach's Alpha (0.8478). We have inverted the polarity of E.1.5[4] and E.1.10 (allocating a higher score to responses that disagreed or strongly disagreed with these statements), since agreement with these statements implied supporting emission augmenting actions. The following Figures present the overall distribution of the index, and its distribution with respect to income class and regional distributions.

[2] We do not run a simulation for $\sigma = 0$, because it is equal to say that an agent has no active neighbours with whom to engage ($\phi = 0$).
[3] See Appendix 3 for a full list of policy statements.
[4] Note that statement E.1.5 is 'we should be able to continue using cars like the current petrol and diesel ones, even if that means increasing pollution and emissions' and statement E.1.10 is 'Spain should exploit all of its resources (coal, oil, gas and minerals) even if this increases emissions and pollution'.

Figure 10. Distribution of the index 'citizens' green policy preference' and with respect to income and regional distributions



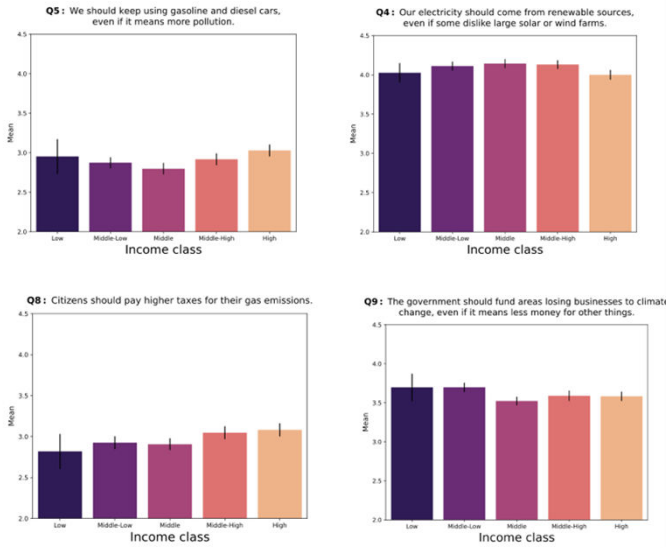


Source: the authors.

As in the previous paper, in the new model we have also implemented different policy scenarios. However, instead of looking at all the previous six (no green policy, uniform, bimodal, regressive, middle and progressive), we have checked in the data if agents have preferences over specific scenarios. We found out that agents do have preferences. Overall, all the questions on policy preferences report a mild acceptance of the proposed policies, and this acceptance is uniformly distributed amongst income classes (see Appendix 3), except for four policies where support depends on the respondents' income. These are E.1.4, E.1.5, E.1.8 and E.1.9,[5] which are good examples of specific regressive, middle and progressive policies. The following Figures show the association between the respondents' preferences and the income class they belong to.

[5] E.1.4. is 'The electricity we consume should come from renewable sources, even if some people don't like large solar or wind installations'; E.1.5 is 'we should be able to continue using cars like the current petrol and diesel ones, even if that means increasing pollution and emissions', E.1.8 is 'Citizens must pay more taxes for our greenhouse gas emissions.' And E.1.9 is 'The government should invest in areas that lose business due to climate change or policies to fight it, even if that means less money for other things'.

Figure 11. Distribution of the main policy scenarios (regressive, middle and progressive) with respect to income classes (in brackets)



Source: the authors.

4. Research questions and set-up of the model

Five research questions are addressed:[6]

(1) Does citizen engagement matter to enhance support for green policies?

(2) Does citizen engagement impact regions differently?

(3) How does self-efficacy in a given income class affect the likelihood of climate policy acceptance?

(4) How do social and political institutions co-evolve?

(5) To what extent are public attitudes toward climate policies affected by social norms and self-efficacy?

4.1. Analytical model

With respect to the original model, we have changed only one equation:

$$\alpha_{i,y+1} = \begin{cases} \gamma \left[(1-\sigma)\alpha_{i,t} + \sigma \dfrac{\mathbf{1}}{\left|\boldsymbol{\eta}_{\boldsymbol{i}}^{(\boldsymbol{a})}\right|} \displaystyle\sum_{\boldsymbol{j}\in\boldsymbol{\eta}_{\boldsymbol{i}}^{(\boldsymbol{a})}} \boldsymbol{\alpha}_{\boldsymbol{j},\boldsymbol{t}} \right], \text{during peer pressure stage} \\ \alpha_{i,t} + r_{p,y}\left[\alpha_{i,t}\left(1-\alpha_{i,t}\right)\right]\beta_i \text{ , during policy stage} \end{cases}$$

[6] The first three research questions are novel to the updated model in this Working Paper and the last two were analysed in the original paper. In the current paper we only checked that the results obtained in both papers were consistent. Figures are available in the Appendix.

Where $\phi_i = \frac{1}{\left|\eta_i^{(a)}\right|}\sum_{j\in\eta_i^{(a)}} \alpha_{j,t}$ and $\eta_i^{(a)}$ is the subset of active links that agent i has. In the previous paper we had a simple average behaviour of the agent's neighbours.

4.2. Network structure

The social network layer includes 10,000 nodes, representing citizens from the 18 regions of Spain divided into five different social income classes. The political layer includes 200 nodes, representing the seats from the 18 regional governments. The links between citizens are created using the stochastic block network model (Holland *et al.*, 1983), tuning (establishing?) connection probabilities between citizens to have an average individual node degree of about 10, as suggested by the literature (Hu & Wang, 2009).

4.3. Simulation parameters

The initial input data comes from the 2023 RIE survey that has collected information from 1,000 Spanish adults (≥18 years old) through phone interviews. The data come from stratified sampling by Autonomous Communities, applying sex and age quotas proportional to the distribution of the population in Spain and proportional to the distribution of the population in each of the strata (Lázaro Touza *et al.*, 2024). The distribution of agents in the social layer per community follows Spain's demographical data while income class distributions follow the survey data from Elcano. The distribution of seats, by community, follows the political data from Araujo (2011), while the colour distribution, by community, depends on the survey data. There are two possible colours for political representatives (seats), green for those who support green policies and brown for those who support non-green policies. The original number of seats is 1,258. In the model it is normalised to 200 seats. Simulations were run with 10,000 individuals and 200 political seats. Different scenarios were considered to analyse the role of different policies and their interaction with income classes and different levels of redistribution of the revenue from a carbon tax: progressive, middle and regressive scenarios.

The strength of social influence (σ) determines how the propensity of agents, α_i, react to changes in propensity in their social network. To study the role of peer pressure or social norms on the evolution of α and on the stability of a green policy we focused on two values of σ: σ = 0 (absence of peer pressure) and σ = 0.25 (low peer pressure). We also study the effect of citizens' engagement through ϕ: $\phi = 0$, no engagement with the outer circle, and $\phi = 1$, strong engagement with the outer circle.

The new results based on the interaction between α_i and ϕ, when σ = 0.25 are as follows.

For the social layer, we generated undirected networks of 10,000 agents with approximately 50,000 links, which results in a mean degree of about 10. The analysis unfolds as follows. First, we run six policy scenarios (one for no green policy, and the five green policy scenarios) with full self-efficacy, (ie, when β = 1). We compare, for a specific policy, the consequence of peer effect on the global evolution of agents' support for green policies. Secondly, we compare the six policy scenarios and their support by

looking at different revenue distribution strategies. The support for specific policies is driven by both income effects linked to each specific policy and peer effects. At the same time, we study how the design and support for each policy influence the final number of green seats. Finally, we show the effect of self-efficacy on the overall system evolution.

The model has been developed by relying on the agent-based approach (Epstein, 2012; Farmer, 2009), because it allows us to fully consider the heterogeneity of our agents, their boundedly rational updating behaviour, and the complex interactions among the networks that compose the artificial economy under investigation, without imposing any analytical restriction, as the traditional approach to economics requires (Fontana, 2010; D'Orazio, 2019; Stiglitz, 2018).

We report average results over 100 runs for each combination of parameters. Replications of identical policy combinations generally varied only slightly –due to stochasticity– underpinning the high robustness of the results. The considered time span for the simulations is 1,000 steps, for a total of 10 seat elections.[7] We begin the simulation with the election of political seats, which are re-elected every 10 implemented policies. Between the implementation of each policy 10 peer influence steps are implemented.

5. Results

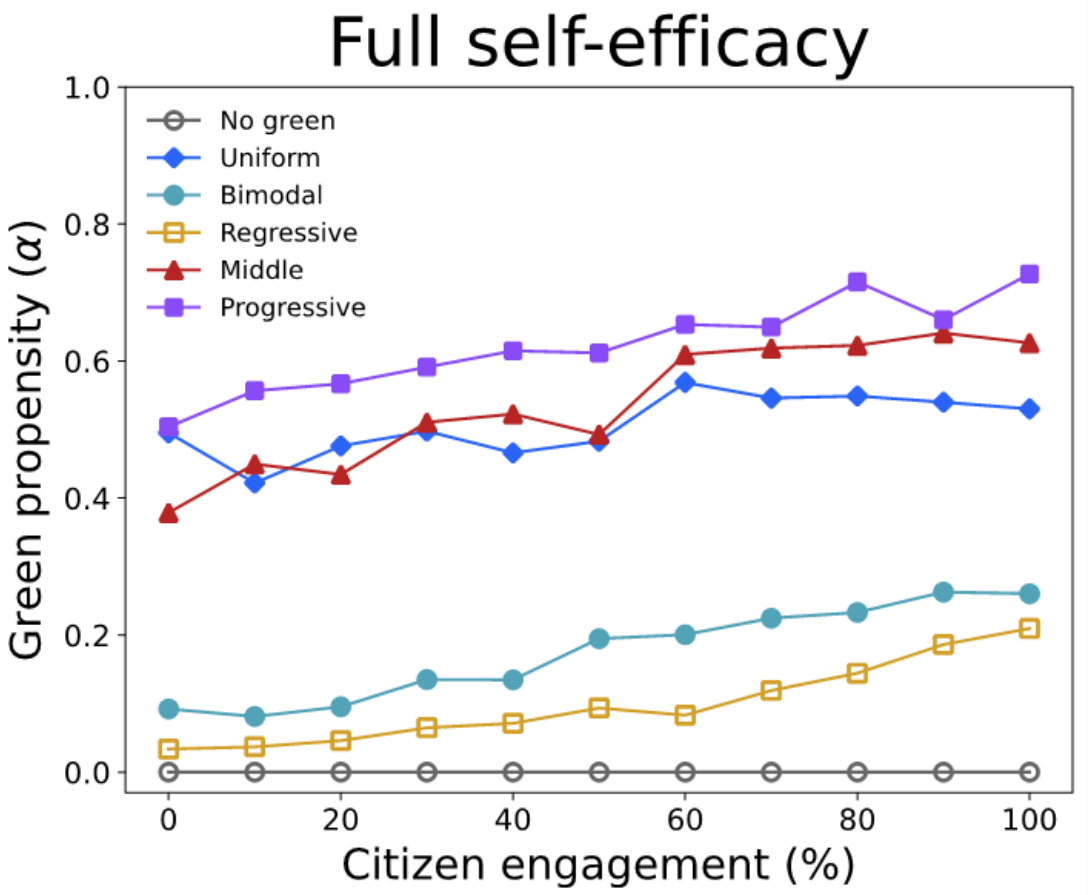
Research question 1: does citizen engagement matter to enhance support of green policies?

Active engagement matters for the support of green policies. Lipari *et al*. (2024) saw that even low levels of peer pressure were enough to increase the likelihood of supporting green policies. In this new model, we further study the effect of peer pressure on climate policy support, trying to show that such a mechanism has a higher impact if citizens not only tend to feel the pressure from their neighbours, but if they actively take a stance on the climate debate. We have introduced a new mechanism called *citizen engagement* (ϕ_i), that measures the number of people each respondent engages with when discussing climate action in their outer social circle (ie, friends and colleagues). If σ_i measures the intensity of peer pressure that an agent suffers, $\boldsymbol{\phi}$ measures whether people are talking to their neighbours or not. Here we present the results from modelling $\boldsymbol{\phi}$, the same for all agents.

The following Figure shows the different levels of policy acceptance (α) of each policy scenario for different levels of engagement (ϕ) and assuming full self-efficacy (ie, $\beta = 1$) and $\sigma = 0.25$.

[7] The seats are assigned through probabilistic rule per community. At the community level, we compute the α_c of the community and we associate the number of seats. Eg, if Andalusia, from the simulated data, has an average α_c =0.4, hence 40% of its seats (seven out of 18 seats), on average, will be green-friendly.

Figure 12. Effect of self-efficacy on green propensity for all policies and peer influence



Source: the authors.

The Figure shows the evolution of green propensity for each policy scenario, at different levels of σ, in the two cases where self-efficacy is considered the same for all income classes.

Overall, the initial level of green propensity is lower than the 2019 data (about 0.05 less), a finding that is aligned with the recently observed lower appetite for climate policies in the EU. Another immediate difference is that as citizen engagement (ϕ) increases (ie, as the number of active links in respondents' outer circle increase) the likelihood of accepting climate policies increases in five out of six policies. The more I engage with my peers, the more I spread my opinion, which results in an increase in the likelihood of green policy acceptance at the global (population) level while reducing pluralistic ignorance. Hence, exposure and engagement are the key to reducing the perception gap induced by pluralistic ignorance. As Andre *et al*. (2024a) propose in their paper 'raising awareness about the broad global support for climate action becomes critically important in promoting a unified response to climate change'. In this Working Paper we show the channels through which awareness can be fostered.

As seen in Lipari *et al*. (2024), the type of policy affects both the initial level and the evolution of an individual's support for green solutions. Hence, the policy analysis shows that highly *progressive* policies (ie, policies that benefit low-income classes) and the

uniform ones (ie, policies that impact equally on all income classes) start off with a higher initial α and are more able to maintain that higher support across income classes. Nevertheless, the uniform has a jagged evolution as ϕ increases. The *middle* policy, though it starts at a lower level with respect to the progressive and the uniform, quickly catches up with the progressive policy for a level of engagement $\phi > 0.5$. Overall, the $\phi > 0.5$ seems to mark an increase of policy acceptance for most scenarios.

Hence, the data show that Spaniards have a degree of citizen engagement of $0.3 \leq \varphi \leq 0.4$, that is lower than the one that the simulations show to be desirable, ie, $\phi > 0.5$ to significantly increase climate policy acceptance. In other words, the more people engage with their social circle (the more people they talk to) the higher the likelihood of accepting climate policies. Therefore, it is not enough to have a moderate sensitivity to peer pressure, it is also key that social connections are active, and that people engage as much as possible with their outer social circle in talking about climate action to increase the global acceptance of green policies. Hence, policies that increase engagement could have beneficial effects on the likelihood of accepting climate policies.

In Appendix 4 we run a robustness check on the effect of citizen engagement when we allow the engagement to be distributed differently, ϕ_i, for income class (hump shaped: higher for the middle class and smaller in low and high incomes). The results remain consistent. Qualitatively, there are no large differences between the unbiased and biased distribution of the citizen engagement parameter on the global green propensity.

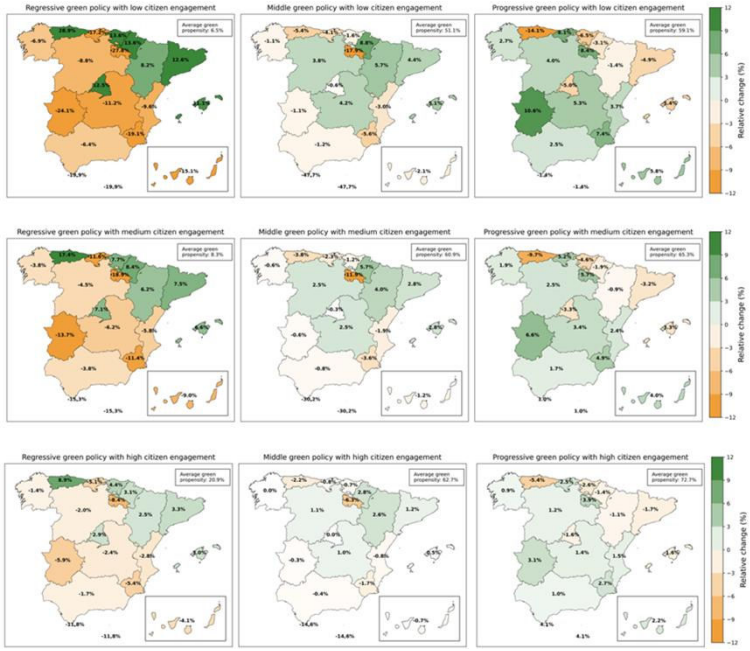
Policy Lesson 1: active engagement matters for the support of green policies.

Recommendation 1: design policies and provide spaces for citizen engagement.

Research question 2: does citizen engagement impact regions differently?

The discussion on the implementation of national mitigation policies needs to consider the regional differences within a country. Whenever we zoom in on regional green policy support, what was valid at the national level need not represent regional support. After all, income inequalities, social norms and green propensity (the likelihood of accepting green policies) exist not only at a national level but also at a regional level, and the reaction of individuals is mediated by their regional institutions and capabilities. Figure 13 shows the regional differences under three main policies (regressive, middle and progressive), when peer pressure is mild ($\sigma = 0.5$) and in three different scenarios of citizen engagement (low, medium and high).

Figure 13. Regional green propensity variation for three main policy scenarios (ie, regressive, middle, and progressive)



Source: the authors.

The regional green propensity variation is computed as the normalised difference between the average regional green propensity and the average national green propensity. Positive variations are colour coded with green while negative variations are in orange. Peer pressure (σ) was set at 0.25, but similar results were obtained for other values. We plot three different scenarios for citizen engagement: high, medium and low.

We report the normalised relative differences between the final green propensities by community and the national average green propensity. As can be seen, the latter is not uniformly distributed across communities since some of them react more positively to specific policies than others. If the policy effect is more homogeneous across communities, the final Spanish map displays a great portion of light grey areas. If the policy effect is heterogeneous across communities, then we can observe polarised scenarios.

As was the case in Lipari *et al* (2024), the regions which are, on average, poorer are those most negatively impacted by the regressive policy and, consequently, their final level of green propensity tends to be lower (eg, in the first line of Figure 13 where citizen engagement is low, Extremadura is the most negatively impacted region by the regressive policy, with a likelihood of supporting the green policy being 24,1% lower compared with the average national green propensity). On the other hand, regressive policies benefit the regions that are richer (eg, northern and eastern regions are greener than the others, indicating a higher likelihood of supporting green regressive policies compared with the national average).

One striking result is that for any policy scenario, higher citizen engagement reduces the difference between regional and national likelihood to accept climate policies while maintaining the sign of the variation (eg, Extremadura, in the regressive scenario, goes from a -24.1% with low engagement to a -5.9% with high engagement). Hence, heterogeneity at the regional level still indicates the importance of running analysis not only considering the average national likelihood of accepting climate policies. At the same time, the results of the effect of the degree of citizen engagement raises a further question: how do we increase citizen engagement at the regional level?

Policy Lesson 2.1: policies affect poorer and richer regions differently, as expected, but progressive and middle green policies (that benefit the middle classes more) garner greater support (or less negative variation vis-à-vis national green propensity).

Recommendation 2.1: policy design should be tailored towards progressive or middle green policies to enhance climate policy acceptance in Spain.

Recommendation 2.2: developing a comprehensive taxonomy of the needs of society based on regional socio-economic and cultural indicators —and examining how these categories align with political orientations and climate perspectives— is essential for crafting effective and inclusive climate policies. The taxonomy could feed into the soon to be updated Just Transition Strategy.

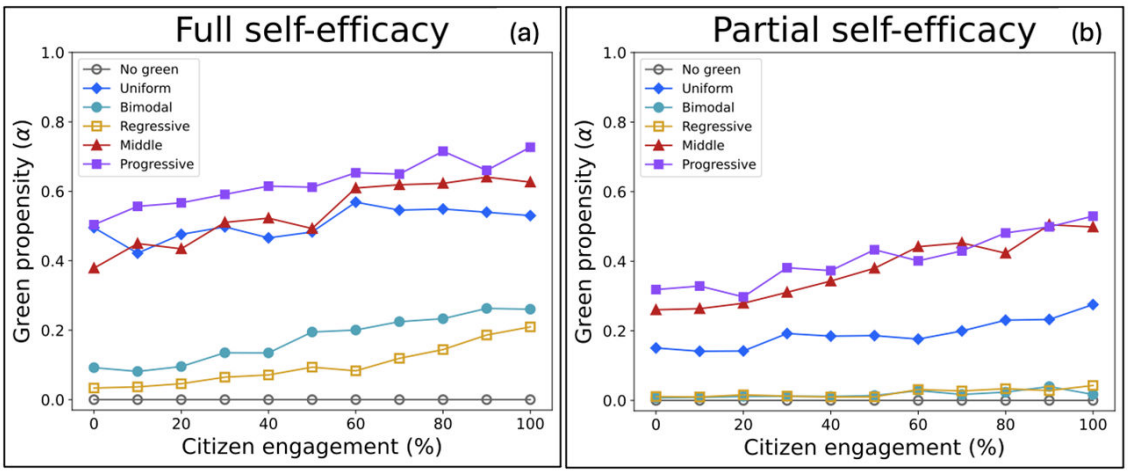
Policy Lesson 2.2: citizen engagement reduces the differences between regional green propensity and national green propensity across policies.

Recommendation 2.2: enhanced citizen engagement could limit the need for heterogeneous (regionally tailored) climate policies.

Research question 3: how does self-efficacy in a given income class affect the likelihood of climate policy acceptance?

In our model self-efficacy β is introduced during the policy stage. When a new policy is implemented, that is the time in which people need to change their behaviour and update their beliefs about their capability to act. If their 'carbon (action) capability' (Whitmarsh *et al.*, 2011; Hampton & Whitmarsh, 2024) is scant (ie, self-efficacy tends to zero) the acceptance of the green policy will fall. This is the result that we see in the two panels in Figure 14.

Figure 14. Effect of self-efficacy on green propensity for all policies and peer influence



Source: the authors.

Figure 14 shows the evolution of green propensity for each policy scenario, at different levels of σ, in the two cases where self-efficacy is considered the same for all income classes (a) and where β is decreasing as the income classes decrease (b).

Figure 14 (b) shows the evolution of the green propensity (α) in all the policies when self-efficacy is heterogeneous across income classes. Heterogeneity in β is modelled considering that as we go down the social ladder, from high-income to low-income classes, the competence of individuals decreases, as shown in Figure 5. As in the original work, the effect of heterogeneous self-efficacy does not have an impact on the ordering of policies, ie, α in middle and progressive green policies are still ranked higher than their more regressive counterparts, but the initial level of α and subsequently its evolution are, across all policies, lower than in the scenario in which there is full self-efficacy (β) across income classes.

Figure 14 shows that the higher the citizen engagement, the higher the evolution of green propensity (α) for the uniform, progressive and middle policies. Though the gap between the uniform scenario and the more progressive policies increases as the level of engagement increases; whereas for three scenarios (no green, bimodal and regressive) the green propensity disappears, no matter the level of citizen engagement when there is partial self-efficacy. As was the case in Lipari *et al*. (2024), assuming full self-efficacy is detrimental for the estimation of the green propensity of the population. Hence, the assumption of a homogeneous (full) self-efficacy, that assumes people would understand perfectly all the features of a policy and will be empowered to act, would lead to wrong estimations of final climate policy acceptance.

A mix of policies or interventions to increase self-efficacy and citizen engagement is desirable to enhance climate policy acceptance. These policies could additionally reinforce each other. According to the theory of the *spiral of silence*, cited above, low self-efficacy could be seen as a possible variable feeding the spiral. According to the spiral of silence theory people observe their social environment in search for opinions and are less likely to express their views if they feel they are not widely shared, especially on controversial issues. Consequently, people with low self-efficacy would reason as

follows: I do not perceive myself in the capacity of following the policy, hence I will not engage in discussions related to green policies. Such denial to discuss, in turn, would increase their own pluralistic ignorance and that of their neighbours.

Thus, it is fundamental to act on a double front: self-efficacy and engagement. On the one hand, we need to intervene on self-efficacy for people to feel empowered to make robust decisions. In the previous paper (Lipari *et al*., 2024) we identified some interventions for increasing self-efficacy, like the boosting policies that aim to increase self-efficacy (β) by fostering existing competencies or developing new ones, such as financial and energy literacy, and enhancing deliberative capabilities (Hertwig & Grüne-Yanoff, 2017). On the other hand, we can think of interventions for increasing engagement, ie, people engage as much as possible with their neighbours in discussing climate action to reduce their pluralistic ignorance with respect to their social circle and, in turn, increase the global acceptance of green policies.

Policy Lesson 3.1: policy acceptance is higher with full self-efficacy, although policy ranking remains unchanged.
Policy Recommendation 3.1: support capacity building initiatives that will enhance climate policy acceptance.

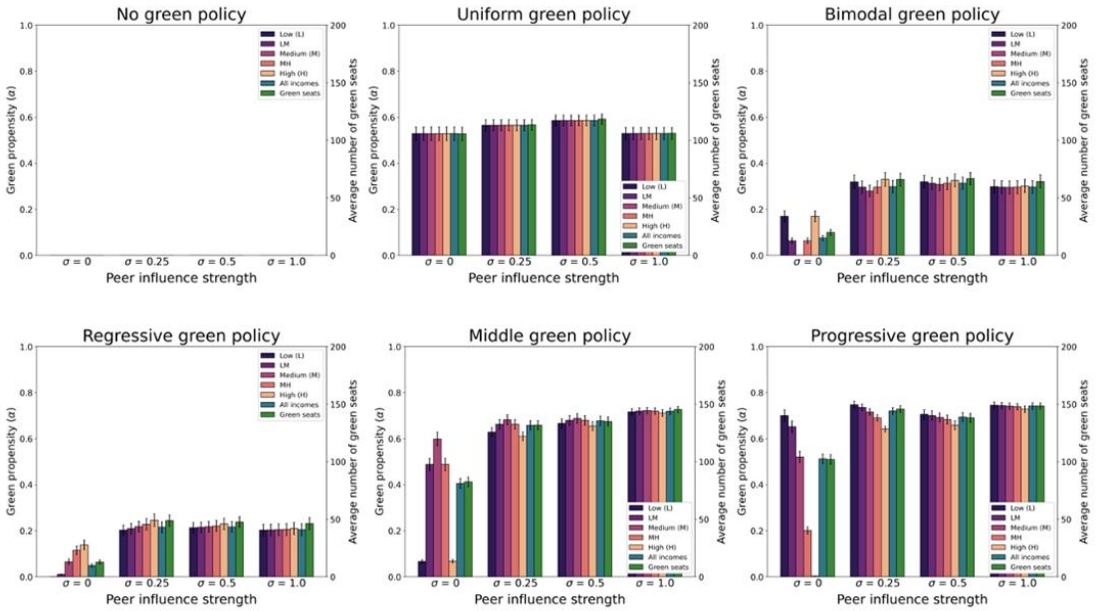
Policy Lesson 3.2: assuming full self-efficacy when there is partial self-efficacy leads to overestimating the likelihood of accepting climate policies.
Policy Recommendation 3.2: collect data on the heterogeneity of citizen self-efficacy and on the extent to which citizens are able and willing to undertake climate action to tailor policy design to the existing level of self-efficacy. Undertake a granular analysis of regions and neighbourhoods that could policy-relevant information on people's climate policy acceptance.
Policy Recommendation 3.3: a mix of policies or interventions that could increase the self-efficacy and the engagement of citizens are desirable. They both could reinforce themselves.

In what follows we display the replication of the results of the original work (Lipari *et al*. 2024), using the new set of parameters according to the updated data from the 2023 survey to conduct a robustness check. This analysis corresponds to research questions 4 and 5.

Research question 4: how do social and political institutions co-evolve?

Research question 5: to what extent are public attitudes toward climate policies affected by social norms and self-efficacy?

Figure 15. The effect of green policies and peer influence on citizens' green propensity and the number of green seats



Source: the authors.

Each panel in Figure 15 represents the final average level of α and the final number of green seats for each policy implementation and for different degrees of peer pressure. When σ =0 peer pressure is absent, for σ =0.25 agents are exposed to low peer pressure, when σ =0.5 peer pressure is mild, and when σ =1 neighbours' influence is strong. Averages and standard errors are reported.

The results, coming from the new model using the new data, are consistent with the results in the original paper. A mild level of peer pressure is sufficient to change the overall distribution of green propensity among income groups. The peer effect modulates the income effect. Whenever the peer effect is null, the response to the policy is driven only by the individual propensity and the income effect relative to the policy. We also observe a co-evolution between social and political institutions. The comparison between the scenario 'No green policy' and the remaining scenarios shows the effect that a brown policy alone (eg, subsidising fossil fuels) has on the evolution of people's green propensity. Whenever the political network does not show any interest in promoting mitigation policy, the strength of green propensity dissipates, at any level of peer pressure, and the political green seats practically disappear in all simulations.

Policy Lesson 4.1: the absence of green policies and regressive policies erode the likelihood of green policy acceptance, independently of the level of peer pressure.
Policy Recommendation 4.1: ensure progressive climate policies remain in place to enhance green propensity.

A corollary of this result, that is outside the scope of this paper, would be to analyse whether political discourse that is ambiguous has the same impact as the absence of a green policy or the design of regressive ones. A recent policy paper from Ecco, an Italian think tank[8] showed that a narrative and a political strategy very randomly organised that gives society information disjointed from the overall picture contributes to the general feeling of helplessness and eco-anxiety, that, in turn, impact citizen engagement and support for green policies.

6. Conclusions and policy implications

This Working Paper aims to understand the extent to which attitudes towards climate policies with asymmetric impacts on the population are affected by citizen engagement, perceived self-efficacy and place of residence. The goal is to uncover ways to strengthen public support for mitigation policies and bridge the gap between citizen concern, attitudes and intentions about climate change and their behaviours. This concluding section summarises the main results and derives some policy implications.

The results from the new simulations are robust when compared with the conclusions of our previous work (Lipari *et al.*, 2024). Policy design that assumes all individuals possess similar capacities, or that regional disparities do not matter, will misconstrue policy acceptance. Instead, policies tailored to the specific needs and characteristics of a heterogeneous population, particularly in terms of income disparities or regional distribution, will better assess climate policy acceptance, arguably yielding a greater effectiveness of these policies. By acknowledging and addressing these differences, policymakers can develop targeted interventions that resonate with diverse segments of the population. Of course, in order to do so, more data is needed at both the regional and individual levels through surveys or experiments.

The first research question of the paper was: does citizen engagement matter to enhance support for green policies? The simulations have shown that active citizen engagement with the survey respondents' outer circle (friends, colleagues) matters in increasing their support for green policies, even when peer pressure is mild, making engagement a significant mechanism for delivering a low carbon development model. While not as divisive as other issues, and despite solid scientific evidence, climate change has become the subject of culture wars (Nadal, 2023). Related to this climate culture-war development, the spiral of silence theory could help explain the lack of citizen engagement that offers a unique opportunity to foster climate-friendly behaviour by correcting misperceptions, which is a relatively simple, scalable and cost-effective

[8] See Giulia Colafrancesco (2024), 'My car, my home, my job: how to reconcile climate policies with people's needs', ECCO, https://eccoclimate.org/my-car-my-home-my-job-how-to-reconcile-climate-policies-with-peoples-needs-and-how-to-generate-consensus/.

intervention. At the same time, investing resources in knowing citizens' social networks can enhance climate policy acceptance.

The second research question analysed the regional effect of citizen engagement. The likelihood of accepting climate policies is not uniformly distributed across regions, since some of them react more positively to specific policies than others. Green propensity in poorer regions is positively affected by progressive policy designs and negatively affected by regressive policies, contrary to what occurs in richer regions. It is interesting nevertheless to note that, even in wealthier regions, progressive policies yield a lower difference in green propensity compared with national figures, especially in high engagement scenarios. Citizen engagement reduces the difference between regional and national green propensities, which raises the question of how to increase citizen engagement at the regional level to foster a national consensus regarding climate policies. Scientific information on climate change and climate action (discussed both in national and local media and produced by independent scientific advisory boards)[9] could help drive such an engagement.

The third question was 'how does self-efficacy in a given income class (bracket) affect the likelihood of climate policy acceptance?'. Socioeconomic inequalities negatively affect citizen engagement, eroding support for green policies. The interaction between self-efficacy and engagement suggests implementing targeted complementary interventions to enhance climate policy acceptance.

Our literature review and simulation results suggest several policy implications for enhancing citizen engagement and acceptance of climate policies:

(1) Designing inclusive participation mechanisms such as citizen assemblies and stakeholder dialogues, among others: policymakers could create inclusive and accessible platforms for citizen engagement, ensuring that diverse voices are heard in climate policy discussions. Some key elements of inclusive governance structures are:

   (a) Stakeholder engagement initiatives: involving a wide range of stakeholders, including local communities, NGOs, the private sector, and government agencies, in the planning and implementation of climate policies. One recent initiative in Spain, *Jornadas de escucha y participación: energías renovables y territorio*, entailed organising five meetings at the Ministry for Ecological Transition and the Demographic Challenge on the deployment of renewable resources to understand the challenges and opportunities of this deployment. It convened stakeholders and citizens from the regions where renewable projects are being implemented. The conclusions and recommendations discussed during those meetings, and the development of Just Renewable Transition Contracts (JRTAs) for the deployment of renewables,[10] could be one way to foster social inclusion and acceptance of climate policies.

[9] Such as the one foreseen in article 37 of the Spanish Climate Change and Energy Transition Law.

[10] See Lara Lázaro Touza *et al.* (2025), 'From phasing-out to phasing-in: lessons from Spain's Just (cont.)

(b) Co-production of knowledge: facilitating collaboration between scientists and local communities to integrate scientific research with indigenous and local knowledge. In the IPCC Sixth Assessment Report (AR6) the concept of inclusive governance structures is emphasised as crucial for effective citizen engagement in climate change policies. One of the key points made in the report is the importance of multilevel and inclusive governance to enhance the resilience and adaptive capacity of communities. This approach involves integrating local knowledge and experiences into broader climate strategies, ensuring that the voices of vulnerable and marginalised populations are heard in the decision-making processes. In the EU, the last Horizon programme includes the funding of two EU Missions on climate change: one on adaptation supporting European regions and communities to become climate resilient by 2030, and another on Climate-Neutral and Smart Cities by 2030. These Missions intend to engage citizens by adopting a collaborative approach to climate research and innovation through multi-level governance and citizen engagement. This new approach could be extended to other climate-related research and innovation initiatives.

(c) Leveraging technology: digital platforms and social media can be powerful tools for mobilising citizen engagement and facilitating transparent communication between governments and the public.

(d) Supporting local initiatives: local governments and NGOs could support community-based projects that encourage sustainable practices and foster civic responsibility.

(e) Education and awareness programmes: to address knowledge gaps, governments could invest in public education campaigns that raise awareness about climate issues and the importance of citizen engagement.

(f) Reduce ambiguity in the political discourse: avoid inconsistencies that risk demotivating citizens, especially those less involved in the topic, and those which nullify any kind of positive effort.

(2) Address equity considerations: ensuring that climate policies address the needs of the most vulnerable and marginalised populations and promoting a just transition are key to enhance the acceptance of climate policies (Sgaravatti & Tagliaprieta, 2024). At an EU level, just transition is seen as key to advance on the implementation of climate policies. By June 2025 Member States will have to develop Social Climate Plans to access the EU's Social Climate Fund (endowed with €65 billion,[11] with an additional 25% that must be funded by Member States from the European Trading System, ETS, revenues to reach €87 billion in mobilised funds between 2026 and 2032). This fund will provide further opportunities to support the low carbon transition

Transition governance framework', Elcano Royal Institute, https://www.realinstitutoelcano.org/en/analyses/from-phasing-out-to-phasing-in-lessons-from-spains-just-transition-governance-framework/.

[11] Note that, throughout the Working Paper, billion = 10^9.

in Spain, especially in renovating low-income households and decarbonising the transport sector. One interesting example of the latter is the development of affordable leasing instruments for electric vehicles such as the one implemented in France and whose beneficiaries are low-income households that need to drive more than 8,000km a year (or more than 15km to get to work).

Just-transition initiatives are widely supported by Spanish citizens (Lázaro Touza *et al*, 2024). Spain has developed innovative governance structures such as the Just Transition Institute and the Just Transition Strategy –that is expected to be updated in 2025– and just-transition agreements. Spain additionally foresaw the allocation of €300 million of the National Recovery and Resilience Plan to just-transition initiatives. Continued support and effective implementation of a just-transition strategy are called for to increase climate policy acceptance.

Finally, the Draghi report on EU competitiveness mentions the need for citizen engagement to achieve decarbonisation and sustainable competitiveness. The report argues that in the absence of support, social inequalities might increase, leaving vulnerable households, industries and territories behind and fostering citizen alienation and geographies of discontent (Rodríguez-Posé & Bartalucci, 2024). Accordingly, targeted support mechanisms that improve citizens' climate action capacities will be critical for ensuring that the energy transition is just, inclusive, economically beneficial and socially acceptable.

To stay the course of just transition there are a few key interventions that could be implanted, such as:

(a) Develop a comprehensive social taxonomy: establish a framework that categorises society based on socio-economic and cultural indicators, linking these to political orientations and climate perspectives.

(b) Tailor policies to address diverse needs: recognise that the transition to a low-carbon economy affects different groups in distinct ways, requiring sector-specific solutions.
- Utilise the taxonomy to design policies that directly address the needs of communities in key areas such as transport, employment and housing.
- Ensure that climate policies prioritise equity, preventing the exclusion of vulnerable populations.

(c) Adapt and improve existing policies: use insights from the taxonomy to identify gaps in current policies and develop more inclusive measures where needed.
- Create mechanisms for continuous feedback from affected communities to refine and adjust policies over time.

(d) Keep an eye on the evolution of consensus: establish a monitoring tool to track public support for climate targets at the national and regional levels.
- Use real-time data on public sentiment to help adjust policies, ensuring they remain relevant and widely supported.

- Identify areas where additional public engagement and education are necessary to build a stronger consensus for climate action.

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Appendices

Appendix 1. Initialisation of parameters

In this Section we present the graphical representation and statistical analysis of the main variables of the model.

1. Individuals' propensity to support green policy (α_i)

Figure A1. Association and correlation test for NEP and knowledge with respect to income and regional distributions

Variable	Income	Communities
New Ecological Paradigm (NEP)	**Spearman Test- rho** There is a weak, but statistically significant, monotonic correlation of 5% (**Agreement** with the results obtained in Lipari *et al*., 2024) **Kruskal-Wallis Test** There is a significant difference (at 5%), at least from the comparison between two income classes (eg, low vs middle and low vs middle-high) (**Disagreement** with the results obtained in Lipari *et al*., 2024)	**Chi-Squared test** No statistically significant association between the variables (**Agreement** with the results obtained in Lipari *et al*., 2024) **Kruskal-Wallis Test** No significant difference (at 5%) between two communities (**Agreement** with the results obtained in Lipari *et al*., 2024)
Knowledge	**Spearman Test- rho** There is no statistically significant, monotonic correlation of 5% (**Disagreement** with the results obtained in Lipari *et al*., 2024) **Kruskal-Wallis Test** There is a significant difference (at 5%), at least from the comparison between two income classes (eg, low vs middle and low vs middle-high) (**Agreement** with the results obtained in Lipari *et al*., 2024)	**Chi-Squared test** No statistically significant association between the variables (**Agreement** with the results obtained in Lipari *et al*., 2024) **Kruskal-Wallis Test** No significant difference (at 5%) between two communities (**Agreement** with the results obtained in Lipari *et al*., 2024)

Source: the authors.

2. Individuals' self-efficacy (β)

Figure A2. Association and correlation test for self-efficacy with respect to income and regional distributions

Variable	Income	Communities
Respondent can use less energy	**Spearman Test- rho** No statistically significant, monotonic correlation of 5% (**Disagreement** with the results obtained in Lipari *et al.*, 2024) **Kruskal-Wallis Test** No statistically significant difference (at 5%), at least from the comparison of two income classes (**Agreement** with the results obtained in Lipari *et al.*, 2024)	**Chi-Squared test** No statistically significant association between the variables. (**Agreement** with the results obtained in Lipari *et al.*, 2024) **Kruskal-Wallis Test** No statistically significant association between the variables (In Lipari *et al.*, 2024, Fisher was used)
Respondent's consumption decisions are important for the Environment	**Spearman Test- rho** No statistically significant, monotonic correlation of 5% (**Disagreement** with the results obtained in Lipari *et al.*, 2024) **Kruskal-Wallis Test** No statistically significant difference (at 5%), at least from the comparison of two income classes (**Agreement** with the results obtained in Lipari *et al.*, 2024)	**Chi-Squared test** No statistically significant association between the variables (**Agreement** with the results obtained in Lipari *et al.*, 2024) **Kruskal-Wallis Test** No statistically significant association between the variables (In Lipari *et al.*, 2024, Fisher was used)

Source: the authors.

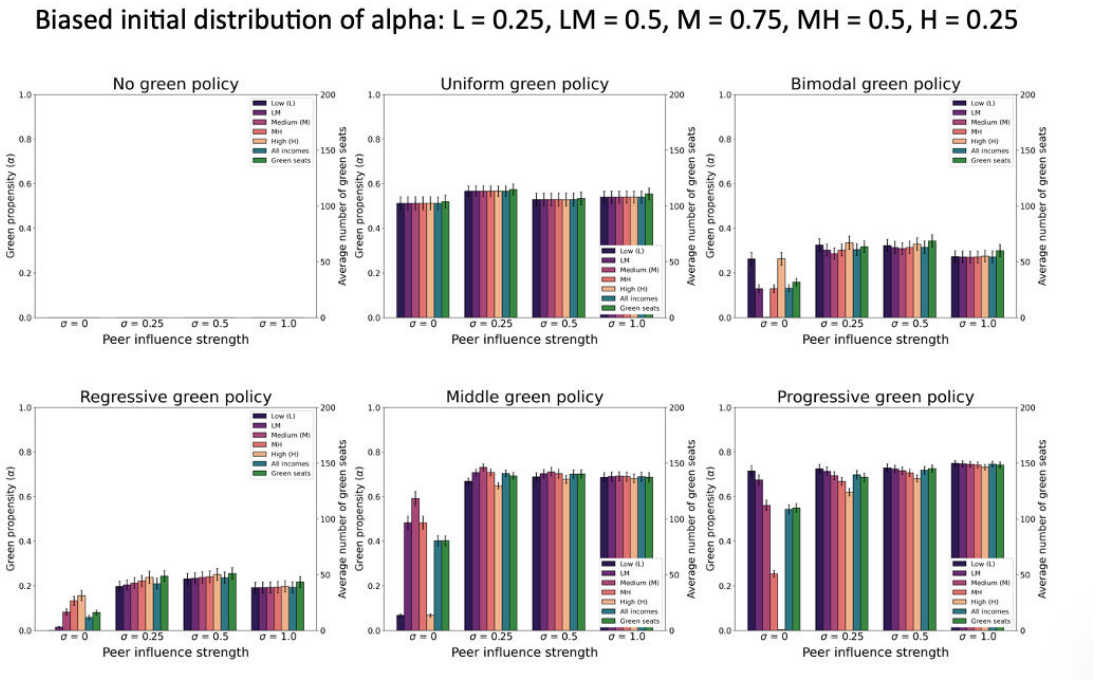
Appendix 2. Results with hump-shaped initial α

In this section we present the results from a heterogeneous distribution of α. We have run simulations with an initial α distributed differently for different income classes (ie, hump-shaped) as a robustness check of the information coming from the construction of α in Section 3.1 of this document.

Figure A3. The effect of green policies and peer influence on citizens' green propensity, and the number of green seats with homogeneous alpha

Source: the authors.

Figure A4. The effect of green policies and peer influence on citizens' green propensity, and the number of green seats with biased alpha



Source: the authors.

Each panel represents the final average level of α and the final number of green seats for each policy implementation and for different degrees of peer influence. When σ =0 peer pressure is absent, for σ =0.25 agents are exposed to low peer pressure, when σ =0.5 pressure from neighbours is mild, and when σ =1 neighbours' influence is pervasive. Averages and standard errors are reported. The two figures differ in the initialisation of the α.

Figure A4 uses biased alpha initialisation, which means that initial distribution of alpha changes according to different income classes: for low-income class initial alpha is about 0.25, for low-middle class, the initial green propensity is 0.5, and so on.

As shown in the two graphs, there are no evident differences between the two initialisations.

Appendix 3. Policy preferences

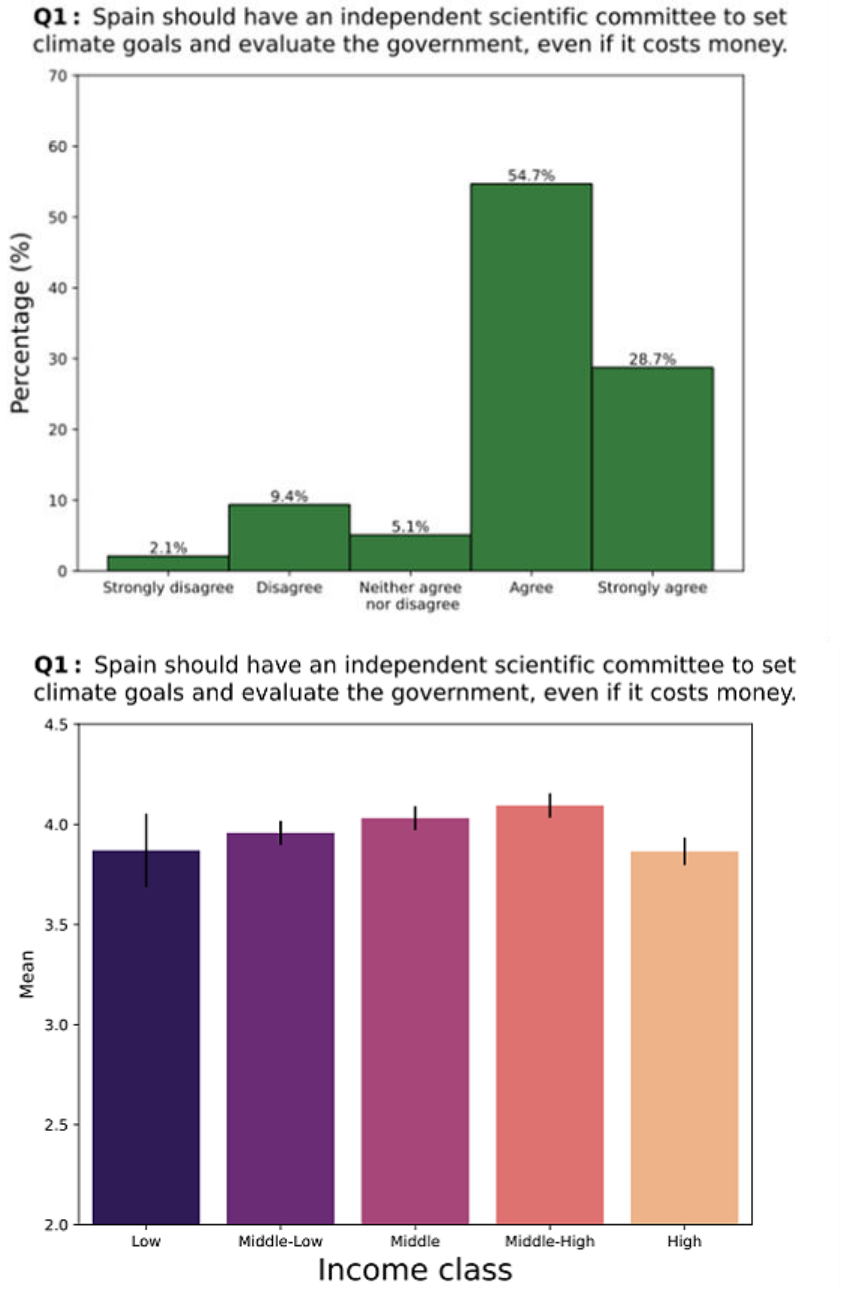
In this section we present the 11 statements to elicit citizens' preferences for different policies.

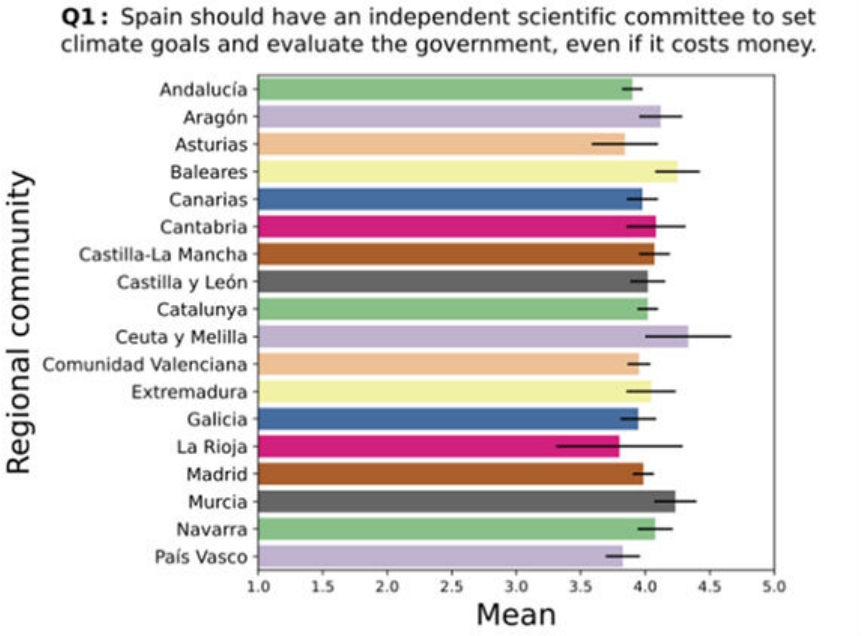
Figure A5. Policy preferences

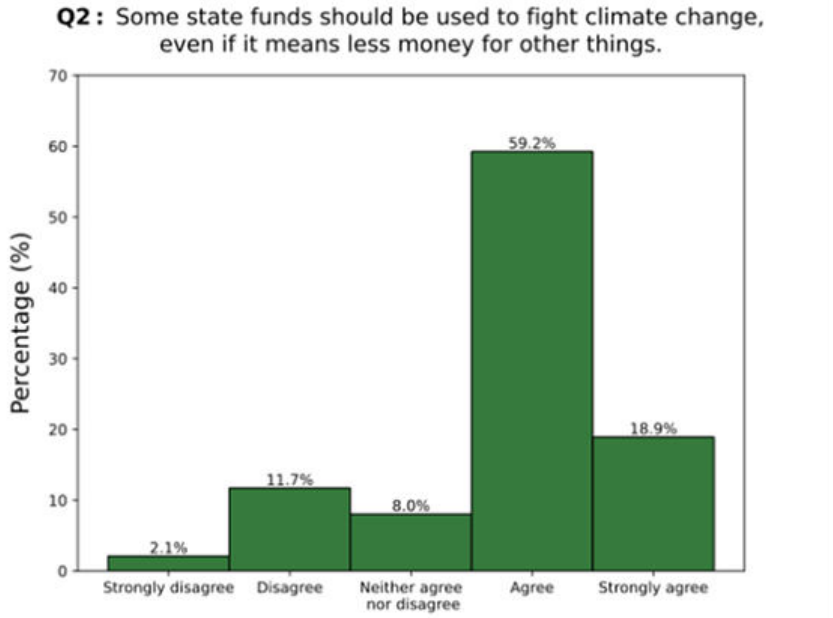
E1 1.	Spain should have a scientific committee independent of the government that proposes climate targets and evaluates governments, even if it costs money.
E1 2.	Part of what the state spends every year should be used to fight climate change, even if it means having less money for other things.
E1 3.	Banks should invest primarily in activities that do not harm the environment.
E1 4.	The electricity we consume should come from renewable sources, even if some people do not like large solar or wind installations.
E1 5.	We should be able to continue using cars like the current petrol and diesel ones, even if that means increasing pollution and emissions.
E1 6.	We should extend the life of nuclear power plants as long as possible.
E1 7.	Parliament (politicians) should adopt the climate targets indicated by scientists.
E1 8.	Citizens must pay more taxes for our gas emissions.
E1 9.	The government should invest in areas that lose business due to climate change or policies to fight it, even if that means less money for other things
E1 10.	Spain should exploit all its resources (coal, oil, gas and minerals) even if this increases emissions and pollution
E1 11.	Spain must act to tackle climate change through laws, plans and strategies.

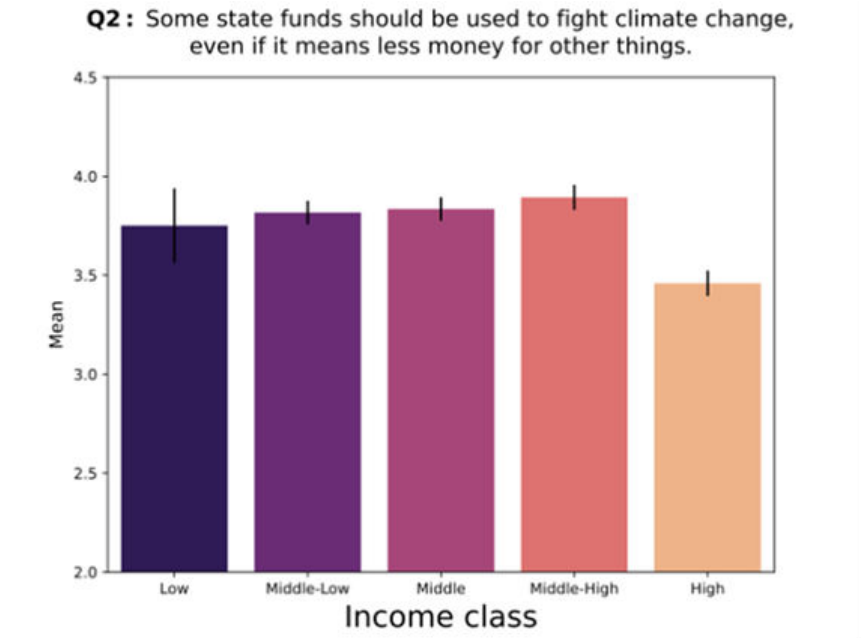
In what follows we display the Figures representing the distribution of each policy preferences according to income classes and regional residency. Each set of three horizontal Figures refers to a different statement. The graphs present the frequency of answers and the distribution of the answers according to income class (brackets) and region.

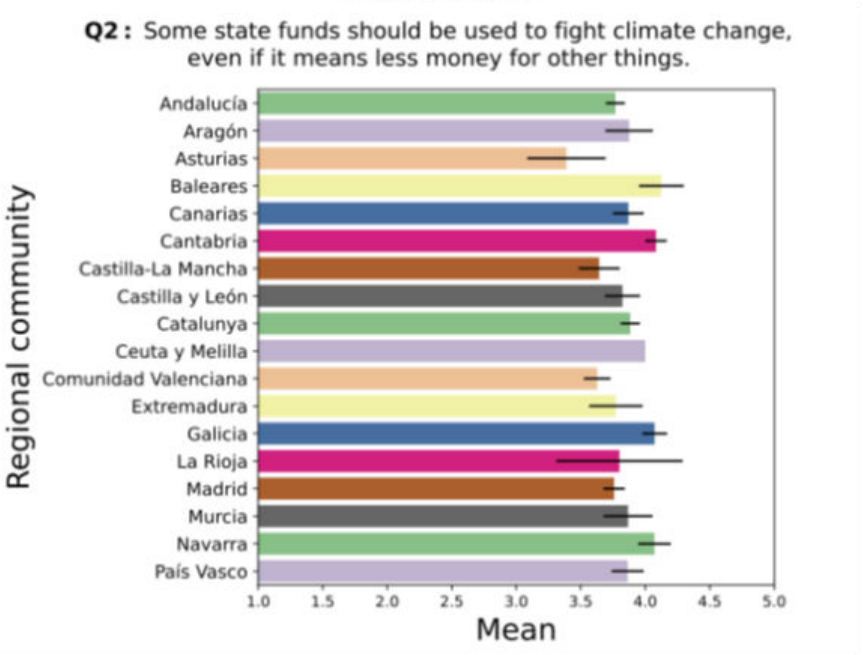
Figure A6. Distribution of policy preferences according to income class and region

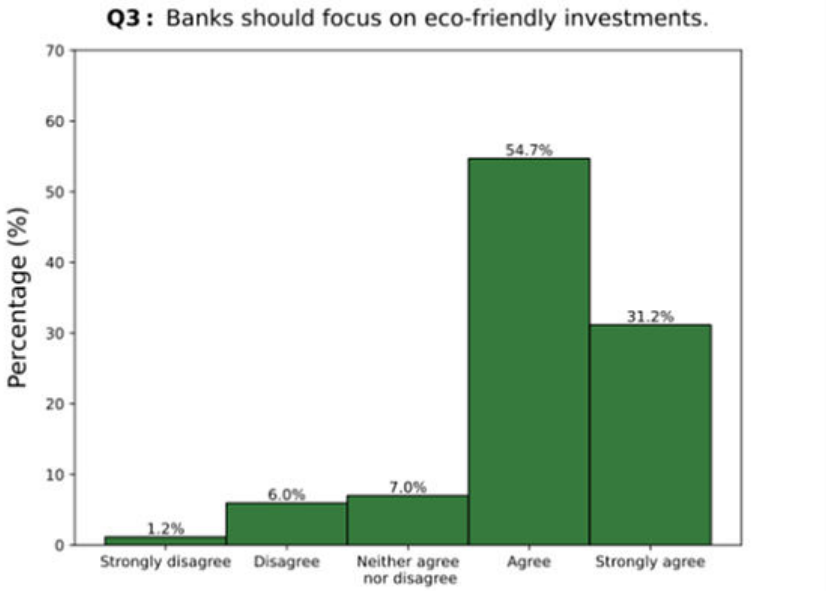


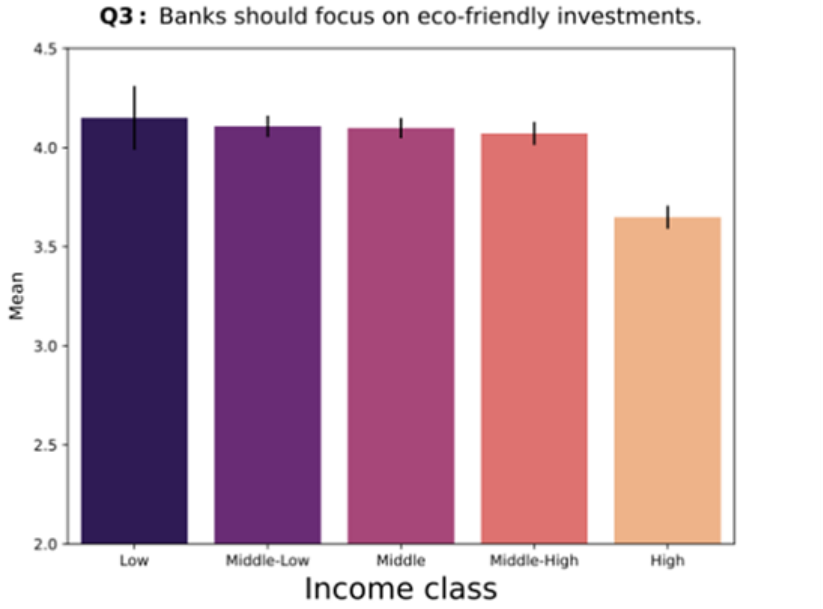

Q1 : Spain should have an independent scientific committee to set climate goals and evaluate the government, even if it costs money.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Mean

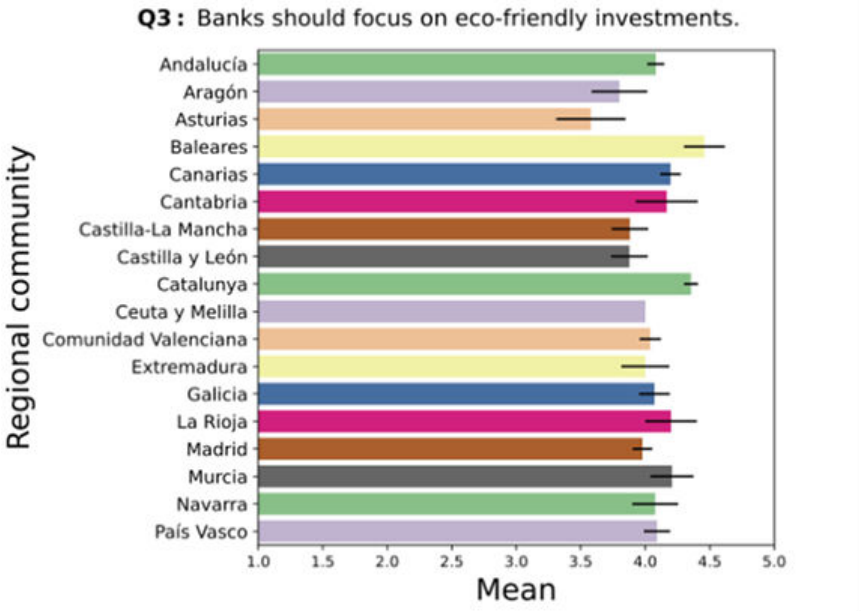

Q2 : Some state funds should be used to fight climate change, even if it means less money for other things.
Percentage (%)
70
60
50
40
30
20
10
0
2.1%
11.7%
8.0%
59.2%
18.9%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree

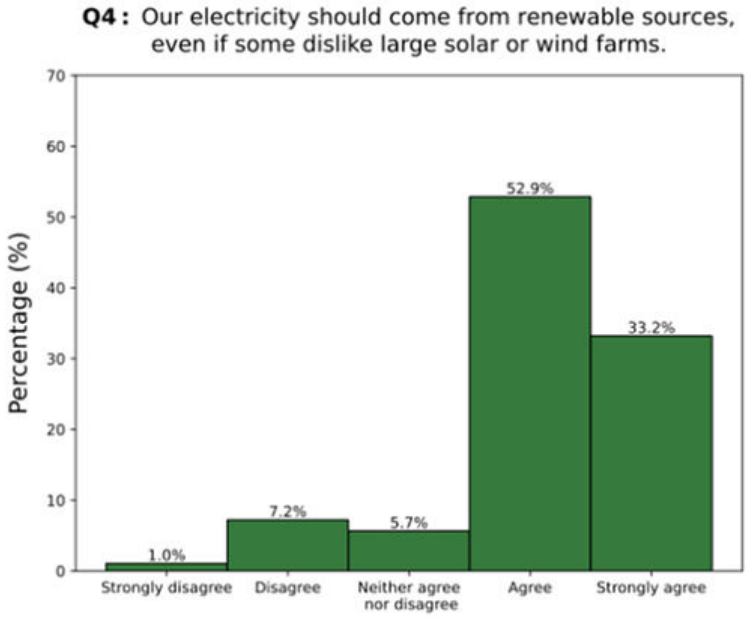

Q2 : Some state funds should be used to fight climate change, even if it means less money for other things.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class

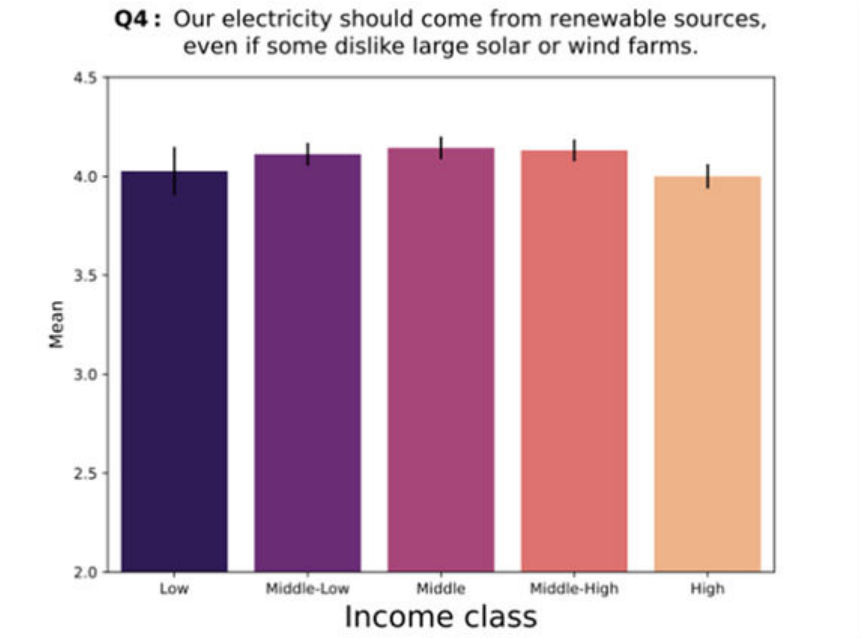

Q2 : Some state funds should be used to fight climate change, even if it means less money for other things.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Mean

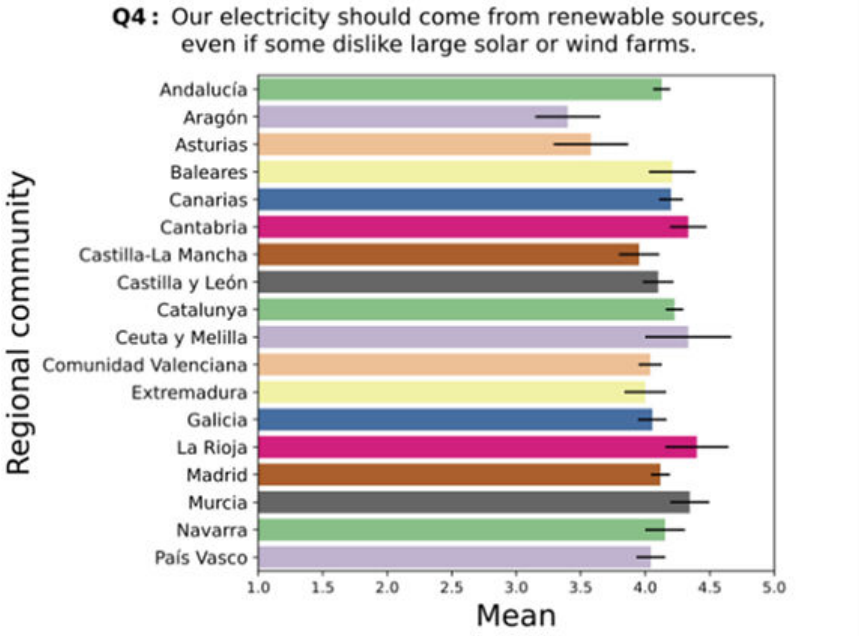

Q3 : Banks should focus on eco-friendly investments.
Percentage (%)
70
60
50
40
30
20
10
0
1.2%
6.0%
7.0%
54.7%
31.2%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree


Q3 : Banks should focus on eco-friendly investments.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class


Q3 : Banks should focus on eco-friendly investments.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Mean


Q4 : Our electricity should come from renewable sources, even if some dislike large solar or wind farms.
Percentage (%)
70
60
50
40
30
20
10
0
1.0%
7.2%
5.7%
52.9%
33.2%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree


Q4 : Our electricity should come from renewable sources, even if some dislike large solar or wind farms.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class


Q4 : Our electricity should come from renewable sources, even if some dislike large solar or wind farms.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
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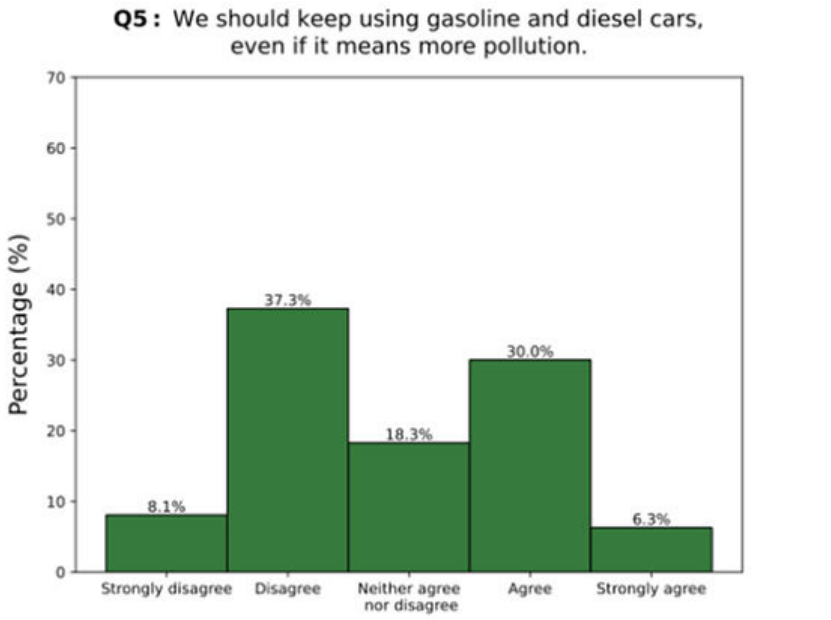
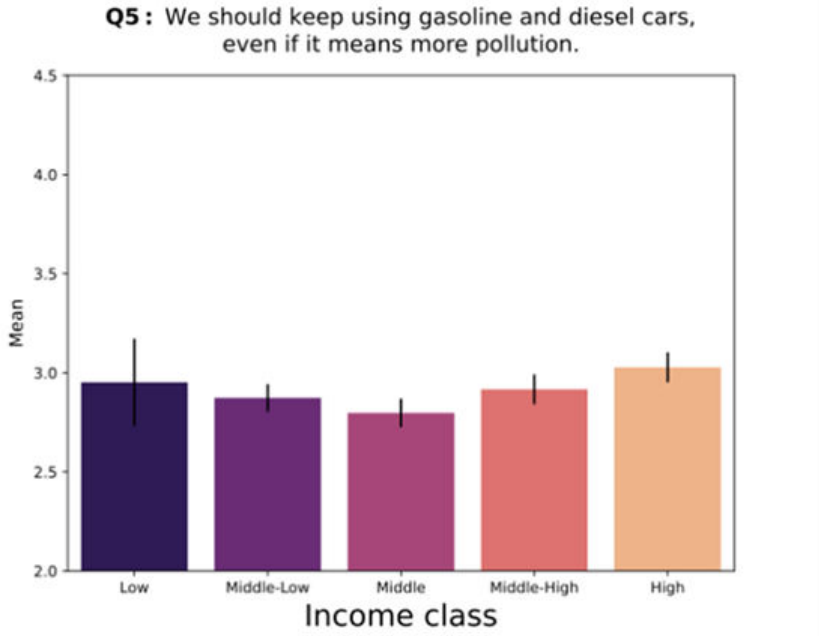
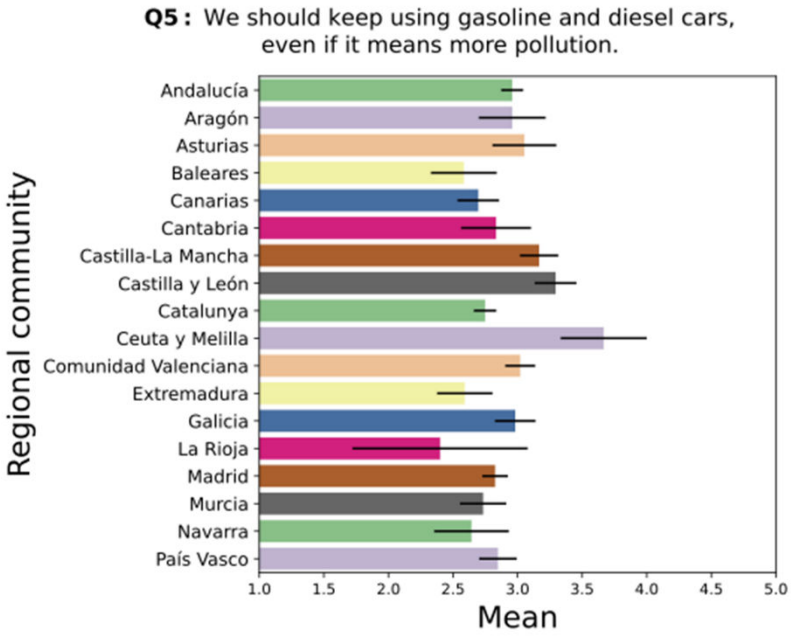
2.5
3.0
3.5
4.0
4.5
5.0
Mean


Q5 : We should keep using gasoline and diesel cars, even if it means more pollution.
Percentage (%)
70
60
50
40
30
20
10
0
8.1%
37.3%
18.3%
30.0%
6.3%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree


Q5 : We should keep using gasoline and diesel cars, even if it means more pollution.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class


Q5 : We should keep using gasoline and diesel cars, even if it means more pollution.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
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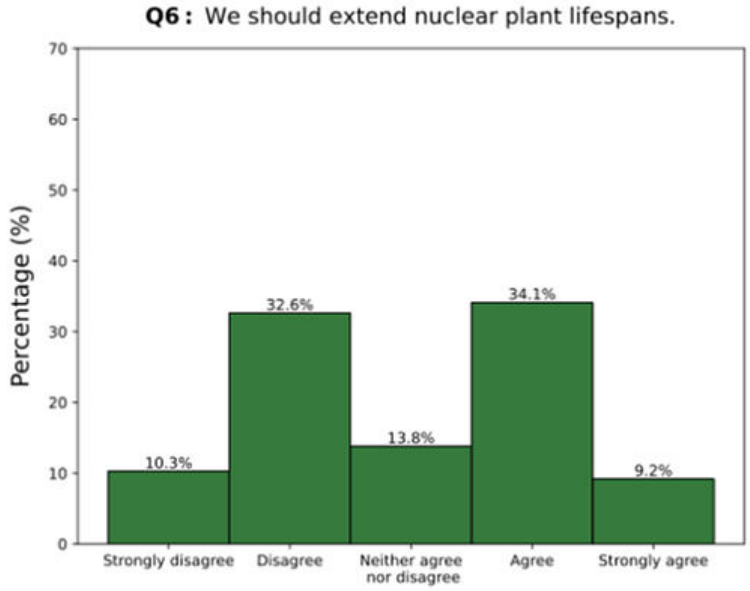
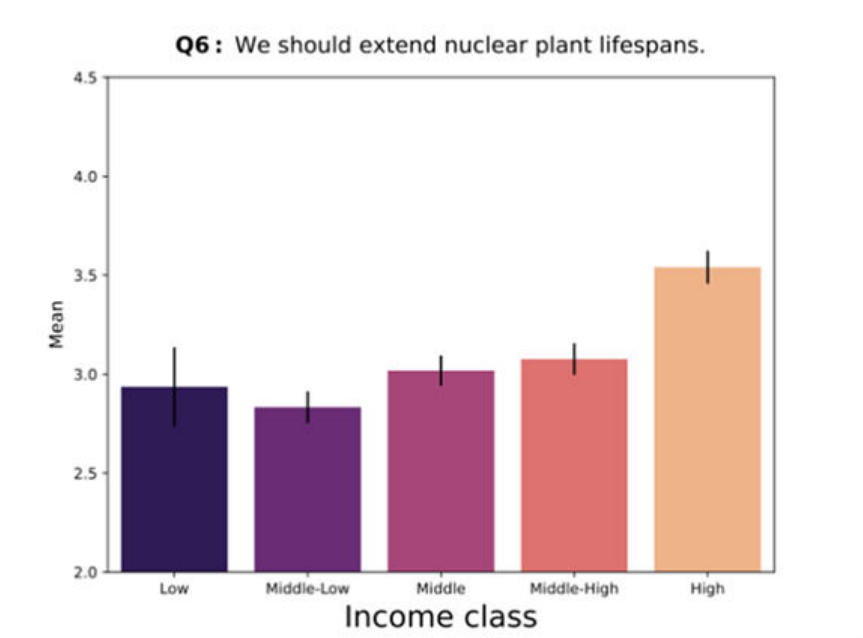
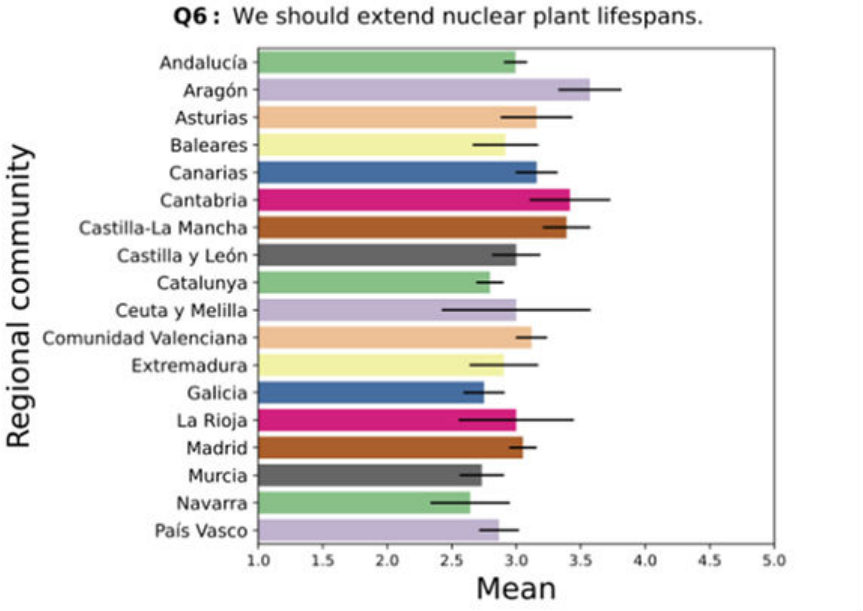
4.0
4.5
5.0
Mean


Q6 : We should extend nuclear plant lifespans.
Percentage (%)
0
10
20
30
40
50
60
70
10.3%
32.6%
13.8%
34.1%
9.2%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree


Q6 : We should extend nuclear plant lifespans.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class


Q6 : We should extend nuclear plant lifespans.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
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País Vasco
1.0
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3.0
3.5
4.0
4.5
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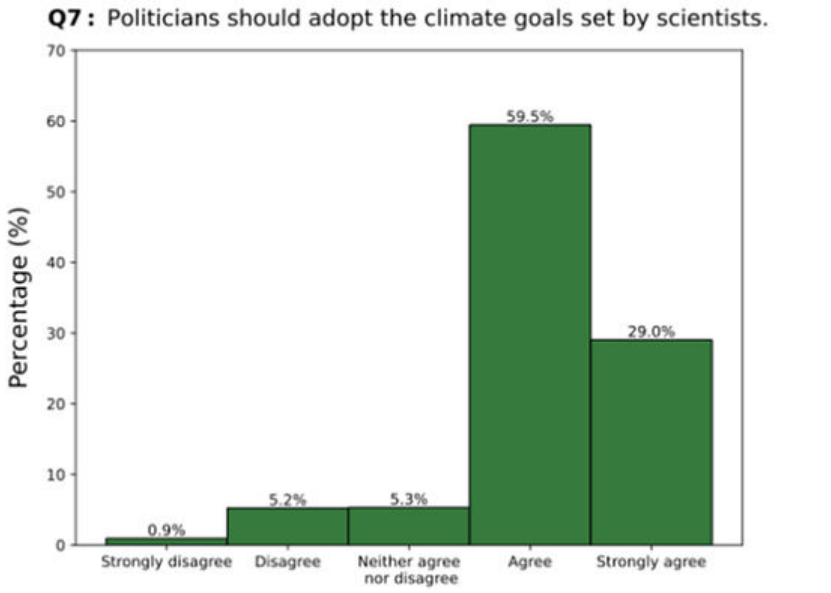
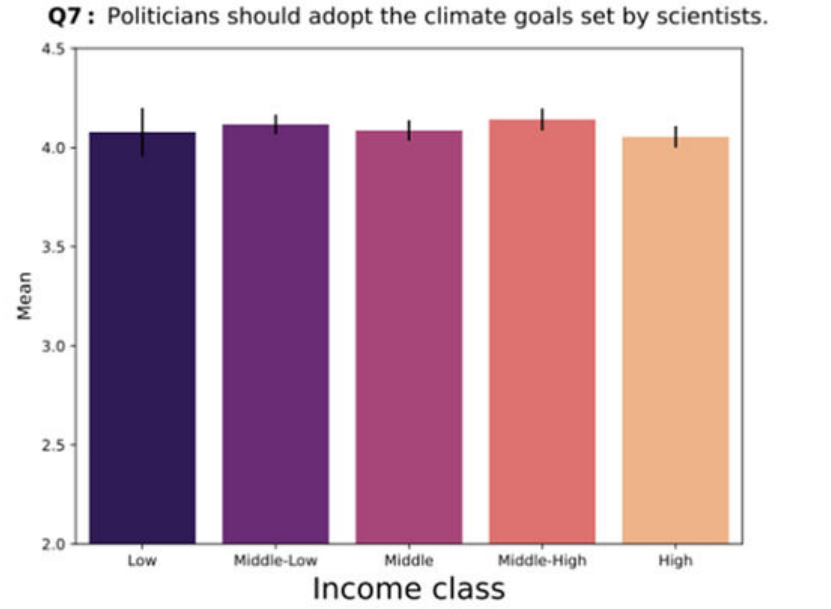
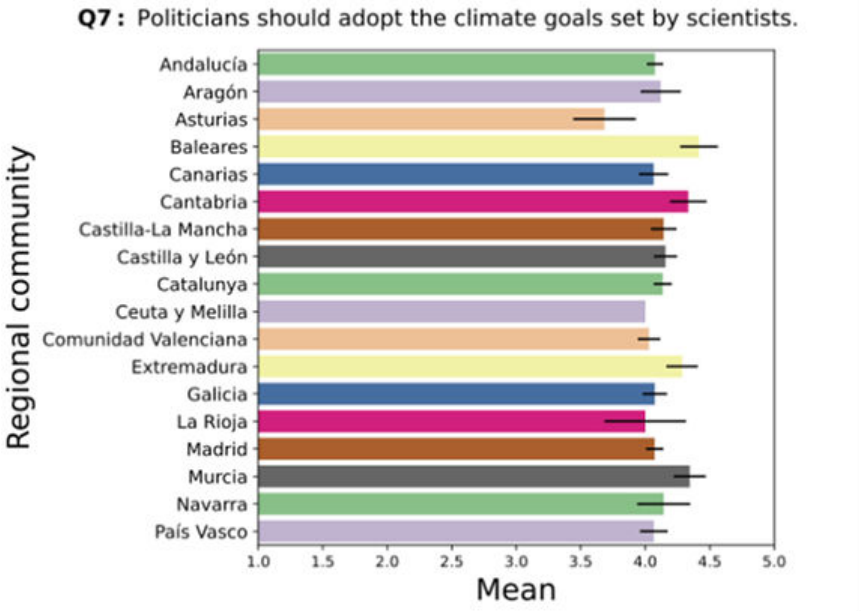
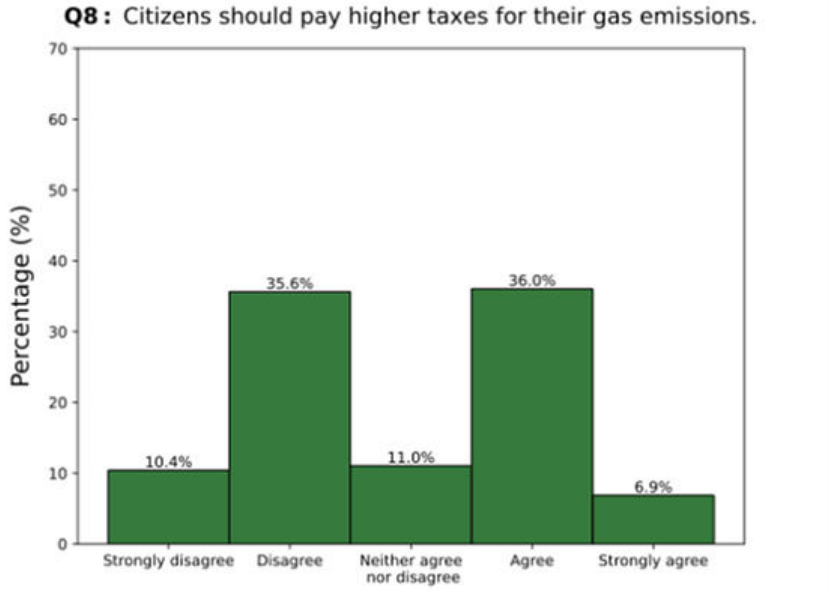
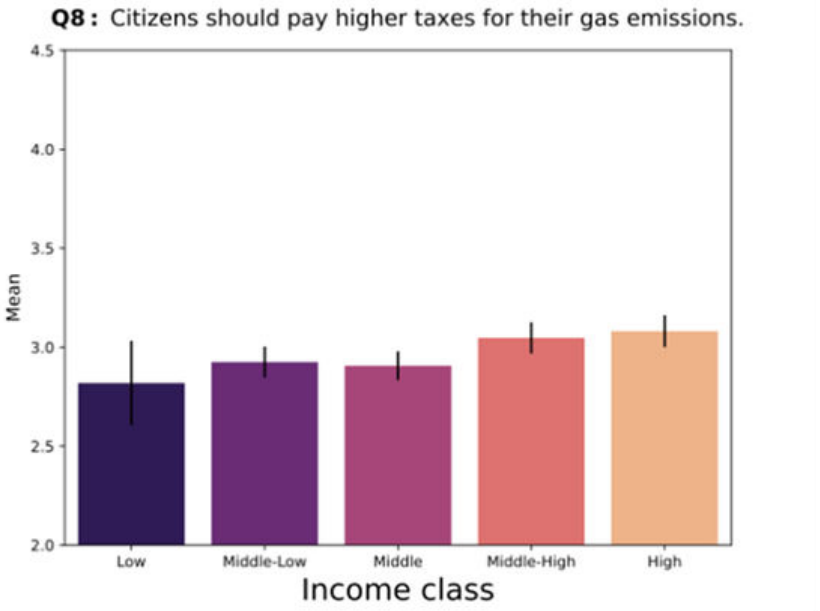
Mean

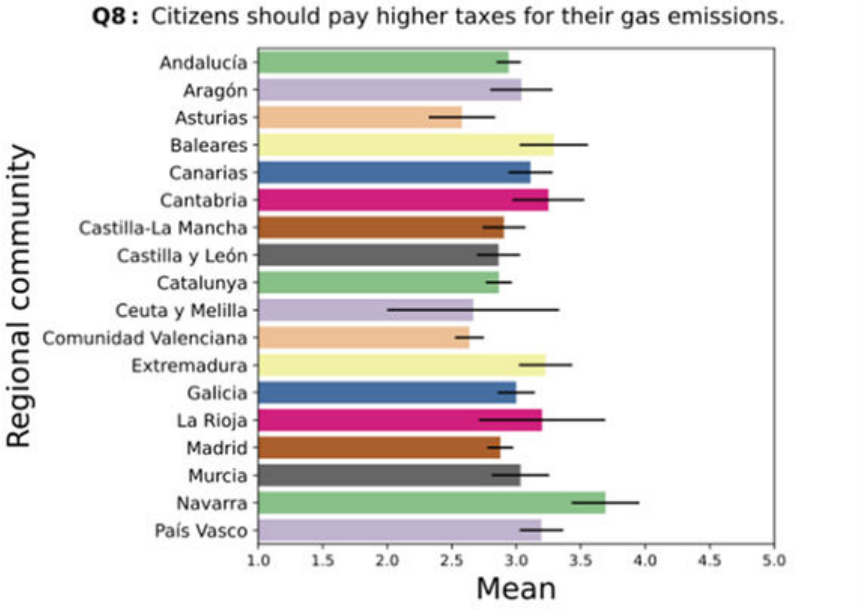

Q7 : Politicians should adopt the climate goals set by scientists.
Percentage (%)
70
60
50
40
30
20
10
0
0.9%
5.2%
5.3%
59.5%
29.0%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree

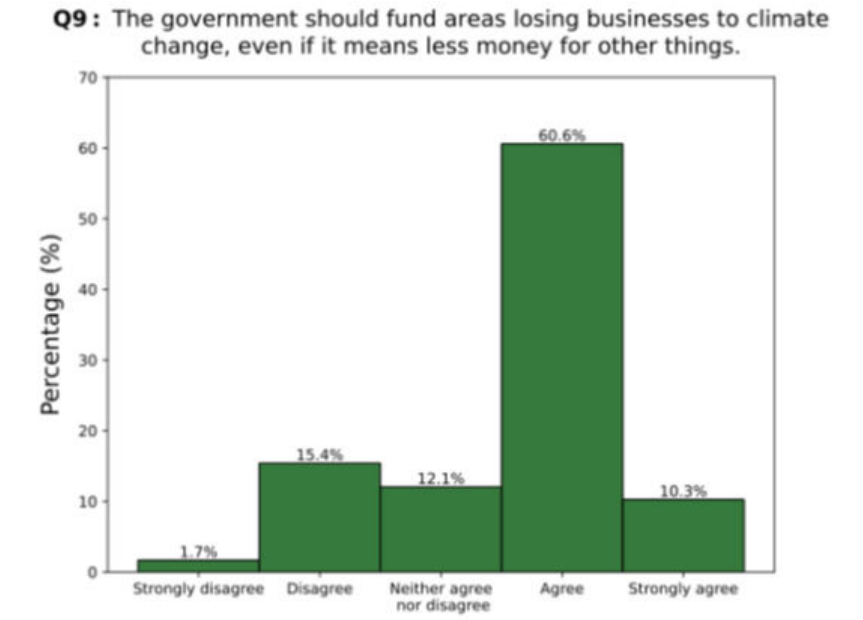

Q7 : Politicians should adopt the climate goals set by scientists.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class

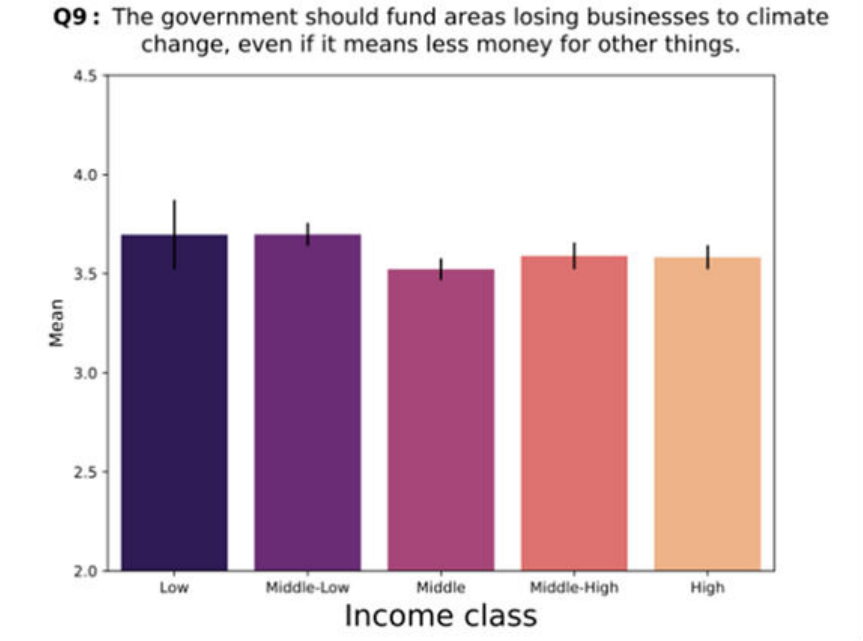

Q7 : Politicians should adopt the climate goals set by scientists.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Mean

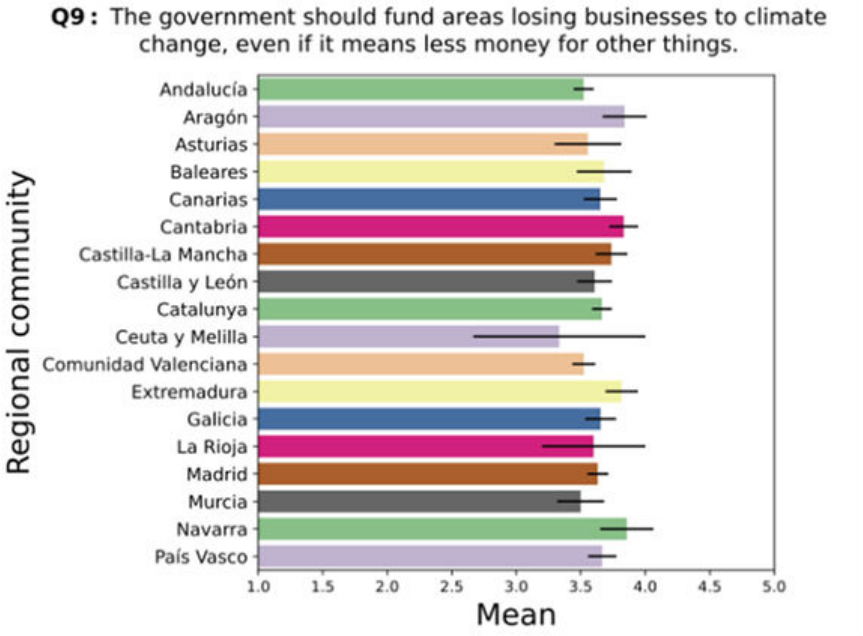

Q8 : Citizens should pay higher taxes for their gas emissions.
Percentage (%)
0
10
20
30
40
50
60
70
10.4%
35.6%
11.0%
36.0%
6.9%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree

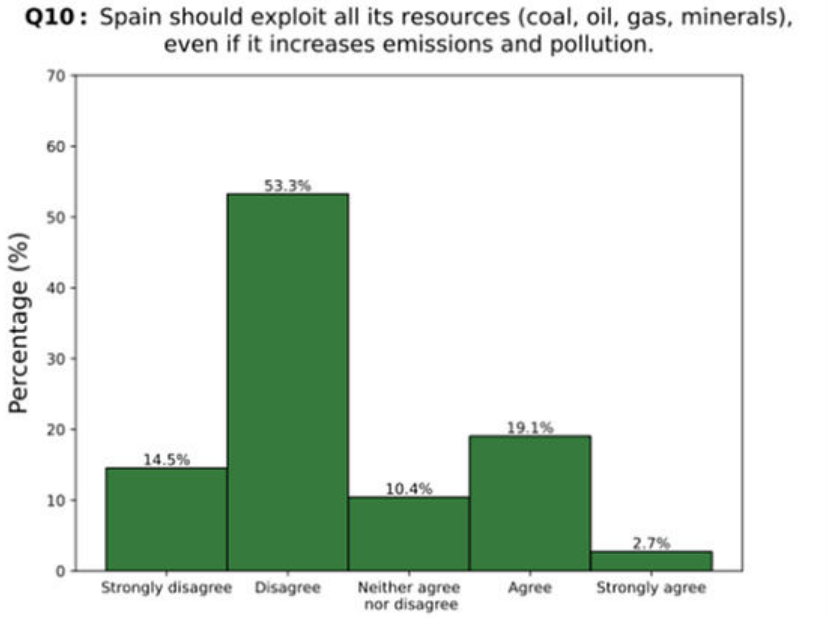

Q8 : Citizens should pay higher taxes for their gas emissions.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class

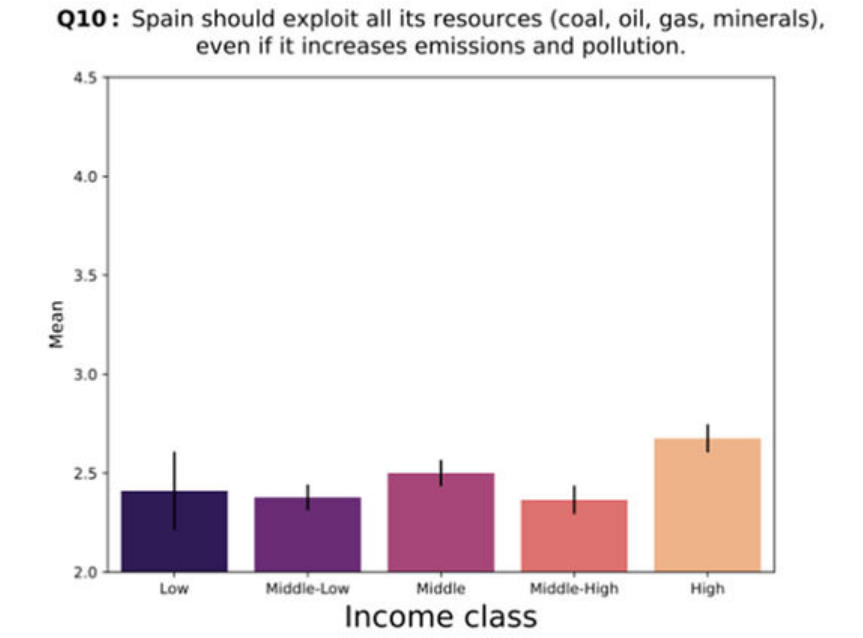

Q8 : Citizens should pay higher taxes for their gas emissions.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Mean

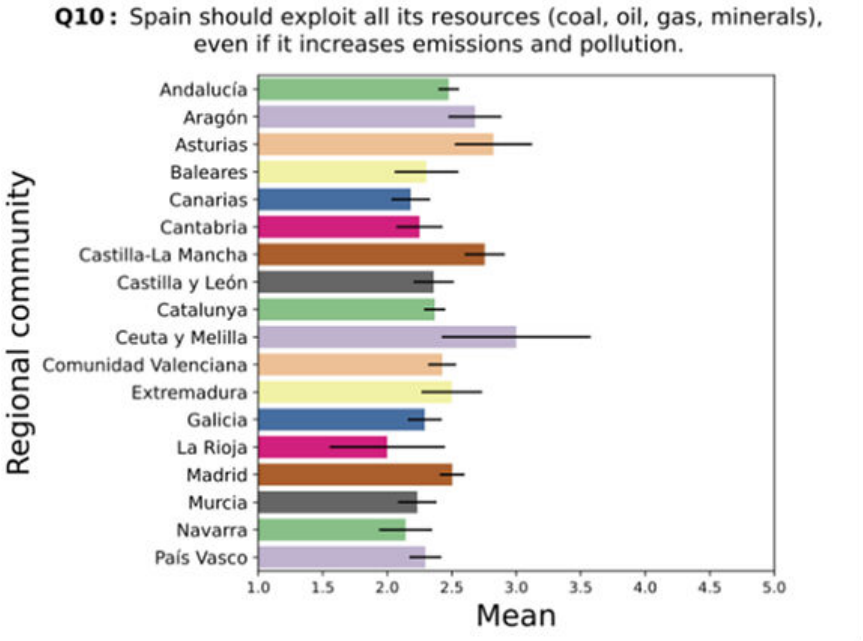

Q9 : The government should fund areas losing businesses to climate change, even if it means less money for other things.
Percentage (%)
70
60
50
40
30
20
10
0
1.7%
15.4%
12.1%
60.6%
10.3%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree

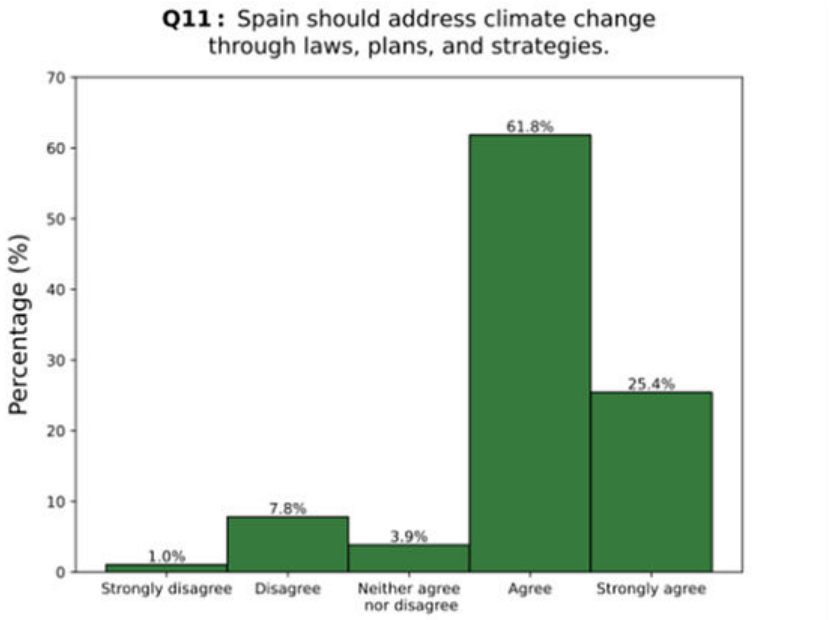

Q9 : The government should fund areas losing businesses to climate change, even if it means less money for other things.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class

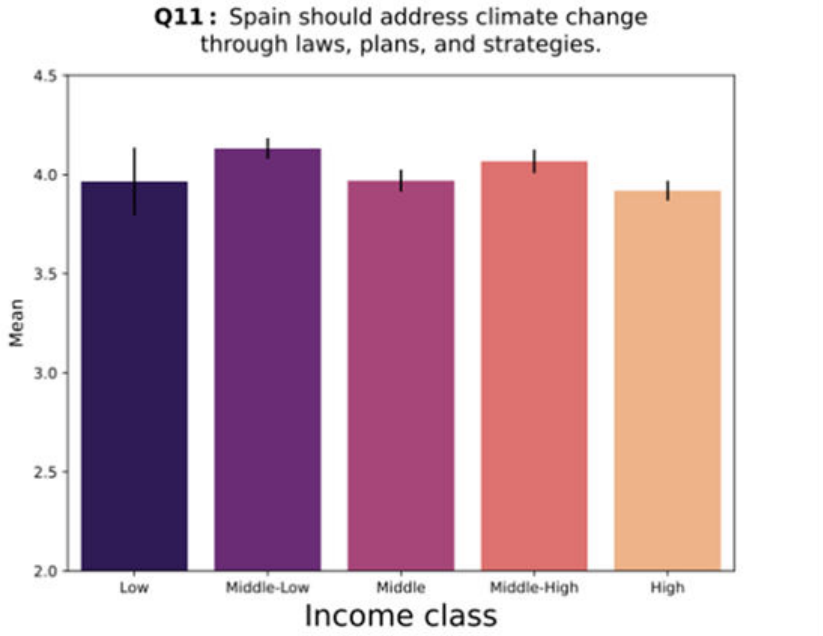

Q9 : The government should fund areas losing businesses to climate change, even if it means less money for other things.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Mean

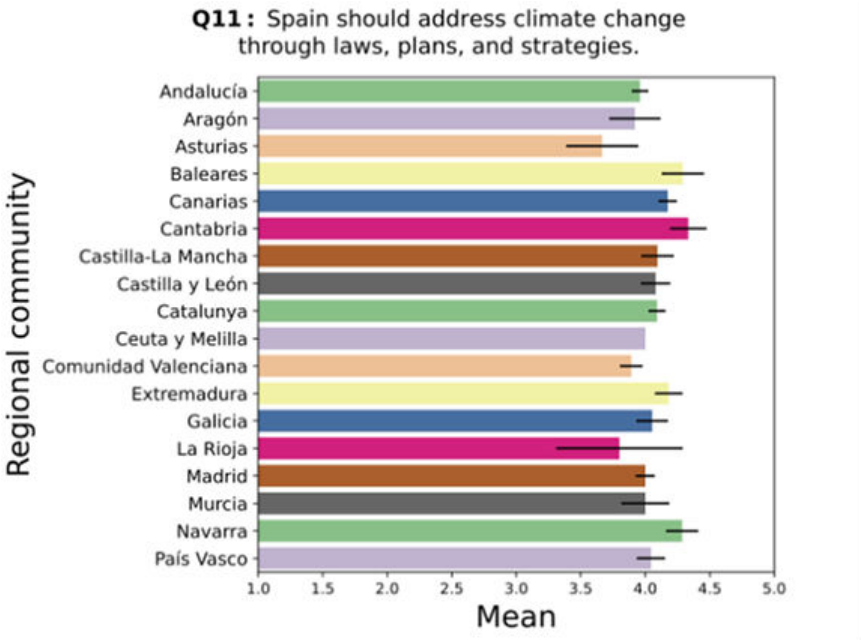

Q10 : Spain should exploit all its resources (coal, oil, gas, minerals), even if it increases emissions and pollution.
Percentage (%)
0
10
20
30
40
50
60
70
14.5%
53.3%
10.4%
19.1%
2.7%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree


Q10 : Spain should exploit all its resources (coal, oil, gas, minerals), even if it increases emissions and pollution.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class


Q10 : Spain should exploit all its resources (coal, oil, gas, minerals), even if it increases emissions and pollution.
Regional community
Andalucía
Aragón
Asturias
Baleares
Canarias
Cantabria
Castilla-La Mancha
Castilla y León
Catalunya
Ceuta y Melilla
Comunidad Valenciana
Extremadura
Galicia
La Rioja
Madrid
Murcia
Navarra
País Vasco
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Mean


Q11 : Spain should address climate change through laws, plans, and strategies.
Percentage (%)
70
60
50
40
30
20
10
0
1.0%
7.8%
3.9%
61.8%
25.4%
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree


Q11 : Spain should address climate change through laws, plans, and strategies.
Mean
4.5
4.0
3.5
3.0
2.5
2.0
Low
Middle-Low
Middle
Middle-High
High
Income class



Source: the authors.

Appendix 4. Results with φ_i distributed differently for income class (robustness check)

In the following graphs we present the results from a heterogeneous distribution of φ_i. In Section 3.3 we stated that we would run two types of simulation:

- φ, equals for all the agents.
- ϕ_i, distributed differently for income class (hump-shaped: higher for middle class and smaller in low and high income).

We run this simulation because from the RIE's data we have a medium degree of citizen engagement, $0.3 \leq \varphi \leq 0.4$; and the engagement was not the same for all income classes. Hence, we wanted to see if the simulation with two different initialisations would produce large differences in the global level of green propensity.

Qualitatively, there are no large differences between the unbiased and biased distribution of the citizen engagement parameter on the global green propensity.

We make an exception for specific policy scenarios and degrees of citizen engagement.

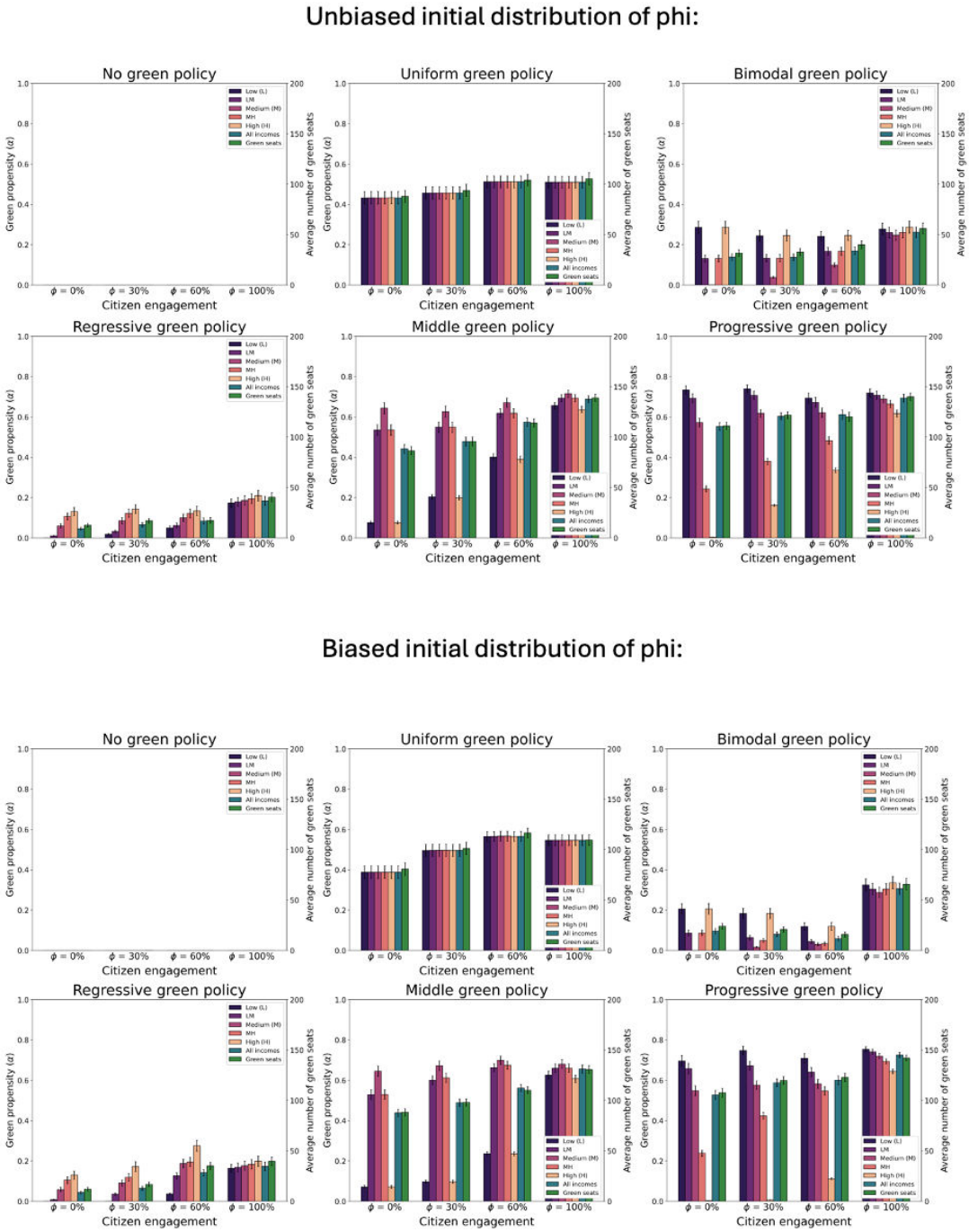
For example, in the bimodal scenario we find, obviously, differences between biased and unbiased citizen engagement, because of the way in which the biased-φ is constructed.

In the regressive scenario $\varphi = 60\%$, meaning that the agents have at least 60% of active links, the final green propensity of all income classes is higher when φ is biased. While for the middle policy scenario, when $0.3 \leq \varphi \leq 0.6$, we observe that in the case of biased-φ initialisation, the low-income and the high-income classes have a lower green propensity than in the case of unbiased-φ initialisation.

Finally, in the progressive scenario, when $0.3 \leq \varphi \leq 0.6$, the results show that in the case of biased- φ initialisation, the high-income classes have a lower green propensity than in the case of unbiased- φ initialisation.

We know, that in reality φ will never be at its maximum, so focus on the middle degree of citizen engagement, when $0.3 \leq \varphi \leq 0.6$.

Figure A7. The effect of green policies and citizen engagement on citizens' green propensity, and the number of green seats



Source: the authors.

Each panel represents the final average level of α and the final number of green seats for each policy implementation and for a different degree of citizen engagement.