Ecological Economics 227 (2025) 108371

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

What about the others? Conditional cooperation, climate change perception and ecological actions☆

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ARTICLE INFO

JEL classification:
H41
Q54
Q58

Keywords:
Climate change
Perception
Ecological actions
Social dilemma
Conditional cooperation

ABSTRACT

Climate challenge can be modelled as a multiplayer prisoner's dilemma where ecological action – e.g., purchasing an electric car or adopting sustainable life-styles – is costly in terms of economic resources, time, and effort. The prisoner's dilemma structure of the game implies that, even though the social benefit is maximized – and every player would be better off – with everyone taking ecological actions, the strategy profile with no player taking action is a Nash equilibrium, assuming players have purely self-regarding preferences. In this paper we analyse how this ecological dilemma is affected by people's perceptions. Using the European Social Survey, we study how urgent the climate threat is perceived by respondents and their beliefs about other countries' actions. Theoretical predictions suggest that the former increases, while the latter does not affect individual willingness to act ecologically when introducing heterogeneity about the effect of worry on intrinsic motivations. Our empirical findings however show that both factors positively affect willingness to act. We interpret the positive effect by arguing that intrinsic motivations are also affected by other people action and show that the effect is weaker as social capital increases.

1. Introduction and literature review

> [I] feel it coming, a series of disasters created through our diligent yet unconscious efforts. If they're big enough to wake up the world, but not enough to smash everything, I 'd call them learning experiences, the only ones able to overcome our inertia. (de Rougemont cited in Partant 1979)

The climate threat is one of the most daunting global challenges of the years to come, and achieving net zero emissions is the goal of most world countries to tackle it. However, achieving such goal requires a combination of coordinated public and private actions involving a radical habits change in domains such as energy production, industry, agriculture, mobility, and housing. In this direction, the International Energy Agency recommended moving to circular economy, replacing high emission with low emission technologies, fossil fuels with renewable or nuclear energy sources, standard transports with sustainable mobility options, and fossil fuels boilers with heat pumps, just to mention only a few examples (Bouckaert et al., 2021).

The required radical change implies relevant individual costs (i.e., money, time, effort, and psychological cost of switching); the costs of doing nothing might be even higher for individuals and societies, though. These *indolence costs* have recently become more visible with the increasing consequences of climate change. Agriculture production is heavily affected by shocks due to more frequent drought spells and extreme climatic events, properties are at higher risk of destruction due to higher hydrogeological risks, and economic opportunities for people living in semi-arid areas have been reduced triggering giant migration flows. All these are examples of the costly consequences of climate change.

Individuals play a fundamental role in the required radical change. People make choices about their waste, transportation, and housing and government policies cannot often intervene so radically to restrict individual capacity. Policy-makers in democracies are not always

☆ We thank Chiara Sotis, Alessio D 'Amato, George Halkos, Cristina Vaquero Piñero, Peter Martinsson, the participants to the 11th IAERE Conference in Naples, Italy, and the 64th SIE Conference in L'Aquila, Italy, and the members of the SDSN Senior Working Group for their useful comments. This version also benefited from the comments of three anonymous reviewers as well as the editor, and we wish to thank them all.

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https://doi.org/10.1016/j.ecolecon.2024.108371
Received 21 April 2023; Received in revised form 6 April 2024; Accepted 31 August 2024
Available online 10 September 2024

able to constrain people's decisions to the most environmentally sustainable option even if this would ensure a socially sustainable and just transition. A longstanding literature has investigated the determinants of the willingness to pay for environmental sustainability, and education and social capital are among the main drivers. More specifically, Kalkbrenner and Roosen (2016) show that trust, social norms, and environmental concerns are three drivers affecting positively and significantly the willingness to participate in in energy communities. In general, the academic literature finds resistance to habit changes, especially environmental habits, although these can be stimulated by shocks. For instance, O'Garra and Fouquet (2022) find that lockdowns during the COVID-19 pandemic have generated a positive increase in people declaring to be willing to reduce voluntary travels and support low-carbon transition.

Another branch of the literature on environmental actions has investigated the nexus between declared willingness to act for the environment and the actual behaviour. While some authors (Brown et al., 1996; Seip and Str, 1996) provided evidence that the declared willingness to pay evaluated with contingent valuation methods overstates actual willingness to pay, more recent evidence (Carlsson and Martinsson, 2001) shows with experimental data that declared and actual willingness to pay do not differ substantially. In this direction, Zabkar and Hosta (2013) find that people who declare to be prosocial also display lower differences between declared willingness to act for the environment and actual behaviour. Dardanoni et al. (2021) in a discrete choice experiment on children and teenagers show that willingness to pay is higher for geographically closer environmental projects and find evidence of the gender difference in environmental responsibility (higher willingness to pay from girls). Their results challenge the view that children lack of cognitive abilities to formulate their environmental preferences (Albertini and Scansy, 2010). Other research contributions show that adults' (parents) willingness to pay for environmental preferences is affected by that revealed by their children (Dupont, 2004; Lawson et al. 2019). Veronesi et al. (2014) find in a discrete choice experiment that Swiss citizens reveal willingness to pay to reduce ecological and health risks from extreme climatic events creating sewer overflows and flooding of residential zones. They also emphasize that climate change perception has a positive effect on the willingness to pay. Yamazaki et al. (2018) find that fishermen in small island communities are technically "inefficient", in the sense that they hold idle capacity as a buffer against potential negative environmental or social shocks. Capacity underutilization is positively correlated with perceived environmental threats or lack to local social capital. These last two contributions are relevant part of the literature emphasizing how the perception of the severity of climate change affects economic decisions.

Policies to fight climate change require strong coordination and, as such, they have been recently investigated using a game theoretic approach. An interesting characterization of games that model climate negotiations has been provided by DeCanio and Fremstad (2013). The authors discuss the conditions that make the climate problem similar to a prisoner's dilemma (PD) and suggest that diplomacy should focus on the urgency of climate risks to make the game like a coordination game. Similarly, Becchetti and Salustri (2019) have modelled environmentally responsible choices using a social dilemma and discuss variables and costs when responsible actions are a Nash equilibrium (NE). More recently, the intrinsic PD nature of ecological interactions has been remarked by Magli and Manfredi (2022). The authors highlight how modelling the dynamic of the interactions may be more complex if policy-makers focus on short-term preferences and current choices alter future payoffs. More specific climate threats have also been modelled to prevent and manage climate risks. For example, Alvarez et al. (2019) have analysed how river flooding risk can be managed and prevented using cooperative games.

We aim to contribute to this literature by arguing that the climate threat problem can be modelled as a multiplayer prisoner's dilemma. Individuals can decide whether to take action or not (i.e., by purchasing a hybrid or electric car, sorting waste, investing in renewable energy as domestic energy source or switching to other sustainable lifestyles) in order to tackle the environmental threat but taking ecological action is more costly than doing nothing. If all individuals take action, the social outcome is the highest and the payoff is the success in addressing in full or in part the environmental problem with the implied economic and social benefits. This equilibrium would Pareto dominate the equilibrium where everyone decides to do nothing. Unfortunately, the latter is the Nash equilibrium of the game that is, the crossing of the players' dominant strategies, if players (which we define as myopically self-interested players in our paper) are assumed as having a utility function depending only on their monetary payoffs. The climate challenge can therefore be modelled from this perspective as having the typical characteristics of a multiplayer prisoner's dilemma. The originality of our contribution is in framing the empirical research on drivers of environmental responsibility to act in a game theoretic framework focusing specifically on the interaction between one's own felt responsibility to act and the perceived action of one's country fellows and other world countries. On the one side, our object of interest is more general and above the willingness to pay for, while, on the other side, it is original in addressing the interaction issue that is crucial given that environmental responsibility is a typical social dilemma where one's own responsibility to act is affected by what other players at stake (country fellows, other world countries) are expected to take action since moves of the other players definitely affect the final outcome. To provide an intuition on our point we have often heard people saying that it is useless to act pro-environment unless China and India choose to follow with decision ecological transition patterns. In our paper we wonder how much this strategic interaction factor matters.

We investigate the impact of the two factors (perception of the seriousness of the climate threat and expectations of whether other countries will act ecologically) in the model and on the willingness to take environmentally sustainable action. Predictions from the multiplayer model assuming that intrinsic motivation is affected by worry about climate change show that the first factor has a positive effect, while the second an insignificant effect on the individual willingness to take action.

We test these theoretical predictions on data from the 10th European Social Survey (ESS10). Our findings show that both factors (the respondent's perception of the gravity of the problem and of how much other countries will act) are strongly positive and significant. In the discussion section we explain that our findings can be reconciled with the benchmark model under the assumption that players' intrinsic motivation are also affected by other players' willingness to act. We also show that the positive effect of ecological action in other countries is significantly lower in countries and regions with higher social capital. Our interpretation is that the latter moves individuals from conditional toward high unconditional intrinsic motivations.

2. The benchmark model and our research hypothesis

In this section we focus on the strategic implications of ecological transition by modelling the climate problem as a multiplayer prisoner's dilemma. Ecological transition requires a set of public and private actions to tackle the climate threat. Whenever government rules do not exclude the opportunity to consume less environmentally friendly products (e.g., a ban on more polluting cars) individuals and households can choose between a more and less environmentally friendly action where we assume that taking the environmentally friendly action is more costly than the alternative. Examples are buying a full electric (or plug-in) car against the less environmentally friendly alternatives, reducing the production of undifferentiated garbage, reusing and recycling, making sustainable housing choices in terms of emissions, investing in renewable energy as domestic energy source, etc.

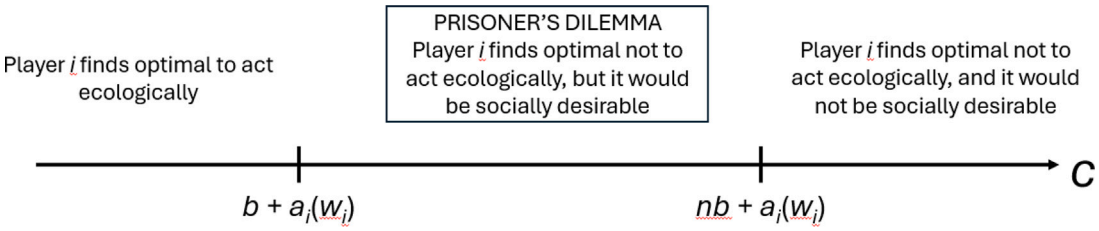

Fig. 1. Effects of intrinsic motivation on the boundaries of the area of the prisoners' dilemma along the segment of the costs of adopting ecologically sustainable behaviour.

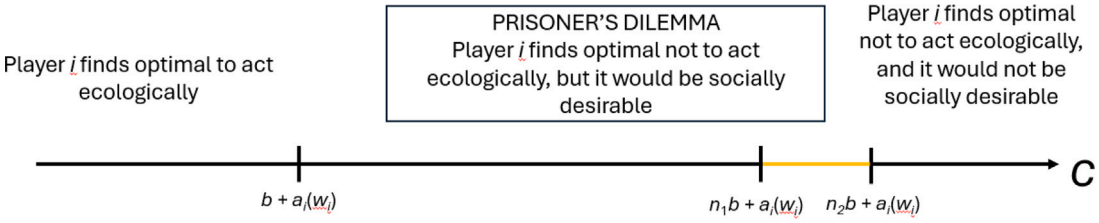

Fig. 2. The effect of an increase in the number of players on mutual ecological action as a Nash equilibrium ($n_1 < n_2$).

Following Becchetti and Salustri (2019), we model the citizen's choice of taking an ecological action as a multiplayer prisoner's dilemma. There are n citizens that can choose between taking an ecological action (E) and remaining in the status quo (R). The ecological action has a positive externality (b) on the environment that benefits all citizens, but requires a costly effort (c) for those who take the action (the ecological citizens) that can be monetary or non-monetary. As mentioned above the cost can have various dimensions (money, time, effort psychological cost of habit change). We also assume that taking the ecological action rewards ecological citizens heterogeneously by an individual value a that represents other-regarding preferences and is a function of how worried about climate change the citizen is. These preferences can be explained by several rationales according to the behavioural economic literature such as pure altruism, guilt aversion (Charness and Dufwenberg, 2006) or warm-glow (Andreoni, 1989, 1990) that can all be viewed as non-pecuniary motivations stimulating individuals to take ecological actions.

Thus, the utility of player i given that there are j ecological citizens can be written as

$$u_i = \begin{cases} (j+1)b + a_i(w_i) - c & \text{if } s_i(j) = E \\ jb & \text{if } s_i(j) = R \end{cases}$$

where $s_i(j)$ denotes the strategy of player i against j ecological citizens and $a_i(\cdot)$ is a reward from intrinsic motivations which positively depends on individual worry about climate challenge (w_i).

Under this framework, and assuming the n citizens are sorted in ascending order over their other-regarding preferences, if the cost of ecological actions is negligible (i.e., $c < b + a_j(w_j)$ for $j = \bar{i}, \ldots, n$), the jth citizen has no incentive to deviate from the Nash equilibrium of *rational ecologism* (i.e., the strategy where every player for which the cost of the ecological action is lower than the benefit takes the ecological action, and the rest of the citizens take the standard action) and the set of this strategies is a Nash equilibrium. However, if $c > b + a_k(w_k)$ for some $k \in [1, \bar{i}]$, then these k citizens will find optimal not to take the ecological action and the rest of citizens will do the opposite, and this strategy profile may be Pareto dominated by rational ecologism if for some of these $k \in [1, \bar{i}]$ we have $c < nb + a_k(w_k)$, i.e., if the cost is lower than the cumulative benefit arising from every player choosing the ecological action (see Fig. 1).

Note that intrinsic motivations shift the region of the Prisoners's dilemma along the segment of costs, making mutual ecological actions more likely to be socially desirable. More specifically, the left boundary occurs at higher costs of adoption (i.e., the threshold of costs that makes mutual ecological action a Nash equilibrium is higher); similarly, the right boundary occurs at higher costs of adoption (i.e., the threshold of costs that makes mutual ecological action socially desirable is also higher). At the same time, a higher number of players makes the Prisoner's dilemma region larger at the expense of mutual ecological action as a Nash equilibrium (Fig. 2).

In predicting theoretically the effects of our two main variables of interest (worry about climate change and perception on how other countries are willing to act ecologically) we formulate the following two propositions.

H_{01}: the player's perception of a higher number of co-operators in the multiplayer dilemma does not increase cooperation

The intuition is as follows. No matter how many more players an individual believes will play cooperatively, the dominant strategy of a myopically self-interested player remains doing nothing. To understand the point in the two-player game doing nothing is the dominant strategy for the myopically self-interested player and therefore it is the optimal strategy even when the other player cooperates. This is the same if we consider a larger number of players. To provide an intuition we can imagine a urban district where everyone has purchased an electric car. The air is cleaner, the emissions are lower and this public good is enjoyed also by the myopically self-interested player. At the margin its choice to cooperate will not change much and the cost of doing it will be higher than the benefit.

H_{02}: enhanced perception of the seriousness of the climate issue does increase the probability of a cooperative choice.

The intuition is that an enhanced perception of the seriousness of the climate issue w_i implies that the player places higher value to the intrinsic reward from ecological action. A higher $a_i(w_i)$ shifts to the right the segment of the prisoner's dilemma so that the maximum cost of adoption of the environmental friendly behaviour is still a Nash equilibrium (area below the prisoners dilemma segment) is higher.

3. Empirical analysis

3.1. Data

We test our research hypothesis using the 10th round of the European Social Survey (ESS10). The European Social Survey is a large cross-country survey that collects information about attitudes, beliefs, and behaviour patterns of people aged above 15 and living in Europe. The 10th round, ESS10, was carried out from September 2020 to August 2022 depending on the country. We analyse the following countries for which we have full information about our variables of interest: Belgium, Bulgaria, Switzerland, Czech Republic, Estonia, Finland, France,

Table 1
Variable legend.

Variable	Description
Dependent variable	
Responsible	The answer to the question *"to what extent you feel it is your personal responsibility to reduce climate change?"* on a 0–10 scale (0 = not at all, …, 10 = a great deal).
Main explanatory variables	
Worried	The answer to the question *"how worried about climate change"* (Not at all worried, not very worried, somewhat worried, very worried, extremely worried).
Governments	The answer to the question *"how likely, governments in enough countries take action to reduce climate change"* on a 0–10 scale (0 = not at all likely, …, 10 = extremely likely).
Other controls	
Female	A (0/1) dummy equal to 1 if the respondent is female.
Age	The age of the respondent, in years.
Education	Respondent years of education.
Income	The decile of the respondent's household total net income within the respondent's country of residence (1 = lowest, 10 = highest).
HHsize	The number of the members in the household.
Marital status	A categorical variable for the respondents' marital status: married, civil union, separated, divorced, widowed, or never married.
Employment	A categorical variable for the respondents' employment status: paid worker, retired, student, houseworker, disabled, unemployed in search, or unemployed not in search.
Life Sat	The answer to the question *"how satisfied with life as a whole"* on a 0–10 scale.
Vote	A (0/1) dummy equal to 1 if the respondent has voted in the last elections.
Politics	The respondent's self-assessed political preference in the left–right scale (0 = extreme left, 10 = extreme right).
Health	A categorical variable with the respondent's self-assessed health status (very good, good, fair, bad, very bad).
Income satisfaction	A categorical variable for the respondent's feeling about their household's income nowadays (living comfortably, coping on, difficult, very difficult).
Country	For each country, a dummy equal to 1 if the respondent is resident in that country. List of countries: Bulgaria, Switzerland, Czech Republic, Estonia, Finland, France, Greece, Croatia, Hungary, Iceland, Italy, Lituania, Montenegro, North Macedonia, The Netherlands, Norway, Portugal, Slovenia, Slovakia.
Active citizen	Respondents who have declared in the last 12 months they have: (i) donated to or participated in political party or pressure group; (ii) worn of displayed campaign badge/sticker; (iii) taken part in public demonstration; (iv) boycotted certain products; (v) signed petition.
Social capital	First factor extracted from a principal component analysis of the following variables: (1) (0/1) dummy =1 if the respondent volunteered for not-for-profit or charitable organization in the last 12 months; (2) (0/1) dummy =1 if the participant donated to or participated in political party or pressure group in the last 12 months. (3) General trust (0–10 scale for the question 'Most people can be trusted or you can't be too careful').

Greece, Croatia, Hungary, Iceland, Ireland, Italy, Lituania, Montenegro, North Macedonia, The Netherlands, Norway, Portugal, Slovenia, Slovakia, and United Kingdom. To address our research question, we are interested in the information about attitudes and beliefs towards climate change. More specifically, our dependent variable is the answer to the question *"to what extent you feel it is your personal responsibility to reduce climate change?"*, with available options being distributed on a 0–10 scale where 0 is *"not at all"* and 10 is *"a great deal"*. Variable legend and descriptive statistics are provided in Tables 1 and 2, respectively. The distribution of the variable shows that around 55.4 percent of respondents provide scores above 5 (Fig. 4A). The two extreme options are chosen by 7.8 (*"not at all"*) and 9.6 (*"a great deal"*) percent of the sample respectively.

Our two main variables of interest are respondent's worry about climate change and perception about government actions against climate change. More specifically the first question is *"How worried about climate change" (not at all worried, very worried, somewhat worried, very worried, extremely worried)* and the second *"How likely, governments in enough countries take action to reduce climate change" (0 = not at all likely,…, 10 = extremely likely)*. We expect a significant correlation government and individual action in a given country, assuming that governmental actions to reduce climate change are interpreted by respondents as aimed at (and effective in) affecting individual behaviours in other countries. Our interpretation is that respondents believe that: (i) government choices remain crucial in ecological transition despite the importance of individual behaviours (e.g. through the national climate plans, emission trading systems, carbon border adjustment mechanisms, the policy of authorization for newly installed capacity and fiscal policies (tax/subsidies) more or less in favour of renewable versus fossil fuels, such as in the issue of environmentally harmful or friendly subsidies); (ii) government behaviour also proxies preferences of citizens or, in any case, can ease or limit their ecological choices.

Descriptive inspection of the first variable shows that only 4.3 percent of respondents are not worried at all, while 37.4 percent of them are very or extremely worried (Fig. 4B). On the second variable, 7 percent believe governments are not at all likely to take actions against climate change (Fig. 4C). It is also remarkable that most of the respondents (59.3 percent) do not choose a score higher than 5 to this question.

3.2. Econometric model

The benchmark specification used to test our research hypothesis is

$$\mathsf{Responsible}_i = \beta_0 + \beta_1 \mathsf{Worried}_i + \beta_2 \mathsf{Governments}_i + \boldsymbol{\beta}_h \mathbf{X}_i + \boldsymbol{\beta}_k \mathbf{Z}_i + \boldsymbol{\beta}_c \mathbf{Country}_i + \varepsilon_i \quad (1)$$

where the dependent variable Responsible measures how much the respondent believes is her/his responsibility to act against climate change; the two main explanatory variables are Worried and Governments, that capture the respondent's degree of concern for climate change and how much the respondent believes other governments will take action against climate change, respectively. We as well control for a vector of sociodemographic characteristics, $\mathbf{X}_i$, which includes sex, age grouped in five-year brackets, years of education, income decile, household size, employment status, and marital status of each respondent; also, we add a vector of political preferences and satisfaction variables, $\mathbf{Z}_i$, which includes self-assessed health, income satisfaction, political preferences, and social capital proxied by whether the respondent had voted in the last election. The model is augmented with a vector of country dummies, $\mathbf{Country}_i$, and estimated using standard errors clustered at country level.

Ordered logit estimate findings are presented in Table 3. Both respondent's perception of the severity of the climate problem and

Table 2
Descriptive statistics.

Variable	Obs.	Mean	Std. dev.	Min	Max
Responsibility to act	36,503	5.94	2.68	0	10
Worried about Climate	36,957	3.23	0.95	1	5
Female	37,611	0.54	0.50	0	1
Other governments action	35,677	4.89	2.46	0	10
Income					
1	29,372	0.058	0.233	0	0
2	29,372	0.11	0.31	0	1
3	29,372	0.11	0.32	0	1
4	29,372	0.12	0.32	0	1
5	29,372	0.12	0.32	0	1
6	29,372	0.11	0.31	0	1
7	29,372	0.11	0.31	0	1
8	29,372	0.10	0.30	0	1
9	29,372	0.08	0.27	0	1
10	29,372	0.08	0.27	0	1
HHsize	37,476	2.55	1.34	1	13
Marital status					
Married	37,267	0.480	0.500	0	1
Civil Union	37,267	0.01	0.10	0	1
Separated	37,267	0.02	0.14	0	1
Divorced	37,267	0.09	0.29	0	1
Widowed	37,267	0.09	0.29	0	1
Never Married	37,267	0.30	0.46	0	1
Employment status					
Retired	37,611	0.27	0.44	0	1
Student	37,611	0.07	0.25	0	1
Unemployed in search	37,611	0.04	0.19	0	1
Unemployed not in search	37,611	0.02	0.14	0	1
Employed	37,611	0.54	0.499	0	1
Houseworker	37,611	0.09	0.29	0	1
Disabled	37,611	0.03	0.16	0	1
Education	37,611	13.25	4.22	0	25
Self-Assessed-Health					
Very good	37,567	0.257	0.437	0	1
Good	37,567	0.42	0.49	0	1
Fair	37,567	0.25	0.43	0	1
Bad	37,567	0.06	0.24	0	1
Very bad	37,567	0.01	0.10	0	1
Politics	32,314	5.22	2.35	0	10
Vote	37,611	0.71	0.45	0	1
Income satisfaction	37,126	2.00	0.85	1	4
Active citizen	36,265	0.05	0.226	0	1
Age class					
15–19	37,319	0.04	0.202	0	1
20–24	37,319	0.06	0.230	0	1
25–29	37,319	0.06	0.233	0	1
30–34	37,319	0.07	0.251	0	1
35–39	37,319	0.08	0.264	0	1
40–44	37,319	0.08	0.273	0	1
45–49	37,319	0.08	0.277	0	1
50–54	37,319	0.09	0.284	0	1
55–59	37,319	0.09	0.287	0	1
60–64	37,319	0.09	0.285	0	1
65–69	37,319	0.08	0.278	0	1
70–74	37,319	0.08	0.265	0	1
75–79	37,319	0.05	0.224	0	1
80–84	37,319	0.04	0.183	0	1
85+	37,319	.02	0.139	0	1

the effort of enough governments to tackle climate change affect positively and significantly the dependent variable. The result is robust to different specifications.

Our first finding implies, consistently with our model, that we may expect that when increasingly frequent extreme climatic events make people always more worried, and therefore more aware of the severity of the situation, they increase intrinsic motivations and the expected payoff of ecological action and stimulate their responsibility to act. In this sense, our findings come in support of the so called hypothesis of the pedagogy of catastrophes.

Our second finding leads to rejecting our first null hypothesis formulated under the assumption that individuals are unaffected by their expectations of other players (government) cooperative behaviour. The significance of the government effort variable can be interpreted as evidence of conditional cooperation, a well-known finding in the experimental behavioural economic literature (Fischbacher et al., 2001) and will discussed more in depth in the section that follows.

In testing our research hypothesis on our second variable of interest (the belief that other governments will/will not act) we use as an approximation an estimate where the dependent variable is assumed to be continuous and calculate that moving from the lowest to the highest value of the perception of other governments effort produces an effect of 1.2 (less than 50 percent its standard deviation) on the dependent variable. The effect of respondent worries is much stronger in magnitude with an impact – when moving from the lowest to the highest value, net of the effect of the other controls introduced in the specification – of 4.8 points that is more than 1.5 the standard deviation of the dependent variable.

Table 3
The effect of perceived severity of climate change and expected action of other governments on responsibility to act for climate change.

Variables	(1)	(2)	(3)	(4)	(5)
Worried	0.992***	0.995***	1.008***	1.008***	1.010***
	(0.063)	(0.064)	(0.063)	(0.063)	(0.063)
Female	0.23***	0.23***	0.24***	0.24***	0.24***
	(0.035)	(0.035)	(0.037)	(0.037)	(0.037)
Education	0.04***	0.04***	0.03***	0.03***	0.03***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)
Socio-demographics	Yes	Yes	Yes	Yes	Yes
Pseudo Log L	-55,842	-55,792	-50,231	-50,177	-50,110
Observations	27,668	27,655	24,990	24,980	24,952

The estimated specification is described in Eq. (1). Column (1) does not include vector $\mathbf{Z}_i$; Columns (2)–(5) add sequentially health, politics, social capital, and income satisfaction.
Robust standard errors clustered at country level in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.

Table 4
The effect of perceived severity of climate change and expected action of other governments on responsibility to act for climate change — sample subgroups.

Variables	(1) Females	(2) Males	(3) ≥55 yo	(4) <55 yo	(5) Voted	(6) Abstained	(7) High educated	(8) Low educated
Worried	1.02***	1.00***	0.91***	1.11***	1.01***	1.03***	1.05***	0.93***
	(0.080)	(0.056)	(0.066)	(0.065)	(0.056)	(0.083)	(0.076)	(0.049)
Governments	0.12***	0.12***	0.13***	0.11***	0.12***	0.12***	0.12***	0.12***
	(0.016)	(0.017)	(0.014)	(0.019)	(0.017)	(0.018)	(0.018)	(0.014)
Female			0.23***	0.25***	0.26***	0.20***	0.26***	0.17***
			(0.037)	(0.045)	(0.044)	(0.046)	(0.042)	(0.055)
Education	0.04***	0.02***	0.03***	0.04***	0.03***	0.03***	0.03***	0.01
	(0.005)	(0.007)	(0.006)	(0.007)	(0.005)	(0.008)	(0.007)	(0.013)
Sociodemographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo Log L	-25,823	-24,217	-23,241	-26,728	-37,922	-12,104	-36,173	-13,817
Observations	13,012	11,940	11,350	13,602	18,963	5,989	18,230	6,722

Note: The estimated specification is described in Eq. 1, section 4. The samples of column (1)-(8) are, respectively, females, males, people aged above 55 years old, people aged 55 or below, people who had voted at the last election, people who had not voted at the last election, people with more than 15 years of education, and people with less than 12 years of education.
Robust standard errors clustered at country level in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.

Among other controls the positive and significant effect of income supports the hypothesis about the risk that environmental action for ecological transition is perceived as a "luxury good" and the importance of just transition policies to avoid hostility of low-income classes to it. The positive effect of education is also expected given the nexus between education and social capital and the characteristics of education programs always more oriented to discuss climate challenges.

4. Robustness checks and discussion

Our model takes into account heterogeneous other-regarding preferences and therefore predicts the positive effect of eco-anxiety on the dependent variable but not that of the responsibility of other governments. In order to account for the observed effect, an extension of it should include players' expectations about to what extent other governments, and consequently other players in the game according to what considered in section 3.1, are acting against climate change. More specifically, the other-regarding preference component could be written as $a(w_i, E_i[E(s_k)])$, where $E_i[E(s_k)]$ if individual i's expectation about the average perception of other players' choice. In this way, theoretical beliefs about others can explain the positive effect of the perception of other government actions shown in the empirical analysis. This assumption could be explained by guilt aversion, where guilt is conditional to the number of those who cooperate. Alternatively, this can be viewed as a Kantian sense of duty, where also the latter is conditional to the number of those who cooperate (e.g., I feel increasingly violating a moral duty if more people cooperate and I do not).

A policy implication of our theoretical and empirical findings is that what can really increase willingness to act is not a higher value of the individual externality generated by the action (since the effect of the latter remains negligible in the presence of a very high number of players in the world ecological game) but her/his intrinsic motivations and all factors affecting it. Updated information on the severity of climate change and education to moral values can therefore crucially affect the likelihood of a cooperative solution to the global ecological game. A further implication relates to the importance of government ecological choices taking into account the positive externalities they generate on ecological action of other players.

4.1. Subsample analyses

We estimate our model delimiting our sabsamples on education, age, income, and social capital. Our two main variables of interest remain positive and significant in all subsamples (Table 4). Age plays a key role, as when we look at the younger subgroup we find that worry for climate change has a stronger effect and other government action a weaker effect on the responsibility to take action. The second effect suggests that the cooperative attitude for ecological actions of the young is less conditional on the expectation of other players' action, consistently with differences in time horizons and intertemporal discount rates of different age classes, with the young expected to suffer more from long run consequences of climate change.

In a further robustness check we introduce the average level of our dependent variable (Responsible) at country and regional level as additional controls. This allows us to net out the effect of the dependent variable from its average in that region and to see if the average responsibility feeling in the region positively affects individual responsibility on its own. At descriptive level, the lowest country average of

Table 5
The effect of perceived severity of climate change and expected action of other governments on responsibility to take action for climate change — controlling for domestic respondents' responsibility and active citizenship.

Variables	All		Active citizens only	
	(1)	(2)	(3)	(4)
Worried	1.01***	1.01***	1.06***	1.05***
	(0.063)	(0.062)	(0.099)	(0.098)
Governments	0.12***	0.12***	0.12***	0.12***
	(0.016)	(0.015)	(0.032)	(0.030)
Responsible country	0.31***		0.22***	
	(0.037)		(0.060)	
Responsible regional		0.56***		0.70***
		(0.067)		(0.147)
Female	0.24***	0.25***	0.28***	0.29***
	(0.037)	(0.038)	(0.100)	(0.098)
Education	0.03***	0.03***	0.04***	0.04***
	(0.005)	(0.005)	(0.012)	(0.011)
Pseudo Log L	-50,110	-49,964	-4,392	-4,376
Observations	24,952	24,952	2,282	2,282

Note: Responsible country and Responsible regional are, respectively, the country average and the NUTS-1 average of Responsible.
Robust standard errors clustered at country level in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.

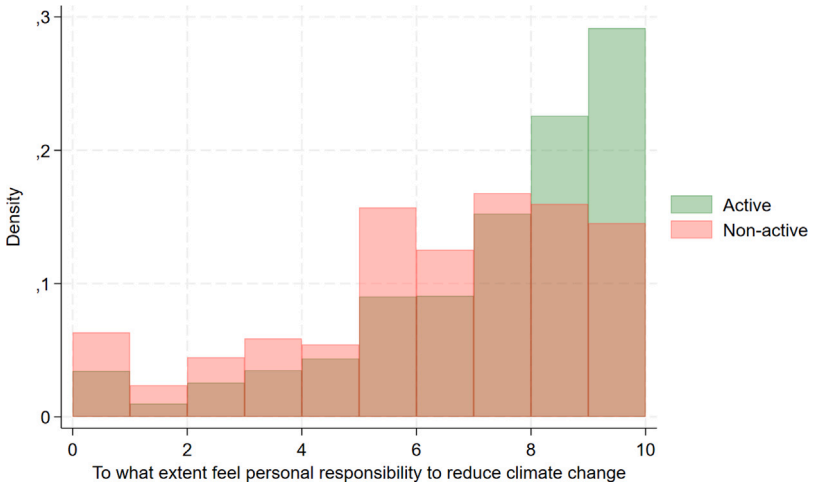

Fig. 3. Effects of intrinsic motivation on the boundaries of the area of the prisoners' dilemma along the segment of the costs of adopting ecologically sustainable behaviour.

responsibility to take action is declared in the Montenegro, while the highest is in France (4.1 vs 7.5, see Table A1). Estimates show that the two main regressors of interest remain positive and significant with the added control also having a positive and significant effect (Table 5, columns 1–4).

In our benchmark specification we consider the respondent's worry and its expectation about other government action as continuous variables in our estimate. Robustness checks using them as categorical variables do not change our main results and show that both variables of other nationals and other government action are strongly positive and significant (results are available upon request).

We acknowledge that the ESS10 measures intention and not action, and this may represent a limit of our analysis. In fact, we implicitly assume that the feeling that it is personal responsibility to take action finds a correspondence in straightforward action but we cannot provide evidence of that. In order to address this problem we identify a subsample of more active citizens by creating a variable summing positive answers to the following five questions of actions taken in the last 12 months: (i) donated to or participated in political party or pressure group; (ii) worn of displayed campaign badge/sticker; (iii) taken part in public demonstration; (iv) boycotted certain products; (v) signed petition. We find that a subsample of respondents (24 percent of the sample) has taken at least three of these five actions in the last year. We regard this group of more active citizens as more reliable in moving from declarations to facts when saying it is their responsibility to act for the environment. For a further check on the nexus between the active citizen variable and personal responsibility to reduce climate change we plot in Fig. 3 the distributions of the dependent variable for individuals with active citizenship index above 2 (more active) against those with active citizenship index below 3 (less active). The difference between the two distributions is remarkable and significant (the null hypothesis of equality of the two distributions is rejected by the Epps–Singleton test (W2 392.913.393, *p*-value 0.000)). We therefore estimate our model for this subsample and for the complementary group. We find that our results are confirmed for both groups. It is also interesting to see that our main findings are confirmed (in terms of declarations of responsibility as measured by our dependent variable) also in the complementary sample.

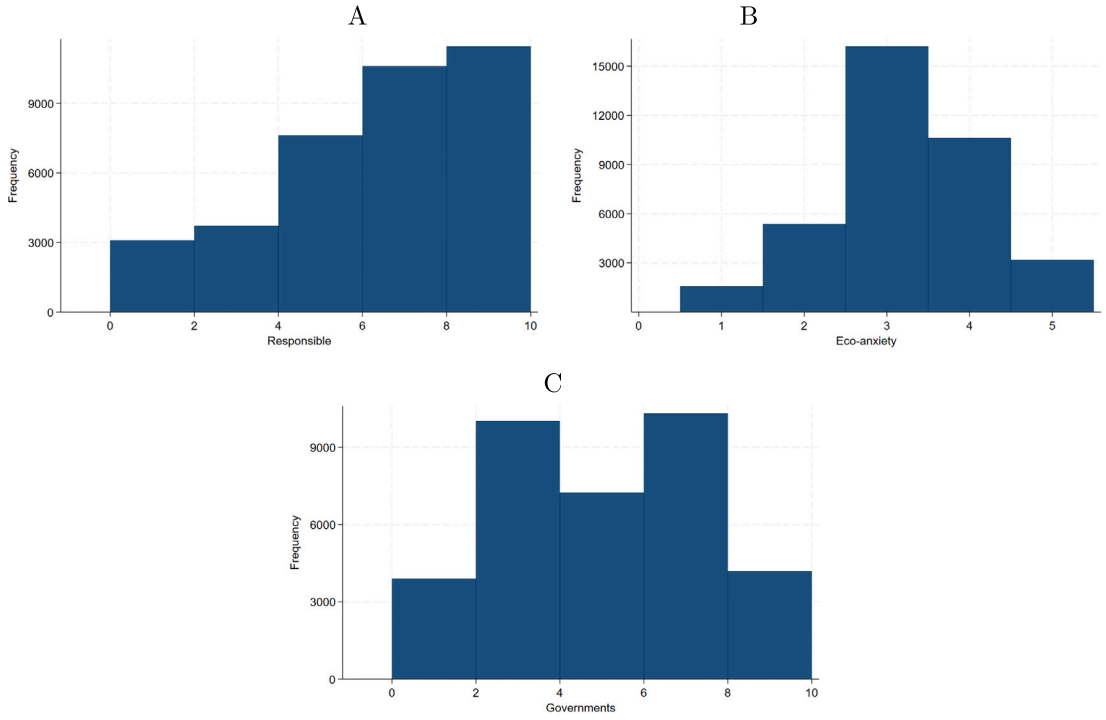

Fig. 4. Frequency distribution of the main variables of interest.
Legend: Figure A shows the frequency distribution of the answer to the question *"to what extent you feel it is your personal responsibility to reduce climate change?"* on a 0–10 scale (0 = not at all, …, 10 = a great deal), grouped in five bins; Figure B shows the frequency distribution of the answer to the question *"how likely, governments in enough countries take action to reduce climate change"* on a 0–10 scale (0 = not at all likely, …, 10 = extremely likely), grouped in five bins; Figure C shows the frequency distribution to the question *"how worried about climate change"* (Not at all worried, not very worried, somewhat worried, very worried, extremely worried).

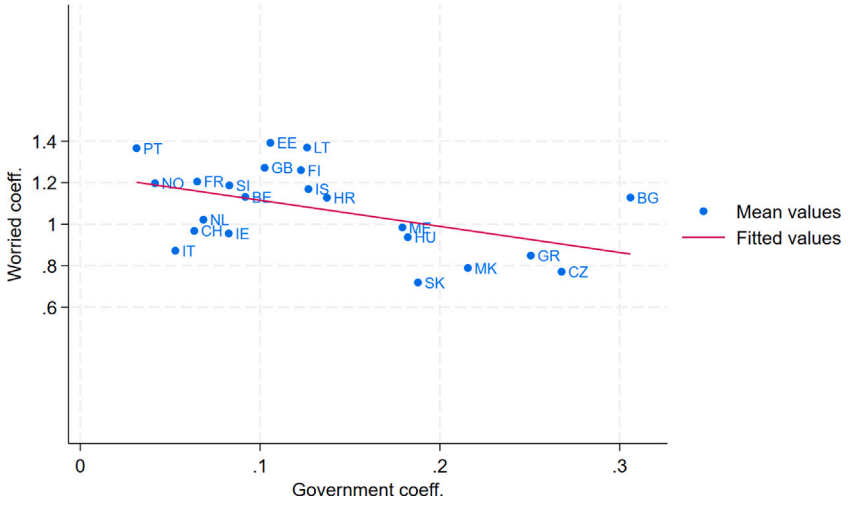

Fig. 5. The effect of perceived severity of climate change and expected action of other governments on the individual respondent's declared responsibility to take action for climate change — distribution of the two coefficients in individual country estimates.
Legend: The horizontal and the vertical axes displays the coefficients β_1 and β_2, respectively, of Eq. (1) arising from the estimates for each single country.

4.2. Explaining country and regional distribution of estimated coefficients

We try to shed more light on country and regional differences of our two main coefficients of interest (reaction to one's own worry and reaction to the belief about the future other government action). The inspection of the distribution of the "worry" and "other government action" coefficients shows a negative correlation between the two: in general, countries with higher level of human and social capital have higher and lower values for the first and second coefficient respectively (Fig. 5). To test whether our conjectures are statistically significant we estimate three specifications where the two coefficients separately taken (or the worry/other government ratio) are, in turn, dependent variables and average country human and social capital (years of education and percent of voters in the last national election

Table 6
Effects of country social and human capital on the estimated effects of perceived severity of climate change and expected action of other governments on responsibility to take action for climate change at country level.

Variables	(1) Ratio	(2) Worried coeff.	(3) Governments coeff.	(4) Ratio	(5) Worried coeff.	(6) Governments coeff.
Vote	23.55**	0.362	−0.274***			
	(10.74)	(0.312)	(0.0905)			
Social capital				15.04**	0.161	−0.132***
				(5.856)	(0.129)	(0.0327)
Education	−0.734	0.0282	−0.0145	−4.598	−0.0173	0.0214
	(2.669)	(0.0392)	(0.0134)	(3.041)	(0.0550)	(0.0136)
Politics	−5.679	−0.0590	0.0676	−1.939	−0.0113	0.0288
	(5.461)	(0.0827)	(0.0435)	(3.996)	(0.0685)	(0.0297)
Constant	19.66	0.518	0.344	82.78*	1.359	−0.297
	(54.85)	(0.875)	(0.369)	(45.43)	(0.818)	(0.230)
Observations	22	22	22	22	22	22
R-squared	0.158	0.158	0.260	0.426	0.108	0.500

Note: Ordinary least squares (OLS) estimates of the model $y = a + b_1 \text{Social capital} + b_2 \text{Education} + b_3 \text{Politics} + c$; y is the ratio between the coefficients β_1 and β_2 estimated for each country using OLS models as in Equation 1 (column 1), or β_1 (column 2), or β_3 (column 3); Social capital, education, and politics represent their respective country average.
Robust standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.

Table 7
Effects of regional social and human capital on the estimated effects of perceived severity of climate change and expected action of other governments on responsibility to take action for climate change at NUTS1 level.

Variables	(1) Ratio	(2) Worried coeff.	(3) Governments coeff.	(4) Ratio	(5) Worried coeff.	(6) Governments coeff.
Vote	92.73	0.319	−0.207**			
	(84.47)	(0.308)	(0.0805)			
Social capital				10.55	0.544*	−0.144***
				(25.48)	(0.312)	(0.0388)
Education	2.084	−0.0564	−0.00344	−9.282	−0.186	0.0294**
	(3.092)	(0.0879)	(0.0128)	(13.33)	(0.136)	(0.0143)
Politics	−28.15	−0.104	−0.0193	−1.566	−0.0635	−0.0200
	(30.76)	(0.134)	(0.0423)	(17.69)	(0.126)	(0.0336)
Constant	14.25	1.893	0.557*	172.5	3.857*	−0.159
	(94.96)	(1.512)	(0.322)	(176.1)	(2.150)	(0.265)
Observations	59	59	59	59	59	59
R-squared	0.045	0.051	0.077	0.003	0.159	0.156

Note: Ordinary least squares (OLS) estimates of the model $y = a + b_1 \text{Socialcapital} + b_2 \text{Education} + b_3 \text{Politics} + c$; y is the ratio between the coefficients β_1 and β_2 estimated for each NUTS1 using OLS models as in Equation 1 (column 1), or β_1 (column 2), or β_3 (column 3); Social capital, education, and politics represent their respective NUTS1 average.
Robust standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.

following Guiso et al. 2014 and many others in the literature (see Durante et al. 2023 among others)) plus placement on the left–right scale of respondents our regressors. Our third dependent variable of interest here (the worry/other government ratio) can be interpreted as the unconditional willingness to take responsibility to act on worries about climate change.

Our findings clearly show the strong and significant effect of social capital on the other government action that drives also the result when the dependent variable is the ratio of the two main coefficients of interest. The "worry" variable seems unaffected by our regressors (Table 6, column 2). Our interpretation is that domestic social capital significantly and positively affects unconditional cooperation that is, the propensity to act even when it is believed that other countries will not act or will act mildly. We replicate our analysis at regional levels using the NUTS 1 classifications recorded in the dataset. Our main findings remain unchanged with social capital significantly and negatively affecting the impact of other governments action on the respondent responsibility to act (Table 7).

In a robustness check, we refine our measure of social capital and exploit several dimensions of social capital considered by the literature, namely general trust, volunteering activities, and political engagement. More specifically, we use a principal component analysis and we extract the principal component from the following three variables: volunteering (0/1 dummy equal to 1 if the respondent has volunteered for a not-for-profit or a charitable organization over the last year), political engagement (0/1 dummy equal to 1 if the respondent has donated to or participated in political party or pressure group over the last year), and general trust (the answer to the question whether most people can be trusted or you cannot be too careful, on a 0–10 scale). Results are consistent with the use of voting as social capital (Tables 6 and 7, columns 4–6).

5. Conclusion

We model the climate challenge as a multiplayer prisoners' dilemma played by individuals with heterogeneous conditional intrinsic motivations where doing nothing is the dominant strategy for a myopically

self-interested player and ends up being the Nash equilibrium creating a social dilemma of ecological transition. We wonder how the perception of the severity of the problem and the belief that other governments will also act ecologically affects the respondent's responsibility to take action.

The prediction of our model where we condition intrinsic motivations to personal worry about climate change is that the first factor affects payoffs and therefore has a positive impact on the responsibility to take action, while the second factor does not change the behaviour of a player conventionally modelled with self-regarding preferences. Our findings show however that both factors affect positively and significantly the dependent variable finding evidence of conditional cooperation in players' preferences. About the second variable we find that not only the expectation that enough other governments will act, but also the average level of responsibility to take action of individuals of the same country and region both affect significantly and independently. We show that these empirical findings can be predicted by an enriched version of our model where intrinsic motivations depend also on other players' action and explain why this could be the case.

If the observed correlation imply also causality the policy implications of the paper would be straightforward. A first indication is that policies that increase the involvement of other states in ecological transition can generate a positive externality by enhancing individuals' responsibility to act. In fact, our findings show that people feel more responsible if they perceive other countries' effort high enough. This is something that should be taken into account when considering for instance pros and cons of initiatives such as the introduction of carbon border adjustment mechanisms (CBAM), where the decision of a given economic area (i.e., the European Union or the US) can increase involvement in ecological transition of third countries. The Carbon Border Adjustment Mechanism establishes that the import of goods and services that use environmental standards (i.e., limits to greenhouse emission in the product life cycle perspective) below those followed by producers of the importing area should pay a tax when entering that area. The effect of the mechanism is that of reducing the risk of environmental dumping, thereby increasing competitiveness of domestic products following high environmental standards and stimulating third countries to raise environmental standards not to pay the border tax. Our findings indicate that a positive externality of the CBAM when it improves environmental engagement of other governments is the increase in the responsibility to take action of individuals in the global ecological game.

Another relevant implication is that communication, information, and education campaigns on the severity of the climate threat can affect significantly the propensity of individuals responsibility to take action. Making people aware of the climate crisis and its consequences increases their responsibility sentiments and, as a result, their likelihood to take cleaner actions. From a government perspective, information campaigns can therefore be seen as an investment in increasing citizens consciousness and actions for the better, and this will make more productive government economic and normative efforts in reducing emissions. Moreover, our results show that concurring changes in perceived responsibility to act at domestic and regional levels can reinforce individual action in this direction.

The limit of our empirical analysis is the lack of measures of effective action so that our conclusions hold if the feeling of responsibility to take action translates into action itself. We partially addressed this problem by identifying a subgroup of activist respondents where willingness and action are more likely to coincide. Future research can test whether our findings are confirmed when having data measuring actual behaviour.

CRediT authorship contribution statement

Leonardo Becchetti: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Gianluigi Conzo:** Data curation, Methodology, Software, Writing – review & editing. **Francesco Salustri:** Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The author declare that they have no conflict of interest.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.ecolecon.2024.108371.

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