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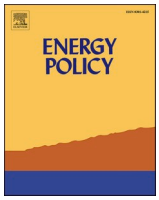

Promoting pro-environmental choices while addressing energy poverty

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ABSTRACT

Policy-makers can address climate change by promoting energy sufficiency and energy efficiency. They can do so through not only traditional economic interventions but also behavioural ones, such as nudges and boosts.

However, some individuals are not free to decide how to engage in these pro-environmental strategies. The energy poor may be prevented from choosing options enabling them to meet their energy needs while emitting less. In this context, a combination of financial and behavioural interventions might help achieve both climate change and energy poverty goals. This study introduces a modified public bad game to investigate experimentally the situation in which individuals can choose how to obtain energy services while producing negative externalities. We implement a behavioural intervention using a practice-based boost to empower the understanding of action interdependence and test whether it increases pro-environmental choices. Additionally, we model the income scarcity underlying energy poverty and test the effect of a financial intervention, both alone and combined with the practice-based boost, on pro-environmental choices. Although we observe no positive impact of the boost on pro-environmental choices, we find that a financial intervention alone is effective at addressing energy poverty while also promoting pro-environmental choices.

1. Introduction

Mitigation strategies related to climate change increasingly emphasize energy efficiency and energy sufficiency as key components (Belaïd and Massié, 2023b; Bertoldi, 2022). Energy efficiency, involving the use of technologies that provide a certain energy service while using less energy, has traditionally dominated energy policy discussions (Dunlop, 2019). In contrast, energy sufficiency addresses consumption levels by limiting the demand for energy services, while ensuring well-being within planetary boundaries (IPCC, 2022).

Understanding the drivers of choices related to energy efficiency and energy sufficiency is essential in this context (Spangenberg and Lorek, 2019). Behavioural economics provides a valuable theoretical framework, offering causal insights into human behaviour. It recognises that individuals are bounded rational (Simon, 1955, 1957) and often rely on heuristics to make decisions (Tversky and Kahneman, 1974), allowing us to systematically understand drivers of choices (Kahneman, 2003) and levers for effective policy interventions (Loewenstein and Chater, 2017).

Policy makers now have a wide array of tools complementing traditional economic interventions to promote behaviour change. These include behavioural economic interventions (Loewenstein and Chater, 2017) of which nudges and boosts represent the main illustrations (Vandyck et al., 2023). Nudges target individual behaviour by addressing cognitive or motivational deficiencies in the intuitive System 1 (Hertwig, 2017). In contrast, boosts focus on empowering individual competences by engaging and strengthening the deliberative System 2 as well as the interplay between the two systems (Grüne-Yanoff and Hertwig, 2016). While there is a wealth of empirical evidence on nudges, boosts have been less applied and require more empirical validation (Banerjee and John, 2021).

Besides finding ways to address climate change, policymakers also face other pressing challenges, such as energy poverty. This is defined as a household's lack of access to essential energy services that provide basic levels and decent standards of living and health (European Commission, 2021). Energy poverty is, thus, a problem of distributive justice that constrains the capacity of the energy poor to act (Walker and Day, 2012) and be protagonist of the energy transition (Della Valle and Czako, 2022). Addressing energy poverty is recognised as a policy priority in Europe, as evidenced by the recent adoption of the revision of

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the Energy Efficiency Directive (European Commission, 2021) and the Second Recommendation on Energy Poverty (European Commission, 2023). In addition to urging Member States to implement measures to address energy poverty, these policy documents underscore the importance of empowering households in energy poverty to actively participate in the transition.

This study seeks to contribute to this broader policy discourse by experimentally evaluating the efficacy of instruments by which citizens' actions can be leveraged to address not only the pressing challenges of climate change, but also the equally critical issue of energy poverty. By doing so, we aim to identify practical solutions that facilitate progress toward both these interconnected policy goals.

To accomplish this objective, we conduct an economic experiment using a modified public bad game. Specifically, we test the effect of a novel behavioural instrument that aims to empower energy efficiency and energy sufficiency actions: a practice-based boost. A boost rather than a nudge has been selected, since the boosting approach is particularly relevant for policy-makers when the target population is vulnerable (Della Valle and Sareen, 2020). This set-up enables us to test whether the boost intervention can effectively promote energy efficiency and energy sufficiency in both the general and the vulnerable populations.

With regard to the experimental method, this has been chosen due to the limited available data on policies targeting both climate change and energy poverty (Bessa and Gouveia, 2022), which do not allow us to adequately assess the efficacy of instruments designed to address both climate change and energy poverty. Instead, through rigorous control over variables, the experimental method enables us to establish causal relationships between interventions and pro-environmental choices (Lunn and Choisdealbha, 2018), providing evidence-based insights for policymakers and researchers in the energy domain (Della Valle and Bertoldi, 2021; Sousa Lourenco et al., 2016).

Our study positions itself at the intersection of several research streams and makes different contributions. First and foremost, it addresses the imperative for energy and climate policies to be justice-aware, particularly concerning energy poverty (Sovacool et al., 2017). We investigate interventions that not only may enable us to address the goals of climate change mitigation, but also tackle the pressing issue of energy poverty. By assessing the efficacy of a novel behavioural instrument in promoting pro-environmental behaviour among both the general and vulnerable populations, we provide evidence to support justice-aware policy development.

Second, our research contributes to the field of behavioural energy policy. We assess the effectiveness of a novel behavioural instrument in promoting energy efficiency and energy sufficiency behaviours. This not only advances our understanding of the behavioural mechanisms that underlie these choices, but also offers practical insights for policymakers looking to employ effective behavioural instruments in their policy mixes (Alt et al., 2024).

Lastly, our study delves into the realm of energy poverty policy. By evaluating the efficacy of interventions on a vulnerable population, we contribute to the broader discourse on addressing energy poverty. Our findings may inform the development of interventions that empower energy-poor households to make pro-environmental choices, thus bridging the gap between energy justice and sustainability.

The paper proceeds as follows: Section 2 presents the conceptual background and research questions; Section 3 describes the theoretical framework and experimental design; Section 4 reports the experimental results, which are discussed in Section 5. Section 6 concludes.

2. Understanding and promoting pro-environmental choices through behavioural economics

2.1. Simulating and boosting pro-environmental choices

Policy strategies have increasingly centred on energy efficiency and energy sufficiency as essential components for addressing the consequences of climate change (Belaïd and Massié, 2023b). In this context, tailored public policies that consider individual drivers, including contextual and attitudinal attributes, and the diverse distribution of sources (i.e. housing stock, income) are more likely to effectively promote energy sufficiency behaviours and investments in energy efficiency (Belaid, 2024). However, for this to happen, understanding the drivers of choices related to energy efficiency and sufficiency becomes crucial (Belaïd and Massié, 2023a).

Behavioural economics provides a valuable theoretical framework, offering causal evidence-based insights to understand human behaviour, including energy sufficiency and energy efficiency choices (Della Valle and Bertoldi, 2022). These evidence-based insights help us understand why some individuals willingly invest in energy efficiency or reduce their energy consumption, even without financial incentives, as they are intrinsically motivated to do so (Chersoni et al., 2022), e.g. because they see investing in energy efficiency as a way to protect the environment (Belaïd and Massié, 2023a).

More specifically, in the realm of behavioural economics, when individuals voluntarily limit energy services or adopt energy-efficient technologies to reduce their carbon footprint without external incentives, they exhibit the so-called pro-environmental behaviours (Chersoni et al., 2022; Sorrell et al., 2020). Pro-environmental behaviours refer to actions that minimize harm to the environment or even benefit it (Steg and Vlek, 2009). This decision can be seen as a cooperative action in a social dilemma, as individuals internalize the associated externalities (Benabou and Tirole, 2012; Brekke and Johansson-Stenman, 2008). Particularly, when individuals are faced with the choice to select through which option (e.g. energy practice, technology) they can obtain an energy service (e.g. heating, cooling), they decide not only their individual utility level (e.g. comfort), but also a certain level of emissions on the society (Gillingham and Palmer, 2014; Sorrell et al., 2020).

A key approach to explore the determinants of these cooperative choices is the experimental one. In fact, the experimental economic method has enabled to derive a wealth of evidence-based insights on drivers and barriers that drive cooperation in social dilemmas (Bó and Fréchette, 2018; Chaudhuri, 2011; Zelmer, 2003). This extensive empirical evidence on barriers and drivers is particularly valuable for policy makers, as it unveils key levers that can be incorporated in policy design (Loewenstein and Chater, 2017). As an example, the evidence that individuals struggle to cooperate when they find it difficult to understand the relationship between their actions' consequences on themselves and others (Alempaki et al., 2022), suggests that empowering the understanding of action interdependence can be a candidate solution to be investigated. More particularly, one can assume, based on the *team reasoning theory*, that making it easier to understand action interdependence may prompt individuals to consider the collective perspective and lead to more cooperative choices (Faillo et al., 2017).

A way to operationalise this evidence-based solution into policy would be through the introduction of a behavioural economic intervention, and specifically a boost empowering individuals' ability to understand the interdependence between their choices, others' choices, and the resulting outcomes. As any type of boosts, this boost would aim to empower individuals to autonomously cope with complex environments by enhancing cognitive processes (Hertwig, 2017). However, whether such a boost would be effective in a complex context involving strategic interactions, like social dilemmas, remains an open question that requires empirical validation, such as through an experiment.

Our study specifically fills this gap in the literature. Not only boosts have been less applied than nudges and require more empirical validation (Banerjee and John, 2021), but also their application to energy-related decisions with strategic interactions between decision-makers remains relatively unexplored (Blasch et al., 2022; Caballero and Ploner, 2022; Lazaric and Toumi, 2022).

To test the efficacy of the boost empowering the understanding of

action interdependence, we conduct an experimental economic study that simulates a scenario where individuals must select from various options how to obtain energy services, each associated with different levels of emissions and utility trade-offs (Gillingham and Palmer, 2014; Sorrell et al., 2020). Individuals can engage in pro-environmental behaviours by either choosing a more expensive but energy-efficient option or a less beneficial yet energy-sufficient one. In doing this, we not only add to the behavioural energy policy literature, but also to the experimental economic one. Particularly, previous studies have simulated energy consumption behaviour in economic laboratory settings, but either did not consider externalities (Casal et al., 2017), or they did not test the effect of boosts on simulated energy consumption behaviour (Fanghella et al., 2021).

2.2. Addressing energy poverty

Promoting behavioural change is a key policy approach to mitigate climate change consequences (Steg et al., 2021). However, as for all climate policies (Belaïd, 2022), also behavioural climate policies are at risk of being regressive if designed without incorporating justice concerns (Della Valle et al., 2023). For this reason, designing climate policies that leave no one behind, such as those that explicitly address energy poverty, becomes key (Vandyck et al., 2023).

In Europe, addressing energy poverty has already become a specific policy priority in Europe in sustainable transition policies (Bessa and Gouveia, 2022). Energy poverty refers to the household's lack of access to essential energy services that provide basic levels and decent standards of living and health (European Commission, 2021). It is a complex problem constraining the capacity of the energy poor to choose how to meet their energy needs (Walker and Day, 2012) and to actively participate in the energy transition (European Commission, 2023). Therefore, it hinders the ability to freely decide how to engage in pro-environmental behaviours (Della Valle and Czako, 2022). On the one hand, vulnerable citizens may face difficulties when considering costly environmentally friendly actions, like investing in energy efficiency, to meet their energy needs (Walker and Day, 2012). On the other hand, financial constraints can push the energy poor into less polluting energy options, as they need to allocate their limited resources for other essential needs (Sunikka-Blank and Galvin, 2012). However, this energy limiting behaviour cannot be considered truly pro-environmental, since it is not voluntarily chosen; rather, it is the result of unmet basic energy needs that require tailored interventions (Cong et al., 2022).

Member States have implemented various interventions, including information measures, consumer protection measures, energy efficiency programs, and financial interventions to address the main drivers of the complex phenomenon of energy poverty (Bessa and Gouveia, 2022; Dobbins et al., 2019). This plethora of different instruments is required to address not only the complex combination of causes that underlines energy poverty (e.g. low income, high energy expenses, and poor energy efficiency in buildings (Belaïd and Flambard, 2023; Simcock et al., 2017)), but also the probability to become energy poor (Belaïd, 2018).

A key intervention is the financial one, such as social tariffs levied on energy bills or provision of basic energy appliances, which specifically addresses the cost of energy (Barrella et al., 2022). By increasing income (i.e., income effects), it helps the energy poor affording to choose among more options to meet energy needs. Thus, a financial intervention targeted at the energy poor not only improves their access to energy, but also their capacity to actively participate in the energy transition by choosing less emitting options. However, it may also lead to increased energy consumption or the utilization of energy-intensive services, potentially resulting in higher emissions (Brockway et al., 2021). This potential rebound effect is also linked to the stream of research investigating how a former experience of economic scarcity affects pro-environmental behaviours (Elbaek et al., 2021; Kraus et al., 2012; Schofield and Venkataramani, 2021).

One way to preserve the efficacy of the financial intervention at addressing both the energy poverty (i.e. access to energy services) and climate change goals (i.e. contained emissions) would be to complement it with a behavioural intervention (DellaValle, 2019). This intervention would likely be a boost, given that, in the realm of behavioural interventions, the boosting approach can empower the typically low contextually-shaped agency of the energy poor more than a nudge (Della Valle and Sareen, 2020). This boost would also increase the likelihood of active participation in the energy transition as energy citizen rather than mere consumers (DellaValle and Czako, 2022).

So far, evidence on the efficacy of interventions addressing energy poverty is growing in Europe (Belaïd, 2022; Bouzarovski et al., 2021; Kyprianou et al., 2019; Pye et al., 2015). However, there is little empirical evidence assessing interventions addressing both climate change and energy poverty through a mix of interventions (Bessa and Gouveia, 2022; Caballero and Della Valle, 2021). Additionally, to the best of our knowledge, there is only one study experimentally testing the effect of a behavioural intervention in the form of a boost on vulnerable citizens' energy behaviours (Caballero and Ploner, 2022). However, this study did not investigate the effect of the boost in combination with a traditional economic intervention.

Our study adds to these streams of research, by experimentally investigating the impact of a policy mix on the willingness of individuals who have experienced income scarcity to engage in pro-environmental choices. In particular, we study a financial transfer alone and in combination with a boost empowering the understanding of action interdependence. To model the income scarcity affecting the energy poor's ability to freely choose among pro-environmental options, we vary income across groups, considering high-income groups, who can afford all available options, and low-income groups, who have financial constraints and can choose among a subset of cheaper options. Finally, we introduce the financial intervention targeting low-income groups in the form of increased income during the course of the experiment, enabling individuals to afford all available options.

We expect the policy mix combining the practice-based boost and the financial intervention to have a twofold effect. On the one hand, it can mitigate the income effects associated with the financial intervention implemented alone, by allowing individuals to explore all "new" affordable options before the game thus learning their individual and collective impact without costs. On the other hand, the boost can promote more pro-environmental choices over less green ones than in the case of the financial intervention alone.

2.3. Research questions

Overall, with this study we address three research questions (RQ).

RQ1. Is the practice-boost an effective tool to promote pro-environmental choices? Is it equally effective in promoting energy sufficient and energy efficient choices?
RQ2. Is a financial intervention in the form of a subsidy to low income people effective at simultaneously addressing energy poverty and promoting pro-environmental choices? With respect to pro-environmental choices, is it equally effective in promoting energy sufficient and energy efficient choices?
RQ3. Finally, is the mix of a financial intervention combined and a practice-boost more effective than a financial intervention alone at simultaneously addressing energy poverty and promoting pro-environmental choices?

3. Experimental design

In this study, we conducted an economic experiment. The choice of this approach is linked with the primary objective of the study: to gain insights into the underlying behavioural mechanisms of pro-environmental choices and test the effect of interventions on those choices. By adopting this approach, we are able to recreate decision-

making scenarios that closely mimic real-world energy-related choices, allowing us to observe and analyse behavioural responses in a controlled setting (Della Valle and Bertoldi, 2021). Particularly, the use of an economic experiment facilitates the isolation of key psychological and behavioural mechanisms that influence pro-environmental choices, which may operate beyond the specific context in which the choices are made. This approach ensures the robustness and validity of our findings and provides a solid foundation for drawing meaningful policy implications (Lunn and Choisdealbha, 2018).

The situation we aim to recreate in the laboratory is one in which an individual has to choose one among different available options to meet energy needs, and the options differ in three dimensions: private benefit, private cost, and social costs.

Consider an individual choosing a means to cool/heat the house. They can naturally ventilate and use curtains/wear warmer clothes and blankets. Alternatively, they can buy a cheap portable ventilator/cheap portable heater. These choices usually have low social costs (i.e., no or low energy is required) and low private benefits (i.e., they are not fully effective at cooling/warming). At the same time, everyone can afford these options. We call these low-benefit-low-cost-low-polluting options "energy sufficient", since they are sufficient to meet individual energy needs.

When more income is available, individuals might also choose a more effective means to cool/heat the house, like an air conditioning (AC) system/heating system. While these technologies might increase private benefits (by effectively meeting cooling/heating needs), they also require more energy and, thus, produce higher emissions. If the larger benefit given by the (more polluting) AC/cooling system compensates the larger private cost, the individual will choose the AC/heating system. However, if all individuals choose the AC/heating system, the total level of pollution can be so high that everybody would have been better off by naturally ventilating/wearing warmer clothes instead.

Nowadays, individuals also have the option to choose energy-efficient systems that cool/heat by using less energy (thus polluting less), although these are usually associated with a higher (private) cost. We call these more expensive-less-polluting options "energy-efficient", since they are able to give the same benefit as the AC system but with lower emissions. However, if the larger (private) cost of the energy-efficient option is not compensated by a larger benefit, individuals might still buy the inefficient AC system.

The problem here is one of negative externality: when choosing the inefficient AC/heating system, an individual is not paying for the total amount of pollution they are generating, as a large part of it is shared with the community. From here, the social dilemma arises: the sufficient outcome is the one in which everybody naturally ventilates/wears warmer clothes, but this is not an equilibrium, as everybody prefers the more expensive but associated with higher benefit AC/cooling system. Similarly, the energy-efficient outcome is the one in which everybody chooses the energy-efficient option, but neither this is an equilibrium, as everybody prefers the inefficient but cheaper AC/heating system. In other words, the only equilibrium outcome is the one in which everybody chooses the inefficient AC system, although everybody would have been better off in both the sufficient and the energy-efficient outcomes.

As explained before, we are interested in investigating whether and how the probability of choosing the sufficient and the energy-efficient options are affected by: i) being exposed to a boost aimed at enhancing the understanding of the action interdependence; and ii) a financial intervention after experiencing scarcity. To do this, we run an economic experiment using a modified public bad setting, similar to Calzolari et al., 2018. Our participants had to choose one among several available options, designed to resemble the different means to cool/heat the house we just described. We consider a baseline condition and four treatments.

- Baseline (Rich): Participants are rich, in the sense that they receive an endowment high enough to be able to choose among all the available options.
- Rich-Boost treatment: Participants are still rich, but we introduce a boost, that is, a practice period during which they could familiarize themselves with the game.
- Poor-Rich treatment: We introduce a scarcity period during which participants are poor, in the sense that they receive a lower endowment, so they could only choose among a subset of cheaper options. However, they receive a financial transfer and become rich during the experiment.
- Poor-Rich-Boost treatment: Similar to the Poor-Rich treatment, but participants also receive a boost at the beginning of the experiment.
- Poor treatment: Participants have the lower endowment throughout the experiment.

This last treatment was introduced because we did not want participants in the “Poor-Rich” treatments to know that they would eventually receive a monetary transfer and adapt their choices accordingly. That is, from the instructions all participants knew they could find themselves in one of three conditions: they could be rich (i.e., with a high endowment), poor (with a low endowment), or poor-rich (that is, poor participants switching to the rich condition during the experiment). A participant receiving a high endowment at the beginning of the experiment knew for sure to be rich, but a participant receiving a low endowment did not know whether they were in the “Poor” or in the “Poor-Rich” condition until the financial transfer was implemented.

In all conditions, we use an abstract context. This enables us to maximize experimental control and avoid experimental demand effects (Alekseev et al., 2017; Zizzo, 2010), while ensuring the replicability of the study irrespective of people’s beliefs (Johansson-Stenman and Konow, 2010; Sommer et al., 2022; Whitmarsh and O’Neill, 2010) and political attitudes (Alesina and Angeletos, 2005; Hahnel et al., 2020) associated with climate change and energy poverty challenges.

3.1. Baseline (rich)

In the baseline condition, participants have to choose one among four available options. At the beginning of the experiment, participants are randomly divided into groups of four. They make their choices over 20 rounds and, in each round, the group composition changed (to avoid direct reciprocity or group effects). In every period of the game, each participant received an endowment of 100 EMU (experimental monetary units), which s/he must use to select one option. The available options differ in three aspects: the private cost (i.e. the price), the individual benefit, and the social cost, that is, the cost that the participant imposes to all the members of the group.

The characteristics for each option are presented in Table 1, representing different types of technologies. Option A is considered the sufficient choice, imposing the lowest social cost to the group. Option B is also relatively sufficient, but less socially optimal than A. On the contrary, Option C imposes the highest cost to the group. Option D resembles the energy-efficient option, providing the same benefit as C but with a lower social cost.

In each round, participants simultaneously choose one option. The total social cost is computed by summing the social costs of the chosen options for each member of the group, and it is then divided equally

Table 1
Options available in the baseline.

Option	Price	Benefit	Social cost
A	20	30	20
B	40	60	40
C	80	120	80
D	90	120	60

among all group members. Each participant's payoff is equal to their initial endowment, plus the net benefit of their chosen option (i.e., the benefit minus the price), minus one fourth of the social cost generated by the entire group. At the end of the experiment, one round is randomly selected by the computer, and the participants' final payoff is based on the selected round.

We refer to this Baseline condition as "Rich" since participants are rich enough to choose any of the available options.

3.2. Treatments

We conducted four treatments to assess the effect of being exposed to a boost and/or receiving a financial transfer after experiencing scarcity. In all treatments, the game and payment structure remained the same as in the baseline. The only difference was the endowment of the participants under scarcity (the participants receiving the lower endowment), which was set at 50 EMU, allowing only options A and B to be chosen (see Table 1).

In the **Rich-Boost** treatment, participants had the opportunity to familiarize themselves with the task before playing the game with the other members of the group (and before knowing whether they would be rich or poor). We introduced a practice-based boost in the form of a user-friendly simulation that enabled participants to explore the relationship between outcomes, their own choices, and the choices of others. During a 10-min practice phase, participants could simulate and infer the consequences of all possible choices under both income scarcity and no income scarcity conditions (see Fig. 1). After this practice phase, they were informed of their actual endowment, and the experiment proceeded as in the baseline.

The **Poor-Rich** treatment represents a situation in which individuals, after experiencing income scarcity, receive a monetary transfer, enabling them to choose more expensive options that were previously precluded. In this treatment, participants received only 50 EMU at the beginning of each of the first ten rounds, limiting their choices to options A and B (see Table 1). However, after the tenth round, participants received 100 EMU at each subsequent round until the end of the game. Notably, participants did not know before the eleventh round whether they would receive the transfer or not.

In the **Poor-Rich-Boost** treatment, we combined both the boost (as in the Rich-Boost treatment) and an initial 10-round period of scarcity (as in the Poor-Rich treatment).

Lastly, in the **Poor** treatment, participants remained financially constrained throughout the 20 periods, without receiving any financial transfer.

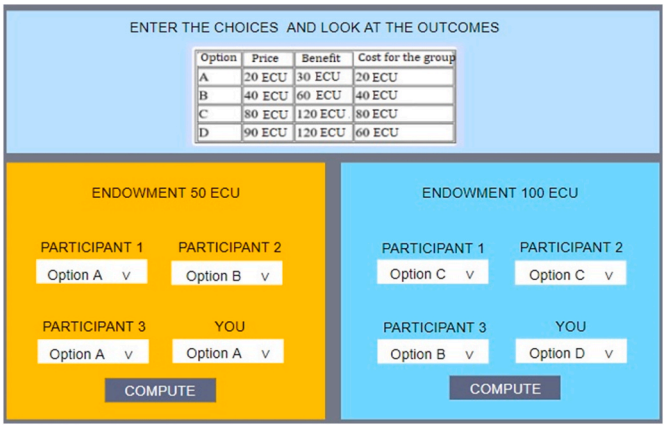

Fig. 1. A screenshot of the simulation tool.

3.3. Procedures

We conducted a laboratory experiment following common practices in experimental economics. In particular, participants were university students, as they provide a starting point for studying underlying mechanisms of behaviour (Falk and Heckman, 2009). The students were recruited through the recruitment platform of the Cognitive and Experimental Economics Laboratory (CEEL) of the University of Trento, which is specifically designed for organizing economic experiments.

The experiment was programmed and conducted using O-Tree. The entire session took place online, utilizing the Zoom platform. Participants received an email confirming their participation, along with a randomly generated alphanumerical ID and the link to access the O-Tree software. Upon joining the meeting on the day of the experiment, participants were immediately instructed to replace their names with the alphanumerical IDs. Additionally, they were asked to mute their microphones and keep their webcams active until the end of the experiment. The cross-subject chat function was disabled to prevent communication between participants during the experiment. At the beginning of the session, instructions (see Appendix) were displayed on the participants' screens and read aloud by an experimenter.[1] Before starting the experiment, participants had the opportunity to ask questions and were required to answer a series of control questions. The instructions were always available on the bottom of the screens, except during the control questions screen. Payments were made through bank transfer, with participants receiving an average of 10€ in addition to a show-up fee of 3€. Each session lasted approximately 1 h and 30 min.

A total of 284 students participated in the experiment. Among them, 64 were randomly assigned to the baseline (Rich) condition, 72 to the Rich-Boost treatment, 72 to the Poor-Rich treatment, 64 to the Poor-Rich-Boost treatment, and 12 to the Poor treatment. The lower number of participants in the Poor treatment is because these data are not meant for analysis. Instead, this treatment was used to make the instructions truthful, as participants did not know whether they would receive the financial intervention at round 11th or not.

To isolate the intervention effect, we sought to control for various sources of heterogeneity that might interact with the choice of different options. Cooperative choices can be influenced by underlying factors in the decision-making process, which may vary across individuals even after random assignment to different groups. Some individuals may choose options that contribute to a public good to conform with socially appropriate behaviour in their relevant reference group (Bicchieri, 2005). Others may be intrinsically motivated to contribute to any public good (Bénabou and Tirole, 2011). Economic preferences, such as trust, reciprocity, and altruism, are also key predictors of decisions to contribute to a public good. Furthermore, time and risk preferences might play a role as option choices involve uncertainty (individuals do not know what others will choose) and time discounting (different consequences may occur at different points in time) (Lades et al., 2021).

To account for these factors, we conducted a post-experiment survey that included the following components.

- The reduced-form module, validated by Falk et al., 2016, served as an instrument to capture economic preferences (time and risk preferences, altruism, reciprocity, and trust) in incentivized experiments.
- We included a reduced version of the Collective Self-Esteem scale (CSE) by Luhtanen and Crocker, 1992, along with an item based on Ando et al., 2007, to assess normative beliefs on similar peers' cooperative behaviour.
- Additionally, we gathered socio-demographic information, such as gender, age, nationality, and economics major.

[1] See (Li et al., 2021) on the use of web-conferencing software to conduct online experiments.

By incorporating these survey elements, we aimed to control for potential confounding variables and ensure a more robust analysis of the intervention's impact on cooperative choices.

3.4. Theoretical framework and theoretical predictions

We model the choice between the different options as a public bad game played between a group of N players. Each player has an endowment equal to e, which s/he must use to choose one among $J \geq 2$ available options.

Options have different prices, and are characterized by a private benefit and a social cost. That is, when choosing option j (where $j = 1...J$), player i (where $i = 1...N$) pays a price equal to c_j , receives a private benefit equal to $\alpha_j c_j$, and imposes a cost equal to $\beta_j c_j$ to all the group. This cost is shared equally among the group: player i only pays a portion $\beta_j c_j / N$ of the social cost, while the rest, $\beta_j c_j (N-1)/N$, is paid by the other members of the group.

Let $b_i = \beta_j c_j$ be the externality generated[2] by player i when choosing option j. The total externality generated by the group is then $B = \sum b_i$. This is shared equally between the group, so each player will pay B/N.

Thus, the payoff of player i depends not only on the option s/he chooses, but also on the options chosen by the other members of the group. Let $B_{-i} = B - b_i$ be the externality generated by the rest of the group. Given B_{-i}, the payoff of player i if s/he chooses option j is then:

$$\pi_i(j, B_{-i}) = e - c_j + \alpha_j c_j - \frac{B}{N} = e + c_j\left(-1 + \alpha_j - \frac{\beta_j}{N}\right) - \frac{B_{-i}}{N} \quad (1)$$

Let $x = (x_1 ... x_N)$ be a profile of players choices, where $x_i \in J$ denotes the choice of player i (that is, if player i chooses option j, then $x_i = j$). Then, a profile $\hat{x}$ (with externality $\widehat{B}$) is a Nash equilibrium (NE) if:

$$\forall x_i \forall i : \pi_i(\hat{x_i}, \widehat{B_{-i}}) \geq \pi_i(x_i, \widehat{B_{-i}}) \quad (2)$$

Assume first that $\alpha_j = \alpha$ and $\beta_j = \beta$ for all j, that is, both the private gain and the social cost are linearly increasing in the price of the option. If it holds:

$$-1 + \alpha - \frac{\beta}{N} > 0 \quad (3)$$

the payoff of player i is increasing in c_j. That is, whenever net private gain $(-1+\alpha)$ is larger than the quota of the social cost that player i has to pay (β/N), player i chooses the most expensive option s/he can afford, independently from the choices of the other players. Since all players in the group face the same set of options, this implies that, if condition (3) holds, in the only NE everybody choose the most expensive option, $\bar{j}$, which is also the one that generates the highest social cost.

Let B^j_{-i} be the total externality generated by the opponents of player i, when they all choose the same option j. The NE payoff of player i is then:

$$\pi_i(\bar{j}, B^{\bar{j}}_{-i}) = e - c_{\bar{j}} + \alpha c_{\bar{j}} - \frac{\beta c_{\bar{j}}}{N} - \frac{B^{\bar{j}}_{-i}}{N} = e + c_{\bar{j}}(-1 + \alpha - \beta) \quad (4)$$

If it holds:

$$-1 + \alpha - \beta > 0 \quad (5)$$

The payoff is decreasing in c_j. That is, whenever the net private gain $(-1+\alpha)$ is not enough to compensate the full social cost imposed to the group (β), the NE outcome is Pareto dominated by the outcome in which everybody chooses the *least* expensive option $\underline{j}$. Note that this is the option that players would choose in the absence of externalities, when they pay the full cost of their choices. However, since there are externalities, players do not bear the full cost of their choices, so the option that maximizes their payoffs is the one with the highest social cost.

Thus, whenever both conditions (3) and (5) hold, the game is a social dilemma: the only NE is when everybody choose the most expensive option $\bar{j}$, but the Pareto dominant outcome is when everybody choose the least expensive option $\underline{j}$.

Assume now that a new technology is developed, allowing the adoption of option m. Compared to the equilibrium option $\bar{j}$ option m generates the same private benefit ($\alpha_m c_m = \alpha c_{\bar{j}}$) with a lower externality ($\beta_m c_m < \beta c_{\bar{j}}$), but it costs more ($c_m > c_{\bar{j}}$). The adoption of the new technology is a Pareto improvement over the NE if $\pi_i(m, B^m_{-i}) \geq \pi_i(\bar{j}, B^{\bar{j}}_{-i})$, that is, if:

$$\beta c_{\bar{j}} - \beta_m c_m > c_m - c_{\bar{j}} \quad (6)$$

However, as long as:

$$(\beta c_{\bar{j}} - \beta_m c_m)/N < c_m - c_{\bar{j}} \quad (7)$$

all players still choose the old technology. That is, as long as the individual gain in efficiency (in terms of lower externality) does not compensate for the higher price of the energy efficient option, nobody will adopt the new technology, even when it generates a Pareto improvement over the equilibrium outcome. Thus, if both conditions 6 and 7 hold, in the only NE players would still produce the maximum amount of externality they can afford. This allows us to state our first theoretical prediction (TP).

TP 1 *If conditions 3, 5, 6 and 7 hold, players choose the option with the highest social cost.*

3.5. Behavioural predictions

In our experiment, Rich participants can choose among all the options in Table 1. Options A, B, C resemble the "old" technologies, with private gains and social costs both increasing with the private cost (the price). We assumed $\alpha = 3/2$ and $\beta = 1$, with $c_A = 20, c_B = 40, c_C = 80$. Note that $-1 + \alpha = 1/2$ and $\beta/N = 1/4$, so both conditions (3) and (4) hold: given these options, the Pareto dominant outcome is the one in which everybody choose A, but the only equilibrium is for everybody to choose C. Option D represents the "new" technology, as we assumed $c_D = 90; \alpha_D = 4/3; \beta_D = 2/3$. That is, while the private benefits of options C and D are the same (120), the social cost of option D (60) is lower than the one of option C (80). It is easy to check that both conditions (6) and (7) hold, so option D is a Pareto improvement over option C, but is not an equilibrium. In the following, we call "pro-environmental" the choice of any option different from C. This is because, when choosing either the sufficient options (A or B), or the energy efficiency option (D), a participant renounce to a private (net) benefit in order to lower the externality produced.

Participants in the Poor-treatment and participants in the first ten rounds of the Poor-Rich-treatments have a lower endowment and they can only choose between option A and option B. Note that the Pareto dominant outcome is the one in which everybody choose option A, but the only equilibrium is for everybody to choose option B.

To sum up, if participants behave according to our TP1, all Rich participants should choose option C, and all Poor participants should choose option B, independently from whether they were exposed to a boost, or not, and independently from whether they received a financial transfer, or not.

At the same time, there is large experimental evidence that participants do cooperate in social dilemmas. In fact, the discussion in section 2 suggests there are several motives for which an individual might prefer an option with a lower cost for the community, such as environmental concerns. This reasoning allows us to make a behavioural prediction

[2] For the ease of the exposition, we consider the social cost associated to the chosen option as the externality generated by player i, although the real externality is just the one imposed to the other players.

(BP) counterpart of TP1.

BP1: Participants also choose options with lower social costs

However, even if individuals have non-monetary concerns, they might fail to engage in pro-environmental behaviours because they might be not fully aware of the consequences of their own actions. Our discussion in Section 2 suggests that individuals might fail to cooperate, if they do not fully understand the relationship between possible strategies, outcomes and payoffs. With this respect, having the chance to practice during the boost phase could make participants more aware of the different outcomes, and more confident that other members of the group are more aware too. If this is the case, then our boost intervention should be effective in helping players coordinate on an option with a lower social cost.

BP2: Boosted participants choose more pro-environmental options than non-boosted ones.

The discussion in Section 2 also suggested that having experienced scarcity in the past might trigger a change in behaviour, when compared with those who did not have such an experience. Still, it is an open question if individuals that were forced (through scarcity) to choose options with lower social costs developed a higher sensitivity to their social environment, leading to more prosocial choices also once the scarcity disappears, or if they instead compensate, thus choosing less prosocial options than those who did not experienced such scarcity.

BP3a If the effect of economic scarcity on prosocial behaviours is *negative*, we expect the financial intervention to induce participants who experienced scarcity to choose pro-environmental options *less* than those who never experienced scarcity.
BP3b*:* If the effect of economic scarcity on prosocial behaviours is *positive*, we expect the financial intervention to induce participants who experienced scarcity to choose pro-environmental options *more* than those who never experienced scarcity.

Scarcity might also have a negative effect on cognitive resources necessary to make complex decisions (Mani et al., 2013). If this is the case, then our boost intervention should be effective in helping participants who experienced scarcity and received a financial intervention to coordinate on an option with a lower social cost.

BP4: Boosted participants who experienced scarcity choose more pro-environmental options than those who only received a financial intervention.

4. Results

To start with, we summarise the distribution of the four options chosen across treatments and conditions. Then, to provide an assessment of the boost effect, we analyse option choices by rich. Second, we analyse option choices by poor-rich to provide an assessment of financial intervention. Finally, we analyse option choices by poor-rich and boosted poor-rich to provide an assessment of the boost effect when combined with the financial intervention.[3]

4.1. Overview of choices

Table 2 presents the average frequency with which each option was chosen during the game for each treatment. Overall, the frequencies in Table 2 support our BP1: participants frequently choose pro-environmental options, with option C being the most chosen in all conditions. However, when focusing on the last ten periods of the game, the frequency of pro-environmental choices varies from 25% (in the Rich Boost treatment) to 41% (in the Poor-Rich treatment). Specifically, option D consistently ranked as the second-most chosen option and was selected most frequently by participants in the Poor-Rich treatment, and least frequently by participants in the Rich-Boost treatment. Option B was chosen most in the Rich treatment, and least in the Poor-Rich treatment. Option A, on the other hand, was selected most in the Poor-Rich-Boost treatment, and least in the Poor-Rich treatment. Overall, Table 2 suggests a potential differential impact of the boost and financial transfer on the sufficient options (A and B) and the energy-efficient option (D), as well as a varying effect of the boost between Rich and Poor-Rich participants. In the following sections, we delve into a detailed analysis of these differences.

4.2. Boost effect on pro-environmental choices

Fig. 2 indicates that choices made by participants with the financial freedom to choose all options and who also received the boost intervention, may differ from those who did not receive the boost. To investigate this further, we conducted a random effect probit estimation (see Table 3) to examine the effect of the boost on participants in the rich condition. The results reveal that participants who received the boost are less likely to choose the energy-efficient option (D) compared to those who did not receive the boost. However, the difference is statistically significant only at the 10% level of significance (see Table A1 in the Appendix for variable descriptions and Table A2 for the regression table with all the variables).

4.3. Financial intervention effect on pro-environmental choices

Fig. 3 indicates that choices made in the last 10 rounds by participants who experienced scarcity and received a financial intervention may differ from the choices made by participants who never experienced scarcity.

In particular, Fig. 3 suggests that, when given the opportunity to choose previously unaffordable options, participants who experienced scarcity choose the "previously forced available" options A and B less frequently than those who were never forced to choose them due to scarcity. At the same time, it indicates that among the new affordable options, those who experienced scarcity choose the socially optimal option D more frequently than those who never experienced scarcity.

The graphical insights are substantiated by random effect probit estimations, where we examine the effect of the financial intervention. Table 4 indicates that participants who received a financial intervention are less likely to choose the energy sufficiency options A and B compared to those who did not require a financial intervention (see Table A3 in the Appendix for the regression table with all the variables). In the case of option A, however, the difference is significant only at the 10% level. More importantly, we observe that participants who received a financial intervention are more likely to choose the energy efficiency option (D) compared to those who did not require a financial intervention.

4.4. Combined effect of financial intervention and boost on pro-environmental choices

Fig. 4 indicates that the combined use of the boost and the financial incentive has a more significant effect in the case of option D (the energy efficiency option). However, contrary to our predictions, participants who received both a financial intervention and a boost chose option D less frequently than those who only received the financial intervention.

The probit regression estimations in Table 5 support the graphical insights. Specifically, participants who received both a financial intervention and a boost exhibit a lower likelihood of choosing the energy efficiency option (D) compared to those who only received the financial intervention (refer to Table A4 in the Appendix for the regression table

[3] The analysis of results was conducted using Stata 15.

Table 2
Overview of option choices by treatments (values in percentage).

Option Treatment	Rich 11-20	Rich Boost 11-20	Poor Rich 11-20	Poor Rich Boost 11-20	Rich 1-20	Rich Boost 1-20	Poor Rich 1-10	Poor Rich Boost 1-10
A	9.38 (0.329)	7.22 (0.023)	4.72 (0.030)	9.84 (0.039)	10.15 (0.0298)	8.9 (0.476)	24.58 (0.046)	30.78 (0.536)
B	9.69 (0.022)	5.28 (0.339)	3.89 (0.039)	5.16 (0.034)	11.01 (0.0325)	7.22 (0.040)	75.42 (0.046)	69.22 (0.536)
C	60.63 (0.062)	74.17 (0.076)	58.75 (0.11)	66.72 (0.077)	54.45 (0.083)	67.62 (0.106)		
D	20.31 (0.048)	13.33 (0.039)	32.64 (0.093)	18.28 (0.065)	24.45 (0.062)	16.33 (0.489)		

St. Deviation in parenthesis.

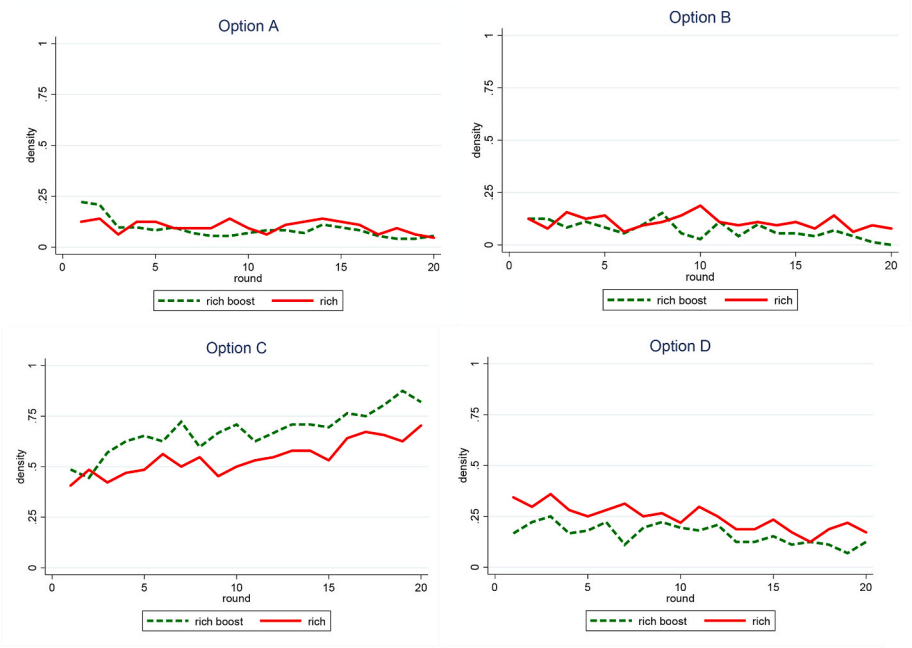

Fig. 2. Choices over time: Rich vs Rich-Boost.

Table 3
Effect of boosting on choices (all rounds, Rich vs Rich Boost).

VARIABLES	choice A	choice B	choice C	choice D
boost	0.0454 (0.272)	−0.265 (0.168)	0.318 (0.297)	−0.385* (0.196)
CONTROL VARIABLES	YES	YES	YES	YES
Constant	−1.198 (0.848)	−2.634*** (0.707)	−0.713 (1.220)	−0.513 (1.156)
Log-pseudo likelihood	−641.80458	−665.87338	−1317.2649	−1028.3129
Observations	2400	2400	2400	2400
Number of n	120[a]	120	120	120

Random effects Probit. Dependent variables: dummies taking value 1 if the corresponding option (A, B, C, D) is chosen, and 0 otherwise.
Clustered standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.
[a] 120 observations instead of 136 as 16 subjects did not reply to all post-experimental survey questions.

with all the variables).

5. Discussion

Overall, our results show that both the boost and the financial intervention have a different effect on the choice of the energy efficient option (D) and the energy sufficient options (A and B). Regarding the boost alone, we find it does not significantly increase the probability to choose the sufficient options A and B, while it slightly significantly decreases the probability to choose the energy-efficient option, thus providing partial support for our BP2. Regarding the financial intervention, while we find it has a mild negative effect on the probability to choose the energy-sufficient options A and B, we find a positive effect on the probability to choose the energy-efficient option. These results seem to support our BP3b. When the financial intervention is combined with the boost, this positive effect is, however, reversed. Overall, these results suggest that a monetary transfer alone can be effective at addressing energy poverty while promoting pro-environmental behaviour, while the combination with a boost empowering the awareness of action interdependence might weaken its impact.

Our study provides evidence-based insights into the effects of both the boost and the financial intervention on energy-related choices, shedding light on their potential policy implications. The observed different effects on the choice of the energy-efficient option (D) and the energy-sufficient options (A and B) indicate that the interventions influence decision-making behaviour in distinct ways.

The lack of a significant increase in the probability to choose the energy-sufficient options (A and B) when the boost is applied alone suggests that the boost intervention may require further refinement to effectively promote sufficiency behaviours. The initial prediction was that the boost would enhance collective team reasoning by increasing

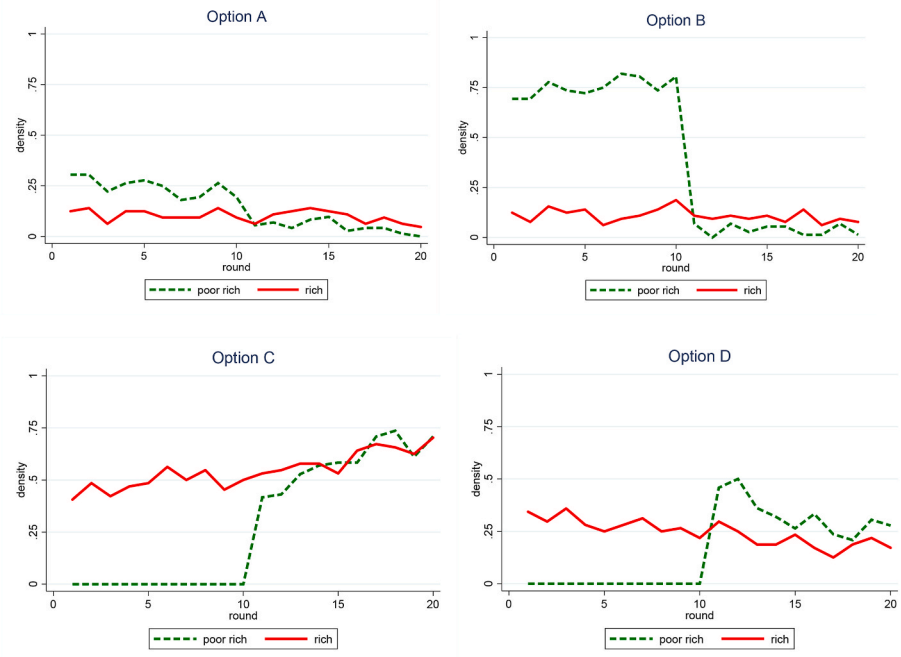

Fig. 3. Choices over time: Rich vs Poor-Rich.

Table 4
Effect of the financial intervention on choices (last 10 rounds, Rich vs Poor-Rich).

VARIABLES	choice A	choice B	choice C	choice D
Poor rich	−0.473*	−0.512***	−0.194	0.616***
	(0.268)	(0.160)	(0.259)	(0.200)
CONTROL VARIABLES	YES	YES	YES	YES
Constant	−1.213	−1.155	−1.331*	0.218
	(1.771)	(0.750)	(0.756)	(0.570)
Log-pseudo likelihood	−282.85605	−296.47811	−769.82627	−676.81086
Observations	1360	1360	1360	1360
Number of n	136	136	136	136

Random effects Probit. Dependent variables: dummies taking value 1 if the corresponding option (A, B, C, D) is chosen, and 0 otherwise.
Clustered standard errors (at session level) in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

understanding of action interdependence and their impact on others. However, it appears that understanding alone might not be sufficient to drive behaviour change, especially in the context of deeply ingrained habits and social norms surrounding energy consumption (Andor and Fels, 2018). To address this limitation and foster collective team reasoning, policymakers could consider incorporating norm-based nudges in conjunction with the boost intervention. Norm-based nudges may play a crucial role in shaping perceptions of energy sufficiency behaviours and can create a social norm that encourages collective sustainable decision-making (Nyborg et al., 2016). Therefore, the boost would help individuals understand the consequences of their energy choices on themselves and others, while norm-based nudges would reinforce the importance of energy sufficiency within the community.

Conversely, the positive effect of the financial intervention on the probability to choose the energy-efficient option (D) highlights the potential of monetary incentives in promoting energy efficiency. Policymakers should consider implementing targeted financial support measures, such as energy-efficient subsidies or rebates, to incentivize the adoption of energy-efficient technologies and practices, especially for the most vulnerable. This approach aligns with existing research suggesting that economic incentives can play a significant role in both driving pro-environmental choices and addressing energy poverty (Bessa and Gouveia, 2022; Maki et al., 2016).

However, our findings also reveal an interesting phenomenon when the financial intervention is combined with the boost, resulting in a reversal of the positive effect observed with the financial intervention alone. This unexpected outcome raises questions about the interplay between monetary incentives and behavioural interventions (Alt et al., 2024). Policymakers should carefully consider the potential unintended consequences of combining different intervention strategies. Further research is warranted to explore the underlying mechanisms behind this interaction effect and to optimize the design of integrated interventions.

In light of these results, policymakers should adopt a comprehensive approach to just-considerate energy policy design (Vandyck et al., 2023). Rather than relying solely on a single intervention, a mix of targeted measures, including financial incentives, boosts, and norm-based nudges, may offer a more holistic solution to promoting pro-environmental behaviours and addressing energy poverty. By combining these interventions, policymakers can create synergies that maximize the positive impact on energy-related decision-making while considering potential trade-offs and unintended consequences.

Moreover, our study underscores the importance of continuously evaluating and adapting policy interventions based on empirical evidence. While our findings provide a starting point, they should be externally validated through real-world field experiments. In fact, external validation is always essential to verify the generalizability and robustness of the results beyond the controlled laboratory setting (Lunn and Choisdealbha, 2018). Future research should also explore conducting experiments utilizing diverse population samples. However, it is essential to acknowledge that diversifying samples may come with the trade-off of potential loss of internal validity due to increased variability among participants or contextual factors (Lunn and Choisdealbha, 2018). Finally, to enhance the reproducibility of our study, a standard practice in economic experiments, we have taken measures to ensure that other researchers can replicate our methods. This includes making the data and code available (Camerer et al., 2016).

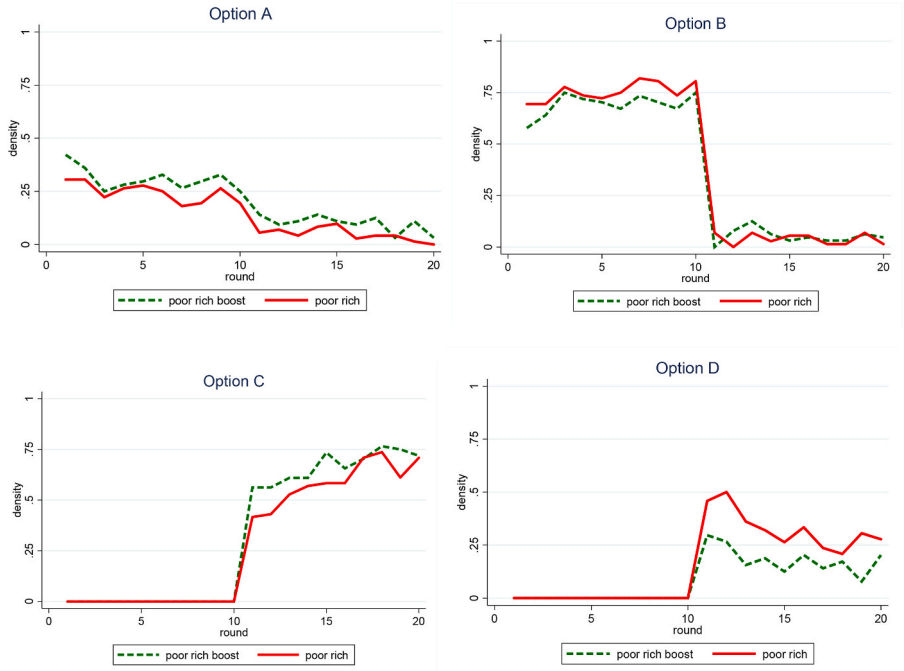

Fig. 4. Choices over time (Poor-Rich vs Poor-Rich-Boost).

Table 5
The effect of the combined use of boost and financial incentives on choices (only last 10 rounds, Poor-Rich vs Poor-Rich-Boost).

VARIABLES	choice A	choice B	choice C	choice D
boost	0.437	0.170	0.330	−0.590***
	(0.389)	(0.296)	(0.391)	(0.219)
CONTROL VARIABLES	YES	YES	YES	YES
Constant	−1.971	−2.458***	0.192	−0.697
	(2.100)	(0.805)	(1.172)	(0.753)
Log-pseudo likelihood	−292.23153	−226.4594	−766.09358	−675.59688
Observations	1360	1360	1360	1360
Number of n	136	136	136	136

Random effects Probit. Dependent variables: dummies taking value 1 if the corresponding option (A, B, C, D) is chosen, and 0 otherwise.
Clustered standard errors (at session level) in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

6. Conclusions and policy implications

In this study, we have employed the lens of behavioural economics and the experimental economic method to gain a deeper understanding of how to promote climate and energy behavioural policies in a just-considerate way. Our research experimentally investigated the drivers of energy sufficiency and energy efficiency decisions using a modified public bad game. Additionally, we experimentally tested the impact of a novel behavioural intervention in the form of a practice-based boost, designed to empower individuals' capacity to understand action interdependence and its potential to increase pro-environmental choices. Furthermore, we modelled income scarcity, which underlies energy poverty, and examined the combined effect of a financial intervention and a practice-based boost on promoting pro-environmental choices.

Our findings reveal that the financial intervention alone effectively encourages individuals who experienced income scarcity to choose the energy efficiency option, which aligns with the stream of research suggesting that economic scarcity can positively influence pro-social behaviours, including pro-environmental ones. In contrast, unexpectedly, the novel boost intervention showed a negative effect on energy efficiency choices, irrespective of whether individuals experienced income scarcity or not. This result contrasts with our initial prediction based on the premise of "team-reasoning", suggesting that empowering the understanding of action interdependence alone could have increased the willingness to engage in pro-environmental choices.

In light of these findings, we recognize the importance of prioritizing financial interventions as a strategy to promote energy efficiency choices, especially in addressing energy poverty within the sustainable transition process. Policymakers should consider implementing targeted financial support measures for low-income households, making energy-efficient options more accessible and affordable.

Moreover, our study highlights the need for a nuanced approach to behavioural interventions in energy policy. While behavioural tools, like boosts, hold promise for fostering pro-environmental behaviours, our results suggest that a one-size-fits-all approach may not be suitable for every context. Policymakers should carefully evaluate the effectiveness of specific behavioural interventions and tailor their strategies based on contextual factors, such as energy-related social norms. As an example, to address the limitations of the boost intervention in promoting energy efficiency choices, policymakers could consider combining it with other interventions, such as norm-based nudges. Norm-based nudges can play a crucial role in shaping perceptions of prevalent behaviours related to energy sufficiency and can create a social norm that encourages collective sustainable decision-making.

Furthermore, our research underscores the importance of considering the broader social and environmental context when designing energy policy measures. Addressing energy poverty and energy justice concerns is crucial to ensuring a just and equitable transition to sustainable energy systems. Policymakers should integrate a mix of multi-aspect interventions, combining financial support with behavioural tools, and ensuring that the most vulnerable populations are not left behind.

Overall, our study's position at the intersection of energy and climate policies, behavioural economics, and energy poverty adds valuable insights to the ongoing policy discourses calling for a combined action towards the energy poverty and climate change challenges. By evaluating the efficacy of interventions on both the general and vulnerable

populations, it contributes to the call for energy and climate policies to be justice-aware, particularly concerning energy poverty. Our findings offer a foundation for developing more effective and just policies to address these pressing issues.

However, as with any research, there are certain limitations to consider. The results of this study are based on a controlled laboratory setting, and external validation through real-world field experiments is necessary to verify the generalizability and robustness of the findings. Additionally, as the field of behavioural economics continues to evolve, future research may uncover new insights and approaches to address the complex drivers of pro-environmental decision-making.

CRediT authorship contribution statement

Nives Della Valle: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Chiara D'Arcangelo:** Conceptualization, Data curation, Writing – review & editing. **Marco Faillo:** Conceptualization, Data curation, Funding acquisition, Project administration, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data are available here https://osf.io/dkbc8/.

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Appendix

Table A1
Description of variables

Name	Variable/survey item	Description	Obs	Mean	Std. Dev.	Min	Max
choice A	Experimental variable	Dummy variable for choice A = 1 if chosen, 0 otherwise	5440[8]	.134	.341	0	1
choice B	Experimental variable	Dummy variable for choice B = 1 if chosen, 0 otherwise	5440	.237	.425	0	1
choice C	Experimental variable	Dummy variable for choice C = 1 if chosen, 0 otherwise	5440	.463	.499	0	1
choice D	Experimental variable	Dummy variable for choice D = 1 if chosen, 0 otherwise	5440	.165	.372	0	1
Boost	Experimental variable	Dummy variable = 1 if individuals received the boost, 0 otherwise					
Poor_rich	Experimental variable	Dummy variable = 1 if treatment = Poor_rich					
female	Which is your gender?	Dummy variable = 1 if female, 0 otherwise	272	.522	.5	0	1
age	Which is your age?	Continuous variable	272	20.309	5.781	1	34
economics student	Are you a student in economics?	Dummy variable = 1 if individuals are economics students, 0 otherwise	272	.717	.451	0	1
Italian	Is your nationality Italian?	Dummy variable = 1 if individuals are Italian, 0 otherwise	272	.934	.249	0	1
normative beliefs	Many peers engage in cooperative behaviours.	Categorical variable based on Likert scale 1–7, with 1 meaning "I totally agree", and 7 meaning "I totally disagree".	272	2.985	1.28	1	7
CSR	• Overall, my social groups are considered well by others • Overall, my group memberships have very little to do with how I feel about myself • In general, I'm glad to be a member of the social groups I belong to • In general, belonging to social groups is an important part of myself image	Average of 4 items based on Likert scale 1–7, with 1 meaning "I totally agree", and 7 meaning "I totally disagree".	256	2.875	.668	1	5.25
time preference	How willing are you to give up something that is beneficial for you today in order to benefit more in the future?	Categorical variable based on Likert scale 1–7, with 1 meaning "I totally agree", and 7 meaning "I totally disagree".	272	2.022	1.031	1	7
risk preference	How willing are you to take risks?	Categorical variable based on Likert scale 1–7, with 1 meaning "I totally agree", and 7 meaning "I totally disagree".	272	2.79	1.31	1	7
altruism	How willing are you to donate to causes without expecting anything in return?	Categorical variable based on Likert scale 1–7, with 1 meaning "I totally agree", and 7 meaning "I totally disagree".	272	3.081	1.466	1	7

(*continued on next page*)

Table A1 (*continued*)

Name	Variable/survey item	Description	Obs	Mean	Std. Dev.	Min	Max
reciprocity	When someone does me a favour I am willing to return it	Categorical variable based on Likert scale 1–7, with 1 meaning "I totally agree", and 7 meaning "I totally disagree".	272	1.61	.89	1	5
trust	I assume that people have only the best intentions	Categorical variable based on Likert scale 1–7, with 1 meaning "I totally agree", and 7 meaning "I totally disagree".	272	3.522	1.023	1	5

[8] 5440 observations represent the choices made by 272 individuals, repeated 20 rounds.

Table A2
Effect of boosting on choices – all variables *(all rounds, Rich vs Rich Boost)*

VARIABLES	choice A	choice B	choice C	choice D
boost	0.0454	−0.265	0.318	−0.385*
	(0.272)	(0.168)	(0.297)	(0.196)
female	0.0304	0.262**	−0.125**	0.133
	(0.0683)	(0.132)	(0.0492)	(0.167)
age	−0.0241	0.0279	0.0173	0.00982
	(0.0408)	(0.0223)	(0.0393)	(0.0225)
economics student	−0.168	0.160	0.000777	0.131
	(0.151)	(0.167)	(0.197)	(0.255)
Italian	−0.892***	−0.100	0.593	−0.116
	(0.252)	(0.236)	(0.659)	(0.952)
normative beliefs	0.0180	0.0529	−0.0899**	0.0695
	(0.0463)	(0.0375)	(0.0421)	(0.0491)
CSR	0.168**	−0.0593	0.0110	−0.0173
	(0.0769)	(0.0929)	(0.105)	(0.0708)
time preference	0.0478	0.190***	−0.0557	0.0214
	(0.0627)	(0.0298)	(0.0654)	(0.118)
risk preference	0.0390	−0.0390	0.0333	−0.0420
	(0.0636)	(0.0930)	(0.0930)	(0.0379)
altruism	−0.103**	−0.0774	0.102*	−0.0283
	(0.0408)	(0.0802)	(0.0610)	(0.0699)
reciprocity	0.282**	0.213*	−0.149	−0.184**
	(0.122)	(0.120)	(0.0945)	(0.0923)
trust	0.0393	−0.000300	0.0556	−0.107
	(0.111)	(0.147)	(0.138)	(0.105)
Constant	−1.198	−2.634***	−0.713	−0.513
	(0.848)	(0.707)	(1.220)	(1.156)
Log-pseudo likelihood	−641.80458	−665.87338	−1317.2649	−1028.3129
Observations	2400	2400	2400	2400
Number of n	120[9]	120	120	120

Random effects Probit. Dependent variables: dummies taking value 1 if the corresponding option (A, B, C, D) is chosen, and 0 otherwise. Clustered standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.
[9] 120 observations instead of 136 as 16 subjects did not reply to all post-experimental survey questions.

Table A3
Effect of the financial intervention on choices – all variables *(last 10 rounds, Rich vs Poor-Rich)*

VARIABLES	choice A	choice B	choice C	choice D
Poor rich	−0.473*	−0.512***	−0.194	0.616***
	(0.268)	(0.160)	(0.259)	(0.200)
female	−0.0505	0.240	−0.488***	0.526***
	(0.233)	(0.155)	(0.149)	(0.197)
age	−0.0507	−0.0157	0.0579**	−0.0265
	(0.0511)	(0.0331)	(0.0273)	(0.0161)
economics student	−0.452**	0.0435	0.412**	−0.112
	(0.179)	(0.207)	(0.192)	(0.204)
Italian	−0.102	−0.700**	0.294	−0.105
	(0.495)	(0.303)	(0.443)	(0.283)
normative beliefs	0.0842	0.0556	0.0665	−0.101
	(0.106)	(0.0718)	(0.0940)	(0.0745)
CSR	−0.0323	−0.00349	−0.0480	0.0321
	(0.0994)	(0.152)	(0.136)	(0.0699)
time preference	0.160	0.0850	0.102	−0.141
	(0.116)	(0.150)	(0.0971)	(0.0997)
risk preference	−0.0111	0.0588	−0.0643	0.0142
	(0.0562)	(0.0706)	(0.100)	(0.0848)
altruism	−0.0160	−0.168***	0.158***	−0.0692
	(0.0825)	(0.0383)	(0.0448)	(0.0443)
reciprocity	0.403*	0.133	−0.0717	−0.279***

(*continued on next page*)

Table A3 (*continued*)

VARIABLES	choice A	choice B	choice C	choice D
	(0.229)	(0.161)	(0.185)	(0.0985)
trust	−0.00391	0.0600	−0.0617	0.0379
	(0.141)	(0.159)	(0.130)	(0.106)
Constant	−1.213	−1.155	−1.331*	0.218
	(1.771)	(0.750)	(0.756)	(0.570)
Log-pseudo likelihood	−282.85605	−296.47811	−769.82627	−676.81086
Observations	1360	1360	1360	1360
Number of n	136	136	136	136

Random effects Probit. Dependent variables: dummies taking value 1 if the corresponding option (A, B, C, D) is chosen, and 0 otherwise. Clustered standard errors (at session level) in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

Table A4
The effect of the combined use of boost and financial incentives on choices – all variables *(only last 10 rounds, Poor-Rich vs Poor-Rich-Boost)*

VARIABLES	choice A	choice B	choice C	choice D
boost	0.437	0.170	0.330	−0.590***
	(0.389)	(0.296)	(0.391)	(0.219)
female	−0.443**	0.532	−0.442***	0.529***
	(0.212)	(0.324)	(0.148)	(0.201)
age	−0.0211	−0.0172	−0.00432	0.0257
	(0.0824)	(0.0521)	(0.0528)	(0.0217)
economics student	−0.229	−0.254**	0.462***	−0.385***
	(0.556)	(0.107)	(0.0705)	(0.136)
Italian	−0.351	−0.129	0.116	0.0555
	(0.328)	(0.368)	(0.402)	(0.208)
normative beliefs	0.0178	0.103**	0.0359	−0.0196*
	(0.0298)	(0.0465)	(0.0369)	(0.0108)
CSR	0.0827	−0.180	0.0153	−0.0416
	(0.141)	(0.211)	(0.141)	(0.120)
time preference	−0.00158	0.113	0.0329	−0.0478
	(0.149)	(0.0754)	(0.119)	(0.103)
risk preference	0.146*	−0.0106	−0.0378	−0.0416
	(0.0807)	(0.0422)	(0.0535)	(0.0399)
altruism	−0.0950**	−0.0661	0.0812**	−0.0195
	(0.0390)	(0.0689)	(0.0409)	(0.0338)
reciprocity	0.215	0.222	−0.0690	−0.0962
	(0.199)	(0.136)	(0.0862)	(0.146)
trust	0.0468	0.180	−0.0915	0.0448
	(0.128)	(0.111)	(0.130)	(0.0650)
Constant	−1.971	−2.458***	0.192	−0.697
	(2.100)	(0.805)	(1.172)	(0.753)
Log-pseudo likelihood	−292.23153	−226.4594	−766.09358	−675.59688
Observations	1360	1360	1360	1360
Number of n	136	136	136	136

Random effects Probit. Dependent variables: dummies taking value 1 if the corresponding option (A, B, C, D) is chosen, and 0 otherwise. Clustered standard errors (at session level) in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

INSTRUCTIONS

(**FOR ALL PARTICIPANTS**)

You are about to take part in an economic experiment for scientific purposes. Read the instructions below carefully. You will in fact earn a reward that will depend on your decisions and some random draws. You will receive your compensation at the end of the experiment. During the experiment your earnings will be calculated in EMU (experimental monetary units). At the end of the experiment, the total of the EMU you have earned will be converted into euro at the following rate:

1 EMU = €0.10

You will in any case earn €3 for participating in the experiment.

During the experiment it is absolutely forbidden to communicate with other participants. In case you violate this rule you will have to leave the experiment and you will not receive any compensation. Should you have any doubts, do not hesitate to raise your hand: the staff will be at your complete disposal. Anonymity will be guaranteed during the experiment. Your identity will never be revealed to other participants.

The experiment involves 20 rounds. At the beginning of each round you will receive an endowment in EMU. At the beginning of the experiment you will be randomly assigned to a category, which will determine your endowment in each round, and which will be the same for the duration of the experiment. The possible categories are as follows.

Group categories	
Category	Endowment
ONE	100 EMU
TWO	50 EMU
THREE	50 EMU in the first 10 rounds and 100 EMU in the last 10 rounds

As you can see, for the categories ONE and TWO the endowment is always the same for all rounds. For category THREE the endowment changes from 50 EMU to 100 EMU after round number 10. In the course of the experiment you will find out which category you belong to. Specifically, at the beginning of the experiment you will find out if you belong to category ONE. If you do not belong to this category, you will find out at the end of round 10 whether you belong to category TWO or THREE.

In each round, you will be randomly assigned to a group consisting of four participants (i.e., in addition to you there are 3 participants) who belong to the same category as you. With each new round, the composition of your group will change, so you will interact with different people in each round, but these people will still belong to the same category as you. For example, if you are assigned to category ONE, all participants you interact with will be from category ONE, while if you are assigned to category TWO, all participants you interact with will be from category TWO.

TASK

In each round you will have to choose one of the options available to you. The options available are: option A, option B, option C, and option D. Each option has a price, produces a benefit for you and generates a cost for the entire group, including you. The total cost to the group will be equal to the sum of the costs generated by individual members and will be redistributed equally among all group members. Your payment in the individual round will be equal to:

$$Endowment - Price + Benefit - \left(\frac{Groupcostgeneratedbyyou + Groupcostgeneratedbyothermembersofthegroup}{4}\right)$$

Prices, benefits, and costs for the group associated with each option are shown in the table below.

Option	Price	Benefit	Cost for the group
A	20 EMU	30 EMU	20 EMU
B	40 EMU	60 EMU	40 EMU
C	80 EMU	120 EMU	80 EMU
D	90 EMU	120 EMU	60 EMU

As you might notice, participants with an endowment of 100 EMU have the possibility to choose any of the four options, in fact all options have a price below 100. In contrast, participants with an endowment of 50 EMU have the possibility to choose only one of the first two options (A or B).

At the end of each round you will be told the payout you have obtained, which will thus depend on your choice and on those of the other group members. At the end of the experiment, one round will be randomly selected for the final payment. At the end of the experiment, you will be asked to answer a short questionnaire and to participate in a short activity that will allow you to get up to two euros in additional compensation.

Let's consider a couple of examples.

Example 1

Consider a group of participants belonging to category ONE. In one round, participants make the following choices.

Participant 1: option B (cost generated for the group = 40 EMU)
Participant 2: option D (cost generated for the group = 60 EMU)
Participant 3: option A (cost generated for the group = 20 EMU)
Participant 4: option C (cost generated for the group = 80 EMU)

So in this case, the total cost generated by the group is 40 + 60+20 + 80 = 200. So each participant will incur a cost equal to 200/4 = 50, regardless of the option chosen. For example, participant 2 chose option D, paying a price of 90 and getting a benefit of 120. Removing the cost generated by the whole group, his payment in this round will be: 100-90 + 120-50 = 80.

Example 2

Consider a group of participants belonging to category TWO. In one round, participants make the following choices.

Participant 1: option B (cost generated for the group = 40 EMU)
Participant 2: option A (cost generated for the group = 20 EMU)
Participant 3: option A (cost generated for the group = 20 EMU)
Participant 4: option B (cost generated for the group = 40 EMU)

So in this case, the total cost generated by the group is 40 + 20+20 + 40 = 120. So each participant will incur a cost equal to 120/4 = 30, regardless of the option chosen. For example, participant 1 chose option B, paying a price of 40 and getting a benefit of 60. Removing the cost generated by the

whole group, his payment in this round will be: 50-40 + 60-30 = 40.

We now ask you to answer some control questions.

Instructions will also be accessible later, at the bottom of the page, in the format you can see below.

(** ONLY FOR TREATED PARTICIPANTS (TREATMENTS: RICH_BOOST AND POOR_RICH_BOOST **)

After you have answered all the control questions correctly, and before you begin the actual experiment, you can familiarize yourself with the task during a practice phase. In the practice phase you will not interact with other participants, but you will take the decisions for all members of a hypothetical group. You will then be able to simulate different scenarios, to better understand how the payments you get during the actual experiment depend on your choices, and on those of other group members. You will have 5 min to complete the practice phase. No monetary compensation is associated with the practice phase. Upon completion of this phase, the actual experiment will begin.

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