Economic Dimensions of Responsible Consumer Behavior in Sustainable Development

Oksana Liashenko
Doctor of Economic Sciences, Professor,
Universidad de Sevilla, Spain
E-mail: oliashenko@us.es
ORCID: https://orcid.org/0000-0001-5489-815X

Olga Demianiuk
Candidate of Economic Sciences, Associate Professor,
West Ukrainian National University, Ukraine
E-mail: olgadem733@gmail.com
ORCID: http://orcid.org/0000-0002-4699-0172

DOI: https://doi.org/10.32782/2707-8019/2025-1-10

Abstract. *Addressing the global imperative of sustainable development requires a comprehensive, data- driven understanding of how individuals make consumption decisions when personal economic incentives conflict with broader collective ecological interests. This study investigates the behavioural mechanisms underpinning responsible consumer choices by integrating social preference theory with decision- framing effects. The research employs the Quantal Response Equilibrium (QRE) framework, accommodating bounded rationality and probabilistic strategic behaviour, to model the dynamic interaction between private utility and environmental responsibility. A behavioural experiment involving 215 participants was conducted using the oTree experimental platform. The study incorporated the Social Value Orientation (SVO) Slider Measure to elicit individual prosocial preferences and a ten- round interactive "Green Consumer Game," in which participants chose among strategies differing in personal payoff levels and ecological consequences, under either gain (reward) or loss (penalty) framing conditions. QRE- based choice probabilities were calibrated using maximum likelihood estimation of the rationality parameter within logit models implemented in Python. The empirical findings demonstrate that individuals with stronger social preferences are significantly more likely to choose environmentally responsible strategies. Framing has a robust effect: reward- based framing was considerably more effective in promoting pro- social decision- making than penalty- based framing. The QRE model achieved superior predictive accuracy compared to the classical Nash Equilibrium (RMSE 0. 069 vs. 0. 079), validating its empirical utility in ethically constrained decision contexts. This study' s novelty and theoretical value lie in applying QRE to ecologically motivated dilemmas, offering a quantitative assessment of how moral preferences and framing jointly shape consumer choice under uncertainty. Its practical contribution provides policymakers and sustainability practitioners with actionable insights for designing behavioural interventions, incentive schemes, and strategic messaging to encourage sustainable consumption across diverse socioeconomic environments.*

Keywords: *behavioural economics, responsible consumer behaviour, sustainable development, social preferences, experimental economics*

JEL Classification: *C91, D03, H41, Q56*

1 Introduction

Human decision-making requires balancing personal benefits with collective well-being, especially concerning social and environmental issues. For example, consumers often face a dilemma between cheaper, less sustainable products that maximise personal gain and more expensive, eco-friendly alternatives that support societal goals at a higher cost. Classical economic models, such as those relying on the Nash Equilibrium (NE), assume that individuals are perfectly rational and prioritise self-interest, predicting outcomes that frequently diverge from real-world behaviour. Empirical evidence shows that people often exhibit bounded rationality and are influenced by social preferences such as fairness, altruism, or ecological concerns, leading to decisions that deviate from strict payoff maximisation (Fehr E. & Schmidt K. M., 2000; Capraro V. & Rand D. G., 2018). To address these discrepancies, behavioural game theory has increasingly turned to the Quantal Response Equilibrium (QRE) framework, which accounts for stochastic strategy selection, where choices are weighted by their expected utility but smoothed by noise, better capturing the nuanced behaviour observed in experimental settings (Goeree L. K. et al., 2005). While QRE has been successfully applied to various strategic contexts, such as auctions and voting (Haile P. et al., 2008), its application to decisions involving explicit trade-offs between personal gains and social preferences, particularly in ecologically relevant scenarios, remains underexplored. This gap is significant given the urgent need to understand how individuals make choices that impact sustainability, a domain where personal incentives often conflict with collective environmental goals.

This study aims to bridge this gap by employing QRE to model trade-offs between personal monetary payoffs and social welfare in a controlled experimental setting. We focus on a "Green Consumer Game," where participants choose between strategies that vary in financial return and ecological impact, reflecting real-world dilemmas such as sustainable consumption. Our approach integrates a composite utility function that combines private payoffs and social welfare, weighted by an individual-specific social preference parameter. Using the oTree platform, we conducted a multi-round experiment with 215 participants, eliciting their social preferences and observing their strategic choices under different framing conditions (e.g., gain vs loss frames). We then calibrated the QRE model to empirical data, comparing its predictive accuracy against NE and observed behaviour.

Our study makes two key contributions. First, it extends the application of QRE to ecologically motivated decision-making, providing a formal framework to analyse how boundedly rational agents navigate personal-social trade-offs in sustainability contexts. Second, it examines the role of contextual framing in shaping these choices, offering insights into policy tools (e.g., nudges, penalties) that can steer behaviour toward socially optimal outcomes. By combining behavioural game theory with experimental evidence, this work advances our understanding of ethically constrained decision-making and informs strategies for promoting sustainable behaviour in economic and societal settings.

2 Literature Review

The interplay between personal gains and social preferences in decision-making is central to behavioural economics and game theory, highlighting human behaviour's complexity in strategic contexts. Traditional models, like the NE, assume perfect rationality and that individuals prioritise personal payoffs over collective welfare. However, evidence shows that people often sacrifice monetary rewards for social values such as fairness and altruism, leading to the advancement of models like the QRE. A substantial body of literature highlights the prevalence of prosocial behaviour in economic interactions, even when it contradicts self-interest. Capraro V. and Rand D. (2018) demonstrate that moral preferences, rather than mere equity or efficiency, drive individuals to act prosocially, often at personal cost. This is supported by neurological studies, such as Gong X. et al. (2020), which reveal empathy's role in cooperative decisions, and Fariña A. et al. (2021), which link social preferences to brain structure, suggesting a biological basis for such tendencies. These findings indicate that utility functions must extend beyond private payoffs to include social welfare components, a concept central to our study's composite utility specification. The QRE framework has emerged as a critical advancement over NE for modelling these behaviours, incorporating stochastic choice to reflect bounded rationality. Goeree J. et al. (2005) argue that QRE's logit-based probabilities better align with experimental data, capturing deviations from perfect rationality observed in strategic settings. Haile P. et al. (2008) and Cason T. and Mui V. (2005) apply QRE to empirical contexts like voting and participation games, showing their ability to account for heterogeneous preferences and uncertainty. Unlike NE's binary predictions, QRE's smooth probability curves modulated by a rationality parameter offer a more realistic depiction of decision-making, a feature our study leverages to analyse trade-offs between personal profit and social impact. Contextual factors, including social norms and framing, further complicate these trade-offs, influencing how preferences manifest in behaviour. Savani K. et al. (2012) illustrate that perceived norms shape choices, aligning them with societal expectations. Edlin A. et al. (2007) show that social preferences can dominate self-interest in collective scenarios like voting. Public goods games provide additional insights: Yu S. et al. (2021) integrate altruism into utility functions, finding it enhances cooperation, while Kurzban R. et al. (2001) and Maiti A. and Dey P. (2020) highlight the roles of inequity aversion and network structures. As explored by Tversky A. and Kahneman D. (1981), framing effects also demonstrate that presentation (e.g., gains vs. losses) alters choices, a dynamic our study tests experimentally.

Despite advancements, a notable gap persists in the literature. QRE has been employed in various strategic contexts, yet its application in modelling trade-offs between personal gains and social preferences, particularly in ecological decisions, is underexplored. Current studies primarily focus on abstract rationality parameters (λ), emphasising the need for experimental validation of QRE's predictive power in socially driven decision-making.

Our study addresses this gap by applying QRE to a "Green Consumer Game," where players weigh personal monetary payoffs against ecological welfare. Building on prior work, we propose a utility function that balances private profit and social impact, calibrated through elicited social preferences, and test it in a multi-round experimental design. We further explore how aggressive framing (e.g., penalties vs. rewards) shifts choice probabilities, offering policy-relevant insights.

3 Materials and Methods

This study investigates trade-offs between personal gains and social preferences in strategic decision-making, focusing on ecological implications through a combination of theoretical modelling and an interactive online experiment conducted on the *oTree* platform. *oTree*, an open-source Python-based framework (Chen D. et al., 2016), was selected for its flexibility in designing multiplayer behavioural experiments and its compatibility with web-based deployment, enabling precise control over game dynamics and data collection. Our methodology integrates a QRE model with a composite utility function, tested via a "Green Consumer Game", followed by modelling and statistical analysis to compare QRE predictions with observed behaviour and classical NE.

Experimental Design. Participants. The experiment involved 215 participants recruited via an online pool (*Prolific*). Participants were assigned unique social preference weights (θ_i) drawn from a uniform distribution over [0,1], reflecting heterogeneity in their prosocial orientations. Informed consent was obtained through oTree's interface, and participants received monetary incentives based on their accumulated payoffs, adjusted by collective outcomes. The "Green Consumer Game" was programmed as a custom oTree application consisting of two phases:

Phase 1: Elicitation of Social Preferences. Before the game commenced, participants filled out a Social Value Orientation (SVO) Slider Measure (Murphy R. et al., 2011) integrated within *oTree*. This module presented a series of hypothetical allocation tasks between self and others, from which $\theta_i \in [0,1]$, designed to quantify each participant's emphasis on social welfare versus personal gain. The *oTree* app recorded these values as player-specific attributes for later rounds.

Phase 2: Strategic Decision Rounds. The core game spanned $T = 10$ repeated rounds, hosted on oTree's server. In each round, participants chose one of three strategies, each with distinct personal payoffs (π_i) and social impacts (W): (1) *Strategy A (Self-Interested)*: $\pi_i = 100$, $W = -5W$ (high profit, high ecological damage); *Strategy B (Balanced)*: $\pi_i = 80$, $W = -1$ (moderate profit, moderate damage); *Strategy C (Socially Responsible)*: $\pi_i = 60$, $W = 0$ (low profit, no damage).

Procedure. Participants accessed the game via a web browser link generated by oTree, requiring no software installation. After completing Phase 1, they entered the 10-round match, selecting one strategy per round via an interactive HTML interface designed with *oTree's* templating system. Post-round feedback, including individual earnings and a group-level environmental degradation index, was displayed using *oTree's* dynamic page rendering. To explore framing effects, two conditions were randomly assigned: (1) *Gain Frame*: Strategy C offered a bonus ($\pi_i = 65$); *Loss Frame*: Strategy A incurred a penalty ($\pi_i = 95$).

The Game Theoretical Model. The game was formalised as a finite normal-form game.

$$G = (N, \{S_i\}(i \in N), \{U_i\}(i \in N)), \tag{1}$$

where $N = \{1,2,...,215\}$, $S_i = \{A,B,C\}$, $S = S_1...S_n$, and U_i: $S \to R$ is the utility function of player i.

Specifically, $U_i(s) = (1 - \theta_i) \times \pi_i(s) + \theta_i \times W(s)$, where $A = \{s \in S | s_i = A$ for all $i \in N\}$, $B = \{s \in S | s_i = B$ for all $i \in N\}$, and $C = \{s \in S \mid s_i = C$ for all $i \in N\}$.

Under QRE, strategy choice probabilities are defined as:

$$P_i(s_i) = exp(\lambda U_i(s_i)) / (\Sigma_{s_i' \in S_i} exp(\lambda U_i(s_i'))), \tag{2}$$

where $\lambda \geq 0$ is the rationality parameter, with

$$U_i(s_i) = (1 - \theta_i)\pi_i(s_i) + \theta_i W(s_i). \tag{3}$$

This function was coded to compute choice probabilities during the experiment dynamically.

Data Collection and Calibration. oTree software automatically recorded data in real-time, including each participant's θ_i, round-by-round choices, utilities, and payoffs, which were exported as a CSV file from oTree's admin interface. To calibrate λ, we applied maximum likelihood estimation (MLE) to the choice data using the following log-likelihood function:

$$LL(\lambda) = \sum_{i=1}^{215}\sum_{t=1}^{10} \ln\left(P_i(s_{i,t}|\theta_i,\lambda)\right) \quad (4)$$

where $s_{i,t}$ – the observed choice in round t – moderate sensitivity to utility differences.

Using *oTree's* bot testing feature, we simulated choice probabilities for Strategy C across $\theta_i \in [0, 1]$ and $\lambda \in [0.1, 3.0]$, generating a heatmap to visualise behavioural patterns. Bots were programmed to replicate the QRE logit model, providing a baseline for comparison. To perform statistical validation, we compared three models: (1) *NE* – deterministic maximization of U_i; (2) *QRE* – probabilistic predictions with $\hat{\lambda}$, derived from *oTree* data; (3) empirical, observed frequencies of Model fit was assessed via RMSE between predicted and observed probabilities.

Software and Tools. The experiment was developed and hosted on *oTree* (version 5.10), leveraging Python 3.9 for backend logic, HTML/CSS for the front end, and *oTree's* Django framework for server management.

4 Results and Discussion

Let the utility of the player i depend on their payoff πi and a social welfare component *W*. We define:

$$U_i(s_i) = (1-\theta_i)\pi_i(s_i) + \theta_i W(s_i), \quad (5)$$

where $\theta_i \in [0,1]$ represents the player's weight on social utility; $\pi_i(s)$ – monetary payoff to player i under profiles; $W(s)$ – social welfare function. Under QRE, players choose strategies probabilistically:

$$P_i(s_i) = \frac{e^{\lambda U_i(s_i, s_{i-1})}}{\sum_{s_i'} e^{\lambda U_i(s_i', s_{i-1})}}, \quad (6)$$

where $\lambda \geq 0$ captures sensitivity to utility: as $\lambda \to \infty$, QRE converges to the Nash equilibrium.

Application to "A Green Consumer Game." We illustrate the model using a simplified consumer decision: (1) *Strategy A*: Buy a cheaper, non-sustainable product; (2) *Strategy B*: Buy a more expensive, eco-friendly product.

The private pay-off is higher for *A*; social welfare is higher for *B*. We simulate how the equilibrium probabilities of choosing B vary with θ and λ. We consider a finite normal-form game:

$$G = (N, \{S_i\}_{i\in N}, \{U_i\}_{i\in N}),$$

where $N = \{1,2,...,n\}$ – the set of players; S_i – the finite set of pure strategies available to player *i*; U_i: $S_1 \times ... \times S_n \to R$ – the utility function of player *i*.

We define a player *i*'s utility as a convex combination of private payoff π_i and social welfare *W*, as (5). Under the QRE framework, players choose strategies probabilistically, with probabilities increasing in expected utility. The QRE logit for the player i is defined as:

$$P_i(s_i) = \frac{exp\left(\lambda \mathbb{E}_{s-i}\left[U_i(s_i, s_{i-1})\right]\right)}{\sum_{s_i'} exp\left(\lambda \mathbb{E}_{s-i}\left[U_i(s_i', s_{i-1})\right]\right)}, \quad (7)$$

where $\lambda \geq 0$ – the rationality parameter (as $\lambda \to \infty$, players behave as in a Nash equilibrium; as $\lambda \to 0$, the behaviour becomes completely random); $\mathbb{E}_{s\text{-}i}$ – denotes the expectation over other players' strategy distributions.

An equilibrium is a fixed point in the system of choice probabilities $\{P_i(s_i)\}_{i\in N}$, such that each player's strategy is consistent with the expected utilities given the strategies of others. This model allows for the analysis of: how the weight on social concerns (θ_i) influences strategic behaviour and how imperfect rationality (via λ) smooths responses and leads to more realistic predictions, the emergence of "ethically constrained" behaviour even when not strictly payoff maximising.

Experimental Game Design. We designed a multi-round interactive game informed by the QRE framework to empirically explore the trade-offs between personal gain and social preferences under bounded rationality. The game consists of two phases: (1) a pre-game questionnaire to elicit players' social preferences and (2) a repeated strategic decision-making game where players choose between options with varying degrees of personal benefit and social cost.

Phase 1: Eliciting Social Preferences. This step estimates the individual-specific parameter θ_i, which reflects a player's weight on social welfare in their utility function. We employ the following instruments: (1) Social Value Orientation (SVO) Slider Measure: Participants are asked to make a series of hypothetical allocations between themselves and others, from which their prosocial orientation is inferred; (2) Schwartz Value Survey (Short Form): Participants rate the importance of values such as benevolence, universalism, and power on a 6- or 10-item Likert scale. The relative weight assigned to social vs. self-enhancing values is used to construct $\theta_i \in [0,1]$.

Phase 2: Strategic Game Rounds. The main game consists of $T = 10$ repeated rounds. Players choose between three distinct investment strategies in each round, each associated with a specific personal payoff π_i and a level of social impact *W*. The available strategy represents a trade-off spectrum:

– Strategy *A* (Self-Interested): Maximizes personal gain but causes severe social damage.

– Strategy *B* (Balanced): Provides moderate gain with moderate social impact.

– Strategy *C* (Socially Responsible): Minimizes or avoids social harm with lower monetary return.

The utility function guiding choice is specified as (5) and strategies options are presented in Table 1.

Feedback and Incentives. After each round, players receive feedback on their monetary earnings and the collective social outcome (e.g., environmental degradation index or public good level). Incentives include real monetary rewards based on accumulated payoffs, possibly augmented or reduced by the group's collective performance. This design allows us to empirically test whether and how players' stated social preferences (θ_i) predict their strategic choices and whether behaviour aligns with Quantal Response Equilibrium predictions.

QRE Analysis. Assuming players follow a logit response based on the utility function incorporating both personal and social components, the probability of choosing strategy $s_i \in \{A, B, C\}$ is given by (6) with the use of composite utility (5). This framework allows smooth behavioural transitions: for small λ, choices are nearly random; as $\lambda \to \infty$, the player almost surely chooses the highest-utility strategy, recovering the best-response/Nash equilibrium.

We collected data for 215 participants, each assigned a unique level of social preference $\theta_i \in [0,1]$, and their recorded strategic decisions according to the QRE model (7) with a fixed rationality parameter $\lambda = 1.2$. Participants chose among three options with distinct trade-offs between personal and social payoffs. Figure 1 illustrates how the probability of selecting a socially responsible strategy (C) changes with social preference weight (θ) under varying levels of rationality (λ), based on the Quantal Response Equilibrium model.

At low levels of rationality ($\lambda = 0.1$), players choose nearly randomly across strategies, regardless of their social concerns. As λ increases, indicating higher sensitivity to utility differences, the probability of selecting the socially responsible option (Strategy C) becomes more responsive to the player's social orientation. For high rationality ($\lambda = 2.0$), small increases in θ lead to significant

Table 1 Strategy Options in Each Game Round

Strategy	**Personal Payoff π_i**	**Social Impact W**	**Interpretation**
A	100	–5	Self-interested (high profit, high damage)
B	80	–1	Balanced (moderate profit, moderate environmental damage
C	60	0	Socially responsible (low profit, no environmental damage)

Source: developed by the authors on their calculations

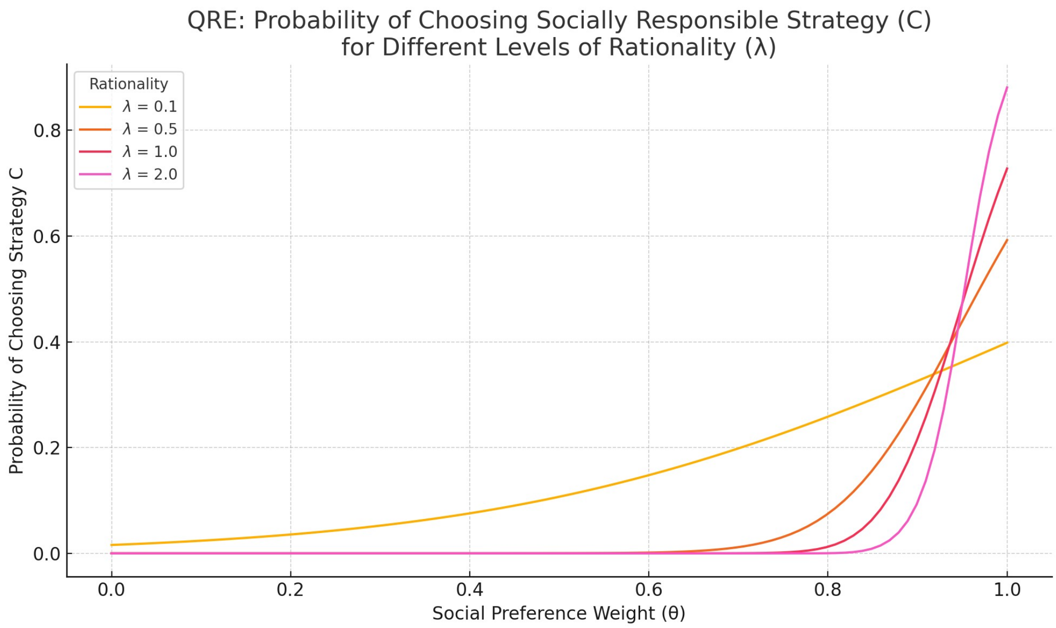

Figure 1 QRE probabilities of choosing the socially responsible strategy (C) as a function of social preference weight θ, for different levels of rationality λ.

Source: developed by the authors on their calculations

jumps in the likelihood of choosing C, indicating sharp transitions in strategic behaviour as players become more value-driven. This gradual adjustment is a key feature of QRE, capturing more realistic behaviour than standard Nash models, which assume perfect best responses. This result highlights the dual role of internal preferences (θ) and cognitive precision (λ) in determining ethically constrained behaviour. Increasing social concern (θ) and rationality (λ) increase the likelihood of eco-friendly choices. QRE captures smooth transitions in behaviour rather than sharp switches, as in Nash models.

To calibrate the model, we estimated a logistic regression where the dependent variable is a binary indicator of choosing the socially responsible strategy (C), and the independent variable is θi. The results indicate a strong positive relationship between social preference weight and the probability of choosing Strategy C. The fitted model follows the expected QRE shape, with the logit curve capturing smooth behavioural transitions. Figure 2 illustrates the observed data and the fitted QRE prediction. As θ increases, the likelihood of selecting the pro-social strategy also increases.

Figure 2 further reinforces the model's empirical validity by comparing the fitted QRE prediction with observed choices. The plot reveals that while most choices remain at low probability levels when θ is below 0.8, the probability of selecting Strategy C rises sharply beyond this threshold. This non-linear increase suggests that a minimum level of social concern is necessary to trigger a behavioural shift toward responsible action. The dispersion of observed choices around the fitted curve also reflects the stochastic nature of decision-making, emphasising that while θ strongly predicts behaviour, individual variability remains significant.

To empirically calibrate the rationality parameter λ, we applied a maximum likelihood estimation (MLE) procedure using the observed choices of 215 simulated participants. Each participant made one strategic choice among three options, with selection probabilities derived from the QRE logit formulation (7) with the composite utility (5) based on the personal payoff and social welfare, and $\theta_i \in [0,1]$ represents the individual's social preference weight. The log-likelihood function was constructed by summing the log probabilities of each participant's observed choice under their respective θ_i. We then minimised the negative log-likelihood over $\lambda > 0$ using numerical optimisation. The resulting estimate is presented in Table 2.

Table 2 MLE Result for Rationality Parameter λ

Parameter	Estimate	Interpretation
λ	1.00	Moderate responsiveness to utility

Source: developed by the authors on their calculations

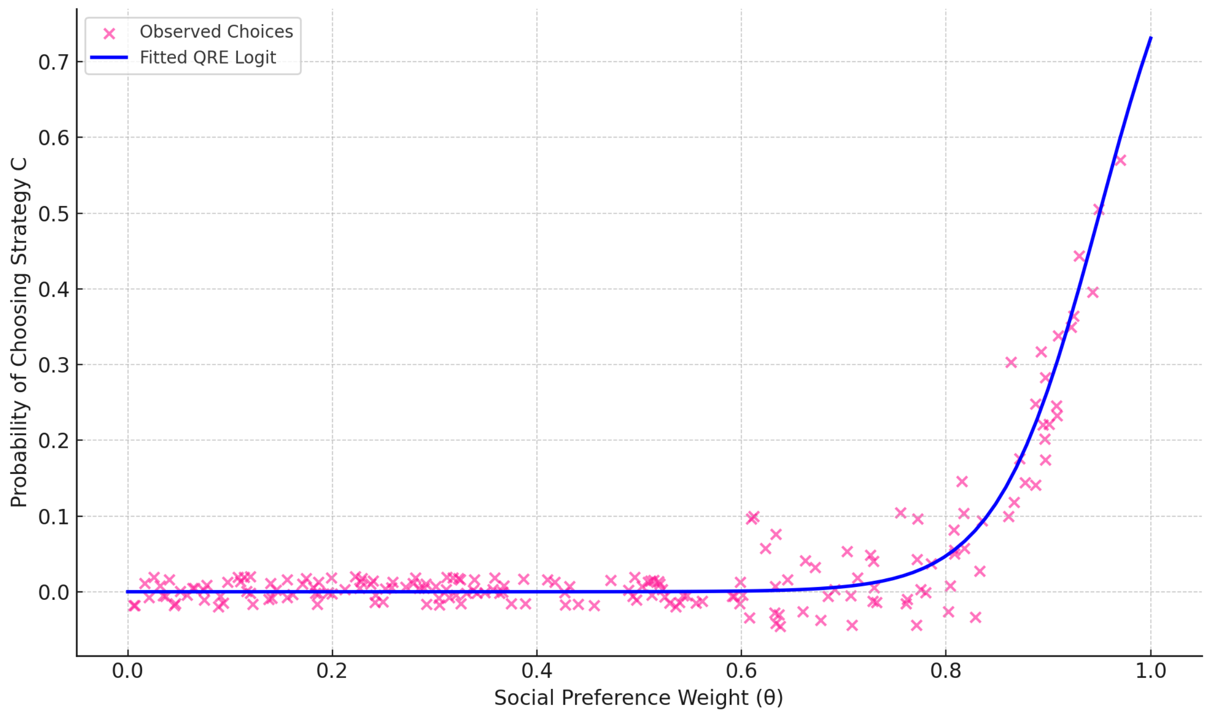

Figure 2 Observed vs. Fitted QRE Probability of Choosing Strategy C

Source: developed by the authors on their calculations

This indicates that participants exhibit moderate sensitivity to utility differences. That is, they are neither perfectly rational (as in NE, $\lambda \to \infty$) nor entirely random ($\lambda \to 0$). Instead, their behaviour is consistent with bounded rationality, which supports the applicability of QRE in socially motivated decision environments. To investigate how players' behaviour varies with their social preference weight θ and rationality parameters λ, we simulated a QRE heatmap (Fig. 3). Each cell in the heat map represents the probability of choosing the socially responsible strategy (C) for a given combination of $\theta \in [0,1]$ and $\lambda \in [0.1,3.0]$. The heatmap (Figure 3), reveals the interaction between preference orientation and decision precision. Behaviour is random mainly for low values of λ, and the probability of choosing Strategy C remains low across all θ. As λ increases, higher values of θ are more likely to lead to the selection of Strategy C, reflecting a sharper transition toward value-driven decisions.

These results confirm the predictive power of the QRE model in capturing nuanced behavioural dynamics, especially in environments where agents consider both personal gains and social impacts.

To further explore the influence of contextual framing on behaviour, we introduced an enhanced (”aggressive”) framing manipulation. Participants were randomly assigned to one of two conditions: (1) *Gain Frame*: The socially responsible option (Strategy C) was presented with a bonus (an additional reward); (2) *Loss Frame*: The self-interested strategy (Strategy A) was penalised through a reduced payment.

The purpose was to test whether the strategic framework alone could change decision patterns independent of intrinsic social preferences (θ). We adjusted the payoff vectors accordingly and recalculated the choice probabilities under the QRE model using the previously estimated rationality parameter λ = 1.00. Figure 4 demonstrates that both framing conditions significantly altered the likelihood of choosing the socially responsible strategy.

In the *loss frame*, participants were more likely to avoid the self-interest option, while in the *gain frame*, even low θ individuals were pushed toward social responsibility. This illustrates how external policy levers (e.g., framing, taxes, subsidies) can interact with internal preferences to influence ethical decision-making.

To evaluate the behavioural accuracy of the QRE, we compared three behavioural models across the full range of social preference weights $\theta \in [0,1]$: *NE (Deterministic)*: Players always select the strategy with the highest expected payoff based solely on utility; *QRE (Probabilistic)*: Strategy selection follows a logit model, smoothed by the estimated rationality parameter λ = 1.00; *Empirical Observations:* Averaged strategy C choices from participants, binned by θ. Figure 5 illustrates the comparison among these three. The Nash prediction

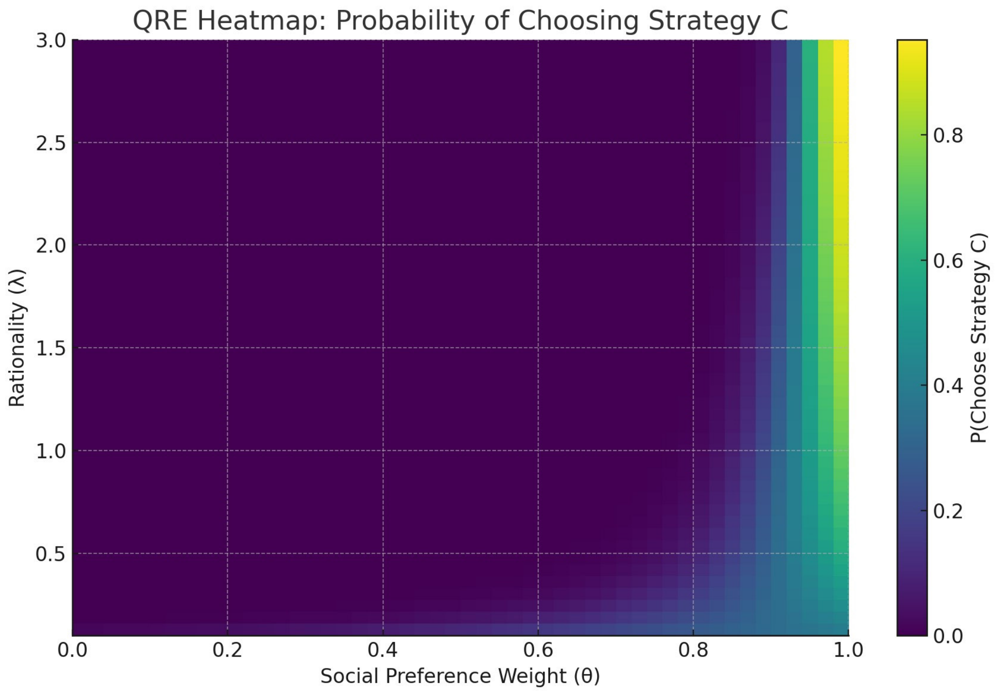

Figure 3 QRE Heatmap: Probability of Choosing Strategy C as a Function of Social

Source: developed by the authors on their calculations

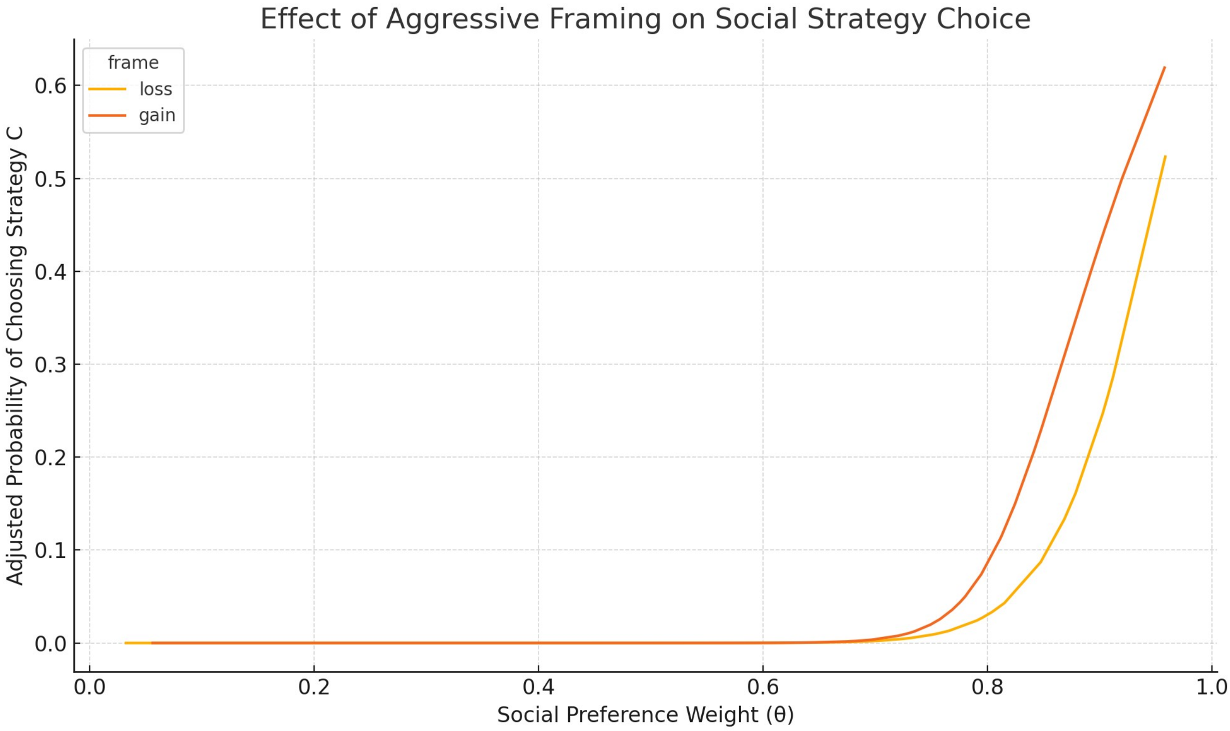

Figure 4 Effect of Aggressive Framing on Probability of Choosing Strategy C (QRE adjusted)

Source: developed by the authors on their calculations

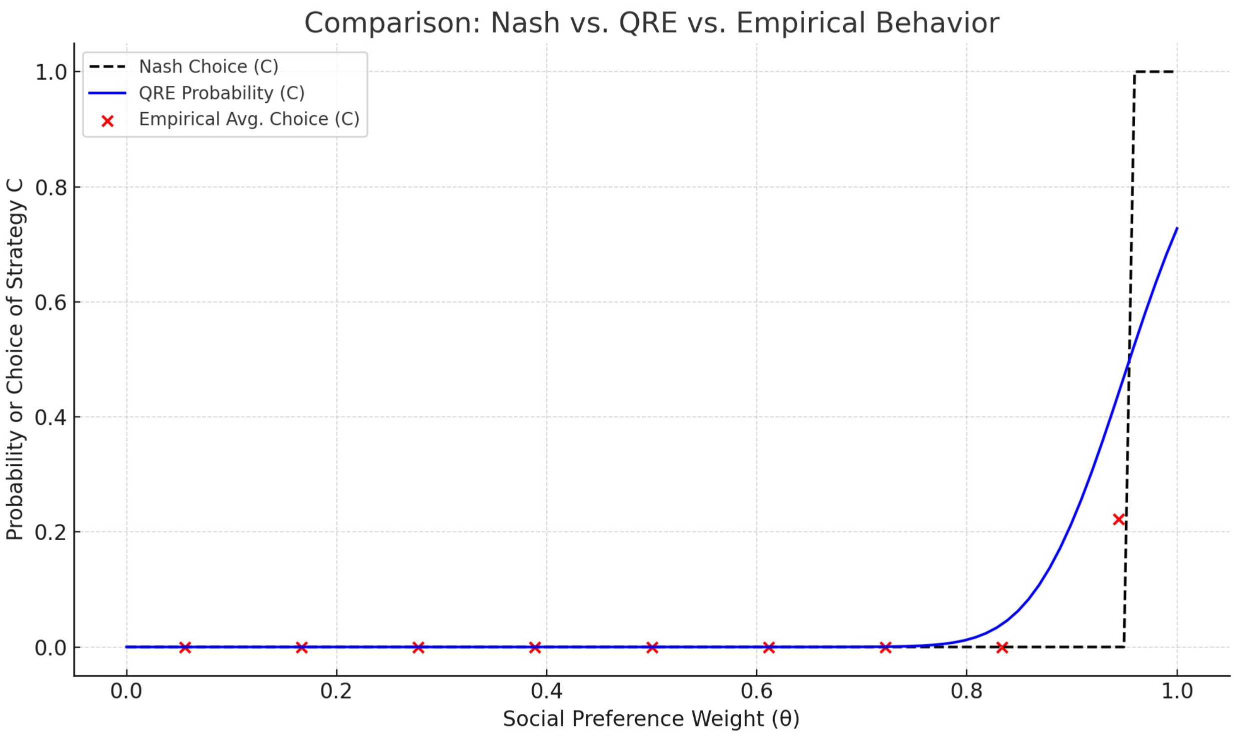

Figure 5 Comparison of Nash, QRE, and Empirical Behavior for Strategy C

Source: developed by the authors on their calculations

is binary and does not capture graded transitions. QRE, on the contrary, exhibits a smooth increase in the probability of choosing Strategy C as social concern increases.

To assess how well the theoretical models predict observed behaviour, we computed the Root Mean Squared Error (RMSE) between the probabilities predicted by the model of choosing strategy C and the empirical average choices across the social preference bins. The comparison includes QRE, a smooth probabilistic model with calibrated λ=1, and NE, a deterministic model assuming players always maximise utility. As shown in Table 3, the QRE model provides a more accurate fit to the empirical data. The lower RMSE suggests that the QRE better captures human decision-making's gradual and probabilistic nature when individuals weigh personal and social outcomes. In contrast, the binary structure of Nash predictions underperforms in replicating observed behavioural variability.

Table 3 Root Mean Squared Error (RMSE) of Model Predictions

Model	RMSE
Quantal Response Equilibrium (QRE)	0.069
Nash Equilibrium	0.079

Source: developed by the authors on their calculations

We examined how individuals balance personal monetary gain and social welfare in strategic contexts. Our research showed that social preferences and decision framing affect ethically constrained economic behavior via a multi-round interactive game and quantitative modeling utilizing Quantal Response Equilibrium (QRE).

Our findings indicate that QRE serves as a better behavioral model than classical Nash Equilibrium, especially in diverse social preference environments. Unlike the rigid binary predictions of Nash, QRE reflects a gradual rise in socially responsible actions as individuals' concern for others (θ) increases, supporting McKelvey R. (1995) and Camerer C.(2004) work on bounded rationality and probabilistic choice.

Those with higher social preference weights were more likely to choose prosocial strategies, aligning with psychological theories like the Social Value Orientation (SVO) and Schwartz's universal values.

Scientifically, this work contributes to behavioural game theory by incorporating social utility into equilibrium modelling without losing tractability. Provides a formal approach for modelling real-world decisions that include self-interested and prosocial motivations. The findings have practical implications for sustainability policy, ethical finance, and behavioural regulation. Policymakers and platform designers can leverage framework effects and probabilistic nudges to steer behaviour toward socially optimal outcomes, even among individuals with low baseline prosocial preferences.

While the experimental design captured a wide range of behaviours, future research could further explore the dynamic adaptation of social preferences (θ) over time, the influence of peer interactions, and cultural differences in framing responsiveness. Longitudinal experiments and cross-context replications would help validate the robustness and generalizability of these findings.

5 Conclusion

Our findings confirm that material payoffs, moral considerations, and contextual framing shape players' decisions. The QRE model effectively described observed behaviour, outperforming classical Nash predictions theoretically and empirically. Additionally, framing manipulations significantly influenced strategy selection, even among individuals with a lower prosocial orientation. These insights underscore the value of combining behavioural game theory with experimental methods to understand better the conditions under which individuals act socially, strategically, or selfishly. They also open avenues for practical applications, including policy design, sustainability promotion, and ethics-based platform governance. Future work should extend this framework to dynamic settings, social learning environments, and field applications, where the interplay between intrinsic motivation and institutional design may further determine the trajectory of collective outcomes.

6 Acknowledgements

We acknowledge the valuable comments from the members of the research group Research in Applied Economics (SEJ258 – Junta de Andalucía, Seville, Spain), as well as the participants of the III Workshop on The Role of Strategic and Cooperative Decisions in Economics and Business (27 March 25, 2025, Osuna, Spain) and the ODISSEI Conference for Social Science in the Netherlands 2024. All remaining errors are our own.

This research has received funding through the MSCA4Ukraine project, which the European Union funds. However, the views and opinions expressed are those of the authors only and do not necessarily reflect those of the European Union. Neither the European Union nor the MSCA4Ukraine Consortium nor any individual member institutions of the MSCA4Ukraine Consortium can be held responsible for them.

References

Camerer, C. (2004). *Behavioural Game Theory: Experiments in Strategic Interaction* . Princeton University Press. 568 p.

Capraro, V., and Rand, D. G. (2018). Do the right thing: Experimental evidence that preferences for moral behavior, rather than equity or efficiency per se, drive human prosociality. *Judgment and Decision Making*, vol. 13 (1), pp. 99–111. DOI: https://doi.org/10.1017/S1930297500008858

Cason, T. and Mui, V. (2005). Uncertainty and resistance to reform in laboratory participation games. European *Journal of Political Economy*, vol. 21(3), pp. 708–737. DOI: https://doi.org/10.1016/j.ejpoleco.2004.12.001

Chen, D. L., Schonger, M., & Wickens, C. (2016). oTree – an open-source platform for laboratory, online, and field experiments. *Journal of Behavioral and Experimental Finance,* vol. 9, pp. 88–97. DOI: https://doi.org/10.1016/j.jbef.2015.12.001

Edlin, A., Gelman, A., & Kaplan, N. (2007). Voting as a rational choice: why and how people vote to improve the well-being of others. *Rationality & Society*, vol. 19 (3), pp. 293–314. DOI: https://doi.org/10.3386/w13562

Fariña, A., Rojek-Giffin, M., Gross, J., & Dreu, C. (2021). Social preferences correlate with the cortical thickness of the orbitofrontal cortex. *Social Cognitive and Affective Neuroscience*, vol. 16(11), pp. 1191–1203. DOI: https://doi.org/10.1093/scan/nsab074

Fehr, E. and Schmidt, K. M. (2000). Theories of fairness and reciprocity – evidence and economic applications. *SSRN Electronic Journal*. CESifo Working Paper, no. 403. 56 p. DOI: https://doi.org/10.2139/ssrn.255223

Goeree, J. K., Holt, C. A., & Palfrey, T. R. (2005). Regular quantal response equilibrium. *Experimental Economics*, vol. 8 (4), pp. 347–367. DOI: https://doi.org/10.1007/s10683-005-5374-7

Gong, X., Sanfey, A., Zhou, X., & Luo, Y. (2020). Distinct behavioral effects and neural mechanisms of reciprocal reputation on cooperative decision-making in gain and loss context. *Preprint from PsyArXiv*. 42 p. DOI: https://doi.org/10.31234/osf.io/b37vx

Haile, P., Hortaçsu, A., & Kosenok, G. (2008). On the empirical content of quantal response equilibrium. American Economic Review, vol. 98(1), pp. 180–200. DOI: https://doi.org/10.1257/aer.98.1.180

Kurzban, R., McCabe, K., Smith, V., & Wilson, B. (2001). Incremental commitment and reciprocity in a real-time public goods game. *Personality and Social Psychology Bulletin*, vol. 27(12), pp. 1662–1673. DOI: https://doi.org/10.1177/01461672012712009

Maiti, A. and Dey, P. (2020). On the parameterized complexity of binary networked public goods game. *arXivLabs: experimental projects with community collaborators* [arXiv:2012.01880]. 26 p. DOI: https://doi.org/10.48550/arxiv.2012.01880

McKelvey, R. D., & Palfrey, T. R. (1995). Quantal response equilibria for normal form games. *Games and Economic Behavior*, vol. 10(1), pp. 6–38. DOI: https://doi.org/10.1006/game.1995.1023

Murphy, R. O., Ackermann, K. A., & Handgraaf, M. J. J. (2011). Measuring social value orientation. *Judgment and Decision Making,* vol. 6(8), pp. 771–781. DOI: https://doi.org/10.1017/S1930297500004204

Savani, K., Morris, M., & Naidu, N. (2012). Deference in Indians decision making: introjected goals or injunctive norms? *Journal of Personality and Social Psychology*, vol. 102(4), pp. 685–699. DOI: https://doi.org/10.1037/a0026415

Tversky, A., and Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, vol. 211(4481), pp. 453–458. DOI: https://doi.org/10.1126/science.7455683

Yu, S., Kempe, D., & Vorobeychik, Y. (2021). Altruism design in networked public goods games., *Proceedings of the Thirtieth International Joint Conference on Artificial Intelligence (IJCAI-21)*. pp. 493–499. DOI: https://doi.org/10.24963/ijcai.2021/69