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Integrating economic mobility into the Public Goods Game: the effect on cooperation

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Abstract
Experimental economists study the Public Goods Game (PGG) to investigate cooperative behavior. This study embedded inequality and income mobility into the PGG to investigate its effect on cooperation. Treatment 1 embedded fixed transfers in-between rounds of the PGG, representing equally distributed income growth. Treatments 2 and 3 embedded variable transfers in-between rounds, representing heterogeneously distributed income growth based on equal proportion of luck and effort (Treatment 2) or a disproportionate amount of luck (Treatment 3). Treatments 2 and 3 also enabled relative income mobility, while treatment 1 restricted any possibility of relative mobility. Results showed that introducing relative income mobility (Treatments 2 and 3) did not lead to greater cooperation (when compared with Treatment 1) among the players. Comparing Treatments 2 and 3, participants contributed more to the PGG when relative income mobility was dependent on effort rather than on luck. Despite theories linking weakened meritocratic beliefs with greater preferences for redistribution, in this study, contribution to the PGG fell when the income mobility process was predominantly luck-based. Unfairness observed in the income mobility process discouraged contribution, even when equity of final outcomes could be achieved through cooperation. This could be because a behavioral component of dissatisfaction against inequity in the income mobility process outweighed the motive of using the PGG to redistribute unfair income. The study also investigated within-treatment behavior of different endowment types (low class, middle class, high class) when various forms of income mobility were integrated. Under these conditions, and when relative income mobility was integrated into the PGG on a predominantly luck-based process, a significant reduction in contribution from the middle class was observed. Endowment inequality did not reduce cooperation, presumably because the associated relative income mobility incorporation into the PGG threatened downward mobility, such that higher-class participants contributed to establish a safety-net.

Keywords
Income mobility, Heterogeneity, Cooperative behavior, Economic fairness, Income redistribution, Public Goods Game, Wealth inequality, Meritocracy, Behavioral study, Prospect of Upward Mobility

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1. Introduction

1.1 Cooperation and Public Goods Games

Perceptions of economic mobility significantly influence judgements of economic fairness (1). This perceived fairness, in turn, can affect the degree of cooperative behavior observed in society (2). To investigate direct causal relationships between economic mobility and cooperative behavior, this study integrated Field & Ok (1999)'s absolute income mobility with the behavioral study of Public Goods Games (PGG) (3).

Cooperation is necessary for society to function; achieving technological advancement, environmental protection, and economic growth requires human collaboration. Public Goods Games in experimental economics allow for the study of cooperative and pro-social behavior under controlled settings. In a standard PGG, subjects are endowed with an equal number of tokens that represent real monetary incentives, which they then either contribute to a public funding pool (pro-social) or withhold for private consumption (free-riding). Then, the total number of tokens contributed to the public pool is multiplied by an enhancement factor and the resultant tokens are distributed equally to every individual. A subject's total payoff is the sum of their private tokens and distributed tokens from the public pool. A dilemma exists between the pro-social choice and free-riding behavior. Contributing to the PGG symbolizes sacrificing private "consumption" for the funding of a "public good" that benefits all of society, but refusing to contribute may be the rational strategy for payoff-maximizing individuals. In a standard PGG, cooperation is maintained for the first few rounds but converges to zero-tokens contributed as participants engage in repeated rounds of the game (4).

The standard PGG, however, makes an implicit assumption that participants are homogenous in their valuation of the public good and their initial endowment. Recent studies have challenged this assumption by incorporating heterogeneity in studying PGGs. Mainly, studies have started to simulate economic inequality's impact on PGGs. What if participants start off with different endowments? Montoya-Lozano et al., (2024) proposed that economic inequality in the form of unequal token distributions at the start of PGGs would result in greater free-riding behavior and less contribution, measured by the number of tokens contributed (5). Kolle (2015) in studying similar heterogeneity in the PGG showed that heterogenous valuation of public goods also resulted in lower cooperation. When agents benefit differently from one token in the public pool, cooperation decreased (6).

Overall, these studies reached a tentative consensus that inequality in PGGs decreased cooperation. Ramalingam & Stoddard (2023) altered the constant nature of inequality in the aforementioned studies. Their study concluded that the redistribution of heterogenous endowments in the PGG across rounds still failed to increase the cooperative behavior of heterogenous groups to the level observed in consistently homogenous groups (7).

In these studies on redistribution in PGGs, however, individuals with lower endowments during the first few rounds of the PGG are guaranteed a higher endowment in the latter rounds, and vice versa. In Derbyshire et al.

(2025), the inverse proportional treatment is similar in that a lower endowment is essentially offset with higher returns from the public good (8). Economic inequality is either resolved and factored out of the equation or mitigated during every round, without exception.

1.2 General study design

This study will embed an abstraction of absolute income mobility in PGGs and thereby avoid this feature of a definite convergence or divergence between the status of "poor," "middle," and "rich" individuals. While greater absolute income mobility often offers a chance for convergence between poor and rich demographics, it is not a certainty. The absolute income mobility that this study integrates into treatments of the Public Goods Game allows, for instance, for the absolute income growth of poor demographics at the expense of widening disparities between the rich and poor. Uncertainty of upward and downward mobility can exert a more interesting influence on cooperation in PGGs with heterogenous individuals. The absolute income mobility will be administered in two main forms that either allows or disallows relative mobility. Two treatments that allow for relative mobility will also differ on whether this relative mobility prioritizes effort or luck in the income mobility process.

Research is scarce on a key factor – income mobility - that may mitigate or amplify economic inequality's impact on cooperative behavior. How do varying forms of income mobility manipulated in repeated PGGs affect cooperative behavior? This question is largely distinct from the existing research on redistribution's impact in heterogenous settings of the PGG (9). Absolute income mobility without restrictions encompasses two possibilities – widening disparities in endowment or shrinking endowment disparity. It does not guarantee either of the two possibilities. This study incorporates absolute income mobility through fixed transfers, variable transfers based equally on luck and effort, and variable transfers based primarily on luck. The manuscript is organized as follows. Section 2 presents the literature review. Section 3 states the hypotheses. Section 4 details the experimental design. Section 5 outlines the results. Section 6 further elaborates and discusses the findings. Section 7 discusses the limitations of the study and suggests future directions for research. Finally, section 8 concludes the study.

2. Literature Review and application to the study

The Public Goods Game can be a mechanism for redistribution when initial endowments are unequal (10). If everyone contributes the same proportion of their heterogenous starting endowment to the public pool, income is more equally distributed at the end of the round. To hypothesize income mobility's effect on preferences for redistribution, and thus for cooperative behavior, this section applies the Prospect of Upward Mobility (POUM) Theory. However, incorporating income mobility to the PGG may affect overall cooperative behavior without necessarily affecting preferences for redistribution. It could affect a multitude of other factors that determine cooperative behavior including environmental uncertainty and group solidarity, among others. Studies on pro-social charitable giving offer useful insights on how such factors may be affected by income mobility.

2.1 Insights from charitable giving

High-income mobility is hypothesized to create "reference" demographics for individuals. Speculating that there are plenty of opportunities to move up the income ladder, low-income individuals may associate closely with the norms and behavior of higher income demographics (11). In other words, low-income individuals set high-income individuals as their "reference" demographic in environments of high economic mobility. In contributions to charity, studies thus show that high income mobility often encourages lower-income demographics to donate based on the pro-social behavior of higher income individuals, to a greater extent than in settings with low-income mobility. Connecting this with studies that suggest poorer demographics often expect donations from the rich and assign an obligation for the rich to contribute pro-socially, it is reasonable to infer that low-income individuals in the income mobility treatment PGG may contribute greater amounts (12). This could also, theoretically, however, be counteracted by the reduction in contributions from the higher income class that expect downward income mobility, although the reverse could also be true in order to establish a safety net.

Hughes & Lukestich (13) in discussing charity donations argued that income volatility and fluctuations for households, which income mobility increases, decreased the willingness to donate. They performed an empirical study with Panel Study of Income Dynamics (PSID) and Center on Philanthropy Panel Study (COPPS) data to arrive at this conclusion. Their conclusion may also apply to the PGG when incorporating income mobility, with both downward and upward possibilities that increase uncertainty. For this experiment, Hughes & Lukestich's findings seemed to support a decrease in overall pro-social behavior in groups treated with uncertainty.

Finally, another insight from the charitable-giving literature is the relevance of group solidarity. In a statistic of charity contributions in the United Kingdom, moderately low-income individuals donated more, as a proportion to their income, than high income individuals. This has largely been explained by the "Socially Deprived Self Concept," which asserts that poorer individuals experience solidarity and a sense of in-group affiliation with others who go through similar struggles (14). With income mobility, such group solidarity may be weakened, leading to a decrease in overall cooperative behavior. While the low, middle, and high-income class is only comprised of one individual in each 3-person group for this PGG experiment, potential inter-class (i.e. low and middle class) solidarity may make the applicability of this theory tenable to this study despite the small sample size.

Of course, these studies on charitable giving cannot be directly generalized to behavior in the PGG although they provide foundational knowledge and must be tested experimentally. Charitable giving relinquishes personal consumption for a pro-social good. Expected future returns from donating to charities is often not a factor in deciding how much to donate. In the PGG, however, depending on beliefs about others' cooperative behavior, contributing to the public good is not necessarily a pure act of altruism over multiple rounds of the game.

2.2 Perception of PGG as a mechanism for redistribution

2.2.1 *Prospect of Upward Mobility*

The Prospect of Upward Mobility (POUM) theory suggests that individuals on the lower end of the income range will express less support for redistributive policies when higher relative income mobility is perceived. With greater perceived opportunities to raise relative income levels on their own, lower income individuals may reject the necessity of redistribution according to POUM. Following Benabou and Ok's (2001) proposal of POUM, many empirical studies have also been conducted (15). In South Korea, Lee (2016) affirmed the validity of the theory using data from the 2009 Korean General Social Survey (16). Applying POUM to the PGG in this study, higher income mobility may decrease overall contribution, and particularly contribution from lower income individuals. This also follows from Bennett (2012)'s conclusions that poorer individuals donate to the PGG with a causal line of thinking: "If I donate, when I need help, others will contribute." To the extent that the PGG is considered as a mechanism for redistribution, income mobility would be expected decrease contribution.

2.2.2 *Meritocratic beliefs undermine redistribution: effort and luck*

Two treatments were applied for this study (treatments 2 and 3) that varied the relative importance of effort and luck in the income-mobility process. Piketty (1995) and Benabou and Tirole (2006) provided the theoretical basis for the observation that rational voters in countries with effort-based income generation processes demand less redistribution (17,18). Kenworthy & McCall (2007) showed that despite rising inequality in OECD countries, preferences for redistribution of income had not steadily increased (19). The meritocratic perception, that effort plays an overwhelming role in determining success may be behind the phenomenon, as this perception provides a justification for income inequality. In relating it to the two PGG treatments in this study, these real-world observations would predict less contribution in the effort-based treatment, where participants may reject the desirability of a redistributive mechanism such as the PGG, and consider disparities as natural products of effort. Preferences for redistribution do not equate to contribution to the PGG, however, especially for lower-income individuals that may believe that they do not have an obligation to contribute. However, establishing group norms of contributing to the PGG can only be achieved by instilling trust in teammates through cooperating. Thus, the lower income-class can still be expected to contribute, intent on drawing contributions from the middle-income and higher-income class for redistribution through the PGG.

Chaudhuri et al. (2023) investigated the impact of determining endowments through merit, versus through luck, specifically in the PGG. They concluded that the poor free-ride more and vote for stronger punishments when others free-ride, if luck is the determining factor of initial endowments (20). Considering the significant effect of determining heterogenous endowments through luck or effort on cooperative behavior, this study embedded and varied both factors in modeling income mobility.

3. Hypotheses

This study tests the following hypotheses: Hypothesis 1 is primarily informed by the POUM (Prospect of Upward Mobility) literature's consensus on the negative effect of income mobility on redistribution and insights from the charitable-giving literature. Hypothesis 2 relates to diminishing preferences for redistribution in settings with meritocratic perceptions. The hypotheses can be explicitly stated as

Hypothesis 1: In PGG treatments that allow for relative income mobility, less cooperative behavior will be observed than from PGG treatments that do not allow for such relative income mobility.

Hypothesis 2: The reduction in cooperative behavior (within treatments that allow for relative income mobility) will be larger when income mobility is more a result of effort than of luck.

4. Materials and Methods

From a high school in East Asia, 51 participants were recruited with incentives of 2 community service hours toward graduation requirements and the chance to win monetary rewards. Students were aged 14-18, sampled from grades 9 to 12. Ethical concerns were cleared with the school administrators and informed consent forms were submitted before participation.

This study constructed three main treatments to evaluate the effect of income mobility on cooperation within PGGs; 1] Fixed transfers 2] Variable transfers determined equally by luck and effort 3] Variable transfers determined primarily by luck. All of these treatments embedded absolute income mobility. The variable transfer treatments (treatments 2 and 3), however, *also* embedded *potential* relative mobility. The fixed transfers treatment (treatment 1), in contrast, restricted any relative mobility.

For the fixed transfer treatment, three students were assigned to a group, and they were each randomly assigned an endowment. Unequal endowments of {1 token, 2 tokens, 3 tokens} were used to model initial economic inequality, and each token could be converted to 0.25 Chinese Yuan (RMB) at the end of the experiment. Participants played the public goods game, where the standard rules applied. They could withhold or contribute their endowment, and the total sum of contributions by all members was multiplied by a factor of 1.5 and distributed equally among all three members. There were a total of 4 rounds due to the limited time availability of participants. The income earned in previous rounds did not carry over to subsequent rounds. In the fixed transfers treatment, endowments increased by 0.5 tokens for everyone in between each round, simulating constant economic growth that is equally distributed. For all three treatments, at the start of each PGG round, participants were shown their group members' endowments for the round.

The variable transfer treatments incorporated a different form of income mobility into repeated rounds of the PGGs. Every element of the treatment was the same as in the fixed transfer treatment, except for between-round transfers. In treatment 2, the total growth of 1.5 tokens/round (multiplication factor) remained the same, but its distribution was unequal. 0.75 of the 1.5 total tokens distributed was randomly distributed to the three agents. This could be a combination of {0.25, 0.5, 0}, {0.5, 0.15, 0.1},

or any other combination of three numbers that summed to 0.75. Agents were able to see their own payoff from this random distribution but were unable to observe others' payoffs from this random process. This portion of between-round transfers modeled luck's role in endowment increases. The remaining 0.75 tokens were distributed based on the amount of effort exerted in an effort-task, modeling hard work's role in endowment increases.

Treatment group 3 used a smaller proportion of effort to luck to determine between-round transfers. Instead of a 1-1 split (as in treatment 2), treatment 3 implemented a 0.5:1 split. Effort-based tasks only distributed 0.5 tokens among the three players, while the chance-based process distributed 1 token among the three players.

The specific effort-assessment task used was highlighted in Gill & Prowse (2018) (21). Multiple sliders on a computer screen were arranged so that the initial position was set to 0 on a slider from 0 to 100. Participants had to exert effort to move the slider with their cursor from 0 to 50. In this experiment, the number of sliders correctly set to 50 determined the effort-based endowment increase for the next period. Where x is the number of sliders moved to 50 by subject i and y is the total number of sliders moved to 50 within a group, each subject received (x/y) *0.75 (for treatment 2), or (x/y) *0.5 (for treatment 3), depending on the treatment group within variable transfers. The luck-based and/or effort-based transfer in between rounds simulated economic growth, heterogeneously distributed between both factors.

The experiment was conducted on laptops, with z-tree experimental economics software installed (22). After the experiment, all participants were de-briefed and monetary incentives were paid out.

5. Results

For the following experimental results, an alpha level of 0.05 was employed. Treatment 1 refers to the fixed transfers treatment. Treatment 2 refers to the variable transfers treatment, where endowment additions were equally dependent on luck and effort. Treatment 3 refers to the variable transfers treatment, where endowment additions were more dependent on luck. There was insufficient evidence to refute hypothesis 1. Hypothesis 2 (cooperation would be greater for treatment 3 than for treatment 2) turned out to be false; however, its reverse (i.e. cooperation was greater for treatment 2 than that for treatment 3) could be statistically justified. Tables 1 through 4 show the average (and average relative) contributions by endowment type and treatment: separately for each round.

The average contribution was calculated as the mean contribution of a certain endowment type across all groups of the same treatment. The relative contribution was calculated as the number of tokens that a participant contributed, divided by their endowment during that round. Its average was the mean of the relative contribution of a certain endowment type, across all groups of the same treatment.

For both the fixed and the variable treatments, the action of each group member was categorized as an action by a low-endowment, middle-endowment, or high-endowment

individual based on their relative endowment ranking during that round.

Table 1. Average and average relative contributions (± Standard Deviation (SD)) by endowment type in round 1

Round 1	Endowment Type	Average Contribution (tokens)	Average Relative Contributions (proportion)
Fixed Transfer (n = 72)	High	0.889 ± 0.800	0.296 ± 0.267
	Mid	0.833 ± 0.983	0.417 ± 0.492
	Low	0.533 ± 0.427	0.533 ± 0.427
	Overall	0.751 ± 0.743	0.415 ± 0.395
Variable Transfer (1:1 effort to luck) (n = 72)	High	1.090 ± 0.833	0.407 ± 0.370
	Mid	1.176 ± 1.316	0.433 ± 0.334
	Low	0.688 ± 0.632	0.086 ± 0.203
	Overall	0.984 ± 0.953	0.309 ± 0.334
Variable Transfer (0.5:1 effort to luck) (n = 60)	High	1.180 ± 1.050	0.393 ± 0.350
	Mid	0.240 ± 0.336	0.120 ± 0.168
	Low	0.090 ± 0.123	0.090 ± 0.124
	Overall	0.503 ± 0.775	0.201 ± 0.260

Table 2. Average and average relative contributions (± SD) by endowment type in round 2

Round 2	Endowment Type	Average Contributions (tokens)	Average Relative Contributions (proportion)
Fixed Transfer (n = 72)	High	1.042 ± 0.843	1.375 ± 1.464
	Mid	1.083 ± 1.201	0.667 ± 1.211
	Low	0.613 ± 0.577	0.522 ± 0.551
	Overall	0.913 ± 0.882	0.380 ± 0.364
Variable Transfer (1:1 effort to luck) (n = 72)	High	0.627 ± 0.810	0.432 ± 0.304
	Mid	0.750 ± 0.800	0.368 ± 0.356
	Low	0.457 ± 0.607	0.346 ± 0.284
	Overall	0.611 ± 0.722	0.382 ± 0.299
Variable Transfer (0.5:1 effort to luck) (n = 60)	High	0.498 ± 0.370	0.145 ± 0.105
	Mid	0.256 ± 0.364	0.113 ± 0.161
	Low	0.560 ± 0.439	0.321 ± 0.235
	Overall	0.438 ± 0.388	0.193 ± 0.188

Table 3. Average and average relative contributions (± SD) by endowment type in round 3

Round 3	Endowment Type	Average Contributions (tokens)	Average Relative Contributions (proportion)
Fixed Transfer (n = 72)	High	1.375 ± 1.464	0.344 ± 0.366
	Mid	0.667 ± 1.211	0.222 ± 0.404
	Low	0.522 ± 0.551	0.261 ± 0.276
	Overall	0.854 ± 1.139	0.276 ± 0.335
Variable Transfer (1:1 effort to luck) (n = 72)	High	0.783 ± 0.926	0.181 ± 0.220
	Mid	1.373 ± 1.277	0.467 ± 0.429
	Low	0.722 ± 0.483	0.382 ± 0.281
	Overall	0.960 ± 0.944	0.343 ± 0.327
Variable Transfer (0.5:1 effort to luck) (n = 60)	High	0.646 ± 0.600	0.173 ± 0.166
	Mid	0.047 ± 0.061	0.055 ± 0.070
	Low	0.420 ± 0.377	0.151 ± 0.199
	Overall	0.371 ± 0.458	0.127 ± 0.153

Table 4. Average and average relative contributions (± SD) by endowment type in round 4

Round 4	Endowment Type	Average Contributions (tokens)	Average Relative Contributions (proportion)
Fixed Transfer (n = 72)	High	0.833 ± 1.395	0.185 ± 0.310
	Mid	0.500 ± 0.837	0.143 ± 0.239
	Low	0.922 ± 0.982	0.369 ± 0.393
	Overall	0.752 ± 1.047	0.232 ± 0.317
Variable Transfer (1:1 effort to luck) (n = 72)	High	0.864 ± 0.945	0.178 ± 0.200
	Mid	0.760 ± 1.629	0.190 ± 0.401
	Low	0.790 ± 0.895	0.418 ± 0.479
	Overall	0.804 ± 1.132	0.262 ± 0.373
Variable Transfer (0.5:1 effort to luck) (n = 60)	High	0.442 ± 0.510	0.126 ± 0.155
	Mid	0.260 ± 0.581	0.075 ± 0.089
	Low	0.402 ± 0.391	0.126 ± 0.175
	Overall	0.368 ± 0.470	0.109 ± 0.136

5.1 Overall contributions across treatments

Table 5 presents the average contributions of each endowment type by treatment, over all four rounds.

Table 5. Average and average relative contributions (± SD) by endowment type over 4 rounds

Treatment	Endowment Type	Average Contributions (tokens)	Average Relative Contributions (proportion)
Fixed Transfer (n = 72)	High	1.035 ± 1.109	0.281 ± 0.286
	Mid	0.771 ± 1.021	0.304 ± 0.408
	Low	0.648 ± 0.644	0.392 ± 0.363
	Overall	0.818 ± 0.947	0.325 ± 0.354
Variable Transfer (1:1 effort to luck) (n = 72)	High	1.106 ± 0.984	0.300 ± 0.290
	Mid	0.960 ± 1.117	0.360 ± 0.375
	Low	0.534 ± 0.580	0.312 ± 0.332
	Overall	0.866 ± 0.942	0.324 ± 0.330
Variable Transfer (0.5:1 effort to luck) (n = 60)	High	0.692 ± 0.693	0.205 ± 0.224
	Mid	0.201 ± 0.363	0.080 ± 0.135
	Low	0.368 ± 0.370	0.188 ± 0.183
	Overall	0.420 ± 0.520	0.157 ± 0.190

The Kruskal-Wallis statistical test was used to compare contributions from each treatment. The statistical analysis treated each individual decision as an independent unit of observation. With $p = 0.04$, there was sufficient evidence to reject the null hypothesis of the test that there is no difference in contributions to the PGG for *all three* treatments. A post-hoc Dunn's test with a Bonferroni correction for multiple comparisons demonstrated that a decrease in *overall* cooperative behavior was clearly observed in treatment 3 when compared to treatment 2 ($p = 0.0178$), but not when compared with treatment 1 ($p = 0.1296$). There was also insufficient evidence to suggest a difference in cooperative behavior between treatment 2 and treatment 1.

The results suggest that enabling relative mobility does not significantly alter the overall cooperative behavior in the PGG (no statistical difference between treatment 1 and 3 and between treatment 1 and 2). However when this relative mobility is generated largely through effort (treatment 2), participants were more cooperative than when the relative mobility was generated primarily by luck (treatment 3). Therefore, there was insufficient evidence to reject hypothesis 1. There was also insufficient evidence to reject hypothesis 2 because it was not formulated as a null hypothesis. However, if hypothesis 2 were to be formulated as its reverse; i.e.; that "*The reduction in cooperative behavior (within treatments that allow for relative income mobility) will be larger when income mobility is more a result of luck than of effort",* this study provided evidence to accept this reverse hypothesis.

5.2 Trends in contributions across treatments

Across four rounds of the PGG, the gradual decrease in cooperative behavior was apparent in treatment 1, treatment 2, and treatment 3. Since the data sets violated the standard assumption of variance homogeneity and normality, an Aligned Rank Transform (ART) ANOVA test was performed instead.

Significant interaction effects between the rounds of the game and the treatment cannot be supported, suggesting that the decrease in cooperative behavior across 4 rounds follow a similar distribution for all treatments (p = 0.6728).

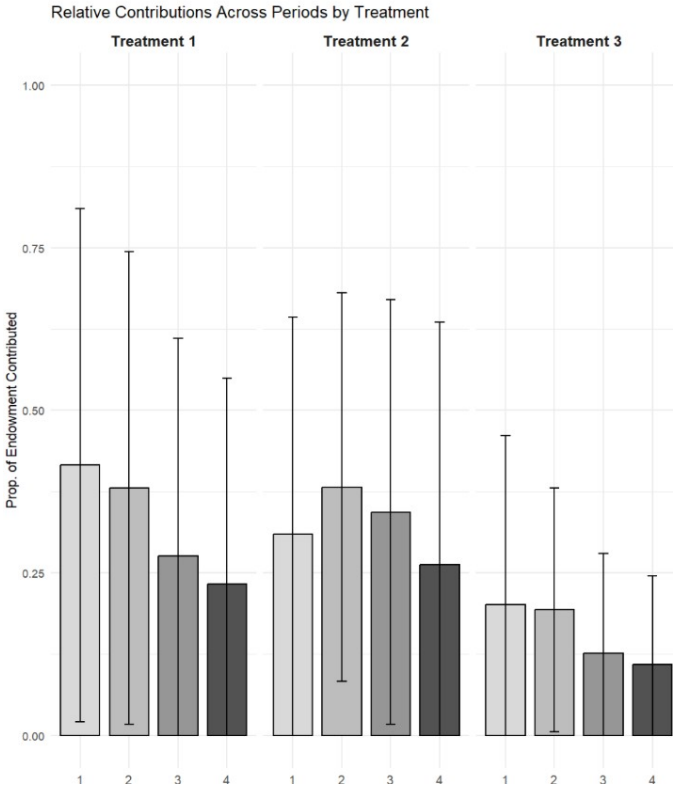

Figure 1. The bar graph shows the average proportion of an agent's endowment contributed across 4 rounds - for all 3 treatments. Each bar from left to right respectively represents rounds 1-4. For each round, the average is computed from all agents' actions: low, middle, and high endowment types. Further note that the figure represents an average proportion of endowments contributed instead of the average raw contribution. The error bars represent ± one standard deviation (SD). The independent decisions of participants in the public goods game results in the relatively large standard deviations. Lower error bars were bounded at zero since negative values are meaningless.

5.3 Within-treatment contribution behavior

The squeezed middle observation from Derbyshire et al (2025) was not observed in any of this study's treatments. The middle class did not contribute significantly more relative to their income. In treatment 1 and treatment 2, the average of relative contributions across all 4 periods were not significantly different by type, based on KW analysis. In treatment 3, though, there were significant differences in relative contributions by endowment type (KW: p = 0.01). Performing the Dunn's test with a Bonferroni correction, middle-class contributions deviated significantly from the lower-income and higher-income class's overall contributions to the PGG (p = 0.007, p = 0.0399). The relative frequency indicates lower cooperative behavior from the middle class, contradicting Derbyshire et al. (2025).

5.4 Experienced status and future behavior

This part of the analysis computed statistics on

the prosocial behavior exhibited by those endowed initially with a middle-class income versus those that experienced mobility to reach the middle class. The "middle class" was strictly defined in each period as the individual with the second greatest income. During the experiment, no cases of upward mobility from the low-income class to high-income class through four rounds of the game (or vice versa) were observed.

This study explores differences between the middle class initially endowed with a 2 RMB income and those that either experienced downward or upward mobility to become middle class, originally endowed with a 1 RMB or 3 RMB income. For treatments 2 and 3, refer to tables 6 and 7 respectively for the contributions by each classification of middle-class individuals. It is important to note that these results are descriptive. Any statistical testing for such unequal and small sample sizes leads to low statistical power, hence such tests were not performed.

Table 6. Categorizing middle class contributions as rounds progress for Treatment 2

Treatment 2	Average relative contribution	Median relative contribution (Q1:Q3)	SD of Relative Contributions
Initially Middle (n = 22)	1.034	0.850 (0.060: 1.150)	1.140
Upward Middle (n = 2)	0.145	0.145 (0.072:0.217)	0.204
Downward Middle (n = 0)	NA	NA	NA

Table 7. Categorizing middle class contributions as rounds progress for Treatment 3.

Treatment 3	Average relative contribution	Median relative contribution (Q1:Q3)	SD of Relative Contributions
Initially Middle (n = 15)	0.08	0.00 (0.00: 0.13)	0.135
Upward Middle (n = 4)	0.01	0.00184	0.022
Downward Middle (n = 1)	0.35	0.35	NA

6. Discussion

This study suggested that inequity-averse participants in the PGG become less cooperative when income mobility is introduced through a chance-based process. Despite theories linking weakened meritocratic beliefs with an increase in redistribution preferences, exposure to unfair processes seemed to subdue contribution in the PGG, which could function as a redistribution mechanism. Cooperation decreased when income mobility was introduced through chance-based processes, even if inspiring stronger contribution norms could mitigate inequity concerns in the long-run. The perception of procedural unfairness seemed to subdue cooperation even when subsequent cooperation could mitigate unfairness in outcomes.

6.1 Chance-based income mobility decreased cooperation

There was insufficient evidence to reject the null Hypothesis 1 of a difference in behavior between variable transfer treatments and the fixed transfer treatment. The absence of relative mobility's negative effect on contribution in the PGG was encouraging. However, the results implied that the perception of the source of that relative income mobility was crucial, depending on whether it was perceived as originating from effort or from luck.

The results demonstrated that a luck-based mobility process surprisingly resulted in lower contribution in the PGG compared to an effort-based (1:1 effort to luck) process. These results contradicted hypothesis 2, which was formulated with the usual assumptions that low meritocratic beliefs foster stronger preferences for redistribution. This study suggests a possible explanation for these results, centering on fairness norms. For participants, a behavioral component of dissatisfaction against inequity in the income mobility process might have outweighed the motive of using the PGG to redistribute unfair income mobility.

It has long been acknowledged that notions of fairness influence decisions of economic agents. In ultimatum games, there is a proposer and a receiver. The proposer is given a fixed sum of money, which they then need to split for themselves and for the receiver. The receiver can either accept or reject the proposal. Rejecting the proposal would lead to both the proposer and the receiver walking away with nothing. The weakly dominant strategy for the receiver is to accept any allocation. Yet, this optimal and perfectly rational action does not occur – precisely due to fairness norms. Tabibnia & Liberman (2007) suggested that this aversion towards unfairness is apparent in brain scans after discovering activation patterns in the ventral striatum, OFC, and VMPFC regions after fair offers were made, but not when unfair offers were made (23).

However, the key question is whether inequity-aversion leads to dissatisfaction-driven noncooperation or whether it leads to cooperation in the hopes of achieving redistribution through the PGG. The results supported the former conclusion. Grosch & Rau (2020) examined the effect of procedural unfairness and wage differentials in workers' "unethical" behavior (24). Workers were assigned to two main treatments: procedurally fair treatments where effort was the sole factor in determining bonus payments and procedurally unfair treatments where some workers competed for a smaller bonus pool. In investigating the prominence of "unethical behavior" in these treatments, participants played the prisoner's dilemma where those in the procedurally unfair-bonus determination treatment cooperated less often (51% compared to 64%). Exposure to unfair distributions of additional income seemed to have led to less cooperation in a seemingly unrelated task, which was also observed in this study. Dissatisfaction and "*frustraters"* from exposure to such procedural unfairness can lead to less cooperation overall, with a rejection of the overall PGG constructed system. This could be true for all agents in the game, even those that receive relatively higher payoffs from the chance-based process. Across the 4 rounds, each agent is likely to have participated in at least one round where they believe they've been "cheated" even if they receive not ungenerous payoffs from the

chance-based process. The motive for greater redistribution under weakened beliefs in meritocracy thus may not have been sufficient to recover cooperation to the level observed in other treatments.

6.2 Within-treatment behavior under income mobility

In the luck-based mobility treatment, middle-income individuals contributed significantly less in the PGG. Middle-income individuals may be especially prone to the dissatisfaction and *frustraters* that encourage non-cooperative behavior in the PGG after exposure to procedurally unfair processes. There may also be alternative explanations, and this study was not equipped with the statistical power to favor one over any other.

Derbyshire et al., (2025), performed an inverse treatment of the PGG. It was found that participants who received higher endowments valued public goods to a lesser extent. A conflict arises between the low endowment and high endowment class, each employing self-serving beliefs about the others' actions to justify contributing less to the PGG. For example, it was found that lower-endowment and high-endowment individuals both believed that the average contribution would only be 6.62 tokens, while the middle-endowment and return individuals believed that 7.71 tokens would be contributed. In this experiment, each token in the public pool was worth the same for everyone, so the Derbyshire et al. inverse treatment was not exactly replicated. However, this study found a significant reduction in contribution from the middle class when all the characteristics of endowment heterogeneity were integrated, and relative income mobility was integrated in the PGG based on a luck-based process. A squeezed middle, as OECD (2019) described, did not occur (25).

Another study demonstrated that endowment inequality reduced cooperation, primarily due to a drop in cooperation from the high-endowment class, in an experiment where participants had no other varying characteristics (10). With income mobility as an operational characteristic, this effect was not observed in this study. This could likely be because of the threat of downward relative mobility. With an objective to avert risk, even richer participants might hope to establish a cooperative contribution norm in the PGG to establish a safety net (26). Expected reciprocity may motivate their contribution to a greater degree when downward mobility poses a threat (27).

7. Limitations and perspectives

Each person in the 3-person group in the PGG was assigned to one of the three categories of low-income, middle-income, or high-income individual. However, for generalized claims to be made about income classes without an assumption of homogenous individuals within an income class, at least two individuals would need to be included for each income class. Otherwise, income mobility's effect on interactions within income groups that may lead to a lower or higher degree of cooperation is ignored. For example, mobility's potential role in undermining group solidarity and cooperation within income classes could not be examined under the current experimental design. This study could not investigate other complex dynamics of within-income-group inequality, and income mobility's role in changing those dynamics to promote or discourage cooperation. This study needs to be

expanded to larger groups with more than one individual per endowment type to be applied to real-life cooperation dilemmas.

Participants may not have viewed the PGG as purely redistributive, especially in the short-term setting of this study. Therefore, applying redistribution theories such as the POUM or meritocratic beliefs directly may have oversimplified participant motivations. The stronger decrease in cooperation in Treatment 3 may thus reflect increased uncertainty or frustration with randomness, in addition to a shift in meritocratic perception. Disentangling these overlapping psychological effects is difficult without incorporating pre- or post-experiment surveys to capture participants' perceptions of fairness, beliefs about others' behavior, or views on income mobility.

The objective of the study was to analyze short-term cooperative behavior. Intergenerational effects, such as adaptation, delayed returns and/or feedback loops – that can only materialize during longitudinal studies – were not addressed. Neither were structural barriers, such as discrimination or systemic inequality.

Group assignments for individuals were fixed throughout the experiment; i.e. individuals were not reassigned to different groups for different rounds or for different treatments. A relatively larger familiarity with within-group individuals' behavior (as the games progressed) may have influenced contributions, cooperation and results. The study results also demonstrated a high variability in participant behavior as evidenced by the large standard deviations. This large variability may have masked subtle treatment differences.

In addition, the denomination of tokens may have also posed another limitation to the study. With the need to balance the experimental currency to real-life monetary incentives at a fair rate and within budgetary constraints, participants were allocated a small number of tokens at the start of the game. Decimal contributions of up to three digits were allowed so as to allow flexibility for participants in the proportion of income they wished to contribute. This could increase cognitive load on participants, creating more noise in the experiment that already employed a relatively complex procedure for participants, and distracting participants away from the primary task of deciding on contributions to the PGG (28). Decimal digits in information about payoffs, contribution amounts, other player's contributions, and each round's endowments could have led to this cognitive clutter influencing unintended behavior in contributing to the PGG (29).

Future research should address both theoretical and practical limitations, by increasing the total monetary pool that can be paid out. This enables larger groups and discrete currency denominations. Additionally, future research should attempt to substitute the slider task and the current experiment's method of modeling effort-based income mobility in different ways. Such research would expand the robustness and the generalizability of this study. Tasks such as counting the number of 7s in a block of numbers or transcribing text could be employed (30).

The particular element of embedding income mobility through the slider task can also be altered for future studies. The sum of income additions and mobility was kept constant

during the experiment. Participants "competed" for a fixed pool of 0.75 or 0.5 tokens. This fixed pool does not pose limitations to comparing luck-based and effort-based mobility in affecting cooperative behavior, since both treatments employed the same task. However, the robustness of this experiment's results can be questioned. If the effort portion of true income mobility were perceived as a non-constant sum, would relative income mobility (as opposed to no relative income mobility, treatment 1) still fail to change cooperative behavior?

Other simple modifications to the income mobility process could be useful. Increasing the total number of tokens distributed between rounds is one possible modification. Greater levels of mobility would guarantee more changes to participants' income status and relative income. This may allow for statistical tests that relate previously experienced status of participants and future behavior after changes in their income status. While tables 6 and 7 shows descriptive figures for this area of study, statistical analysis could not be performed due to small sample sizes.

8. Conclusion

The attributes of inequality and relative income mobility were incorporated into a Public Goods Game to investigate their effect on cooperation. There was no significant difference in the extent of cooperative behavior when the PGG treatment that did not allow for relative income mobility (treatment 1) was compared with treatments that did allow relative income mobility (treatments 2 and 3). In other words, introducing relative income mobility in the PGG did not affect the magnitude of cooperative behavior. However when this relative mobility was generated largely through effort (treatment 2), participants were more cooperative than when the relative mobility was generated primarily by luck (treatment 3). This could be because dissatisfaction against inequity in the income mobility process discouraged using the PGG contributing to the public good even when this contribution could redistribute unfairly accumulated income. Such dissatisfaction was particular evident by a significant reduction in contribution from the middle class.

Endowment inequality did not reduce cooperation, presumably because the associated relative income mobility incorporation into the PGG threatened downward mobility, such that higher-class participants contributed to establish a safety-net.

9. References

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