

Impact of Perceived Income Inequality on Private Provision of Public Goods

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ABSTRACT

Experimental literature on public goods games has suggested that perceived income inequality may lead to an unpredicted impact on group contribution and individual behaviors. A standard linear public goods experiment is conducted to investigate the impact of perceived income inequality on the provision of public goods. Substantial inequality was introduced both in the endowment level. Two aspects of perceived income inequality were investigated: information about substantial inequality and the origin of income and inequality. This research discovered that contribution level was significantly higher when information about inequality was only privately known, the origin of income and inequality has no salient impact on group contribution, people with different endowments roughly contribute the same portion to public account.

Keywords: Public goods game, heterogeneity, perceived income inequality, experiment

1. INTRODUCTION

Within the global and localized context of rising income inequality, recent studies have revealed the negative impact of income inequality on collective action and mutual cooperation. As for the field of experimental economics, multiple studies have investigated the impact of income inequality on contribution to public goods with differing measurement of income inequality. This paper would further develop upon existing literature to study the impact of perceived income inequality, framed by the origin of income inequality and information about inequality, on the voluntary provision of public goods based on the standard linear public goods game developed by Isaac, Walker, and Thomas[1].

This research drew the following conclusions from the experiment. First, private information conditions would significantly increase group contribution, especially in the early phases of the game. Second, the origin of income heterogeneity does not impact the total contribution level. Third, individuals of three endowment groups contribute roughly the same portion of their income to the public account.

1.1. Literature Review

1.1.1. Public goods game

In 1972, Bohm[2] introduced the experimental approach to the study of private provision of public goods. The public goods game was introduced by Marwell and Ames (1979)[3]. The prototype was later standardized by Isaac, Walker, and Thomas(1984)[1].

In a standard public goods game, individual subjects were required to allocate their endowment E_i between a private account and a public account. The individual return from private accounts would be exactly the amount of investment C_i . The total contribution to public accounts was multiplied by a constant marginal per capita return, and returned to each member of the group, no matter how much they contribute. The total return from each trial of the public goods game equals $C_i + mpcr * \sum (E_i - C_i)$.

A prisoner's dilemma was intentionally created by making the marginal per capita return from public accounts lower than the marginal return of investing in private accounts. Since the marginal cost of contributing to public account exceeds the marginal return, the individual optimal option is to allocate all their tokens to private accounts (in another word, to free ride), as predicted by the Nash equilibrium. Nevertheless, in reality, the total contribution was substantially above the theoretical prediction. Prior to repetition, the subjects tend to contribute 40-60 percent of their endowment to the public account (Dawes & Thaler, 1988, p. 189)[4]; even with the decay in contribution level over the course of repeated trials, the level of contributions was still somehow between 15% and 25%[5]. Multiple factors that may have a potential effect on the total contribution have been examined within the framework of public goods games. Ledyard offered an early yet comprehensive review on individual variables influencing public goods provision in standard public goods game[6]; In latter research, Kollock reviewed more comprehensively social dilemmas in theory and their solutions, categorized into motivational, strategic, and structural solutions that each deal with incompletely egotistic subjects[7], egotistic subjects, and rules of the game in the context of social dilemmas. This study, while focused on two variables—origin of endowment and public information about income heterogeneity, studies the aggregate effect of the two conditions to simulate how

people perceive income inequality and make decisions based on their knowledge.

1.1.2 Perceived income inequality and public goods provision

1.1.2.1. Defining perceived income inequality

A distinction has to be made between income heterogeneity and perceived income inequality as discussed in this study. The former concept entails the actual shape of income distribution and the relative placement of individuals in the whole population, which were not only elusive due to limited access to information and bounded rationality, but also only intermittently determine the grievances related to income inequality[8]. Instead, the cognitive recognition of inequality at the individual level directly affects people's concerns about inequality and their preferences for economic policies(Bottero, 2019; Cruces et al., 2013)[9][10]. The disparity between perceived inequality and substantial inequality is sometimes attributed to the dichotomy of true and false consciousness, both of which were derived from Marxist tradition and emphasized the level of subjective consciousness of the reality of inequality[9]. Nevertheless, the perception of inequality, which can alternatively be reflected by preferences for distributive policies, was determined by more diverse factors: upward mobility(Bénabou and Ok, 2001)[11], belief in fair competition [12], belief in the origin of income heterogeneity[13-14], together with recognition of the substantial income inequality.

Income inequality has been associated with multiple unfavorable conditions related to public sentiment and group cohesion. In an institutional analysis of the impact of inequality, Meltzer and Richard (1981)[15] suggested that greater income inequality would lead to expansion of government in response to median voters' demand for income redistribution. More researches are concerned about the psychological impact of economic inequality, especially its influence on social capital. Rothstein and Uslaner(2005)[16] showed a correlation between economic inequality and unequal opportunities and diminishing level of social trust and proposed to create "a sense of equal opportunity"(Rothstein & Uslaner, 2005, p.30)[16] as its remedy. Wilkinson(2002)[17], Costa and Kahn(2001)[18], and Putnam(2000)[19] also concluded that income inequality is a crucial contributing factor to declining social capital. Notably, Cote et al. (2015)[20] reported more selfish behavior for high-income individuals in setting with greater income inequality. As the level of generosity was determined by cooperative behavior while playing the trust game, it suggested a negative association between income inequality and pro-social behaviors in general of the relatively better-off members of the group, as they were motivated by the conserving impulse to maintain their relative economic

placement, legitimized by narratives of meritocracy (Cote et al., 2015, p.4)[20]. If income inequality was commonly known, it is also likely that individuals with lower wealth will also depress their level of contribution both to equalize their wealth relative to individuals with higher wealth and to protest their inferior economic placement.

Income heterogeneity has been introduced with three measures: varying endowments(Marwell & Ames, 1979; Rapoport & Suleiman, 1993; Chan et al., 1999; Cherry, Kroll, and Shogren, 2003; Hofmeyr, Burns, and Visser, 2008)[3][21][22][23][24], different value for unit public goods— marginal per capita return(Isaac, Walker, and Thomas, 1984; Fisher et al., 1995; Isaac, McCue, and Plott, 1982; Chan et al., 1999)[1][25][26][23], or fixed payment for experimental subjects(Anderson et al., 2004)[27], together with attempts to introduce income heterogeneity outside the framework of a public good game(Georgantzis and Proestakis, 2011)[28].

As income inequality, in reality, impacts the capability of contribution, in this study, income heterogeneity was introduced at the level of endowments, modeling the individual ability to privately contribute to public goods provision. Based on the basic mechanism of the public goods game, among these factors, the origin of income heterogeneity and information about substantial income inequality were selected as variables of the experiment.

1.1.2.2. Experimental literature on public information and public goods provision

Anderson (2004)[27] examined the effect of public information on income heterogeneity by controlling the knowledge of the heterogeneous fixed payments of others. They discovered no significant effect of income heterogeneity on public goods provision when the fixed payment was privately known. Nevertheless, when income heterogeneity was revealed publicly, the experimenters observed a significant reducing effect on the provision of the public good. Incomplete information, therefore, entails a positive impact on group contribution compared with the contribution level under complete information condition.

Brookshire et al. (1993)[29] similarly reported lower contribution under complete information, in which the payoff chart and endowments of others were made public when the payoff structure and endowment for each subject were made heterogeneous. No such effect was discovered when the endowment and payoff structure were homogenous. In a review paper summarizing the results of the Brookshire case and four other cases involving income heterogeneity, Ledyard(1994)[6] conjectured that incomplete information always leads to greater contributions to the public account with heterogeneous distribution of income.

Despite the differing conclusions drawn upon the heterogeneity effect on group contribution, Chan et al. (1999)[22] rejected the Ledyard conjecture by reporting the negative impact of incomplete information on group contribution when endowments, as well as preferences,

were homogenous. Nevertheless, they also noted that the Ledyard conjecture applies in a heterogeneous environment. Nevertheless, the non-linear experimental environment and two factorial inequality of the two pieces of research conducted by Chan et al. (1996,1999)[30][22] weakened their comparability to our study, which was conducted in a linear environment and introduced heterogeneity at the endowment level. The experimental settings of our experiment are therefore closer to that of Ledyard(1994)[6] and Anderson(2003)[27]. 1.1.2.3. Experimental literature on the origin of income heterogeneity and public goods provision

Wit found that heterogeneous endowments assigned according to merits would lead to a decrease in group contribution compared with contributions under conditions of windfall endowment[31].

Cherry, Kroll, and Shogren compared the contribution with endowments earned and assigned based on merits and windfall endowments[23]. The endowment was either earned and assigned based on the grades in a quiz of 17 GMAT questions or assigned randomly. They concluded with no statistically significant impact of the origin of endowment on the level of contributions. Similarly, Georgantz'is and Proestakis also failed to find a significant impact of the origin of heterogeneity on group contribution [28]. In contrast to previous researches who compared the origins of a windfall or by effort, the two origins of heterogeneity, in this case, were randomly or by design. In the random treatment, the heterogeneous endowments were distributed by chance, but in the "by design" treatment, the heterogenous endowment was distributed based on the real wealth of experimental subjects. In both of the cases, the information about other group members' endowments was known to all.

The experimental design of this experiment to introduce the varying origin of endowments is similar to the design of Cherry, Kroll, and Shogren[23]. In the meritocratic origin condition, subjects were asked to earn endowments by taking a quiz consisted of 20 selective questions from the grammar and writing section from a sample test of the Scholastic Assessment Test. Endowments in meritocratic origin condition were distributed based on ranking within the group of three subjects, making it not entirely the same as the design in the Cherry case. In the random origin condition, heterogeneous endowments were directly assigned randomly to subjects.

1.2 Theories

As an application of prisoner's dilemma, the standard behavior in linear public goods game was always to free ride, as the marginal return from free ride strictly exceeds the return from unit contribution. Nevertheless, empirical evidence has suggested that the Nash equilibrium prediction rarely conforms the reality, which raises skepticism around the basic assumption of the neoclassical economic models of rational, selfish economic man. Clinging to the premise of unbounded rationality, theoretical models were introduced to include more

diverse drives and motivations(altruism theory and equity/inequality aversion theory), or to take structural and social influences into account(reciprocity theory, reputation building).

The theory of altruism proposes that aside from economic interest, the incomes of others are also sources of utility. As this model explains the absence of free ride in real public goods game, it failed to take account of the decay of total contribution over repetitive trials, and the endgame effect as it suggests unconditional contribution(Keser and Winden, 2000)[32]. Andreoni and Miller(1996)[33] upheld the theory of altruism with experimental evidence drew from dictator games and public goods games, which was addressed as a "multi-person dictator game", and only looked at the first iteration of public goods games. It is skeptical whether the results can be replicated in a repetitive public goods game.

The equity theory indicates that people are also motivated by their relative economic placement within a group. Similarly, the inequality aversion theory proposes that people are concerned about inequality, and may intensify their aversion to inequality if their economic placement is inferior to others. Therefore, the model predicts that people with higher wealth would contribute a larger percentage of their income to the public account to address wealth inequality, while people with lower wealth would contribute less proportionally for the same purpose(Buckley and Croson, 2005, p.940)[34].

The theory of reciprocity proposes that if reciprocal subjects believe that others are being reciprocal too, the level of contribution would increase significantly. The theory implies that cues of kindness or hostility would accumulate social capital, which encourages mutual trust and cooperative behaviors. Sugden(1984)[35]suggested, in a heterogeneous environment, individuals would contribute their "fair share" of the endowment to the public account. Fischbacher et al(2000)[36] reported that roughly 50% of people acted as "conditional cooperators", which, according to their presumption, is the synonym for reciprocal contribution behavior.

Neither of these theories is conclusive or universal enough to fully resolve the deviation of reality from theoretical prediction. Andreoni and Miller(1996)[33] discovered, in their ambitious task to generalize a utility function for altruism, varying focuses of utility functions. Rapoport and Suleiman(1993)[21] also proposed the division of subjects into categories of personalities with varying preferences and suggested future studies to identify the issue of personality and attitudes. In recent experimental literature, Mansell(2020)[37] investigated the responsiveness to social cues in two distinctive personality groups(liberals and conservatives) using a linear public goods game, furthering the experimental literature by introducing the personalities into consideration.

1.3. Experimental design

The subjects were randomly assigned to four different treatment groups determined by the 2*2 factorial combinations as follows:

PuM: Heterogenous endowment assigned based on rankings, information about others' endowment was made public

PrM: Heterogenous endowment assigned based on rankings, information about others' endowment was made public

PuR: Windfall endowment assigned asymmetrically, only know one's own endowment

PrR: Windfall endowment assigned asymmetrically, only know one's own endowment

The experiment involves two stages. In stage 1, subjects that were assigned to the meritocracy conditions would take efforts to earn their endowments by answering twelve grammar questions. Heterogenous endowments(200 tokens, 150 tokens, and 100 tokens) were then assigned on the basis of their ranking. For subjects assigned to random conditions, windfall endowment was assigned with heterogeneity decided randomly.

Prior to stage II, subjects from different groups received differently framed message about the origin of endowment inequality. For the groups assigned to the meritocracy origin of endowment inequality, subjects in the group were told that the amount of endowment was distributed in strict accordance with their ranking in stage I. For the groups assigned to the random origin of endowments, the subjects were told that they have earned their claim to the endowment, and the exact amount was randomly assigned. In the private information condition, the subjects only know the amount of their own endowment and have no information about the endowments of others. In the public information condition, the subjects were also informed of the endowments of his two other group members. The identity of experimental subjects remained anonymous throughout the game.

In stage II, the subjects played a linear public goods game by groups through WeChat. Each subject was contacted individually to keep the identity of other group members confidential. During each round, the subjects were

required to allocate their tokens earned in the previous stage between their own private account and a public account. The amount allocated to the public account is considered as individual contribution. The total individual contributions were then accumulated, multiplied by the marginal per capita return, which, in this experiment, is designed to be 0.5, and returned to the participant. After each round, all subjects were informed of their own earning in that round and their own aggregate earnings so far. Each participant's savings in a private account and return from public account combined equals the participant's total earning, in terms of experimental tokens, from each round. The subjects had been informed that the tokens could be converted to real money by the exchange rate of 100 tokens for on yuan.

After the game was finished, the subjects were invited to answer a few followup questions. All of the respondents were asked about their main motivations while making contributions. For subjects assigned with private information condition, they were further inquired about their awareness of income heterogeneity.

1.4. Results

A total number of 27 subjects and 9 groups were tested. One group was removed for a subject's misunderstanding of rules. Table 1 shows the exact mean contribution of each treatment. Figure 1 visualizes the patterns inherent to the data. Our results conform to earlier widely accepted findings of public goods games. This research discovers a strong downward trend of group contribution from its peak in phase 1 to the lowest point in the last phase, but still substantially above zero. Among the 27 subjects taking the experiment, only one showed completely selfish behavior and chose to contribute zero to the public account at phase 1(the group was abandoned for one subject's misunderstanding of rules). Nevertheless, in the last phase, around 67% of all experimental subjects chose to free ride, while the remaining subjects contributed substantially lower amount as compared with previous rounds, demonstrating the endgame effect.

Table 1 Mean contribution by treatment and phase

Treatment	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
PrM	367.5	341	272.5	222.5	155	72.5
PrR	345	320	230	185	130	27.5
PuM	197.5	210	212.5	157.5	140	62.5
PuR	235	190	155	145	112.5	28

Observation 1. Incomplete information about inequality would significantly increase group contribution. This research discovers convincing support for observation 1. Figure 1 shows the mean group contribution per phase for each treatment. As shown by the trend, the aggregate contribution of groups under private information conditions is significantly higher than that of groups under public information conditions. The disparity was especially visible in the first two phases but gradually converged ever since with the decay in group contribution. Nevertheless, in general, this research found that the contribution level of groups in which public information about endowment heterogeneity was disclosed was significantly lower than groups in which the amount of endowment of others was held private under the condition of the same endowment origin. Group contributions from PrM(private information, heterogeneous endowments assigned based on merits) are significantly larger than that under PuM(public information, endowments assigned based on merits) conditions using a two-sample t-test($p=0.0376<0.1$, $t=1.8786$, one-tailed). Similarly, group contributions from PrR(private information, heterogeneous endowments assigned randomly) was also significantly larger, albeit with a greater p-value, than that under PuR(public information, heterogeneous endowments assigned randomly) conditions ($p=0.0863<0.1$, $t=1.4211$, one-tailed).



Figure 1. Mean contribution by treatment over six phases.

More convincing evidence was drawn from a comparison of the total contribution level by each endowment group under two information conditions respectively. As figure 2 shows, for the high endowment group(assigned with 200 tokens) and median endowment group (assigned with 150 tokens), the contribution level was significantly higher under the private information condition compared with contribution under public information condition. The contribution level was roughly equal under two information conditions for the low endowment group. In contrast to the salient difference in high and median endowment groups, group contribution under the private information condition was only slightly, but not significantly, higher than that under the public information condition. The disparity in contribution patterns across endowment groups was largely the result of the

consciousness of endowment inequality under private information conditions. This research discovered that four out of five experimental subjects(with one group abandoned) assigned with low income(100 tokens) under private information condition were aware of the income heterogeneity and their low economic placement in the group, as the group contribution exceeds or approaches the twofold of their endowment. As a result, the low endowment individuals under private information conditions may undercontribute due to their knowledge of income inequality[30]. In contrast, only one subject from the median endowment group under private information condition reported suspicion for the heterogeneous distribution of endowments in our followup interview. The quick decay of group contribution also refrained the salience of the positive impact of private information condition on group contribution. The disparity between group contribution under private information condition and group contribution under public information condition was striking in phase 1 and 2, but gradually decayed and converged ever since phase 3, and ultimately diminished at phase 4 and phase 5 with great influence from the endgame effect. Therefore, an experiment with more phases is expected to yield a more convincing difference. The observed overcontribution under incomplete information contradicts the prediction of the inequality aversion model as the median and high endowment group contributed significantly less when they were aware of the income inequality. This result, however, closely corresponds with the social capital analysis of income inequality, as the cooperative behaviors were restrained by awareness of inequality. In particular, our observation confirms the conclusion from Cote et al.[20], which reports that the rich will be less generous to preserve their relative economic placement.

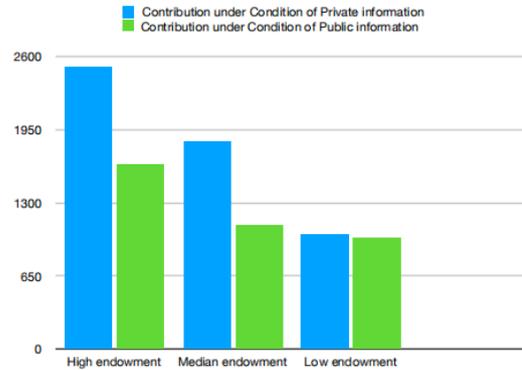


Figure 2. Absolute group contribution by endowment group and information conditions

Observation 2. The origin of endowment inequality does not have a significant impact on the contributions to public goods. Using similar experimental design and context, our conclusion conforms to Cherry, Kroll, and Shogren[23] that the origin of endowment inequality does not have a significant impact on the contributions to public goods.

Figure 1 shows the mean group contributions per phase across conditions of random origin of endowment inequality and the meritocratic origin of endowment inequality. By comparing treatment groups with the same information conditions but varying origin conditions, this research found neither significant disparities nor visible patterns in terms of group contribution across these groups. Group contributions from PrM(private information, heterogeneous endowments assigned based on merits) are not statistically significantly different from PrR(private information, endowments assigned randomly) conditions using a two-sample t-test($p=0.7376>0.1$, $t=0.6466$, one-tailed). Group contributions from PuM(public information, heterogeneous endowments assigned based on merits) also have no statistically significant difference from the contribution level under PuR(public information, heterogeneous endowments assigned randomly) conditions ($p=0.7221>0.1$, $t=0.5985$, one-tailed).

Observation 3. Each endowment group contribute roughly the same portion of their disposable income to the public account

Figure 3 shows the absolute amount of endowments contributed to the public account by subjects from high, median, and low endowment groups. In general, patterns, shows that the absolute contribution to public accounts increases with a higher economic placement among the group, which confirms to the altruism model and reciprocity model.

Nevertheless, evidence pointed out that total contribution by each endowment group as a percentage of their total endowment showed striking closeness. 43.25% of the total endowment was contributed by a high endowment group; the percentage for the median endowment group was 40.99%; for the low endowment group, it was 41.35%. Although the contribution pattern at the individual level does not follow the model prediction, in general, the total contribution by each endowment group showed to be at the dynamic equilibrium of a relatively stable “fair share”, as predicted by Sodgen[34]. Our result also conforms to the conclusion drew by empirical results from Hofmeyr, Burns, and Visser.

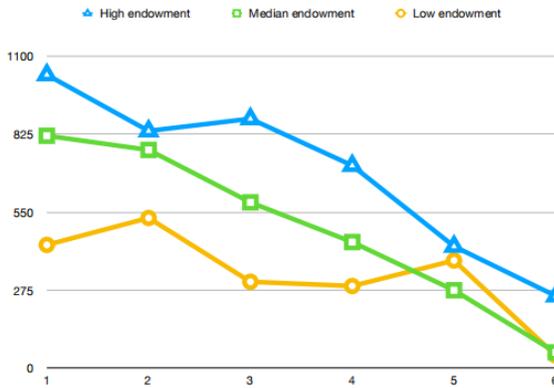


Figure 3. Absolute endowment contributed to the public account per phase by endowment groups

Table 2. Contribution by individual subjects and phases. A, B, C represents high, median, and low endowment groups respectively.

Treatment	1	2	3	4	5	6
PrM1A	200	100	80	200	0	20
PrM1B	150	150	25	30	100	0
PrM1C	60	70	70	40	60	0
PrM2A	150	122	100	100	60	50
PrM2B	100	150	100	50	70	50
PrM2C	75	90	50	25	20	0
PuM1A	25	25	15	15	20	20
PuM1B	150	15	60	70	0	0
PuM1C	20	80	50	60	80	15
PuM2A	150	180	200	120	80	90
PuM2B	50	70	100	50	20	0
PuM2C	0	50	0	0	80	0
PrR1A	50	60	55	70	70	30
PrR1B	50	100	100	100	0	0
PrR1C	60	50	25	10	0	0
PrR2A	200	200	200	100	100	25
PrR2B	150	150	50	75	50	0
PrR2C	430	430	280	175	150	25
PuR1A	100	100	120	50	30	0
PuR1B	70	60	50	60	30	5
PuR1C	20	30	10	0	0	0

2. CONCLUSION

Our follow up interview questions examined crudely the motivational theories. This research concluded that preference differs considerably among endowment groups with varying focuses. Among all valid responses, 9 out of 24 subjects reported that they were primarily motivated to maximize their economic return; 7 out of 24 subjects reported that they contributed to reciprocate their similarly reciprocal group members; 3 out of 24 subjects reported that they contributed for fairness. The five remaining subjects reported that they would contribute if they believe their return would be higher than their endowments. The result of the interview questions corroborates the previous discovery that people are driven by a variety of motivations to contribute to public account, with varying focuses of their utility functions. Furthermore, among the nine subjects who claim to maximize their economic return, all of them contributed to the public account for the first four rounds, despite the dominant strategy of freeride. With the stated primary objective of maximizing economic return, the research conjectures that these subjects, as the reputation theory suggests, are concerned about building their reputation as generous and reciprocal individuals, a symbolic gesture believed to be profitable in the long term.

This research conjectures that loss aversion, the motivation to maintain the income level above certain threshold, was also decisive factor influencing contributing behavior. Based on the responses from interview and the contribution behavior, this research conjectures that the threshold was somehow maintained at endowment level or the return from last round.

Due to limited time and resources, too few samples were taken to make the results immune from the impact of a few outliers on the general population. The endgame effect also constituted a confounding factor for the general trend. This research expect these problems to be resolved in followup research with greater number of participants and improved design.

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