

Cost-Benefit in Fairness Decision Making

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Abstract—We researched on the effect of cost-benefit ratios on humans' fairness decision making using a modification of dictator game. In the modified dictator game, we manipulated the cost-benefit ratios in three conditions: the 1-to-3, the 1-to-1, and the 3-to-1 cost-benefit condition. Our results indicated that humans' fairness decision-making is sensitive to cost-benefit ratios. In particular, we found that (a) more people shifted to the selfish decision when the cost increased, (b) people tended to be fair in the 1-to-1 cost-benefit ratio, and (c) people tended to share all they have when cost-benefit ratio was relative low. Our study helped reconciling conflict results of previous studies and shed light on how cost-benefit ratios affect people's decision-making.

Index Terms—Prosociality, cost-benefit ratio, dictator game, altruistic.

I. INTRODUCTION

Prosociality plays a vital role in Nature and spreads through human society. We have observed prosociality and cooperation in genomes, cells, multicellular, social animals, and human society [1]. Philosophers, writers, theologians, biological and social scientists have grappled for centuries with the question of what are the factors that make humans to be prosocial? According to the theory of Natural Selection, evolution rewards only for individuals who are self-interested: Every genome, cells, multicellular organisms, social insects and humans should focus on their self-interest and compete with their competitors because of limited resources. However, it is common to observe that prosociality and cooperation not only in human society but also in animal's world [2]. Fifty years of theory have investigated the selection pressures that can cause organisms to be prosocial: a) Kin Selection that "natural selection can favor cooperation if the donor and the recipient of an altruistic act are genetic relatives", b) Direct Reciprocity that natural selection can favor cooperation if two individuals repeatedly encounter, c) Indirect Reciprocity that individuals can cooperate without a direct reciprocation if they can establish a good reputation rewarded by other, d) Network Reciprocity that natural selection can favor cooperation if individuals in a group interact more often with some than other, and e) Group Selection that cooperative groups are more successful than defective groups [1]. However, not much research has paid attention to the effect of cost-benefit ratios on prosocial behaviors [3]-[4].

We take a new look at cost-benefit ratios by asking how cost-benefit ratios affect human's fairness decision. To examine this question, we made a modification on the standard dictator game. In the standard dictator game, one

person (e.g., Dictator Dan) decides how to split money (usually tokenized as monetary units) between himself and another player [5]. The dictator role is randomly assigned, preventing any player from claiming any special privilege (other than the benefit of chance). Dan's decision is final: Once made, both players receive their allocated sums and the game ends. In this experimental paradigm, both the selfish and the fair decisions are readily identifiable: Dan can keep all the money (i.e., a selfish decision: earning the highest payoff for the self), or he can split it evenly between himself and his partner (i.e., a fair decision: each gets a fair slice since neither did anything to deserve more). Furthermore, granting Dan and his partner anonymity and limiting the game to a single round minimize the impact of outside social influences (i.e., fear of punishment or expectations of reciprocity).

A simple modification to the cost-benefit ratios of the standard dictator game allows us to also examine how cost-benefit ratios affect fairness decision making. Drawing inspiration from existing studies [6], we created three conditions with cost-benefit ratios varied from 1-to-1, 1-to-3, and 3-to-1. In the 1-to-1 cost-benefit ratio condition, the receiver got 1 Yuan (the Chinese currency) for every 1 Yuan given by the dictator. In the 1-to-3 cost-benefit ratio condition, the receiver got 3 Yuan for every 1 Yuan given by the dictator, and in the 3-to-1 cost-benefit condition the receiver got 1 Yuan for every 3 Yuan given by the dictator. All participants were assigned to the dictator role and were asked to imagine of receiving an allotment of 100 Yuan.

We propose a discrete decision framework that identified decisions as the selfish, the fair, and the altruistic decisions. We defined the selfish decision as giving 0 Yuan, the fair decision as delivering an equal amount to both sides (i.e., giving 25 Yuan in the 1-to-3, giving 50 Yuan in the 1-to-1, and giving 75 Yuan in the 3-to-1 cost-benefit ratio condition), and defined the altruistic decision as giving all 100 Yuan to the receiver. We hypothesize that: (a) because of the constraint of efficiency, participants are more likely to be selfish when costs increase, (b) the 50/50 split fairness norm enhances people's tendency to give fairly in the 1-to-1 cost-benefit ratio condition, and (c) when the benefits are comparatively higher, participants are more likely to be altruistic.

II. METHODS

A. Participants

We recruited 226 participants (Mage = 23, SD = 8, 51% male), through Wenjuanxing—a commonly used survey website in China. All participants completed the study online.

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B. Materials and Procedure

This experiment employed a modification of the dictator game. In the standard dictator game, one person decides how to split money between himself and another player. The dictator role is randomly assigned. Once dictator's decision is made, both players receive their allocated sums and the game ends. In this modification of the standard dictator game, we created three cost-benefit ratio conditions: 1-to-3, 1-to-1, and 3-to-1 cost-benefit ratio condition. For maximizing the number of data, all participants were assigned to the dictator role (though they would be told they were with other real participants who are recipients), and assigned to all three cost-benefit conditions. In order to prevent order effect, the orders of those three cost-benefit conditions will be randomly given. We instructed the participants to imagine they (i.e. dictators) would be endowed with 100 Yuan while their recipients would be given 0 Yuan. Participants were then asked to decide how much they will share with their partners in each three conditions. Several examples of money given and results presented simultaneously with each cost-benefit conditions. This makes the ratios be easily understood and helps to reduce the effect of varied calculation difficulties among different cost-benefit conditions.

III. RESULT

We conducted this study by using a modified dictator game, which allowed us to examine the effect of cost-benefit ratios on prosocial behaviors. In the modified dictator game, we created three cost-benefit ratio conditions: the 1-to-3, the 1-to-1 and the 3-to-1 cost-benefit condition. All participants were assigned to the dictator role and imagined that they received an initial amount of 100 Yuan to divide between themselves and the other players. We determined participants' decisions based on the money they shared and put them into three discrete categories: (I) We considered the fair decision as delivering an equal amount between the two sides: Participants shared 50 Yuan in the 1-to-1 cost-benefit ratio condition, shared 75 Yuan in the 3-to-1 cost-benefit ratio condition, or shared 25 Yuan in the 1-to-3 cost-benefit ratio condition. (II) We considered the selfish decision as sharing (and delivering) 0 Yuan to the partner across all three conditions. (III) We considered the altruistic decision as sharing all 100 Yuan to the other players across all three conditions.

We found that, as predicted, once the cost-benefit ratio increased (i.e., the cost went up relative to the benefit), people's choice changed accordingly: (a) more people shifted to the selfish decision when the cost increased, (b) people tended to be fair in the 1-to-1 cost-benefit ratio, and (c) people tended to share all they have when cost-benefit ratio was relatively low.

A. High Cost Makes People More Selfish

In the study, individuals in the 3-to-1 cost-benefit ratio condition on average passed 36.51 Yuan ($SD = 31.30$) to the other, while individuals in 1-to-1 and 1-to-3 cost-benefit ratio conditions on average passed 46.63 Yuan ($SD = 24.20$) and 58.76 Yuan ($SD = 34.03$), respectively (see Fig. 1). We also

found a significantly higher percentage of participants acted selfishly in the 3-to-1 cost-benefit ratio condition (32.1%) compared to the 1-to-1 (12.1%; (effect size = -0.196 , $p < 0.001$, 95% CI = $(-0.198, -0.193)$) and the 1-to-3 cost-benefit ratio condition (8.9%; (effect size = -0.231 , $p < 0.001$, 95% CI = $(-0.233, -0.229)$) (see Table I). These results suggested that efficiency plays a role in fairness decision making: When it is more expensive and less efficient (i.e., the 3-to-1 cost-benefit ratio condition) to give, more people tend to be completely selfish [7].

TABLE I: PERCENTAGE OF SELFISH DECISIONS BY COST-BENEFIT RATIOS

Cost-benefit Ratios	Mean	Standard Errors	Standard Deviation
1:3	0.0893	0.0191	0.285
1:1	0.121	0.0218	0.331
3:1	0.321	0.0313	0.468

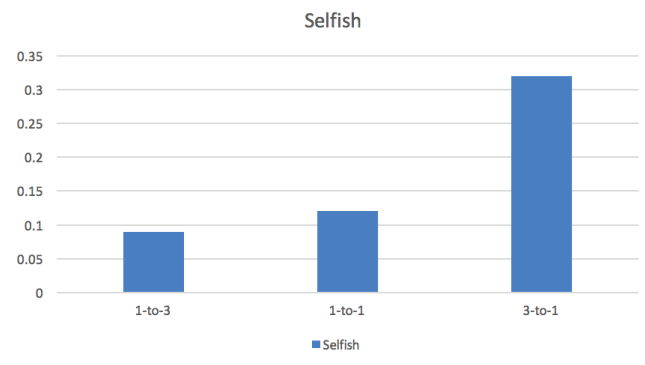


Fig. 1. Percentage of selfish decisions by cost-benefit ratios.

B. 50/50 Even-split Norm is Important in the 1-to-1 Cost-Benefit Ratio Condition

The above result showed that when it was more expensive to give, people followed the efficiency rule and shifted to the selfish decision. Based on the efficiency rule, the hypothesis on the fair decision is that: when it was more expensive to be fair, fewer people would choose to make the fair decision. This hypothesis predicted the most amount of fair decisions in the 1-to-3, the middle amount of fair decisions in the 1-to-1, and the least amount of fair decisions in the 3-to-1 cost-benefit ratio condition. However, we found a different result. We found that more participants in the 1-to-1 cost-benefit ratio condition made the fair decision than participants in the 1-to-3 (effect size = -0.511 , $p < 0.001$, 95% CI = $(-0.513, -0.509)$) or the 3-to-1 (effect size = -0.560 , $p < 0.001$, 95% CI = $(-0.562, -0.558)$) cost-benefit ratio condition (see Fig. 2). This result suggested that most people acted fairly when the fair decision is an even-split of 50/50 (see Table II). This result provides evidence for the 50/50 even-split norm: Although this is not the most efficient condition to be fair, but a big number of people followed the even-split social norm and still acted fairly. In daily-life interaction, the even-split interaction is the most common fair-split situation. Given that social and cultural norms emphasize the positive effect of the fairness norm in human society, a big number of people internalize this norm and

behave accordingly in our experiment.

TABLE II. PERCENTAGE OF FAIR DECISIONS BY COST-BENEFIT RATIOS

Cost-benefit Ratios	Mean	Standard Errors	Standard Deviation
1:3	0.0804	0.0182	0.272
1:1	0.594	0.0329	0.493
3:1	0.0313	0.0117	0.174

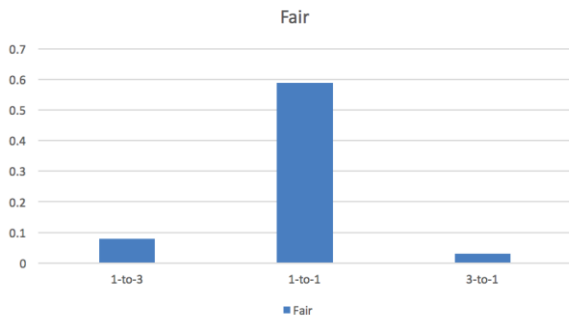


Fig. 2. Percentage of fair decisions by cost-benefit ratios.

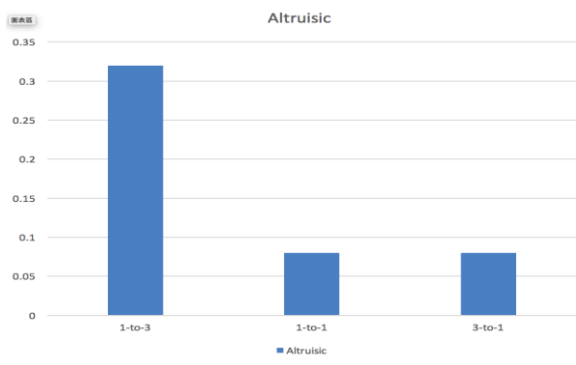


Fig. 3. Percentage of altruistic decisions by cost-benefit ratios.

C. Humans Are Altruistic When Benefit Outweigh Cost

Surprisingly, an interesting pattern emerged from the 1-to-3 cost-benefit ratio condition: a comparatively high percentage of participants chose to give all the money to other partner (31.3%) (see Fig. 3). Moreover, participants shared a sizable amount of money on average compared to other two conditions (58.76 Yuan (SD=0.47) in 1-to-3, 46.42 Yuan (SD=0.27) in 1-to-1 (effect size = -0.236, $p < 0.001$, 95% CI = (-0.238, -0.234)), and 36.51 Yuan (SD=0.26) in 3-to-1 cost-benefit ratio condition (effect size = -0.240, $p < 0.001$, 95% CI = (-0.242, -0.238))) (see Table III). This finding turns out that when the benefit to the other becomes relatively high, more people choose to act altruistically. This is likely to be due to the maximizing rule: When it was very cheap to give (i.e., the 1-to-3 cost-benefit ratio condition), participants wanted to give all their money to maximize the benefit (and also the group payoff).

TABLE III: PERCENTAGE OF ALTRUISTIC DECISIONS BY COST-BENEFIT RATIOS

Cost-benefit Ratios	Mean	Standard Errors	Standard Deviation
1:3	0.313	0.0310	0.466

1:1	0.0804	0.0182	0.272
3:1	0.0759	0.0177	0.265

IV. DISCUSSION

In this study, we investigated the effect of cost-benefit ratios on people’s monetary sharing. We conducted a modification of the standard dictator game by changing the cost-benefit ratio of sharing. We found that participants were more likely to be selfish when costs increased. This finding is in line with the efficiency rule: when the cost of giving is high (i.e. when giving is inefficient), participants are more likely to be selfish (i.e. keep all the money). This finding is consistent with the evolutionary and economic perspective: People are less likely to act prosocially when it is costly to share. In other words, people tend to minimize costs. Similarly, we found that when the benefit was comparatively high, participants were more likely to be altruistic and give everything. This finding also fits the efficiency rule but in a slightly different way: People tend to give more when it is relatively cheap to give, which means people have a tendency to maximize benefits. Minimizing costs and maximizing benefits are like the two sides of a coin. Importantly, we also found that participants had a strong tendency to give fairly in the 1-to-1 cost-benefit ratio condition. This can be explained by the 50/50 split social norm: In daily life interaction, the even-split decision is the normally also the fair decision so people internalize the even-split heuristic as a shortcut of fair decision.

A. Significance of the Current Study

A surprising finding of the current study is that a big percentage of people in the 1-to-3 cost-benefit condition chose to behave altruistically and share all they have. This altruistic behavior led to a self-payoff of 0 Yuan and an other-payoff of 300 Yuan, and created a results of big disadvantageous unfairness. Obviously, the effect of the maximizing rule here is strong enough to overcome the effect of disadvantageous unfairness aversion.

Importantly, our results also found a 50/50 even split heuristic. Past researches took it for granted that the even-split decision was the fair decision. Our study made a distinction between the even-split heuristic and the real fair decision via the cost-benefit manipulation and found a strong even split heuristic rather than a tendency towards a fair decision per se.

Findings from past dictator game studies solely focus on average donation. We believe this analytical approach may bias their findings. A careful examination of prior dictator game results suggests that dictators, rather than making a single decision along a continuum (e.g., “How much should I give?”), are largely selecting from a smaller number of discrete options (e.g., “Should I give anything?”, “Should I be fair?”). For example, a recent meta-analysis of dictator game studies has highlighted that the two most popular response options, by a wide margin, are giving nothing and giving exactly half [8]. Specifically, across 328 dictator game studies ($N = 20,813$), 36% of people gave nothing at all and 17% gave exactly half. Furthermore, because the definition of a fair choice changes when researchers manipulate cost-benefit

ratios (as is done in some of the studies included in this meta-analysis), 17% likely underestimates the number of decisions participants actually intended to be fair. A big difference from the current study is that we propose a discrete framework, in which participants' choices are viewed as belonging to one of three decision strategies: selfish, fair, or altruistic. We found that most of people are just simply deciding to be fair, self-interested, or altruistic other than deciding how much to give. Our discrete framework approach provides future studies with a new scope of analyzing.

B. Limitations of the Current Study

The sample size of our study is relatively small. As a result, our findings bear the risk of under power. Besides, no real money was involved in our study, so participants might find the whole interaction less real. For the direction of future studies, recruiting a bigger sample and making the money sharing interaction with real money could help clear these possible bias of our current study. Besides, other factors such as gender differences and age variation should be examined through a precise lens.

In sum, we proposed a discrete decision framework that predicts decision as selfish, fair, and altruistic. These findings broaden our understanding of effect of cost-benefit ratio on people's decision making, and advance and incorporate models of previous studies.

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