

# The Effectiveness of Shared Leadership on Public Goods Provision

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**Abstract**—In this research, traditional public goods experiment is modified to test the effectiveness of shared leadership on public goods provision. With the proposed shared leadership index, mean difference test, linear regression and local regression are employed to test the hypothesis. The results show significant positive relation between shared leadership and public goods contribution rate. It suggests management could employ shared leadership to improve group project performance where free riding might exist. Experimental method is used at the first time to measure shared leadership in the field of experimental economy and leadership.

**Index Terms**—shared leadership; social networks; public goods

## I. RESEARCH PROBLEM AND PURPOSE

Based on the theories of free-riding and rationality assumption, individual would not be willing to privately provide public goods because the dominant strategy for the private public goods provision is “free riding”, even though the symmetric Pareto optimal is achieved by contributing all the endowment [1]. However, real world practice and laboratory experiments have shown some violations against the expectation of free riding. Scholars consider the violation resulted from human’s propensity to “cooperation”. Andreoni (1995) proposed the cooperation is caused by “confusion” and “kindness” and conducted an experiment to test [1]. The results showed that the “confusion” and “kindness” could contribute significantly to the public goods provision. However, many of the previous public experiments excluded communication between subjects to avoid strategic interaction, which is not realistic in real world. To solve it, studies which allowed communication showed that the provision rate of public goods was significantly increased by communication [2]. Communication is considered as a significant source of cooperation.

Although various causes of cooperation have been considered by scholars, “leadership” has not been examined by scholars. Leadership is a kind of activity that develops a vision for change and then motivates and enables people to achieve the vision [3]. Thereby, leadership could aim to develop a vision targeting the Pareto optimal and then motivate team members to

achieve the vision by urging them contribute all the endowment. Corresponding to the real world, government or firms could serve as leaders for public goods provision by advocating or encouraging. Consequently, we expect leadership could be a source of cooperation. We will conduct the experiment to test the hypothesis.

Despite the use of leadership, the type of leadership should be taken into consideration. Scholars argued that despite designated formal leader, informal leaders could possibly emerge in a team-based environment, which is called shared leadership, distributed leadership or collective leadership [4,5]. Shared leadership is a new form of leadership model. Only a few researches have been conducted about it. Shared leadership has been empirically proven to have superiority over traditional vertical leadership [6]. However, the effects of shared leadership in public goods remain unrevealed. Could shared leadership act like cooperation to improve public goods contribution rate? We will test its effect with an experiment in this paper.

The purpose of this paper is to design and conduct an experiment to test the effect of shared leadership in the context of public goods provision. The contributions are two folds. First, our study proposes a new way-experiment to measure the concept of shared leadership, which sheds light on the exploration of further experiment design of leadership. Second, it is based on the experiment of public goods in experimental economy, which explains the shared leadership mechanism with the theory in economy. In the following sections, we will first review relevant extant literatures on public goods experiment and shared leadership to develop theoretical hypotheses. Then we will present the experiment design corresponding to the proposed hypothesis and discuss the results.

## II. LITERATURE REVIEW AND HYPOTHESIS PROPOSITION

### A. Public Goods Experiment, Communication and Leadership

According to rationality assumption, game theory and theories of free-riding, the provision of public goods should have very few private contributions because the

<sup>1</sup> Shared leadership, distributed leadership and collective leadership will be used interchangeably in this paper.

dominant strategy should be zero even though the Pareto optimal outcome is contributing all the endowment [1]. Theoretical deduction indicates unless there is perfect cooperation between people, people would tend to act as free riders for their own interest. However, in real life, in contrary to the theoretical assumptions, a significant number of individuals are willing to contribute public goods, such as donation to charity foundation, private provision of community security, etc.

Even in the experimental environment, the provision rate of public goods is significantly above zero. The common public goods experiment involves more than 2 subjects. Each subject is assigned to have certain amount of tokens in his/her private account when the experiment starts. The amount of tokens the subject has earned during the experiment can be exchanged to real money at a specific rate when the experiment ends. When the experiment starts, the subject can contribute any amount of his/her tokens from the private account to the group account. Then the tokens in group account will be equally distributed to each subject's private account when this round ends. The resulted tokens in private account would be what the subject earns in this round.

Dawes and van de Kragt (1986) had the result as 51%. There are always some subjects willing to contribute considerable amount of public goods, which violates the free riding assumption [7].

The violation against "free-riding" assumption shows that human behavior has very strong "cooperation" propensity. In order to solve the "cooperation" problem, Andreoni (1995) conducted an experiment considering two proposed sources of cooperation, "kindness" and "confusion" [1]. Confusion means the lack of understanding about the experiment rules. Kindness represents the motivation from Altruism, meaning even if the subjects fully understand the experiment rules, he or she still chooses to contribute public goods. The main contribution of this research is that it indicated kindness or altruism is an important source of cooperation in public goods provision, which was an oversight in the economics community. However, the experiment only considered two sources of cooperation and prohibited communications, thus the result about confusion might not be applicable in different context.

In our research, we would explore a new source of "cooperation". Leadership is defined as a kind of activity that develops a vision for change and then motivates and enables people to achieve the vision [3]. Thus we consider leadership as a source of cooperation, which has not been considered by previous studies. As matter of fact, the Pareto optimal outcome should be to contribute all the endowment if there are more than two participants [1]. If there is a leader who can discover the Pareto optimal solution and motivate his followers to achieve it, then the public goods contribution should be significantly more than the team without leader. In addition, we expect that in the 10 rounds repeated experiments, the public goods contribution would increase as the experiment repeats because the leader

would push the team toward the Pareto optimal by increasing privately contribution.

As we introduce leadership into the experiment setting, the communication would be inevitably introduced into the experiment. After all, communication is one of the premises of effective leadership. In the area of commutation involved public goods experiments, considerable number of studies have shown that communication could significantly improve cooperation. Isaac & Walker (1988) showed that that face-to-face communication can reduce free-riding behavior, resulting in higher contribution rate [8].

## B. Shared Leadership

### 1). The rise of shared leadership

General speaking, "shared leadership" [9] (or called "collective leadership" [4], "distributed leadership" [5] is a team based leadership model that several formal or informal leaders are allowed to emerge within a team. Pearce & Conger (2003) defined shared leadership as a simultaneous, ongoing, mutual influence process involving the serial emergence of official as well as unofficial leaders.

In recent years, due to the dramatically change of internal environment, such as the rise of team-based knowledge work [9], team-based environment [5], increasing use of empowered teams and flattening of organizational structures, as well as the increasingly challenging external environment including the increasingly unpredictable, dynamic and complex environment [10], more rapidly emerging and complex problems [11] and increasing domestic or global competition [12], traditional vertical leadership has been found to have some ineffectiveness [13, 14], therefore, a new leadership model – "Shared Leadership" [9] (or called "Collective Leadership" by [4], "Distributed Leadership" by [5], they are interchangeable in this paper) has emerged to counter the new challenging environment (such as Dell's practices in "office of CEO").

As the business environment keeps changing, especially the increasing use of R&D teams, virtual teams, global organization and venture start-ups, shared leadership has been proven superiority to vertical leadership in these new areas [14,15]. However, given the significant importance of shared leadership in the new business practice, shared leadership has not received considerable number of in-depth studies compared with traditional leadership models. In several top journals on leadership research, there are only less than 1% studies from 1985 to 2009 focusing on shared leadership [16]. There is a significant research oversight on topics of shared leadership. Thus, it is of great value to conduct shared leadership research in various contexts to shed light on further research.

### 2). Network structure of shared leadership

One way to elicit the structural nature of shared leadership is to examine the network structure of shared leadership. Two forms of shared leadership network structure, distributed-coordinated and distributed-fragmented, are proposed and studied. Distributed-fragmented structure emerges when the formal leader

and emergent leader (informal leader) are not able to recognize one another's leadership and thus coordinate ineffectively. And the group might be torn apart. In the contrary, if formal and emergent leader could recognize one another's leadership, which is called distributed-coordinated structure, then they would be able to synchronize their leadership so that decision making and action are more effectively channeled within the group.

Despite Contractor et al. (2012) examined the network structure of shared leadership from the topology perspective, which has studied much more kinds of topological structure of shared leadership network, carrying out more insights [17]. Contractor et al. (2012) proposed and discussed the use of network metrics [17]. Contractor et al. (2012) incorporated two more dimensions of shared leadership network – “Role Multiplexity” and “Rotation” into the network metrics [17]. “Member Concentration” refers to the concentration of shared leadership in one or a handful of individuals. “Role Multiplexity” represents the extent to how the members involve in multiple leadership roles. “Rotation” refers to the dynamics that the member concentration and role multiplexity change over time.

### 3). *Performance outcomes of shared leadership*

As the importance of shared leadership is only noticed by scholars in the recent twenty years, the influence of shared leadership on organization outcomes have not yet been well studied. Most of the studies focus on the performance outcomes, rather than the attitude outcomes, such as work satisfactions.

Shared leadership has been proved to have positive effect on performance outcome in many studies. Avolio, Jung, Murry & Sivasubramaniam (1996) in a study of undergraduate project teams, used individual level data and found that shared leadership has positive relation with self-ratings of team effectiveness [18]. Taggar et al. (1999) also found that if individuals in a team exert more leadership (represented by mean level of individual leadership, and rated by other members), then the team would be more effective [19]. Members have very high degree of decision-making latitude for improving their responsible areas operations. And members are engaging in complex tasks that requires interdependence and collaborations of different roles and skills. By using longitudinal data, the study found shared leadership is a better predictor than vertical leadership in terms of manager, customer and team self-ratings of effectiveness. Ensley et al. (2006) conducted research in the context of entrepreneurial top management teams (TMTs) [14]. The study found that decentralized, shared leadership is better predictor for new venture performance than vertical leadership in samples of fast growing startups TMTs. Carson et al. (2007) conducted an empirical research in 59 consulting team in university [20]. It found out that shared leadership could significantly predict team performance as rated by clients. Heck & Hallinger (2010) conducted an empirical research in context of school operation using four-year period data of distributed leadership, school improvement capacity and student performance [21]. The study found that change in

distributed leadership and organizational capacity for improvement make positive influence on student learning in reading and math.

While most of the studies successfully found positive relation between shared leadership and performance outcomes, some do not. Neubert (1999) conducted an empirical research to study the relationship between shared leadership (represents by leader dispersion, which is the number of informal leaders divided by team size) and 21 manufacturing teams [22]. It turns out that there is no significant positive relation between shared leadership and outcomes in manufacturing context. However, empirical research on 28 field-based sales teams failed to find support for the hypothesis. The reason why the some researches fail to find positive influence of shared leadership is probably the followings. Firstly, these researches are conducted based on teams those do not require complementary skills, creation and different roles. Pearce (2008) states that knowledge work has characteristics of 1) interdependence 2) creativity 3) complexity, and shared leadership has been proved to be efficient in knowledge work, therefore, we propose that necessary condition for shared leadership to be effective might be work with characteristics of 1) interdependence 2) creativity and 3) complexity [9]. Secondly, these researches focus on performance outcome rather than attitude outcome. Scholars have found evidence that dispersed decision-making process has positive effect on attitude outcome such as member satisfaction [23].

Therefore, based on the increased performance outcome brought by shared leadership, if we apply shared leadership in the public goods experiment, the shared leadership would possibly outperform vertical leadership in terms of leading team members toward the Pareto optimal outcome because shared leadership might be easier than vertical leadership to find a better way towards Pareto optimal and motivate team members to achieve it. We propose the following hypothesis.

**Hypothesis 1.** Shared leadership could make significant positive effect on team public goods contribution rate.

### 4). *Attitude outcomes of shared leadership*

Nearly all of the above studies found that shared leadership has positive effect on performance outcome. However, there are only a few studies considering attitude outcome. It might be due to the difficulty to define and measure the attitude outcome. However, the attitude outcome is of significant value. From the economic perspective, there are always reasons that the utility function by which a person makes optimal choice should include the attitude outcome. It is unrealistic to assume the utility function only includes the performance outcome. Therefore, some scholars have conducted studies about the shared leadership's effect on attitude outcomes.

Scholars have proposed various frameworks considering attitude outcomes, which provide directions for further empirical research. Pearce (2008) found shared leadership could mitigate anti-citizenship behavior in teams [9]. Anti-citizenship behavior is defined as defiance, avoidance of work or

counterproductive work behavior. Sivasubramaniam, Murry, Avolio, & Jung (2002) found that team-level leadership is significantly linked to higher performance outcome, represented by higher project grades [24]. Meanwhile, they also found team-level leadership could lead to attitude outcome, represented by higher team potency beliefs. Lovelace et al. (2007) proposed an interesting framework explaining how shared leadership would improve work environment [25]. It states that share leadership could increase engagement in work by sense of “flow” and empowerment. The sense of flow would help the employee find a balance between difficulty and ease, thus reducing the anxiety, depression and exhaustion. Pearce et al. (2008) proposed the first framework considering corruption [9]. Pearce et al (2008) found that TMT shared leadership can act as a moderator between CEO and executive corruption. When shared leadership is high, the negative relationship between CEO responsibility disposition and corruption will be weaker [9]. When shared leadership is lower, the negative relationship between CEO responsibility disposition and corruption will be stronger. Friedrich et al. (2009) proposed in the framework that collective leadership could improve team performance capabilities, through this process, collective leadership would improve attitude outcomes such as decision acceptance, productivity, follower satisfaction and follower trust [11].

Based on the previous studies, we propose that shared leadership could make significant effect on attitude outcome, such satisfaction. Therefore, we have the following hypothesis.

**Hypothesis 2.** Shared leadership could make significant effect on team satisfaction.

### III. EXPERIMENT DESIGN

#### A. Basic Public Goods Experiment

First of all, we need to understand the basic public goods experiment because our experiment is derived from it.

In the experiment, subjects are given some tokens (in our research, 100 tokens) in their private account when the experiment starts. No communication would be allowed between subjects. During the experiment, subject can contribute any amount of his/her tokens from private account to the team account. After everyone has made contribution action, the tokens in team account would be equally distributed to all the subjects' private account, that is, each subject would receive (team account/ number of subjects) tokens from team account. The amount of tokens remain in the private account would be the earning in this round. The experiment earning could be exchanged to real monetary earning at some rate. Then, the experiment would repeat totally 10 rounds.

#### B. General Design: Two Teams and 10 Rounds

In order to test the 2 hypothesis we propose, we need to design an experiment involving 2 teams and 10 rounds. Each team would have 5 participants. In each round,

team members would be randomly assigned to different teams to avoid strategic behavior among participants. Totally, there would be 2 teams 5 Subjects = 10 Subjects involved in the experiment.

#### C. Modification on Basic Public Goods Experiment

##### 1) Modification 1: Communication and leadership

In order to test the hypothesis about leadership, each team would be randomly assigned a leader (formal leader) at the beginning of each round. However, when employing leadership, it would inevitably introduce communication into the experiment. As a result, the effect of leadership might be mixed with communication.

As for the communication process, in order to maintain consistent comparison with previous research, we adopt Issac & Walker (1988)'s communication setting [8]. A four minutes communication session is allowed during each round. During other time, no communication is allowed.

Besides, to make the leader has the incentive to lead team, making the leadership process effective. Formal leader would be associated with benefit and risk. The benefit is the extra 25% cash bonus if his team wins. But if his team loses, the leader would be subject to a -25% cash punishment.

##### 2) Modification 2: Two Teams (5 people each) Competition

In order to make the leadership effective, the first thing is to create a competitive environment, and then the leader would form a more meaningful plan to lead the team. In each round, two teams would compete against each other. The team with the most tokens in team account would be the winner, others would be the loser. The victory or lost would definitely change leader's earning a lot. Thus, it would motivate the leader to lead the team for victory. By doing this, we create an effective leadership process.

##### 3) Modification 3: Shared Leadership and Satisfaction Survey

In the end of each round, shared leadership and satisfaction survey would be conducted to measure the degree of shared leadership and team satisfaction. The measurement would be discussed in next section.

##### 4) Modification 4: Determine the Exchange Rate of Experiment Earning to Real Monetary Earning

In order to calculate the amount of tokens would be needed, we simulate the experiment by Excel. Each subject is given 100 tokens when the experiment begins. The simulation would be conducted by changing different amount of contribution. The results show that the total amount of tokens would be around 11500.

### IV. MEASURES

#### A. Shared Leadership

##### 1) Data collection and visualization

We would measure shared leadership from a network perspective. In each team, respondents will be provided an alphabetical list of the names of all members (including the formal leader) in their group and asked to

check the names of the people they perceived to be a leader. Respondents are free to nominate as many or as few leaders as they think appropriate. And we specify on the questionnaire that individuals perceived as leaders “may or may not be officially designated as leaders” by the election.

Data from the questionnaire will be arranged in a binary matrix, where each cell  $X_{ij}$  corresponded to  $i$ 's relation to  $j$  as reported by  $i$ . If  $i$  reported  $j$  as a leader, then the cell  $X_{ij}$  was coded as 1; otherwise, the cell  $X_{ij}$  was coded as 0. The leadership data from different teams are each coded in a separate matrix.

We then use UCINET 6.2's NetDraw Function to generate the image of the leadership network by importing the matrix data.

### B. Team Satisfaction

We used a 5-item scale adapted from Churchill, Neil & Walker (1974)'s 12-item scale measuring job satisfaction, which is a classic work in measuring job satisfaction [26]. In our research, we would apply Churchill et al. (1974)'s 12-item scale directly [26]. Each item is a 5-point Likert scale ranging from “strongly disagree” and “strongly agree”. Team members, including formal leader, is asked to fill the form after each experiment. The mean score of the 12 items is the satisfaction measure for the individual team member.

## V. RESULTS

### A. Team Contribution Rate

Contribution rate, as the major results of public goods experiment, previous studies [1,8] have plotted and examined the contribution rate in order to identify the trend, implications and compare it with relevant researches. For conducting consistent comparison, the contribution rate will also be examined in this research.

The calculation of the contribution rate is consistent with previous studies [1,8], wherein, the contribution rate in one round equals to the sum of the tokens contributed by each member divided by the sum of each member's initial tokens (or called the initial endowment)<sup>3</sup>.

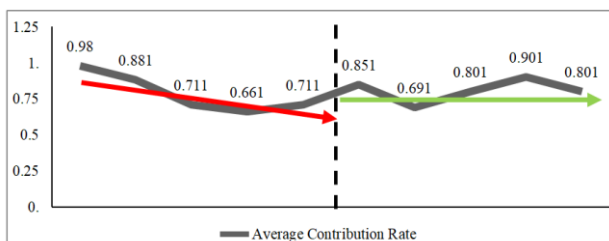


Figure 1. Average contribution rate in each round

Fig. 1. is the plot of the average contribution rate of two teams in each round. By examining the pattern and trend, it could be identified that a possible downward trend existing in the first five rounds. After round five, the contribution rate seems to fluctuate around 0.8 in the remaining rounds.

According to Andreoni (1995), the first and second rounds' high contribution rate (0.98 and 0.881) might result from the “kindness” and “confusion” [1]. “Kindness” indicates human tends to cooperate and contribute more in the beginning, but after knowing the benefit from free-riding, the “kindnesses” would be diminishing, driving the contribution rate lower. Despite the “kindness”, the “confusion” about the experiment regulation and lack of information jointly leads the participants prefer some kinds of conservative actions, that is, to be consistent with teammates and do what teammates do. Based on the video record, most of the conversations in the first few rounds reflect the significant confusion about how to conduct optimal action and strategy. As the effects of “kindness” and “confusion” are diminishing and the dominated free-riding strategy is identified, some of the participants decide to contribute less or even zero, driving the contribution rate significantly lower.

However, after round fifth, the contribution rate fluctuates around 0.8. Compared with previous five rounds, there is no significant trend. Notice that four of the last five rounds have contribution rate larger than 0.8, significantly higher than those no communication involved public goods experiment. The result is consistent with Issac & Walker (1988)'s experiment with communication [8]. The reason is that communication might lead team members to coordinate individual's action for the best of the team's collective benefit.

As for this research, despite communication, leadership is added. Theoretically, leadership could make more significant effect than communication because leader could exert influential power to one's decision making and action taking. However, in this research, we cannot differentiate leadership effect directly from communication effect because we do not have a control group. If more funding is approved, there would be control group in further research.

Based on this finding, it is concluded that different rounds do not significantly influence the contribution rate. Therefore, when we build the model that considers contribution rate as the dependent variable, the independent variables would not include round number.

### B. Formal Leader Contribution

As the formal leader's reward or loss is related with team performance, which is higher if contribution is higher, thereby, the formal leader should contribute the most in each round. If it is true, it would indicate our incentive plan for the leader is successful, which is the premise of the leadership process. Except for two formal leaders, all the formal leaders contribute every token (100 tokens) they have, consistent with our hypothesis. Therefore, we conclude the incentive plan for the leader

<sup>2</sup> [http://www.hks.harvard.edu/netgov/files/NIPS/Halgin\\_NIPS\\_2008.pdf](http://www.hks.harvard.edu/netgov/files/NIPS/Halgin_NIPS_2008.pdf)

<sup>3</sup> For example, team A has 3 participants named No.1, No.2 and No.3, and each one has initial tokens of 10. If No.1, No.2 and No.3 contribute 5, 6 and 8 tokens respectively, then the contribution rate will be  $(5+6+8)/(10+10+10)=0.633$ .

is effective. Consequently, the leadership process is proved to be effective.

### C. Mean Difference Test: Existing of Shared Leadership

In the previous section of shared leadership measurement, we state that if the average in-degree centrality is larger than 0.8, then it indicates existing of shared leadership. According to this criteria, we divide the sample into two group, shared leadership group with larger than 0.8 average in-degree and non-shared leadership group with only 0.8 average in-degree.

#### 1) Contribution rate

Firstly, we examine the contribution rate and compare the difference in shared leadership group and non-shared leadership group. In the shared leadership group, the overall average of contribution rate is 0.860462, it seems much larger than non-shared leadership group's average contribution rate, which is only 0.684571.

If we examine the contribution rate of the individual samples instead of the overall group average, the difference is somewhat more obvious and informative. In the shared leadership group, we can find 5 samples have 100% contribution rate, that is everyone has "contributed everything", they successfully reach the "Pareto Optimal"! While in non-shared leadership group, the highest contribution rate is only 0.82, even less than the overall average contribution rate of the shared leadership group.

In order to prudentially and statistically examine whether the mean difference of two groups' contribution rate is significant or not, we conduct Welch Two Sample t-test. The null hypothesis is that the two means are equal.

The p-value of the statistics is less than the 0.5 significance level, indicating the average contribution rates of two groups are significantly different. Therefore, we can conclude that the contribution rate of shared leadership group is significantly higher than that of non-shared leadership group. Hence we have proved the "hypothesis 1: Shared leadership could make significant positive effect on team public goods contribution rate". However, in order to generate more insights about the relation between shared leadership and contribution rate, we need to conduct more rigorous regression analysis.

#### 2) Satisfaction

Secondly, we examine the contribution rate and compare the difference in shared leadership group and non-shared leadership group.

In shared leadership group, the largest satisfaction is 3.7, while in non-shared leadership group, the largest satisfaction is only 3.38333. There are 7 samples in shared leadership group having higher satisfaction than the highest satisfaction score of the non-shared leadership group.

In order to prudentially and statistically examine whether the mean difference of two groups' satisfaction is significant or not, we conduct Welch Two Sample t-test. The null hypothesis is that the two means are equal. The p-value of the statistics is less than the 0.5 significance level, indicating the average satisfaction of two groups are significantly different. Therefore, we can conclude that the satisfaction rate of shared leadership

group is significantly higher than that of non-shared leadership group. Hence we have proved the "hypothesis 2: Shared leadership could make significant effect on team satisfaction". However, in order to generate more insights about the relation between shared leadership and satisfaction, we need to conduct more rigorous regression analysis.

### D. Regression Analysis: Test Hypothesis 1

First of all, we will conduct regression analysis on contribution rate and shared leadership to further test the hypothesis 1. The dependent variable is contribution rate, and the independent variable is shared leadership index.

To better explore the pattern and relation between variables, we take advantage of "Local Regression" and the classical linear regression. Local regression is in fact the integration of multiple linear regressions in different data subsets. By local regression, we can examine how the relations between two variables change across different data subsets instead of the overall relation estimated by simple linear regression. One of the best advantages of local regression is that it's a non-parametric method, which is very flexible to estimate various data relations without pre-determine the underlying models, best for exploring unknown data relations.

We examine the result. The coefficient estimated is significant with value of 0.40421, meaning if the shared leadership index increases by 1 standard deviation then the contribution rate would increase by 0.40421 standard deviation. Besides, the intercept is insignificant, that's because we use standardized data, which has the mean value as 0, making the intercept not significantly different from 0.

In conclusion for this test, the hypothesis 1 is mostly supported, however, not fully evidently. For further research, larger sample size is suggested and factors about the "fault line" should be considered.

### E. Regression Analysis: Test Hypothesis 2

In this section, we test hypothesis 2: Shared leadership could make significant effect on team satisfaction by regressing Satisfaction on Shared Leadership Index. The dependent variable is satisfaction, while the independent variable is shared leadership index.

Although the parameter estimated by linear regression is statistically significant (p-value=0.079), the local regression line has a steeper "fault line" drop than the previous model, indicating the positive relation between satisfaction and shared leadership index is weaker than the relation between contribution rate and shared leadership index. In fact, the lowest point of the local regression is even lower than the left most point, indicating the relation between satisfaction and shared leadership index is negative before the lowest point of the local regression!

As for the hypothesis 2, the linear regression result statistically proves it. The parameter value estimated is 0.40187, very close to the coefficient of SHA to CON we have estimated in hypothesis 1 test.

## VI. CONCLUSION

## A. Main Finding

In this public goods experiment, we made some change as opposed to traditional public goods experiment. In order to make this experiment comparable to previous research, except for the changes we clearly state, other experiment setting is consistent with previous research. By introducing communication and leadership into the experiment, we test whether shared leadership could make significant influence on contribution rate and satisfaction.

## 1) Shared leadership index and mean difference test

To measure the degree of shared leadership, a new kind of measurement, "Shared Leadership Index" is proposed, taking advantages of sociometrics to quantify the network structure. We not only consider the average leadership in each team member, but also consider how the leadership is distributed across the team. We take the heterogeneity of the shared leadership distribution into consideration.

In the mean difference test, both hypothesis 1 and hypothesis 2 are significantly proved. However, the mean difference test just examines the difference between two groups, shared leadership group and non-shared leadership group. It doesn't tell us about how the dependent variable changes with respect to the change of shared leadership. Therefore, regression analysis is applied as followed.

## 2) Regression analysis

In regression analysis, the results are mixed with significance and insignificance. The two possible causes are outlier and the "fault line" of the regression line. It has been proved that the estimation is very sensitive to the outlier. When including the outlier, hypothesis 1 and hypothesis 2 are both evidently proved. However, after excluding the outlier, the two hypotheses are rejected.

In fact, deleting the outlier is not the only cause for the insignificance. By local regression, we find significant "fault line" in the middle of the regression line. It reveals that the relation between shared leadership index and the dependent variable (Contribution Rate and Satisfaction) could be different (negative or positive) in different intervals of shared leadership index.

## 3) Management implication

As for real world business practice, the public goods experiment in this research is similar to some group project. Especially in some large global companies, various group projects are often formed temporally for some purposes. In these group projects, each team member's reward is only related with the group performance, thus free-riding phenomena might exist. As the team structure is more frequently used by companies, how to increase the team efficiency and decrease the free-riding behavior is crucial to company's success.

This experiment result indicates that shared leadership might be a good way to directly improve team performance and satisfaction or improve team performance via improved satisfaction.

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