Effects of Anonymity on Cooperation in Common Pool Resources Games

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1. Introduction

Our aim in conducting this experiment is to check whether anonymity affects cooperation in the common pool resources game. We hypothesize that as anonymity increases within a group, an individual act more self-interested because she is protected from all the peer pressure or societal stigma if she extracted too much.

We divide players into 4 different groups. Each of them has anywhere from 10-15 players. The rules for each of the groups are as follows:

1. **Independent Anonymous Group:** Players belonging to the group will not be able to talk to each other, which means decision making is purely independent and they cannot intervene in each other's decision-making process. Moreover, the amount of resources extracted by each player will be hidden, and no other player can see it.

2. **Independent Non-Anonymous Group:** The rules for this group is pretty much the same as the previous one, but the amount of resources extracted by each player will be shown at the end of the round in a leader board.

3. **Interactive Anonymous Group:** Players in the group will be able to chat with each other, which may or may not affect the decision-making process of them. As the name suggests, the amount of resources extracted by each player will be hidden, and no other player can access it.

4. **Interactive Non-Anonymous Group:** Similar to the previous group, players are able to chat with each other and moreover, similar to the second group, the amount of resources extracted by each player will be shown at the end of the round in a leader board.

2. Game Mechanics

Players are supposed to mine coal for a certain payoff. The price in the conducted experiment is 100 INR per coal. More the players extract coal, more cost they will have to bear. The cost is determined by the following equation:

$$Cost = c\frac{x_i(x_i + x_{-i})}{\theta} \tag{1}$$

where,

$$\begin{aligned} x_i &= \text{The amount of coal extracted by the } i^{th} \text{ player} \\ x_{-i} &= \text{The amount of coal extracted by all the players} \\ &\quad \text{except the } i^{th} \text{ player} \\ \theta &= \text{The total amount of resources present} \\ c &= \text{Cost multiplier} \end{aligned}$$

c in the current experiment is chosen to be 70 INR and θ is chosen to be 100.
Notice that as the total extraction by all players increases ($x_i + x_{-i}$), the cost also increases. Hence, more scarce the resource gets, cost for extraction increases correspondingly.

The total payoff for each player turns out to be:

$$\pi_i(x_i) = px_i - c\frac{x_i(x_i + x_{-i})}{\theta} \tag{2}$$

where,

$$\begin{aligned} p &= \text{price per coal} \\ x_i &= \text{The amount of coal extracted by the } i^{th} \text{ player} \\ x_{-i} &= \text{The amount of coal extracted by all the players} \\ &\quad \text{except the } i^{th} \text{ player} \\ \theta &= \text{The total amount of resources present} \\ c &= \text{Cost multiplier} \end{aligned}$$

3. Theory

The players are expected to portray either of the two behaviors:

- Self-interest
- Cooperation

We expect that as the anonymity increases, the feeling of "getting away" from self-interested actions also increases hence, resulting in less cooperation. On the other hand, as the feeling of being exposed increases as the anonymity decreases, we expect players to show more cooperation.

3.1. Self-Interest

We maximize the individual pay-off of the player to solve for the best response function for it i^{th} player.

$$\frac{d\pi_i}{dx_i} = p - c\frac{2x_i + x_{-i}}{\theta}$$
$$0 = p - c\frac{2x_i + x_{-i}}{\theta}$$
$$x_i(x_{-i}) = \frac{\theta p - cx_{-i}}{2c} \quad (3)$$

Assuming uniform distribution of the extraction (i.e. symmetric nash equilibrium) and 'n' players, we get

$$x_i = x$$
$$x_{-i} = n - 1(x)$$

Inserting the above values into eq (3), we get

$$x = \frac{\theta p - c(n-1)x}{2c}$$
$$2cx = \theta p - c(n-1)x$$
$$c(n+1)x = \theta p$$
$$x = \frac{\theta p}{(n+1)c} \quad (4)$$

If we insert the values that we have assumed for this experiment and taking only 2 players,

$$\theta = 100$$
$$p = 100$$
$$c = 70$$
$$n = 2$$

we get $x = 47.6$ and total extraction to be 95.2. Hence, the payoff for each player (using eq (2)) turns out to be 1587.936 INR.

3.2. Cooperation

We maximize the sum of payoffs of all players. We assume an uniform distribution of extraction (i.e. symmetric nash equilibrium) and 'n' players.

$$\pi_{total} = \sum(px - c\frac{x(nx)}{\theta})$$
$$\pi_{total} = npx - c\frac{(nx)^2}{\theta}$$
$$\frac{d\pi_{total}}{dx} = np - 2c\frac{n^2x}{\theta}$$
$$0 = np - 2c\frac{n^2x}{\theta}$$
$$x = \frac{\theta p}{2nc} \quad (5)$$

If we insert the values that we have assumed for this experiment and taking only 2 players,

$$\theta = 100$$
$$p = 100$$
$$c = 70$$
$$n = 2$$

we get $x = 35.7$ and total extraction to be 71.4. Hence, the payoff for each player (using eq (2)) turns out to be 1785.714 INR.

3.3. Analysis

As we can see with the example of 2 players, the payoff for each player is better when they choose to cooperate and conserve the resource.

4. Method

Here, we will discuss how we plan to compare the experimental data to theoretical predictions to determine whether a group or an individual portrays cooperation or not.

4.1. Data collection and Organization

- For each group, the extraction by each player and the total extraction and its corresponding payoffs will be recorded.
- The data will be categorized into:
  1. Individual level: extractions level and payoffs per player
  2. Group level: extractions level and payoff for the overall group
- The collected and organized data for each group will be used for comparison in the next stage.

4.2. Comparison and Statistical Analysis

- **Individual Level:** Each player's individual extraction will be checked if it's closer to theoretically computed self-interested extraction or cooperative extraction. In general, individual extraction is expected to be higher.
- **Group level**: Overall group extraction will be tested if it's on the higher-end or the lower-end to test if the self-interested behavior was dominant or vice-versa. Benchmarks would be created according to the theoretically computed group extractions for each case.
- Following statistical analysis tools will be used to test our hypothesis that anonymity affects cooperation between individuals.

1. **T-tests:** It will be used to determine if the observed behavior was self-interested or cooperative by comparing observed payoffs to theoretical payoffs on both levels. **[Classification of exhibited behaviors]**

2. **Chi-squared tests:** The groups will be compared with each other using chi-squared tests to check if there exists a difference in observed behaviors across the groups and if anonymity actually has any effects on choice distribution. **[Testing if anonymity has any effect on choices]**

3. **Regression Analysis:** Linear regression model will be used to quantify the effects of anonymity on cooperation and how well can anonymity predict the level of cooperation between the players. **[How well anonymity affects the choices]**

- Using the above techniques, we will successfully be able to determine if our hypothesis "Increasing the anonymity decreases the cooperation among players in CPR games" is true or not.

5. Conclusion

In this experiment, we aimed to examine the relationship between anonymity and cooperation in common pool resource (CPR) games. Our hypothesis suggested that increased anonymity would lead to greater self-interested behavior due to the absence of peer pressure or societal consequences, whereas reduced anonymity would promote cooperation as individuals become more accountable for their actions.

By dividing participants into four distinct groups—varying in their ability to interact and their level of anonymity—we designed a framework to isolate the effects of anonymity and interaction on resource extraction decisions. The game mechanics were structured to highlight the trade-off between individual incentives and collective welfare, with theoretical benchmarks for self-interest and cooperation providing the basis for comparison.

Our proposed analysis employs statistical tools such as T-tests, Chi-squared tests, and regression analysis to evaluate the collected data. At the individual level, we compare each player's behavior against theoretical predictions, while at the group level, we assess overall resource extraction to determine the prevalence of cooperative or self-interested behavior. These analyses will allow us to quantify the impact of anonymity on decision-making and cooperation within CPR settings.

If the hypothesis holds true, we expect to observe higher resource extraction (indicating self-interest) in the independent anonymous group and lower extraction (indicating cooperation) in the interactive non-anonymous group. The results will provide valuable insights into how social visibility and communication influence collective outcomes, with potential implications for managing shared resources in real-world scenarios.

In conclusion, our experiment underscores the importance of accountability and social interaction in fostering cooperative behavior. By testing the effects of anonymity on CPR dilemmas, we aim to contribute to the broader understanding of human decision-making in resource-sharing contexts and provide a basis for future research in behavioral economics.