# Does information matter in the commons? Experimental evidence

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# Introduction

- Examples of common-pool resources (CPRs) include fisheries, groundwater basins, oil fields, irrigation systems, grazing commons, and computer facilities
- Studies show that the so-called "tragedy of the commons" may be mitigated to a significant extent by institutional arrange
- Perfect information on the payoff function
- The provision of more accurate information may be highly costly
- Does a better knowledge of the CPR payoff structure make subjects more conscious of the externalities and then help to avoid the "tragedy of the commons"?
- Do subjects use this information to better exploit the resource?

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# Main Points

- CPR game repeated over a long time horizon
- Two treatments,(1) one with complete information and (2) one with no information on the payoff function.
- Aggregate behavior is not significantly different between the two treatments (NE)
- The results suggest that costly enterprises with the aim of improving the quality of information on the payoff structure of a CPR may not be profitable

# The common-pool resource game

- 50 periods, a group of 6 individuals plays a constituent game aimed at representing the appropriation problem in a CPR.
- Players are aware of the number of periods to be played
- The game is symmetric and no communication between players is allowed.
- In the constituent game $\Gamma = (N, X, u)$, players face the decision problem of distributing a fixed endowment (labeled $k$) between two markets

- the CPR market (market 1) and a 'private market' (market 2)
- $x_i$ is player $i$'s investment in the CPR market, $x_i$ set membership, variant $X_i = \{5.00, 5.01, 5.02, \ldots, 30\}$, $x = (x_1, x_2, \ldots, x_6)$ and $k = 35$
- $(35 - x_i)$ is player $i$'s investment in the private marke
- Player $i$'s payoff function

$$u_i(x) = \left(120 \sum_{j=1}^{6} x_j - 1.165 \left(\sum_{j=1}^{6} x_j\right)^2\right) \frac{x_i}{\sum_{j=1}^{6} x_j} + (135 - 6(35 - x_i))(35 - x_i). \tag{1}$$

# Nash equilibrium and optimal solution

- CPR game has a unique Nash Equilibrium, which happens to be symmetric
- The SNE of the constituent game is calculated by assuming that the individual strategy space is the continuum between 5 and 30.
- player i's best-reply function in the constituent game:

$$b_i(x_{-i}) = \left\{ x_i \in X_i : u_i(x_i, x_{-i}) \geq u_i(x_i', x_{-i}) \text{ for all } x_i' \in X_i \right\}, \quad \text{for all } i \in N, \tag{2}$$

where $x_{-i} = (x_1, \ldots, x_{i-1}, x_{i+1}, \ldots, x_6)$. The individual best-reply function can be obtained by

$$\frac{\partial u_i(x_i, x_{-i})}{\partial x_i} = 405 - 1.165 \sum_{\substack{j=1 \\ j \neq i}}^{5} x_j - 14.33 x_i = 0, \quad \text{for all } i \in N, \tag{3}$$

and hence

$$b_i(x_{-i}) = 28.26 - 0.08 \sum_{\substack{j=1 \\ j \neq i}}^{5} x_j, \quad \text{for all } i \in N. \tag{4}$$

- Then,

$$p_i(x_{-i}) = \left\{ x_i \in X_i : \sum_{j=1}^{6} u_j(x_i, x_{-i}) \geq \sum_{j=1}^{6} u_j(x_i', x_{-i}) \text{ for all } x_i' \in X_i \right\}. \tag{5}$$

Then

$$\frac{\partial \sum_{j=1}^{6} u_j(x_i, x_{-i})}{\partial x_i} = 405 - 2.33 \sum_{\substack{j=1 \\ j \neq i}}^{5} x_j - 14.33 x_i = 0, \tag{6}$$

- Laboratory for Experimental Economics at the University of Bonn.
- Volunteer subjects
- Two treatments: (1) Complete-information Treatment and (2) Minimal-information Treatment [all information regarding the structure of payoffs was omitted]
- The period-by-period information about outcomes was the same in both treatments.
- Subjects were told that individual decisions remained anonymous to the group and that the game was symmetric

- **Result 1**. There is no significant difference between the investment decisions at the aggregate level in the two treatments.

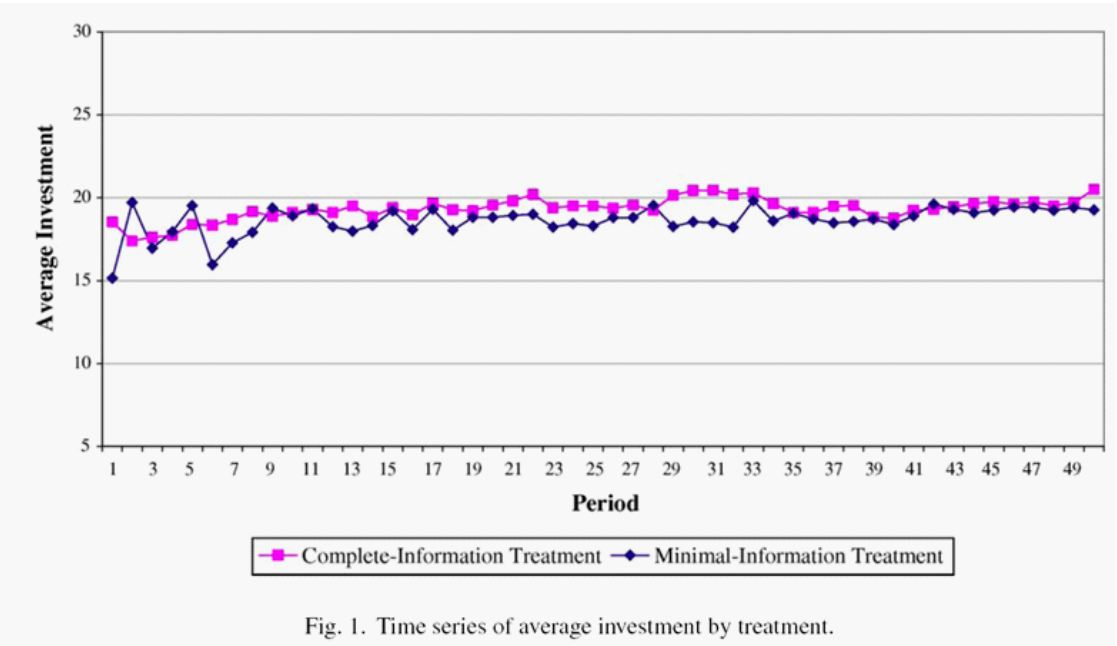


Fig. 1. Time series of average investment by treatment.

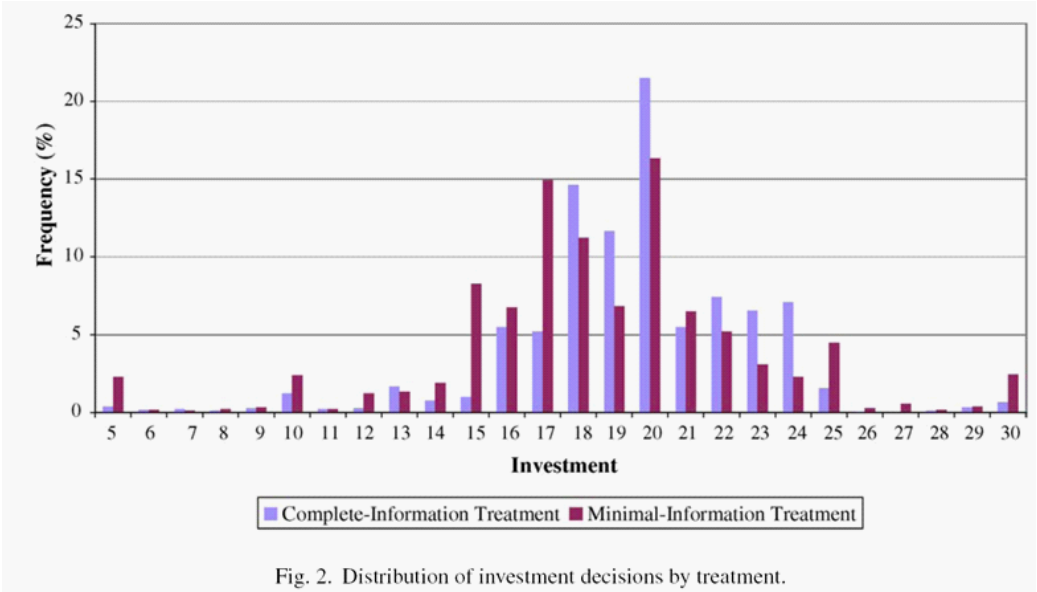


Fig. 2. Distribution of investment decisions by treatment.

- **Result 2**. In the first third of the experiment, dispersion in the pattern of individual investment decisions in the Minimal-information Treatment is greater than that observed in the Complete-information Treatment.

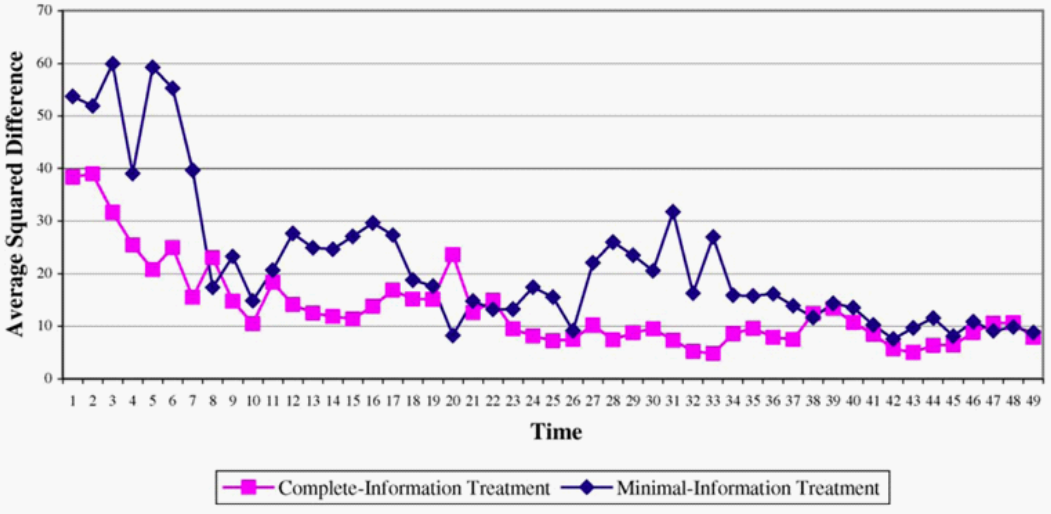


Fig. 4. Time series of the average squared differences between individually observed and predicted investments by the best-reply function.

- Since technical studies that have the aim of improving the knowledge on the relation between decisions and payoffs in CPR settings may be highly costly, it is a crucial question, relevant for policy-making, to evaluate the behavioral usefulness of these studies.
- He finds that there is no significant difference in the investment decisions at the aggregate level between those groups in the Complete-information Treatment, and those in the Minimal-information Treatment.
- The results of this paper suggest that the priorities in the CPR institutional agenda may have to be reconsidered.