1. "Rent Dissipation in a Limited-Access Common-Pool Resource: Experimental Evidence" (abbreviated as WGO in the following) reports the results from six experiments (8 players each, 20-30 rounds long) designed to investigate rent dissipation in a non-cooperative limited access laboratory environment.

The experiments were conducted with experienced subjects, (experience implies that each subject had participated in a similar decision game before)[1] drawn from the Indiana undergraduate population using the PLATO computer system, which allowed for minimal experimental interaction, crucial in a non-cooperative game. Prior to recruiting, potential participants were informed that they were going to participate in an experiment where they would be making decisions in an "economic choice" environment, and that the money they would earn would depend on their own and everyone else's decisions. Anonymity of cash earnings and all investment decisions was guaranteed. New Participants were told that they would be endowed with a certain number of tokens (either 10 or 25) that they were free to allocate between two markets. Market 1 was described as investment opportunity in which each token yielded a constant rate of output and each unit of output yielded a fixed return. Market 2, the Common-Pool-Resource, was described as a market that yielded a rate of output per token dependent upon the total number of tokens invested overall. This rate of output at each level of total group investment was presented in functional and tabular form. Participants were informed they would receive a level of output from Market 2 that was equivalent to the percentage of total group tokens they invested. Further, they were informed that each unit of output in the CPR (Market 2) would yield a constant rate of return as in Market 1. A production function with declining MRP (marginal revenue product) guaranteed that individual investments in the CPR created a production externality on the productivity of other participants' investments.

In order to explain how group payoffs from the CPR depend on overall group investment in the CPR and how a specific subject's payoff from the CPR depends on his relative investment, it is best to introduce the individual payoff function. Given the strategy space of $x_i \in \{0, 1, 2, ...,$

[•] Critical summary of: Rent Dissipation in a Limited-Access Common-Pool Resource: Experimental Evidence, by J. Walker, R. Gardner and E. Ostrom, in Journal of Environmental Economics and Management, 19, 1990, p. 203-211. Literature used:
Walker, J., Gardner, R., Ostrom, E. (1992) Covenants With and Without a Sword: Self-Governance is possible, American Political Science Review 86(2), 1992, p.404-417

[1] The use of experienced subjects increases the likelihood that participants actually understand the decision problem, which increases confidence in the accuracy of data obtained.

T}, where T denotes the token endowment and x_i the number of tokens invested in the CPR, the payoff for player i, $h_i(x)$, in cents, is:

$$h_i(x)=5(T-x_i) + (x_i/\sum x_i)(23\sum x_i - 0.25(\sum x_i)^2) \quad [1]$$

Equation 1 is comprised of three parts. The first part, $5(T-x_i)$, describes the payoffs from Market 1. Every token invested there ($T-x_i$, being the total amount of tokens minus those invested in the CPR) yields a constant 5 cents. The second part, $(x_i/\sum x_i)$, determines the share of Market 2 earnings the individual receives. As is obvious, the share is equivalent to the percentage of total group tokens invested by the respective individual. The last part represents the production function for the CPR exhibiting declining MRP (marginal revenue product). The optimal investment decision for the individual participant is determined by taking the derivative with respect to x_i and setting it equal to zero. This equates the marginal returns to investment in each market. The new equation 2 is:

$$23 - 0.25 \sum x_i - 0.25\, x_i = 5 \quad [2]$$

In this equation the externality problem becomes obvious. Investing x_i tokens in the CPR diminishes not only the marginal productivity for that participant but also for all other agents as well because all players are affected by a change in $\sum x_i$. As a result, the optimal choice for every individual depends on the choices made by all other players.

2. The measurement of rent accrual used in WGO is distinct from the measurement of market efficiency as used, for example, in the induced S&D markets discussed at the beginning of the semester. Overall efficiency is dependent on the number of tokens available whereas rent accrual as measured in WGO is solely dependent on the production function for Market 2 and opportunity cost. If the number of tokens available to each participant increases, investments in the CPR are not affected. Only the earnings in Market 1 increase. As long as Pareto optimal strategies are compared, this method is not problematic. Problems arise, however, when investments in the CPR are suboptimal (e.g., investments close to the Nash equilibrium) as could often be observed. With increased endowments, the relative contribution of the CPR to the efficiency measure declines and allocation errors become less and less important. If, for example,

all 8 individuals are endowed with 10,000 tokens each and they all choose to contribute 8 to the CPR and the remaining 9992 to Market 1, the divergences between the two measures become apparent. The measurement of rent accrual results in subjects earning approximately 39.506% of maximum rents in Market 2, whereas the overall efficiency measure leads to a seemingly near optimal result of 99.951% overall efficiency.[2] This result is due to the fact that the importance of the CPR is far outweighed by Market 1. Since Market 1 presents a sure thing, and especially since our measure should be indifferent to the token endowment, the rent accrual method has correctly been chosen to compare performance in varying experiments.

3. The most striking result was that even though the equilibrium prediction is the same for both low- and high-endowment (10 and 25 tokens) environments, the high-endowment environment exhibited lower net yields. Aggregated over all experimental periods, the average level of rents accrued in the 10 token design equaled 37.2% as opposed to –3.16% in the high-endowment game.[3] Looking at the individual experiments, the authors found that rent declined and increased in a pulsing pattern. Even though this pattern tended to recur across decision periods within an experiment, symmetry across experiments with respect to the amplitude or the timing of the “rent peaks” could not be found. Although there was a tendency for the fluctuations around the Nash equilibrium to decrease, no clear signs that the experiments were stabilizing could be discerned. Looking at the individual players in the individual experiments, no evidence could be found that individual investments stabilized around the Nash equilibrium as opposed to the aggregate data.

Over all experiments rents averaged only 5.7% of the optimum. Further, the level of rents accrued in the experiments with 25 tokens fell well below those levels predicted by standard models including the TRD (total rent dissipation) model used for open-access resources.

WGO document the severity of the allocation problem faced by individuals in a non-cooperative common-pool resource environment. One important question raised at the end of the paper regarding the role of communication has been treated in a later paper entitled “Covenants With and Without a Sword: Self-Governance Is Possible”.

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[2] The 39.506% is calculated in the following manner: $[(x_i/\sum x_i)\ (23\sum x_i - 0.25(\sum x_i)^2)] - [(x_i)5]$ is calculated for x_i values of 8 (Nash) and 4.5 (Pareto) for every player symmetrically. The result is obtained by dividing the Pareto from the Nash result. The 99.951% is calculated in the following manner: $5(T-x_i) + (x_i/\sum x_i)(23\sum x_i - 0.25(\sum x_i)^2)$ is calculated for x_i values of 8 (Nash) and 4.5 (Pareto) for every player symmetrically and using T=10000. Again, the result is obtained by dividing the Pareto from the Nash result.

[3] It would be interesting to examine whether the “magic” division of the token endowment (i.e., 50%) plays a role. In the 10 token design, this rule of thumb (?) would have led to good results.