Common-Pool Resources: Over Extraction and Allocation Mechanisms

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Fundamentals from Economics

- Opportunity Costs imply the need for appropriation rules and allocation mechanisms that guide resource units to their most highly valued uses.
- Lack of effective property rights often lead to overuse and resource degradation.
- Policy changes, without careful thought to responses, often have unintended consequences.
The nature of goods and their allocation

<table>
<thead>
<tr>
<th>Ability to Exclude</th>
<th>Rivalry or Subtractability in Use</th>
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</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Private goods</td>
<td>Toll goods</td>
</tr>
<tr>
<td>Common-Pool Resources (CPRs)</td>
<td>Public goods</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
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A Basic Model of CPRs

• Open Access – with full replenishment per period
• Resource generates valued resource units (water), where the level of water extracted is a quadratic function of extraction effort (L).
• L has an opportunity cost (e.g. wage (w) that is foregone if the labor is used for extraction).

• Value: Total Product of Labor: \( Q_w = f(L) = (aL - bL^2) \)
• Value: Average Product of Labor = \( (a - bL) \)
• Value: Marginal Product of Labor = \( (a - 2bL) \)
Value of Water extracted

VAP\_L

VMP\_L

Rents

Optimal Extraction (maximize rents)

Open Access Equilibrium (zero rents)

Wage = MC

Labor
Story may be worse

• Insufficient or high variability in replenishment rates
• Time dependence and strategic “race to the water”
• Degradation of the Water Resource
• Degradation of the broader resource system (the broader public good)
• Limited Access may help – but there still exists the problem of non-cooperation and strategic behavior
Rent Dissipation in an Experimental Laboratory

• Limited access - groups of 8 made anonymous appropriation decisions in a setting designed to capture the incentives of the CPR.

• The decision setting is repeated with “feedback” on group outcomes.

• Limited-access non-cooperative outcome generates 37% of maximum rents – 8 tokens used for appropriation.

• Treatment conditions: a) appropriation capacity, b) face-to-face communication; c) individual imposed sanctions
<table>
<thead>
<tr>
<th>Decision Setting</th>
<th>Decision Rounds 1-10</th>
<th>Decision Rounds 11-25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Capacity to Appropriate</td>
<td>47%</td>
<td>35%</td>
</tr>
<tr>
<td>High Capacity to Appropriate</td>
<td>-22%</td>
<td>21%</td>
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</tbody>
</table>

**High Capacity – Imposed Institutional Change After Round 10**

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<tbody>
<tr>
<td>One-Shot Communication</td>
<td>-26%</td>
<td>53%</td>
</tr>
<tr>
<td>Repeated Communication</td>
<td>9%</td>
<td>73%</td>
</tr>
<tr>
<td>Imposed Sanction Opportunity</td>
<td>-37%</td>
<td>36%</td>
</tr>
<tr>
<td>One-Shot Communication &amp; Sanction Opportunity</td>
<td>-14%</td>
<td>84%</td>
</tr>
</tbody>
</table>

**High Capacity – Endogenous Institutional Change After Round 10**

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<tbody>
<tr>
<td>One Shot Communication &amp; No Sanction Chosen</td>
<td>42%</td>
<td>53%</td>
</tr>
<tr>
<td>One Shot Communication &amp; Sanction Chosen</td>
<td>-11%</td>
<td>91%</td>
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</tbody>
</table>
Experiments: With Incomplete Collective Action

• Insiders – face-to-face communication with ability to make verbal commitments.

• Outsiders – vary their ability to respond to insiders.
  – Protocol 1 – outsiders: computerized Nash players
  – Protocol 2 – outsiders: unrestricted human players
  – Protocol 3 – outsiders: restricted human players
Experimental Results: SSW Insiders and Outsiders
Summary Results

• Human outsiders respond strategically to opportunities created by insiders;
• Insiders deviate more frequently from agreement with imperfect monitoring;
• Insiders anticipate issues and are less likely to reach agreements.
Implementing a market mechanism

• Suppose policies can be designed to assign effective property rights that are tradeable.

Viewed from the perspective of a competitive market mechanism, with price taking behavior, yields the model of Supply and Demand.
Perfect Competition as a Market Allocation Mechanism

Demand

Supply

Maximum Willingness to Pay

Minimum Willingness to Accept

Pe

Qe

Qwater/t

Jim Walker – Short Course
Markets as a solution? Some not-so-small issues

• Assignment of effective property rights
• Transaction costs – e.g. information, policing/monitoring, enforcing
• Externalities in production and consumption
• Public acceptance of the allocation process (assigning property rights and the market allocation)
Collective Action - lessons from a pioneer

A Subset of Ostrom Design Principles

- “Governing the Commons”
  - Clearly defined boundaries (including who has appropriation rights)
  - Effective Monitoring
  - Graduated Sanctions
  - Appropriate conflict resolution mechanisms
  - Opportunity for rules to be conditioned on bottom up approach
  - Rules designed to address appropriation and conflict across larger/overlapping resources – nested rules

“No Panaceas” – importance of local information and conditions
Selected References

• **Gardner, Roy, Michael Moore, and James Walker.** 1997,d "Governing A Groundwater Commons: A Strategic and Laboratory Analysis of Western Water Law," Economic Inquiry, April, 218-234.


Thank You