Common-Pool Resources (Ch 34)
and
Public Goods (Ch 36)

March 3, 2010
Final Exam Details

- End-of-quarter festivities
  - Review session: F 3/12 2-4pm IV THEA1
  - Extra OH: Sun 3/14 4-6pm, TBA
  - Final Exam: T 3/16 IV THEA1 (here)

- Format: Mult choice + long answers, < 3 hours worth

- Bring: pink ParScore Scantron, pencil

- Don’t bring: blue-book, calculator, visible phone, electronic devices
Final Exam Details

- Focus of coverage: Equilibrium (16), Monopoly (24,25), Oligopoly (27), Exchange/General Eq. (31), Externalities (34), Public Goods (36)
- For the most part: only cumulative to the extent that new material builds on old
- How to study: do workouts/quizzes/practice problems, come to OH with questions
- Next Thursday’s class: review/synthesis. Will revisit important topics/messages
- Grading: see syllabus
Common-Pool Resources and Public Goods

What do these goods/resources have in common?

- Fisheries
- (Public) freeways
- National Security
- Broadcast radio/tv
- Clean air
- National parks

If *anyone* has access to the resource or can consume the good, then *everyone* can. E.g. you can’t prevent someone from breathing air or receiving radio waves.
Public Resources and Public Goods

What do these goods/resources have in common?

- Fisheries
- (Public) freeways
- National Security
- Broadcast radio/tv
- Clean air
- National parks

We call these types of goods **non-excludable** because all consumers can consume them.
Some of these goods are like ‘regular’ goods in that one person’s consumption detracts from others’ use.

E.g. fisheries can be overfished, public pastures can be overgrazed, freeways can be congested.

These types of goods are **rival** in consumption.

Goods that are non-excludable, yet rival in consumption are known as commons, or common-pool resources.
Common-Pool Resources

- Problem: property rights are not well defined
- *The Tragedy of the Commons* occurs when people share the same resource without well-defined property rights
- Individuals don’t take into account the fact that their use of the resource detracts from others’ consumption
- This leads to overuse of the resource
Common-Pool Resources: Example

- All people in a village graze cows in a common field
- It costs $a = 10$ to buy a cow and it’s only value is the milk it produces
- With $c$ cows grazing on the field, total value of their milk is $f(c) = 100\sqrt{c}$.
- Milk per cow:
  \[
  \frac{f(c)}{c} = \frac{100\sqrt{c}}{c} = \frac{100}{\sqrt{c}}
  \]
- Nobody owns the land—entry is not restricted

*How many cows will and should the village raise?*
Common-Pool Resources: Example

How many cows *will* the village raise? (Competitive Outcome)

- Each villager will buy and graze a cow whenever she can make a profit by doing so.
- Profit from owning a cow, given $c$ cows on the field:

$$\pi = \frac{f(c)}{c} - a = \frac{100}{\sqrt{c}} - 10$$

- As long as buying a cow is profitable, someone will go ahead and buy another cow.
- I.e. stop buying cows when profit $\pi$ is zero.

$$\frac{100}{\sqrt{c^*}} = 10$$

- Average product = average cost
- $c^* = 100$ cows in equilibrium
- Total net-value of milk is zero!
Common-Pool Resources: Example

How many cows *should* the village raise? (Optimal Outcome)

- A “social planner” would maximize the total net-value ($\Pi$) of raising cows:

$$\max_c c \frac{f(c)}{c} - ac = \max_c f(c) - ac = \max_c 100 \sqrt{c} - 10c$$

- Optimality condition: $\frac{\partial \Pi}{\partial c} = 0$
- $100 \left( \frac{1}{2} \right) \frac{1}{\sqrt{c^p}} = 10$
- Marginal product = marginal cost
- $c^p = 25$
- Total net-value of milk is

$$100 \sqrt{c^p} - 10c^p = 100 \sqrt{25} - 10 \cdot 25 = 250$$
Common-Pool Resources: Example

- Marginal product = marginal cost: maximizes total profit
- Average product = average cost: eke out last bit of profit

### Milk

\[ p_c = f'(c^p) \]

\[ f(c^p) \]

\[ f(c^*) = \frac{f(c^*)}{c^*} = p_c \]
The Tragedy of the Commons

- The commons are overgrazed—tragedically

- A villager increases her profit by adding a cow, but lowers the profit of everyone else (and the profitability of her other cows)

- She doesn’t internalize the cost her cow imposes on the rest of the village

- Examples: over-fishing, over-logging, over-use of parks, traffic congestion
Public Resources and Public Goods

Recall our list of some **non-excludable** goods.

- Fisheries
- (Public) freeways
- National Security
- Broadcast radio/tv
- Clean air
- National parks

Some of these, e.g. fisheries we labeled **rival** because one person’s use detracts from that of others.
Public Resources and Public Goods

Recall our list of some **non-excludable** goods.

- Fisheries
- (Public) freeways
- National Security
- Broadcast radio/tv
- Clean air
- National parks

For others, e.g. clean air, radio waves, this is not the case.
Recall our list of some non-excludable goods.

- Fisheries
- (Public) freeways
- National Security
- Broadcast radio/tv
- Clean air
- National parks

We call such goods non-rival because each consumer can consume all of the good, without reducing it’s availability/quality to others.
Public Goods

- A good that is both **non-excludable** and **non-rival** is called a (pure) public good.
- Public good users care little about who else uses it.
- Knowing this, individuals have an incentive to free-ride, relying on others to provide (enough of) the good.
- Because of this, public goods are under-provided.
Public Goods: Examples

- National Security
- Broadcast radio/tv
- Clean air
- National parks
- Road and highways (disregarding congestion)
Public Goods

Key questions:

- When should public goods be provided and how much?
- When will they actually be provided and how much?
- How can we get people to truthfully reveal their willingness to pay for a public good?
When *should* a public good be provided?

- Suppose it costs $c$ to provide the good
- Two consumers, $A$ and $B$
- Have reservation prices $r_A$, $r_B$
- If their payments (to provide the good) are $g_A$ and $g_B$...
- They need $g_A + g_B \geq c$ to provide the good
When *should* a public good be provided?

- For the payments to be individually rational, we need $g_A \leq r_A$ and $g_B \leq r_B$.
- If $r_A + r_B > c$, then they can provide the good without anyone paying more than his or her reservation price.
- In other words, $r_A + r_B > c$ means that it is Pareto-improving, or efficient, to supply the good.
Providing Public Goods

When *will* a public good be provided privately?

- Suppose $r_A > c$ and $r_B < c$
- Then $A$ would supply the good even if $B$ contributes nothing
- Free-riding: $B$ enjoys the good for free
When *will* a public good be provided privately?

- Now suppose $r_A < c$ and $r_B < c$

- Then neither will supply the good alone

- Yet, if $r_A + r_B > c$, it is Pareto-improving to supply it

- $A$ and $B$ may try to free-ride on each other, causing no good to be supplied
Let’s take a closer look at free-riding, and how it may be overcome

- Suppose $A$ and $B$ each have just two actions: individually supply a public good, or not
- Cost of supply $c = 100$
- $A$ values the good at 80
- $B$ values the good at 65
- $80 + 65 > 100$, so supplying the good is Pareto-improving
Free-Riding

<table>
<thead>
<tr>
<th></th>
<th>Buy</th>
<th>Don’t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy</td>
<td>-20, -35</td>
<td>-20, 65</td>
</tr>
<tr>
<td>Don’t</td>
<td>100, -35</td>
<td>0, 0</td>
</tr>
</tbody>
</table>

- What are the NE?
- (Don’t buy, Don’t buy) is the unique NE, and it is inefficient.
Free-Riding

How can we overcome this problem?

- **Possible solution:** let $A$ and $B$ make partial contributions to supplying the good

- E.g. $A$ contributes 60 and $B$ contributes 40

- $A$’s payoff from the good if contributes is $20 > 0$

- $B$’s payoff from the good if contributes is $25 > 0$
Free-Riding

New game:

<table>
<thead>
<tr>
<th></th>
<th>Contribute</th>
<th>Don’t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribute</td>
<td>20, 25</td>
<td>−60, 0</td>
</tr>
<tr>
<td>Don’t</td>
<td>0, −40</td>
<td>0, 0</td>
</tr>
</tbody>
</table>

- What are the NE?
- Both (Contribute, Contribute) and (Don’t, Don’t) are NE.
Free-Riding

- Allowing partial contributions makes possible the supply of a public good when no individual will supply the good alone.
- But what contribution scheme is best?
- Also, free-riding can persist even with contributions.