Collective action

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① <u>Nonexcludable</u>: A Person who has not Contributed & incurred a cost cannot be Prevented from enjoying the benefits.

② <u>Nonrival</u>: No Person's benefits are diminished by the fact that someone else is also enjoying the benefits.

A project with Properties ① & ② is a pure Public good Project.

e.g. Public infrastructure.

e.g. 2 farmer Irrigation Project.

Cost = $C(n)$ ← # of People involved e.g. $C(1) = 7$ $C(2) = 4$ ← Cost per farmer

Benefits = $B(n)$ $B(1) = 6$ $B(2) = 8$

$P(n)$ = Payoff = $B(n) - C(n)$

		II: Build	II: Not
I	Build	4,4	(-1),6
I	Not	6,(-1)	0,0

6−7 = −1

<u>Not building</u> is the dominant Strategy. Same as Hawk Strategy in PD.

Social optimum is (build, build) outcome.

<u>free rider</u>: it is best to reap benefits of other player

alternative example: $C(1) = 4$, $C(2) = 3$ then

		II: B	II: Not
I	B	5,5	(2,6)°
I	Not	(6,2)°	0,0

° NE

Social optima = 10 > 2+6

Large groups

Consider N farmers $C(n) = $ Cost $B(n) = $ Benefit

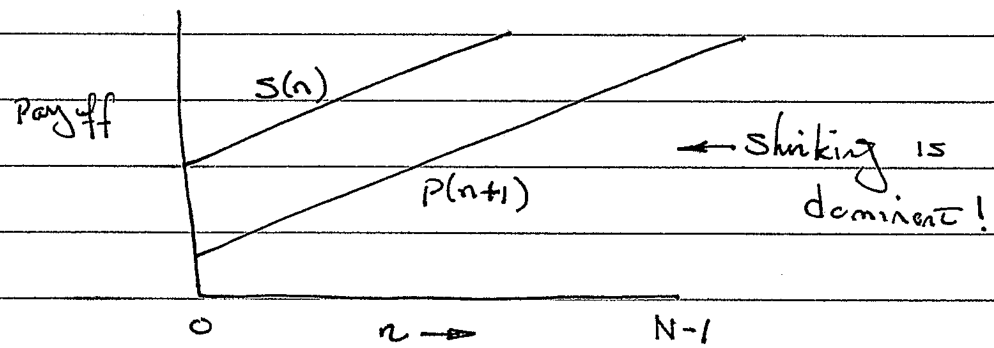
$P(n) = B(n) - C(n) = $ Payoff for a Participant

$S(n) = B(n) = $ shirker Benefit

Consider N−1 others … → n Participants / $(N-1-n)$ shirkers

If $P(n+1) > S(n) \rightarrow$ Participate

If $P(n+1) < S(n) \rightarrow$ Shirk



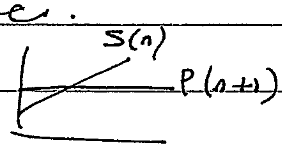
$T(n) = $ Social Payoff $= n \cdot P(n) + (N-n)\,S(n)$

$= N\,S(n) - n\left[S(n) - P(n)\right].$

We seek value of n to maximize $T(n)$ for social optimum

Society benefits most iff all Participated.

Nash Equil iff $S(n)$ & $P(n+1)$ intersect.



Externality

E.g. 8000 Commuters driving from city to suburb

Expressway (P), Local Roads (S)

15 min uncongested ↑ 45 min regardless of volume

∀ driver increases volume for all drivers by 0.005 min ($\sim \frac{1}{4}$ second)

Payoff = minutes of time saved from one hour.

For local roads: ∀n $S(n) = 60 - 45 = 15$ min invariant on n.

For Expressway: $P(n) = \begin{cases} 60 - 15 = 45 & \text{for } n = \phi \\ 45 - .005n & \text{depends on } n. \end{cases}$

E.g. if 4000 cars on expressway, $n = 4000$; $15 \times 4000 \times .005 = 35$ min Commute Time

$$P(4000) = 60 - 35 = 25 \text{ min}$$

If one person (you) switch from local to expressway, ∃ 4001 cars

Commute Time $= 4001 \times .005 = 35.005$ min

$P(n+1) = P(4001) = 24.995$ min

$P(n+1) > S(n)$ } ⟹ Private incentive to switch

$24.995 > 15$

marginal private gain $= P(n+1) - S(n) = 9.995°$ min

Effect For others: $P(4001) - P(4000) = -.005$ For expressway drivers → $4000 \times -.005 = -20^{+}$ minutes

$P(4001) - S(4000) = 0$ For local drivers.

Externality (Spillover Effect) = when one person's action affects others.

Marginal Social gain = marginal private gain + marginal spillover effect on society. gain might be positive or negative

marginal social gain $= (4000 \times -.005)^{+} + 9.995° = -10.005$

negative impact

General Case

Let $T(n)$ = Social payoff function

n = # of people choosing P. So $N-n$ choose S

Let n people choose P, one person switches from S to P,

$$T(n+1) = (n+1)\cdot P(n+1) + [N-(n+1)]\,S(n+1)$$

$$T(n+1) - T(n) = \big(P(n+1) - S(n)\big) + n\,[P(n+1) - P(n)] + [N-(n+1)]\,[S(n+1) - S(n)]$$

- $P(n+1) - S(n)$: marginal private gain of switcher
- $S(n+1)$: loss of local driver
- $n\,[P(n+1) - P(n)] + [N-(n+1)]\,[S(n+1) - S(n)]$: marginal spillover effect on others

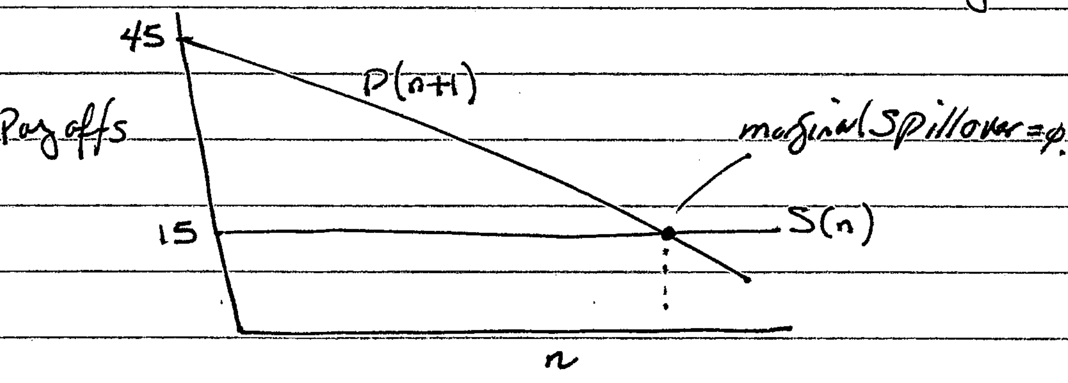
If n is very large we will not look at one person difference but a rate of change $T'(n)\,dn$

Since $T(n) = n\cdot P(n) + (N-n)\,S(n)$.

$$T'(n) = P(n) + n\,P'(n) - S(n) + (N-n)\,S'(n)$$

$$= [P(n) - S(n)] + n\,P'(n) + (N-n)\,S'(n).$$

- whole expression: marginal social gain
- $P(n) - S(n)$: marginal private gain



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<u>internalizing externality</u>: making each person pay for social externalities, e.g., taxes, tolls