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This week, you have learnt

- Monopolistic Competition
  - What are the characteristics of the monopolistically competitive market? – Product characteristic, pricing and market power, profit, entry and exit, long-run equilibrium
- Oligopoly and Game Theory
  - A game (in ECON 101) consists of Players, Actions, Payoffs (PAP) – how to write a payoff table? How to solve the game? What is the equilibrium?
  - Dominant strategy: Action A is a *dominant strategy* if "no matter what my opponent does, I'm always better off doing Action A"
- Externalities
  - What is positive externality? What is negative externality? How do they enter into the costs or benefits?
  - Marginal Private Cost vs. Marginal Social Cost, Marginal Private Benefit vs. Marginal Social Benefit
- Public Goods
  - What is vertical summation? How to do vertical summation?
  - Why do public goods admit vertical summation?
  - Classification of private goods, public goods, common resources and club goods according to exclusivity and rivalry
- Common Resources
  - How do people think when they use common resources? People think on the average but the society is better off as a whole if the marginal result is realized.

Exercises

1. (*Game Theory*) Let us remind the relics of cold war. Consider the game of arms race between two countries: Country A and Country B. Both countries can decide to build "Nuclear" or "Non-nuclear" weapons. If both countries decide to build nuclear weapons, they receive the payoff of 0, as they are wastefully utilizing the resources. If both countries decide not to build nuclear weapons, both receive the payoff of 2, as they employ their resources somewhere else more efficiently. If one country has the nuclear weapon but the other has not, the country that has the nuclear weapon is more powerful and receives the payoff of 4, while the country that has no nuclear weapon is prone to being attacked and receives the payoff of -4.
   a. From the story above, construct the payoff table. Make sure you describe every elements of the game in the table.

		Country B	
		Nuclear	*Non-nuclear*
Country A	*Nuclear*	*0 , 0*	*4 , -4*
	Non-nuclear	*-4 , 4*	*2 , 2*

   b. Are there dominant strategies for Country A and Country B? Explain.
   Country A: No matter what Country B does, A is always better off with Nuclear.
   Country B: No matter what Country A does, B is always better off with Nuclear.
   So dominant strategies for Country A and Country B are {Nuclear, Nuclear}
   c. What is the equilibrium outcome of the game? Make sure you describe the equilibrium strategies and payoffs of both players.

The equilibrium outcome of the game is both Country A and Country B build Nuclear weapon; both receive the payoff of 0.

d. Suppose Country A promises to build "Non-nuclear" weapon, do you think this is a believable promise? Why or why not? What about Country B?
The promise is not believable. Since Country A will always have incentive to deviate (cheat) from what she has promised. The same applies to Country B.

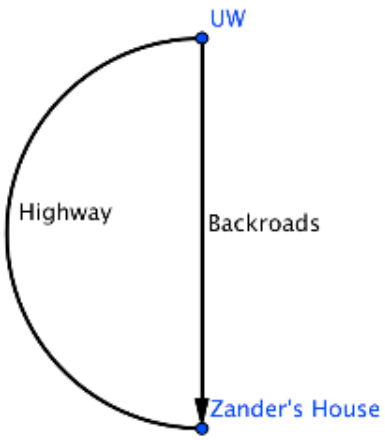
e. Suppose the game structure is changed to the following: let Country A moves first and she has decided that, regardless of what Country B would do, she would build the "Nuclear" weapon. What should Country B do and why?
Taking into account that Country A will choose to build Nuclear weapon, Country B will build the nuclear weapon as 0 > - 4.

2. (*Externalities*) The production of fluorescent lamp involves hazardous Mercury (Hg), which is dumped into the river after the production process. Firms have marginal (private) cost of producing fluorescent lamp given by $MPC = 30 + Q$. For each lamp produced, the mercury cleanup in the river costs $30. The firms face the demand for fluorescent lamp given by $P = 480 - 2Q$.
   a. Is the externality negative or positive? Give the equation for marginal social cost.
   The externality is negative, which is a burden to the society, this shifts the MPC up. The equation for marginal social cost is MSC = MPC + Negative Externality = 60 + Q.
   b. Without consideration of societal consequence, what is the market equilibrium quantity that firms produce? At what price?
   Equating MPC to P to receive 480 – 2Q = 30 + Q, so Q = 150 and P = 180.
   c. If firms think about the societal consequence, what is the socially optimal quantity that firms produce? At what price?
   Equating MSC to P to receive 480 – 2Q = 60 + Q, so $Q_{so} = 140$ and $P_{so} = 200$.
   d. From b., is the market equilibrium resulting in over-production or under-production? What is the deadweight loss resulting from negligence of firm to the society?
   The market equilibrium results in over-production by 10 units. The deadweight loss from over-production is ½ × (150 – 140) × (210 – 180) = 150.
   e. Observing the devastating result from firms neglecting the social cost, the government wishes to step in and imposes the regulation so that firms produce at the socially optimal quantity. Design a regulation to dis-incentivize producers from the market outcome.
   Impose a per-unit tax by $30 to make the producer realize the MSC.

3. (*Externalities*) You are hosting a post-game party at Camp Randall. The marginal cost to you in hosting the party is given by $MPC = 30 + 3Q$. The party makes everyone happy, so the externality caused by the party is given by $2Q$. Write down the marginal social cost. Is Beer-pong under-supplied or over-supplied compared to socially optimal outcome? How can the government incentivize you to host socially optimal outcome?
   The externality is positive, which is beneficial to the society, this shifts the MPC down. Hence, the marginal social cost is MSC = MPC – Positive Externality = 30 + Q.
   The market arrangement (by buyers and sellers realizing MPC) under-supplies compared to socially optimal quantity of party. The government can incentivize by subsidizing the party.

4. (*Public Goods*) Consider the problem of dorm room toilet used by two roommates: Alice and Bob. Alice has the valuation towards the cleanliness of toilet as $P = 10 - Q$, where Q is the cleanliness score and P is the per-unit price of cleanliness, i.e. time-value in cleaning. Bob has the valuation of $P = 14 - Q$. The marginal cost of cleaning the toilet is $MC = 8$.
   a. If Alice decides to free-ride Bob in cleaning, what would be the market outcome?
      The demand for cleanliness of Bob is active, setting $P = MC$ gives $14 - Q = 8$, so $Q = 6$
   b. Find the total demand for toilet cleanliness. What is the socially optimal cleanliness? At what price?
      The total demand is $P = 24 - 2Q$, when $0 \le Q \le 10$ and $P = 14 - Q$, when $10 \le Q \le 14$. Setting $P = MC$ gives $Q_{so} = 8$ and $P_{so} = 8$.
   c. Compare the answers from a. and b., is there the problem of under-provision of cleanliness?
      Under free riding, the problem of under-provision of public goods exists.
   d. What is the total consumer surplus when there is no free riding?
      Consumer surplus is obtained from $\frac{1}{2} \times (24 - 8) \times 8 = 64$.
   e. What should be the scheme of time-value contributed by Alice and Bob?
      At $Q_{so} = 8$, Alice values the cleanliness at $P = 2$, while Bob values at $P = 6$.

5. (*Common Resources*) After the semester is over, Aiday, Gueyon, Moheb, and Wooyoung each plan to travel from UW to Zander's house for a party. The four of them will each drive separately and must choose to travel one of two routes. They can take the Backroads, a direct, but more easily congested route. Or, they can take the Highway, which is a longer route, but less congested. The problem can be summarized in the figure.



   Let X and Y be the number of travelers on the Highway and on Backroads, respectively.
   The total number of travelers can be written as $X + Y = 4$.
   The total travel time of all four persons, in minutes, is given by $30X + 15Y^2$.
   The average time on the Highway per person is 30 minutes.
   The average time on the Backroads per person is $15Y$ minutes.
   The marginal time on the Highway per person is 30 minutes.
   The marginal time on the Backroads is $30Y$ minutes.
   a. If people are freely allowed to choose their route, how many people will choose the Highway? How many will choose the Backroads? How long does it take per person on each route? What is the total travel time of all four persons?
      People think on average; hence, they will equate the average quantities. (Imagine you are travelling from point A to B with two possible routes, which road will you choose? You will go to the route that gets there faster between the two. So do other people who will switch between the two routes until the time it takes on two routes are equal.)

Equating the averages 30 = 15Y gives Y = 2 and X = 4 – Y = 2. So, 2 persons will choose each route. The Highway takes 30 minutes, and the Backroads takes 15 x 2 = 30 minutes. The total travel time of all four persons is 120 minutes.

b. What is the socially optimal number of travelers on each route? How long does it take on each route?
Social optimality requires marginal to be equal. (Since each road is not the same, should you put more cars on the bad and easily congested road? No! You should put less car!)
Equating the marginal 30 = 30Y gives Y = 1 and X = 4 – Y = 3. Hence, only 1 person should be put on Backroads and the other 3 persons on Highway. The Highway takes 30 minutes and the Backroads takes 15 minutes. The total travel time of all four persons is 105 minutes.

THE END
Good Luck for Your Final Exam