Public economics (Prof. Parisi, academic year 2023-24)

Exercises: externalities.

1. Consider a firm producing one good in a perfectly competitive market and a negative externality (pollution). Demand is given by the function $p = 20 - q$, total cost by the function $CT = 100 + q^2$, whereas the (marginal) externality is fixed, $e = 2$. With the help of a graph, calculate:
   a) the market (private) quantity;
   b) the socially optimal quantity. Illustrate graphically how the social optimum can be obtained with the application of a Pigouvian tax and calculate the tax revenue.

   Results: (a) $q=6,6$; (b) $q=6$. Tax revenue=12.

2. Refer again to the previous exercise. Show graphically the effects of a specific tax on output (pollution) to correct for the negative externality. Calculate:
   a) tax revenue;
   b) the externality borne by the society before and after the tax.

   Results: (a) Tax revenue=12; (b) e=13,2; e=12

3. Consider exercise 1 but now assume that the negative (marginal) externality increases over the quantity: $e = q$. Calculate:
   a) the market (private) quantity;
   b) the socially optimal quantity.

   Results: (a) $q=6,6$, (b) $q=5$.

4. In relation to the previous exercise assume the Government introduces a specific (Pigouvian) tax on output (pollution) to correct for the negative externality. Show graphically the effects of the tax and calculate:
   a) tax revenue;
   b) the total externality borne by the society before and after the tax.

   Results: (a) tax revenue=25; (b) e=21,7; e=12,5.

5. In relation to the previous exercise discuss why it is not optimal to eliminate the negative externality and the practical difficulties in implementing a Pigouvian tax. Discussion in class.

6. A competitive industry releases one unit of waste into the atmosphere for each unit of the product. The inverse demand function is given by $p = 20 - q$, the private marginal cost by $MC_p = 2 + q$, the marginal external cost by $e = 0,5q$. Calculate:
   a) the market equilibrium price and quantity for the product;
   b) the equilibrium quantity and price at the social optimum.
   Represent the results graphically.

   Results: (a) $q=9$, $p=11$; (b) $q=7,2$, $p=12,8$.

7. Following the previous exercise now assume the Government imposes an emission tax of t Euros per unit of emissions. Calculate how large must be the tax if the market is to produce the socially efficient quantity and tax revenue.
Moreover, represent the effects of the introduction of the tax graphically.

   Results: t=3,6; tax revenue=25,9

8. We now consider the effects of a negative consumption externality. Student A smokes but his office mate B hates smoking. A and B have the following utility functions. $U^A = 100 + 10z - 0,1z^2$ and $U^B = 100 - 10z$, where z is the number of cigarettes smoked. Determine:
   a) the number if cigarettes smoked by A when the externality on B is ignored (hint: maximize the utility function of A);
   b) the socially optimal level of cigarettes that should be smoked by A (hint: maximize the joint utility function);

   Results: (a) z=50; (b) z=0.

9. Following the previous exercise calculate the optimal Pigouvian tax needed to reach the social optimum. Hint: maximize the utility function of A including the effect of the tax (which is a cost for student A).

   Results: t=10.

10. Refer back to the consumption externality and discuss in which circumstances the negative externality can be corrected by a private agreement (Coase theorem) between student A and student B. Are such agreements likely to work in practices?

11. Discuss the following statements.
    a) If your consumption of cigarettes produces negative externalities for your partner (which you ignore), then you are consuming more cigarettes than is Pareto-efficient.
    b) It is generally efficient to set and emission standard allowing zero pollution.
    c) Since pollution is bad, it would be socially optimal to prohibit the use of any production process that creates pollution.
    d) A tax on cigarettes induces the market for cigarettes to perform more efficiently.
    e) A ban on smoking is necessarily efficient.
    f) A competitive market with a positive externality produces less output than is efficient.
    g) Education might produce positive externalities and should be subsidized by the government.