

**ENVIRONMENTAL ECONOMICS (IKT5131)**  
**Assignment #3 (April 13, 2021)**  
**Assoc. Prof. Tunç Durmaz**

**DUE DATE:** 12:59, Apr 20, 2021/Tue. **Send** your assignment by email to mailbox@tuncdurmaz.com. The **format** of the file name is “Asg3\_StudentID\_NameSurname”

**Introduction to the theory of environmental policy**

1. Suppose that there are two firms ( $j = 1, 2$ ) in an industry. The abatement cost and damage functions are

$$C_j(e_j) = \begin{cases} (k_j - b_j e_j)^2 / 2b_j, & \text{for all } e_j \leq k_j / b_j, \\ 0 & \text{otherwise,} \end{cases} \quad (1)$$

where  $k_j, b_j > 0$ . The damage function is

$$D(E) = \frac{d}{2} E^2,$$

where  $d > 0$  and  $E \equiv e_1 + e_2$ .

- a- Calculate the marginal abatement cost curves of the firms.
- b- Calculate the socially optimal allocation and level of pollution. Assume that the environmental authority aims at establishing an aggregate emissions level of  $E = 16$  units.

In the following, let  $k_1 = 10, b_1 = 1, k_2 = 12,$  and  $b_2 = 0.5$

- c- What is the unregulated market emission level for each firm?
- d- What is each firm's abatement and the aggregate abatement costs if the government requires  $e_j = 8$  for each firm?
- e- What is the tax rate the environmental authority has to charge to achieve the target of  $E = 16$ ? What is each firm's abatement cost and the aggregate abatement cost if the authority charges this tax rate? What is each firm's tax payment?
- f- Suppose that the authority issues tradable emissions permits where each firm is grandfathered an initial endowment of 8 units (as well as permits as one permit allows for one unit of emission). If the permit market is competitive, that is the market price for permits? How many does each firm buy or sell? What is each firm's total cost (i.e., abatement cost plus/net of permit expenses/revenues)?
- g- Now suppose that the authority auctions off 16 permits. What is the competitive auction price? What is each firm's total cost? What are government revenues?
- h- What would be the per unit subsidy needed to achieve a total of 16 units of emission (i.e.,  $E = 16$ )? What baseline emission level, below which the firms receive a subsidy, should the authority set? What is each firm's total cost? What is the expenditure of the authority/government under the subsidy policy?
- i- Summarize the outcomes of each policy in a table under the following headings: Total abatement cost; Total industry cost; Government revenue (or expense)

2. In this problem, we are going to focus on the benefits of two individuals, and make use of quadratic utility functions. Suppose that the utility functions of the two individuals A and B are as follows:

$$U_A(x) = x - \alpha x^2/2,$$
$$U_B(x, y) = y - \beta y^2/2 - \gamma xy, \quad \alpha, \beta, \gamma > 0.$$

Hence, A's consumption of  $x$  has an external effect on individual B's consumption (e.g., noise pollution caused by loud music or smoke from neighbor's backyard barbecue). For simplicity, assume that  $x$  and the pollution (noise, smoke, etc.) it causes is one-on-one. Answer the following questions:

- a- Calculate the non-regulated level of  $x$  if the polluter has the right to pollute.
- b- Calculate the level of  $x$  under the polluter pays principle.
- c- Calculate the efficient solution.
- d- Determine the payoffs for both parties under no regulation and the polluter pays principle for  $\alpha = 2, \beta = 2$  and  $\gamma = 1$ .
- e- Assume that there are transaction costs of  $Tr=1/240$ . Which contract will individual B suggest to A if individual A has the right to pollute and individual B has to pay the transaction costs? What are the final payoffs to both parties?