Economics 428   Gallant
Homework 7   Fall 2021
November 11

During class on the date shown in the "Detailed Calendar" at the course web site, we will have an in-class permit trading exercise. As preparation for that exercise, please review the information in Section 1 and answer the questions in Sections 2 through 5.

1 Market Structure

- **Participants:** The firms are assigned a number. Odd numbered firms differ from even numbered firms in their abatement costs. Otherwise firms are the same.

- **Output market:** The firms operate in the same country. Each firm produces the same product. Total home country production is small relative to global production so the firms take the market price of 40 per unit of output as given.

- **Production:** Each firm's production cost associated with Q units of output is $C(Q) = Q$ up to a capacity of 20 (all firms have the same cost function and same capacity constraint). Marginal cost is constant at 1.

- **Pollution:** Each unit of output produces one unit of pollution.

- **Pollution abatement:** A firm can reduce its emissions by investing in pollution abatement. For odd-numbered firms, the cost of reducing pollution by A units is $C_{odd}^A(A) = 3A^2$. For even-numbered firms, the cost is $C_{even}^A(A) = A^2$. Thus, odd-numbered firms have relatively higher abatement costs than even-numbered firms. Marginal abatement costs are $6A$ for odd-numbered firms and $2A$ for even-numbered firms.

- **Simplification:** There are the same number of odd and even firms. Thus, you can assume that there are only two firms, Firm 1 and Firm 2, to answer the questions that follow.

2   No regulation

Suppose there is no environmental regulation. What quantity will each firm produce? How much will each firm choose to abate? What will be the profit of each firm?

3   Emission cap

Suppose the government of the firms' home country institutes a cap on emissions of 10 units, with each unit of pollution in excess of this limit fined at a rate of 70/unit. A firm's pollution associated with output Q is $Q - A$. To avoid the fine, a firm must have $Q - A \leq 10$. What quantity will each firm produce? How much will each firm choose to abate? What will be the profit of each firm?

4   Cap and Trade

Consider a cap-and-trade policy whereby the government of the firms' home country issues tradable emission permits to the firms. Each firm is issued 10 permits. Each permit allows a firm to emit one unit of pollution. Firm's can buy or sell permits. A firm's production must equal permits on hand after trading plus abatement. A firm is fined \$70 for each unit of production that exceeds permits on hand plus abatement.

Consider five different production choices

1. $Q_1 = 14, Q_2 = 10$

2. $Q_1 = 10, Q_2 = 14$

3. $Q_1 = 16, Q_2 = 20$

4. $Q_1 = 20, Q_2 = 16$

5. $Q_1 = 20, Q_2 = 20$

 For each of the five production choices above answer the following

1. Will Firm 2 sell to Firm 1 or will Firm 1 sell to Firm 2?

2. How many permits will be sold?

3. What will be the permit price?

4. How much will each firm choose to abate?

5. What will be the profit of each firm?

5   Summary

Fill in the following table. What quantities will the two firms choose under cap-and-trade. Why does a cap-and-trade policy result in more total output, more total abatement, and more total profit than an emission cap policy?

Senario	Q_1	Q_2	A_1	A_2	Π_1	Π_2	P_x
No Regulation							na
Emission Cap							na
Cap and Trade	14	10					
Cap and Trade	10	14					
Cap and Trade	16	20					
Cap and Trade	20	16					
Cap and Trade	20	20					