

Problem Set 5

Cap and Trade and Pollution Taxes

- 1.
- a. Imagine there are only two firms in Swarthmore. One is Kuperberg's Kars, a large car manufacturer, and the other is Magenheim's Mops, a cleaning supplies manufacturer. Each firm pollutes the air with 5 units of "Essie Mae's Emissions". Prof. Art Carr of the Swarthmore College's Engineering Department has conducted a study and determined that the total costs (TCR) of reducing emissions for each firm are as shown in Table 1. Find the marginal cost (MCR) of emission reduction for each firm by filling in Table 1. Draw the two firms' MCR of emissions in a graph.

Table 1
Individual Firms

Essie Emissions Reduction	Kuperberg's Kars TCR of Reduction (\$)	Kuperberg's Kars MCR of Reduction	Magenheim's Mops TCR of Reduction (\$)	Magenheim's Mops MCR of Reduction
0	0	---	0	---
1	4		2	
2	12		6	
3	24		12	
4	40		20	
5	60		30	

- b. Note that there are 10 units of emissions in Swarthmore. Table 2 shows the total social cost of reduction of these 10 units by adding the costs of the two firms together. (It is a bit tricky to obtain this total cost for the two firms combined but Table 2 is consistent with Table 1. Extra credit: can you figure out how table 2's total social cost of reduction is derived from the two firms' costs in Table 1?). Table 2 also shows the total social benefit of reducing emissions from the improved air quality, as also found by Prof. Carr's study. Complete Table 2.

Table 2
Society as a whole (Swarthmore)

Essie Emissions Reduction	Total Social Cost of Reduction for the two firms (TCR) (\$)	Social Marginal Cost of Reduction	Total Social Benefit of Reduction (TBR) (\$)	Social Marginal Benefit of Reduction	Total Net Social Benefit (TBR-TCR)
1	2		19		
2	6		36		
3	10		51		
4	16		64		
5	24		75		
6	32		84		
7	42		91		
8	54		96		
9	70		99		
10	90		100		

- c. Find the socially optimal total amount of emissions reduction in Swarthmore. Explain why this is optimal. What is the total net social benefit from reducing emissions to this level? Show the optimal level of reduction on a diagram that plots social marginal costs of reduction and social marginal benefits.
2. Assume that firms do not gain any social benefit of emissions reduction and have no incentive to reduce. Therefore, without government intervention, neither firm will spend the money necessary to reduce emissions to the optimal amount. The Swarthmore Economics Department has pointed out that this is a market failure and has proposed various alternative policies: taxation of emissions, capping emissions, cap and trade, and cap and trade with auction. Consider first a tax on emissions to correct this market failure.
 - a. What is the socially optimal tax (per unit of emissions) that should be levied on the firms?
 - b. At this tax level, what will be the total amount of emissions reduction? What will be the tax revenue?
 - c. What is the emissions reduction undertaken by each firm? Which firm reduced emissions more and why?
 3. An alternative to a tax is an emissions cap on each firm. The cap is the maximum allowable pollution. Assume that the Swarthmore borough wants the market to reduce emissions by the total optimal amount found in question 1, and then divides the emissions cap equally between the two firms, i.e., it grants equal pollution “rights” to each of the two firms in the amount of the cap. Note that if X is the desired reduction found in question 1, and with 10 units of pollution before reduction X then:

$$\text{Total market CAP} = 10 - X.$$
 - a. What will be the cap on each firm?
 - b. Which method (tax or cap) yields a lower total cost of reduction? Which method is inefficient?
 4. Now suppose the town imposes the same cap as in question 3, but now allows the firms to trade emissions rights.
 - a. Which firm will be willing to buy credits and which will be willing to sell? Why?
 - b. What will be the quantity of emission credits bought and sold and what is the equilibrium price of each emissions credit (allows a firm to produce one unit of Essie Mae’s emissions)?
 - c. Does the price of an emissions credit equal the tax in question 2? Why or why not?
 5. If the town auctions the number of emission permits from question 1 to the two firms instead of providing them for free,
 - a. How many permits will each firm buy and at what price? Is this preferable to providing pollution rights to firms for free?
 - b. How much revenue will the auction raise?
 - c. How does this revenue compare to the tax revenue obtained in question 2?