ECON4910, Spring 2010

Seminar 6

Problem 1

A large group of countries is considering an international environmental agreement to reduce the emissions of a transboundary pollutant that has the property that it is the sum of emissions from all of the countries that effects the environment in each country. The countries agree that the sum of emissions should be reduced to 50% of the pre-agreement sum of emissions. Four types of international agreements are proposed

1. Each country is required to cut back its emissions to 50% of its pre-agreement level

2. Countries are given quotas proportionally to their pre-agreement emission levels. The sum of quotas is 50% of the sum of pre-agreement emissions. Quotas may be traded among countries, i.e. a country can sell/buy quotas to/from another country if both countries reach an agreement on such a trade.

3. Countries are given quotas proportionally to their population level. Otherwise this agreement is the same as the one above.

4. Each country is required to have a domestic emission tax. The tax rate is the same for all countries, and is set through the international agreement at a level that is so high that the sum of emissions from all countries is 50% of the sum of pre-agreement emissions.

Discuss similarities and differences between these four alternative agreements.

Problem 2

Consider the following two-stage game: In stage 1 each of N identical countries decides whether or not to join a coalition of countries. In stage 2 both the coalition members and the outsiders determine their emission levels. In the second stage, the coalition maximizes the payoff to each of its members, and each outsider maximizes its own payoff.

Emissions are either 0 or 1. The cost to a country of reducing its emissions from 1 to 0 is c. The environmental cost to each country is bE, where E is total emissions. Assume that $b < c < bN$.

1. Describe the outcome of this game.

2. Show how total emissions and total welfare depend on c.

3. Assume that each country has some disutility of being an outsider when there exists a coalition of emission abating countries, and that this disutility is larger the larger this coalition is. Let this feature be modeled by assuming that the payoff to an outsider that does not abate is $bn - \gamma n$, where $\gamma > 0$ and n is the number of abating countries in a coalition. How does this change in the model affect the outcome of the game?

Problem 3

Emissions to a lake from a sector of the economy are given by

$$x = E - a \tag{1}$$

where E is exogenous (and positive) and a is abatement. The abatement cost function is

$$c(a) = \frac{a^2}{2} \tag{2}$$

Emissions accumulate in the lake according to the differential equation

$$\dot{A} = x - \alpha A \tag{3}$$

where A is the stock of the pollutant in the lake and the depreciation parameter is positive.

The environmental damage cost is assumed to be given by the function

$$D(A) = \frac{bA^2}{2} \tag{4}$$

where b is a positive parameter.

The environmental regulator sets an emission tax in order to regulate the amount of emissions.

1. Derive the qualitative properties of the time paths of the optimal emission tax and the optimal emission rate.

2. Show how the long-run levels of the emission tax and the emission rate depend on the sizes of the parameters and b.

Assume that there is a possibility of cleaning the lake at a unit cost k per unit pollution reduction, so that the total cleaning cost is ky and (3) is replaced by

$$\dot{A} = x - y - \alpha A \tag{5}$$

where y must be non-negative.

3. Show how your answers to (1) and (2) are changed when (3) is replaced by (5).