Chapter 12 Public Goods and Global Climate Change

Homework 12.1. Now suppose we have a third consumer. Marginal benefits for the three consumers are as follows

$$MB_1 = 150 - A$$
$$MB_2 = 100 - 0.5A$$
$$MB_3 = 120 - A$$

12.1a. If MC = 70, what would be the individual optimal amounts of abatement?

12.1b. What would the total marginal benefit curve be?

12.1c. Where would the kinks be?

12.1d. What would be the social optimum?

12.1e. Now suppose the cost of CO_2 abatement is $TC = 50 + 0.5A^2$. What would be the social optimum?

Homework 12.2. Suppose that region 3 in Homework 12.1 is a region that benefits from global warming and they would lose from abatement. Let their benefit curve above be the costs they suffer from abatement of CO2. Thus, the relevant curves for the three regions are:

$$MB_1 = 150 - A$$
$$MB_2 = 100 - 0.5A$$
$$MC_3 = 120 - A$$

or the marginal benefits MB_3 are $-MC_3 = -120 + A$. What is the new social optimum under this scenario if CO_2 abatement costs are \$70 per ton?

Homework 12.3. Both costs and benefits of CO_2 abatement are uncertain. Suppose that you have the above two benefit scenarios but you also have three possible abatement cost scenarios. The first has probability 0.4 and the second has probability0.10 and the third has the remaining probability.

$$MC_1 = 10 + 0.1A$$
$$MC_2 = 20 + 0.15A$$
$$MC_3 = 30 + 0.2A$$

12.3a. What is the probability of cost scenario 3?

12.3b. What is the expected cost?

12.3c. If you maximize expected net benefits, what is the optimal level of abatement for this case?

Homework 12.4. Suppose we put some credence on Porter's hypothesis and that scenario 2 actually represents decreasing production costs resulting from abatement. We represent them as negative marginal costs of abatement. Thus, we write the three scenarios as

$$MC_1 = 10 + 0.1A$$
$$MC_2 = -20 - 0.15A$$
$$MC_3 = 30 + 0.2A.$$

12.4a. Using the same probabilities for the scenarios as in 12.3, what is the new expected marginal cost curve?

12.4b. If you maximize expected net benefits, what is the optimal level of abatement for this case?

Homework 12.5. Verify the above statement by two separate experiments.

12.5a. Recompute the costs when only the interest rate is changed to 20 %.

12.5b. Recompute the costs when only the price of electricity is changed to $0.05 per kilowatt hour.

12.5c. At what interest rate is the incandescent light cheaper?

Homework 12.6. Let the following represent the losses for our option choice that now includes adaptation

	GW	NGW
Do Nothing	1000	0
Mitigate	400	200
Adapt	150	200

Which choice is the one that minimaxes regrets?

Homework 12.7. What would you expect the following events to do to the value of the Euro. Support your answer with a diagram.

12.7a. Oil prices increase and Europe needs more foreign currency to import oil.

12.7b. As the European Economies strengthen, European interest rates increase.

12.7c. Increasing productivity in the U.S. lowers U.S. inflation.

12.7d. What do you expect increasing oil prices will do to the exchange rates for OPEC countries? Remember that oil is paid for using dollars?

Homework 12.8. There is a tendency for the prices of tradeable goods to converge towards each other differing only by transport cost.

    12.8a. Why do you think this would be?

    12.8b. Non-tradeable goods prices, however, may not converge. Thus, exchange rates may not truly represent the purchasing power of the two currencies within a given country. Exchange rates that represent the relative purchasing power of currencies are also computed and could be an alternative way of converting the GDP's from one currency to another. Such indexes are called purchasing power parity indexes. For one country find their exchange rate, their purchasing power parity index, their GDP, and their population. Which index suggests that they have a higher dollar GDP per capita? You can find most of these statistics in the CIA Factbook http://www.cia.gov/cia/publications/factbook/. Another good source of International Financial Statistics is the International Monetary Funds publication International Financial Statistics.

    show an example where PPP undervalues and one where PPP overvalues. Get a source of PPP

Exchange Rate (1998) for $1	Purchasing Power Parity Index (1999)	GDP (1998)	Population (1998)
7.92FF/$1.43=5.54FF/$	Couldn't find	8535.1/5.54 $1.53 trillion	58.85 million

Sources: IFS nov 2000

    12.8c. What are some of the other statistics you might find useful if you are considering a large energy investment in a foreign country?

Homework 12.9. The Economist Magazine is an excellent source of economic news. Reading this magazine as you are taking economics classes will give you practice in applying the analytical skills you are learning and help you better understand economics of the world around you and to make better economic decisions in your personal and professional life. Look through recent issues of the Economist and find one story relating to the economy and one relating to energy issues. Turn in copies of the articles along with a brief summary of each.

Homework 12.10. Coal emits 27.9 tons of carbon/billion BTU, gas emits 14.4 tons of carbon/billion BTU, and oil emits 23.9 tons of carbon/billion BTU.

12.10a. If a carbon tax (T) were passed of $0.50 per billion BTU on coal, what would be the carbon equivalent tax on oil and on gas? (Note Tcoal/Toil = Carbon coal/Carbon oil.)

12.10b. If all of the tax is passed on to consumers, what would be the percentage change in carbon emissions from the tax? To answer this question, find the most recent prices and consumption for oil, gas and coal at http://www.eia.doe.gov and use own price elasticities for coal, oil, and gas of -1.14, -0.81, and -1.32 that were found in the literature. You may assume that cross price elasticities are zero to make the problem easier. If you need to convert from physical units to BTUs you may use 1 barrel of oil = 5,800,000 BTUs, 1 short ton of coal = 22,500,000 BTUs and one thousand cubic feet of natural gas (typically abbreviated 1 mcf) = 1,000,000 BTUs.

Prices and consumption for coal, gas and oil:

1999	Oil	Gas	Coal
Price	$17/bbl $2.9k / billion BTU	$2 /mcf $2k / billion BTU	$32/ston $1.4k / billion BTU
Consumption	3,500 MTO	2,100 MTOE	2100 MTOE
BTU	140 billion BTU	85 billion BTU	85 billion BTU
$\mathfrak{m}$	-0.81	-1.32	-1.14

MTOE = Million Tonne Oil Equivalent

1 MTO = 7 bbl

Source: http://www.eia.doe.gov/ and http://www.bp.com

12.10c. If income growth in the U.S. averages 2.5% a year between the year of your last data (n) and 2012, income elasticities are 0.7, 0.8, and 1.1 for coal, oil, and natural gas, respectively, what BTU taxes would insure that the U.S. meetits target of a 7% reduction below 1990 carbon emissions levels by 2012?

12.10d. I suspect that the elasticities that I found and gave you in b are too elastic. If my suspicions are correct, would the above taxes cause more or less emissions reductions than you computed? Why or why not?

Homework 12.11. (contributed by Woo-Jin Yoon) Three neighboring firms are located in a highly polluted region (we assume that the responsibility for the pollution cannot be attributed to anyone of them specifically). The three small firms will benefit from pollution abatement; however, their benefits are not equal, for:

firm 1 : MB1 = 60 − A;

firm 2 : MB2 = 24 − (1/3)A;

firm 3 : MB3 = 55 − (1/2)A.

The abatement cost is the same for all of them = \$25 to abate each unit of pollution.

12.11a. If each firm does not know the abatement plans of the other firms, what would be the amount of total abatement?

12.11b. What are the social marginal benefits in this case?

12.11c. What is the socially optimal level of abatement?

12.11d. If the cost of CO_2 abatement is TC = 50 + 0.5A^2. What would be the amount of total abatement and the social optimum?

Homework 12.12. (contributed by Kelsey) Slowing climate change represents a public good. The following marginal benefits of abatement also represents the demand for slowing climate change for 3 individuals.

MB1 = 400 − 5a

MB2 = 200 − 2a

MB3 = 300 − 8a

Although many theorists suggest marginal costs will take one form, there are a few who believe costs will behave differently. Uncertainty in this case is represented by the probabilities associated with the following marginal cost curves.

MC1 = 100 + 20a   20% probability of occurring

MC2 = 40 + 25a   80% probability of occurring

12.12a. Determine the socially optimal amount of abatement.

12.12b. Determine the private optimal amount of abatement for each individual assuming they know each other's preferences.

12.12c. What is the socially optimal amount of abatement if we know with certainty (100% probability) MC1 represents the true economic costs?

12.12d. What is the cost of uncertainty, or the efficiency lost in solution a. if MC1 represents the true economic costs?

Homeowork 12.13. (contributed by Matthew Adkins) Over the last few years, global warming has become an increasing concern. List two economic proposals on how to combat global warming. In your answer, make sure to discuss the inherent challenges

and properties of CO_2 emissions. What do you believe is the best policy for efficiently reducing CO_2 emissions, and why?

Homework 12.14. See if you can find a well-publicized example where you think that either industry or environmental groups distorted the political process and we may have more or less abatement than is socially optimal.