

**Midterm Exam**  
Spring 2001

**DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO.**

**Instructions**

Write your STUDENT NUMBER in the upper right corner of this exam. Do NOT write your name.

SHOW ALL YOUR WORK. Answers without supporting work will receive little or no credit.

Do all your work on this exam. If you need extra space, write on the backs of the pages. However, if you do write an answer on the back of a page, *be sure you've noted that near the question.*

There are 70 points possible on the exam and you'll have 75 minutes to complete it.

**Question 1 (2 parts, 20 points)**

- (a) Many substances are known as “transboundary” pollutants because they are emitted in one political jurisdiction but cause problems in other jurisdictions downstream or downwind. One example is sulfur dioxide, which is emitted in the mid-western US and carried into Canada. There is no international organization that could impose emissions taxes on the US. Does this mean that transboundary sulfur dioxide emissions are likely to be inefficient? Please discuss in detail.

**Question 1, continued.**

- (b) Suppose that a particular policy would give \$100 of benefits to person *A* and impose \$120 of costs on person *B*. If the benefits and costs occur at a single point in time, would it be a good idea to proceed with this policy? Explain. Now suppose that the costs imposed on person *B* don't occur for 25 years. Does this change your recommendation? If so, is it fair to treat people differently just because they happen to live at different times?

**Question 2 (2 parts, 20 points total)**

An important aspect of global warming is that the damages from it occur fairly far in the future. As a result, there may be time to develop new energy technologies that could allow us to reduce or eliminate the problem at lower cost than we could now. However, it is uncertain whether any such breakthroughs will occur.

For example, suppose that it is known that the damages from global warming will be  $D$  dollars per year forever, starting in 51 years. There is a 70% chance that  $D$  will be \$10 billion and a 30% chance that it will be \$160 billion. Throughout the problem, you may assume that the interest rate is 5%.

- (a) Suppose that the danger from global warming could be eliminated by a policy that would cost \$10 billion per year forever, with the first payment occurring in one year. Determine whether it would be a good idea to adopt this policy. Be sure to show all your work, and to explain your final result in words.

**Question 2, continued.**

- (b) Now suppose that an alternative policy is available. Under this policy, \$40 billion dollars would be spent immediately (a single payment in year 0) to fund a 25 year energy technology research program. The \$40 billion would pay for the entire cost of the program: there would be no additional payments during the next 25 years. There is a 60% chance that the project would succeed. If it did, it would allow climate change to be avoided at a cost of \$4 billion per year forever, starting in year 26. If it fails, however, it will have no effect. Is this project a good idea? Show all your work and explain your answer in words.

**Question 3 (1 part, 10 points total)**

Twenty-five years ago, sections of the Bronx (part of New York City) were in terrible condition: there were many abandoned buildings and vacant lots, and there was a lot of crime. To keep things from becoming even worse, the city government encouraged people to start using the vacant lots (which belonged to the city) for gardens. A lot of people did, and there are now hundreds of gardens throughout the Bronx, and they are very popular. However, the city is now short of affordable housing and the government is considering destroying the gardens to build new housing units.

- (a) Suppose that there are 100 gardens, and that each one could be converted to a housing unit that could be rented to a low income household for \$10,000 per year. In addition, suppose that 100,000 people live in or near the Bronx, and that each person's annual benefit from  $Q$  gardens is given by:  $MB_i = 1 - Q/80$ . How many gardens, if any, should be converted to housing? How many should be preserved? Be sure to show your work.

**Question 4 (2 parts, 20 points total)**

When pollution control regulations are first established, or are substantially tightened, existing plants are often given special, more lenient rules or exempted from the regulations entirely. This is known as “grandfathering” and it is very controversial, at least in retrospect. Many factories in Texas, for example, were grandfathered decades ago and remain exempt from essentially all air pollution regulations. This problem asks you to work through a stylized example.

Suppose there are 1 million households that consume a particular product. Each household’s demand for the good is given by  $P = 100 - 4Q_i$ , where  $Q_i$  is the amount of the good household  $i$  consumes. The product is produced by 100 identical firms, each of which has a marginal cost of \$20 and a maximum capacity of 200,000 units. In addition, production of the good creates pollution that causes \$4 worth of damage per unit produced.

- (a) Solve for the market equilibrium. Determine the price, total quantity, quantity purchased by each household, and the quantity produced by each firm. Is this efficient? If not, please calculate the following things: the efficient price, the efficient total output, and the social surplus that could be gained by moving from the market equilibrium to the efficient point.

**Question 4, continued.**

- (b) Over time, the population in the region is expected to grow to 2 million. Suppose that the government passes a law requiring *new* firms in the industry to use a pollution control device that eliminates their pollution but raises their marginal cost to \$24 per unit. The existing 100 firms are exempt as long as they do not increase their capacity beyond 200,000 units. Determine the market equilibrium price and total quantity after the population increase. How much of the total output will be produced by new firms entering the market? How much by the old firms? Are the old firms better or worse off than they were in part (a)? Calculate how much they gain or lose and discuss the implications of this for the political process.