

ECN 275/375 – Natural resource and environmental economics  
12:15-15:15 March 4, 2022

All help aids allowed except assistance from others.

This test consists of 3 questions, for a total score of 100 points.

All questions are to be answered. You may answer in English or Norwegian.

**In the case that you find a question unclear, or you are uncertain about what is meant, state the extra assumptions you need to be able to answer the question.**

**When I submit my answers on this test, I confirm that I have worked alone on my answers and not cooperated with others. I am aware that cooperation with others is to be considered an attempt or a contribution to cheat.**

**I am aware of the consequences of cheating (Ch. 39, Academic regulations for NMBU).**

**Your name:** NN (+ ECN 275 or ECN 375)

### Question 1 (30 points)

The total cost function for producing quantity of a public good,  $Z$ , is  $TC(Z) = bZ + cZ^2$ , where  $b$  and  $c$  are coefficients in the cost function.

- (a) (i) Find the marginal cost function for producing  $Z$ . (ii) Show that the conditions needed on the technical coefficients  $b$  and  $c$  to have a valid standard supply function are  $b < 0$ , and  $c > 0$ . Show mathematically and add comments if necessary. **(10 points)**

**Answer:** (i) write answer here

(ii) write answer here

- (b) (i) Write down the profit function for producing  $Z$ , and (ii) solve for the profit maximizing quantity of  $Z$ .

**Answer:** (i) answer here

(ii) answer here

- (c) Citizens have a utility function that reflects that welfare is obtained from consumption of a private good,  $Q$ , and the public good  $Z$ . (i) Formulate the social welfare maximization problem for a representative citizen, define terms you add, and explain your reasoning behind your formulation. Note that you are not asked to formulate a specific functional form for the utility function.

(ii) Write down the Lagrangian that corresponds to your formulation in (i), and use the first-order conditions to characterize the solution. **(10 points)**

**Answer:** (i) answer here

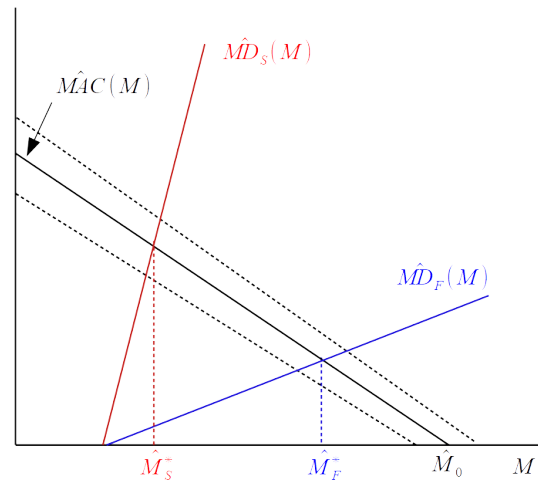
(ii) answer here

Question 2 on next page

### Question 2 (30 points)

Consider marginal abatement costs and marginal damages as functions of emissions,  $M$ , as illustrated in the graph to the right where:

- $\hat{M}AC(M)$ , the expected marginal abatement costs are uncertain. This uncertainty is captured by an upper and lower bound around the expected MAC-curve.
- $\hat{M}D_i(M)$  are the expected marginal damages (marginal economic costs), where  $i$  captures two mutually exclusive states, flat,  $\hat{M}D_F(M)$ , or steep,  $\hat{M}D_S(M)$ .



- (a) Assume that the marginal abatement cost curve,  $MAC(M)$ , is known with certainty, while it is uncertain which of the two marginal damage curves,  $\hat{M}D_F(M)$  or  $\hat{M}D_S(M)$ , that best represents the true marginal damage curve. Explain why the expected optimal emission level,  $\hat{M}^*$ , is located between  $\hat{M}_S^*$  and  $\hat{M}_F^*$  before the true marginal damage curve is known. **(10 points)**

**Answer:** answer here

- (b) Suppose that the uncertainty about marginal damages have been sufficiently resolved to conclude that marginal damages are adequately represented by  $\hat{M}D_S(M)$ . Now, introduce uncertainty about the location of the marginal cost function,  $MAC(M)$ , which is definitely not as steep as the marginal damage function. What are the implications of this uncertainty for the choice of policy instrument? Show graphically, and if possible add further justifications for your choice. **(10 points)**

**Answer:** answer here

- (c) Which of the two uncertainties, uncertainty on the benefit side or uncertainty on the cost side, is usually most difficult to resolve? Briefly justify your answer. **(10 points)**

**Answer:** answer here

Question 3 on next page.

### Question 3 (40 points)

The use of genetically modified organisms (GMOs) is a controversial issues in today's policy debate, with strong proponents for allowing more wide spread use, and opponents for the opposite.

Proponents for GMOs argue that with reduced growth in food production, GMOs are among the most promising ways of maintaining or increasing growth in global food supplies. They also point to GMOs contributing to less demand for pesticides. Reduced pesticide use may have beneficial environmental effects in addition to reducing consumer's and farm worker's exposure to pesticides or pesticide residues.

Skeptics towards GMOs argue that the long term health effects from consuming genetically modified (GM) foods are still not sufficiently investigated, and that GMOs may pose severe biological risks if not properly contained, for example if traits of the GMO spread to wild plants and animals.

- (a) (i) Define the term externality and explain what internalization means. (ii) Which of the **above listed effects in the lead text** could be termed *externalities*? **(10 points)**

**Answer:** (i) answer here

(ii) answer here

- (b) What are the economic approaches available for dealing with the possible externalities from GMOs? Briefly discuss the advantages of the various proposals. **(10 points)**

**Answer:** answer here

- (c) With large uncertainties surrounding more widespread adoption of GMOs, some argue that allowing for an increase in the use of GMOs could have irreversible impacts, particularly related to effects on ecosystems with uncontrolled spread of GMO attributes to other plants or insects. Name what you deem the most relevant economic tool for analyzing such potentially irreversible outcomes. Justify your choice, and briefly formulate verbally how such an analysis could be structured, and how an optimal decision is made. **(10 points)**

**Answer:** answer here

- (d) (i) Provide a graphical illustration that captures the essence of your answer in (c) where the decision alternatives are expand the use of GMOs or ban GMOs. Clearly define the terms that you are using. (ii) Provide a mathematical formulation that matches your graphical illustration. **(10 points)**

**Answer:** (i) answer here

(ii) answer here