UNIVERSITY OF OSLO
DEPARTMENT OF ECONOMICS

Exam: **ECON4910 – Environmental Economics**

Date of exam: Wednesday, May 9, 2018 **Grades are given:** May 31, 2018

Time for exam: 09.00 a.m. – 12.00 noon

The problem set covers 3 pages (incl. cover sheet)

Resources allowed:
- No written or printed resources – or calculator - is allowed (except if you have been granted use of a dictionary from the Faculty of Social Sciences)

The grades given: A-F, with A as the best and E as the weakest passing grade. F is fail.

Final Exam - 4910 - Environmental Economics
Spring 2018

If you get stuck, and have questions or if the text/problem below is confusing/unclear, please do the following: Make and state clearly your assumptions (/interpretations of the text), and continue your analysis based on that.

Each of problems 1-3 will have equal weight in the grade.

Problem 1. Discounting, CBA, and Climate Change

i) Assume an agent has a CRRA utility function with $u_t = \frac{c_t^{1-\eta}}{1-\eta}$ and the Ramsey equation is $r = \rho + \eta g$. Use this equation as the basis for discounting future consumption steams.
   (a) Explain the meaning of each term.
   (b) Assume we expect that consumption levels fall in the future. When does this warrant a negative discount rate for a cost-benefit analysis?
   (c) Give two different reasons related to the Ramsey equation why developing countries usually employ higher discount rates than fully developed countries.
   (d) You have to evaluate a project with non-market benefits. State and briefly (!) explain two different methods to find the value of such non-market benefits.

ii) Write down the complete set of equations (including objective function) for a minimalistic integrated assessment model of climate change that includes global atmospheric temperature. You can be general or specific as you spell out the equations. Explain each equation in a couple of sentences. What are the relevant state variables?
Emissions affect production in two ways (directly and indirectly). Explain how. For both channels discuss whether they should have a convex or a concave impact on production.

Problem 2. Prices vs. quantities

Suppose that $q \geq 0$ measures a firm's/industry's abatement level, and that the cost of abating q is $C(q) = q(\theta + cq)$, where $\theta = 2$ with 50% chance, and $\theta = 4$ with 50% chance. Suppose the society's benefit from abating q is $B(q) = q(8 - q)$. A planner seeks to maximize $B(q) - C(q)$. The planner sets a policy without knowing the realization of θ, but θ is known by the firm/industry when they make their decision.

i) Suppose the planner specifies a quantity requirement (quota), q. What is the optimal q?

ii) What is the expected deadweight loss, given this optimal q?

iii) Suppose the planner specifies a subsidy, s, and that the firm/industry maximizes $sq - C(q)$. What is the optimal s, from the planner's point of view?

iv) What is the expected deadweight loss, given this optimal s?

v) When is the deadweight loss of the subsidy smaller than the deadweight loss of the quantity measure? Discuss what determines the answer and the intuition for this result.

Problem 3. Supply-side policies

Consider n countries and that in each country i, the demand for fossil fuel consumption y_i is $y_i = D(p) = b - p$, where $b > 0$ is a constant while p is the fossil fuel price. The supply in country i is $x_i = S(p) = p$. Suppose only country $i = 1$ sets a climate policy while all the other countries (or, the consumers and the producers in these other countries) take the price p as given. Fossil fuel is tradable globally.

i) In words: What do you think happens to the equilibrium choice of y_i and x_i, for $i > 1$, when country $i = 1$ reduces x_1 while keeping y_1 fixed?

ii) Can you derive the formula that answers question 3(a) exactly?

iii) Suppose that total pollution is $E = \sum_{i=1}^{n} e_i x_i$, where $e_i > 0$ measures how "dirty" the fossil fuel from country i is. Please derive the condition for when E decreases, if x_1 decreases marginally, while y_1 is hold constant.

iv) Suppose we hold fixed every e_i, except for e_2 (this is the emission level from a unit emission in country 2). Suppose e_2 increases. How do you think the larger e_2 will influence country 1's optimal choice of y_1 and x_1?