Midterm Exam for Resource Economics (LESE3210)

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1. (20points. each 4 points) Answer 'T' for true, or 'F' for false.

(1) ____F_____ Proven Reserve of oil indicates how long the oil can be extracted.
(if you say "Yes", 2 points are given)

(2) ___T_____ When the interest rate is lower than the growth rate of net price of an exhaustible resource, it is better to delay the extraction of the resource.

(3) _____F_____ Shadow price of an exhaustible resource tends to increase when the stock of the resource increases due to addition of new reservoir.

(3) ____F_____ When the supply curve of gasoline is perfectly inelastic with respect to the own price, gasoline tax is transferred to consumers.

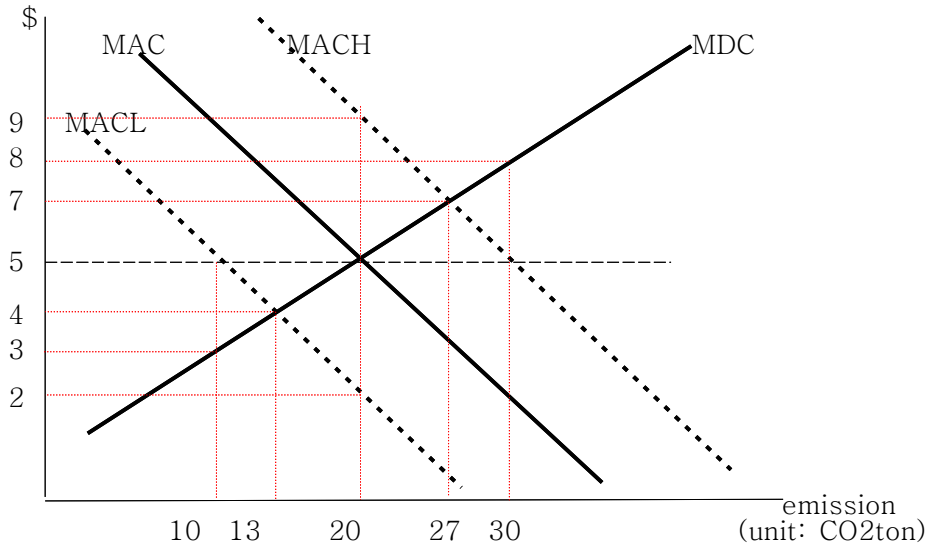
(4) ____T_____ As the grandfathered emission permits increases, the capacity of 'Revenue Recycling' is deteriorated.

2. (20 points) Graph provided below illustrates the Weitzman's theorem when there is asymmetric information of marginal abatement cost (MAC) to reduce greenhouse gases. For government, the probabilities for firm's real MAC curve to be MACH and MACL are 30% and 70%, respectively. However, firm knows its real MAC with certainty.

(1) (5 points) When marginal damage cost is given by MDC as below, what is optimal emission level? If carbon tax is implemented, what is the optimal carbon tax rate per CO2 ton?

(2) (15 points) Among carbon tax and tradable emission permit system, which e nvironmental policy is more desirable to reduce greenhouse gases? Your answer must be based on numerical comparison of possible social losses under each policy scheme.

(a) How much is the social loss under carbon tax when real MAC is MACH?
(b) How much is the social loss under tradable permit system when real MAC is MACH?
(c) How much is the social loss under carbon tax when real MAC is MACL?
(d) How much is the social loss under tradable permit system when real MAC is MACL?
(e) Compare the expected social loss under carbon tax and permit system. Then provide your answers.



Answers:

(a) What is the social loss under carbon tax when real MAC is MACH?

3*1*1/2=3/2, 3*2*1/2=6/2 ==> 9/2=4.5

(b) What is the social loss under tradable perm it system when real MAC is MACH?

7+7=14

(c) What is the social loss under carbon tax when real MAC is MACL?

1.5+1.5 =3

(d) What is the social loss under tradable permit system when real MAC is MACL?

7/2 + 7*2/2 =21/2

(e) Compare the expected social loss under carbon tax and permit system. Then provide your answers.

Carbon tax: 0.3*9/2+0.7*3 = 3.45

ETS: 0.3*14+ 0.7*21/2= 11.55

Carbon tax is preferrable.

3. (40 points, basic 7) Consider an inverse demand curve given by $P_t = a - bq_t$ where q_t denotes the extraction amount of exhaustible resource at time t. For each unit of q_t, royalty for exploitation technology denoted by R must be paid to foreign company. We consider 2 period problem with $t = 1,2$.

(1) (5 points, 2) After considering the royalty cost, derive the total benefit of this resource use as a function of q_t.

Answer: $B_t = \int_0^{q_t} (a - bs)ds - Rq_t = aq_t - \frac{b}{2}q_t^2 - Rq_t$

(2) (5 points,2) Suppose that the extraction cost is $C_t = cq_t^2$ as a convex function. $\overline{Q}$ is total reserve of this resource at initial time. r is the discount rate. Construct the Lagrangian function to maximize benefit subject to resource constraint over 2 periods.

Answer: $L = aq_1 - bq_1^2/2 - Rq_1 - cq_1^2 + \{aq_2 - bq_2^2/2 - Rq_2 - cq_2^2\}/(1+r) + \lambda(\overline{Q} - q_1 - q_2)$

(3) (15 points,3) Provide the first order conditions and then optimal extraction amount q_1^*, q_2^* and the Lagrangian multiplier λ. Discuss the effects of royalty R and interest rate $\overline{Q}$ on the extraction schedule.

Answer: $\frac{\partial L}{\partial q_1} = a - bq_1 - R - 2c_1q_1 - \lambda = 0$, $\frac{\partial L}{\partial q_2} = \frac{a - bq_2 - R - 2c_2q_2}{(1+r)} - \lambda = 0$, $\overline{Q} = q_1 + q_2$.

By rearranging, we have $q_2^* = \frac{\overline{Q}(b+2c) - \lambda^* r}{2(b+2c)}$, $q_1^* = \overline{Q} - q_2^*$, and

$\lambda^* = \left(\frac{2(a-R)}{b+2c} - \overline{Q}\right)\left(\frac{b+2c}{2+r}\right)$.

As R increases, λ^* decreases. Then, q_2^* increases whereas q_1^* increases.

As $\overline{Q}$ increases, λ^* decreases. This gives a rise to q_2. The effect of q_1 is also increasing.

(5) (15 points, 3) Backstop technology that can replace this resource will be

available when the second period starts. What is the optimal q_1^*, q_2^* ?
Answer: Under the condition that backstop technology replaces the resource, it is always optimal to choose $q_1^* = \overline{Q}$, $q_2^* = 0$.

4. (20 points) Business sector is concerned about economic impacts of tradable emission permit system because the system will eventually raise the production costs in a manner of permit price. To ease such concerns, initial allocation of permits is grandfathered based on free allocation. Do you think grandfathering of permits is helpful in achieving two targets: mitigation of greenhouse gases and reduction of firms' compliance cost? If so, what is your rationale? If not, what is your suggested alternative?