ECON4910 - Spring 2020

Each subquestion can give at most 5 points. If you believe the text is imprecise and that you need to make additional assumptions, please state your assumptions clearly as "Assumption 1:...", etc. Write and draw clearly.

1. Prices vs Quantities

Consider a country with consumers that suffers $C(g)$ from the pollution g, and a large number of identical firms. The benefit for the firms is given by $B(g) \equiv \pi(g) - \pi(0)$, defined as the difference in aggregate profit if the firms can pollute g rather than nothing.

a. Illustrate the market equililbrium for g if there is no regulation, both graphically and mathematically, and compare it to what you consider to be "first best".

b. Discuss: (i) Is the problem incorrect prices — and if so, why (explain)? (ii) Is the problem that there is a missing market – and if so, why (explain)? (iii) Is the problem that there is an externality – and if so, why (explain)? (iv) Is the problem that there is a public good – and if so, why (explain)? (v) Is the problem that there are imperfectly defined property rights – and if so, why (explain)?

c. Which of (i)-(v) fits best for climate change? Explain.

d. What policies – prices or quotas – do you suggest to implement g if there are uncertainties in the C function only? And what if there are uncertainties only in the B function? Please use a figure to explain.

e. Both prices and quotas lead to inefficiency losses when there are uncertainties in the B' functions only. In particular, suppose $B(g) = g - (g + \theta)^2 / 2$, where $\theta \in \{0, 1\}$. Can you design a better policy than the prices and the quotas, discussed in question d?

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2. Repeated games.

Suppose $B(g_i + R_i)$ is every country's i's benefit of emitting $g_i \in \{\underline{g}, \overline{g}\}$, where R_i is the energy produced from the renewables. The environmental cost is $C\left(\sum_j g_j\right) = \sum_j g_j$. Let there be n countries.

a. Under which conditions is the set of emission-decisions similar to a prisonner dilemma game? Do you think these conditions hold in reality?

b. Suppose the common discount factor is δ. Let $R_i = R$ be fixed. Under which condition is there an equilibrium where everyone emits little? What strategies support this equilibrim? Do you find them to be realistic?

c. How does the answer in b change if R increases?

d. The Paris Agreement emphasizes transparency, so that it is easier to observe countries' compliance to their promised emission cuts. What is the benefit or effect of that, in the model here? What are the consequences for the necessary level of R?

Discounting and Integrated Assessment of Climate Change. The problem contributes 25 points and each Roman numbered question up to 5 points.

  i)   Write down and explain the different components of the social discount rate.

The graph below is produced with an extended version of the DICE model. The authors explicitly distinguish between environmental and produced goods. They use the utility function

$$ U = \frac{1}{1-\eta} \left[\alpha \left(E_t - \overline{E} \right)^\theta + (1-\alpha) c_t^\theta \right]^{\frac{1-\eta}{\theta}} $$

where E_t is the level of the environmental good and c_t the consumption level of the produced good. The authors refer to θ theta as the substitution parameter.

The relative price effect (RPE) is defined as the relative change of the marginal utility of the environmental good over the relative change of the marginal utility of the produced good

$$ RPE_t = \frac{\frac{d}{dt}\left(\frac{U_{E_t}}{U_{c_t}} \right)}{\left(\frac{U_{E_t}}{U_{c_t}} \right)} . $$

The figure below plots the relative price effect over the substitution parameter (different typesetting but same theta as in the utility equation above).

Relative price effect 2100, %
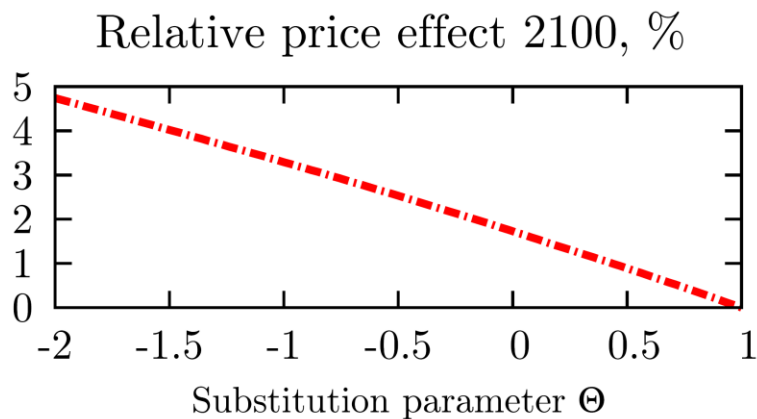
  ii)   Describe, interpret, and explain the graph.
  iii)   Assume we translate the relative price effect into the discount rate for the environmental good. How will it affect the environmental discount rate?
  iv)   Define the Social Cost of Carbon and explain how you think that this two-good modification of the DICE model affects the Social Cost of Carbon?
  v)   Explain how you would implement such a two-good extension of the DICE model. For this purpose, write down the equations that will require change, and suggest an alternative formulation that incorporates environmental goods explicitly and separates them from produced consumption.
          Note: This problem is neither about recalling the exact quantitative DICE equations nor about suggesting a quantitatively correct alteration, but about explaining the abstract qualitative changes to DICE required.