Environment & Resource Field Exam

Tuesday, June 9th, 2020

12:00pm-3:00pm

This is a closed book exam. Please answer all four questions. You have three hours to complete the exam. Put your ID number on the upper corner of each page Answer each question separately and start each question on a new page. Please make sure you email me your completed exam by 3:00pm.

Good Luck!

Resources Field Exam 2020

All questions have equal weight.

a) Consider two distinct contexts. In the first, $f(x;\alpha) = \frac{\partial C(x;\alpha)}{\partial x}$ and in the second, $\frac{dx}{dt} = F(x;\alpha)$. In the first context x^* is a local *minimum* and in the second it is a *stable* steady state. In both cases an increase in α increases x^*. What does this statement imply about the sign(s) of $\frac{\partial f(x;\alpha)}{\partial \alpha}\big|_{x^*}$ and $\frac{\partial F(x;\alpha)}{\partial \alpha}\big|_{x^*}$? (Explain briefly.)

b) Write the dynamic programming equation for the control problem

$$\max_{\{c_t\}} \sum_{t=0}^{\infty} \beta^t \ln c_t \text{ subject to } k_{t+1} = k_t^\alpha - c_t.$$

Explain how to solve this problem to determine the optimal consumption function. (A verbal description is sufficient.)

c) Describe how the model in part (b) has been extended to study climate change. (Summarize the major features of the climate model, using minimal notation.) What feature makes it possible to obtain a closed form solution to the optimal carbon tax in this climate model?

d) An earlier expected arrival of a substitute for fossil fuels can alter the equilibrium extraction of fossil fuels before the substitute becomes available. Explain the mechanism for this possibility. Give an example of how the earlier expected arrival can exacerbate climate change. What is the name economists use to describe this possibility?

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For all parts, explain your answer using intuition, explanation and mathematics as you are able. **If you need to make additional assumptions/interpretations in order to answer a question, detail your assumptions or explain how they matter.** All parts on this page are worth the same number of points.

(a) **True or false:** The optimal Pigouvian tax on a good that creates an externality depends on the cost of adaptive investments related to the externality. (I.e., the social cost of carbon depends on the cost of building sea walls to mitigate damages from sea level rise.) Explain your reasoning.

(b) **True or false:** All else equal, the optimal Pigouvian tax on a good that creates an externality will be higher for a good that has a steeper (more inelastic) demand curve. (Assume a competitive market.) Explain your reasoning.

(c) Consider an economy with a homogenous good X and a numeraire Z. A representative price-taking consumer with exogenous income has utility $U(X) + Z$, where U is increasing and concave. A continuum of price taking firms, indexed by j, produce X, so that $\sum_j x_j \equiv X$. Firms have heterogeneous costs of production $c_j(x_j)$. All cost functions are increasing and convex, with regularity condition $c_j(0) = 0$, so that all firms are producing some X in equilibrium. Production of x_j creates emissions e_j according to the function $e_j = x_j - a_j$, where a_j is abatement that each firm can achieve at additional (separable) cost $g_j(a_j)$, which is potentially heterogeneous across firms, but for all firms is increasing, convex, and has $g_j(0) = 0$. Assume that negative emissions are not possible, so $a_j \leq x_j$.

A planner considers one of two policies. First is a tax on emissions, with all revenue rebated lump-sum equally to each firm. Second is a **tradable** performance standard, under which each firm is entitled to θ units of emissions per unit of output. If firms emit less than θ times their output, they are allowed to sell the excess to another firm. If they emit more, they must purchase credits.

  (i) Write down a firm's profit maximization problem when they are subject to the tradable performance standard.

  (ii) **True or false:** Because an emissions tax is more efficient than a performance standard in this setting, moving from a performance standard to an emissions tax that results in the same level of emissions in equilibrium will make all agents better off. Explain your answer.

  (iii) Explain intuitively and/or mathematically why the tradable performance standard and the tax either (a) have the same cost effectiveness or (b) why they differ in their cost effectiveness.

Suppose you are studying how ground-level ozone air pollution affects the value of timber. You plan to study this question by investigating how ozone pollution quality the value of forest land sold for timber harvesting. You would like to use the hedonic model to analyze this relationship.

a. What are the key assumptions required to apply the hedonic model in this setting, and to what extent are they well satisfied in this setting?

b. Draw one graph illustrating the key ideas of the hedonic model in this setting. Label the important parts of the graph, and explain their economic interpretation.

c. Suppose you estimated a cross-sectional regression of land values on ozone pollution and some other variables that influence the value of lands sold for timber harvesting:

$$P_i = \beta_0 + \beta_1 X_i + W_i'\theta + \varepsilon_i$$

Here P_i is the sale price of land tract i, X_i measures ozone pollution, and W_i is a vector of other control variables (soil quality, road proximity, etc.). Explain the economic interpretation of the coefficient β_1. Briefly describe reasons why this is or is not likely to identify the relevant component of the hedonic model.

d. Suppose you would like to evaluate the Bye Bye Ozone Pollution (BEBOP) Act of 1993, which spent a hundred billion dollars to decrease ground-level ozone pollution in timber harvesting areas. To what extent would the parameter β_1 provide information needed to evaluate the BEBOP Act? What additional econometric model would you like to estimate that would help improve that evaluation? (You can write the regression equation or just describe the economics of what you need to do.) To what extent is that additional model feasible to identify and estimate, and why?

e. Suppose the timber lands were sold by auction. How would this change your answers to subparts (c) and (d)? If you need to make additional assumptions for your answer, state the assumptions.

Power supply interruptions are ubiquitous in many developing economies. It is important to understand how consumer welfare is impacted by frequent outages. One empirical approach has involved estimating households' marginal willingness to pay (MWTP) for incremental quality improvements in settings with frequent supply interruptions.

Suppose you are working in a context where fans are among the most important electric appliances owned by households. You notice that some households have purchased fans with integrated battery storage, making it possible to run the fan through power outages.

- Suppose power supply reliability is measured in terms of the number of interruptions per year, Suppose the frequency of these interruptions I_d varies significantly across districts indexed by d.

- Let $S_j = 1$ if fan model j has battery storage. Otherwise, the fan is a conventional model with no energy storage: $S_j = 0$.

- Suppose electric fan prices (P_{jd}) vary across districts (and models), but electricity prices do not.

- Other fan attributes valued by households are captured by ξ_j.

- Data on district-level fan sales allow you to estimate the share of the market in each district d claimed by fan model j and the residual share of the district market that chooses the outside option (no fan).

Latent utility is specified simply as:

$$U_{idj} = \alpha P_{jd} + \beta S_j \cdot I_d + \xi_j + \varepsilon_{idj} \tag{1}$$

Question (i) Suppose you invoke the standard logit assumption that the error term ε distributed $\sim iidEV1$. What is the unconditional probability that household i chooses fan model j.

Question (ii) In this simple conditional logit context, derive a linear estimating equation that relates district market shares to observable and unobservable fan attributes.

Question (iii) How could you use the estimates of this empirical choice model to construct an estimate of the average household's willingness to pay for an incremental reduction in annual power supply interruptions?

Question (iv) Thinking critically, discuss one concern (there are many - choose one) with interpreting your MWTP estimate from (iii) as an unbiased measure of the value these households would obtain from an incremental improvement in power supply reliability.