Environmental & Resource Field Exam

Tuesday, May 25, 2021

From 1:00-4pm

Please answer all the questions.

You have 3 hours to complete the exam.

Put your ID number on the upper right corner of each page. Answer all questions separately and start each question on a new page.

Good Luck!

QUESTION #1

Question from Larry's module for ERE field exam 2021

A climate-related stock, S_t (e.g. atmospheric carbon) evolves according to $S_{t+1} = x_t + \delta S_t$, where x_t is the flow of pollution and $0 \leq \delta \leq 1$. The flow payoff is $\pi(x_t, S_t)$ and the single period discount factor is $0 < \beta < 1$. The stock at $t = 0$ is S_0, given. At known time T society will have available a source of cheap and clean energy, causing emissions at $t \geq T$ to equal 0. The scrap value of the carbon stock at T is $g(S_T) < 0$ for $S_T > 0$. Assume that the necessary conditions for an interior optimum are sufficient.

1. (a) Write down society's objective and the planner's DPE. Derive and then interpret the Euler equation for this problem.

   (b) Specialize the Euler equation for the case $\delta = 0$. Is the resulting problem still a dynamic problem (as distinct from a succession of static problems)? Explain your answer, and explain how you would solve this problem.

   (c) (We're back to the case where $\delta > 0$.) If the stock at $T + \tau$, is $S_{T+\tau}$ society's flow of benefit is $\pi(0, S_{T+\tau})$, because emissions are zero by assumption at $T + \tau$, for $\tau \geq 0$. Suppose that at time T society has a technology that enables it to remove s units of the stock of atmospheric carbon at a cost γs; s is a choice variable and γ is the unit cost of removal.

      (i) What is the planner's optimization problem at T, and what is the relation between this optimization problem and the scrap function $g(S_T)$?

      (ii) Suppose that at T it is optimal to remove some of the carbon stock. (The optimal s is positive). Would the planner want to spread out this removal over time, or would she want to carry out the entire planned removal at the first possible time, i.e. at $t = T$?

      (ii) How does a decrease in γ change the trajectory of emissions for $t < T$?

Question #2

Suppose you want to measure the marginal willingness to pay for improving drinking water quality. Suppose the Safe Drinking Water Act used a randomized controlled trial to allocate federal funding to improve drinking water quality in different counties and times. Imagine you estimate the value of this funding by estimating the following equation:

$$P_{it} = \beta_0 + \beta_1 X_{it} + W_{it}'\theta + \mu_i + \alpha_t + \varepsilon_{it}$$

Here *P* is the value of houses sold in county *i* and year *t*, *X* measures the cumulative investment to improve water quality, *W* are home characteristics (bedrooms, bathrooms, etc.), and μ and α are fixed effects for counties and years.

a. Is an OLS estimate of β_1 likely to suffer from omitted variables bias? Why or why not? If so, what is an important potential omitted variable and what is the likely sign of the bias?

b. Now assume this equation provides a consistent and unbiased estimate of the parameter β_1. Furthermore, assume the standard assumptions of the hedonic model are satisfied (perfect competition, every consumer buys exactly one home, everyone has complete information, continuous attributes, etc.). Would using the parameter β_1 provide a complete and full estimate of the marginal willingness to pay for drinking water quality improvements from the Safe Drinking Water Act? Why or why not? If not, what additional information or estimate would you need to provide a complete and full measure of the marginal willingness to pay?

c. Now suppose that housing information is unavailable, but you instead estimate have comprehensive data on health outcomes. You estimate the same equation above, but now P_{it} represents a series of health outcomes. In different estimates, P_{it} includes mortality, and hospital admissions, infant health, and similar measures of the disutility that people experience from ill-health effects of polluted drinking water. Would estimates using only these health outcomes data provide a full measure of the marginal willingness to pay for water quality? Why or why not? If not, what additional information or estimate would you need to provide a complete and full measure of the marginal willingness to pay?

d. In part c, once you have estimated health effects of drinking water pollution, you want to translate these units of health outcomes (deaths, hospital admissions, infant birthweight, etc.) into monetary values. What is the most accurate and informative way to do this? Please give enough information that it could guide a research assistant through the process and understand the key steps and rationale and methodology for them.

QUESTION #3

Qualifying Exam: Question from ARE 264, Module 1
Spring 2021

For all parts, you should not suppose that there is a single right answer. Assessment will be based your ability to mobilize concepts from the course to rigorously approach each item.

(a) Imagine that a social planner, which has a strong preference for equity, wants to correct market failures associated with a good that creates a negative externality equal to ϕ per unit consumed. Suppose that the planner learns that the good is consumed predominantly by low-income households. How would that change the planner's preferred policy? (3 points)

(b) A product called Gloop is produced at industrial facilities throughout the country. Gloop production creates toxic air pollution that spreads in a local area around facilities. Individuals exposed to each additional unit of the toxic emissions experience, on average, \$0.05 of harm.

(i) What pieces of information would you need to derive the (second best) efficient uniform tax on production of Gloop? List these items as bullet points, with a brief (roughly 1 sentence) explanation as to why you need that information. (2 points)

(ii) Explain circumstances under which some alternative policy could be more efficient than a uniform production tax per unit of Gloop. (2 points)

(c) In a problem set, you explored how the optimal corrective tax on an externality-causing good differed when the producer had market power. One version of the result in the homework is that the second-best tax under monopoly is $t^{SB} = \phi + p'q$, where p' is the demand derivative and ϕ is marginal damages. This question asks you to modify that setup by allowing there to be a single firm that has price setting power, but allow for the possibility that there is also a competitive fringe.

The monopolist can choose a price. For the given price, a consumer will demand a quantity, $q(p)$, which you can assume is downward sloping and invertible, so that you can write $p(q)$ as a function. Also for any given price, a set of price-taking firms will provide $s(p)$ quantity of the good. This fringe supply is upward sloping and invertible. The monopolist will thus provide the residual amount, $q(p) - s(p) = m(p)$. Just to reiterate: the monopolist quantity is denoted m, and total consumption q equals m plus some supply from the competitive fringe: $q = m + s$. The monopolist's cost of production is $c(m)$, which is increasing.

(i) Intuitively, explain how the second-best tax rate in this case will relate to two baselines: (i) the result (restated) above about the second-best tax rate in the presence of monopoly, and (ii) the Pigouvian tax result under competitive supply. You can use the notation if you would like, but it is fine if you choose to describe your thinking only in words. (2 points)

(ii) Write down the planner's objective function that you could use as a starting place for solving the model fully. (No need to solve it, just state the problem). (1 point)

QUESTION #4

EEE Applications of Discrete Choice Models

In California, retail electricity prices (per kWh) vary significantly across utility service territories due to differences in regulated rate structures, authorized capital cost recovery requirements, and other factors. Whereas some utilities charge retail rates that are approximately equal to social marginal cost (SMC), others charge prices that are significantly higher.

You want to know whether high electricity prices are impacting households' electric vehicle (EV) adoption choices. If gasoline and electricity are priced at social marginal cost, fueling vehicles with electricity (versus gasoline) is less expensive per mile. High electricity prices could be slowing efficient EV adoption.

You have household-level data on all new car purchases (by address) in California. You also have detailed information on gasoline prices, electricity rates by utility territory, and vehicle attributes. You write down a model (similar to Grigolon et al.) where the indirect utility of household i from purchasing vehicle j is defined as:

$$u_{ij} = x_j\beta_i^x - \alpha_i(p_j + \gamma\rho M_i e_j f_j) + \xi_j + \epsilon_{ij} \quad (1)$$

x_j is a vector of observed vehicle model characteristics (such as vehicle size, horsepower, engine type). p_j is the vehicle purchase price. M_i is annual vehicle miles traveled. e_j is a measure of fuel efficiency (gallons per mile for gas; kWh per mile for EVs). f_j is the fuel price (electricity or gasoline). The ρ parameter is the capitalization coefficient which is calibrated using an assumed discount rate and time horizon (as in Grigolon et al.). The ξ_j is the structural error which captures unobserved (by you) quality characteristics.

1. You start with a simple conditional logit (CL). You impose the restriction that parameters (α, β, M) do not vary across households. The disturbance term ϵ_{ij} is assumed to be distributed $\sim$ iid EV1. Households make vehicle purchase choices to maximize latent indirect utility. You plan to estimate the model using several years of data. You define T markets as utility service territory/year combinations with I_t potential consumers in each market. Vehicle prices and fuel prices vary across markets. The share of market t claimed by vehicle model j is denoted s_{jt}.

   Show how the system of $J + 1$ market share equations implied by this standard CL choice model can be manipulated to derive a *linear* estimating equation.

2. Equation (1) assumes that consumers weigh a dollar of electricity costs and a dollar of gasoline costs symmetrically in their purchase decisions. Is this a safe assumption? If yes, why? If not, how might a violation of this assumption impact your coefficient estimates?

3. In principle, you can use the estimated CL model to assess if/how consumer surplus (derived from these vehicle purchase choices) would change if consumers facing high retail electricity prices had instead faced electricity prices = SMC. Explain how you would estimate these consumer surplus changes within the context of the conditional logit choice model. For the purpose of this question, you can ignore any supply-side/general equilibrium effects.

4. In this vehicle choice context, why might you be concerned about the restrictive assumptions imposed by this CL model? In other words, why might a random parameter (or "mixed") logit specification be preferred over the simpler conditional logit model?