Environmental & Resource Field Exam

Friday, May 27th

9:00am-12:00pm

Room 241 Giannini Hall

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.

Good Luck!

Question 1

Meredit

Discrete Choice Models in EEE

Burgess, Greenstone, and Ryan (2020) implement a large scale field experiment that investigates households' willingness to pay for electricity access in India. The authors randomly vary the offered tariff for solar microgrid access across villages. They then use this subscription price variation in the estimation of a more structural electricity demand model.

The authors begin by estimating the following linear IV specification using the data they collect from the field experiment:

$$S_{tv} = \beta_0 + \beta_1 \hat{Price}_{tv} + \epsilon_{tv} \tag{1}$$

$$Price_{tv} = \alpha_0 + \alpha T_v + \eta_{tv}, \tag{2}$$

where S_{tv} is the share of the market in village v and time t that purchases electricity from a micro-grid. They instrument for the microgrid subscription price $Price_{vt}$ using the experimental treatment assignment T_v .

(a) Provide a brief but precise interpretation of the β_1 parameter.

Whereas equation (1) estimates household demand for micro-grid access, policymakers are interested in how households value electricity access more generally. To shed light on this question, the authors specify a demand model that incorporates all electricity access options (e.g. grid connections, rooftop solar, microgrids, or diesel generators). The model assumes that households choose the energy access option j that maximizes utility. The utility that household i in village v in survey wave t derives from alternative j given by:

$$U_{ijtv} = \beta_{price} Price_{jtv} + \beta_{avail} Avail_{jtv} + \xi_{jtv} + \epsilon_{ijtv} \tag{3}$$

The observable choice characteristics (electricity prices and hours of available supply) are calibrated using survey responses averaged by village v and time t. The ξ_{jtv} capture quality attributes that the authors cannot observe.

(b) The authors estimate the parameters of this choice model in two stages. Please provide an intuitive explanation of this two stage approach (for the purpose of the exam question, you can ignore the nested error structure and answer as if the authors estimate a simple conditional logit model.). Please make direct reference to the equation they estimate in each stage. Comment, in particular, on how the authors use the experimental price variation to estimate β_{price}. Do you have concerns about this approach in this choice model context? If yes, please elaborate. If no, why not?

(c) Let J denote the observed energy access choice set. Let J' denote a counterfactual scenario in which grid access is not available. Using this notation, explain how the authors use the estimated model coefficients to estimate household willingness to pay for grid access among this population of households. As above, you can ignore the nested logit structure and answer as if the authors use a simple conditional logit model.

Question 2

Joe

Suppose a government is thinking of regulating the allowed emission rate of new vehicles, which is defined as the grams of NOx air pollution emitted per mile driven. Consider a model of this problem with the following assumptions:

- There is a continuum of consumers, with measure one, who buy either new vehicles (N) or used vehicles (U), so N+U=1
- All new vehicles are identical, and all used vehicles are identical (i.e., there is no product differentiation among new vehicles, or among used vehicles, so the only differentiation is between new versus used)
- Each period, every consumer chooses to own either a new or a used vehicle
- A consumer who buys a new vehicle in one period may scrap it the next period, and receive scrap value 0, or may repair it, at cost k, drawn from the cumulative distribution function H(k).
- A new vehicle which is repaired this period may be driven as used next period; or if a new vehicle is not repaired, then it is scrapped.
- Let p denote the equilibrium price of used vehicles.
- This model analyzes the steady state, so N and U are the same in all time periods, and no time subscripts are needed.
- You can assume that the demand for used vehicles is given by the following expression: $G(\psi\text{-}p\text{-}H(p)(p\text{-}\check{k}))$, where G() is the cumulative distribution function of consumers' preference for new over used vehicles; ψ is the cost of a new vehicle; and $\check{k}$ is the expected cost of repairing a vehicle when it is newly purchased. Hence, equilibrium in the used vehicle market (supply equals demand) can be written as follows:

(1) $$H(p) / [1-H(p)] = G(\psi\text{-}p\text{-}H(p)(p\text{-}\check{k}))$$

a. Show that the supply of used vehicles can be written as H(p) / [1-H(p)]. (Hint: start from the fact that the number of used vehicles equals the number of new vehicles times the share of new vehicles that are not scrapped, and go from there.)

b. Conceptually, what does the term $H(p)(p\text{-}\check{k})$ represent? Please explain its meaning in words that a non-specialist could understand.

c. Suppose new vehicle exhaust standards get more stringent, which makes it more expensive to produce a new vehicle. Use equation (1) to discuss how these standards affect the market for used vehicles.

d. Suppose no part of the US has any regulation of air pollution from vehicles, except that California in one year begins imposing very strict air pollution regulations for new vehicles. Would looking at the change in home values in California provide a complete measure of how these regulations affect social welfare? Why or why not? Please ignore internal validity or endogeneity concerns (i.e., don't worry about omitted variables bias, reverse causality, or measurement error).

e. Suppose a national government runs a randomized control trial (RCT) that randomly requires some makes and models of new vehicles to comply with exhaust standards, and other new vehicles don't need to. Further suppose you use that RCT to estimate the resulting change in the price of the new vehicles. Does that estimate provide all the information needed to evaluate how new vehicle standards affect social welfare? Why or why not?

Joe: In 2e, prices include markups, so observing a change in car prices doesn't necessarily tell you about marginal costs. For 2e, you also need to know how the policies affect pollution emissions, and what people's marginal

Question 3 Jim

Qualifying Exam: Question from ARE 264, Module 1
Spring 2022

Each part will be weighted equally within this module. If you need to make additional assumptions/interpretations in order to answer a question, detail your assumptions or explain how they matter.

Setup: One challenging environmental problem is "fugitive methane" from oil and gas wells. Fugitive methane is an accidental byproduct of gas and oil production. It is leaked directly into the atmosphere, where it causes climate change by acting as a greenhouse gas. Producers have various actions they can take to reduce these leaks, but the government knows relatively little about what these actions are, how effective they would be, and how costly they might prove. Presumably, the available actions, their effectiveness, and their costs will vary across producers.

A critical challenge in designing policy to address fugitive methane is that the emissions are difficult to **measure**. Remote detection tools (airplanes, satellites) can measure the ambient concentration of methane at larger geographic areas that might contain dozens of individual wells operated by many firms, but these tools are currently inadequate to assign emissions to a single source (well).

Suppose it was possible to build a costly **new measurement system** (NMS) that would enable accurate assignment of emissions to each source (well). (Imagine a fleet of drones with infrared cameras that could continuously monitor each well in the US.) The NMS would be expensive to build, so regulators need to decide whether the system is worth building.

To answer the questions below, you need to read the narrative above, identify the key features of the policy problem, and then decide which models/tools from the course are relevant. You will be assessed in large part based on your ability to identify relevant models and to invoke their core insights in your answers.

(a) Suppose first that the NMS was not built, and the only available policy was a tax per unit of output of the good, X (imagine a composite output of oil and gas as one good for simplicity). Conceptually, what tax rate on X would maximize efficiency and why? What information would you need in order to recommend a specific tax rate per unit of X? Intuitively, explain why this tax rate is not fully efficient, or explain the conditions under which it would be fully efficient.

(b) Suppose now that NMS is available, and policymakers can directly impose a tax based on emissions, E. Would a per unit tax on emissions be fully efficient, why or why not? What information would you need to set the optimal tax rate? Under what conditions might you prefer a policy other than a direct tax on emissions in this setting?

(c) Write down a simple economic model that you would recommend using to calculate the value of the NMS to the social planner, and explain how you would use it. You do not need to fully solve it, the point is the setup. Assume that if the system is not built, the policy intervention will be a tax on output, but if the system is built, the policy intervention will be a tax on emissions. Explain what features you would include in your model and why, and, to the extent possible, write down an expression for this value and/or the related optimization problems.

Question 4 Reed

ARE 264: Empirical Energy and Environmental Economics

Reed Walker

Spring 2022

Directions: please read through all the questions prior to starting this section to be able to appropriately balance your time. Please be concise in your response to questions.

1. [10 points] When exploring the social costs of pollution externalities, researchers often explore treatment effect heterogeneity (i.e. are some groups more sensitive to the treatment than others).
   (a) When damage functions are non-linear, it is often difficult to separate out heterogeneity in damages based on non-linear dose-response from other forms of heterogeneity in damages. Why?
   (b) Attributing causal interpretations to heterogeneity can be difficult. Why?
   (c) Describe empirical setups or lessons from papers that attempt to address these issues in a compelling way.

2. [10 points] In early, pathbreaking paper Mendelsohn, Nordhaus, and Shaw (1994) demonstrated how to use hedonic methods to value climate impacts. They use what they call a "Ricardian" approach: Basically the distinction of studying land rents rather than ag production
   (a) Why is the Ricardian approach useful for thinking about climate risk and adaptation?
   (b) What are empirical challenges associated with Ricardian approach, as implemented by MNS (1994), and how did the literature (or how would you) attempt to address these challenges?

3. [10 points] Consider a simply Cobb-Douglas production function with static (L) and dynamic (K) inputs. Let A be a hicks-neutral productivity shifter.

$$Q = AL^{\alpha}K^{\beta}$$

   Setup a cost-minimization problem using this production technology, and show how the first order condition for a variable input can be used to relate firm markups to output elasticities and an input's share of revenue

4. [5 points] Ganapati, Shapiro, and Walker explore the pass-through of energy input costs into output prices using data from US manufacturers. Why is pass-through a useful statistic from a policy or research perspective?

5. [5 points] Many polluting firms are thought to have some form of market power. Describe two implications of market power for the design and implementation of environmental policies