Environmental and Resource Field Exam

Thursday, May 24th

1:00pm-4:00pm

Room 248 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

Question for ERE field exam

Use an optimal control problem to (i) model the competitive equilibrium of a price-taking fishery with perfect property rights; (ii) explain how you would analyze this model; and propose a specific question (e.g. about comparative statics or dynamics), explaining how you would answer that question.

Your problem formulation must identify the state variable and the control variable; it must include a description of the flow payoff, the equation of motion, and the discount function. Formulate the model in either discrete or continuous time (your choice). Depending on that choice, your answer to parts ii and iii might use the Maximum Principle and phase portrait analysis, or dynamic programming and numerical methods.

Question 2

**Question : Siting, sorting, and the inequitable distribution of environmental nuisance**

There is a strong and well-documented correlation between pollution exposure, poverty, and race in the United States. This has fueled efforts to incorporate environmental justice concerns into the fabric of air quality regulations. However, an effective policy response requires an understanding of underlying mechanisms.

In class we discussed two possible mechanisms: (1) Discriminatory siting of polluting facilities could explain inequitable exposure; (2) Post-siting housing market sorting provides an alternative explanation if poor air quality is associated with low housing values and low income households sort into relatively affordable (albeit unhealthy) neighborhoods.

A growing empirical literature seeks to discern the relative importance of these two explanations.

1. One empirical approach uses geographically aggregated (e.g., census tract) data to look for evidence of nuisance-driven changes in demographic composition. Let $\Delta P_i^d$ represent the change in population share for demographic group $d$ living in census tract $i$ over some period of time. $\Delta X_i$ captures changes in other factors (such as crime rates, school quality, demographic pre-trends). $\Delta Q_i$ captures changes (ideally exogenous) in environmental quality in census tract $i$.

$$\Delta P_i^d = \beta' \Delta X_i + \theta \Delta Q_i + u_i$$

Suppose the estimated $\theta$ coefficient is negative and statistically significant for disadvantaged minority groups, suggesting that minority population shares increase as measured environmental quality declines.

**Why might we be concerned about interpreting this as evidence that minority groups "come to the nuisance" to meet housing needs? Please be precise in your answer.**

2. An alternative empirical strategy imposes more structure on the underlying neighborhood choices that drive changes in demographic composition. For example, Depro et al. (2015) specify the mean utility from living in location $k$, $\delta_k$, as a function of observable attributes of that location ($X_k$), a structural error unobserved by the econometrician ($\xi_k$), and a vector of preference parameters $\beta$.

$$\delta_k = f(X_k, \xi_k; \beta) \tag{1}$$

The change in utility an individual $i$ currently living in location $k$ receives from moving to location $j$ is given by:

$$U_{i,j} - U_{i,k} = (\delta_j - \delta_k) - \mu MC_{j,k} - (\eta_{i,j} - \eta_{i,k}) \tag{2}$$

where $MC_{j,k}$ is the monetary cost of moving from $k$ to $j$. Assume for the purpose of this question that this moving cost can be accurately measured.

Assume households choose neighborhoods to maximize latent utility. Further assume that the $\eta_{i,k}$ are independently and identically distributed Type I extreme value. **Show how these assumptions about the underlying economics and the statistical properties of the error terms allow researchers to derive equations that determine the share of households who move to each location $j$ (thus allowing them to estimate the parameters of the individual neighborhood choice model using geographically aggregated population shares).**

3. Using estimation methods and algorithms we discussed in class, mean utility parameters $\delta_k$ are estimated separately by racial group. Ultimately, we are interested in testing whether MWTP to avoid pollution risks varies significantly across groups (consistent with neighborhood sorting). One complication is that the $\delta_k$ are not directly comparable across groups. Explain why. **How can this identification problem be addressed in this setting? (If you cannot remember the specifics of the strategy deployed in the Depro et al. paper, discuss how this identification problem can be addressed more generally).**

Question 3

# Qualifying Exam: Question from ARE 264, Module 1 (Walker)
# Spring 2018

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 them. Each of the six parts is worth the same number of points.

1. Dell, Jones, and Olken, (2012) suggest that warming a country's climate harms low-income countries more because they have greater vulnerability to climate. Burke, Hsiang, and Miguel (2015) suggest that warming a country's climate harms low-income countries more because poor countries tend to be hotter and damages are nonlinear in temperature. If vulnerability to heat results from being poor, then policies might focus on reducing future vulnerability by reducing future poverty, whereas if nonlinearities generate high marginal effects of heat regardless of income, then policies might focus on reducing overall exposure to heat by mitigating climate change.

    - Who is correct? Increases in temperatures disproportionately impact low-income countries. Increases in temperature disproportionately impact warmer countries. Warmer countries are also mostly low-income. How would you go about adjudicating between the two, given that high temperatures and low per-capita incomes are nearly perfectly correlated in the cross-section?

2. The hedonic model is often used to value non-market amenities (e.g. air pollution). Greenstone and Gallagher (2008) use hedonics to explore the welfare consequences of Superfund remediation.

    (a) The researchers rightly point out that Superfund cleanups are endogenous. Describe their research design and the way they circumvent the endogeneity problem.

    (b) The primary findings of Greenstone and Gallagher (2008) pertain to housing price appreciation after Superfund remediation. However, they also focus on the size of the housing stock before/after remediation. What is the role of housing stock in their simple welfare framework?

3. We discussed in class how researchers use assumptions about firm cost minimization to estimate firm-level markups from a production function. Setup a cost-minimization problem using the following Cobb-Douglas production function

$$Q = AK^{\alpha}L^{\beta}$$

    where output $Q$ is related to capital inputs $K$, labor inputs $L$, and a productivity shifter $A$. Using the first order condition of the cost minimization problem, show how a plant-level markup is related to both the output elasticity of the production function ($\beta$) and also the labor expenditure share of total revenue ($\frac{wL}{PQ}$), where $w$ are per unit wage costs, $r$ are per unit capital costs, and $P$ is the plant output price.

4. Consider the stylized duopoly model outlined in Fowlie (2009). Meredith used this model to deliver insights into the welfare implications associated with incomplete environmental regulation. In her example, duopolists have emissions $e_1$ and $e_2$

- Marginal costs $C_i'(q_i) = c_i \quad i = 1, 2$
- Demand $P(q_{low} + q_{high}) = a - bq_1 - bq_2$
- $\tau$ represents marginal damages of emissions $e_i$

One can define total welfare as gross consumer benefit from consumption less production costs less monetized damages from emissions

$$W(d_1, d_2) = \int_0^{Q(d_1,d_2)} D(s)ds - \sum_{i=1}^{2} c_i q_i(d_1, d_2) - \tau \sum_{i=1}^{2} e_i q_i(d_1.d_2).$$

where $d_1$ and $d_2$ index whether firm $i$ is regulated (i.e. $d_i = 1$) or unregulated (i.e. $d_i = 1$). The regulator will only want to introduce the incomplete regulation if doing so improves welfare. With this setup one can consider the change in welfare from some incomplete regulatory policy $W(1, 0)$ relative to a completely unregulated benchmark $W(0, 0)$

$$W(1,0) - W(0,0) = \int_{Q^B}^{Q^{COMP}} P(s)ds + \frac{\tau}{3b}\left(e_1(3c_1 - 2\overline{c})\right) + \frac{\tau^2}{3b}(3e_1^2 - 2e_1\overline{e}).$$

(a) Describe in words what each of the three terms on the right hand side of the equation represent.

(b) What are the signs of each of these three terms (positive, negative, or indeterminate)?

(c) Under what conditions will this expression be $> 0$? Please use words in place of math.

5. In a paper with Joe Shapiro and Sharat Ganapati we explore the relationship between plant energy costs, marginal costs, markups, and output prices . The table below shows regression estimates of log(marginal cost) regressed on interactions between state electricity generation shares and log(fuel prices). Interpret the coefficient on the gas price ×gas share coefficient.

| | Lag (t-0) (1) |
|---|---|
| Coal Price × Coal Share | 0.092 |
| | (0.387) |
| Gas Price × Gas Share | 0.779*** |
| | (0.175) |
| Oil Price × Oil Share | 0.136 |
| | (0.341) |
| Plant FE | X |
| Year FE | X |
| State Trends | X |
| Region-Year FE | |
| Product-Year FE | |

Question 4

# Qualifying Exam: Question from ARE 264, Module 2
# Spring 2018

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 them. Each of the six parts is worth the same number of points.

(a) Consider a standard pollutant where each unit of emissions causes a constant marginal external cost on society that is uniform across many possible sources of emissions, where emissions come from the production process of some good.

**True or false:** In this setting, an emissions tax will always be more cost effective than a performance standard (e.g., a limit on emissions per unit of output). Explain.

(b) Consumption of Scelero causes a negative externality equal to $\phi$ per unit. A government is considering imposing a tax on Scelero to maximize social welfare, but consumers of Scelero are known to make mistakes in comprehending the prices of the good. Assume that Scelero is sold in a competitive market with an upward-sloping aggregate supply curve, and a downward-sloping aggregate marginal benefit curve (i.e., true marginal benefits are declining).

(i) Suppose that consumers accurately understand the pre-tax price of Scelero, but they under-perceive taxes, so that they perceive (i.e., make decisions based on) a price equal to $p + \theta t$ where $p$ is the pre-tax price, $t$ is the tax, and $0 < \theta < 1$. Will the optimal tax on Scelero be larger than, smaller than, or equal to $\phi$? Explain.

(ii) Suppose alternatively that consumers accurately perceive taxes, but that they are confused about the pre-tax price because of add-on pricing or some other shrouded attribute. Now, consumers perceive a price equal to $\gamma p + t$, with $0 < \gamma < 1$. In this case, will the optimal tax on Scelero be larger than, smaller than, or equal to $\phi$? Explain.

(c) A set of price-taking firms indexed $1, ..., J$ use two inputs to create a homogenous output $q$ that is purchased by price-taking consumers. One input $N$ is clean (no externality), and the other input $D$ is dirty. The dirty output causes an externality equal to $\phi$ per unit of $D$. All firms have the same production function, $q(N, D)$ which is increasing and concave in both arguments, with a positive cross-partial derivative. But, $N$ is a local input, the price of which varies across locations, while $D$ is a national input with a uniform price across firms. As a result, in the no-policy baseline, firms use different ratios of $N$ and $D$ per unit of $q$.

(i) Briefly describe the different ways in which the private market is inefficient due to the externality in this setting. (I.e., what are the margins of adjustment that can improve social welfare?)

(ii) Suppose the planner has only one policy instrument, a uniform (i.e., the same for each firm) tax on $D$. Describe the optimal tax on $D$ intuitively and mathematically.

(iii) Suppose the planner has only one policy instrument, a uniform (i.e., the same for each firm) tax on $q$. Describe the optimal tax on $q$ intuitively and mathematically.