

## Resource & Environmental Economics Field Examination

**May 2021**

Instructions:

You have 4 hours to complete the exam. This time commences at the end of a 15-minute reading period during which no writing is allowed.

Please place your assigned "alpha letter" on every page so we can identify your exam. Do not add your name, social security number, or UIN. Write on only one side of the page, leaving at least one-inch margins. Number each page and make sure the pages are in order.

Answer **four** of the following five questions.

1. You are asked to do a study on how climate change is likely to affect the damages that weeds impose on crops
  - a) What techniques could you use to estimate the effects of climate change on weed incidence? List the strengths and shortcomings of each of these techniques.
  - b) Suppose you had estimates of the effects of weeds on crop yields. What techniques could you use to see the damages from the increased weed populations on welfare derived from crop production and consumption? Assume you also have the results from part a above. What are the strengths and weaknesses of the techniques you mention?
  
2. Trading of greenhouse gas offsets is commonly discussed as an important mitigation approach
  - a) Why is fungibility of mitigation options an important issue when considering adding agricultural emissions into trading markets?
  - b) Could you do anything in market design to take fungibility into account?
  - c) The U.S. Farm Bureau has said that all farmers should be paid for storing carbon by changing tillage even if they have used that tillage method for years. Does this proposal have economic merit?
  - d) How would implementing the proposal in c) (i.e., paying all farmers) affect the cost of carbon?
  
3. You have been asked to estimate the economic cost of wild fires in forests that are in the mountains that surround a city. Due to poor forest management and climate change, fires have gotten substantially worse in the last two decades. The purpose of your study is to determine whether the city should expend substantial city resources to fight the fires.

There is a variety of impacts of the fires.

First, they diminish air quality in the city. Because winds blow from west to east, when fires occur they substantially diminish air quality in the western part of the city, with little effect on air quality in the eastern part.

Second, fires obviously affect where people can go to hike and camp. There are 8 zones around the city, North, North-East, East, South-East, South, South-West, West, North-West (N, NE, E, SE, S, SW, W, NW). If a fire occurs in one of the zones, then all destinations within that zone are closed.

Third, the fires have had a significant effect on wildlife in the mountains. Interestingly, some species have been hurt by the fires, while others have benefitted.

Your goal is to obtain a comprehensive value of the damages of the wild fires. You have access to very rich data and can carry out surveys as required. Describe the study or studies that you would carry out, including

- a) the value(s) you would be estimating and the population(s) who have these values;
- b) a brief description(s) of the theoretical model(s) underlying any values that you estimate;
- c) a brief description of the data you would need; and
- d) a brief description of the econometric models that you would use.

4. There is increasing interest in technology to capture CO<sub>2</sub>, say  $z_t^C$ , to mitigate climate change. Given that CO<sub>2</sub> accumulates continuously in the atmosphere, causing cumulative damages, reducing CO<sub>2</sub> will have benefits that extend into the distant future. At the same time, CO<sub>2</sub> emissions, say  $z_t^E$ , lead to valuable economic activity. You can assume that the functions describing the cost of carbon capture,  $c(z_t^C)$ , and how emissions generate benefits,  $u(z_t^E)$ , are known and constant over time.
- Develop a parsimonious theoretical model that would be used to identify the optimal level of carbon capture technology.
  - Using this model, describe the optimal relationship between emissions and carbon capture.
  - If you wanted to provide a subsidy for carbon capture, how would you calculate the optimal unit price that businesses that provide carbon capture should be paid?
  - Suppose that you are able to identify the optimal rate at which net emissions should be allowed. A system has been proposed in which emissions,  $z_t^E$ , are capped, but emitters are allowed to purchase additional rights to emit from the carbon capture industry. Using your model, show whether such a system could lead to the optimal levels of  $z_t^E$  and  $z_t^C$ .
5. The electricity market in Texas is composed of a wholesale market, in which generators sell electricity to utilities, and a retail market, in which utilities sell electricity to end-users (households, businesses, etc.) In the wholesale market, the price of electricity changes every minute and reflects the real-time cost of generating electricity. Assume that the most efficient generators are also those with lowest cost, so when demand for electricity is high, the system operator has to dispatch generators that are less efficient (higher cost). In the retail market, most consumers (over 90%) sign up for fixed-price contracts, in which the price they pay for electricity does not vary with time of day or system conditions.
- What is the economic inefficiency in this market and, based on this inefficiency, how does the actual market equilibrium compare to the socially optimal equilibrium?
- Suppose that the state legislature is considering some reforms. Specifically, the legislation would transition retail customers to one of two pricing plans: either a) real-time prices, where prices would change very frequently—say, every five minutes—to reflect real-time system conditions or b) variable-rate prices, where prices would change depending on time of day or season (peak/off-peak), but much less frequently than under the real-time pricing plan.
- Discuss the costs and benefits of each plan.
  - Given the costs and benefits you identified in i), which plan would result in higher social welfare?
  - Under what conditions would the plan you identified in ii) be better than the status quo (i.e., fixed-rate pricing)? Be sure to specify what “better” means.