# Environmental Economics Practice Questions

Matthew Gordon and Helene Ollivier

## 1 Practice Question 1

Wetlands may protect households from flooding due to hurricanes and rising sea levels. In Taylor and Druckenmiller (2022), the authors use a hedonic regression to evaluate the benefits of wetland preservation for storm protection.

a) Write down a simple hedonic regression that could be used to evaluate these benefits. Define key variables, and interpret the coefficients.

b) What data would you need to estimate such a regression?

c) Assess the internal validity of your approach. What are the key identification assumptions? Are they plausible? What would an ideal randomized experiment look like to measure household benefits of wetlands?

d) Assess the external validity of your approach. How would you address the Lucas critique that we can never learn anything by looking at estimates based on historical data?

e) How would you expect the following changes to affect your regression coefficients:

   1) The introduction of a highly subsidized flood insurance program
   2) Improvements in weather forecasting technologies
   3) The introduction of new technologies that make it feasible to remove greenhouse gases from the atmosphere at a low cost.

f) Imagine the government decides to finance a large wetland restoration campaign based on these findings. Why might this project induce moral hazard? How could they finance such a project in a way that reduces this issue?

## 2 Practice Question 2

In Meghir et al (2019) researchers conducted an RCT providing free bus vouchers to low-income rural households in Bangladesh. The vouchers allowed households to migrate to nearby urban areas to look for work during the 'lean-season' - the time of year when food shortages are particularly acute.

a) Consider a household's decision to migrate seasonally. What are the main factors that would go into such a decision. Write down an outline of a model that captures some of these considerations (e.g. no need to specify functional forms, just write what household utility would depend on, key constraints, etc. . . )

b) Would you expect richer households or poorer households to be more likely to use the subsidy? Explain why, referencing your model.

c) Interpret this table from the paper (the dependent variable is consumption). What are the researchers testing for? What did they find?

Table 4: Effect of migration incentives on the exposure of consumption to income

| | Round 4 | | | | Diff in Diff | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log income (round 4) | 0.157*** | 0.169*** | 0.130*** | 0.140*** | 0.112** | 0.109** |
| | (0.027) | (0.028) | (0.028) | (0.029) | (0.054) | (0.046) |
| Treatment effect on log income | -0.073*** | -0.066** | -0.072*** | -0.061** | -0.077 | -0.099** |
| | (0.027) | (0.027) | (0.027) | (0.026) | (0.061) | (0.046) |
| Village-round FE | X | X | X | X | X | X |
| Household FE | | | | | X | X |
| Household head controls | | X | | X | | |
| Resource controls | | | X | X | | |
| Includes baseline | | | | | X | X |
| Includes 2013 | | | | | | X |
| Observations | 1857 | 1857 | 1857 | 1857 | 2166 | 4371 |
| R squared | 0.186 | 0.221 | 0.217 | 0.267 | 0.791 | 0.721 |

*Note:* Table presents coefficients of the effect of log annual per capita income on log annual per capita consumption and the interaction with treatment ($\beta_0$ and $\beta_1$ from Equation 2). All models control for village fixed effects and all other interactions between treatment and log income as well as log income interacted with 2011 treatments. Column (2) additionally adds household head controls, column (3) adds household resource controls, and column (4) adds both household head and resource controls. Columns (5) and (6) show the result of difference-in-difference specifications, with the first coefficient shown being the interaction between log income and round 4, and the second coefficient shown being the interaction between treatment, log income, and a post-experiment indicator. Column (5) includes baseline data, and column (6) includes both baseline and 2013 data, and both include household fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

d) These results could be said to contradict the Munshi and Rosenzweig (2016) paper we discussed in class, which argues that rural risk sharing networks are the cause of the large urban-rural wage gap in India. Why? How could you reconcile the two?

# 3 Practice Question 3

Farmers in the Sahel decide whether to plant maize – a high-yielding crop that requires sufficient rainfall, or sorghum – a crop with lower average yields that is more drought resistant.

a) What are the main factors that would go into such a decision? Write down an outline of a model that captures some of these considerations (e.g., no need to specify functional forms, just write what household utility would depend on, key constraints, etc.).

b) Among two different groups facing similar climatic conditions, one grows mostly maize, and the other grows mostly sorghum. If you ran the following regression on each group separately, for which group would you expect $\beta$ to be larger:

$\log(consumption_{it}) = \beta \log(income_{it}) + \mu_i + \gamma_t + \epsilon_{it}$

where $\mu_i$ is a household fixed effect, and $\gamma_t$ is a year fixed effect.

c) A famous researcher runs a regression of drought on sorghum yields using the following model:

$\text{Yields}_{it} = \beta_1 DroughtIndex_{it} + \beta_2 DroughtIndex_{it} \times time + \mu_i + \gamma_t + \epsilon_{it}$

where $i$ denotes regions and $t$ denotes years. They find a negative coefficient on $\beta_1$ and a null effect for $\beta_2$. The researcher argues this shows farmers are not adapting to climate change. Why do they say that? Why might they be wrong?

d) Imagine running an RCT that tests the effects of providing these farmers with long-term forecasts that can accurately predict seasonal rainfall before the planting season. What would you expect the effects to be? What would they depend on? Write down a regression model that could test your hypotheses.

# 4 Practice Question 4

Compare two potential policies to regulate air pollution in the electricity sector: a command-and-control policy that would require all power plants to install pollution abatement equipment, or a cap-and-trade program that would allow power plants to trade permits for emissions. Assume both policies would reduce pollution by the same amount. Which policy would you advise the following actors to pursue and why?

- The government of Mongolia has a single large coal plant that produces most of the nation's electricity.
- The government of Japan has large baseload power plants in major urban centers (high marginal abatement costs) and less-utilized coal plants in low-population rural areas.
- Imagine that you have a dataset that allows you to estimate marginal abatement costs for every power plant in the US. Some states are exposed to a cap-and-trade program, and some states have command-and-control. Assume the policy regime is randomly assigned.

  What would you expect the distribution of abatement costs to look like under each regime? Write down a regression to test your hypothesis (hypotheses?).
- Imagine you saw no differences in your estimates. What would be some possible reasons why?

# 5 Practice Question 5: Essay

Why does incomplete environmental regulation have ambiguous effects on total emissions in a market with imperfect competition? Present arguments that would yield higher total emissions after the regulation and arguments that would yield lower total emissions.

# Suggested Answers:

# Practice Question 1

a) A simple hedonic regression:

$$P_i = \alpha + \beta W_i + \gamma X_i + \epsilon_i$$

where:

- $P_i$: Property price for household $i$,
- $W_i$: Wetland coverage or proximity,
- $X_i$: Control variables (e.g., income, property characteristics),
- $\beta$: Marginal willingness to pay for wetland benefits.

Interpretation: $\beta$ represents the effect of wetlands on property prices, holding other factors constant.

b) Required data:

- Property transaction prices,
- Geographic and environmental data on wetland coverage,
- Socioeconomic variables (income, demographics),
- Property characteristics (size, age, etc.).

c) Internal validity:

- Key assumption: Wetland proximity is exogenous.
- Threats: Omitted variable bias, reverse causality.
- Ideal experiment: Randomly allocate wetland restoration projects and measure changes in property prices.

d) External validity:

- Lucas critique: Historical data may not reflect future conditions.
- Response: Combine historical analysis with structural models to predict changes under future scenarios.

e) Effect of changes:

1) Subsidized flood insurance: Decreases $\beta$, as wetland benefits may be less valued.
2) Better weather forecasting: Likely decreases $\beta$, as reliance on wetlands for storm protection diminishes.
3) New greenhouse gas technologies: Possibly decreases – if climate change is easier to address, probability of large future storms is lower, so benefits of wetlands are also lower.

f) Moral hazard and financing:

- Moral hazard: Households may build in risky areas, expecting protection.
- Solution: raise taxes on developments that are protected by new wetlands.

# Practice Question 2

a) Many possible answers. One example:

$$U = U(C, V_C)$$

Subject to:

$$C \leq Y - M$$

C is consumption, $V_C$ is the variance in consumption, Y is income and M is migration costs. Assume urban income > rural income, urban income variance > rural income variance. Migrate if:

$$U_u = U(C_u, V_{Cu}) > U_r = U(C_r, V_{Cr})$$

b) Many acceptable answers:

- Poorer households may use subsidies more due to liquidity constraints.
- Richer households may be less reliant on rural risk sharing networks due to savings.

c) Table interpretation: This is a test of risk sharing, similar to the Townsend test. The null hypothesis on the coefficient on income is that income is uncorrelated with consumption (perfect risk-sharing or consumption smoothing). This null is rejected - income is correlated with consumption. However treatment reduces the coefficient on log income, in other words the migration subsidies improve risk sharing.

d) Munshi and Rosenzweig (2016) argued that migration meant leaving the rural risk sharing network. Urban incomes are higher, but households that migrate are no longer insured by the caste network. This paper finds that migration subsidies improve risk sharing. A possible reconciliation is that the migration in this paper is temporary seasonal migration, so households do not lose access to the risk sharing network.

## Practice Question 3

a) Model for crop choice:

$$U = U(C, V_C), Y_S \sim N(\mu_s, \sigma_s), Y_M \sim N(\mu_M, \sigma_M)$$

$$C < Y$$

$Y_S$ is income from sorghum, $Y_M$ is income from maize, and $\mu$ and $\sigma$ are the mean and standard deviation of income for each crop respectively. Assume

$$\mu_M > \mu_S; \sigma_M > \sigma_S$$

and that utility is increasing in average consumption but decreasing in the variance of consumption.

b) If we assume the groups are equally risk averse, the group that is growing maize is likely to have access to better means of smoothing consumption, so $\beta$ would be lower.

c) Climate change adaptation:

- Negative $\beta_1$: Yields decline with drought.
- Null $\beta_2$: Marginal effect of drought on yields is not changing over time.
- Counterargument: Adaptation may occur through other means - perhaps farmers have developed better insurance schemes, or are planting less sorghum.

d) Farmers that expect a bad year and get good news might switch to maize. Farmers that expect a good year and get bad news might switch to sorghum. Other answers also possible.

$$CropChoice_{it} = \alpha + \beta_1 Forecast_{it} + \beta_2 Prior + \beta_3 Forecast \times Prior + \epsilon_{it}$$

Where Prior reflects the farmer's pre-forecast expectations.

## Practice Question 4

a) In Mongolia, command-and-control preferred: Single large plant simplifies enforcement, no gains from trade.

b) Japan: Possibly also command and control preferred. Cap and trade would lower pollution by more in the rural areas with lower population, due to the lower marginal abatement costs in those plants.

c) Would expect the variance of abatement costs to be lower in states with cap and trade.

$$Var(AbatementCost_{ij}) = \alpha + \beta CapTrade_j + \epsilon_{ij}$$

d) Many possible answers, perhaps plants all have similar technologies, so abatement costs don't differ by very much and command and control is equally efficient.

# 6 Practice Question 5

Possible answers:

- Leakage to unregulated firms
- Leakage to unregulated plants within same firm
- Composition effects: change in industry mix
- Composition effects: shift of production toward more efficient firms within industries
- Technique effects: green technologies change production technology/efficiency + learning spillovers
- Production networks: changes in intermediate firms affect downstream firms
- Changes in market power changes production decisions