Environmental Economics: Models, Data, and Policy Design

Syllabus

Course information

Class name: This class used to be called "Empirical Environmental Economics." We changed the name, but it's the same class!
Course numbers: ECON 177, SUSTAIN 130/230.
Class times and locations: Mondays and Wednesdays from 3:30-5:20PM in Lathrop 282. Friday classes 9:30 to 10:20AM and 10:30-11:20AM in STLC 115. Students may choose which Friday class they prefer to attend each week.
Final exam time: Wednesday, December 9, 2026, from 7-10PM in Lathrop 282.
Canvas site: https://canvas.stanford.edu/courses/214576.
Prerequisites: You must have experience with regression analysis (e.g., ECON 102 or 108, CS 129, EARTHSYS 140, HUMBIO 88, POLISCI 150C, or STATS 60 or 101).

If you plan to take microeconomics (e.g., ECON 1, 50, or 51) or a class on intro to programming in R, we recommend you take those either beforehand or concurrently. If you have no economics background, you may still be comfortable in class if you are strong in math, statistics, and/or computer science. If you have not used R before, that is OK: we will guide you from the beginning. If you have used R before, you can still learn a lot in this class through the applications.

This class can satisfy requirements in the following majors (and possibly others):

- Economics major Field Course
- Economics major Certificate in Environmental Economics
- Data Science BS Technical Elective
- Data Science BA Climate and Environment pathway option
- Earth Systems BS Human Environmental Systems track option
- Design BS Breadth in Discipline / Climate and Environment Pathway
- STS BS and BA Depth in Discipline
- Sustainability MS and MA Core Program Requirement
- Civil & Environmental Engineering BS Atmosphere and Energy Track, Energy Core
- Civil & Environmental Engineering MS Atmosphere and Energy Track, Energy Core
- WAYS - Social Inquiry

Teaching team

Professor: Hunt Allcott
Website: allcott.stanford.edu
Email: allcott@stanford.edu
Please call me "Professor Allcott." After you graduate, please call me "Hunt."
We'll have gatherings at my home and also office hours throughout the quarter. The sign-up sheet and list of times is here.

Teaching Assistants:

- James Han: jamhan@stanford.edu
- Anna Tavakolian: annatav@stanford.edu
- Zahra Thabet: zthabet@stanford.edu

Office hours:

- Fridays 2-4PM; 4-6PM

Course overview

Are you interested in environmental and energy policy? Do you want to improve your data science skills? If so, Environmental Economics is for you.

In the first few weeks of class, you'll use data and microeconomic modeling to quantify the harms from pollution, including estimating the social cost of carbon emissions. For the rest of the quarter, you'll use more data and microeconomic modeling to evaluate major environmental policies such as pollution taxes, cap-and-trade programs, and subsidies for clean technologies. You will consider overall benefits and costs as well as distributional equity, which can inform discussions of environmental justice. You will learn and practice useful data science skills, including applied econometrics/causal inference methods (e.g., difference-in-differences, instrumental variables, and regression discontinuity) and equilibrium modeling.

The class has weekly problem sets involving data analysis in R, plus a final paper. Class sessions feature active learning, discussions, and small-group case studies. You should only enroll if you expect to attend regularly and complete the problem sets on time. The final paper is a great way to generate ideas for and get started on a senior thesis.

Comparison to related classes

- Econ 155, "Climate Change and Global Inequality," spends more time on issues in developing countries.
- Econ 175: "Environmental Economic Theory," focuses more on mathematical theory.
- GEP 29, "Economics for Sustainability," is more introductory.
- CEE 173S, "Electricity Economics," focuses specifically on the electric power sector.
- Econ 177, "Environmental Economics: Models, Data, and Policy Design" (this class), helps you learn and implement data analyses methods in a way that many people find valuable for their careers – but this takes more work each week.

Learning goals

Through active engagement in this course, you will:

1. Be able to qualitatively explain how environmental policy design choices impact economic efficiency (overall benefits and costs) and social equity.
2. Be able to quantitatively evaluate major environmental policies in terms of both efficiency and equity.
3. Develop data analytics skills, including finding/cleaning/manipulating data, applied econometrics & causal inference (e.g., difference-in-differences, instrumental variables, and regression discontinuity), and equilibrium modeling, that are useful for a wide range of applications (not limited to environment & energy).
4. Build new connections and friendships with a community of people interested in data science and sustainability.

Course materials

Poll Everywhere: Sign up for an account at polleverywhere.com.

Google forms: We'll use google forms to submit results of some in-class case-studies. If you don't have a google account, you'll need to sign up for one here.

Computer: Bring your laptop computer to class every day to answer polls and work with data. You'll need to be connected to WiFi and have Poll Everywhere working when class starts.

If your computer is open during each class time, you should close all apps and windows other than those that we are using for class. Your smartphone should be put away during class except if you are using it for polls.

Data analysis software: we will use R for demonstrations in class. Thus, we suggest you use R as well, and you might use RStudio for code development. If you prefer, you can instead do the problem sets in other software packages (Stata, python, etc.).

Textbook: There is no required textbook. All readings will be available online or through Canvas.

Grading and deadlines

This is a five-unit course, which means that you can expect 15 hours of work per week, including class time. Grading will not be on a curve; if everyone does well, everyone will get a good grade. The table below summarizes the work and contribution to the overall course grade. All deadlines listed below are at 11:59PM Pacific Time.

The class is the same for graduate students enrolling in Sustain 230, except that our expectations (and grading standards) for the final project will be at the graduate level.

Category	**% of grade**	**Notes**
Class participation (measured through PollEverywhere and Google Forms responses)	15%	• Polls will be part of your grade starting the second week of class. • There will typically be multiple polls per day. Often there is no right answer; in these cases you get credit for any response. If there is a right answer, you'll get more credit for the right response. • Sometimes the software doesn't work well, or you have to miss class for an interview or competition or because you are sick. Thus, we will drop the two class days on which you have the lowest scores. • We will typically have polls at the very beginning of class.
Problem sets	30%	• There will be up to nine problem sets, due each Monday (at 11:59PM Pacific Time). • A fundamental (and fun) part of the class is to discuss the problem sets on Tuesdays in class. Thus, (i) no credit can be awarded for submissions received after class begins, and (ii) assignment extensions are not possible and would constitute what Stanford calls a "fundamental alteration of the course." • Late submissions will receive partial credit that declines linearly

Category	% of grade	Notes
		from 100% if submitted on time to 0% if submitted at the beginning of class on Tuesday, i.e. 100% – (hours late) / 16.5. ● The one exception is that any students who join the class late can submit any problem sets they missed by the Monday after they join. ● When computing grades, we will give only 25% of the usual weight to the one problem set on which you have the lowest grade.
Final project	25%	The 25% is divided into: ● 4% for research questions memo, due Wednesday, October 22, 2025. ● 4% for hypothetical draft introduction and literature review, due Thursday, November 13, 2025. ● 4% for data description and empirical strategy, due the Monday before Thanksgiving (November 24, 2025). ● 8% for final paper, due the Saturday at the end of finals week (December 13, 2025). We can't accept this late because we need to submit grades to the registrar soon after. ● 5% for verbal discussion of final project during final exam time. See below for details on the final project.
Final exam	30%	● There will be a final exam covering material from the entire quarter.

Course policies

1. **Honor Code**: The teaching team and students follow the Stanford Honor Code.
2. **Common syllabus**: We follow the policies in Stanford's economics common syllabus (including the policy on correcting any errors in grading).
3. **Attendance**: We hope to make the class time useful and fun. We expect that everyone will attend class (including Fridays) except in exceptional circumstances, such as an interview, a competition, or because you are sick.
4. **Random calling:** Every day in class, we'll discuss the readings, problem sets, and other things. During these discussions, we'll randomly select students to share their thoughts with the class. We do random selection instead of asking for volunteers because it helps engage everyone, not just a few people. We'll be nice when we call on you, and it's totally OK if you don't have the right answer.
5. **Emergencies:** The teaching team wants to do everything we can to accommodate diverse personal situations. The teaching team can extend assignment deadlines or modify course requirements in exceptional situations, such as the death of a family member or a medical emergency. Please email the TA, cc'ing Professor Allcott, if such a situation arises.

In any given quarter, many of us will have other personal events that are less severe than these two examples. It can be hard to assess the severity of these situations in a way that is fair to everyone, so we usually don't extend deadlines or otherwise modify course requirements. However, the teaching team stands ready to support you and help you catch up on the materials.

6. **Accessibility:** Stanford is committed to providing equal educational opportunities for disabled students. Disabled students are a valued and essential part of the Stanford community. We welcome you to our class.
   If you experience disability, please register with the Office of Accessible Education (OAE). Professional staff will evaluate your needs, support appropriate and reasonable accommodations, and prepare an Academic Accommodation Letter for faculty. To get started, or to re-initiate services, please visit oae.stanford.edu.
   If you already have an Academic Accommodation Letter, we invite you to share your letter with us. Academic Accommodation Letters should be shared at the earliest possible opportunity so we may partner with you and OAE to identify any barriers to access and inclusion that might be encountered in your experience of this course.
   (You probably know that the above is standard language, but we agree wholeheartedly, and please let us know how we can help.)
7. **Online resources and AI.** We encourage you to use AI tools such as ChatGPT. Of course, you should not let this resource diminish your learning. The in-class polls and final exam will measure how much you've learned the material.
8. **Group work:** We encourage you to do the problem sets in groups, and for the final project, you are welcome to ask the same research question as others and share ideas and data sources. However, you must submit your own individual problem sets and final projects.
9. **Questions and discussion board**: We've set up the Discussions page on Canvas. If you have questions about the problem sets, please post them there instead of emailing us. Many others may have the same questions, so your questions benefit everyone!

Community building and support

In addition to covering the material, one of our goals for the quarter is to build a community of students and faculty interested in environmental economics. We hope you'll come to office hours, even if you don't have a specific question – we're happy to discuss broader issues around environmental economics, career options, etc. We look forward to getting to know you!

Schedule and readings

Every week has a different topic but the same structure:

1. Monday night:
    a. Problem sets due. Problem sets include both data analysis on last week's topic and short questions on the reading for the upcoming week.
    b. Readings:
        i. Lecture notes: *before class*, you should (i) skim the lecture notes and (ii) be able to answer the discussion questions listed at the end. *After class*, you may need to refer to these notes to complete the problem set.
        ii. Readings other than lecture notes: you should read and understand these *before class*.
2. Tuesday class: discuss and extend the problem set that was due the night before, then introduce the week's topic.
3. Thursday class: further discussion of the week's topic.
4. Friday class: recap of week and programming insights for the problem set.

We will regularly use the following references:

- Allcott, Hunt (2024). Environmental Economics Lecture Notes.
- Brown, Matt (2023). R for Applied Economics: A Beginner's Guide
- Cunningham, Scott (2023). Causal Inference: The Mixtape.
- Harris, Jonathan, and Brian Roach (2018). Environmental Economics: A Contemporary Approach. Available from Canvas/readings/.

Part I: Valuing the environment

Topic 1: Overview

The goals for this week are:

1. Get excited about the course, including appreciating the importance of quantitative and causal analysis for environmental policy evaluation.
2. Review and apply basic microeconomic concepts (such as demand and supply elasticities, surplus, and market failures) to an environmental policy setting.
3. Review and apply basic statistics concepts (such as linear regression and exogeneity) to an environmental policy setting.
4. Begin to get to know your classmates.

Readings:

- Lecture Notes Chapters 1-3: Overview, Microeconomics for Environmental Policy Evaluation, and Linear Regression.

Lecture slides:
- Overview_public.pdf

Problem set:
- In this week's problem set, you'll get started on basic data manipulation, graphing, and regression analysis in R, while studying the relationship between income, pollution, and health.

Section materials:
- R demo code
- Public slides

Topic 2: Non-market valuation overview

The goals for this week are:
1. Identify types of environmental services and describe how they can be quantified in dollar units.
2. Apply the Rubin Causal Model and regression discontinuity (an important empirical method) to an environmental policy setting.

Readings:
- New York Times article from 1981 on the debate over benefit-cost analysis.
    - This article covers Executive Order 12291, which is famous because it is the first major use of benefit-cost analysis in the U.S. government. We love this article because it beautifully lays out both the reasons for using benefit-cost analysis and the concerns that it raises.
- Harris and Roach, Chapters 6 and 7.3. *Pay special attention to the contingent valuation section on pages 138-142, as we'll use that for an in-class case study.*
    - This gives an overview of the types of environmental services and how we measure them, including how we use the value of a statistical life (VSL) to translate mortality effects into dollar units.
- Ebenstein et al. (2017) on the Huai River Policy. *Focus on the introduction and figures; the rest of the paper is optional.*
    - This paper is the most famous application of regression discontinuity in environmental economics. Its results have dramatically shaped our understanding of the harms from air pollution.
- Lecture Notes Chapters 4 and 5: Rubin Causal Model and Regression Discontinuity.

Lecture slides:
- Non-market valuation_public.pdf

Problem set:
- In this week's problem set, you'll work with the Huai River Policy data, using regression discontinuity to estimate the effect of air pollution on life expectancy.

Section materials:
- Public slides

Topic 3: Social cost of carbon

The goals for this week are:
1. Thoughtfully choose and implement panel data approaches (pooled OLS and fixed effects) in the context of estimating climate impacts.
2. Be able to explain how the social cost of carbon is estimated and the economic principles behind the choice of discount rates and other key parameters.
3. Estimate the social cost of carbon and show how it depends on key parameters such as the discount rate, economic growth, and inequality.

Readings:
- New York Times article on the Trump Administration's social cost of carbon.
    - This article nicely lays out why the social cost of carbon matters and how different assumptions can give very different results.
- Carleton and Greenstone (2022) on how the social cost of carbon is computed. *The introduction (pages 196-199) is required. The rest is entirely optional.*
- Lecture Notes Chapters 6 and 7: Social Cost of Carbon and Panel Data.
- Barreca et al. (2016) on the effect of temperature on mortality. *The introduction (Section I) is required. The rest is entirely optional.*
    - The effect of temperature on mortality is a key input to determining the social cost of carbon. This paper shows how to estimate that effect using panel data, and shows that the effect decreased over the 20th century in the U.S.

Lecture slides:
- SCC_public.pdf

Datasets for in-class analyses:
- climate_ag.csv, with starter code here: climate_ag_example_code.R
- SCC_country_data.csv

Problem set:

- In this week's problem set, you'll work with the data from Barreca et al. (2016), using panel data to estimate the effect of temperature on mortality.

Section materials (2025.10.10):

- Public slides
- R demo code
- State fips code database

Section materials (2025.10.17):

- Public slides
- R demo code

Topic 4: Environmental justice, locational sorting, and hedonics

The goals for this week are:

1. Use data to describe the relationship between neighborhood demographics and environmental quality in the U.S., and quantify the underlying mechanisms.
2. Implement difference-in-differences analyses to estimate the value of local environmental quality.

Readings:

- Banzhaf, Ma, and Timmins (2019): an overview of environmental justice in the *Journal of Economic Perspectives*.
    - This is an authoritative overview of how economists think about environmental justice.
- Lecture Notes Chapters 8 and 9: Locational Sorting and Hedonics and Difference-in-Differences.
- Greenstone and Gallagher (2008) on the effect of Superfund cleanups on local property values. *Sections I, II, and VII are required. The rest is entirely optional.*
    - This paper is one of the most famous non-market valuation analyses. It thoughtfully uses hedonics to estimate the benefits of Superfund, one of the most important environmental laws in U.S. history.
- If you are interested in the economics of environmental justice, we suggest the following additional readings, but they are *entirely optional*:
    - Economist magazine articles on environmental justice from 2010 and 2022
    - The preface (pages 1-9) of Cole and Foster's (2001) excellent history of the environmental justice movement, available from Canvas/readings/.

Lecture slides:

- Locational sorting_public.pdf

- Environmental justice_public.pdf

Dataset for in-class analysis:
- TX_toxics.csv, with starter code here: TX_toxics_example_code.R
- Siting-sorting starter code here: Siting_sorting_example_code.R
- Additional code from former course TA: TX_toxics_Matt_sample_code.R

Problem set:
- In this week's problem set, you'll work with the data from Greenstone and Gallagher (2008), using difference-in-differences to estimate the effect of Superfund cleanups on local property values.

Part II: Policy evaluation

Topic 5: Corrective taxes

The goals for this week are:
1. Explain key intuitions around corrective taxes, including (i) why economists like corrective taxes and (ii) how supply and demand elasticities determine the economic incidence and net benefits of a corrective tax.
2. Quantify the efficiency and distributional consequences of a corrective tax.
3. Apply instrumental variables estimation to an environmental policy setting, including thinking of valid instruments, evaluating key assumptions, and interpreting results.

Readings:
- Economist and New York Times articles on carbon taxes.
    - These articles provide perfect motivation and context as we begin the policy evaluation part of class. They acknowledge that corrective taxes are the logical solution to externality problems but then focus on why they are imperfect and politically unpopular.
- Harris and Roach Chapters 3.1 and 3.2.
    - This gives a non-mathematical overview of corrective taxation. The substance is similar to the Corrective Taxes lecture note, but it may be useful to start with this reading before moving to the lecture note.
- Lecture Notes Chapters 10 and 11: Corrective Taxes and Instrumental Variables
    - The problem set will use the formulas derived in Section 10.3 (tax incidence) and 10.5 (welfare effects).

Lecture slides:
- CorrectiveTaxes_public.pdf

Datasets for in-class analyses:

- PollutionHealth.csv, with starter code here: IV_example_code.R
- eia_gasoline.csv, with starter code here: GasTax_example_code.R

Problem set:

- In this week's problem set, you'll use instrumental variables to estimate the elasticity of gasoline demand. You'll then use that estimate to quantify the net benefits and distributional effects of the optimal gas tax.

Topic 6: Corrective subsidies

The goals for this week are:

1. Explain the key intuitions around when corrective subsidies do vs. do not achieve the social optimum.
2. Apply multinomial logit estimation to an environmental policy setting and explain the advantages and limitations of the logit model.

Readings:

- Economist magazine article on the Inflation Reduction Act.
    - This is a high-level overview of the Inflation Reduction Act, which includes the electric vehicle subsidies that we'll study this week.
- Lecture Notes Chapter 12: Multinomial Logit Model
    - The multinomial logit model is a powerful framework for estimating consumer demand when we make discrete choices — for example, which car to buy.

Lecture slides:

- CorrectiveSubsidies_public.pdf

Dataset for in-class analyses:

- vehicle_data.csv

Problem set:

- In this week's problem set, you'll work with auto market data, using the multinomial logit model to estimate the welfare effects of electric vehicle subsidies.

Section materials:

- Public slides

Topic 7: Environmental regulation in electricity markets

The goals for this week are:

1. Explain the mechanics of why different classes of environmental policies (such as CO2 pricing vs. emission rate standards) are more or less economically efficient or cost effective, as well as how design issues such as leakage and waterbed effects change cost effectiveness.
2. Quantitatively evaluate the effects of CO2 pricing policies in an electric power market.
3. Continue building relationships with classmates, including classmates you haven't worked with yet.

Readings:

- New York Times articles on the demise of cap-and-trade and the 2023 power sector CO2 emission rate standards.
    - These articles nicely describe the history and political debates around the policies we'll study this week.
- Harris and Roach: Chapter 8.
    - This chapter gives a nice overview of the differences between classes of environmental policies and what makes them more or less economically efficient.
- A brief overview of electricity markets written by economists at the think tank Resources for the Future
- Lecture Notes Chapter 13: Electricity Market Dispatch Models
- *Entirely optional:* the Catalyst podcast, hosted by venture capitalist Shayle Kann, is your professor's very favorite sustainability-related podcast. It provides useful insight on environmental policy and the clean tech business. They have a great episode on the EPA's 2023 power sector emissions rule, which we'll discuss in class.

Lecture slides:

- Environmental regulation in electricity markets_public.pdf
- Modeling electricity markets_public.pdf
- Prices vs. Quantities_public.pdf

Electricity regulation game:

- Link

Datasets for in-class analyses:

- pjm_plants.csv and pjm_hourly.csv

Problem set:

- In this week's problem set, you'll program an electricity market dispatch model and use it to simulate the effects of CO2 pricing via taxes or a cap-and-trade program.

Section materials:

- Public slides

Topics 8: Retail electricity pricing

The goals for this week are:

1. Develop and propose new economic policies (specifically, electricity pricing reforms) considering economic efficiency (including environmental impacts) and distributional equity.
2. Quantitatively evaluate your proposed reforms without specific instructions. This will allow you to practice empirical techniques you've learned and figure out how to apply them to open-ended challenges.

Readings:

- A CNET article on income-graduated fixed charges on electricity bills.
- University of California Energy Institute blogs on electricity price distortions (here) and income-graduated fixed charges (here and here).
    - This blog is perhaps the best place for thoughtful discussion of environmental and energy economics applied to important policy issues.
- Lecture Notes Chapter 14: Regulated Energy Pricing with Externalities
- *Entirely optional:* the Schmalensee and Stavins (2019) overview of the Clean Air Act in the *Journal of Economic Perspectives.*
    - This gives nice background on some of the issues we'll discuss as we recap the carbon pricing problem set.

Lecture slides:

- Retail electricity pricing_public.pdf

Problem set:

- In this week's problem set, you'll propose and evaluate electricity pricing reforms in California and will have a chance to present those to the class.

Section materials:

- Public slides

Topic 9: U.S. environmental policy discussion capstone
The goals for this week are:

1. Further solidify your ability to qualitatively explain how environmental policy design choices affect efficiency and equity, in the context of several important policies.
2. Further solidify your abilities to scope and design empirical analyses to evaluate environmental policies.
3. Further practice your presentation skills!

Lecture slides:

- US environmental policy discussion_public.pdf
- Fall 2025 shared presentation slides

Final project

The final project is to write a short research paper (typically around 8-10 pages) that uses data to answer an environmental economics research question. The final project will help to achieve all four learning goals described above: it will help you to qualitatively describe the tradeoffs and quantitatively evaluate the environmental policy of your choice, build data analysis skills on the dataset of your choice, and foster community through group discussions of research ideas and your progress.

The final project has four components, as described below.

1. Research questions memo

A clear research question can be stated in one sentence ending in a question mark. Here are a few examples that can be done with publicly available data:

A. What are the net benefits of electric vehicle tax credits, and how do they compare to the benefits of a carbon tax? To estimate the elasticity of demand for electric vehicles, you could use public data here and variation from the Inflation Reduction Act Clean Vehicle Credits or the 2015 California rebates here.
B. What are the effects of {Superfund cleanups, wind farms, or power plant closures} on local demographic sorting and property values? (Related papers here and here.)
C. What are the efficiency and distributional implications of setting residential electricity or natural gas prices at social marginal cost? (Related paper here.)
D. Do polluting plants (coal power plants, facilities on the Toxic Release Inventory, landfills, etc.) open in lower-income neighborhoods, and how do those

neighborhood incomes change after the facilities open? (Related papers here and here.)

E. What are the effects of high temperatures on {mortality, crime, agriculture, or economic output}? (Related papers here and here.)
F. What is the willingness-to-pay for climate amenities, as measured by hedonic or discrete choice models of housing markets in the United States of elsewhere? What is the predicted welfare loss from climate change in those models? (Related papers here and here.)
G. How do the air pollution benefits from wind or solar power plants vary across regions of the US? (Related papers here and here.)
H. Do lower-income people have less money left over for food in months with high energy bills? (Related papers here and here.)
I. How large is leakage from the Regional Greenhouse Gas Initiative, as measured by increases in fossil generation outside RGGI states when allowance prices rise? (Related papers here and here.)

For the **research questions memo**, you will list at least four research questions that interest you. For each question:

1. State the research question in one sentence ending in a question mark.
2. Briefly describe the data you would use to answer the question. If you're not sure whether the right data are available, that's OK – the teaching team can help brainstorm.
3. In 1-2 sentences, state the quantitative methods (empirical strategy, simulation approach, etc.) you would use to answer the research question.

This memo will typically be about one page long.

Since generating research ideas can be difficult and we have limited time within the quarter, there is no requirement that you do something novel. You are welcome to replicate an existing paper, as long as you at least slightly change or extend the previous analysis, for example by simplifying the approach or adding additional years of data. You are also welcome to study one of the questions written above. However, at least two of the questions in your research questions memo must be different from the example questions given above.

Everyone must discuss their research questions with Professor Allcott or a TA before proceeding. We will set up extended office hours for those discussions. We also encourage you to discuss your ideas with your classmates and brainstorm with AI tools. After all that, choose the one research question that interests you the most.

2. Hypothetical draft introduction and literature review

Your **hypothetical draft introduction** is the full introduction to the paper you envision, including hypothetical discussion of your possible results and conclusions. Your introduction must have the following format:

- Paragraph 1: motivate the importance of a research question for the real world. Continuing Professor Allcott's example research question, *The Inflation Reduction Act is perhaps the most significant climate policy in US history. A key component of this policy is the expansion of the Clean Vehicle Credits, which will provide hundreds of billions of dollars in tax credits to buyers of qualifying electric vehicles. …*
- Paragraph 2: state your research question. This is one sentence ending in a question mark. For example, *What are the efficiency and distributional consequences of the Clean Vehicle Credits?*
- Paragraph 3: describe what you do. For example, *We use vehicle sales quantities and transaction prices in nationwide vehicle registration data from 2018-2023. We separate vehicle models into three groups: qualifying EVs, non-qualifying EVs, and controls. We then run event study specifications that demonstrate the time path of prices and sales quantities for qualifying and non-qualifying EVs relative to controls from January 2022 through the end of 2023. …*
- Paragraph 4: describe what you find. For example, *We find that the prices of qualifying EVs rose by XX percent relative to controls, suggesting pass-through rates averaging YY percent of the maximum available tax credit.* [For the hypothetical draft intro assignment, you will just speculate about what you might find when you get the data.]
- Paragraph 5: limitations. For example, *Because we look only within vehicles over time, we cannot identify the effects of the credits on the entry of new vehicle models. Furthermore, …*
- Paragraph 6: brief highlights of your contributions to the literature. This is a summary of your literature review section
- Paragraph 7: road map. For example, *Sections 1-6, respectively, present the literature review, overview of the Clean Vehicle Credit policy, data description, empirical strategy, results, and conclusion.*

The hypothetical draft introduction will typically be about one or two pages long.

Your **literature review** is an overview of the existing research in the area. For this class, we'll just do a simple version of a literature review. First, describe the three most closely related papers, in one paragraph per paper. Then, describe what you do differently and how you contribute to the literature. Because this is just a term paper, you may be very similar to previous work, and you won't be graded on making some important contribution. However, you should be able to say at least a couple of small things that you are doing differently.

- ChatGPT and other AI tools should be helpful here in (i) finding and then (ii)

summarizing the most closely related papers. But if asked, you should be knowledgeable about these three related papers without the help of AI.
- Focus on recent overview papers (in journals such as the Annual Review of Economics or Journal of Economic Perspectives) and research papers in the NBER working paper series and/or the best journals (e.g., American Economic Review, Quarterly Journal of Economics, Journal of Political Economy, Review of Economic Studies, Econometrica, the American Economic Journals, Journal of Public Economics, and Journal of the Association of Environmental and Resource Economists).

The literature review will typically be about one page long. At the end of your paper, you should also include a bibliography of works cited. Use inline citations (e.g., "Sallee (2011) finds ...") and bibliography formatting following the economics honors thesis style guide available here.

3. Data description and empirical strategy

The **data description** is just a brief description of the data, including where you got the data, the key variables you'll use, and how you cleaned the data. You should have a table presenting descriptive statistics, e.g. means, standard deviations, minima, maxima, and sample sizes for the variables you use. You might also plot histograms and scatterplots to explore the data further and check for errors.
The **empirical strategy** is a precise description of how you (will) analyze the data. It should include a regression equation (for empirical papers) or a mathematical description of your model (for simulation papers.) It should be detailed enough that someone else would write the same analysis code and get the same results as you do. You should also clearly state the assumptions required to interpret your coefficient estimates as causal.

The data description and empirical strategy will typically be about two pages long.

4. Final paper

The final paper will typically have the following format:
- Section 1: introduction.
- Section 2: literature review.
- Section 3: overview of the policy or relevant institutional details and background.
- Section 4: data description. This will typically have a descriptive statistics table.
- Section 5: empirical strategy. This may be diff-in-diff, RD, simulation model, etc. Clearly describe what you do using both words and math.
- Section 6: results.
- Section 7: conclusion and discussion.

The final paper will typically be about 8-10 pages long. Empirical work is full of surprises and invariably takes longer than you expect, so start early!

Additional advice on final project

Datasets

The following datasets are publicly available and often useful for environmental economics work:

- IPUMS census and survey data from the US and other countries. This includes the American Community Survey, which has demographic information and property values by neighborhood.
- EPA Clean Air Markets Program Data. This includes power plant emissions and operation data.
- US Energy Information Administration. This includes a wealth of data on electricity, natural gas, oil, coal, renewable energy.
- EPA Toxic Release Inventory.
- National Center for Health Statistics.
- Mortality data are for the US available from the National Vital Statistics System and from mortality.org.
- Mortality data for all countries are available from the World Health Organization.
- US county-level economic data (income, GDP, etc.) are available from the BEA and BLS.
- Temperature and other weather data are available from NOAA here and here.
- US air pollution data are available from the EPA. Global air pollution data are available from the WHO.
- National Household Travel Survey. This has vehicle ownership and use from samples of US households, taken every 5-10 years.
- Residential Energy Consumption Survey. This has energy consumption and household characteristics from samples of US households, taken every 4-6 years.
- ICPSR has a wealth of other datasets.

Example papers

American Economic Review: Insights (AER-I) is a top economics journal that publishes "shorter" papers that are about the length of a serious term paper, or perhaps slightly longer. (Submissions are limited to 7,000 words and five figures and tables.) Published papers in AER-I are thus nice examples of the style and structure you should shoot for. Three example environmental economics papers in AER-I are here, here, and here.

Writing style

We all have different writing styles for different situations. In this class, we'll ask you to use a scholarly writing style.

- *Do not state opinions*. This should be a scientific paper, not an op-ed. Do not state opinions or make normative statements (i.e. what policymakers *should* do). However, your research should be policy relevant. How do we make *policy-relevant* statements without making *normative* statements? Be precise about what your research actually says! For example, instead of writing, "my research suggests that the US should have a carbon tax," you might write, "in my model, a carbon tax would have larger net benefits than fuel economy standards."
- *Use causal language if and only if you are making a causal statement based on a causal research design*.
- *Be precise.*
    - Say "I" when you mean "I," use the correct tense, and use active voice. For example:
        - "I collected house price data from the ACS."
        - "I surveyed 400 people."
        - "I use a logit model to estimate choices between vehicles." (Generally we describe analyses in the present tense, e.g. "I regress Y on X" or "I find Z.")
        - "I find that Superfund cleanups did not statistically significantly affect property values." (The property value data are historical, so the effect on property values is described as being in the past.)
    - Avoid unnecessary adjectives and hyperbolic language. For example, do not say "the effect is massive" or "the results shatter our expectations."

Bellamare (2020) is a useful although advanced overview of economics writing style.

Additional resources

Environmental economics career guide

Click here for the Environmental Economics Career Guide, which was put together by recent graduate Jackson Parell.

Microeconomics

CORE Econ provides an online introductory economics textbook. Chapter 8 can be used to review supply, demand, and equilibrium.

Environmental economics and clean tech

Media:

- Canary Media

- Heatmap News
- Greentech Media
- Latitude Media
- Bloomberg New Energy Finance
- New York Times Climate and Environment coverage

Podcasts:

- Catalyst
- Climate Rising
- Volts
- Switched On
- Carbon Copy

Econometrics and causal inference

Two useful online books are:

- Causal Inference: The Mixtape by Cunningham
- The Effect by Huntington-Klein. This is very similar to Cunningham but with less formal math.

R

Some useful tutorials for those with limited previous R exposure:

- Coding Club
- Cyclismo
- Swirl, e.g. short intro course and getting and cleaning data
- Quarter-length courses from Ozan Jaquette and Ed Rubin
- Hadley Wickam functional programming overview

Campus-wide resources

- Writing tutors from the Hume Center for Writing and Speaking, to sharpen your essay-writing skills
- Academic coaches from the Center for Teaching and Learning, to help you manage your time and work effectively
- Study halls, organized by the Center for Teaching and Learning, to work and learn in quiet companionship with other students
- Study Tips and Tools, from the Center for Teaching and Learning
- Undergraduate Advising Directors, Academic Advising
- Well-Being services, including well-being coaches, Vaden Health Center
- Subject Matter Tutoring, Center for Teaching and Learning
- Tutoring for Student Athletes, AARC

- The Flourish newsletter on health and wellness
- First Generation and/or Low-Income Student Success Center, including financial support