

# **Environmental and Development Economics**

## Module 1 - Introduction

Raahil Madhok  
UMN Applied Economics

2024-08-30

# Introduce yourself

- ▶ First, lets do introductions
- ▶ Name, year, memorable summer activity, **research interests**
- ▶ Why are you taking this class?

- ▶ **Class Time/Location:** Tues/Thurs 11:45am-1:25pm, Ruttan 119
- ▶ **Office Hours:** Thursdays 1:30pm-2:30pm, Ruttan 337D
- ▶ **Course website:** <https://github.com/rmadhok/enviro-dev-grad>
  - ▶ lectures, assignments, syllabus
  - ▶ Try to skim reading(s) beforehand
- ▶ **Assignments:** Upload through Canvas

# Today

- ▶ Why study environmental economics in LMICs?
- ▶ Course overview + detailed outline
- ▶ Grade breakdown
- ▶ If time: conceptual framework for environment & development econ

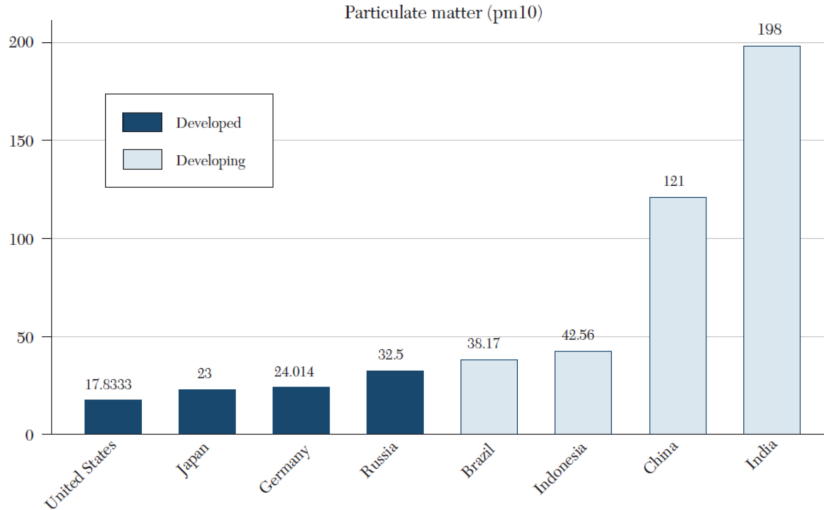
# Why study environmental economics in LMICs?

# Why study environmental economics in LMICs?

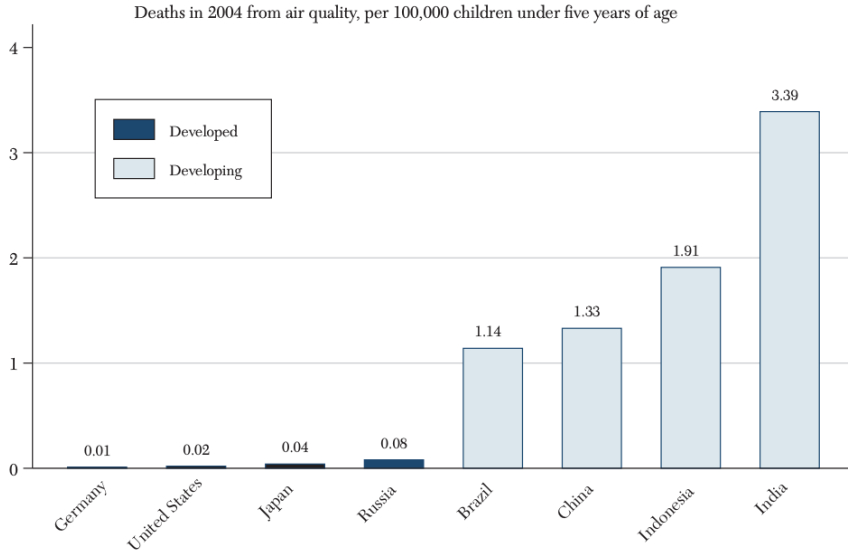
- ▶ Environmental quality is worse and has worse consequences in LMICs
  - ▶ Highest pollution, highest deforestation
- ▶ New field: room for applied theory, empirical innovation
- ▶ Data breakthroughs
  - ▶ Measurement: remote sensing, DHS, etc.
  - ▶ Access: lower barriers to government access and experimentation
- ▶ Evidence needed; big implications for poverty alleviation

# Environmental quality worse in LMICs

Panel A. Air pollution



# Disease burden higher in LMICs





# Is environmental economics different in LMICs?

My answer: sometimes...

- ▶ Magnitudes
  - ▶ Same questions, but costs and benefits different
- ▶ **Local** environmental quality is more important
- ▶ Different topics
  - ▶ cookstoves, enforcement/corruption, ethnic favoritism
- ▶ Institutions and state capacity

# Course Overview

# Course Overview: There is no textbook

Instead, I am organizing around **FIVE** key questions:

- ① How does economic development affect the environment, and vice versa?
- ② Why is environmental quality so bad in developing countries?
- ③ What are the costs of poor environmental quality in developing countries?
- ④ Why is WTP for environmental quality low in developing countries?
- ⑤ What are the political economy barriers to environmental protection?

# Course Approach

I will:

- ▶ Frame (almost) each topic with some theory
- ▶ Teach applied papers
  - ▶ research design, identification strategy, estimation techniques
  - ▶ aim for two per class (please skim beforehand)
- ▶ Emphasize recent papers

I will NOT:

- ▶ Teach econometrics
- ▶ Teach coding
- ▶ Teach every topic in environment/development

# Course Goals

- ① Show you environment/development research frontier
- ② Inspire your thesis/JMP ideas
- ③ Advance your training as applied microeconomists
- ④ Show you what makes a top-tier research question

# Course Structure

- ▶ This is a brand new class, so I give myself leeway to make changes
- ▶ You have the unique opportunity to determine direction of the course
  - ▶ Think about what topics do and don't interest you
  - ▶ And let me know!
- ▶ Please check the course website regularly for updates

# Course Outline and Topics

## **Module 1: Introduction**

- ▶ Lecture 1: Course intro + how to use theory to ask the right questions

## **Module 2: The effect of development on the environment**

- ▶ Lecture 2: Income effects
- ▶ Lecture 3: Access to capital (technology and infrastructure)



## **Module 3: The effect of environment on development**

- ▶ Lecture 4: Health
- ▶ Lecture 5: Productivity

## **Module 4: Why is WTP low in developing countries?**

- ▶ Lecture 6: Revealed preference approaches
- ▶ Lecture 7: Incentive compatible approaches

## **Module 5: Environmental Policy Design**

- ▶ Lecture 8: Monitoring, enforcement
- ▶ Lecture 9: Barriers to optimal design

## **Module 6: Political Economy of the Environment**

- ▶ Lecture 10: Electoral cycles, corruption
- ▶ Lecture 11: State Capacity

## **Module 7: Research Proposal Presentations**

- ▶ Lecture 12: TBD
- ▶ Lecture 13: Presentations
- ▶ Lecture 14: Presentations

# Grade Breakdown

# Breakdown

In-class presentations	10%
Replication Assignment	20%
Research Proposal	60 %
Participation	10%

## In-class presentations (10%)

- ▶ I want you to become expert conference presenters after taking this class
- ▶ At start of **each** class, you'll give a 10 min paper presentation
  - ▶ The paper for presentation is on the syllabus
- ▶ Each student submits **10** summary slides (5% of grade)
  - ▶ motivation, research question, methods, results
  - ▶ 10 mins presentation + 5 mins Q&A (5% of grade)
- ▶ I will select presenter on-the-spot
  - ▶ **randomly** with replacement\*\*

\*\* If you are never chosen, your grade is based on slides.

# Problem Set (20%)

- ▶ You will replicate an environment/development paper
  - ▶ You will also **extend** the results
  - ▶ Many papers on the syllabus have replication files
- ▶ You will submit a write-up explaining what you did
- ▶ You will become familiar with coding in publication-quality papers
- ▶ You will use R or Stata

# Research Proposal (60%)

Written Proposal	30%	Oct. 31
First Draft	pass/fail %	Oct. 3rd
Peer Review	20%	Oct. 10th
Proposal Presentation	10%	Oct 15/17

- ▶ You will develop a research proposal for an original idea
  - ▶ You are NOT expected to actually do the analysis
  - ▶ I will provide small deadlines (first draft, etc.) along the way
- ▶ Come to office hours to pitch your idea
- ▶ You will peer review each others proposals
- ▶ You will present the proposal at the end of the semester (30 mins)



## Participation (10%)

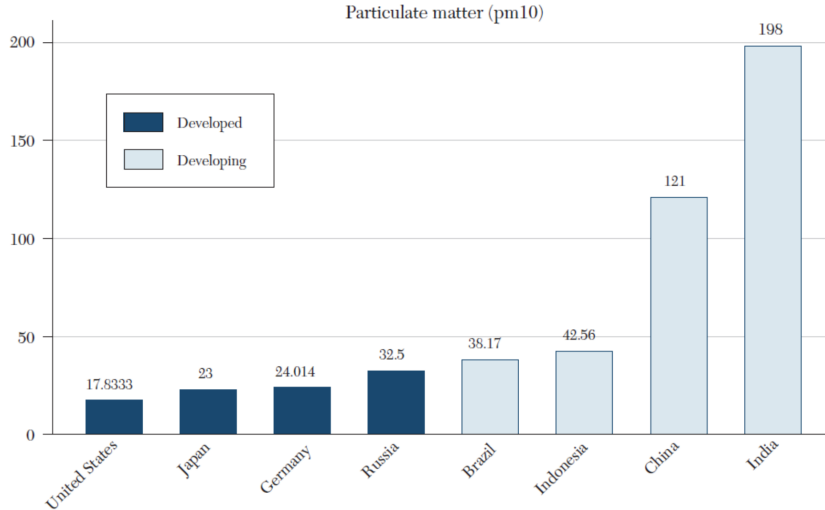
- ▶ I take this seriously
- ▶ Not enough to just show up to class
- ▶ Quality of questions/discussion count

# Questions?

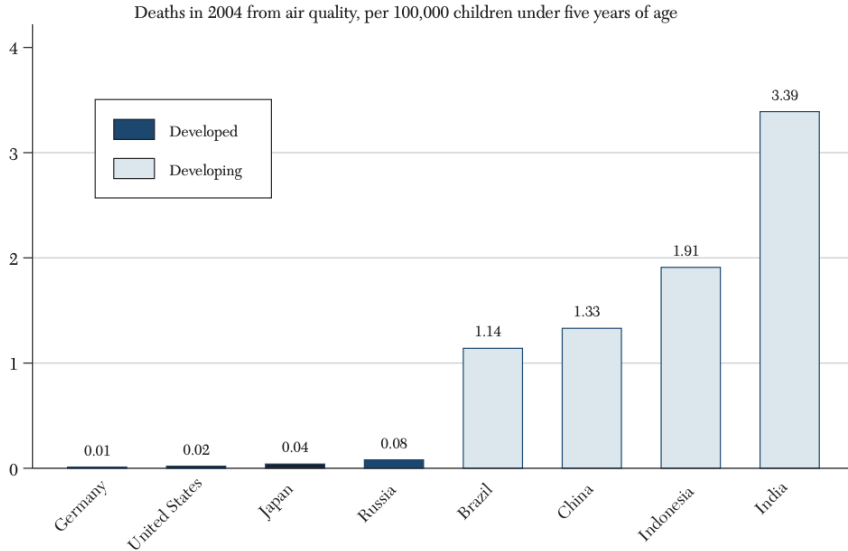
- ▶ **Guiding question:** Why is environmental quality so low in LMICs?
- ▶ Your explanations
- ▶ **Main goal:** Conceptual framework
  - ▶ Four *theory-informed explanations*
  - ▶ Set the stage for rest of class

# Remember from last time

Panel A. Air pollution



# Remember from last time



# Why is environmental quality low in LMICs?

- ▶ MWTP is low (paradox)
  - ▶ Berkouwer and Dean (2022): \$12 for clean air
  - ▶ Kremer et al. (2013): ~ \$4 for clean water
    - ▶ Imply VSL \$USD 860 vs \$USD 8.6 million for USA
- ▶ Do we take this as given? Perhaps status quo is optimal
  - ▶ is bad environmental quality another dimension of poverty?
- ▶ Is welfare loss from pollution greater in rich countries, even though they're cleaner?
- ▶ **What are your explanations?**

# Theory-informed Explanations

Greenstone and Jack (2013)

## Aside: why is applied theory important?

- ▶ Builds structure for answering big (and small) questions
- ▶ Generates potentially unexpected insights w/ testable predictions
- ▶ In reverse: helps rationalize results
- ▶ Gets you into better journals (and better jobs)
- ▶ Field is headed that way (from my recent experience)



# Conceptual Framework of Environmental and Development Economics

- ▶ Social planner chooses optimal EQ where social  $MWTP_e = MC$ 
  - ▶ Need to know MWTP for representative agent

Set up:

- ▶  $n$  identical agents with utility from consumption, EQ, and health
- ▶ Initial wealth  $y_0$ , health  $h_0$ , environmental equality  $e_0$
- ▶ health depends on self-protection,  $s$ , and  $e$
- ▶ Assume perfect markets (i.e. no externalities)

- ▶ Agent chooses  $c$ ,  $\Delta e$ , and  $s$  to maximize:

$$U(e, h(s, e), c) \quad \text{s.t.} \quad y \geq c_e(\Delta e) + c_s(s) + c$$

- ▶ where wealth (endowment + income) and experienced EQ are:

$$y = y_0 + \Delta y(e, h(s, e))$$

$$e = e_0 + \Delta e + a(c, s)$$

- ▶ where  $a(c, s)$  captures impact of  $c$  and  $s$  on EQ

# Model Particulars

- ▶ EQ affects utility directly through existence value
- ▶ EQ affects utility indirectly via health (which also affects income)
  - ▶ e.g. pollution exposure affects productivity
  - ▶ This can be mitigated by self-protection,  $s$  (e.g. mask, air purifier)
- ▶ EQ affects income, which in turn affects utility via budget constraint
  - ▶ e.g. agricultural productivity
- ▶ Experienced EQ depends directly on  $\Delta e$ , and indirectly via  $c$ ,  $s$ 
  - ▶  $a(c, s)$ : defensive investments i.e. clean cookstove, bottled water, etc.

## MWTP for improving environmental quality

- ▶ Let  $\lambda_e = \frac{\partial u}{\partial \Delta e}$ ,  $\lambda_y = \frac{\partial u}{\partial c}$
- ▶ Set up lagrangian and solve for  $MWTP_e$ :

$$MWTP_e = \frac{\lambda_e}{\lambda_y} = \frac{1}{\lambda_y} \left( \frac{\partial u}{\partial e} + \frac{\partial u}{\partial h} \frac{\partial h}{\partial e} \right) + \frac{\partial \Delta y}{\partial e} + \frac{\partial \Delta y}{\partial h} \frac{\partial h}{\partial e}$$

- ▶ aesthetic benefit from improved EQ (converted to dollars)
- ▶ indirect benefit of EQ for health (converted to dollars)
- ▶ direct impact of EQ on income and indirect impact via health

**Note:** if  $U''(c) < 0$ , low  $y \rightarrow$  high MUC ( $\lambda_y$ ) and low  $MWTP_e$

## MWTP for self-protection

- Set up lagrangian and solve for  $MWTP_s$

$$\begin{aligned} MWTP_s &= \frac{\lambda_s}{\lambda_y} \\ &= \frac{1}{\lambda_y} \left( \frac{\partial u}{\partial e} \frac{\partial a}{\partial s} + \frac{\partial u}{\partial h} \left( \frac{\partial h}{\partial s} + \frac{\partial h}{\partial e} \frac{\partial a}{\partial s} \right) \right) + \frac{\partial \Delta y}{\partial e} \frac{\partial a}{\partial s} + \frac{\partial \Delta y}{\partial h} \left( \frac{\partial h}{\partial s} + \frac{\partial h}{\partial e} \frac{\partial a}{\partial s} \right) \end{aligned}$$

- indirect effect of  $s$  on EQ and health (converted to dollars)
- indirect effect of  $s$  on income via productivity and health

**Note:** if  $U''(c) < 0$ , high  $y \rightarrow$  low MUC ( $\lambda_y$ ) and high  $MWTP_s$

# The Social Planner

- ▶ In first best, social planner sets  $MB = MC$ 
  - ▶ where  $MC_e = \frac{\partial c_e}{\partial \Delta e}$  and  $MC_s = \frac{\partial c_s}{\partial \Delta s}$
- ▶ But to aggregate over  $n$ , we must assume:
  - ▶ No preferences of her own
  - ▶ No market failures
  - ▶ Can observe true MWTP
  - ▶ Anything else?
- ▶ Do these hold in LMICs?

# Course Structure

- ▶ Set the stage:
  - ▶ how does environment affect development ( $\frac{\partial h}{\partial e}$ ) (week 2)
  - ▶ how does development affect the environment (week 3)
- ▶ Bulk of course:
  - ▶ Explain why environmental quality low in LMICs
  - ▶ Identify as many parameters of the social planner problem as possible
- ▶ Goal: where can you make a contribution?

# Why is environmental quality so low in LMICs?

Four explanations informed by the model:

- ① High marginal utility of consumption
- ② High marginal abatement costs – includes state capacity
- ③ Political economy distortions (first best violation)
- ④ Market failures (first best violation)
  - ▶ frictions cause revealed MWTP  $\neq$  true MWTP



# Preview of Answers

# 1. High marginal utility of consumption

- ▶ Intuitively, poor people care more about meeting basic consumption needs
- ▶ Economically, agent trades off  $c$  and  $e$  by setting  $u'(c) = u'(e)$ 
  - ▶ If  $u''(c) < 0$ , prefer  $c$  at lower levels of  $y$
  - ▶ even if health benefits of  $e$  are large!
- ▶ **Very** few revealed preference studies on  $MWTP_e$ 
  - ▶ Kremer et al. (2013) randomly clean up springs in Kenya
  - ▶ WTP USD 11/year for clean water; VSL of USD 860
- ▶ Larger literature on  $u'(h)$  also suggests low valuation (Berkouwer and Dean, 2022)

## 2. High MC

- ▶ High MAC suggests sub-optimal environmental quality. Why?
  - ▶ Upward sloping MAC suggests low MC in poor countries
- ▶ MC not only driven by MAC; also reflects weak state capacity
  - ▶ Enforcement (Duflo et al., 2013)
  - ▶ Incentives (Jagnani and Mahadevan, 2024; Gulzaar and Dipoppa, 2024)
  - ▶ Spillovers (Viera et al. 2024)
- ▶ High MC **does not** mean deviation from first best

### 3. Political economy

- ▶ Social planner includes own utility weights social welfare function
  - ▶ i.e. corruption
- ▶ Many examples from LMICs
  - ▶ pollution (Duflo et al., 2013)
  - ▶ deforestation (Burgess et al., 2012; Viera et al., 2024)
  - ▶ human-wildlife conflict (Madhok et al., 2024)
- ▶ Leads to second best policy (inefficient)

## 4. Market Failures

- ▶ This is partially a course on development economics
  - ▶ About market failures: land, labor, credit, etc.
- ▶ Implication for us: revealed  $MWTP_e \neq$  first best  $MWTP_e$
- ▶ Example: weak property rights  $\rightarrow$  underinvestment in  $e$ 
  - ▶ Underestimate  $MWTP_e$  from observed data
  - ▶ RCT evidence from crop-burning PES contracts: Jack et al. (2024)

# Lots of room for research

- ▶ Environment and development economics is new
  - ▶ Challenge: find something unique about LMICs
- ▶ Goal: identify model parameters
- ▶ Evidence on many parameters are absent
- ▶ Barriers to research in LMICs are falling
  - ▶ remote sensing, administrative/survey data, webscraping

## Next Class

- ▶ In-class presentations
- ▶ Impact of economic development on the environment (income effects)
- ▶ Impact of development on the environment (forests, biodiversity)

# Aside: Best Practice for Short Presentations



# Best Practices: Structure

- ▶ You cannot present a paper in 10 minutes
  - ▶ Do not give detailed lit review or go into extreme detail
- ▶ Instead, you are giving a trailer for the movie
  - ▶ Convince the audience that they should read the paper
- ▶ Your goal is only to state why the paper is important, and what you did
- ▶ Convey paper's importance in first slide

# Best Practices: Slides

- ▶ Motivation + broad research question (1 slide)
- ▶ Full paper overview (1 slide)
- ▶ Lit review (optional, 1 slide)
- ▶ Background (1 slide)
- ▶ Data (2 slides)
- ▶ Empirical Strategy (2 slides)
- ▶ Results (2 slides)
- ▶ Summary (1 slide)

## Example of Preview Slide

- ▶ **Question:** How do firms react to tribal forest policy?
- ▶ **Idea:** Model aggregate economic response and changes in firm composition
- ▶ **Setting:** India Forest Rights Act (2008)
  - ▶ Imposes transaction cost on firms
- ▶ **Data:** Manufacturing census (2001-2015); Deforestation permits (2001-2021)
- ▶ **Empirical Strategy:** Diff-in-diff using policy shift in tribal and non-tribal district

### Results Preview

- 1) decline in firm activity, 2) less forest encroachment by industry
- 2) larger, but less productive firms survive

# Best Practices: Slide Format

- ▶ 1 minute per slide
- ▶ Avoid chart junk
- ▶ One line bullets
  - ▶ No need for full sentences
- ▶ Vary text slides and text + image slides
- ▶ Don't put too many equations
  - ▶ Save details for speaking, or talk “about” equation
- ▶ Summarize findings again at the end

# Best Practices: Presentation

- ▶ Speak clearly and loudly
- ▶ Speak slowly
- ▶ Look at audience; Do not show your back
- ▶ Do not stand in front of slides
- ▶ Avoid jargon
- ▶ Avoid pacing around room
- ▶ Stick to your time limit