

a broad outline of the course

First half:

Microeconomic Foundations:

- Social choice: Ultimately, a government should aim to somehow aggregate citizens' preferences over both goods and bads.
 - Possible individual preferences over the environment: biocentrism, anthropocentrism, sustainability.
 - Arrow's Impossibility Theorem—the nonexistence of a social welfare function that satisfies some basic fairness/consistency criteria.
 - Even though a perfect social choice function is unavailable, there are some alternative criteria that can be used to make collective decisions:
 - Pareto Criterion—Unanimity
 - Potential Pareto Improvement—pareto improvement with transfers
 - Compensation Principle—potential pareto improvement without transfers.
 - For the rest of the course, we are primarily concerned with efficiency—how to achieve it when the market doesn't naturally arrive at it.
- Efficiency of Markets:
 - Efficiency under exchange—an Edgeworth Box illustration (tangency of indifference curves)
 - Efficiency with production—tangency of the PPF and consumer's indifference curve
 - Definition of efficiency—an allocation is efficient if there is no allocation that is pareto preferred to it. In particular, with markets it is defined by the following conditions:
 - MRT's equalized across firms
 - MRS's equalized across consumers
 - MRT's and MRS's both equalized to the price ratios
 - Definition of Equilibrium
 - First Welfare Theorem, and necessary assumptions
 - Second Welfare Theorem, and necessary assumptions
 - Efficiency across time periods
- Cost-Benefit Analysis:
 - Consumer and Producer surplus under supply and demand (without externalities)
 - Methods for measuring costs and benefits:
 - WTP/WTA
 - Indirect Methods:
 - Averting Behaviour (Substitutability)
 - Weak Complementarity Approach
 - Hedonic Methods

- Contingent Valuation
 - Critiques of cost-benefit analysis

Why the environment violates assumptions for free-market efficiency, and what we can do about it:

- Key deviations: externalities, poorly-defined property rights, transaction costs. So now the free-market equilibrium need no longer be efficient.
- Public Goods
 - Definition of public goods/bads as nonrival and nonexcludable
 - Aggregating demand for public goods (sum demand vertically)
 - Private provision of public goods might lead to inefficient outcomes (when individuals make isolated decisions about purchases)—the free-rider problem
 - When to provide a public good—when aggregate marginal benefit exceeds marginal cost
 - Lindahl Pricing can generate efficient production, but is too infeasible in practice.
 - Public goods involve externalities—equilibrium price system in a free-market does not take full effect of externalities into account (laundry-steel mill example)
- Property Rights
 - Coase Theorem: Efficiency can be achieved by assigning property rights over public goods (and allowing other agents to compensate the holder of these rights)
 - The Coase Theorem requires several assumptions. In particular, the “no transaction costs” assumption is problematic and rarely satisfied in practice.
- Government Intervention to achieve efficiency (Command and Control versus Incentive Mechanisms):
 - Command and Control: pros and cons
 - Incentive Mechanisms
 - General pros and cons
 - Pollution Fees (Pigovian fees or subsidies)
 - Without fees, firms will pollute as long as there are marginal savings from polluting. The government sets fees so that, at the new equilibrium, societal marginal damage from pollution equals firms’ aggregate marginal savings (horizontal summation of individual MS curves) from pollution.
 - Since the fee is fixed, the equimarginal principle is satisfied. If the fee is correct, then $MS=MD$ is also satisfied.
 - Alternatively, subsidies can also achieve efficiency, but with potential problems (effectively assigns property rights to firms; the subsidy must come from somewhere; long-run over-production)

- Marketable Permits—the government sets the maximum allowed level of pollution, and then allows firms to trade for these rights.
 - Forcing firms to assume full liability
 - Fullerton and Kinnaman: Empirical paper about the pros and cons of a Pigovian fee
 - Extensions:
 - Space
 - Assume a linear relationship between emissions from source and pollution at receptor. The transfer coefficient is the rate at which a change in emissions at a source affects pollution at a receptor.
 - Efficiency requires that MD of total pollution be equal to individual firms' MS scaled by the relevant transfer coefficients.
 - Optimal Pigovian fees now differ across firms. If the government must use a single fee, it chooses the fee that minimizes the total dead weight loss.
 - Marketable Permits are often easier to implement:
 - Ambient Pollution permits
 - Emission permits
 - Trading equilibria are similar to before, except that they now take transfer coefficients into account.
 - Time
 - We must take time into account when there are stock pollutants.
 - Efficiency requires that firms' marginal savings from pollution equal the aggregated (over time) marginal costs from an additional unit of pollution today (discounted by the relevant time discount factor and the persistence of pollution).
 - Another issue related to time: temporal variability
 - Unknown Control Costs
 - We assume that the government is aware of the MD curve but unsure about the firm's MS curve (marginal savings from pollution).
 - Firms have an incentive to lie:
 - Under a permit system, a firm wants to pretend it has a high MS curve.
 - Under a fee system, a firm wants to pretend it has a low MS curve.
 - It is possible to use a system of fees and rewards that encourage high MS firms to tell the truth while discouraging low MS firms from lying and claiming to be high MS too (two constraint example)
 - Alternatively, the government can choose either taxes or permits so as to minimize the total expected welfare loss (but not eliminate it).
 - Weitzman proposition: under uncertainty, permits are preferred if MD relatively more steeply sloped than MS; and fees are preferred in the opposite case.

Second half:

Chapter 11—Audits, Enforcement, and Moral Hazard:

- Before we begin, a brief overview: In the last half of the course, we studied why free markets might lead to inefficient outcomes because of externalities associated with environmental goods, and how the government can intervene to correct these inefficiencies. We looked at some richer models (involving time, space) and finally loosened the assumption of perfect information (allowing the government to be uncertain about the firm's **type**). Now, we look at another kind of informational limitation—the government is unable to fully observe the firm's **actions**. In later chapters we study the environment in the context of trade and macroeconomics and then move to models with more empirical implications.
- A simple model of incentives in regulation—the problem of unobserved actions:
 - The firm's abatement activity happens along two dimensions. Only one of these is observable by the EPA. This can sometimes lead to “second-best” regulation—requiring the firm to over-abate on the observable dimension.
- Monitoring emissions—now we look at some specific problems and ways to get around them:
 - Regulation with unobserved emissions—ambient pollution observed but emissions unobserved (multiple polluters). Efficiency can be achieved by appropriate tax/subsidy combination.
 - Midnight dumping—firm can engage in safe dumping (more expensive to firm, less damage to society) and illicit dumping. Only safe dumping is observable.
 - Solution: subsidize safe dumping. Problem: this creates over-generation of waste.
 - Solution: Assuming total waste generation is observable, tax waste generation and subsidize safe disposal (effectively charging a tax on illicit disposal).
- Enforcement—fines and audits.
 - The EPA might find it costly to obtain information about each firm's actions, even though it *could*. It can choose to audit firms randomly and impose a very large fine for violation (this increases the “marginal cost” of violation for the firm, since violation results in a positive probability of a fine).

Chapter 12—Risk and Uncertainty:

- Not covered in class. Recall the problem with BP and the Exxon Valdez spill. In problems where the damage occurs with positive probability but not certainty, we equate marginal savings from pollution (for the firm) to *expected* marginal damage from pollution (to society).

Levinson—Environmental Kuznets Curve

- An inverse-U-shaped relationship between pollution and income might be entirely efficient (simple model).

- Levinson empirical results: Cross-country, time-series graphs of SO₂ and GDP give no evidence of this shape. Some evidence found in the relationship between predicted fatal accident rate and income (cross-section of US households).

Chapter 13—International and Interregional Competition:

- This chapter summarizes some of the issues about the effects of trade/competition between regions on pollution (also relates to some student presentations from class).
- Jurisdictional Competition: positive taxes and competition for capital might lead to suboptimal levels of pollution.
- Pros and cons of international trade with respect to pollution (supplementary readings).
- Greenstone (JPE, 2002)

Chapter 14—Economy-wide Effects of Environmental Regulations:

- In order to correctly assess the effect of economic regulations on the macroeconomy, we need to incorporate it into our growth accounting.
- TFP growth:
 - Labour-productivity growth—problem: does not account for substitution when relative prices of labour and capital change.
 - TFP growth not taking into account environmental change underestimates true growth (think of “dirty air” as an input in production)
- Jorgenson-Wilcoxon (Rand Journal, 1990)

Gollop-Roberts—Estimating marginal costs of abatement:

- They construct a measure of regulation, write firm’s cost function in terms of it, and come up with a marginal cost function in terms of observables.

Chapter 15—Environmental Demand Theory:

- We frequently talk of marginal damage, but this is very hard to measure. To do so, we need to know how individuals value environmental goods and how their surplus is reduced when environmental quality worsens. Since there are no explicit markets for environmental goods, we cannot make inferences from direct market transactions.
- Concepts of individual demand: WTP, MWTP
- Types of environmental goods: Use value, nonuse value
- Measuring demand: Revealed preference (hedonics, household production), stated preferences (contingent valuation)
- Consumer demand theory:
 - Utility-maximization subject to budget constraint—demand curve
 - Cost-minimization subject to fixed utility constraint—compensated demand curve
 - Compensated demand gives us the Expenditure function—the cheapest way to attain a fixed utility at given prices.
 - Compensating variation (change in income required, after price change, to keep consumer at original utility level); Equivalent variation (change in

income required, in the absence of the price change, to give consumer the same utility she would get after the price change)

- From this we can derive WTP and MWTP.
- Restricted demand (compensated demand functions at different, fixed, levels of environmental quality)—this leads to MWTP for environmental goods.

Chapter 16—Hedonic Price Methods:

- This is a revealed preference method for inferring the marginal value of an environmental good.
- General issues:
 - Agricultural land
 - Closed vs. Open cities.
- Hedonic pricing model—house prices and air pollution
- Chay-Greenstone (2003)—estimating MWTP for air quality by looking at housing market (relationship between housing prices and environmental quality).

Chapter 17—Household Production:

- Further revealed preference methods to measure demand for environmental goods.
- Defensive expenditures—a model with noise pollution and expenditure on soundproofing (observed changes in defensive expenditures will understate the true MWTP for a reduction in noise pollution).
- Travel cost methods

Chapter 18—Constructed Markets:

- Stated preferences—CV
- Experimental Markets—an actual artificially constructed market for an environmental good.
- Pros and cons.

Greenstone-Gallagher—Superfund paper