Lecture # 18 – Estimating Benefits/Costs of Environmental Policy

I. Estimating Benefits (continued)

- Muller and Mendelsohn provide an example of marginal damage, showing how marginal damages can vary across geography.
    - Use the Air Pollution Emissions Experiments and Policy model (APEEP), which they introduce in a 2007 paper.
    - Damages depend on where they are released.
    - Population exposed matters
        - APEEP models transport of pollutants from the source to affected populations.
    - Their model considers how an efficient pollution control system could establish an exchange rate for pollution across different regions.
        - Calculate the marginal damages for 10,000 sources measured by the EPA for six pollutants:
            - particulate matter (<= 10 micrometers)
            - fine particulate matter (<= 2.5 micrometers)
            - nitrogen oxides (NOX)
            - sulfur dioxide (SO2)
            - volatile organic compounds (VOC)
            - ammonia
    - Research steps
        - Collect data on emission from EPA
            - Non-point sources measured at the county level
            - Point sources modeled individually
        - Calculate marginal damages
            - First, estimate total damages from all reported emissions in the model
            - Next, add one ton of one pollutant at one source and recompute
                - The difference in total damages is marginal damage.
                - Damage calculations in APEEP include:
                    - health effects
                    - reduced crop and timber yields
                    - lost recreation services
                    - reduced visibility
                - Use research on mortality rates from recent scientific studies to link changes in emissions to mortality
            - Repeat for each pollutant and each source (60,000 combinations)
            - Use value of life studies (to be discussed later in the semester) to assign dollar values to changed mortality rates
                - Assume a value of statistical life (VSL) of $2 million.

- Results
  - Table 1 shows the range of marginal damages for each pollutant
    - Note that there is much spatial variation.
    - For example, marginal damages from ammonia range from $100/ton to $59,450/ton
  - Figures 1 and 2 show variation across the US
    - Lowest in rural western US
    - Median sources near suburban areas
    - Highest MD near large metro areas
  - Table 2 shows the various quantiles for SO_2 and the trading ratios implied
    - For example, damages from a source in Hudson, NJ are 49.4 times worse than a source in Klamath, OR
    - Implies a trading scheme would require a reduction of nearly 50 tons of SO_2 in Klamath to offset one ton SO_2 in Hudson
    - Note that such a policy would discourage, for example urban polluters buying permits from rural sources

II. The Value of Ecosystem Services: Water

- What makes estimating a social cost of water pollution challenging?
    - Role of place matters
        - Where pollution occurs matters for water
            - Some pollution may be highly concentrated locally, but not impact other areas
            - Pollution near major drinking sources more harmful
            - Compare to carbon emissions, whose impacts are global
    - Characteristic of the area where pollution occurs matters
        - E.g. population, presence of endangered species
    - As a result, Kling *et al*. argue that a social cost of water pollution is important conceptually, but a single estimate is not possible
- Four things needed to estimate a social cost of water:
    - Identify the source of pollution
    - Identify how pollutants move through the environment
    - Estimate the impact of pollutants on ecosystem services
        - Many current studies focus on recreation.
        - What else matters
            - Access to drinking water
                - Not just about municipal systems, which can be treated. About 15% of Americans get drinking water from wells
            - Commercial uses
                - Fisheries
                - Transportation (e.g. on rivers)
                - Industrial uses of water
    - Estimate how these services are valued by people
- Note the importance of estimating *marginal* values of a specific resource.
    - Without any ecosystem services, life could not be sustained
        - But, this implies that the *total value* of ecosystem services is infinite!
        - Also note that marginal benefits will increase as more ecosystems are destroyed
    - Early studies often gave implausibly high values, because they focused on total benefits.
        - This led to the work being discredited.

III. Estimating Costs

- Important concerns:
  - Establishing the baseline
    - We want to compare costs *with* regulation versus *without* regulation, not *before* and *after* regulation.
      - Even without regulation, we expect some things to change over time.
  - Distributional issues
    - Note that costs will often be focused on a few individuals (e.g. affected firms or communities).
    - Benefits are more likely to affect a wider range of people.
    - Thus, equity concerns will be an issue.
- Types of costs
  - Direct costs – purchases of tangible units such as equipment, labor, and land
  - Opportunity costs – the value of the best forgone opportunity.
    - It is what we give up by using a resource for this use, rather than the next best alternative use.
      - Example: an opportunity cost of going to school is foregone salary.
    - Important to distinguish between costs and transfers.
  - Environmental costs – because most regulations focus on a single pollutant, regulating one pollutant may increase the use of another pollutant.
    - Example: using scrubbers to clean SO_2 emissions leaves behind a sludge that must be disposed of.
  - Enforcement costs
- The study by Shapiro and Walker (2020) uses offset permit trades to estimate the marginal costs of abatement
  - Offsets are used in non-attainment counties
    - Generated when existing firms reduce pollution
    - Purchased by new firms or firms wishing to expand operations
    - Represent the marginal costs of abatement, since firms selling offsets need to be compensated for the additional costs of increasing pollution abatement.
  - They compare their estimates of marginal abatement costs to the marginal benefits of reducing pollution in each county
    - Use existing studies of benefits that allow for different marginal benefits in different counties

- Results
    - Marginal benefits of air pollution reductions exceed the costs in all but one county
    - The exception is Houston, TX
        - There, the cost of additional regulation for volatile organic compounds exceeds the benefits
    - The price of offsets is high in Houston
    - Cheaper natural gas increased demand to open new petrochemical plants in the area
- Example: cost of the Mercury and Air Toxics Standards (MATS)
    - Used an Integrated Planning Model (IPM) to project compliance costs
        - Computer model of generation capacity, electricity demand, and constraints faced by each electricity generator.
        - Used to calculate the lowest cost options for meeting electricity demand under different regulatory constraints.
            - Compliance options include:
                - Switching from coal to natural gas
                - Installing new abatement technologies
                    - Expected many firms would install new abatement technology that would capture not only mercury, but also SO_2 and particulate matter.
    - Table 3 shows projected changes in costs
    - Monitoring and enforcement add another $0.2 billion (Table 4)
    - Table 5 shows projected changes in generation mix.
        - Note baseline is not just before versus after.
        - Renewables increase from 2007-2015 in base case.

IV. How Accurate are Cost Estimates?

- Sources of error
    - One difficulty is that errors can come in many ways.
    - The most obvious is incorrectly estimating the costs of control.
    - However, even if the cost of control is estimated correctly, predictions about emissions levels, number of plants, etc. can also be wrong.
        - See examples on pages 303-304 of Harrington *et al*.
- Evaluation of estimates
    - Harrington *et al*. study 28 estimates of the cost of regulation.
    - They compare pre-regulation estimates to actual costs after the regulation is in place.
        - Label an estimate as “accurate” if it within 25% higher or lower than the actual costs.

- Results:

	Accurate	Overestimate	Underestimate	Unable to Determine
Quantity Reduction	13	9	4	2
Unit Pollution Reduction Cost	8	14	6	0
Total Cost	5	15	3	5

    - Costs more likely to be overestimated
    - As noted in class, we have not learned from earlier mistakes. A follow-up study in 2015 found similar results.
- Discussion of results:
    - The three underestimates were for rather "minor" regulations: EPA aldicarb and CDEC bans and OSHA's powdered platform regulation.
    - EPA and OSHA tend to overestimate reductions, but not per unit costs. As a result, total costs are overestimated.
    - State and foreign agencies were more likely to overestimate per unit costs.
    - For market-based polices, seven of the eight estimates overestimated costs!
        - Note that this is where we would expect technological innovation to be most important.
- Why do errors occur?
    - Many estimates ignore the possibility of technological innovation.
        - Regulators have an obligation to identify a means of complying with the regulation, which usually means considering current technologies.
        - Future technologies are much harder to predict.
    - Quantity errors: misestimating baseline emissions
        - However, keep in mind that this also means that benefits are wrong.
        - For example, overestimating emissions reductions overestimates costs, but also overstates the benefits.
    - Regulations may change during the public comment period.
        - Thus, cost estimates aren't for the final regulation.
    - Estimates may focus on maximum values, rather than means.
        - Especially if rely on industry for data.
    - Asymmetric correction of errors.
        - Firms are likely to bring underestimates to the attention of regulators. There is no similar group with strong incentives to bring overestimates to the attention of regulators.