Lecture # 18 – Costs of Environmental Policy/Benefit-Cost Analysis

I. 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 SO2 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

II. 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.

III. Introduction to Benefit-Cost Analysis

- *Goal*: Maximize total net benefits (= total benefits - total costs).
- Benefit-cost analysis calculates the costs and benefits of a project and finds the total net benefits.
- Note that some costs and benefits can be observed directly from market data. Others will need to be inferred from data.
- Steps to benefit-cost analysis
    1. Specify clearly the project or program.
        - For environmental economics, this is usually a physical project such as a dam or wastewater treatment plant, or a regulatory program, such as pollution control standards.
    2. Determine quantitatively the inputs and outputs of the program.
        - Can be difficult – for example, general equilibrium effects.
        - Also, it is important to distinguish between *transfers* of resources due to substitution and the creation of new resources.
        - For example, jobs created by a project should normally not be included as a benefit.
            - Jobs created are a transfer of resources. If the project wasn't done, the workers could have been used elsewhere.
    3. Estimate the social costs and benefits of these inputs and outputs.
        - Identify potentially affected benefit categories
            - What are all the potential effects?
            - Research physical effects of the pollutants. How do they change as a result of policy?
            - Which benefits are the most important to include?
        - Quantify significant endpoints
            - What changes relative to baseline will occur because of the policy?
        - Estimate the values of the effects
            - Uses the tools we discussed over the past weeks
    4. Compare these costs and benefits.
        - Here, one can also include other considerations, such as equity.

- The *Economist* article "The rule of more" shows how assumptions matter
    - Including co-benefits made the net benefits of environmental regulations higher.
        - For example, an Obama Administration analysis found that most of the estimated benefits from reducing mercury pollution come from other related benefits.
            - Reducing mercury pollution reduces the use of coal, which also reduces fine particulate matter.
        - The Trump Administration said that these co-benefits should not be included.
    - We discussed in class whether such benefits should be included.
        - Being transparent about assumptions is important.
- In this class we'll focus on two issues particularly important for environmental policy:
    - Uncertainty
    - Discounting
- Students who would like a review of the details of benefit-cost analysis, you can view my lecture notes from the topic in my fall economics class. The last set of lectures cover benefit-cost analysis.

IV. Dealing with Uncertainty

- The first step in dealing with uncertainty is risk assessment.
- Risk has two components:
    1. stochastic – depends on chance
    2. systematic – depends on circumstances (e.g. a smoker is more likely to get cancer)
- In addition, assessing risk involves two concerns:
    - the probability of an event occurring
    - how serious the event will be
- Risk assessment
    - First, we focus on finding the probability of an event occurring.
        - Historical data
            - Risk can be determined by looking at past records.
            - However, it is important to be aware of changes that occur over time. For example, increased safety features reduce the risk of death from auto accidents. This is a change in systemic risk.
        - Engineering studies of new technologies
            - Component analysis is often used to assess the risks of new technologies.
            - Problem: components may be related.
        - Risk by analogy
            - Often, time lags make perceiving risk difficult.
                - For example, cancer may be caused after exposure to a toxin, but only after many years.
                - As a result, studies on animals are often used to extrapolate human risks.
                    - Problems:
                        - Animals are exposed to unrealistically high doses of toxins in the laboratory.
                        - Need to extrapolate risk of humans from low exposure from calculated risk based on high exposure.
                        - Physiology of animals and humans may be different.
                        - The risk may be different for different people.

- Once risk has been assessed, policy makers face several alternatives for using the information:
  - Benefit cost analysis
    - For BCA, pieces of information needed to deal with risk include:
      - The risk probability
        - The government often uses conservative estimates (e.g. 95% percentile).
      - The population exposed
        - For example, Superfund regulations consider possible future populations on a site.
      - The value of a life
  - Avoid upper bound of risks
    - Government agencies, such as EPA, often use conservative risk estimates (e.g. 95% percentiles)
    - However, this adds up
      - If use 95% percentiles for several estimates, actual percentile is above 99% (.95 x .95 x .95)
      - Consider two chemical hazards:
        - Chemical A poses a known risk of 2 in 100,000
        - Chemical B is uncertain
        - 9 out of 10 scientists believe no risk
        - 1 out of 10 believe risk is 6 in 100,000
        - Government policy says risk of B is greater, since focuses on upper bound – that is, greatest potential risk.
        - However, chemical A has a higher expected value of risk.
  - Cost-Effectiveness analysis
    - Rather than compare costs and benefits, simply show that the agency has adopted the cheapest way possible to achieve its goal.
      - Takes the policy objective as worthwhile.
    - We can than ask if the costs justify the benefits received, without needing to place a dollar value on the benefits.
  - Risk-risk analysis
    - Compare risk after regulation to risk before.
    - Notes that regulation will affect behaviors, and could even increase risk.
    - Substitution of risks is important
      - If substances that replace banned substances are also risky, net gain from banning the substance is not as great as it seems.

- As we discussed in class, climate change provides an example where uncertainties are high and using cost-benefit analysis is challenging. Reasons for high uncertainty include:
    - Difficulty understanding the severity of climate change itself (e.g. cascading effects leading to high damages).
    - Impacts that are hard to value in dollars (e.g. ecosystem services)
    - Difficult to extrapolate from current experience what impacts will be, since some effects of climate change will be unprecedented.
        - This also means that people may adapt to climate change in unexpected ways.
    - Some low probability events have nearly infinite damages, making the expected value of damage's very high. How much can we reasonably spend?
        - E.g. Weitzman's "Dismal Theorem"