Lecture # 10 – Policy Instrument Choice: Theory

I. Uncertainty in Environmental Economics

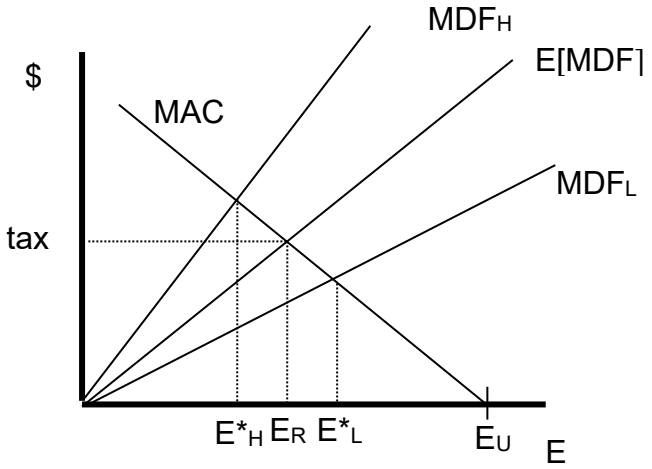
- What is uncertain in environmental policy?
    - What will the damages be?
        - Uncertainties in:
            - Physical and ecological processes: (e.g. how will the pollutants interact with the natural environment?)
            - What are the economic impacts of the resulting environmental effects?
            - How might technology evolve to ameliorate these effects?
        - What will the costs of policy be?
            - How will individuals respond to policy?
            - How will technology change in response to policy?
        - What discount rate should we use to evaluate future benefits and costs?
            - Depends, for example, on marginal return to capital. This will change over time.
- Uncertainty is a problem for all policy decisions.
    - Often dealt with using expected values.
- Given this, what makes uncertainty different for environmental problems?
    - Uncertainty for environmental problems is highly non-linear
        - Damages may be barely noticeable for low levels, but become severe above some uncertain threshold, or tipping point.
            - For policy, this is important because we don't want to go beyond the tipping point.
            - However, the tipping point itself is often uncertain.
        - Uncertainties may interact. For example, the benefits of climate change reductions depend on:
            - Expected GHG levels without abatement (BAU)
            - How rapidly CHG concentrations grow in response to emissions
            - Effect of concentrations on temperatures
            - Economic impact of higher temperatures
        - Similarly, cost of abatement may be low for low levels of abatement, but be very high for total abatement (e.g. climate change)
            - While these may be well-known for some pollutants (e.g. SO_2, NO_X), for others, costs are uncertain
            - For climate change, the level of tax needed to meet an emissions target depends on how responsive energy use is to prices.
                - There are decent estimates for short-run.
                - However, for the long-run, this is more challenging.

            - Our ability to substitute in the long-run depends on how well alternative energy sources substitute for fossil fuels.
            - This is highly dependent on technological change.
            - It may be that large reductions are very costly.
    - Irreversibilities
        - Two types of irreversibilites:
            - Environmental damage often irreversible.
                - Can't undo cutting down a virgin forest or extinction.
                - Takes many years to remove carbon emissions
                - Thus, adopting a policy now has a sunk benefit (e.g. a negative opportunity cost)
                    - Suggests traditional cost-benefit analysis biased against policy adoption.
            - Abatement efforts involve sunk costs
                - Often in the form of capital expenditures
                    - However, may just be lost expenditures
                    - Thus, there is an opportunity cost to adopting a policy now, rather than waiting for more information
                    - This works in the opposite direction, suggesting that traditional cost-benefit analysis biased for policy adoption.
    - Long time horizons
        - Makes results very sensitive to the choice of discount rate.
        - We will discuss this in the cost-benefit section of the course.
- Policy implications
    - Policy timing
        - Should we wait until we learn more, or should we act quickly?
        - When do irreversibilities matter?
            - Only if there is uncertainty. If we know with certainty how future generations will value the changes, we can incorporate that into our cost-benefit analysis.
            - Only affects current decisions if it would constrain future choices under plausible conditions.
                - E.g. if, in the future, we would want negative carbon emissions to reverse climate change, we might emit less today, since negative emissions in the future are impossible.
            - One key here is long-lived effects
                - In a "good news" scenario, we can roll back policy
                - However, in a "bad news" scenario, we cannot correct the situation.

- Policy intensity
    - Choice depends not just on expected values, but on variance
    - That is, on the shape of the curves (what Pindyck calls convexity)
        - Do costs increase faster at higher levels of abatement?
        - Do marginal damages get worse as emissions increase?
- Choice of policy instrument
    - The choice of policy instrument depends on what is uncertain

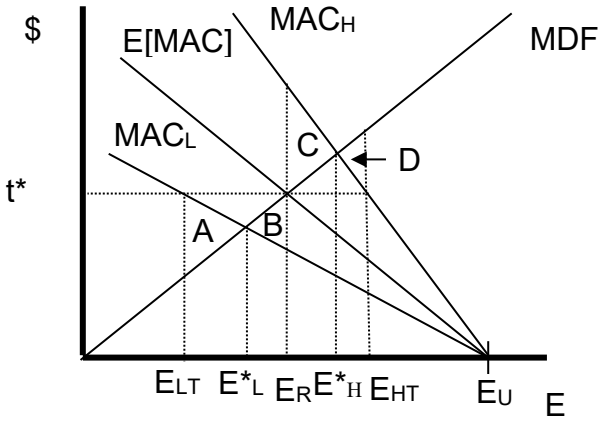
II. The Role of Uncertainty: Choice of Policy Instruments

- When marginal abatement costs or marginal damages are uncertain, we make policy based on the expected value, or our best guesses.
- Uncertainty about MDF causes problems for either regulations or taxes.



    - If command and control is chosen, we regulate where MAC = E[MDF]
        - We end up with E_R emissions
    - If a tax is used, the firm equates the tax to the MAC
        - We end up with E_R emissions
    - Thus, either a tax or CAC regulation results in the same level of emissions.

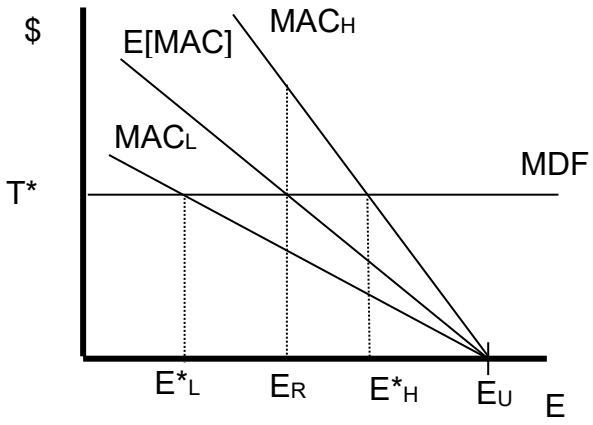
- However, since MAC is needed to make fees (or permits) work, uncertainty about MAC can affect the desired policy.



  - Tax:
    - Set at t*
    - Error if MAC_L:
      - E_{LT} is too few emissions (tax is too high)
      - Area A (MAC > MDF)
    - Error if MAC_H
      - Q_{HT} is too many emissions (tax is too low)
      - Area D (MDF > MAC)
  - Regulation:
    - Set at E_R
    - Error if MAC_L:
      - Too many emissions (regulation is too weak)
      - Area B (MDF > MAC)
    - Error if MAC_H
      - Too few emissions (regulation is too strong)
      - Area C (MAC > MDF)

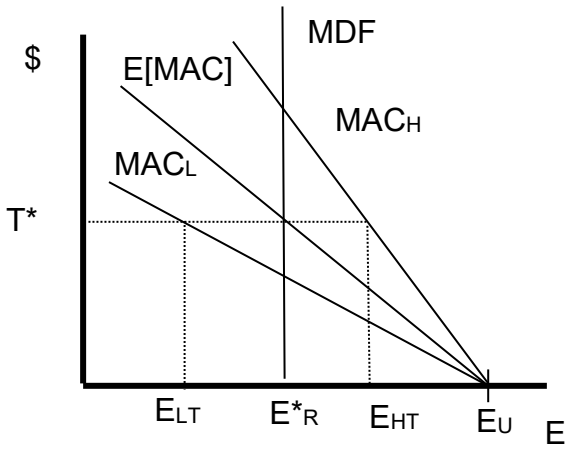
- The magnitude of the error depends on the slope of the curves.
  - Intuition:
    - Regulation allows no flexibility in the quantity regulated to react to new knowledge about costs.
    - Tax allows the quantity of emissions to change, but the level that occurs will not be correct.
    - To demonstrate, consider two extreme cases:

- Example 1: Flat MDF



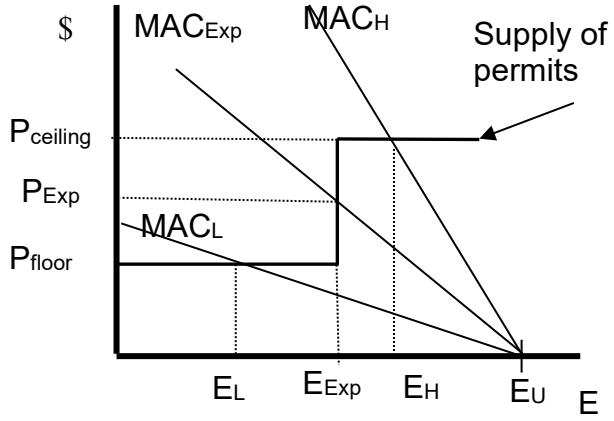
  - Tax:
    - No error
    - The tax approximates the MDF
  - Regulation:
    - MAC_L => too little control
    - MAC_H => too much control

- Example 2: Vertical MDF



  - Tax:
    - MAC_L => too much control (tax is too high)
    - MAC_H => too little control (tax is too low)
  - Regulation:
    - No error
    - The regulation approximates the MDF
- Lesson:
  - When MDF is steeper, mistakes with quantity are more costly. Thus, regulation is a better option.
  - When MDF is flatter, a tax is better, because the tax represents MDF well.

- A third option: combining permits with price floors and/or ceilings
    - One problem with the above analysis is that fees are rarely used.
    - Permits are more practical politically, but restrict quantity even if costs are high.
    - Setting price floors and ceilings helps to mimic an upward sloping supply curve
    - Implementation:
        - Along with emissions targets, the government sets both a price floor and price ceiling
            - If the price of permits rises above the price ceiling, the government sell extra permits to maintain this price.
            - If the price falls below the price floor, the government withdraws permits from the markets
        - This keeps the price within a narrow band, and avoids big surprises
        - The California permit market is an example



    - Note that if a MDF were drawn through the two equilibrium points, it would approximate a flatter MDF
    - Compared to just cap-and-trade, which is a quantity restriction, the limits on price reduce price uncertainty, but increases quantity uncertainty
        - Thus, policymakers still need to consider which matters more

- Other effects of uncertainty on policy instruments
    - Banking allowances across periods
        - When prices are lower than expected, can save allowances for future use
        - Can use these banked allowances when prices are unexpectedly high (e.g. a year with robust growth)
    - Policy flexibility
        - With uncertainty, we want to be able to adjust policy to new information
        - That may be easier with tradable permits if banking and borrowing allowed
            - E.g. if new information leads to expectations of tighter future regulations, can start banking allowances immediately