Lecture # 10 – Policy Instrument Choice: Theory

I. Uncertainty in Environmental Economics

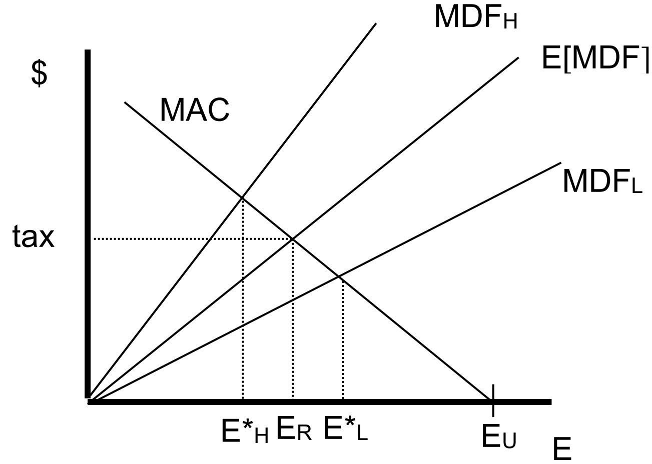
- What is uncertain in environmental policy?
    - What will the damages be?
        - Uncertainties in:
            - Physical and ecological processes: (e.g. how will the pollutants interact with the natural environment?)
            - What are the economic impacts of the resulting environmental effects?
            - 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

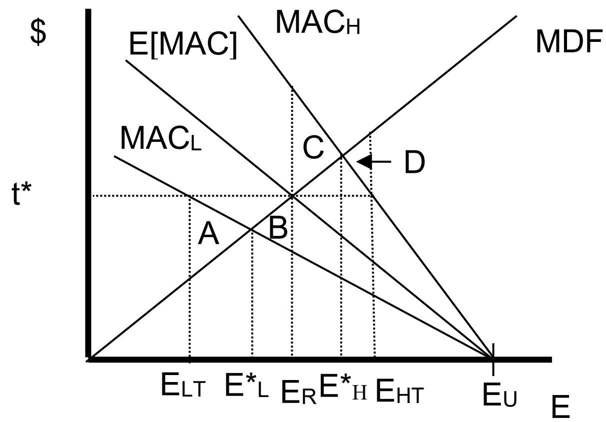
II. The Role of Uncertainty: Choice of Policy Instruments

- 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.

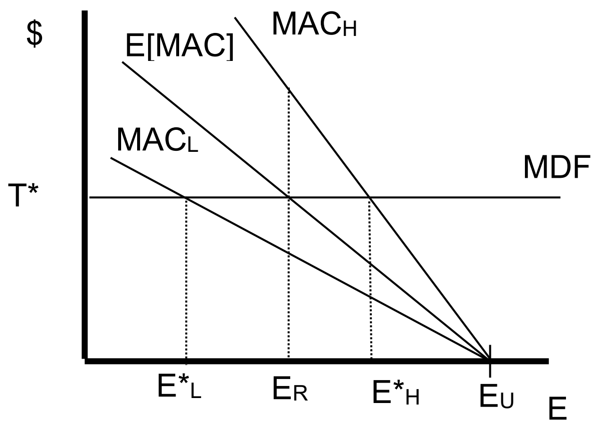
- However, since MAC is needed to make fees (or permits) work, uncertainty about MAC can affect the desired policy.



  - 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)

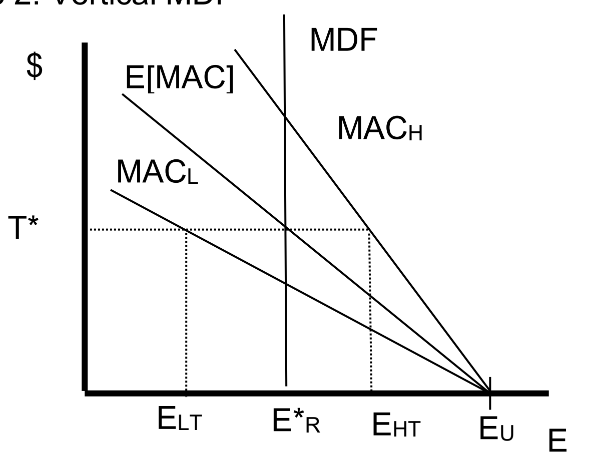
- The magnitude of the error depends on the slope of the curves.
  - Intuition:
    - Regulation allows no flexibility in the quantity regulated to react to new knowledge about costs.
    - Tax allows the quantity of emissions to change, but the level that occurs will not be correct.
    - To demonstrate,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

- Example 1: Flat MDF



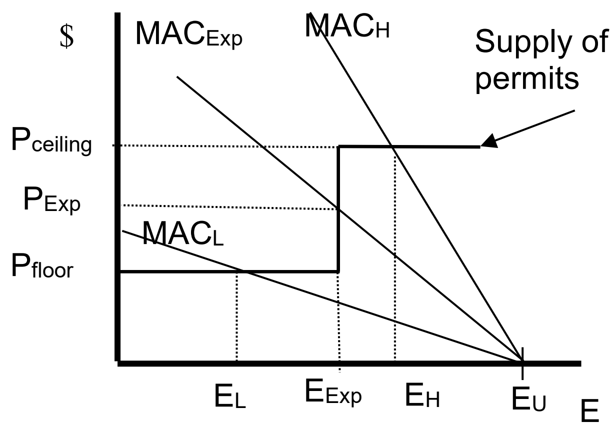
  - Tax:
    - No error
    - The tax approximates the MDF
  - Regulation:
    - MAC_L => too little control
    - MAC_H => too much control

- 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

III. What Matters for Policy Instrument Choice?

- Cost-effectiveness
    - Recall that costs will be minimized when marginal abatement costs are equal across all polluters. This includes:
        - Individual units have flexibility across different means of reducing pollution (e.g. installing a scrubber, reducing output, using cleaner fuel)
        - Is there flexibility across different units in the same sector?
        - Is there flexibility across sectors?
        - Are households and firms both considered?
            - For example, reducing air pollution may be more difficult if emissions from vehicles are not regulated
    - Rarely are instruments broad enough to minimize costs across all of these
        - Fowlie et al. (2012) estimate marginal abatement costs for NOX reduction from point source (power plants) and non-point sources (autos)
            - NO_X emissions at power plants covered by two regional trading programs (Ozone Transport Commission) and NO_X Budget Program
            - Vehicle emissions covered by "Tier 2" command and control standards in the 1990 CAA, which reduced allowable grams per mile of NO_X by 77%
        - Estimate that marginal abatement costs are twice as high for point sources than non-point sources
        - Estimate that inefficiencies raise abatement costs by $1.6 billion
            - This is about six percent of the total costs of compliance with both sets of regulations
        - An efficient policy would raise the cap on NOX emissions in power plants by about 45%, and reduce emissions in autos by about 15%

    - More often, cost-effectiveness within a sector is the policy goal
    - How do different instruments perform?
        - Market-based instruments can minimize abatement costs within the covered sector(s), but the policy chosen matters
            - Subsidies are similar to taxes, but provide the wrong incentives for level of output
                - Leads to excess entry
            - As we've discussed earlier, an output tax is less cost-effective than emission fees, as it does not offer flexibility within a firm. Reducing output is the only option.
            - Direct regulatory instruments will not minimize abatement costs
                - Technology mandates require a specific means of reduction
                    - May also require firms to meet the same goals, unless there are vintage-differentiated regulations
                    - Gives no incentive to use cleaner inputs
                        - Focuses on end-of-pipe solutions
                    - Doesn't give incentives to reduce output, as firms aren't charged for remaining emissions
                - Performance standards give flexibility on how the target is met, but…
                    - Doesn't give incentives to reduce output
                    - Doesn't minimize costs across sources
            - When will incentive-based programs offer the largest gains?
                - When there is heterogeneity among firms
- Administrative costs
    - Includes monitoring and enforcement
    - Consider difference between point and non-point sources
        - To put a price on pollution, need to know how much pollution occurs
        - If monitoring is expensive, market-based policies may no longer be cost-effective
    - Might administrative costs (and thus the appropriate policy instrument) be different in lower-income countries?
        - Effective environmental policy depends on regulatory capacity to be effective
            - Regulators must check compliance and sanction violators

- Fiscal interactions
    - Revenues raised from environmental taxes can help lower other taxes
    - But higher consumer prices from environmental taxes reduce real wages
    - What does this mean for policy?
        - Is the tax system able to exploit the revenue-recycling effect?
- Distributional impacts
    - How are owners of polluting enterprises affected compared to others?
        - Permits
            - Initial allocation matters
                - Are allowances free?
                    - If so, firms receive economic rents
        - Fees
            - As we've seen, cost firms more unless there are rebates or exemptions
        - Command-and-control
            - Less cost to the firm (e.g. don't pay for what they do emit, only what they reduce)
            - But, what if not cost-effective? Are some firms worse off?
    - Distribution across household income groups
        - Low income households tend to spend a greater share of their budgets on energy and energy-intensive goods
        - How revenues are recycled matters
            - Note that lowering payroll or income taxes doesn't help those who don't pay those taxes, such as retired or unemployed people
- Other policy challenges: interactions among policies
    - Multiple externalities
        - For example, reducing carbon emissions also reduces pollution such as SO_2 and NO_X (e.g. because less coal is used)
        - Should each pollutant be taxed separately, or are the administrative costs too high?
    - Regulatory interactions
        - For example, regulated utilities have different incentives for passing along cost savings and/or the value of freely allocated permits
        - Regulated utilities cannot raise prices to capture the opportunity cost of using freely allocated permits
    - Multiple jurisdictions
        - Leakage is a concern
        - If costs increase in one state, firms can move elsewhere
        - If the pollutant is global, such as carbon dioxide, the regulating state has imposed a cost on itself without reducing emissions.
        - Thus, need to weigh benefits of avoiding leakage against potential cost effectiveness of the market-based instrument.
        - For market-based policies, broader markets allow for more cost heterogeneity and greater potential for trades