

Lecture # 10 – Policy Instrument Choice: Theory

I. Uncertainty in Environmental Economics

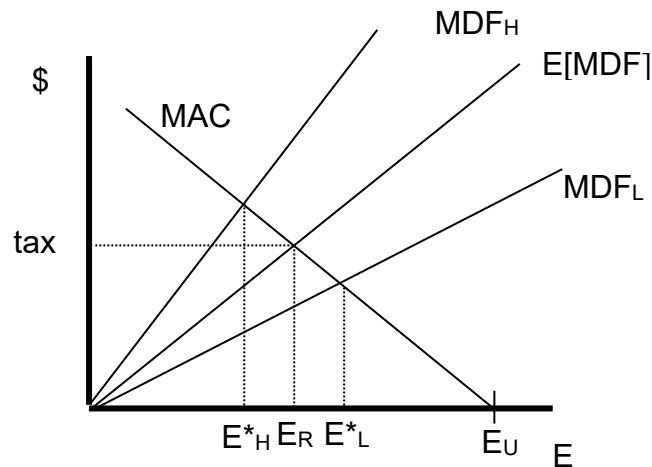
- What is uncertain in environmental policy?
 - What will the damages be?
 - Uncertainties in:
 - Physical and ecological processes: (e.g. how will the pollutants interact with the natural environment?)
 - What are the economic impacts of the resulting environmental effects?
 - How might technology evolve 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. SO₂, 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 irreversibilities:
 - 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

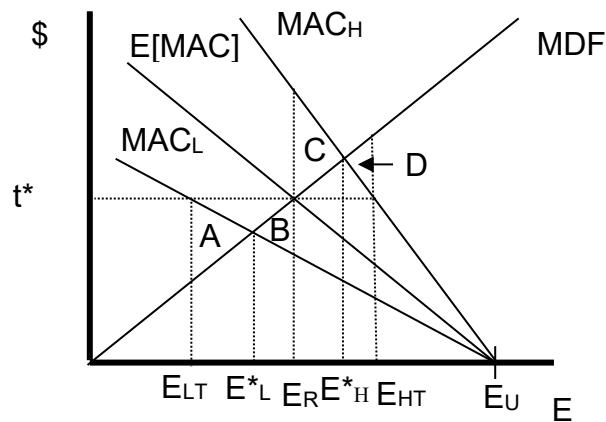
II. The Role of Uncertainty: Choice of Policy Instruments

- 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.



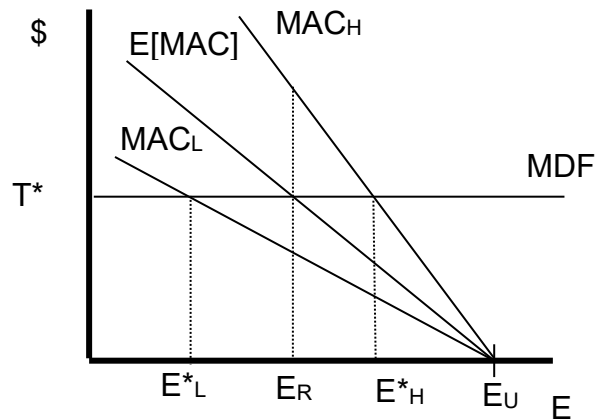
- If command and control is chosen, we regulate where $MAC = E[MDF]$
 - We end up with E_R emissions
- If a tax is used, the firm equates the tax to the MAC
 - We end up with E_R emissions
- Thus, either a tax or CAC regulation results in the same level of emissions.

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



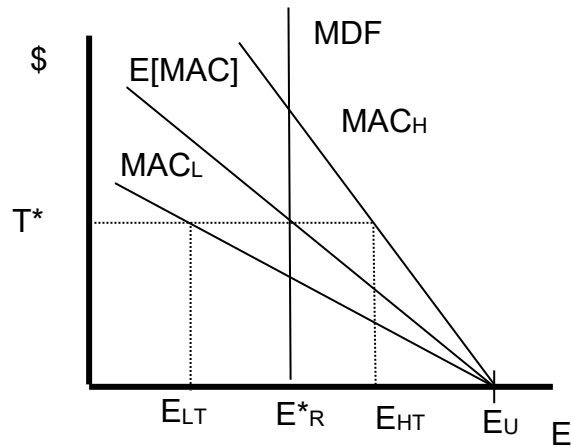
- Tax:
 - Set at t^*
 - Error if MAC_L :
 - E_{LT} is too few emissions (tax is too high)
 - Area A ($MAC > MDF$)
 - Error if MAC_H
 - E_{HT} is too many emissions (tax is too low)
 - Area D ($MDF > MAC$)
- Regulation:
 - Set at E_R
 - Error if MAC_L :
 - Too many emissions (regulation is too weak)
 - 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:
 - $MAC_L \Rightarrow$ too little control
 - $MAC_H \Rightarrow$ too much control

- Example 2: Vertical MDF



- Tax:
 - $MAC_L \Rightarrow$ too much control (tax is too high)
 - $MAC_H \Rightarrow$ 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.

- 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? (to discuss on Wednesday)

- 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 NO_x 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 NO_x 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 SO₂ 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