Lecture # 6 -- Command and Control/Taxes and Subsidies

I. Economic Analysis of Standards (continued)

- We began comparing the policy options we discussed on Monday to the four goals for a policy measure in Aldy and Pizer:
  - Emission levels and intensity not comprehensive
    - Affected by many factors unrelated to emissions
  - Emission levels and intensity are easy to measure and replicate
    - Make them practical for international agreements
  - Aldy and Pizer suggest that surveillance by other countries will be important
- Example: US gasoline content regulations for VOCs & NOX leading to ozone
  - Auffhammer/Kellogg (AER 2011) study the effect of US gasoline content regulations, which differ across states
  - Federal rules limit total evaporation of VOCs from gasoline (called Reid Vapor Pressure regulations, or RVP)
    - New rules introduced in 1989, take full effect in 1991
    - More stringent in summertime
    - Vary across region, from allowing 9.0 psi evaporation to 7.8 psi in non-attainment areas.
      - Some localities even chose a more stringent 7.0 psi limit.
    - They don't consider how much impact each VOC has on ozone
  - Severe non-attainment areas must use reformulated gasoline (RFG), which has stricter limits on benzene and requires at least 2% oxygen from an additive such as MTBE or ethanol
    - Other areas may opt to use RFG as part of their plans to reach attainment
  - California state regulations place strict limits on the specific VOCs found most important for forming ozone
- Research strategy
  - Use regression analysis to compare ozone concentrations in areas treated with one of the regulations above to unregulated control regions
    - Regression controls for other factors, such as weather, that affect ozone
  - General federal rules (labeled RVP in Figure 5a that I showed in class) range from 9.0 psi to 7.8 psi or lower. The 9.0 counties serve as a baseline.
    - Focus on June-August, because ozone peaks then and that is when seasonal regulations are in effect.

- Results
    - More stringent RVP rules had almost no effect.
        - Note in figure 5a that the RVP counties and baseline counties have very similar trends
    - RFG rules in 1995 led to modest reductions in ozone (Figure 5b)
    - More stringent California rules had a larger effect (Figure 5c)
        - Ozone concentrations fell by about 16%
- Why the difference?
    - The federal standards are more flexible. Because they don’t target specific VOCs, firms focus those that are easiest to reduce (primarily butane).
        - This lowers compliance costs (just 1-1.5 cents/gallon) but has less environmental benefit. Butane is not highly reactive in forming ozone.
    - The California standard focuses specifically on compounds known to be most problematic for ozone (olefins & aromatic hydrocarbons that are 3-10 times more reactive than butanes)
        - Compliance cost is higher (8-11 cents per gallon), but has larger environmental impact
- Other advantages and disadvantages of standards
    - Advantages of standards
        - Set simple and direct goals.
        - Know final amount with certainty (may be beneficial if a slight mistake is costly).
            - Particularly desirable if the optimal level of pollution is near zero.
            - In that case, banning the activity is simpler than collecting fees.
        - Appeals to a sense of fairness
        - May be easier to monitor than fees.
            - Fees require constant monitoring.
            - Regulation could be enforced with random monitoring and large fines.
    - Disadvantages of standards
        - Inefficient if more than one polluter. This raises the cost of the policy.
        - To set the efficient level of pollution, need to know the firm's marginal abatement costs. Firms may be reluctant to reveal these costs.
        - May be seen as adversarial

- Should standards be applied uniformly?
  - Federal standards apply throughout the U.S. Is it appropriate to have uniform standards across regions?
    - Are the needs of rural and urban areas similar?
    - If marginal damages differ across regions, a uniform standard cannot be efficient in both jurisdictions.
      - However, having different standards increases costs to the government.
    - Note in this case the issue is variation in the marginal damage function.
  - Should standards be the same across firms?
    - Efficiency is achieved when MAC is equal across firms, which won't happen with uniform standards unless MAC curves are the same.
      - By efficiency, we mean that any given abatement level is achieved at the lowest cost possible.
    - Note that MAC may even vary across regions, as in the example of arsenic in drinking water.
- Vintage differentiated regulation can help address differences in MAC from command and control. However, it raises additional issues, particularly with dynamic investment decisions.
  - With vintage differentiated regulation (VDR), standards depend on the entry date of each unit.
    - Newer units face more restrictive regulations.
    - Older units are often exempt ("grandfathering")
  - Examples
    - Clean Air Act New Source Review
    - Emissions standards for automobiles
    - Clean Water Act effluent limits for water treatment plants
  - Why use VDR?
    - Efficiency
      - Costs are lower for newer units
      - Relates to equimarginal principle
        - Holding all plants to the same standard is not cost effective
        - In principle, CAC could mimic an efficient standard if each plant's regulations varied depending on MAC.
        - However, this is hard to observe.
        - If MAC correlates with vintage, using vintage (which is easily observed) to differentiate regulations makes CAC more efficient.
    - Equity
      - Rules aren't changed in midstream
    - Politics
      - Easier to pass regulations if don't harm existing firms
      - Potential for economic rent for existing firms if VDR makes entry into the market harder.

- Effect on investment
  - Firms invest if NPV of benefits (net of O&M costs) > cost of investment
    - VDR makes investment more costly
      - Both initial costs and O&M costs higher
    - As a result, investment falls, and capital is kept longer
    - In extreme cases, VDR could lead to more emissions in the short run, as older, less efficient equipment is kept longer than before.
- Example: New Source Review
  - New Source Review (NSR) is part of the Clean Air Act
    - Regulations apply only to new sources
    - However, existing sources that make major modifications must also comply.
  - Several studies find that NSR lowers investment, thus extending the life of power plants.
  - NSR can also raise the cost of operating newer plants.
    - As a result, newer plants may be idled first.
  - NSR can discourage investment at older plants.
    - However, Wolfram and Bushnell (2012) find that this effect is small.
    - They find that NSR reduces capital expenditures at existing plants, but they find no change in operating costs, fuel efficiency, or emissions.

II. Output Taxes and Subsidies

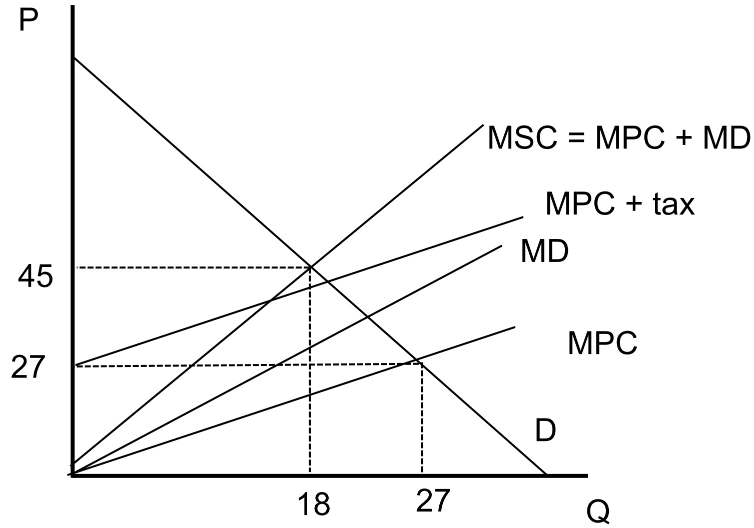
- *Goal:* to set prices so that the actor includes social costs in her decision.
    - Often referred to as Pigouvian Tax for the economist who first expressed this idea
    - A Pigouvian Tax is a tax equal to the marginal damage inflicted by an activity
- Economists prefer taxes over regulation because they achieve pollution reduction at the lowest possible cost.
    - This is because they encourage the cheapest reduction possibilities to be done first.
- Two types of taxes
    - A tax on output: a tax levied on each unit of output in an amount equal to the marginal damage that it inflicts at the efficient level of production.
        - Taxing output is a second-best solution. It would be better to tax the pollution directly.
        - Although the level of output is correct for the technology being used, the firm doesn't have the correct incentives to use the appropriate technology (e.g. pollution control, more efficient machines, etc.) because there is no price placed on pollution.
        - However, there may be times when this is the best we can do.
            - For example, we cannot measure the actual emissions from cars, so we instead tax gasoline consumption, since pollution is a by-product of gasoline consumption
    - Emissions fees -- a tax per unit of pollutant emitted
        - Emissions fees are more direct, and thus more desirable.
        - However, sometimes measuring emissions may be difficult (e.g. emissions from cars). In that case, a tax on output is a possible fallback.
- We look first at taxes and subsidies on output, and then turn to emission fees.

- Example: a tax on output

Demand:
  $P = 81\text{-}2Q$

  $MPC = Q$
  $MD = 1.5Q$

In free market:
equate MPC = D
  $81 – 2Q = Q$
  $81 = 3Q$
  $Q = 81/3$
  $\boldsymbol{Q = 27}$



To find the price, plug this quantity into either supply or demand to get ***P* = $27:**
  $P = 81 – 2(27) = \$27$
    or
  $P = (27) = \$27$

Now, add pollution
  $MSC = MD + MPC = 1.5Q + Q = 2.5Q$

Efficient solution: equate MSC and D
  $2.5Q = 81 – 2Q$
  $4.5Q = 81$
  $Q = 81/4.5$
  $\boldsymbol{Q = 18}$

To get the price, plug the quantity of 18 into demand:
  $P = 81 – 2(18) = \$\mathbf{45}$.

We can achieve the efficient solution with a Pigouvian tax:
  MD @ $Q = 18(1/.5) = 27$
A $27 tax shifts the MPC curve up to MPC + tax:

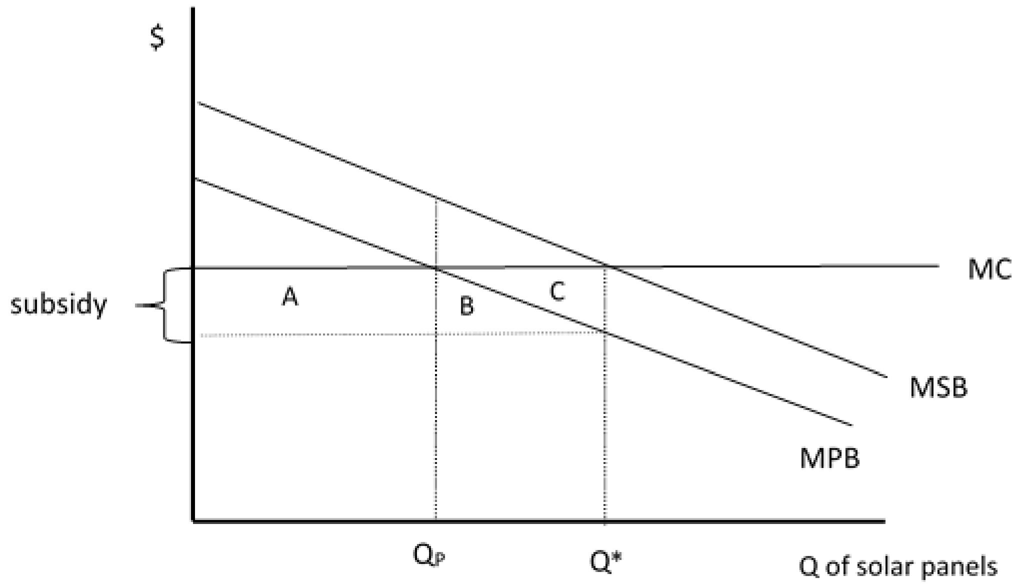
The private solution is now: MPC + tax = D
  $Q + 27 = 81 – 2Q$
  $3Q = 54$
  $Q = 18$

Note that this is the efficient solution – the tax internalizes the externality!

Also notice that the price does not increase by the full $27. That is because the producer price falls – both consumers and producers bear the burden of the tax. At Q= 18, the marginal private cost equals $18. Thus, the price received by producers falls from $27 to $18. The difference between the consumer price ($45) and producer price ($18) equals the Pigouvian tax of $27.

- The Pigouvian tax works by internalizing the cost of the externality. We can do the same thing with a subsidy.
    - In this case, the opportunity cost of polluting is losing the subsidy.
    - Types of subsidies:
        - An abatement equipment subsidy would pay a firm for adopting a specific abatement technology.
        - A per unit subsidy pays a firm for each unit of pollution reduced below some predetermined level.
            - Most environmental subsidies are the first, encouraging consumption of an environmentally friendly good (e.g. solar panels, EV's)
    - Problems with subsidies
        - Firms may enter market, so that total pollution increases
        - Need to raise taxes to pay for subsidies
        - Subsidies are often politically motivated and can be difficult to remove when no longer needed.
        - Very different distributional effects
            - The polluter receives money from the government, rather than paying
            - Benefits often go to higher income households, as they are more likely to invest in new equipment (e.g. hybrid vehicle, solar panels)

        - Payments typically more than necessary to induce adoption of the technology



        - In the graph above, MPB represents the marginal private benefits of solar panels, and MSB the marginal social benefits.
        - Without a subsidy, consumers compare MPB to marginal cost and choose Q_P. The optimal level is Q*.
        - A subsidy equal to the difference between MSB and MPB will induce the correct quantity of solar panels.
        - However, much of the money spend does not directly change behavior.
            - Area A represents payments to people who would have purchased solar panels even without the subsidy
            - Area B is a payment to new adopters above and beyond the minimum necessary to get them to buy the solar panels (since their MPB is higher than the MC + subsidy)
            - Only area C is required to get these extra adopters to choose Q*.
    - Advantages of subsidies
        - Politically more feasible than raising taxes or increasing regulation
        - Targeted subsidies could help low-income families
        - Provides support for new or emerging technologies