Lecture # 3 -- Modeling Pollution

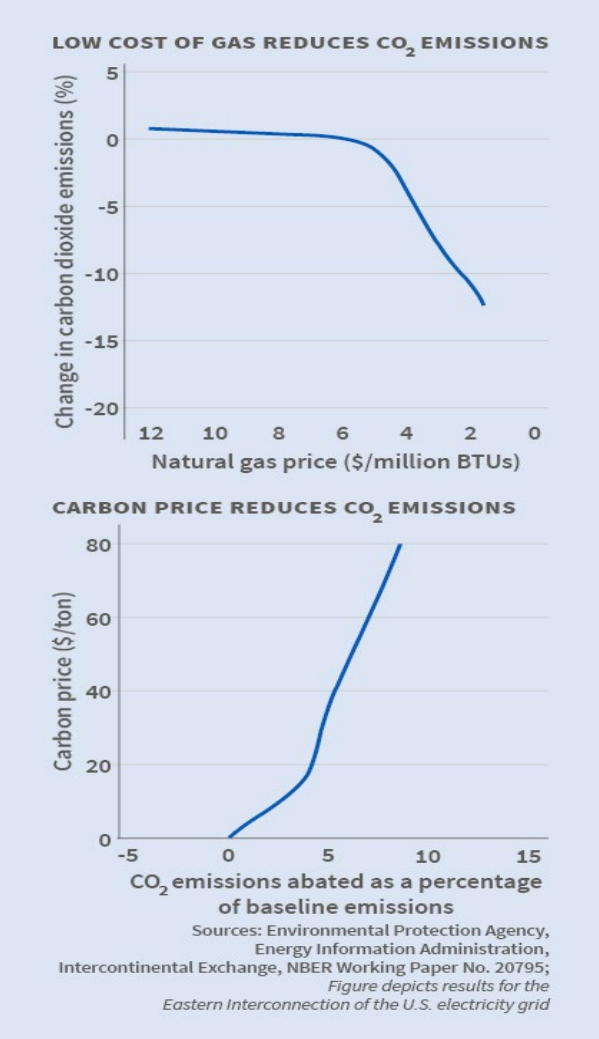
I. The Marginal Damage Function

- Our goal, of course, is to develop policies that lead to an optimal level of pollution.
    - Recall that the optimal level of pollution is not zero.
    - We need to consider the marginal costs and marginal benefits of pollution.
- The marginal damage function shows the damage done by an additional unit of pollution.
    - It is upward-sloping.
    - The slope normally gets steeper as emissions increase.
        - However, it may level off if there is a point where no more damage can be done (e.g. all the pond life is dead).
    - We can look at damage in one of two ways:
        - Emissions damage functions -- the marginal damage done by additional flows of emissions.
        - Ambient damage functions -- the marginal damage done by additional concentrations of pollution in the ambient environment.
    - The area under the marginal damage function shows the total damages.
- The type of pollutant affects the shape:
    - An example where it gets steep very suddenly is a *threshold effect*.
    - Flow pollutant – A pollutant that the environment can absorb. As a result, only the amount that occurs at a specific point in time matters (e.g. waste flowing into the river).
        - For a flow pollutant, the MDF does not change over time (if other things remain equal).
    - Stock pollutant – A pollutant that the environment cannot absorb. The level of the pollutant in the environment grows over time as the pollutant is accumulated.
        - Example: CO2 emissions (take 200 years to decay).
        - MDF is flat, and shifts up over time, because the stock keeps getting larger.
- Things that affect the position of the MDF include:
    - Population
    - Time of year

II. The Marginal Abatement Cost Curve

- Marginal abatement costs can be:
    - The costs of reducing pollution (e.g. costs of scrubbers, labor needed to maintain them, etc.).
    - The opportunity costs of lowering consumption or production.
- The marginal abatement cost curve is downward sloping, and equals zero at the level of unconstrained emissions.
    - Firms choose the easiest ways to reduce pollution first.
    - It may flatten if economies of scale are present.
- Things affecting the position of the MAC:
    - Technology
- Example of marginal abatement costs:
    - Recent work by Cullen and Mansur (NBER Working Paper #20795) uses changes in natural gas prices to estimate abatement costs for carbon dioxide
    - As gas prices fall, more utilities switch from coal to gas, lowering CO2 emissions
    - They use data on prices, coal and gas consumption, and emissions to show how carbon emissions in the electric utility industry change as gas prices change.

- Results



- $10 per ton tax on CO2 would reduce emissions by 4%.
- $60 per ton tax on CO2 would reduce emissions by 10%
- Thus, it becomes increasingly more expensive to meet more stringent targets, resulting in a steep curve.

III. The Equimarginal Principle

- To add together the MAC of individual firms, we use a horizontal summation. See Figure 5-5 in Field and the spreadsheet from today's class.
    - Note that this follows from what Field calls the equimarginal principle – to minimize total abatement costs, choose the lowest marginal abatement costs first, even if it means one firm does more than the other.
    - *Intuition*: we do the simplest (the cheapest) abatement first.
    - The *Economist* article "Giving up carbs" provides an example.
        - Aggregate marginal abatement costs for the whole economy are found by identifying the cheapest possible options first.
        - Note that these curves are uncertain, as the marginal abatement costs may vary in different places.