Public Economics (ECON 131)
Section #9: Externalities

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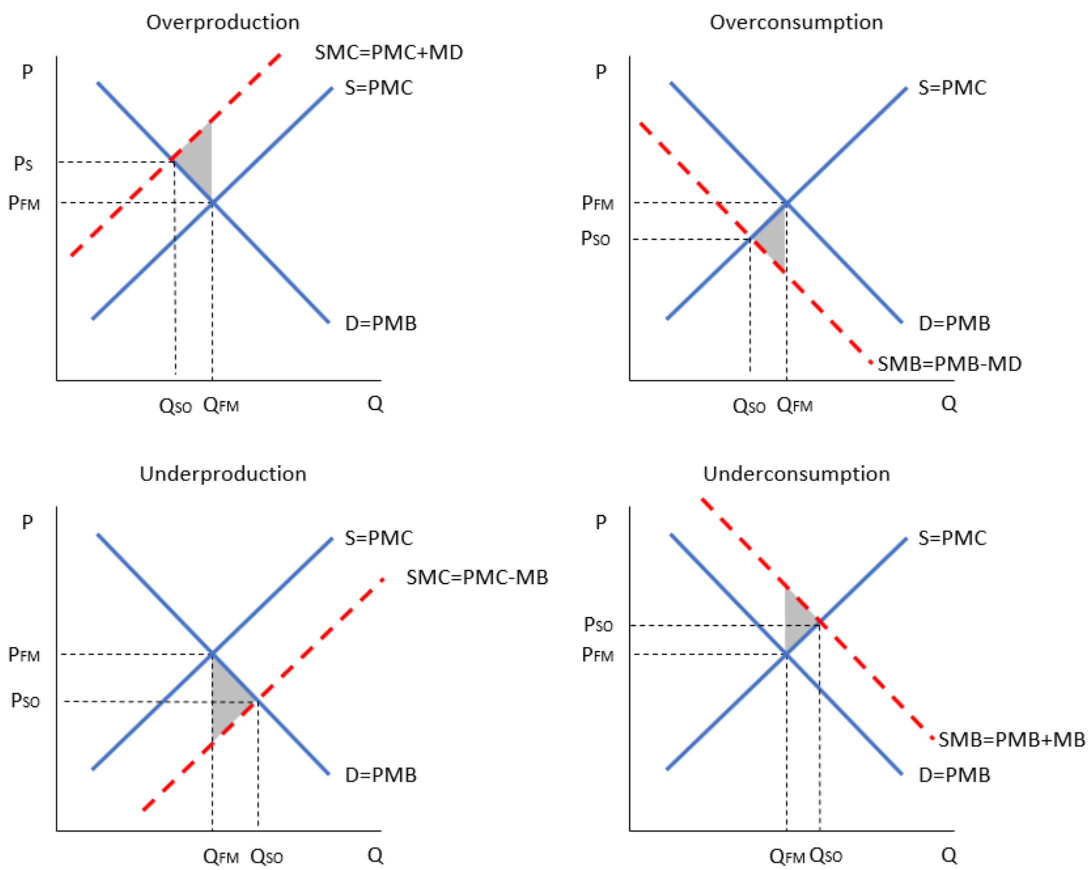
1 Externalities

1.1 Key concepts

- **Market failure:** A problem that causes the market economy to deliver an outcome that does not maximize efficiency.
  - Externalities, asymmetric information, individual failures
- **Externality:** An externality arises when the action of an agent directly makes other agents better off (positive externality) or worse off (negative externality), with no costs or benefits to the acting agent.
- Externalities can occur because of production or consumption
- Private vs. social marginal cost:
  - Private marginal cost (PMC): is the direct marginal cost of producing/consuming an additional unit of a good
  - Social marginal cost (SMC): is the PMC + marginal damages (MD), ie the PMC + any additional costs associated with production/consumption that are imposed on others in the economy

- In a free market, equilibrium where PMB = PMC
- Social optimum at SMB = SMC
- If PMB $\neq$ SMB and/or PMC $\neq$ SMC $\Rightarrow$ private market leads to inefficient outcome



- We say an agent **internalizes the externality** when, due either to private negotiations or government actions, the price of an action fully reflects the external costs or benefits of that action.
  - Private negotiations can bring result in socially optimal quantity as long as (a) there are well-defined property rights (b) costless bargaining, and (c) competitive markets (**Coase theorem**—but see lecture slides for some limitations)
  - Public policy can enter when Coase conditions are not met:
    - price policy (tax or subsidy)
    - quantity regulation (command and control or tradable permits)

1.2 Practice Problems

1.2.1 Based on Gruber Ch.05, Q.13

Suppose that demand for a product is $Q = 1,000 - 4P$ and supply is $Q = -200 + 2P$. Furthermore, suppose that the marginal external damage of this product is \$6 per unit.

(a) How many more units of this product will the free market produce than is socially optimal?

(b) Calculate the deadweight loss associated with the externality.

Solution:

(a) To answer this question, first calculate what the free market would do by setting demand equal to supply:

$$1,000 - 4P = -200 + 2P \qquad \text{or} \qquad 1,200 = 6P.$$

Thus, $P_{FM} = 200$ and $Q_{FM} = 1,000 - 4(200) = 200$.

The socially optimal level occurs when the marginal external cost is included in the calculation. I will list a two different (but equivalent) ways to solve this problem:

i) Externality price added to consumers (i.e. *overconsumption*):

Suppose the \$6 externality were added to the price each consumer had to pay (as if there were a tax on consumers). Then, the consumer pays \$6 more than the producer receives, so $P^D = P^S + 6$, where P^D is the price that consumers pay, and P^S is the price that producers receive.

Then demand would be $Q^D = 1,000 - 4P^D = 1,000 - 4(P^S + 6)$. Supply is still $Q^S = -200 + 2P^S$.

Solving for P^S and Q by setting demand equal to supply:

$$1,000 - 4(P^S + 6) = -200 + 2P^S$$

Thus, $P^S_{SO} = 196$. To find Q_{SO}, plug this price back into the supply curve (since we are plugging in the "supply" price) to get $Q_{SO} = 192$.

ii) Externality price added to producers (i.e. *overproduction*):

Supppose the \$6 externality were subracted from the price each producer received (as if there were a tax on producers). Then, the producer receives \$6 less than the consumer pays, so $P^S = P^D - 6$.

Then, supply would be $Q^S = -200 + 2P^S = -200 + 2(P^D - 6)$ and demand would still be $Q^D = 1,000 - 4P^D$.

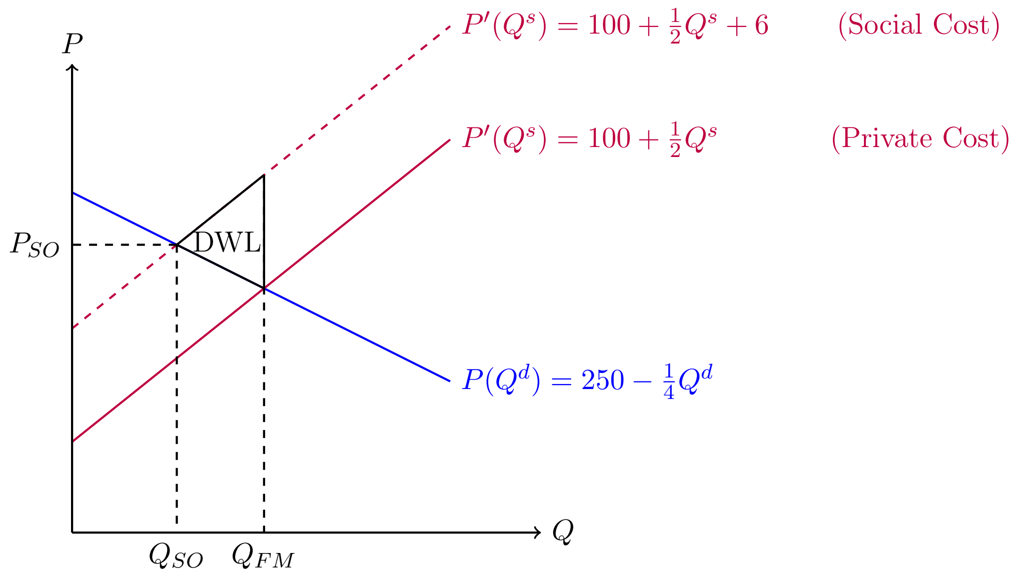
Solving for P^D and Q by setting demand equal to supply:

$$-200 + 2(P^D - 6) = 1,000 - 4P^D$$

Thus, $P^D_{SO} = 202$. Plugging the price back into the demand curve (since we are plugging in the "demand" price), we get $Q_{SO} = 192$.

Note that either solution gives $Q_{SO} = 192$. This means that the free market will produce 8 units more than is socially optimal.

The results for the case of overproduction are also listed in the graph below.



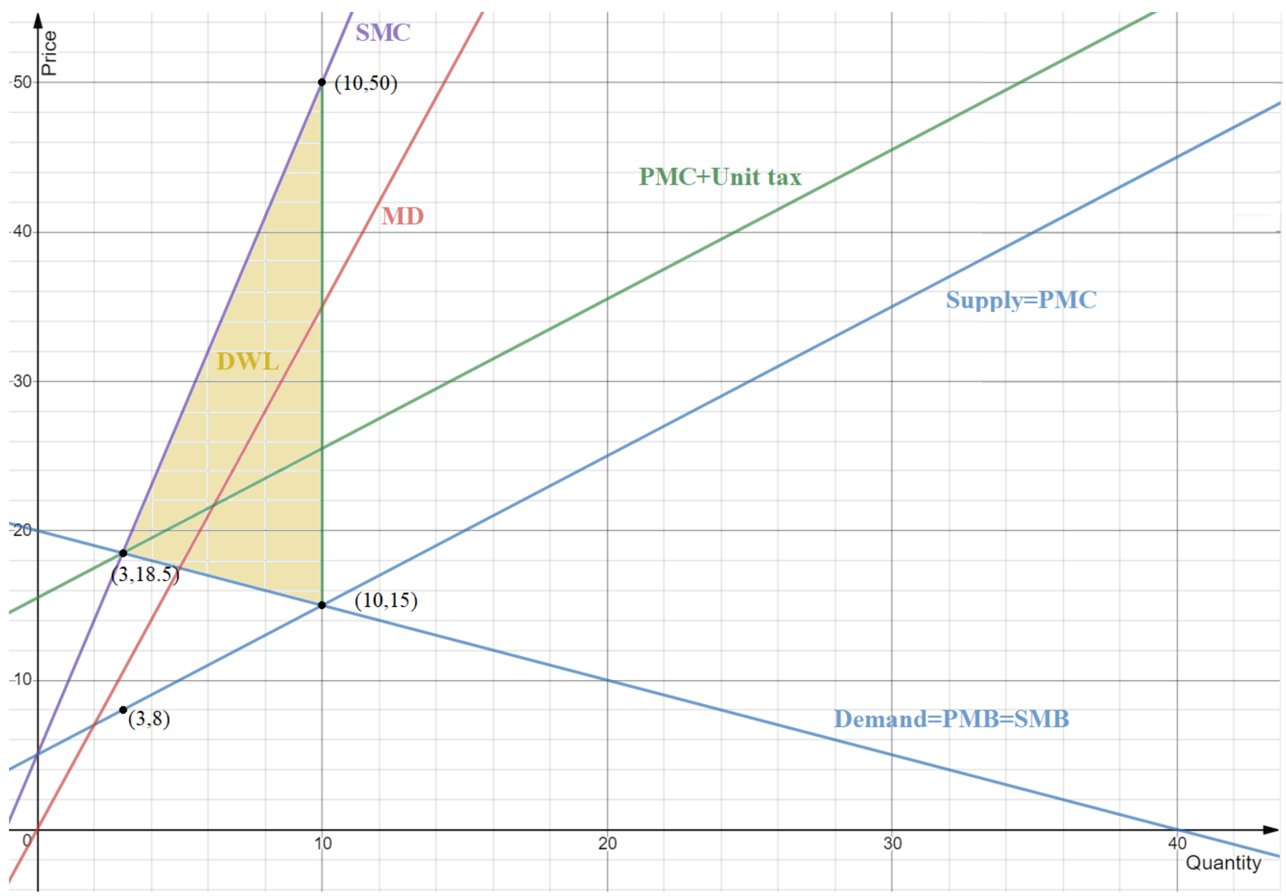
(b) Deadweight loss is the area of the triangle labelled on the graph. The height of the triangle is 6 (the amount of the marginal damage) and width is 8 (i.e. $Q_{FM} - Q_{SO}$) : $\frac{1}{2}(6 \times 8) = 24$.

1.3 Additional Practice Problems

1.3.1 When marginal damage is not constant

A coal-fired power plant releases air pollution into the atmosphere for every unit of electricity produced. The inverse demand function for coal-fired electricity is $P_d = 20 - \frac{1}{2}Q$, which represents the marginal benefit curve where Q is the quantity consumed when consumers pay price P_d. The inverse supply curve for coal-fired electricity is $P_s = 5 + Q$, which represents the marginal private cost curve when the power plant produces Q units. The marginal damage from emissions is given by $MD = 3.5Q$, which describes the cost of greenhouse gas emissions and local air pollution when the industry generates Q units of coal-fired electricity.

(a) Illustrate the market for the coal fired electricity with a supply/demand graph. Be sure to draw the curves for demand, supply, marginal damage, and social marginal cost.



(b) What are the equilibrium price and quantity for coal fired electricity when there is no correction for the externality?

Setting $P_d = P_s$ results in $P_{priv} = 15$ and $Q_{priv} = 10$.

(c) How much coal fired electricity should the market supply at the social optimum?

We see that $SMC = P_s + MD = 5 + Q + 3.5Q = 5 + 4.5Q$ Setting $P_d = SMC$, $20 - 0.5Q = 5 + 4.5Q$, gives $15 = 5Q^*$, ie $Q^* = 3$ and $P^* = 18.5$

(d) How large is the deadweight loss from the externality?

DWL here is the added cost to society by producing more than the social optimum. The price difference between $P = 5 + 4.5Q$ and $P = 5 + Q$ at $Q = 10is(5 + 45) - (5 + 10) = 35$. The change in quantity between the private Q and optimal Q is 7 $DWL = 1/2 * 35 * 7 = 122.5$

(e) Is it possible for the government to achieve the social optimum by imposing a per-unit fee on emissions? If not, explain why it is not possible. If so, how large must the emission fee be if the market is to produce the socially efficient amount of coal fired electricity? Also, draw the firm's supply curve with the new emission fee on your graph.

It is possible: We want $SMC = P_S$ at Q^*. We choose a tax so that $P^* = 5 + Q^* + t$, ie $18.5 = 5 + 3 + t$, so $t = 10.5$. That tax is equal to the amount of marginal damage **at the socially optimum quantity**.

1.3.2 Gruber Ch.05, Q.4

In the midwestern United States, where winds tend to blow from west to east, states tend to more easily approve new polluting industries near their eastern borders than in other parts of the state. Why do you think this is true?

Solution:

- When a state approves new polluting industries, it imposes an externality on neighboring "downwind" states.
- The polluting state does not face the marginal external damage caused to citizens of the “downwind” states.
- This is an example of the case of overproduction – the state (and polluters) don’t internalize the cost of the pollution, and so they produce more than socially optimal.
- As a counterexample, there may be other reasons that these industries are located on the eastern borders. Lots of cities are on the east borders of midwestern states, likely because there was a gradual process of westward expansion of settlers during the 19th century. Examples include Detroit, Chicago, Milwaukee, and the Twin Cities. It may be that industrial plants tend to be located near such population (employment) centers.