Econ 57a, Environmental Economics, Fall 2019

Module 2: Efficiency

- Supply, demand, and equilibrium
- Efficiency and the equimarginal principle
- Benefits and costs for environmental services

The King of Burgers

Robert Baratheon is a huge burger lover. One day he walks into a burger place, and finds the menu to be the following:

Burgers	No. Sausages	Price	WTP
Veggie Burger	0	$4	$5
Cheeseburger	1	$6	$8.5
Double Cheeseburger	2	$8	$11
Triple Cheeseburger	3	$10	$12.5
The Ultimate Cheeseburger	4	$12	$13

Maximize net benefits

Burgers	Price	WTP	Net Benefit
Veggie Burger	$4	$5	$1
Cheeseburger	$6	$8.5	$2.5

Burgers	Price	WTP	Net Benefit
Double Cheeseburger	\$8	\$11	\$3
Triple Cheeseburger	\$10	\$12.5	\$2.5
The Ultimate Cheeseburger	\$12	\$13	\$1

Some Algebra

WTP: $-0.5Q^2 + 4Q + 5$

The demand for beef sausage:

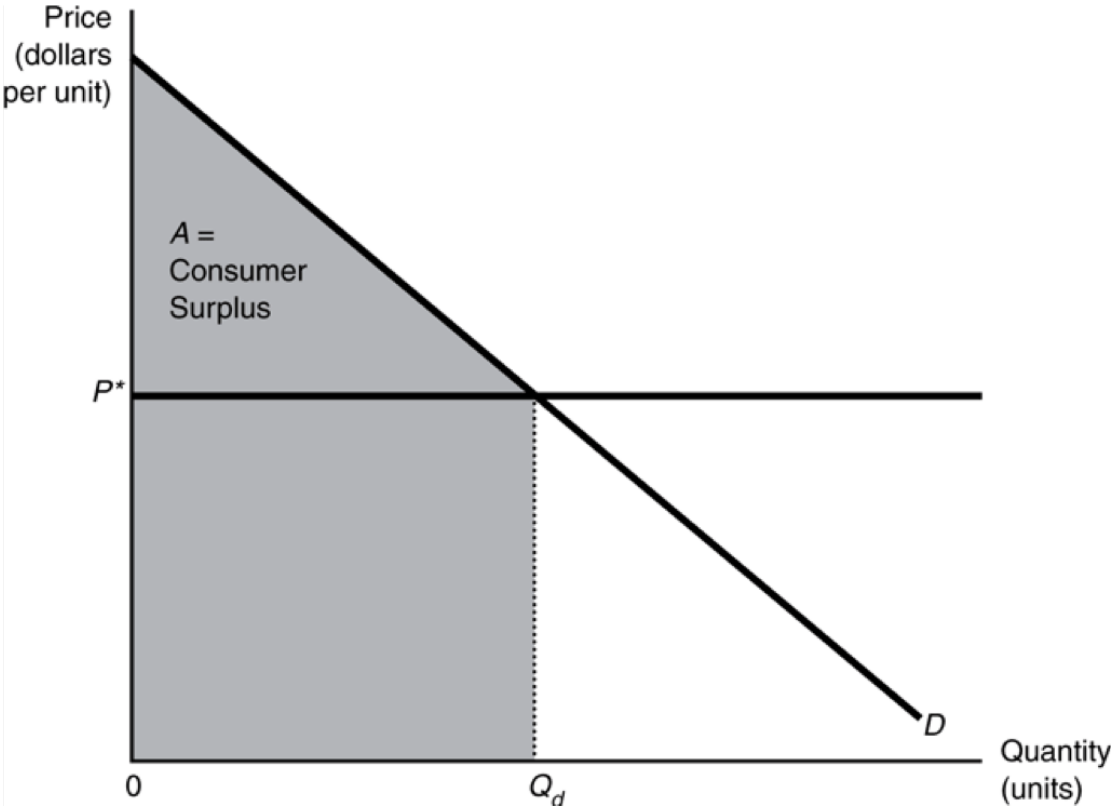
P = 4-Q

Price for beef sausage

P = 2

Net benefit is maximized when price equals marginal benefit

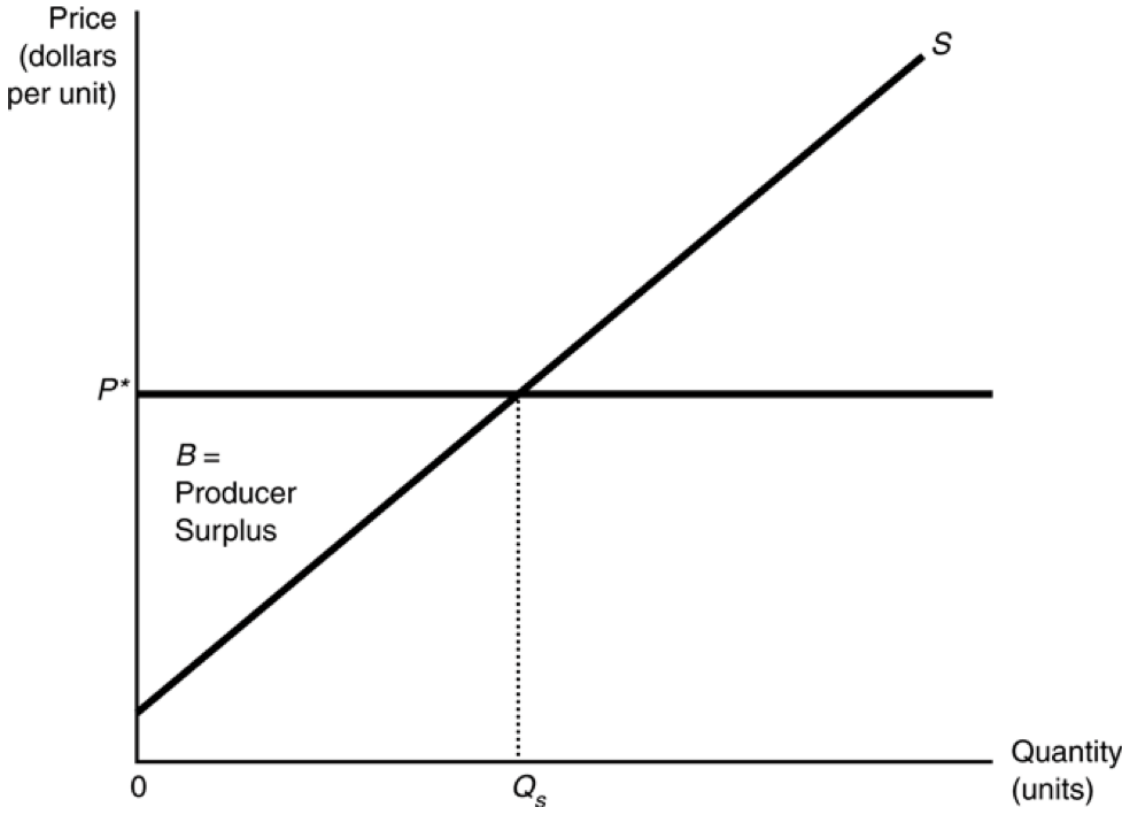
Q = 2



Consumer surplus

Consumer surplus is the value that consumers receive from an allocation minus what it costs them to obtain it. Consumer surplus is measured as the area under the demand curve minus the consumer's cost.

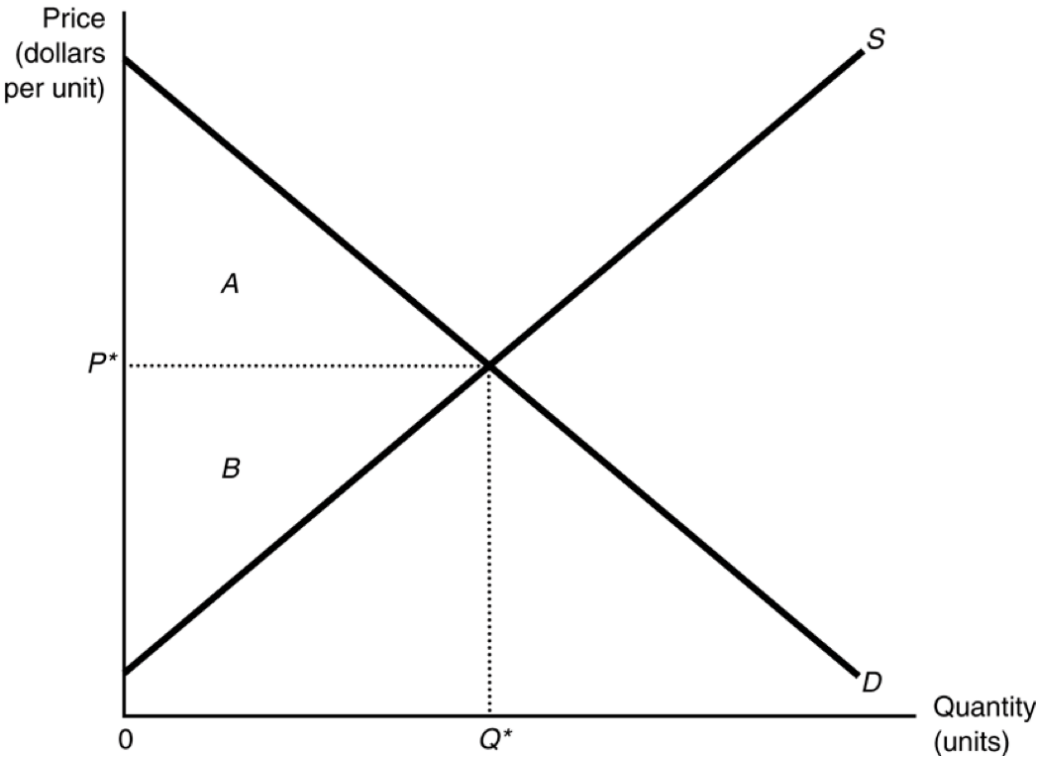
Producer surplus



Producer surplus

- Producer surplus is the difference between the amount that a seller receives minus what the seller would be willing to accept for the good.
- Given price P*, the seller maximizes his or her own producer surplus by choosing to sell Qs units.
- The producer surplus is designated by area B, the area under the price line that lies over the marginal cost curve, bounded from the left by the vertical axis and the right by the quantity of the good.

Equilibrium



A market equilibrium is characterized by the **equimarginal principle**, i.e.,

- For the consumer, price equals marginal benefit
- For the producer, price equals marginal cost
- Thus a market equilibrium is characterized by:

Marginal Benefit = Marginal Cost

The First Welfare Theorem

a.k.a the Invisible Hand Theorem

> A *complete and competitive market* leads to a *Pareto efficient* allocation of resources.
> - Adam Smith

- Pareto efficiency: no other feasible allocation could benefit at least one person without any deleterious effects on some other person
- Equilibrium from a competitive market is (Pareto) efficient

Positive and Normative Economics

Positive inquiry: what is, what was, or what will be (factual judgment)
Normative inquiry: what ought to be (value judgment)

- Economic efficiency essentially means to maximize social welfare

- Entails a normative judgment, i.e., what the society should be doing
- What about distribution of income? Environmental justice?

Question

What if you have waited in line for three hours for this amazing burger. Will your choice be different?

What if the restaurant has given you a free five-dollar coupon for your each visit?

What if on the way to the restaurant, you lost that five-dollar coupon?

What if the place is offering you a $11 coupon for your each visit?

What if in addition to the price the restaurant charges, the city collect a burger tax of $4 for each burger?

So, what happens when the good in question is environmental pollution?

Question: What is the optimal level of particulate matters (PM)?

Figure 1: Source: Science, http://www.sciencemag.org/news/2017/01/brain-pollution-evidence-builds-dirty-air-causes-alzheimer-s-dementia

Figure 2: Source: Huffington Post, http://www.huffingtonpost.com/2013/10/15/europe-air-pollution-wood-fires-diesel-cars_n_4099578.html

We need to find:

- A demand curve
  - How much will we benefit from reducing pollution?
- A supply curve
  - How much will it cost to reduce pollution?
- An optimal level of pollution that equates supply and demand

Exposure to particulate matters will cause:

- Alzheimer's (Science, 2017)
- Dementia (Bishop et al., 2017)
- Lower test scores (Ebenstein et al. 2016)
- Irrational stock trading behavior (Heyes et al. 2016)
- And much more

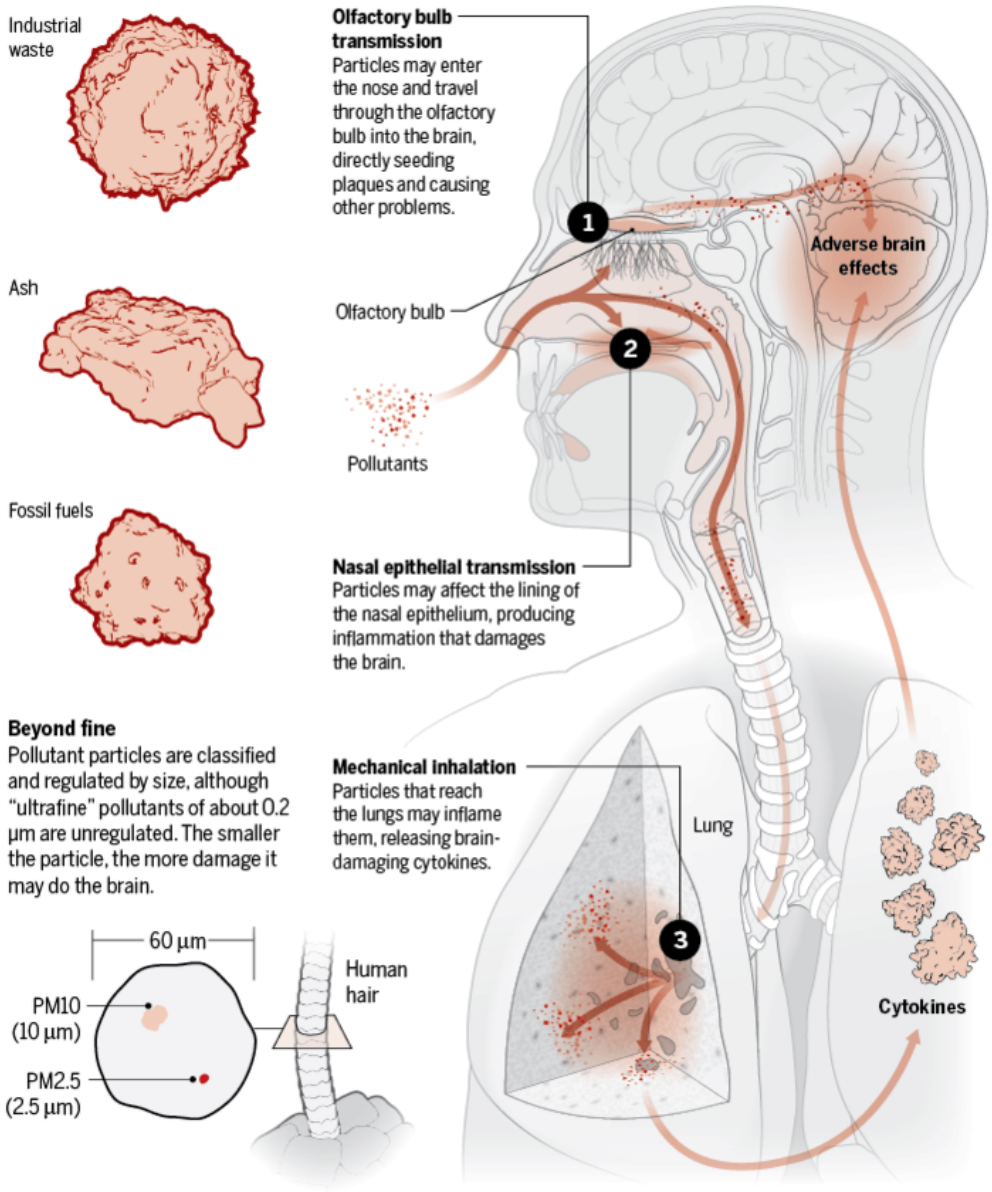
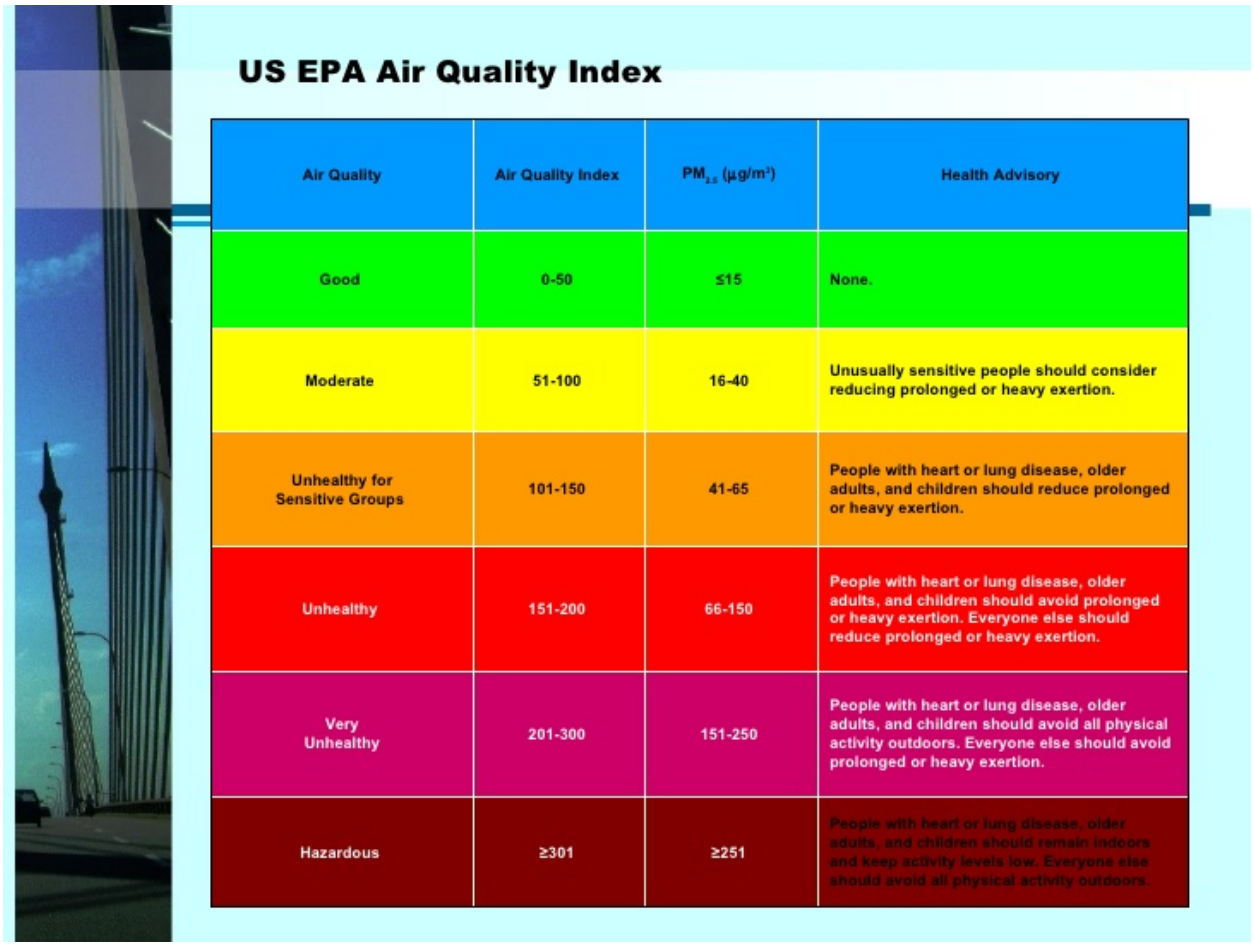


Figure 3: Source: Science, http://www.sciencemag.org/news/2017/01/brain-pollution-evidence-builds-dirty-air-causes-alzheimer-s-dementia



US EPA Air Quality Index

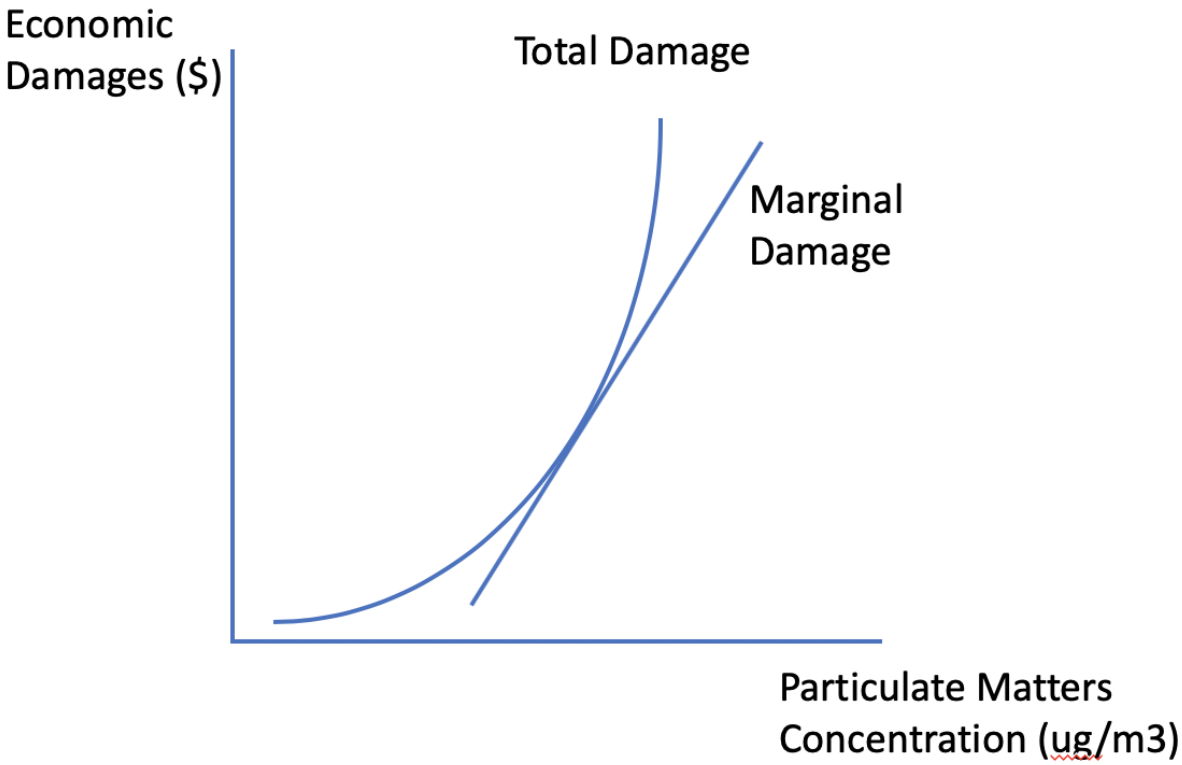
Air Quality	Air Quality Index	$PM_{2.5}$ ($\mu g/m^3$)	Health Advisory
Good	0-50	≤15	None.
Moderate	51-100	16-40	Unusually sensitive people should consider reducing prolonged or heavy exertion.
Unhealthy for Sensitive Groups	101-150	41-65	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
Unhealthy	151-200	66-150	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy	201-300	151-250	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.
Hazardous	≥301	≥251	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.

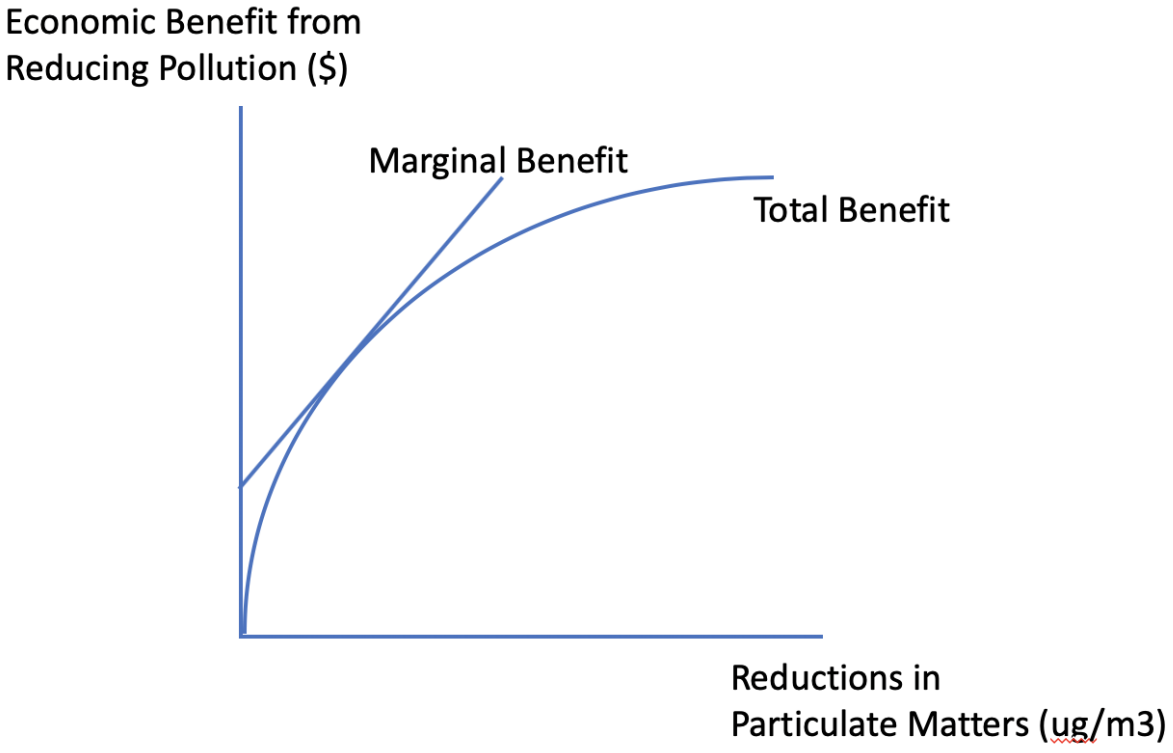
AQI: Health Impacts

AQI	Possible Health Impacts
Good	minimal impact
Satisfactory	minor breathing discomfort to sensitive people
Moderate	breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor	breathing discomfort to people on prolonged exposure and discomfort to people with heart disease with short exposure
Very Poor	respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases
Severe	respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases

The higher the AQI, greater the air pollution and health concerns

Marginal benefit of (reducing) environmental pollution





What about the costs

Ways to reduce particulate matters:

- Ban straw burning
- Switching from coal fired to natural gas fired power plants
- Stringent vehicle emission standards
- Switching to electric cars
- And...

The Beijing Olympics

Beijing is notorious for its poor air quality.

But during the 2008 Beijing Olympics, the air quality is surprisingly good. Why?

> Factories in Beijing and the surrounding region were ordered to shut down weeks ahead of the opening ceremony.
>
> Nineteen days before the Games were due to start, officials implemented restrictions on the use of private automobiles in the city.
>
> Technicians practiced seeding clouds to bring cleansing rains.

-USC US-China Institute

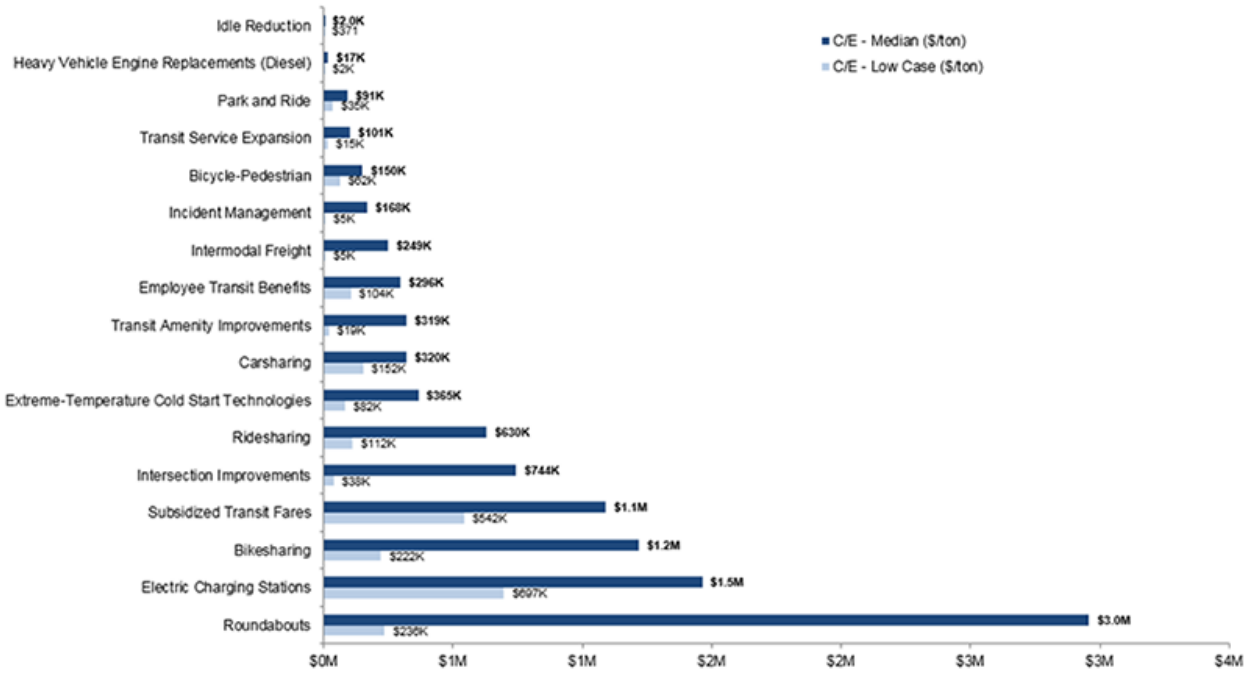
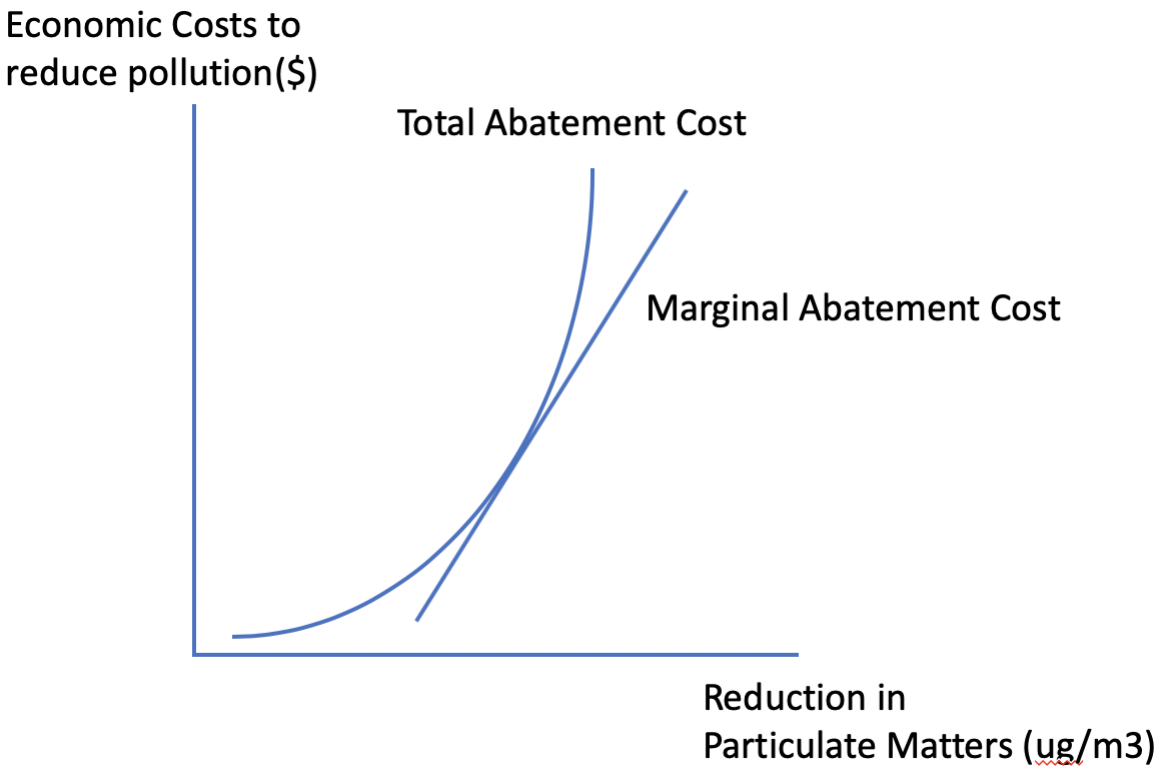
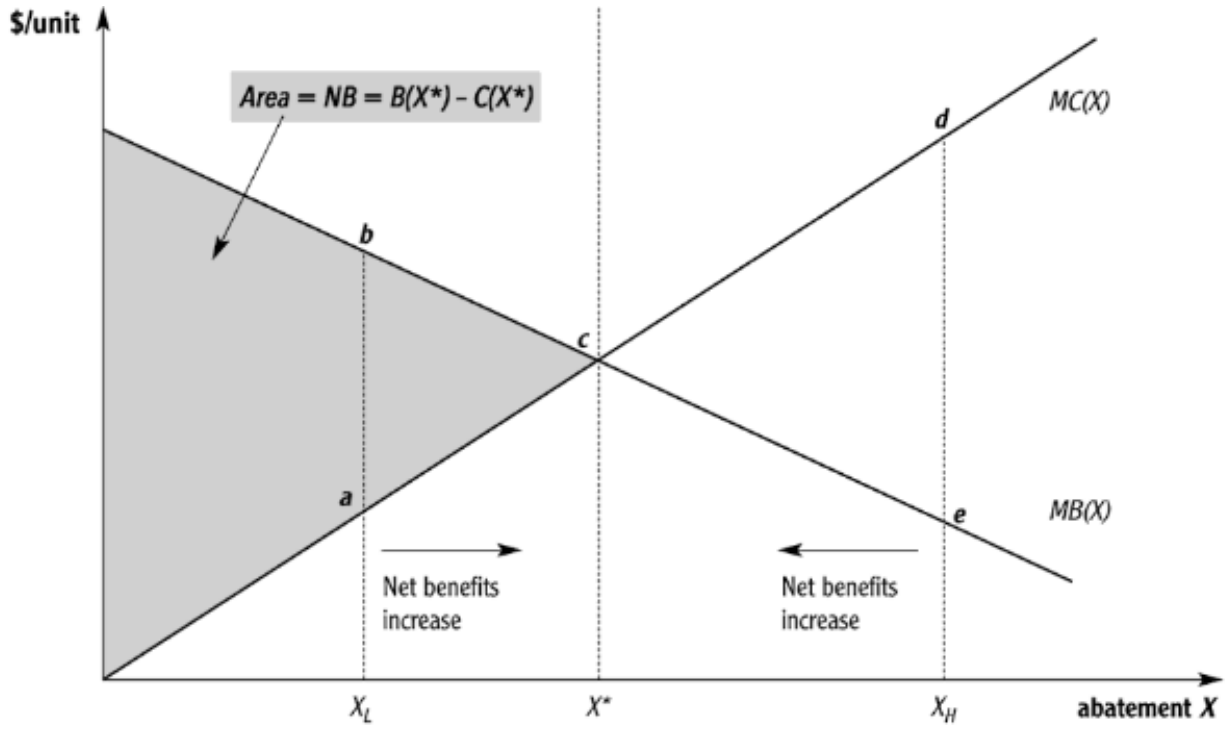
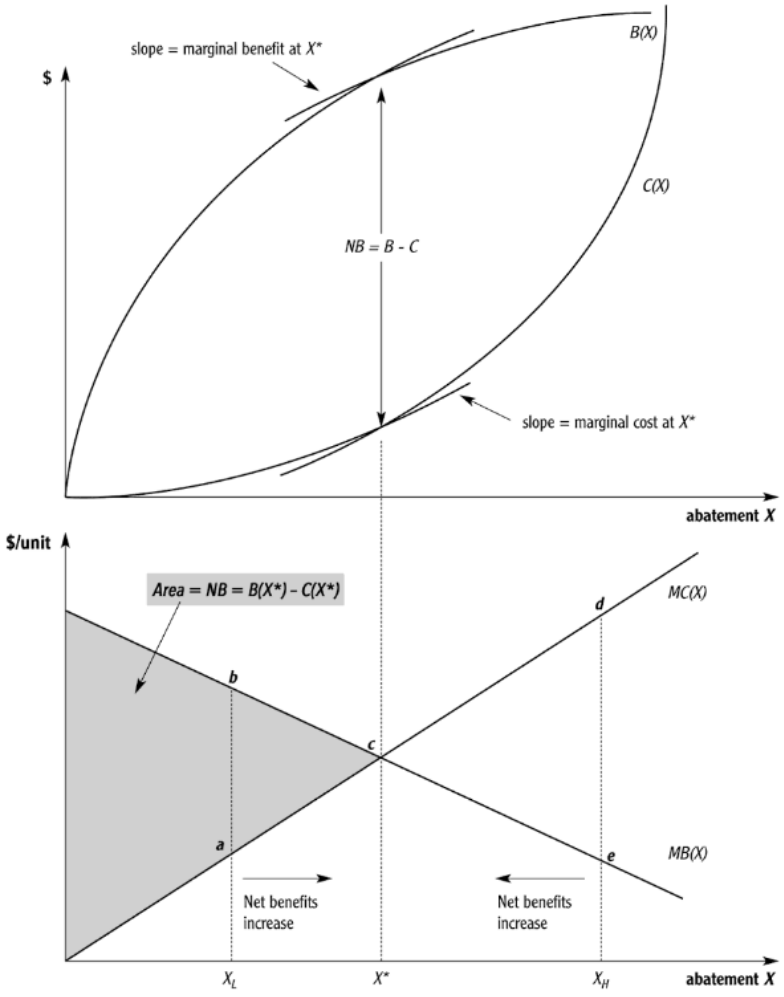
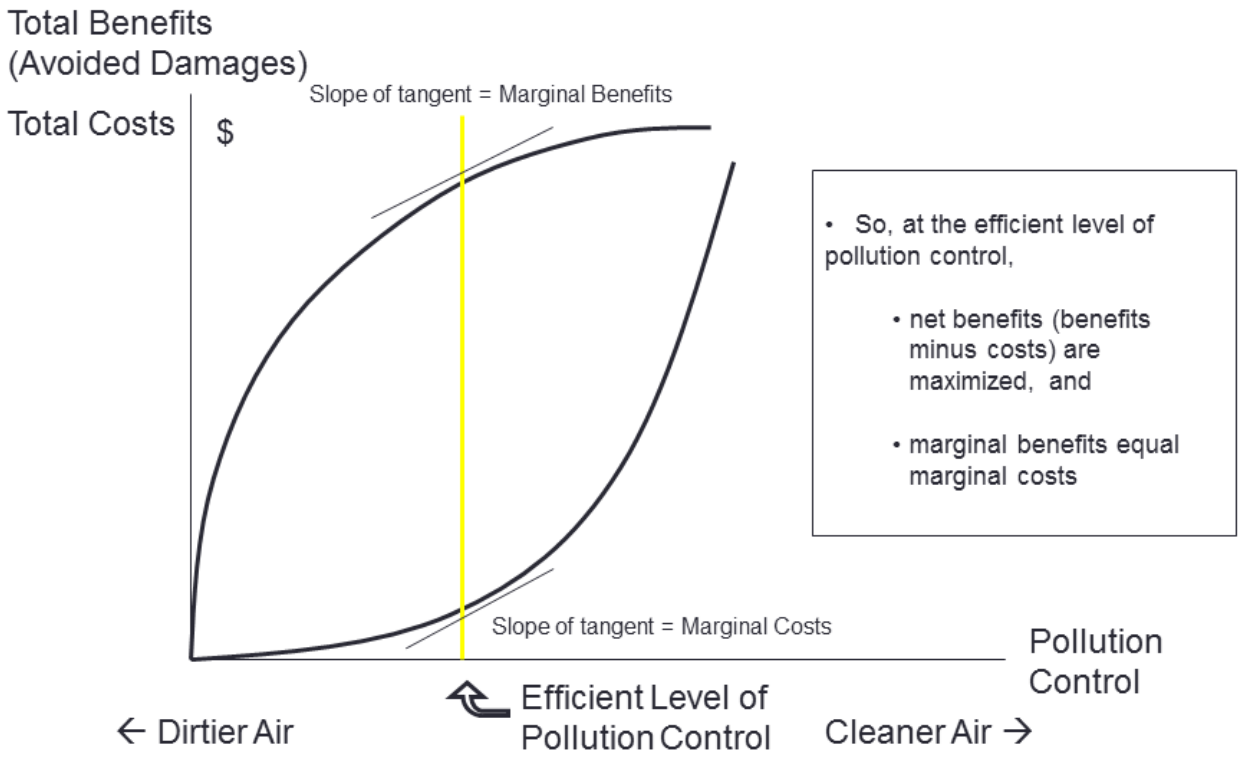


Figure 4: Source: Department of Transportation




$/unit
Area = NB = B(X*) – C(X*)
MC(X)
d
b
c
a
e
MB(X)
Net benefits increase
Net benefits increase
X_L
X^*
X_H
abatement X


slope = marginal benefit at X*
B(X)
$
C(X)
NB = B - C
slope = marginal cost at X*
abatement X
$/unit
Area = NB = B(X*) - C(X*)
d
MC(X)
b
c
a
e
MB(X)
Net benefits increase
Net benefits increase
X_L
X*
X_H
abatement X



Question: when will the MB = MC approach go wrong?

- Pollution abatement exhibits economies of scale
  - Hazardous waste sites
  - Cost function is not convex
- Marginal damage from pollution decreases
  - Party Noise
  - Benefit function is not concave

- MB > MC when everything is cleaned up
  - Leaded gasoline
  - Corner solutions
- MB < MC without cleaning up
  - Don't buy that burger