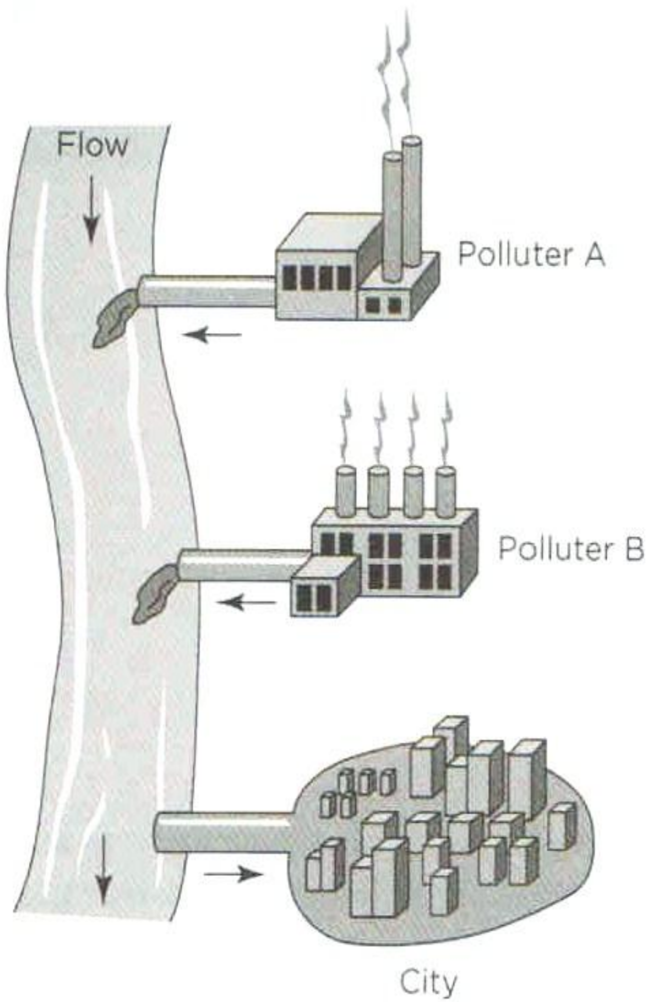
Chapter 15: Spatial and Temporal Dimensions of Regulation

Effect of Space in Pollution Control:
Consider two polluter mills located upstream and a locality drawing drinking water from the river downstream.
Assuming that river is useful only for drawing water for the locality.

The river cleans itself to some extent.
More downstream we go lesser is the impact of the pollutants dumped upstream.
So location of the polluter becomes important in designing economic incentives based pollution regulations.
It complicates the pollution regulations.



Sources and *Receptors*

Source is a point of discharge of emissions. Each firm is a source.
Receptor is a point at which we are concerned of the ambient pollution.
The intake point from the river for the municipality water supply is an example of receptor.

Spatial and Temporal Dimensions of Regulation

If there are various sources of pollution 1,2,3,….i, Then pollution at receptor j

$$p_j = f_1(e_1, e_2, e_3, \ldots\ldots e_i) + B_j \qquad \ldots\ldots\ldots\ldots\ldots\ldots \; 1$$

Where B_j is some background level of pollution, which can be zero (*Often assumed* $B_j = 0$).

Assuming a linear relationship (which is generally true for pollution problems)

$$p_j = \sum_i a_{ij} e_i + B_j \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 2$$

Coefficient a_{ij} is called ***transfer coefficient***.

If we change emission at some source by small amount $\boldsymbol{\Delta e_i}$ then pollution to receptor will change by $\boldsymbol{a_{ij} \Delta e_i}$

Definition of Transfer Coefficient*: Suppose a change in emissions* $\boldsymbol{\Delta e_i}$ *from source i results in a change in pollution* $\boldsymbol{\Delta p_j}$ *at receptor j. The transfer coefficient between the source i and receptor j is defined as the ratio of change in pollution at j to change in emissions at i:*

$$\boldsymbol{a_{ij} = \Delta p_j / \Delta e_i} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

It gives us a conversion rate from emission to ambient concentrations.

How much pollution do we want? What is the Efficient amount of pollution?

Efficiency requires equality between ***Marginal savings from emissions*** for a firm and ***Marginal damage from ambient pollution*** for a receptor.

Either convert firm's marginal saving function to *marginal saving per unit of ambient pollution*.
Or convert locality's marginal damage function to *marginal damage per unit of emission*.

MDE_i (e_i) : Marginal damage per unit of emission from source i
MDA(p): Marginal damage per unit of ambient pollution

$$MDE_i = \{D(p+ \Delta p) – D(p)\} / \Delta e_i$$

$$= MDA(p).\ \Delta p/ \Delta e_i$$

$$= a_i\ MDA(p) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.4$$

Condition for efficient amount of pollution?

Marginal Savings from Emissions = Marginal Damage from emissions (for all sources)
For i =1,2,3, ……I sources of pollution

$$MS_i(e_i) = - MC_i(e_i) = MDE_i$$
$$= a_i MDA(p) \qquad \text{For all } i =1,2,3, \ldots\ldots I \qquad \ldots\ldots\ldots\ldots\ldots.5$$

$MC_i(e_i) = - a_i MDA(p)$ For all i =1,2,3, ……I …………………5

We divide equation 5 by a_i on both sides

$MC_i(e_i)/a_i = - MDA(p)$ For all i =1,2,3, ……I

MC(e)/a is marginal cost per unit of ambient pollution

If there are two sources m and n then efficiency requires

$MC_m(e_m)/a_m = MC_n(e_n)/a_n = - MDA(p)$ …………………6

It implies that marginal cost per unit of ambient pollution must be equal to the negative of marginal damage per unit of ambient pollution.

and all sources of pollution must have same marginal cost of emissions normalized by the source's transfer coefficient.

So if a source has more impact upon ambient pollution (a is larger) its marginal cost of pollution control (marginal cost of emissions) must be larger. This is modified equi-marginal principle for ambient pollution..

Thus we derive to essential conditions for efficiency

1. Marginal cost of emissions, normalized by the transfer coefficient, must be equalized for all sources.

2. The normalized marginal cost of emissions must equal negative of marginal damage.

Example:

Sources: two factories dumping waste in the river

Receptor: a municipality downstream drawing water from river

Transfer coefficients of the two factories

$a_1 = 2$

$a_1 = 3$

Marginal cost of controlling emissions

$MC_i = -14 + 7e_i$ $\qquad$ $i = 1,2$

$MDA(p) = p$

Assume that background pollution is zero.

How much each source should emit for efficiency?

$MC_1(e_1) / a_1 = (-14+7e_1)/2 = MC_2(e_2) / a_2 = (-14+7e_2)/3$

$(-14+7e_1)/2 = (-14+7e_2)/3$

$-42+21e_1 = -28+14e_2$

$21e_1 - 14e_2 = 14$ ………………………………… 1

$MC_1(e_1) / a_1 = (-14+7e_1)/2 = -MDA(p)$

$= - MDA\ (2e_1 + 3e_2) = - (2e_1 + 3e_2)$

$-14+7e_1 = -4e_1 - 6e_2$

$11e_1 + 6e_2 = 14$ ………………………………………2sol

$e_1 = 1$

$e_2 = 0.5$

MC for firm 1 = -7

MC for firm 2 = -10.5

Total ambient pollution = 3.5

Emission Fees

How emission fees should be determined to bring efficiency?

Emission fee and ambient differentiated emission fee

Consider t_i as ambient differentiated emission fee for each firm i. So it is efficient.
The firm responds to any emission fee by direct cost plus emission fee.

For that each firm will equate negative of Marginal Cost with emission fee

$MC_i(e_i) = t_i$ for all sources 7

If we have ony two firms ‘m’ and ‘n’ then for efficieny

$t_n/a_n = t_m/a_m$ 8

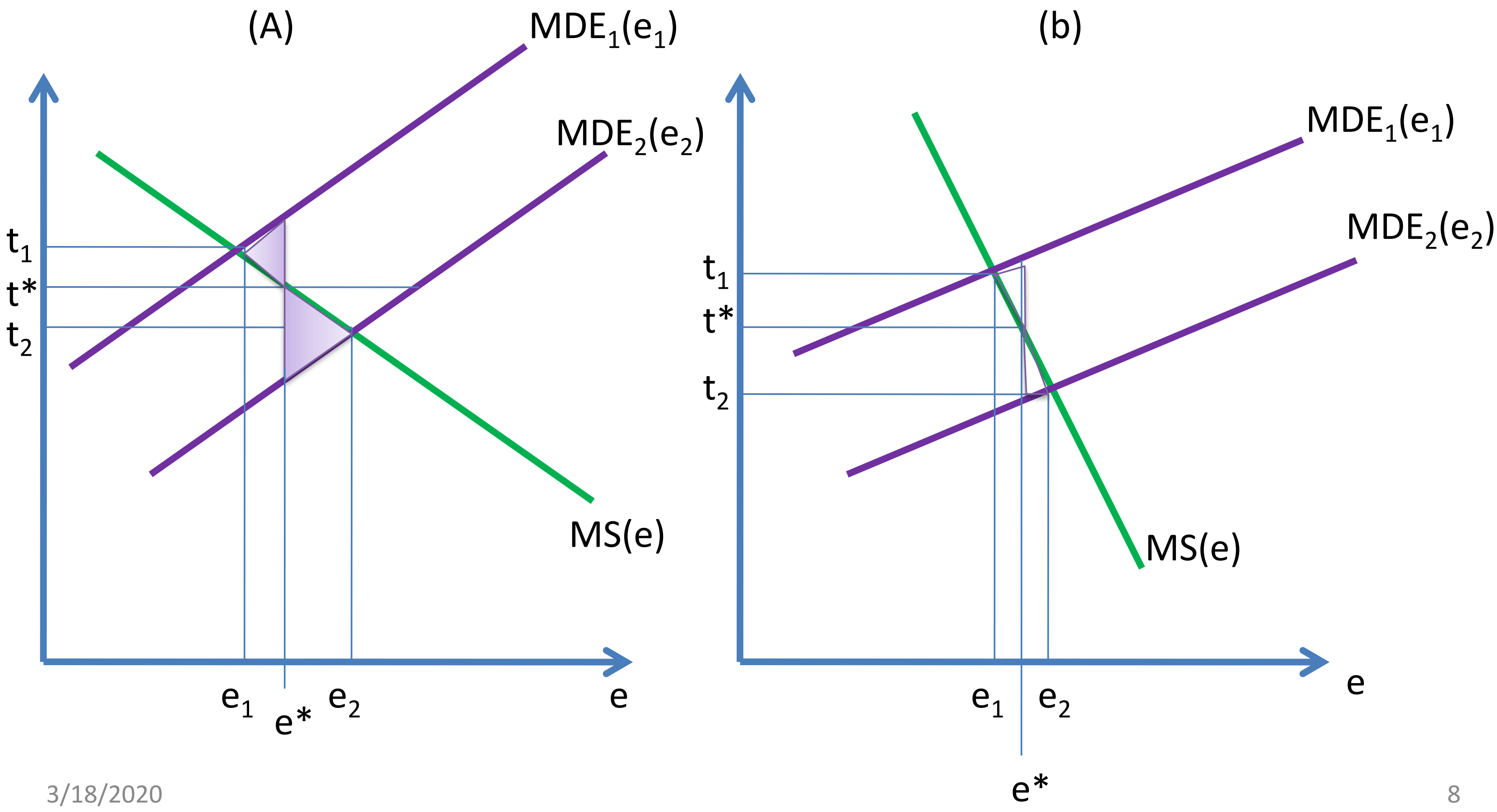
and $t_n=a_n\ MDA(p)$ for firm n 9

and $t_m=a_m\ MDA(p)$ for firm m 10

First Condition: Emissions fees normalized by transfer coefficients must be equal for all the firms.
Second Condition: For any firm marginal Damage per unit of Emission must be equal to the emission fee.

INEFFICIENCIES FROM UNIFORM EMISSION FEE

Uniform emission fees disregard this spatial impact upon ambient pollution and turn out to be inefficient.
Optimal uniform emission fee is that which minimizes the total area of the two tiangles.



Marketable Ambient Permits

An ambient pollution permit for a receptor j gives the holder the right to emit at any location, provided the incremental pollution at receptor j does not exceed the permitted amount.

- Ambient pollution permits are to be held by all sources in the region to emit.
- These permits takes into account the effects of emission on ambient pollution at receptor.
- These permits can be traded in the market.

Consider two sources (firms) and one receptor
Suppose L_1 ambient permits are given to firm 1 and L_2 ambient permits are given to firm 2.
Trading in these permits is allowed.
Suppose after trading l_1 and l_2 permits are held by firm 1 and firm 2 .

$$L_1 + L_2 = l_1 + l_2 \qquad \text{...1}$$

Emission and ambient pollution levels are connected through transfer coefficients. If all the permits are used by the firms then:

$$a_1 e_1 = l_1 \qquad \text{...2a}$$

$$a_2 e_2 = l_2 \qquad \text{...2b}$$

Total costs (TC) for each firm are

$$TC_1(e_1) = C_1(e_1) + \Pi\ (l_1 - L_1)$$
$$= C_1(e_1) + \Pi\ (a_1 e_1 - L_1) \quad \text{..............................3a}$$

$$TC_2(e_2) = C_2(e_2) + \Pi\ (l_2 - L_2)$$
$$= C_2(e_2) + \Pi\ (a_2 e_2 - L_2) \quad \text{..............................3b}$$

$C_i(e_i)$ is direct cost to firm excluding permit costs.
To minimize total cost, Marginal Total Cost = 0

$$MTC_1(e_1) = MC_1(e_1) + a_1\ \Pi = 0 \quad \text{..............................4a}$$

$$MTC_2(e_2) = MC_2(e_2) + a_2\ \Pi = 0 \quad \text{..............................4b}$$

$$MC_1(e_1)\ /\ a_1 = MC_2(e_2)\ /a_2 = -\Pi$$

$$\mathbf{MS_1(e_1)\ /\ a_1 = MS_2(e_2)\ /a_2 = \Pi} \quad \text{..............................5}$$

$$a_1e_1 + a_1e_1 = l_1 + l_2 = L_1 + L_2 = L$$
$$\mathbf{a_1e_1 + a_1e_1 = L} \quad \text{..............................6}$$

Example:

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Receptor: a municipality downstream drawing water from river

Transfer coefficients of the two factories

$a_1 = 2$

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Marginal cost of controlling emissions

$MC_i = -14 + 7e_i$ $\quad\quad$ $i = 1,2$

$MDA(p) = p$

Assume that background pollution is zero.

How much each source should emit for efficiency?

Suppose permits for 5 tons of pollution were issued. Calculate resulting emissions and price of permit.

$MC_1(e_1) / a_1 = -\Pi$

$(-14+7e_1)/2 = -\Pi$ or $\mathbf{(-14+7e_1) = -2\Pi}$

$MC_2(e_2) / a_2 = -\Pi$

$(-14+7e_2)/3 = -\Pi$ or $\mathbf{(-14+7e_2) = -3\Pi}$

$a_1e_1 + a_1e_1 = L$ or $\mathbf{2e_1 + 3e_1 = 5}$

$e_1 = 1.23$
$e_2 = 0.85$
$\Pi = 2.69$

Multiple Sources and Receptors:

Consider many sources (polluters) $i = 1,2,3,........I$
And many receptors $j = 1,2,3..........J$

Suppose government decides a cap of efficient pollution level **s*** at each receptor.
Government distributes $\mathbf{L_j = s^*}$ number of ambient pollution permits for each receptor, j .

How each of the polluter firm buys these permits?

Let l_i^j be the number of permits held by the source i to pollute receptor j.

$$s^* = L_j \geq \sum_i l_i^j$$

total permits after trading for receptor j must be less than or equal to total permits issued for receptor j

if all permits are used and none is lost then:

$$s^* = L_j = \sum l_i^j$$

For a firm **i** to emit $\mathbf{e_i}$ and pollute by $\mathbf{a_{ij}e_i}$ the requirement of permit

$$a_{ij}e_i \geq l_i^j \quad \text{for all } j$$

or,

$$e_i \geq l_i^j / a_{ij} \quad \text{for all } j$$

So permissible emissions for source *i* $e_i^* = \min\{l_i^j / a_{ij}\}$

Multiple Sources and Receptors

Each firm will emit such that

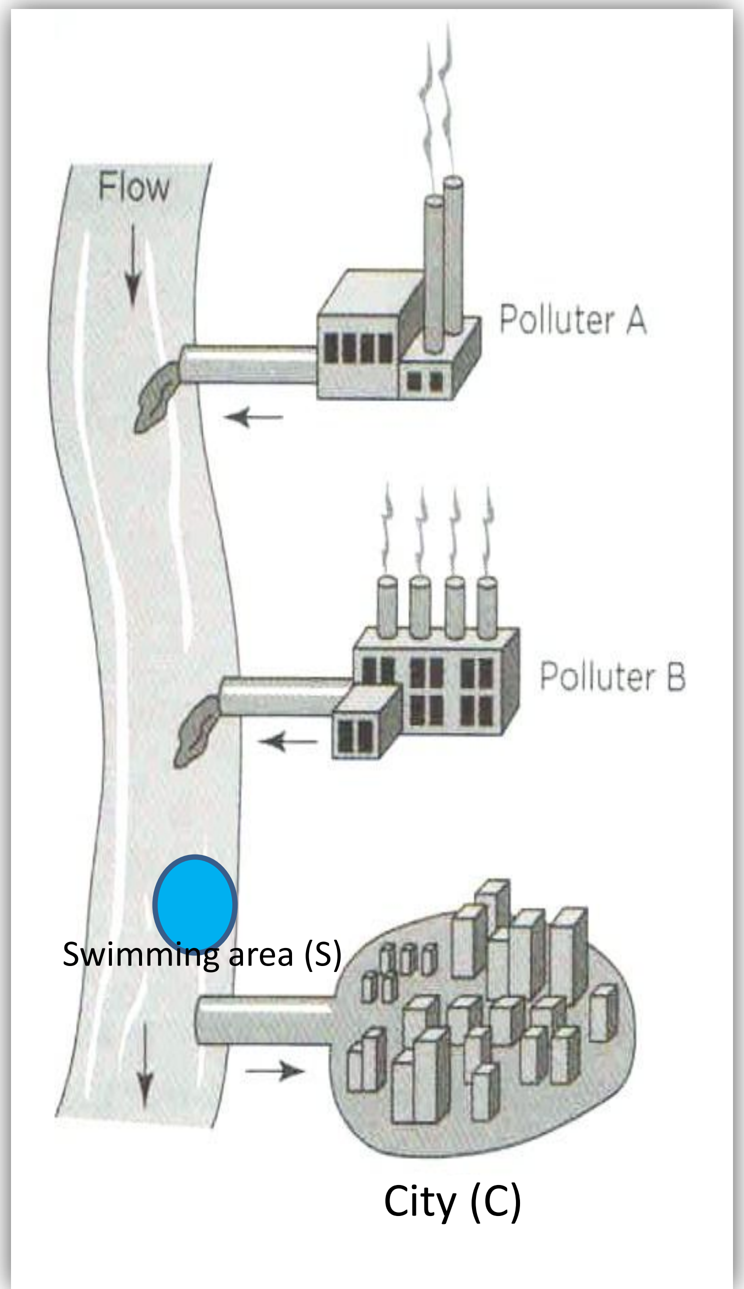
$MC_i(e_i) = -\sum a_{ij} \Pi_j$

Where Π_j is the price of permit for receptor j.
a_{ij} is transfer coefficient of emission at source I causing pollution at receptor j.

Three results follow:

1. For any initial distribution of ambient pollution permits a market equilibrium exists after trading.
2. Emissions from each source under ambient pollution permit system are efficient (least cost).
3. If the price of permits in equilibrium equals marginal damage from pollution efficiency has been obtained.

$$MC_i(e_i)/a_i = -MDA(\bar{s})$$ for all sources i



Stock Pollutants (intertemporal Consideration)

Many types of pollutants accumulate in the atmosphere and the damage from them is done not only today and but in future also. Environment takes a long time to clean some type of pollutants.

Pollutants that accumulate over time are called Stock Pollutants.

***Definition**: Assume a pollutant accumulate in the environment according to the following process:*

$$s(t) = \delta s(t-1) + e(t) \qquad \text{.........................1}$$

s(t) is the stock of pollutant at any given time t

$$(0 \leq \delta \geq 1)$$

e(t) is emission rate of the pollutant

δ *is persistence rate of the pollutant and*

if δ *= 0* then pollutant is a pure flow pollutant.

if δ *> 0* then pollutant is a stock pollutant.

if δ *= 1* then pollutant is a persistent pollutant.

Assume that pollution damage depends only on s(t).

Pollutant that accumulate over time are stock pollutants (Green House Gases, CFCs etc). Pollutants that quickly fade away are flow pollutants (Carbon, Sulfur Particles).

Time period is important in distinguishing between stock and flow pollutants.

There is no sharp line between stock and flow pollutants. There is ambiguity.

If the pollutant accumulation is a dominant characteristics than it is a stock pollutant. Then cutting down on current emissions will not have much impact on pollution damage.

Damage from a stock pollutant occur over a period of time.

It is more complex to determine efficient level of stock pollutant.

Marginal cost of emission = Marginal damage from pollution (efficiency condition)

But marginal damage must include damage over a period of time.

Consider a calculation of net cost of emission e_t today (t=1):

$$NetCosts = NC = \sum_{t=1}^{\infty} \beta^{t-1}\{C_t(e_t) + D_t(s_t)\} \qquad \text{.............................2}$$

β is the discount of future at a discount rate of r. $\beta = \frac{1}{1+r}$

For an emission level e(t) which minimizes the Net Cost.

Best current level of emission e_1

$$\frac{\Delta NC}{\Delta e_1} = \sum_{t=1}^{\infty} \beta^{t-1}\{\Delta C_t(e_t)/\Delta e_1 + \Delta D_t(s_t)/\Delta e_1\} = 0 \qquad \text{..........................3}$$

$$= \sum_{t=1}^{\infty} \beta^{t-1}[\frac{\Delta C_t(e_t)}{\Delta e_1} + \frac{\Delta D_t(s_t)}{\Delta s_t} . \frac{\Delta s_t}{\Delta e_1}] = 0 \qquad \text{...........................4}$$

Term $\frac{\Delta C_1(e_1)}{\Delta e_1}$ is the marginal cost when t =1. For all $t \neq 1$ all costs are constant.

Stock of pollution at time t is the sum of previously emitted pollution after appropriately adjusting for decay.

$$s_t = e_t + \delta e_{t-1} + \delta^2 e_{t-2} + \ldots\ldots + \delta^t e_{t-i} + \ldots.. + \delta^{t-1} e_1 + \delta^t s_0 \qquad \text{................5}$$

So $$\frac{\Delta s_t}{\Delta e_1} = \delta^{t-1} \qquad \text{................6}$$

$$\frac{\Delta NC}{\Delta e_1} = MC_1(e_1) + \sum_{t=1}^{\infty} \beta^{t-1}\delta^{t-1} MD_t(s_t) = 0 \qquad \text{.................7}$$

$$-MC_1(e_1) = \sum_{t=1}^{\infty} \beta^{t-1}\delta^{t-1} MD_t(s_t) \qquad \text{..........................8}$$

$$MS_1(e_1) = \sum_{t=1}^{\infty} \beta^{t-1}\delta^{t-1} MD_t(s_t) \qquad \text{..........................9}$$

From equation 8 it is clear that
for efficiency

Marginal saving from one unit of emission today equal to the sum of a marginal damages that may occur in future with those marginal damages discounted by two factors
The discount factor β
Persistence rate of pollutant δ. If $\delta = 0$ then it is a flow pollutant and marginal saving today will equal marginal damage today only.

Environmental Goods and Ordinary Goods

Environmental Goods: Air Pollution, Water Pollution, Air quality, water quality, beautiful panorama over land and ocean, smoggy scene in the city

How to explore preferences for such goods in consumer theory?

- A trade off between using resources for conventional consumer goods or environmental protection.

- How much a consumer is willing to sacrifice for a particular environmental good?
- How to elicit true alue? Absence of market for environmental good.

Example: How to generate demand curve for clean air in a city?

Environmental Goods and Ordinary Goods

- A market exist for ordinary goods. We can compute quantity demanded at various prices for ordinary goods.

- What about a demand curve for clean air in a city?

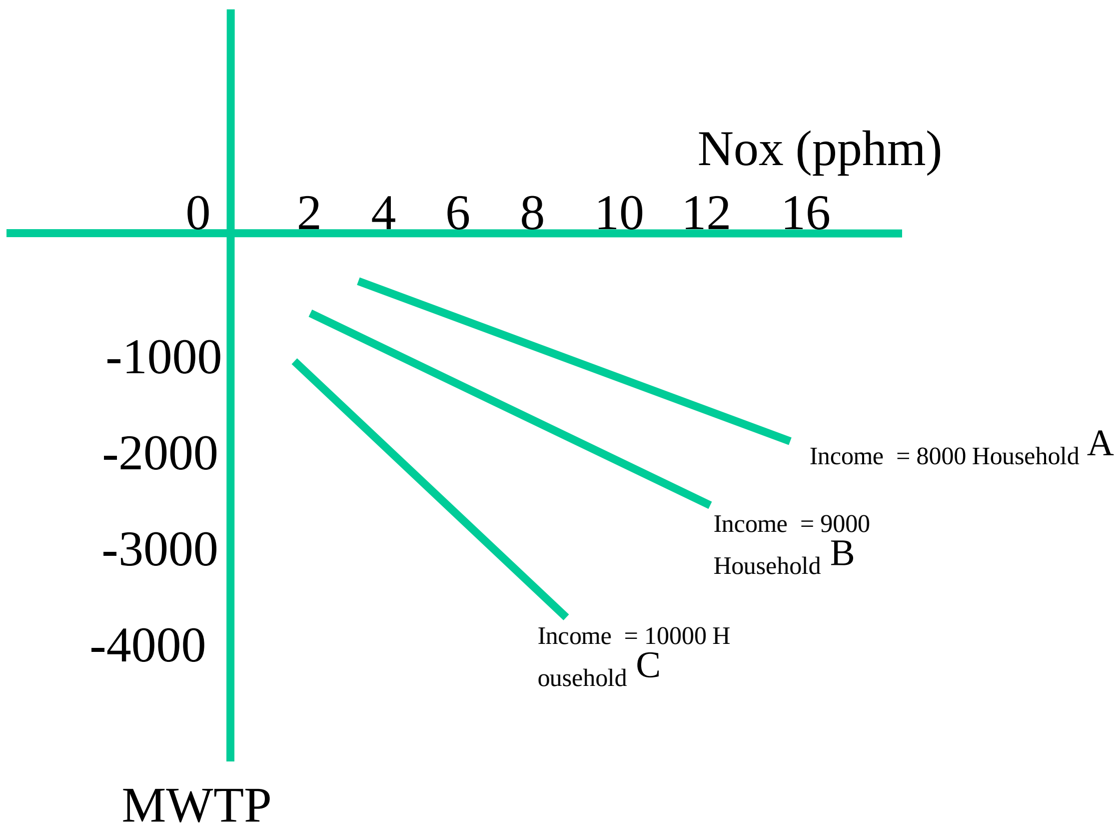
  With low air quality individuals are willing to pay relatively more.

  They are willing to pay less for additional units of clean air

  If there is no market for a good there is no price for it.

- Ordinary public good and environmental goods also differ on supply side.

Prices and Marginal willingness to Pay



WTP and WTA

- Marginal Willingness to Pay (MWTP)

  If the consumer is getting something he doesn't possess.

  Marginal benefit of having one less unit of pollution

  MWTP for one more unit of pollution is negative.

- Marginal Willingness to Accept (MWTA)

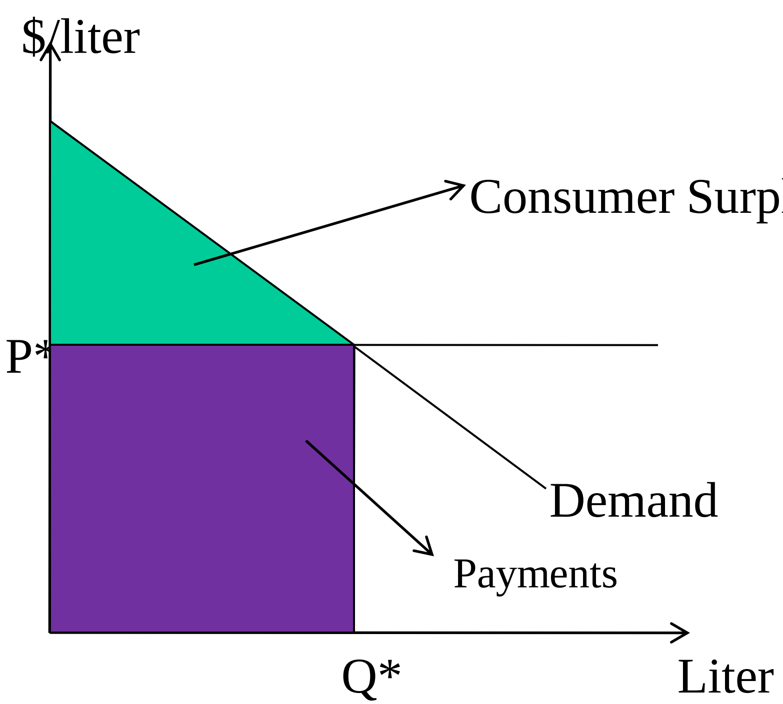
  If the consumer is giving up something he possesses.

  Marginal damage of having one more unit of pollution.

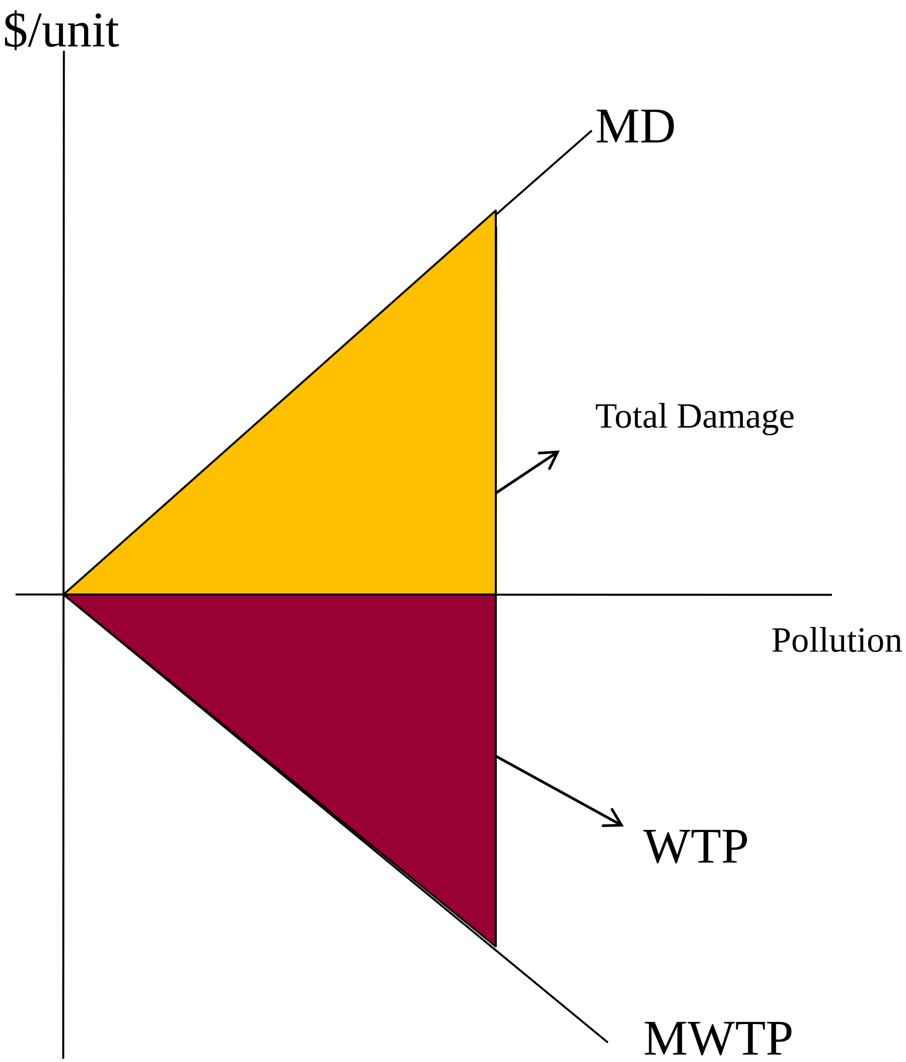
  MWTP for one less unit of pollution is positive.

MWTP for (p+1) = - MWTA (p)

WTP vs MWTP



$/liter
Consumer Surplus
P*
Demand
Payments
Q*
Liter



$/unit
MD
Total Damage
Pollution
WTP
MWTP

Type of Environmental Goods

- Classifying environmental goods

  basis:

  Nature of pollution: water quality, air quality

  Damage: How people perceive damage?

  Health effects, damage to agriculture, damage to buildings and materials etc.

Use Value vs Non Use Value

- Use value is the value derived form consuming a good.

  In the case of environmental goods it include the current use, expected use and possible use.

Direct impact of environment. Damage to health and non health effects like noise, odors, or visual impact.

Material damage causes less direct impact on humans.

Indirect impact of environment: Damage to ecosystem (agriculture, forests, fishery, pharmaceuticals and recreational use of ecosystem)

Use Value vs Non Use Value

- Non use value is a controversial aspect of value.

It is a gain in the person's utility without the person actually applying the good.

Ecosystem in remote part of the world.

1. Existence Value: A value attached to knowing something exist.
2. Altruistic Value: Value one derives from others utility/welfare.
3. Bequest Value: Well being of descendants.

Measuring Demand for Environmental goods

1. **Revealed Preference**

Observe real choice from some market and infer information on the trade off between money and environmental good.

Hedonics

Household Production

2. **Stated Preference**

Asking people how they would trade off money for environmental good.
:::Opinion polls & surveys

Absence of real choice,
Lack of realism
Difficult to get accurate information

Contingent Valuation Method: direct revelation from potential consumers; *Value contingent upon there being a market.*

Measuring Demand for Environmental goods

3**. Experimental market:**
Subjects are given some money and asked to make choice using that money.

Constructed market: hypothetical or real

1. **Laboratory experiments** to find how people trade money for environmental goods.

These are Expensive

Based on non random samples: so generalization become difficult.

2**. Official referendum :** Environmental goods offered to community through referenda.

Revealed Preference and Restricted Demand

Estimate demand curve for environmental good.

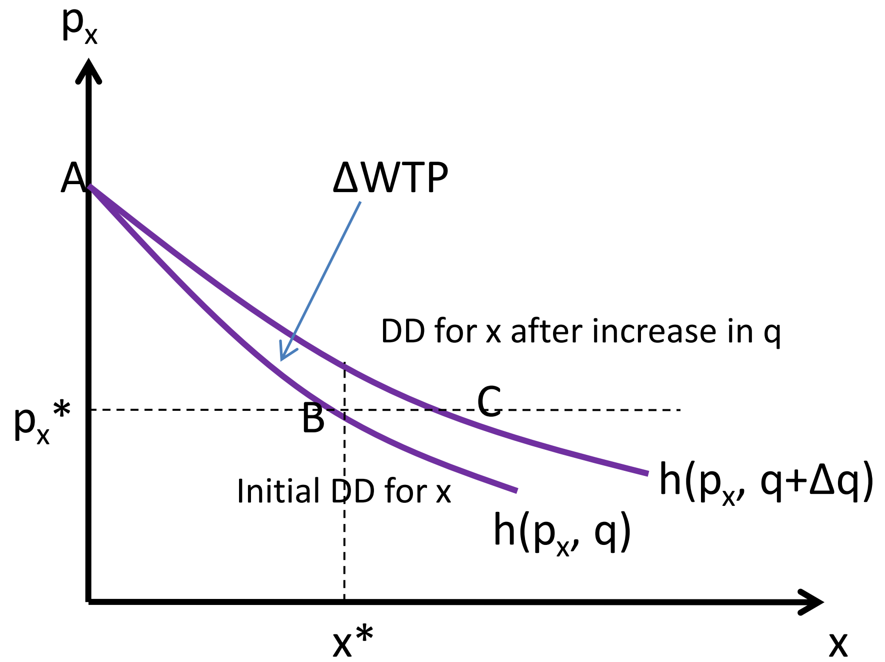
By observing actual behavior of individuals. By looking at how they make trade off between market good and environmental good.

Restricted Demand

$x = h(p_x, q)$

x is the quantity of market good
p_x is the price for market good
q is environment good

$\Delta WTP / \Delta q = MWTP = f(p_x, q)$



Caution: It tells only the lower bound of the value for environmental goods.

Willingness to Pay (WTP):

What a person would pay for more of an environmental good.

Willingness to Accept (WTA):

What a person would accept as a compensation for a little less of an environmental good.

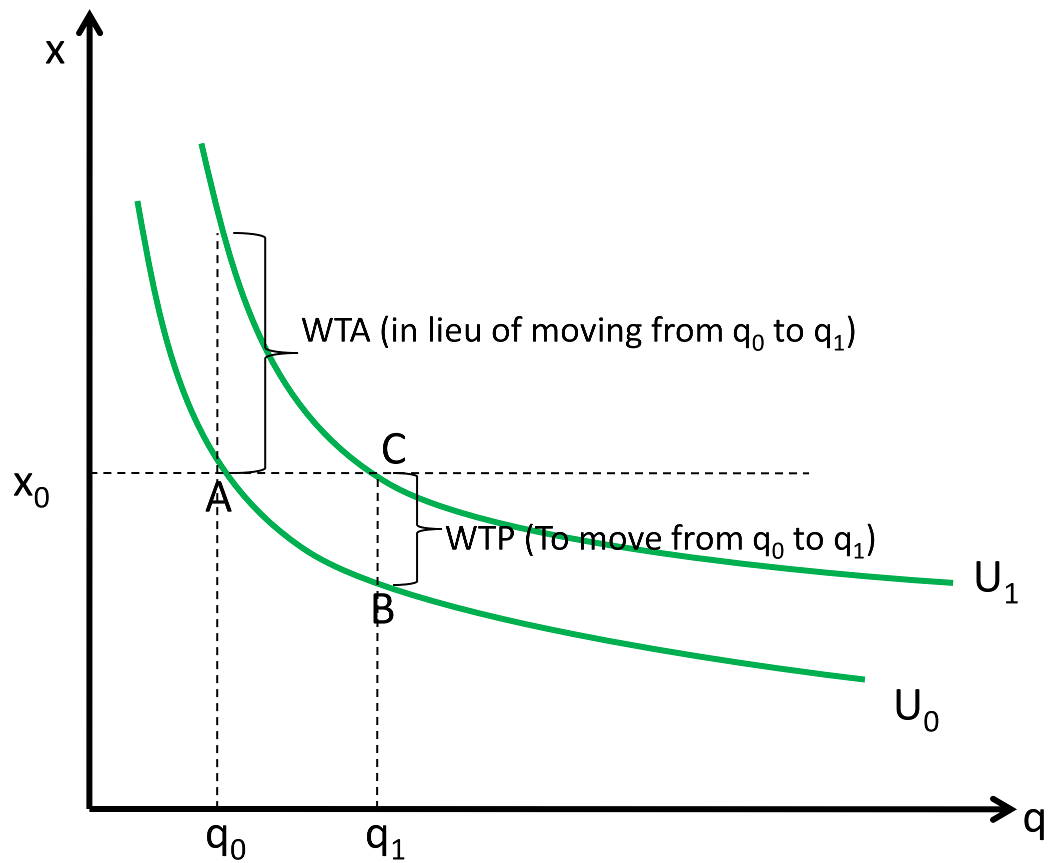
MWTP and MWTA

For many people :
MWTA > MWTP

WTP is determined by income or wealth but WTA is not.

Change in the environmental good is large (non marginal) and q & x are not perfect substitute.

Indifference curve should be curved or DD curve for environmental good is downward slopping.



Question:

Suppose Jose consumes only housing (H) and air quality (A) so that

U(H,A) = A.H

His Income = \$10, P_H = \$2

a) If air quality is 2, how much housing does he consume? Plot his IC and budget constraint.
b) If air quality rises to 4, how much housing does he consume? Plot his IC and budget constraint.
c) How much he is willing to pay for this improvement in air quality from 2 to 4?

HEDONIC PRICE THEORY

Hedonics: Inferring the value placed on specific characteristics of goods based on the observed price of bundle of characteristics.

A single homogenous city or area and : single market
One commodity (house) in the city : single good;
Each house has single characteristic: air quality (z)

How the price of a house varies with the pollution level?
p(z) : house price as a function of air quality (z)

Assume that market is competitive.

A. **The Consumer**:

Assume a typical consumer having income **y** utility function **U**

$$U = U(X,z)$$

He purchases exactly one house shown by air quality and ordinary good.
Price of the ordinary good is assumed to be 1.

$$\text{Max } U = U(X,z)$$

Subject to $X + p(z) = y$

Let U* be the utility our consumer desires
Suppose θ is the maximum he is willing to bid for the house to attain that utility U*

$$\max \theta$$

Such that

$$U(X,z) \geq U^*$$
$$X + \theta = y$$

For given values of y, z and U* we determine how much money is available for house

$\theta(y,z,U^*)$ (bid function)

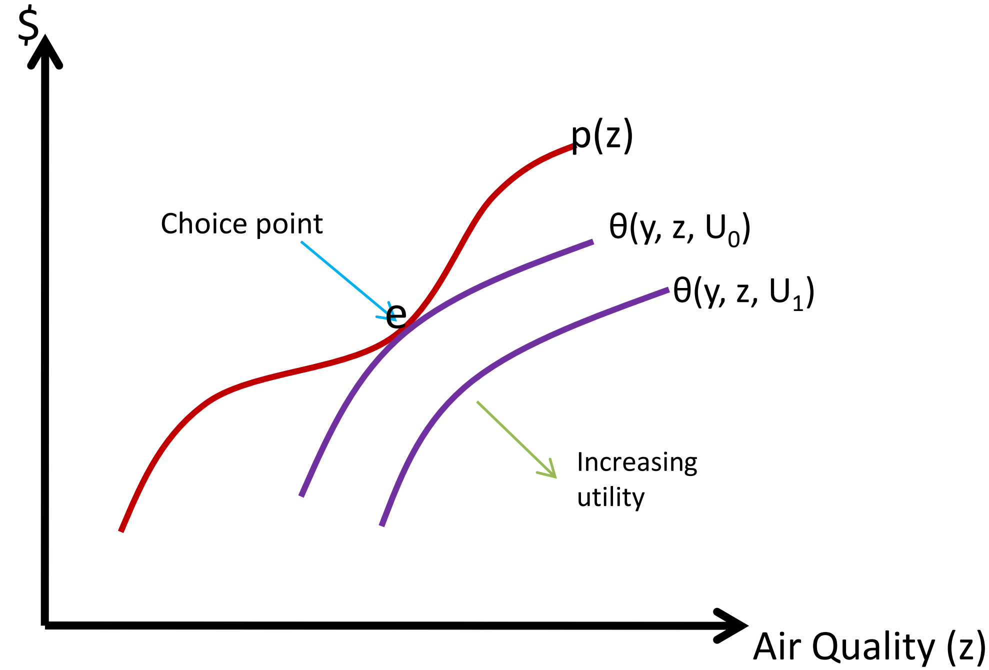
Bid function θ(y,z,U*) represents the amount of money consumer is willing to bid for the house with characteristics z, to keep utility U*, assuming income y.

Hedonic price function p(z) is determined by the market.

Consumer problem: what level of z to choose to maximize utility?

At choice point e

- ❑ Utility is maximum
- ❑ The amount consumer is willing to pay is equal to the price p(z).



B. The Producer:

Different producers in the different segments of the housing market have different cost structure.

Assume: Different producers within a segment face constant returns to scale. Cost of producing one more house of characteristics z is constant.

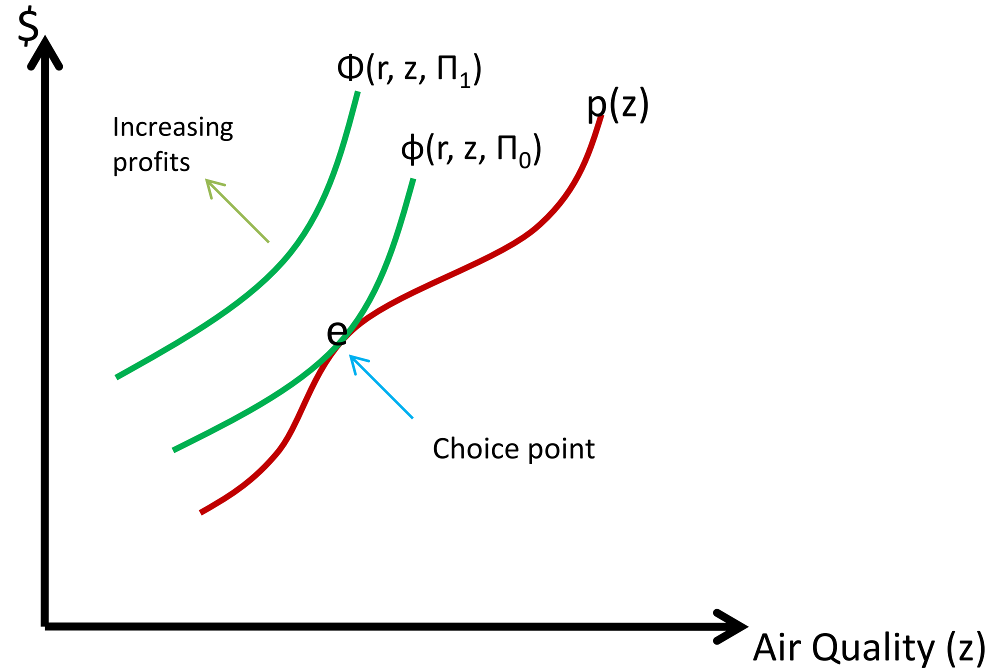
Let input price be r

Unit cost of a producer c(r,z)

If producer offers price Φ

Profit per house

$$\Pi = \Phi - c(r,z)$$



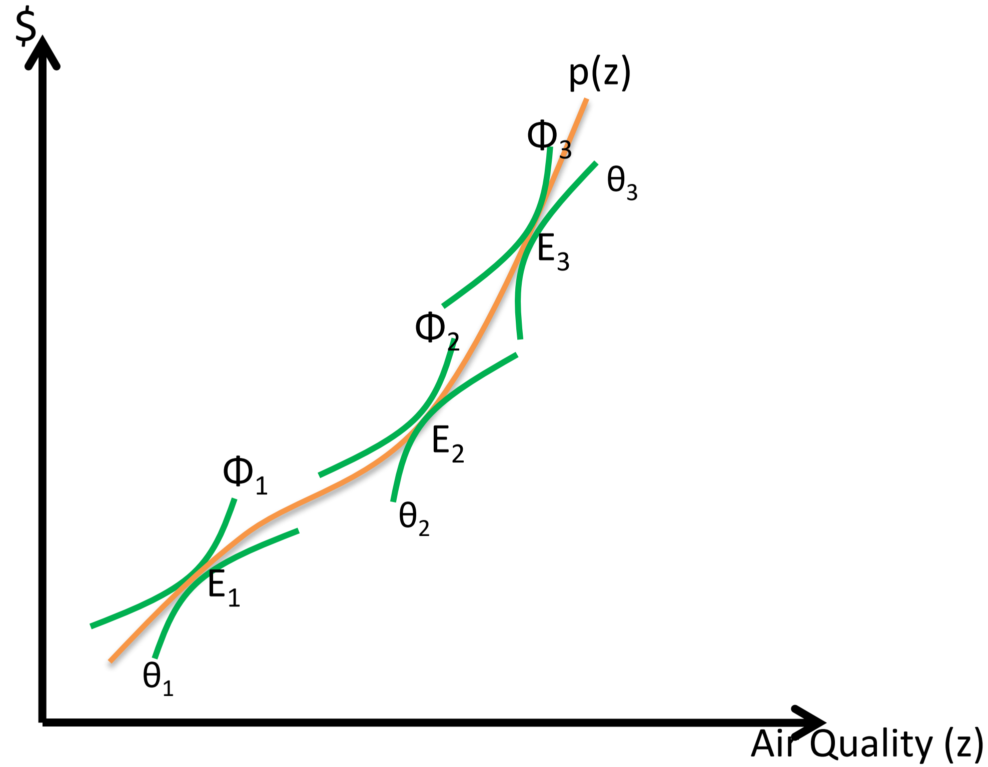
Offer function Φ(r,z, Π) : Price necessary to obtain certain level of profit, given the level of characteristics z.

The price, producer is willing to offer, to obtain particular level of profit Π, given r and z.

<u>**Market Equilibrium**</u>

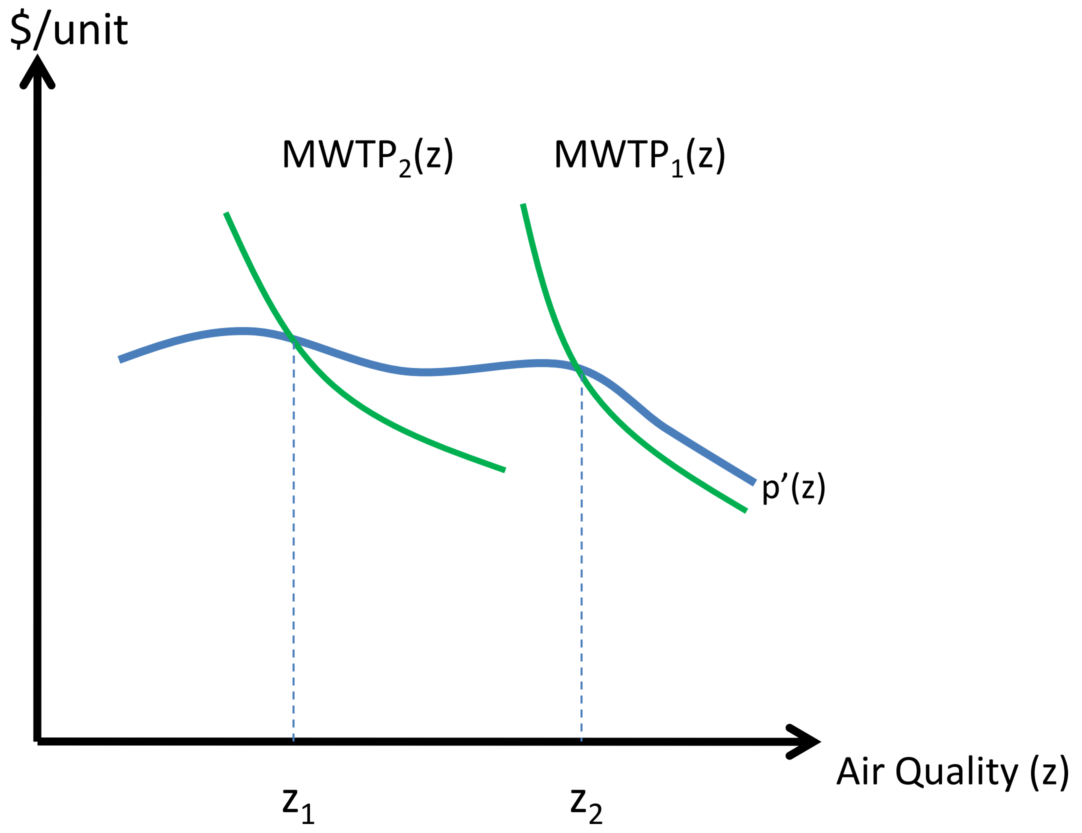
Every point along the hedonic price function corresponds to the tangency between the bid function of some consumer and the offer function of some producer.

Hedonic Price Function p(z) shows how the price of a house changes with the air quality levels. It also tells the marginal price of air quality at different levels of air quality (z).



What about the marginal willingness of a consumer to pay for air quality??

- Marginal price of z (as a function of z)
- Marginal willingness to pay for z (as a function of z)



Suppose consumers making choice here differ in their observable characteristics (α).
Suppose producers here differ in their observable characteristics (β).

Then equations for supply and demand

$$p'(z) = f(z,\alpha)$$
$$p'(z) = g(z, \beta)$$

$p'(z)$ is the slope of the price function.

$f(z,\alpha)$ is the marginal willingness to pay MWTP(z). MWTP depends upon z and α.
(it is a kind of inverse DD function.)

$p'(z) = g(z, \beta)$ is analogous to inverse supply function. Price here is related to z and β.
β is the cost factor in the industry.

Stated Preference: Contingent Valuation Method

Finding an individual's willingness to pay for a good by asking set of questions or conducting a survey.

Example: WTP for reducing the risk of water contamination

Questionnaire: Describe the good; elicit willingness to pay; collect background information of the respondents (economic and demographic characteristics).

Sample Questionnaire on Reducing Water Supply Contamination

Section A: Introduction

Purpose of survey

Section B: Background Attitude and Information

Opinion about tap water quality

What precaution the Household has taken in last five years

Range of monthly income of the household

Section C: Value of Water Quality Improvement

Max tax your household can pay to attain certain level of reduction in contamination of water

Section D: Background Information

Age, Number of members in household,

Percentage of marks in last class attended by respondent and his/her spouse,

Average monthly water and sewer bill

Years of residents in the city

$$WTP(q_0, q_1) = f(P, q_0, q_1, Q, Y, T)$$

q_0 : is the initial risk in water quality.

q_1 : is the risk after the water quality has been made safe.

P : is the price of market good

Q : is the quantity of other environmental good

Y : is the income

T : assorted characteristics of the individual

Components of a Contingent Valuation Study

1. Define market scenario
2. Choose elicitation method
3. Design market administration
4. Design sampling
5. Design of experiment
6. Estimate willingness to pay function

1. Define market scenario

The market scenario is the information to be given to the respondent to place him/her in the right frame of mind to give meaningful responses to the questions.

How to describe the good to be valued?? It must be realistic description.

If the market scenario is not **understandable** and **plausible** to the respondent, the data will be questionable.

Payment mechanism must be realistic to convince the respondents.

Provide a right context to the survey : educating the respondents about the background of the problem.

2. choosing elicitation method

How best to obtain valuation response? Four primary ways to elicit value:

a. Direct Question:

b. Bidding Game: Problem of *starting point bias*

c. Payment card

d. Referendum Choice

3. Design market administration

Administering the survey:

a. **Mail :** Cheapest but problem of non response and questionable results.

b. **Internet :** Relatively cheap and easy but questionable

c. **Telephone :** Relatively cheap and easy; Biasness due to the unknown nature of respondents
Visual cues can't be used (photographs)
'Do not disturb' obligations of telecom operators

a. **In-person:** Most expensive to administer
Can be most reliable
Problem of interviewer bias
Social desirability bias
Problem of comparability when many interviewers are used.

Careful pretesting of the survey is essential.
Wording of each question is important
Organisation of the survey

4. Design sampling or Choosing the respondents

What should be the sample frame

Which group of people to be targeted ?

In which geographical area?

Whether individuals or households?

Random Sample

We need to precisely define the population and than draw the sample randomly

5. Experimental Design:

How to collect appropriate information in an efficient manner without unintentional biases?

6. Estimation of WTP function:

All vital information must be collected in the survey to statistically measure the WTP function.

Problems with Contingent Valuation

Contingent valuation approach is highly controversial.

1. The values elicited in CV surveys are not based on real resource decisions – they are hypothetical. No money is at stake for the respondents.

2. Ambiguity in what people are valuing.

3. Embedding problem originating from existence value of the environment.

Experimental Markets

Constructing a market where none existed before. There are two methods to do so:

A. Laboratory Experiments:

- Experiments done in lab on volunteer (e.g. students).
- Money to be paid by students for good and received for bad.
- Real money is exchanged for experimental commodities.
- Real money is given to them and then asked to make real decisions

i) Participants make real decisions for real resources
ii) Participants leave the experiment richer than when they began.

Experimental economics in environmental problems helps in determining:
i) divergence between WTP and WTA.
ii) Validity of Contingent Valuation

B. Field Experiments:

•Making a market in the real word where one has not existed previously.

(Example: Government regulation or market imperfection precluding operation of a market system.

Lottery based allocation of goods or on first come first served basis)

•An experimental market can be constructed with permission to study consumer behavior.

Field Experiments can be classified in three categories:

i) **Artefactual field experiments:** Lab experiments using "real" instead of University students. (Easiest to execute)

ii) **Framed field Experiments:** using general population as experimental subjects in a non lab setting. (most common type)

iii) **Natural field experiments:** Same as framed field experiments except that the subjects naturally undertake the experimental activities. (most desirable)

Referenda