Lecture – 11A, 11B

Energy Resources, Economics and Environment

Utility and Social Choice

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Questions in Environmental Policy

What is the right balance between environmental protection and use?

How much environmental protection should we have?

Social and Political question

Translate individual preferences into a group or societal choice

Examples Environmental choices

- Air Pollution in Santiago, Chile - Diesel buses, automobiles
- California Gnatcatcher – endangered species – Southern California
- Three Gorges dam in China – reservoir 500 km in length

  (Kolstad)

Indian Examples

- Narmada Valley Project
- Pathrakadavu Hydroelectric Project – Lion tailed Macaque
- Vedanta – Bauxite mining in Niyamgiri hills in Orissa
- Iron Ore Mining in Goa
- Mumbai’s coastal road project
- Metro Shed in Aarey

Pathrakadavu Hydroelectric Project

Major features of the project

Height of the dam	:	64.5 m
Length	:	275 m
Reservoir area	:	4.40 ha
Full reservoir level	:	488 m above msl
Installed capacity	:	70 MW
Annual energy	:	214 mu
Total area required	:	40.90 ha
Forest area required	:	22.16 ha (54%)
Estimated cost	:	Rs.420 crores

Philosophical Perspectives

- Biocentrism – Intrinsic value
- Sustainability- health of ecosystem
- Anthropocentrism
- Precautionary Principle

Intrinsic value

Instrumental value

BIOCENTRISM

- Biologic world at the centre of the value system.
- All living beings have intrinsic value regardless of their instrumental value.
- Something can be totally useless and still have intrinsic value. E.g. Small pox virus

SUSTAINABILITY

- Leopold (1949) – Land ethic – health of ecosystem is of paramount importance
- An environmental policy is right if it preserves the integrity of an ecosystem and wrong if it does not
- Is this consistent with natural resource use for humans?

SUSTAINABILITY

- Is this consistent with natural resource use for humans?
- Yes, provided the use does not degrade the environment.
- Fishing is acceptable, but overfishing is not logging is acceptable, provided the long term health of the forest is not jeopardised (affected)

SUSTAINABILITY

- Sustainability- commonly used- often not precisely defined
- Brundtland commission – Sustainability ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’

SUSTAINABILITY

- Robert Solow – defines sustainability as making sure that the next generation is as well off as the present generation and ensuring that this continues for all time.
- Aspects of Sustainability
  - Degree to which 'natural capital' can be viably replaced by 'human capital'
  - Obligation that present generation owes to future generations

SUSTAINABILITY

- Man made capital (machines, buildings) and knowledge are substitutes for natural capital, particularly natural resources.
- Are sustainability and biocentrism consistent?
- E.g. Hunting not acceptable for biocentrists but acceptable from a sustainability viewpoint – desirable to reduce overpopulation.

Sustainability and Biocentrism

Are sustainability and biocentrism consistent?

E.g. Hunting not acceptable for biocentrists but acceptable from a sustainability viewpoint – desirable to reduce overpopulation.

ANTHROPOCENTRISM

- Human centric viewpoint
- Environment – only there for one purpose – to provide material gratification for humans
- Anthropocentrism – only instrumental value to the environment.

- Utilitarianism – well being people attain from the environment – materialistic, spiritual, instrumental or intrinsic. Californian grat catcher may have utilitarian value but not instrumental value.

Utilitarianism

- Well being people attain from the environment – materialistic, spiritual, instrumental or intrinsic.
- Californian gnat catcher may have utilitarian value but not instrumental value.
- Perception, feeling

Social choice from individual values

- Methods for making decisions about specific projects or regulations that have environmental impact – based on individual preferences
- No restrictions on individual preferences

Social choice from individual values

N- person society $i = 1, 2, \ldots N$

- Assume one composite material good x
- $x = (x_1, x_2, x_3, x_i, x_M)$
- Individual consumption
- e – quality of environment – assumed to be the same for everyone

Social choice from individual values

Utility – well being – obtained from bundle of material and environmental goods.

$$(x, e) \rightarrow U_i(x_i, e)$$

Substituition of x,e

- Pure biocentrists – no substitution of x for e
- Extreme anthropocentrist – no substitution of e for x

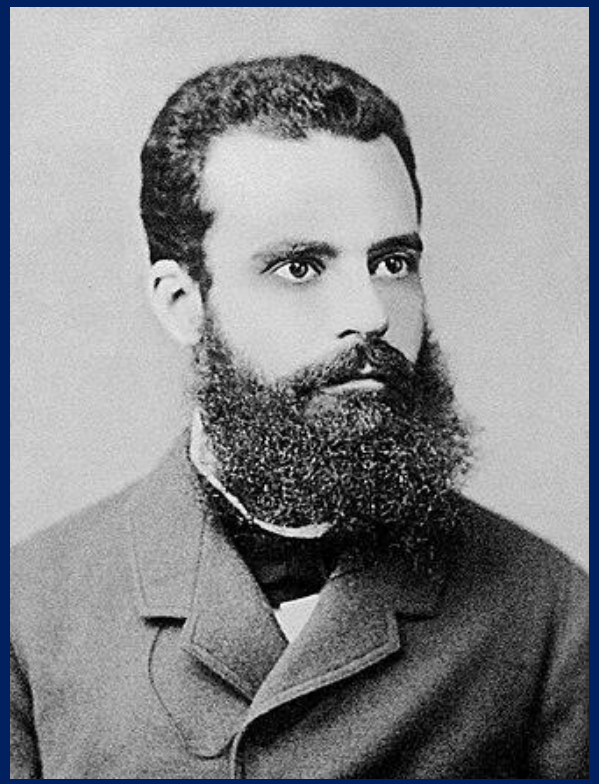
Future Generations

- Future generations may benefit from preserving environment today.
- Hence $U_i(x_i\ ,\ e,\ U_j)$
- where U_j – utility of person j – in a future generation

Choosing between two bundles

- Consider two bundles of goods
- $A(x', e') = (x'_1, x'_2 \ --- \ x'_N \ , \ e')$
- $B(x'', e'') = (x''_1, x''_2 \ --- \ x''_N \ , \ e'')$
- Should society choose A or B?
- How do we generate a set of societal preferences over different bundles given individual preferences over the same bundles

Pareto Criterion



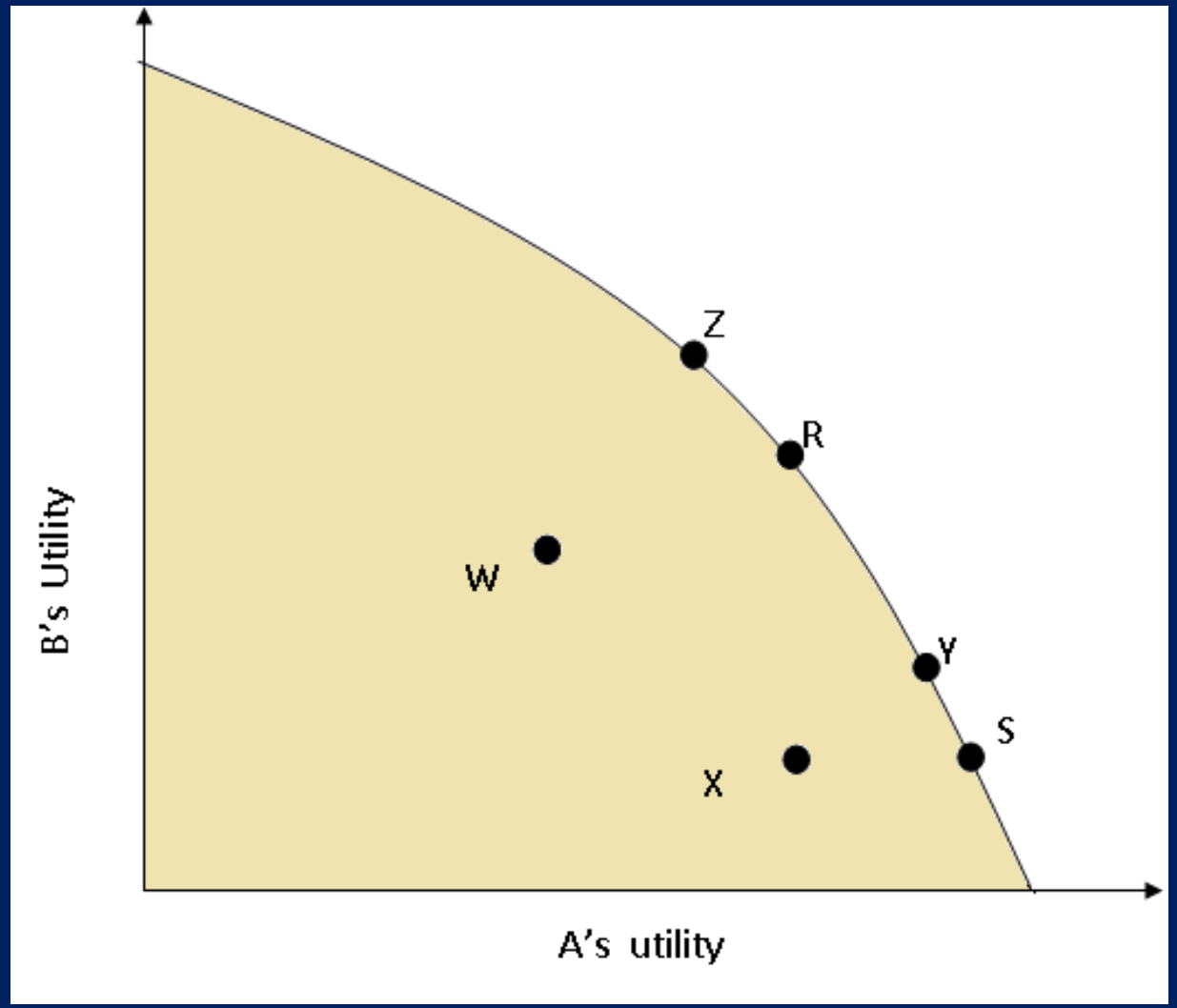
Vilfredo Pareto (1848-1923)

Italian economist

Pareto Optimality

https://en.wikipedia.org/wiki/Vilfredo_Pareto

Utility Possibilities for two person society

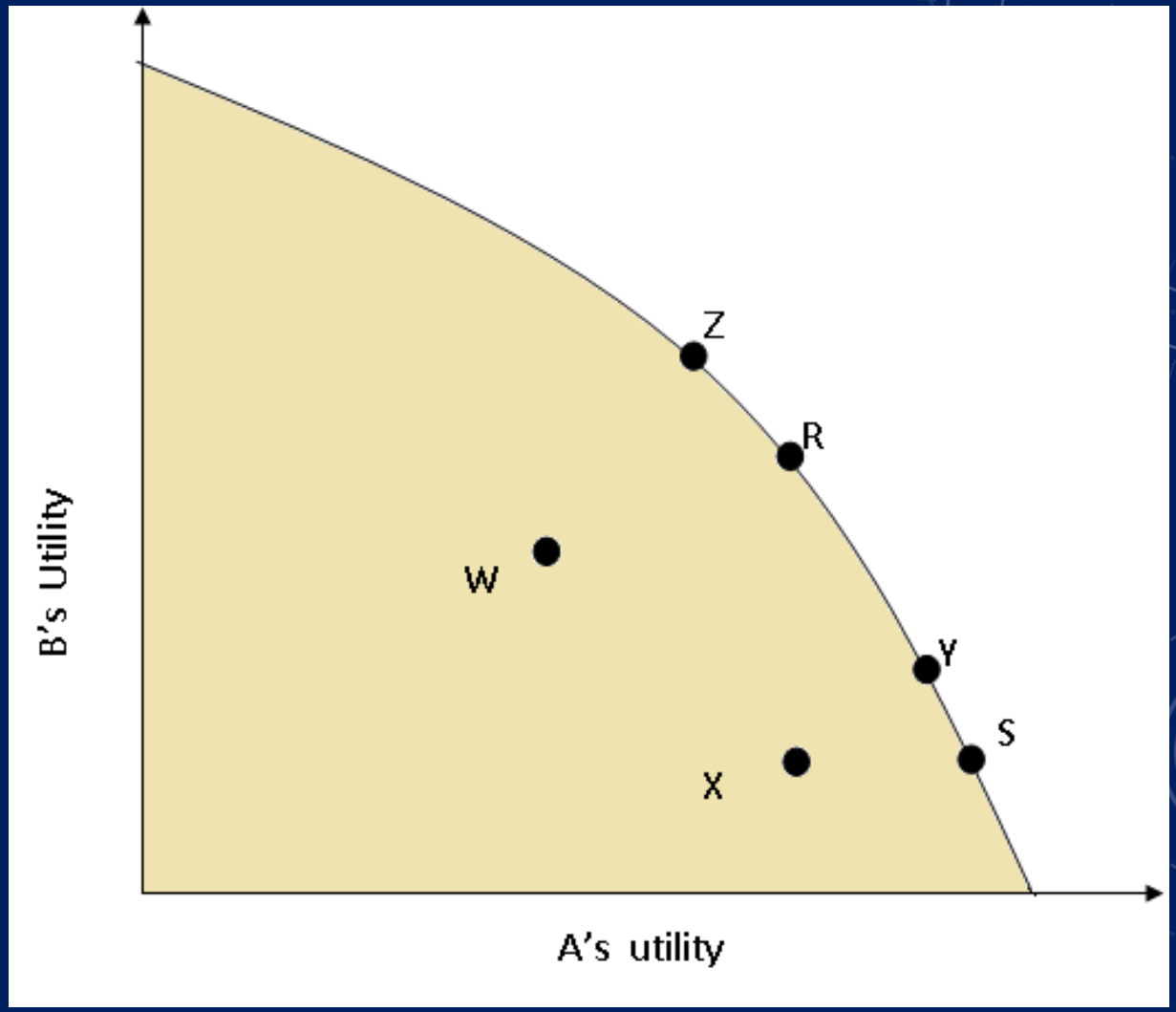


Source: Kolstad, 1999

Utility Possibilities for two person society

Z = Pareto preferred to W

Y – Pareto preferred to X



Source: Kolstad, 1999

Pareto Criterion

Start with two consumption bundles

$$a' = (x', e') \; and \;\; a'' = (x'', e')$$

and a group of people $i = 1, \ldots\ldots, N$ with utility functions U_i defined over the consumption bundles. Then for the group as a whole, a' is Pareto preferred to a'' if for every individual i

$$U_i(a') \geq U_i(a'')$$

and for at least one individual

$$\hat{\imath} \quad U_i(a') > U_i(a'')$$

For a' to be better than a''
everybody has to be at least as well off
at least one has to be better off.

Pareto Criterion

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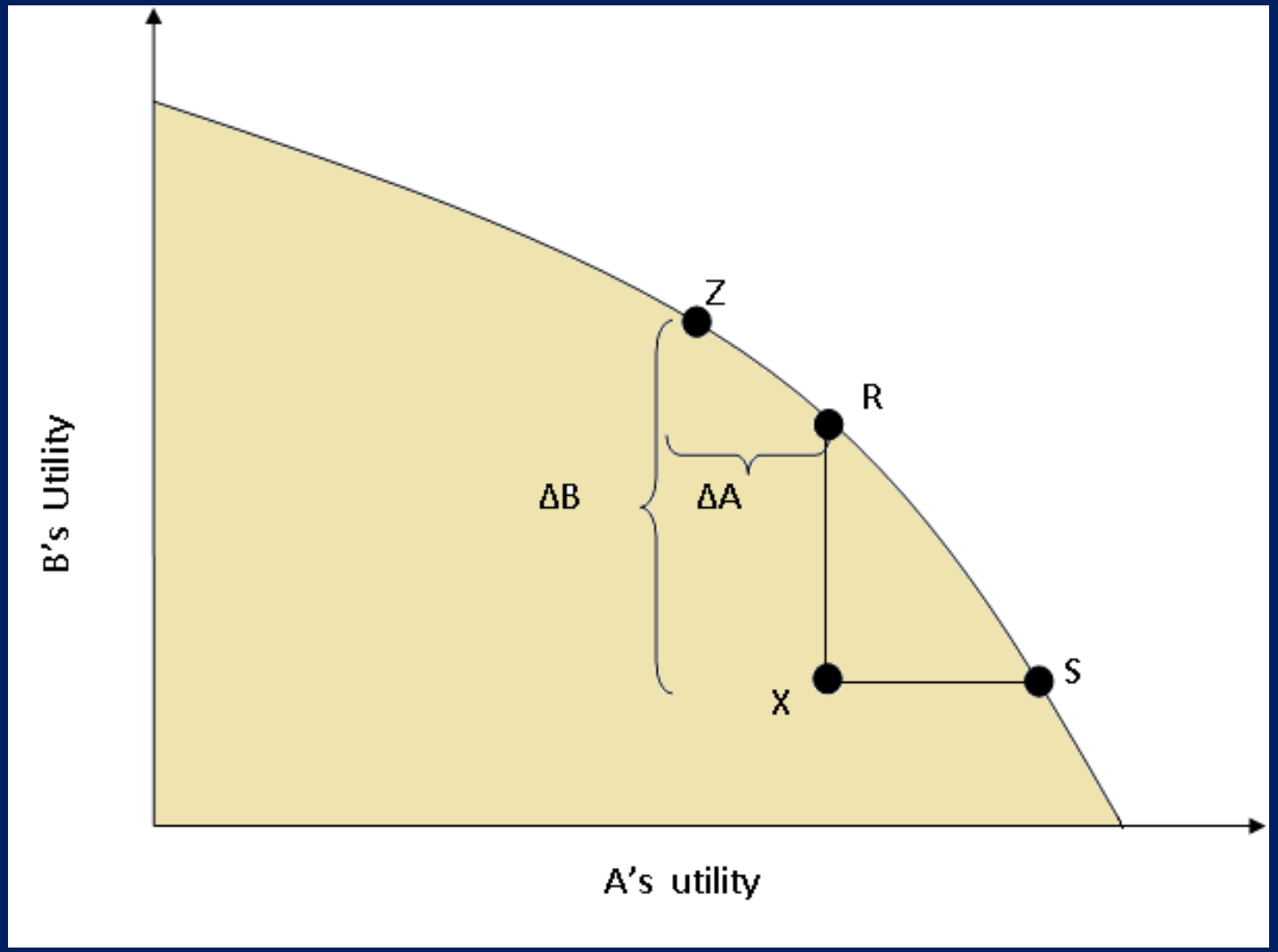
Pareto Criterion

For a' to be better than a''

everybody has to be at least as well off ,at least one has to be better off.

Pareto criteria – unanimity

An illustration of potential Pareto improvement



Source: Kolstad, 1999

Potential Pareto Improvement

- Allow transfers of resources among individuals to increase the unanimity of opinion regarding the options.
- Suppose 80% of the population prefer a to b while 20% prefer h to a
- According to the Pareto criterian we cannot say whether a or b is preferred.
- Suppose the 80% can transfer resources to b – suppose resource transfer large enough – unanimity can be reached on option a.

Potential Pareto Improvement

Apart from x , e we now have a tradeable resource – such as money y

$$\sum_i z_i = 0$$

Compare $(a', y - z)$ is Pareto preferred to (a'', y)

possible to choose a' - compensate the non-gainers

Potential Pareto Improvement

Assume an economy of $i = 1,2, \ldots \ldots \ldots, N$ individuals. Suppose we compare two bundles $a' = (x', e')$ and $a'' = (x'', e'')$ at a given distribution of tradeable resources y. If there exists a vector of transfers from individuals z which sum to zero such that

$(a', y - z)$ is Pareto preferred to

(a'', y) then a' is a potential

Pareto improvement over a'

Kalder – Hicks Compensation Principle.

If transfers could be made to achieve unanimity on a particular choice, then the choice is socially desirable, even if the transfers are not actually made.

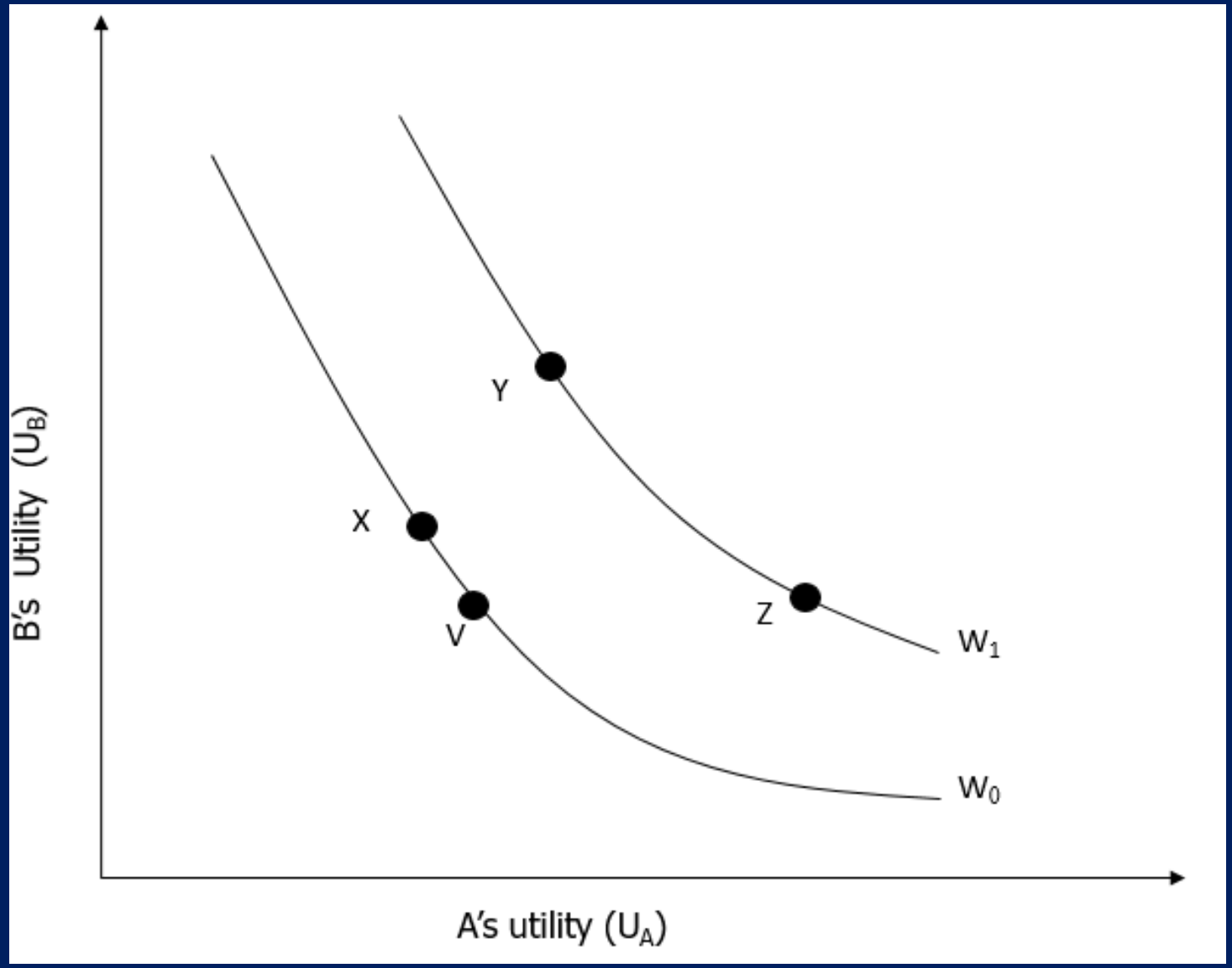
Compensation – idea of equity

Decoupled from determining whether the choice/ project is a good idea or not.

Voting

- Voting rule does not need unanimity.
- Majority rule – cannot take into account intensity of preferences

Social Indifference Curves



Source: Kolstad, 1999

Social Welfare function

$$W(u_1, u_2, \dots \dots u_N)$$

If in comparing two bundles $W(u_1, (a), \dots u_N\ (a)) > W(u_1\ (b) - u_N\ (b))$ is equivalent to a being socially preferred to b then W is a Bergson Samuelson social welfare function.

Benthamite Social Welfare Function

$$W(u_1, u_2, \ldots\ldots u_N) = \sum_{i=1}^{N} \theta_i u_i$$

$$\theta_i \geq 0$$

Egalitarian Social Welfare Function

$$W(u_1, u_2, \ldots\ldots\ldots u_N)$$

$$= \sum u_i - \lambda \sum_i \left[u_i - \min(u_i) \right]$$

Rawlsian Social Welfare Function

$$W(u_1, u_2, \ldots\ldots\ldots..u_N) = \mathrm{Min}_i(u_i)$$

References

- Charles Kolstad, Environmental Economics, Vol. 1, Oxford University Press (1999).
- https://en.wikipedia.org/wiki/Vilfredo_Pareto

Lecture – 11C , 11D

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Utility and Social Choice

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Kenneth Arrow

1922-2017

Nobel Prize Economics 1972

"for their pioneering contributions to general economic equilibrium theory and welfare theory."

A DIFFICULTY IN THE CONCEPT OF SOCIAL WELFARE

KENNETH J. ARROW[1]

Stanford University

Arrow's Impossibility Theorem

- 'that interpersonal comparison of utilities has no meaning and … that there is no meaning relevant to welfare comparisons in the measurability of individual utility.'
- Kenneth Arrow

Arrow – Social Choice Mechanism

- Completeness
- Unanimity
- Non-Dictatorship
- Transitivity
- Independence of Irrelevant Alternatives
- Universality

Arrow – Social Choice Mechanism

- Completeness – All social alternatives can be compared
- Unanimity- if all prefer a to b, society prefers a to b
- Non-Dictatorship – no one should always get their way
- Transitivity – a $\succcurlyeq$b, b $\succcurlyeq$c implies a $\succcurlyeq$c

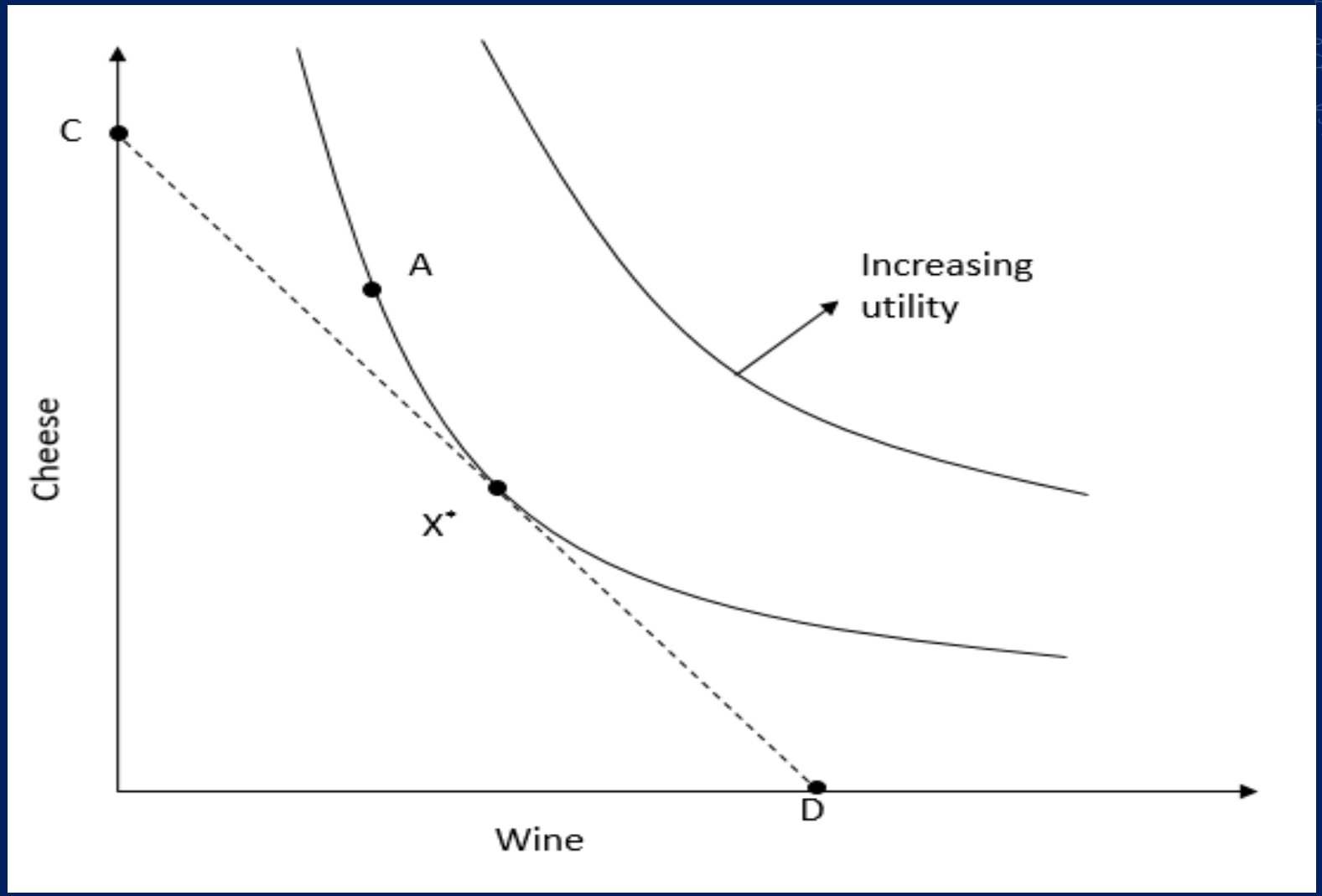
Arrow – Social Choice Mechanism

- Independence of Irrelevant Alternatives
  Society's choice between a and b does not depend on other alternatives
- Universality – Any possible individual rankings of alternatives is possible

Arrows Impossibility Theorem

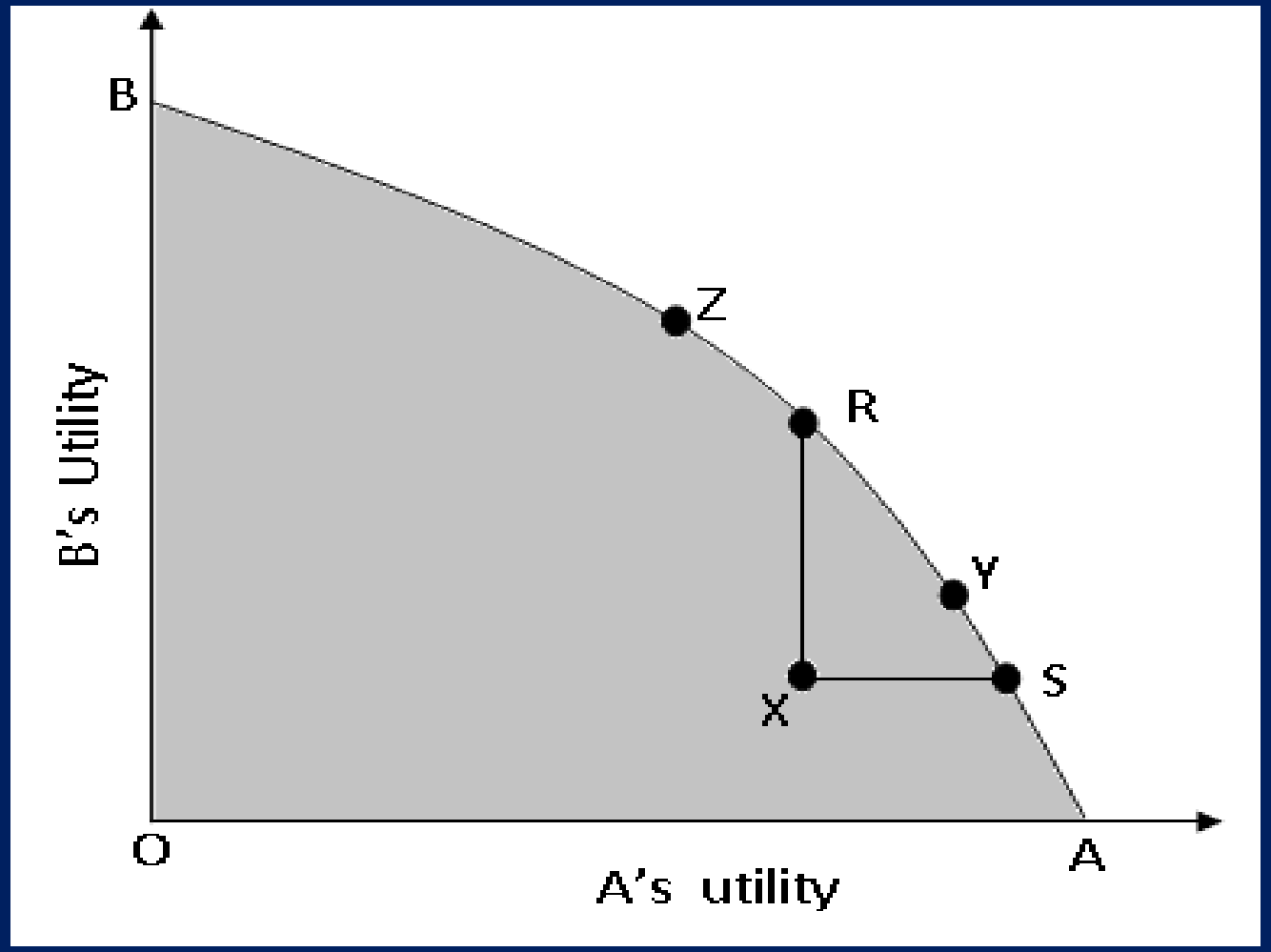
- There is no rule satisfying the six axioms for converting individual preferences into a social preference ordering
- No neat theory of social decision making possible

Utility – Two commodities



Source: Kolstad, 1999

Pareto dominance



Source: Kolstad, 1999

Pareto Frontier

- Definition- All allocations for which there are no allocations that are Pareto preferred
- An allocation is efficient if it lies on the Pareto frontier

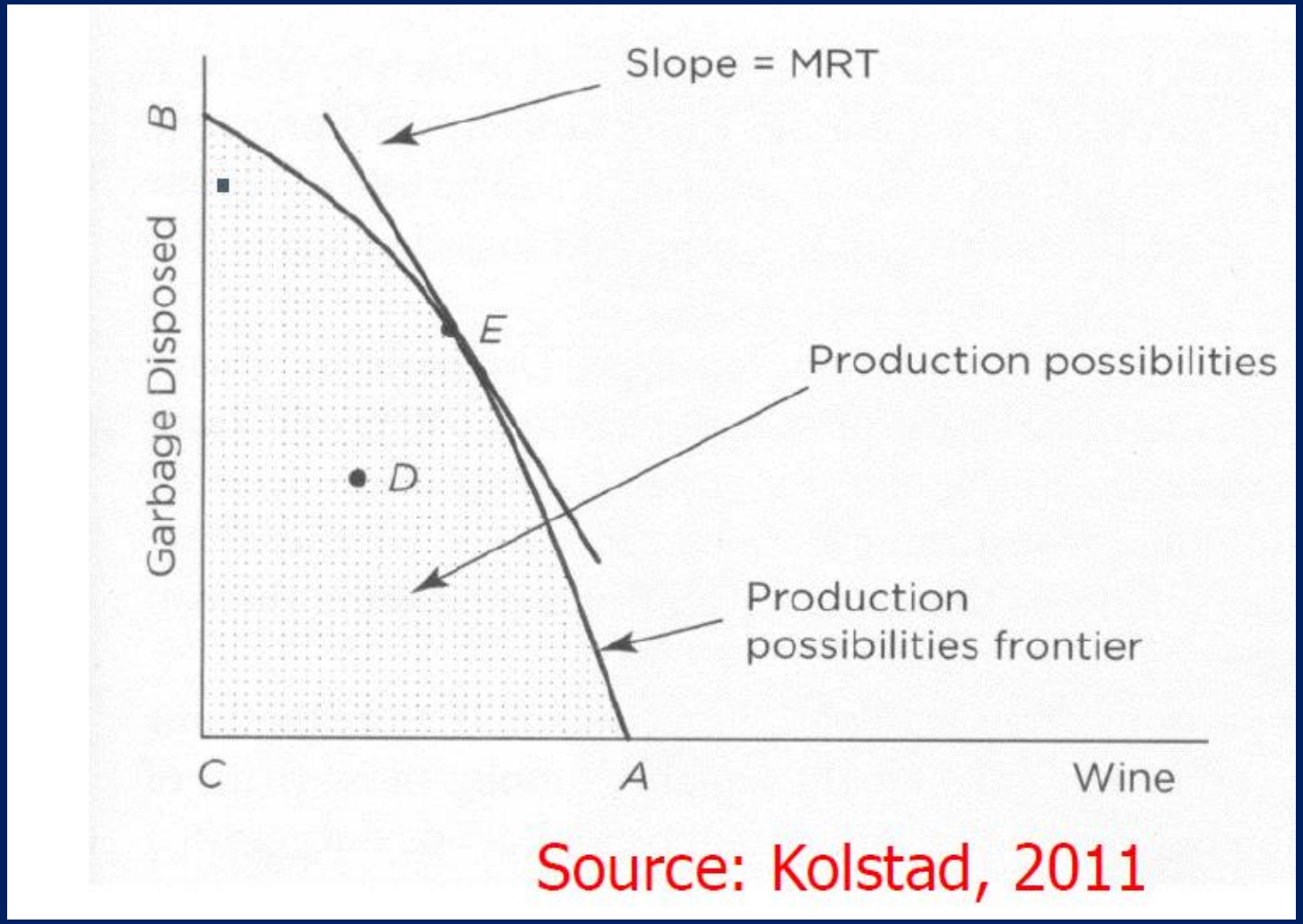
Economic Inefficiency

- Inefficiency in exchange
- Inefficiency in Production

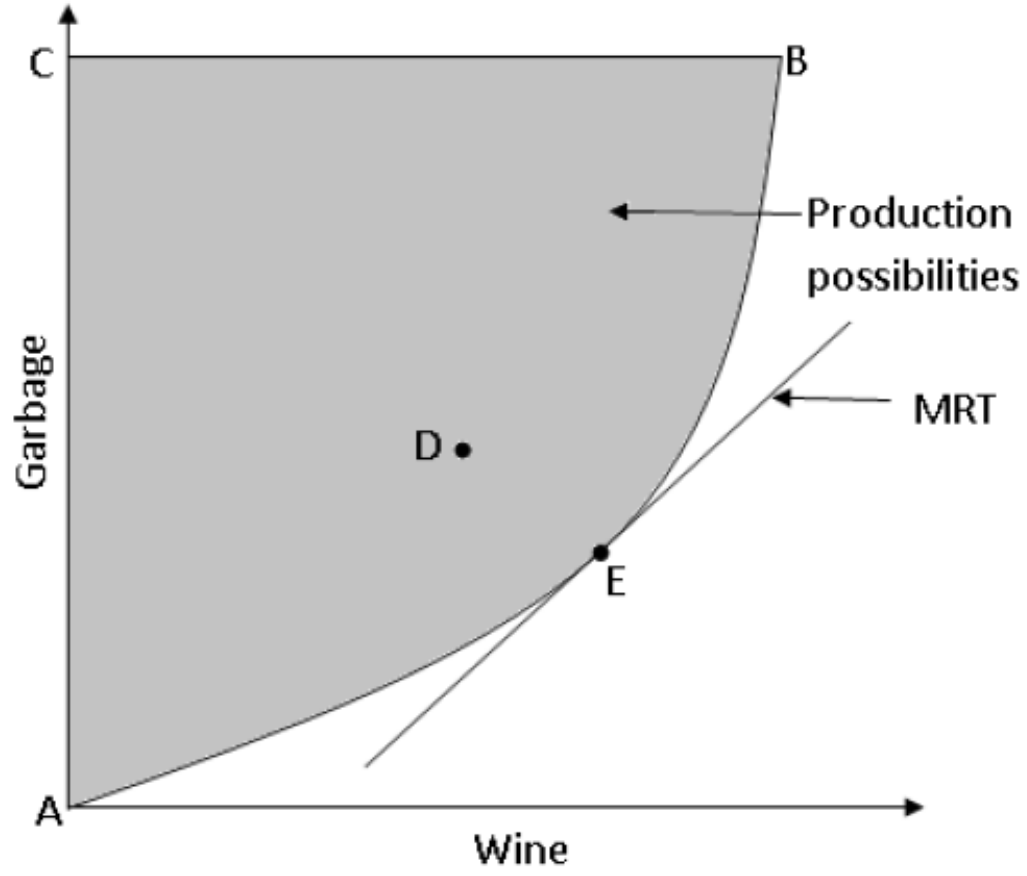
Efficiency in Trade

$$MRS_A = \frac{MU_A^1}{MU_A^2} = \frac{MU_B^1}{MU_B^2} = MRS_B = \frac{p_1}{p_2}$$

Efficiency in Production



Efficiency in Production

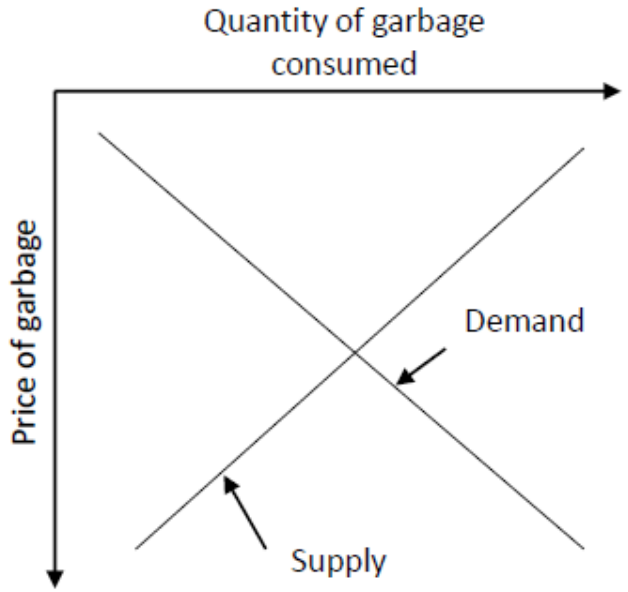


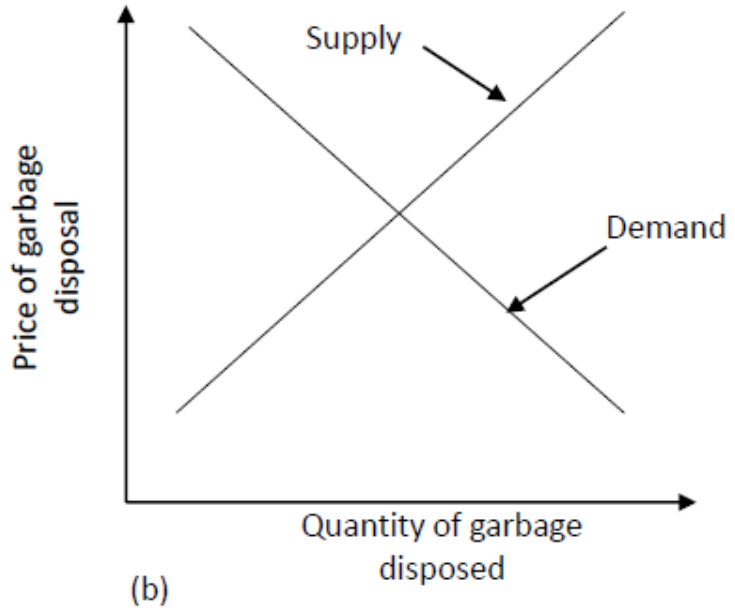
Source: Kolstad, 1999

Equimarginal principle

- Marginal rate of transformation between pollution and the good should be the same for all producers
- Marginal rate of pollution control should be the same for all firms

Two interpretations of garbage





Source: Kolstad, 1999

Assumptions

- Complete Property Rights
- Atomistic Participants
- Complete Information
- No Transaction Costs

First Theorem of Welfare Economics

In a competitive economy, a market equilibrium is Pareto optimal

Second Theorem of Welfare Economics

In a competitive economy, any Pareto optimum can be achieved by market forces provided the resources of the economy are appropriately distributed before the market is allowed to operate

THE BANK MEMO

Lawrence H. Summers
Chief Economist-The World Bank
December 12, 1991

Our Words: The Lawrence Summers Memo, 1991

The Memo

'Dirty' Industries: Just between you and me, shouldn't the World Bank be encouraging MORE migration of the dirty industries to the LDCs [Less Developed Countries]? I can think of three reasons:

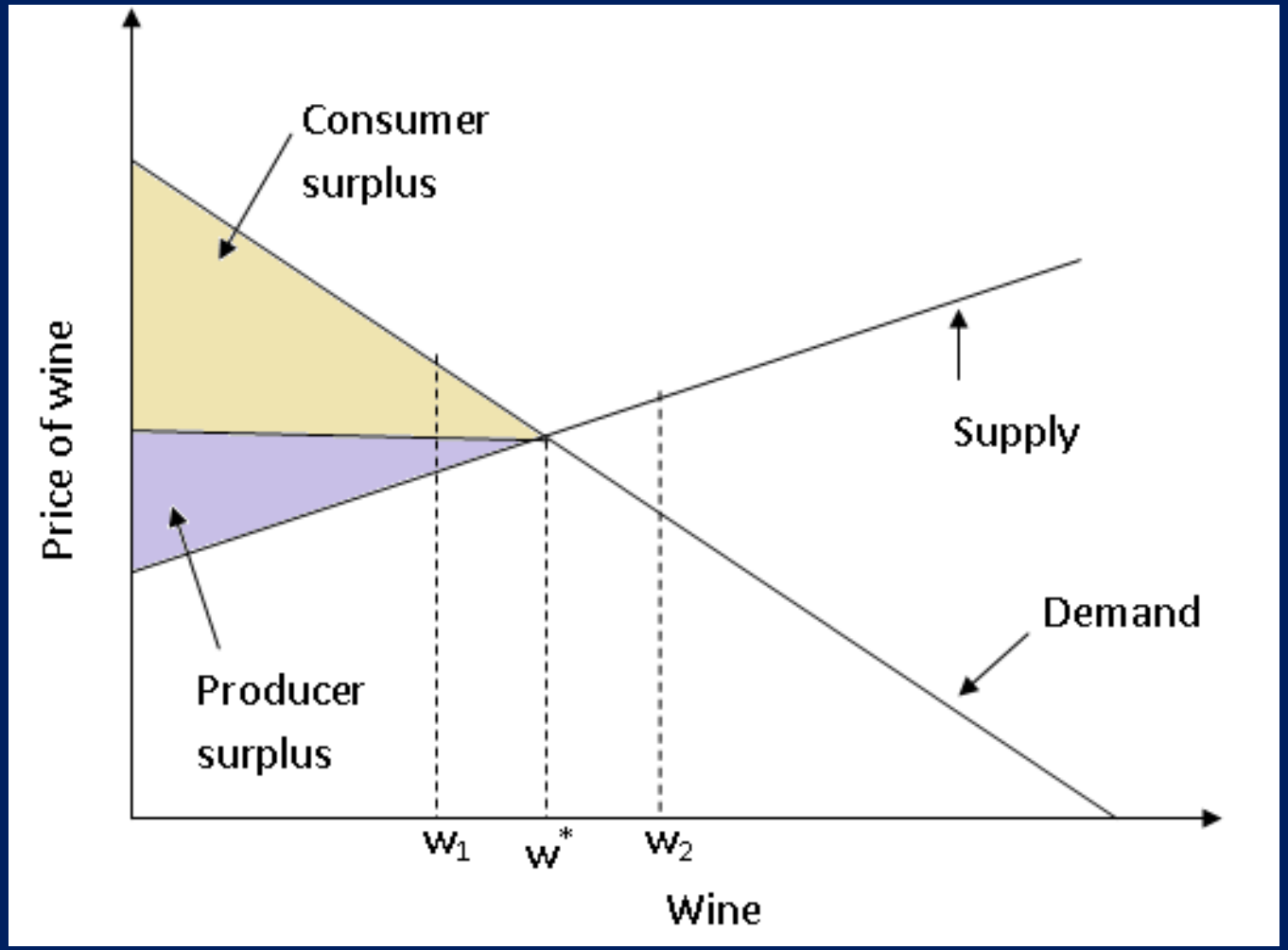
1) The measurements of the costs of health impairing pollution depends on the foregone earnings from increased morbidity and mortality. From this point of view a given amount of health impairing pollution should be done in the country with the lowest cost, which will be the country with the lowest wages. I think the economic logic behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that

2) The costs of pollution are likely to be non-linear as the initial increments of pollution probably have very low cost. I've always though that under-populated countries in Africa are vastly UNDER-polluted, their air quality is probably vastly inefficiently low compared to Los Angeles or Mexico City. Only the lamentable facts that so much pollution is generated by non-tradable industries (transport, electrical generation)and that the unit transport costs of solid waste are so high prevent world welfare enhancing trade in air pollution and waste.

3) The demand for a clean environment for aesthetic and health reasons is likely to have very high income elasticity. The concern over an agent that causes a one in a million change in the odds of prostrate cancer is obviously going to be much higher in a country where people survive to get prostrate cancer than in a country where under 5 mortality is is 200 per thousand. Also, much of the concern over industrial atmosphere discharge is about visibility impairing particulates. These discharges may have very little direct health impact. Clearly trade in goods that embody aesthetic pollution concerns could be welfare enhancing. While production is mobile the consumption of pretty air is a non-tradable.

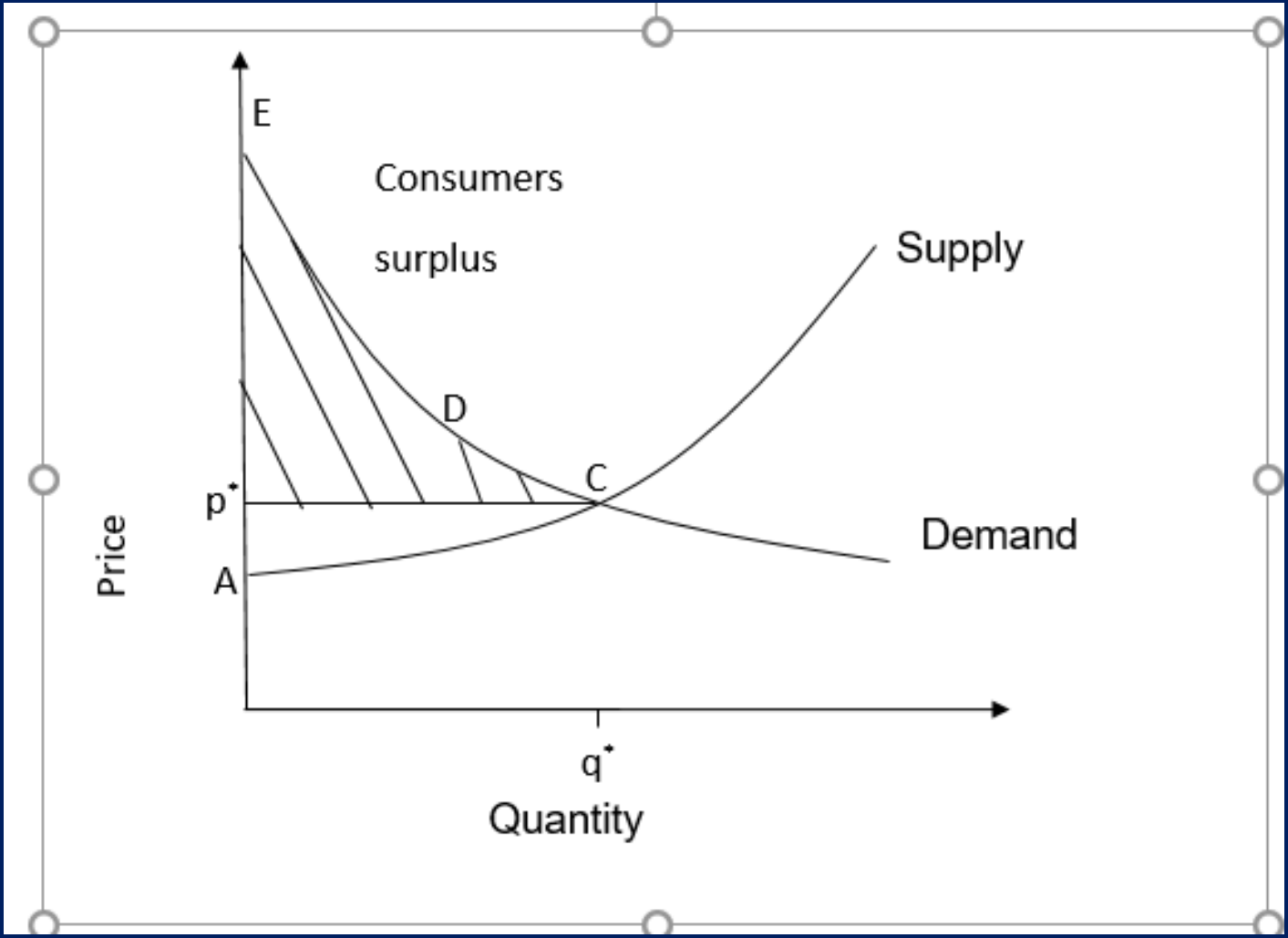
The problem with the arguments against all of these proposals for more pollution in LDCs (intrinsic rights to certain goods, moral reasons, social concerns, lack of adequate markets, etc.) could be turned around and used more or less effectively against every Bank proposal for liberalization

Consumer/ Producer Surplus



Source: Kolstad, 1999

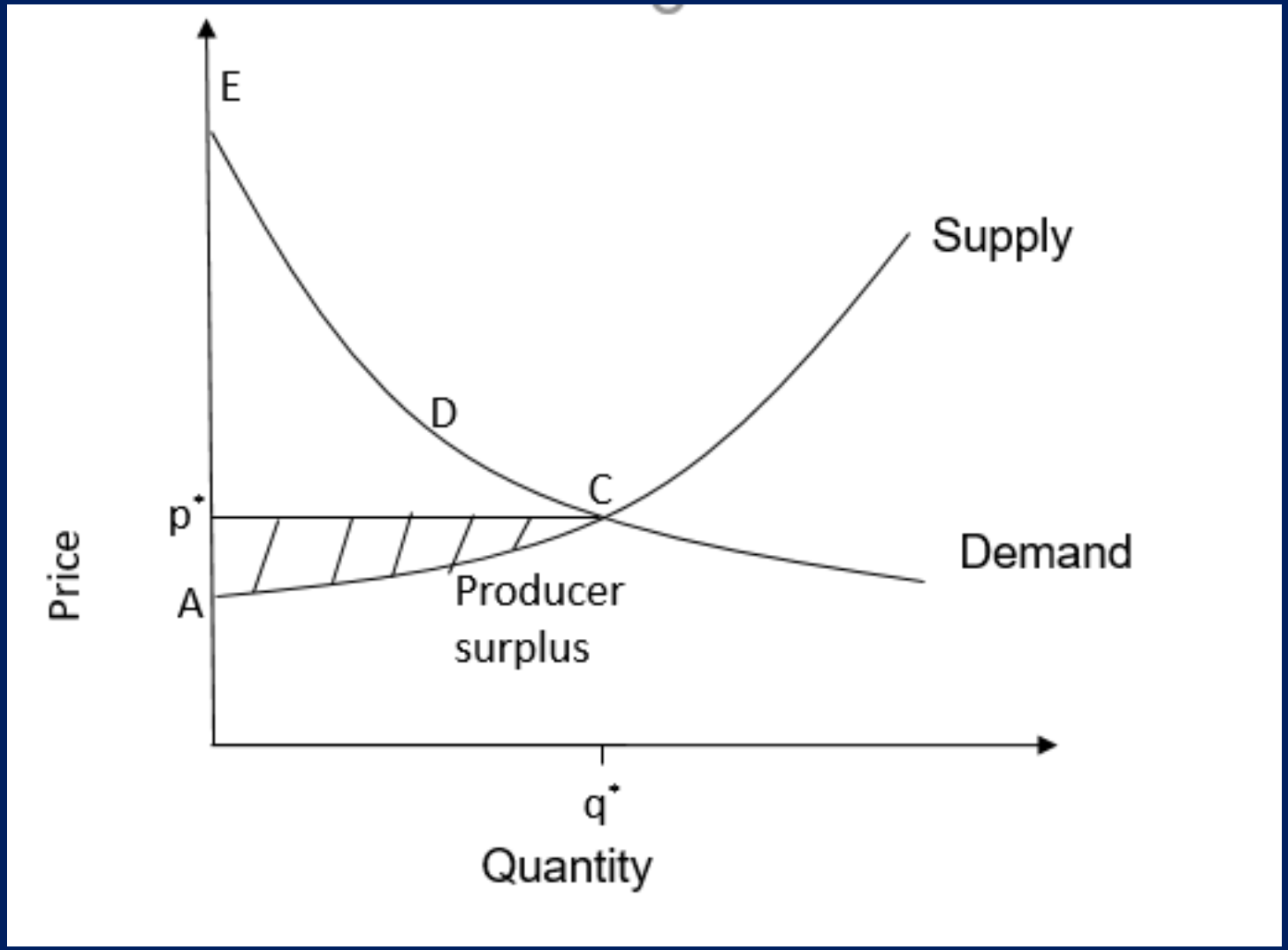
Consumers surplus



Consumer Surplus

- Consumption of q* units for a consumer
- Area between demand curve and the horizontal line p= p* (between q =0 and q=q*)

Producers surplus



Producer Surplus

- Production of q* units for a producer
- Area between the horizontal line p= p* and the supply curve (between q =0 and q=q*)

First Theorem of Welfare Economics

In a competitive economy, a market equilibrium is Pareto optimal

Second Theorem of Welfare Economics

In a competitive economy, any Pareto optimum can be achieved by market forces provided the resources of the economy are appropriately distributed before the market is allowed to operate

Sample example

The supply curve for petrol in a country is given as P=10+ 2Q . The demand curve for petrol is given as P= 100- 4Q where P is the price in Rs/ litre and Q is the Quantity (in appropriate units say million tonnes).

Plot the supply demand curves and determine the equilibrium price and quantity. What is the consumer surplus and the producers surplus?- show these on the plot

- If the government decides to fix a price of Rs 50/ litre, explain what happens to the consumer and producer surplus? Is this price fixing efficient?

References

- Charles Kolstad, Environmental Economics, Vol. 1, Oxford University Press (1999).
- Charles Kolstad, Environmental Economics, second edition, Oxford University Press (2011).
- Webb, The Economics of Energy
- Our Words: The Lawrence Summers Memo, December 12, 1991.