Professional Career Program

Environmental Economic Theory No. 5

Benefits and costs analysis: how to measure benefits.

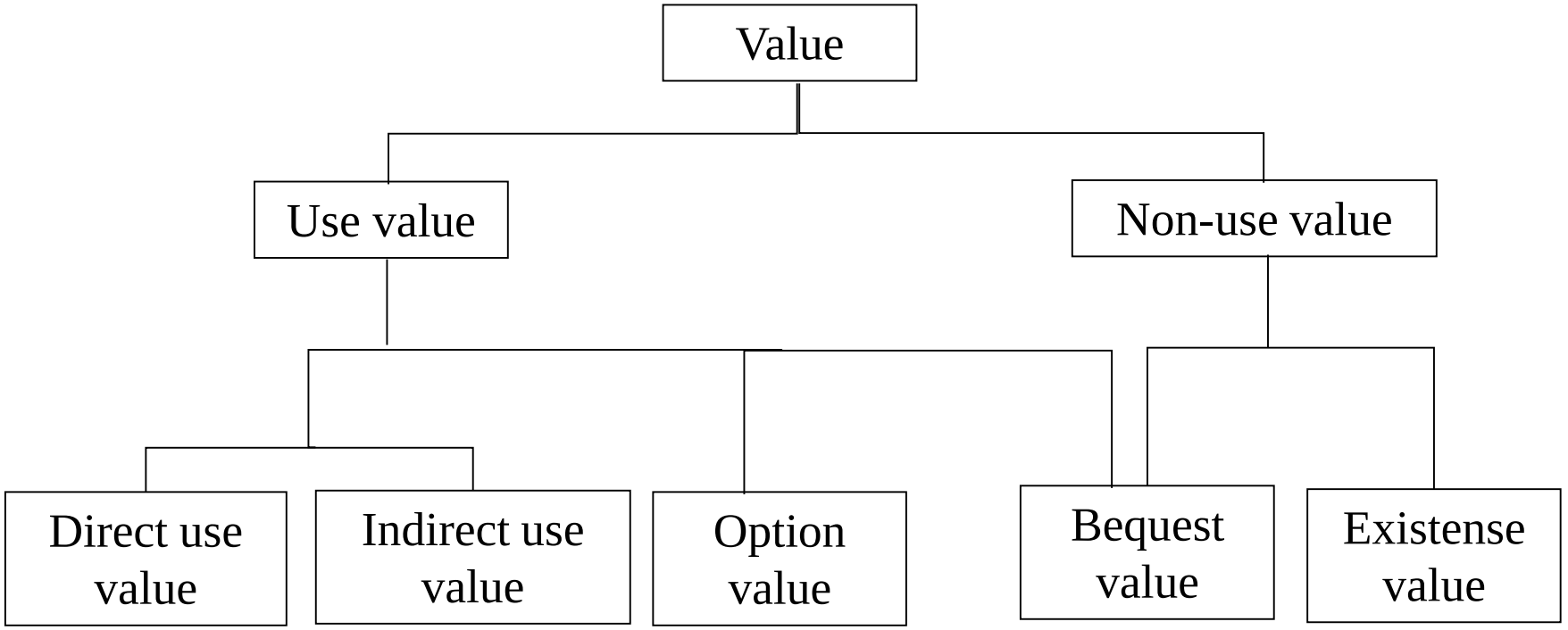
Instructor: Eiji HOSODA

Textbook: Barry .C. Field & Martha K. Fields (2009)
Environmental Economics - an introduction,
McGraw-Hill, International Edition

PCP Environmental Economic Theory (Hosoda)
Homework 6
30 October 2018

1. Theme: What is a scheme of tradable emission permits or entitlements? Describe how it works and point out its merits and demerits. How can it be applied to real environmental issues? For better understanding, use a concrete example or experience, hopefully, in your own countries if it is introduced.
2. Language: English.
3. Volume: A4 two pages. Single space. 12 points.
4. Submission period: 9 a.m. 5 November ~ 6 November 2018.
5. Submission: Submit your paper in a pdf file. A file name must be "HW6.xxx.pdf" (xxx=your name). Send your file to hosoda@econ.keio.ac.jp.
6. Remark: Sources other than internet documents are recommendable. If you use internet information, check plural sources and compare them. List references you have used.

Before going to the details
What is *value*?



Turner, R.K., D. Pearce, and I. Baitman (2001) *Introduction to Environmental Economics*.

Explanation of value of natural environment

- Direct use value: value which comes from direct utilization of services of natural environment
- Indirect use value: value which comes from indirect utilization of natural environment, through the external economy that it provides
- Option value: value which comes from preserving the option to utilize services of natural environment in the future
- Existence value: value which comes from the pure existence of natural environment
- Bequest value: value which comes from the welfare that the natural environment may give future generations

Scarcity and value

- The notion of scarcity is a very important concept in economics.
- It means that there is not sufficient amount of goods or services which satisfy human wants or needs.
- In other words, there is a close relationship between scarcity and value.
- Actually, value is basically determined mainly by scarcity.

Scarcity and value (cont.)

- As the degree of scarcity increases, value also increases.
- If there is no scarcity for some resources, their value may possibly be zero.
- There is something which is indispensable for human beings and so precious in this sense, but is not scarce, and whose value is supposed to be zero.
- A good example is air.

Value and market price

- If goods or services are marketable, market prices reflect their value and thus scarcity.
- Obviously, some goods are not marketable so that scarcity is not reflected in economic transaction.
- Environmental goods or resources are a good example.

The aim of today's lecture

- It was revealed that benefits of something are nothing but what people are willing to pay for it.
- As for a private good, willingness to pay for it is realized as a price in a market.
- There is no market price for environment quality, since there is no market for environmental quality.
- Then, how can we estimate willingness to pay for environmental quality?
- Without the estimation of willingness to pay for environmental quality, there should be no proper policy to keep or enhance environmental quality.

Some remarks

- Even if no one expresses WTP for something in natural environment, it has scarcity value, since it may have existence value.
- Existence value is not measured by WTP in many cases.
- One may not express any WTP for a snake, it surely has existence value.

Some remarks (cont.)

- Even a price of an ordinary commodity does not reflect scarcity on a certain occasion.
- Speculative purchase of a commodity disturbs a market, making a gap wider and wider between its scarcity and the market price.
- A Hunt brothers' case is a good example.
- In the late 1970's, they bought up a huge amount of silver in a speculative way, expecting gain of sales soon after the buying.

Some remarks (cont.)

- Just after their buying up of a huge amount of silver, its price rose abruptly.
- Soon after that, it fell down and went back to the former level of price.
- Apparently, the abrupt rise and down of a silver price is nothing to do with scarcity of silver.
- They were caused by Hunt brothers' speculative investment on silver.

Damages and

- It may sound strange if one says that benefits of environmental could be measured by damages.
- Indeed, it could be.
- But how?

The damage function

- The benefits of environmental quality are measured by reduction of damages.
- Negative damages equal positive benefits, and vice versa.
- Thus, if we can measure the environmental damages, we may say that the benefits can be measured also.
- The measurement of the environmental damages needs epidemiologists' work in many cases. This is often a hard work.

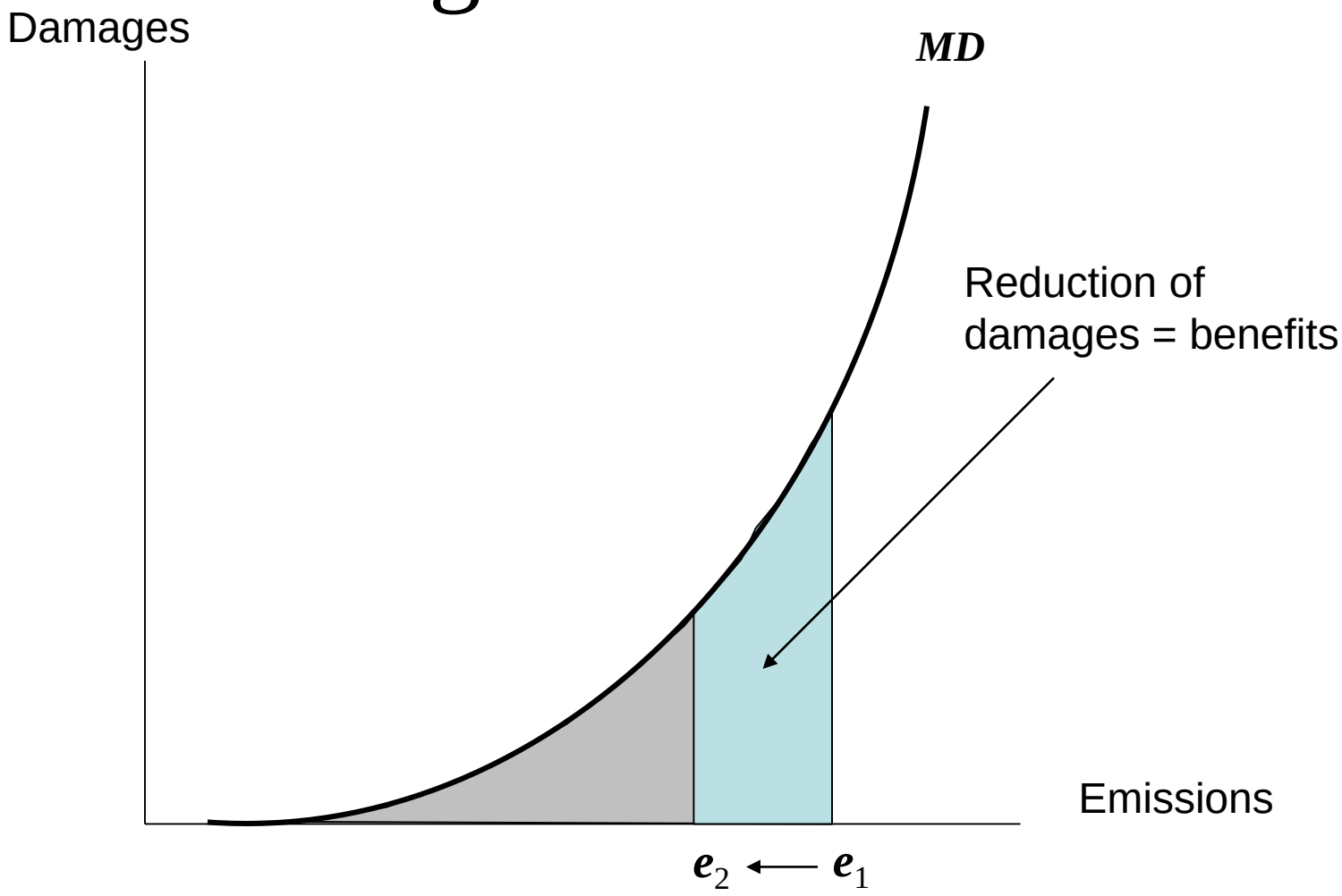
Epidemiologic works (1)

- Very often, epidemiologic works are important for solving pollution problems.
- A rigorous scientific *proof* is infeasible, and not required for identifying a polluter in quite a few environmental problems.
- This does not mean that epidemiologic works do not have scientific validity.
- On the contrary, it can show how the relationship between cause and effect is identified by a scientific manner.

Epidemiologic works (2)

- A rigorous scientific proof is infeasible in quite a few pollution cases, since it is almost difficult to examine rigorously the relationship between cause and effect of pollution.
- Laboratory experiments are often not applicable to actual pollution cases.
- To save pollution victims, it is considered sufficient to confirm that probability of adverse effects caused by pollution is sufficiently high.

Explanation by means of a figure: damages and benefits



Example

- Suppose a marginal damage function is expressed as $f(x) = x^2$. (The total damage function is expressed as TD = $(1/3)x^3$. (Why?)
- Suppose that the amount of emissions is reduced from 2 to 1, then {(8/3) – (1/3)}=(7/3) units of benefits are obtained by the reduction of external diseconomy or damages.

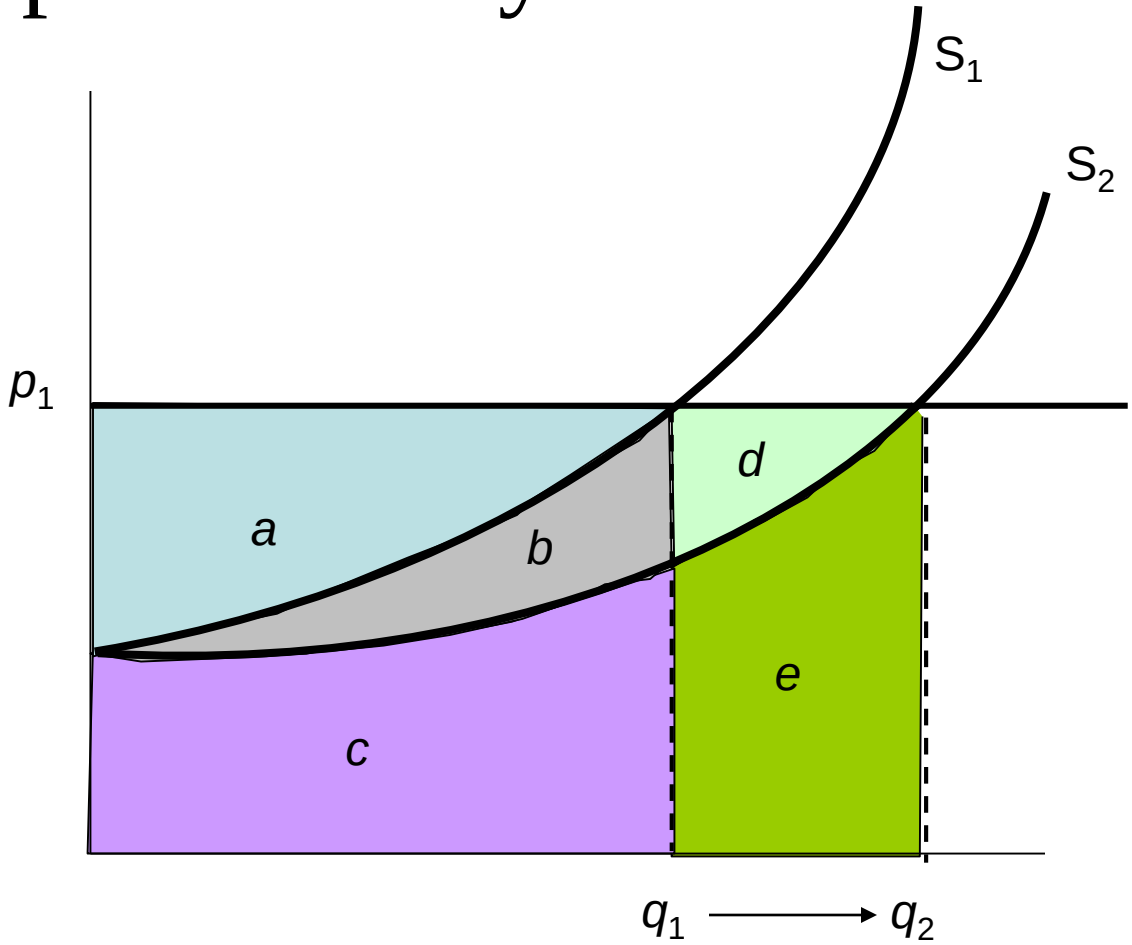
Measuring damages directly

- Damages are, in some pollution cases, measured by the cost of illness (COI), which consists of direct and indirect costs.
- According to this approach, the environmental benefits are measured by the reduction of health-related costs.
- The improved health may, however, produce other benefits than the reduction of the costs.
- COI may underestimate increases in benefits.

The effects of pollution on production costs

- As environment is improved, not only human health but also economic conditions are improved.
- Thus, if pollution is prevented somehow, the production costs are possibly reduced.
- As environment is improved, production may be promoted further than before.
- The net benefits will surely be increased.
- Hence, an economy and environment go together in such a case.

Explanation by means of a figure



But we need much information to know the shift of the MC curve.

As environmental quality increases, the marginal cost curve shifts downward. Then, profits increase by the amount of (b + d). Since it is not so easy to measure the marginal costs, the increased profits may be approximated by of (d + e) or $p_1(q_1 - q_2)$ instead of (b + d).

An Exercise

- Suppose that the marginal social cost function shifts down from $MC_1 = 2 + 2x$ to $MC_2 = 2 + x$.
- Moreover, suppose that the price is 4.
- Then, how much benefits are gained from this improvement of environment?

Material damages

- There are other benefits when environmental quality is improved.
- Scenic beauty may also be improved.
- Historical heritages may be maintained much better than before.
- As the amount of acid rain was decreased, the speed of corrosion of bronze statues became slower.

Problems with direct damage approaches

- The direct damage approaches are incomplete.
- Theses approaches only count benefits which are measured in markets.
- Therefore, non-market values cannot be measured by these approaches.
- Clearly, non-market value *is* very important when we talk about environmental improvement.
- Another problem with these approaches is that people may change their behaviors and adjust to environmental pollution.

Willingness to pay, again!

- It must be remembered that benefits can be expressed by willingness to pay.
- Particularly when measurement of non-market value is crucial, we had better estimate willingness to pay somehow.
- There are mainly three methods to estimate willingness to pay.
- Estimation of substitutes (averting costs)
  Estimation of price differences which reflect environmental quality (hedonic method, travel cost approach)

  Estimation by survey (contingent valuation method).

Averting costs

- Value of environmental quality can sometimes be measured by averting costs.
- Averting costs, which are used for keeping environmental quality, are *revealed* value in markets.
- They may underestimate the real value when they are applied to measurement of human health.
- The amount of averting costs depends on income levels.

The value of human life as expressed in wage rates

- People sometimes say “human life is beyond measurement”.
- Yes, it is true. But we often make decisions which affect our health or life.
- Some people choose risky business with higher wage rate.
- They are revealing their willingness to pay for health or even life, getting more money.
- Then, willingness to pay can be measured by differences of wage rates.

Value of *statistical* life (VSL)

- This does not express any value of life in moral senses.
- Statistically economic value of life can be estimated; industrial wage rate studies.
- The wages are relatively low in safer industries, and relatively higher in risky industries.
- The wage rate studies have revealed VSLs, which are expressed in broad ranges.

Some remarks (1)

- There are many factors which affect wage differences.
- It is hard to identify the factor which *precisely* measures VSLs.
- For example, regions, technology, corporate governance and so on matter.
- There may not be sufficient data to measure VSL.

Some remarks (2)

- Therefore, VSL cannot be a precise index of economic value of life.
- Yet, it can be a reference point which shows us how one can accept risk for higher wages.

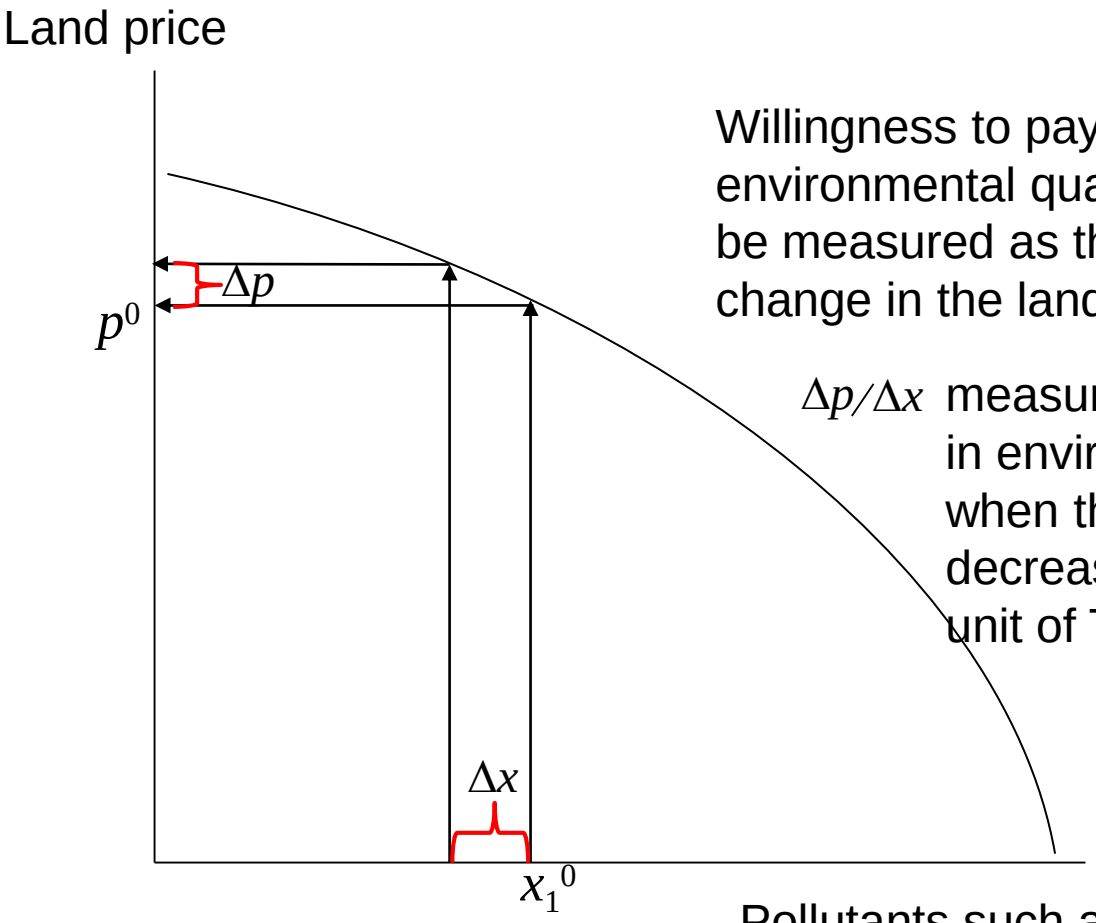
A. Hedonic analysis (1)

- A price sometimes reflects many characteristics which are embodied in goods or services.
- Particularly, a price of land is considered as a function of its characteristics.
- Then, the price of a certain land may be expressed as $p_L = \phi(x_1, x_2, \ldots, x_n)$.
- Suppose is x_1 environmental quality, and x_2, …, x_n are other qualities.

A. Hedonic analysis (2)

- If there are sufficient number of observations so that only x_1 is regarded as a control variable, other variables being constant.
- This means that we can estimate p_L as a function of only x_1, namely environmental quality.
- Hence, we can measure the willingness to pay for environmental quality.

Explanation by means of a figure



Willingness to pay for environmental quality can be measured as the change in the land price.

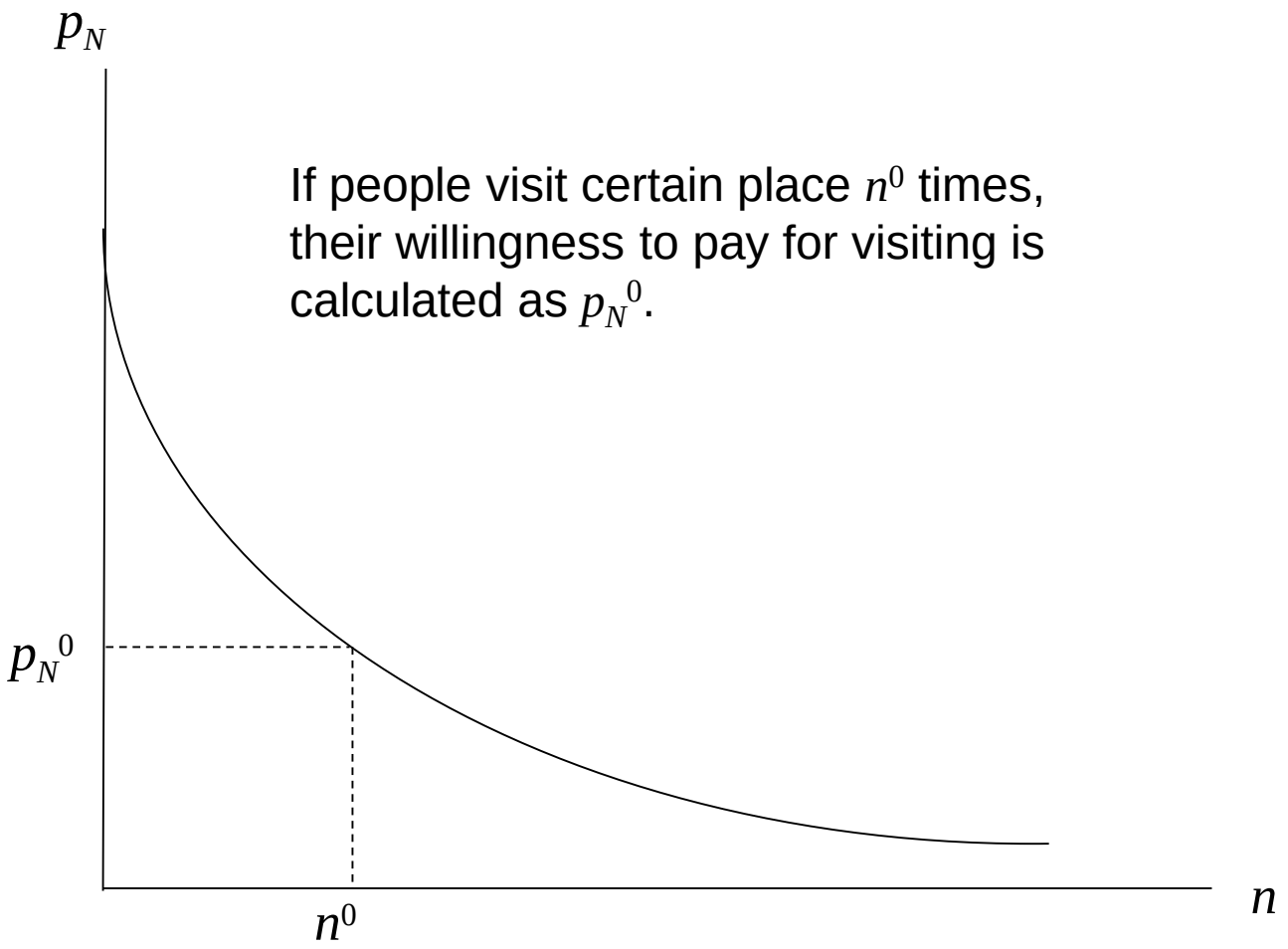
$\Delta p/\Delta x$ measures an increase in environmental value when there is a decrease by one small unit of TSP.

Pollutants such as TSP (Total Suspended Particulate Matter)

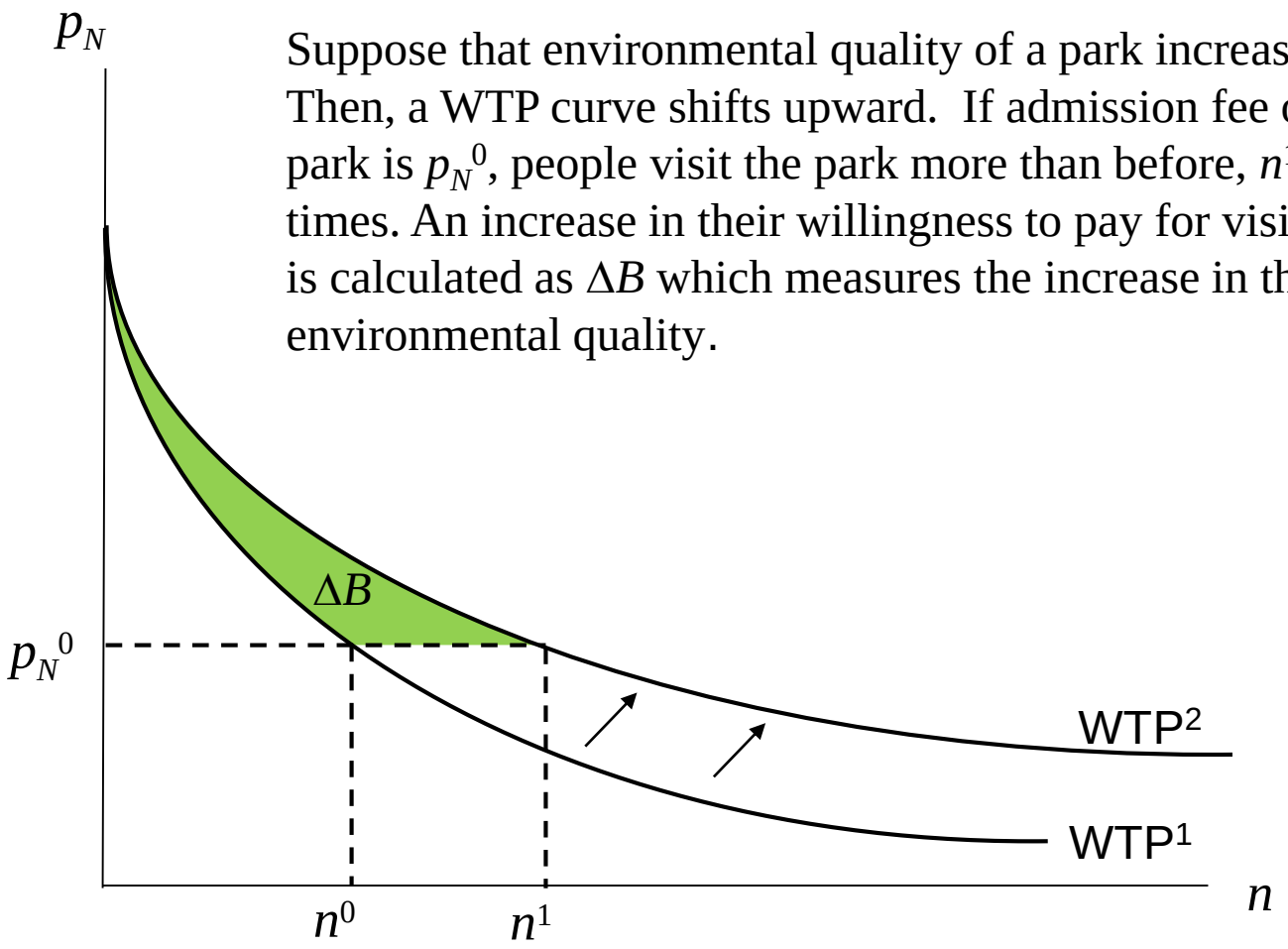
B. Travel cost approach

- Willingness to pay for environmental quality can be measured by travel costs.
- People go to countryside for their enjoyment, recreation and so on.
- To do so, they have to sacrifice time, giving up possible wages (opportunity cost).
- Then, we can consider that willingness to pay for environmental quality is revealed as the opportunity cost.

Explanation by means of a figure (1)



Explanation by means of a figure (2)



Suppose that environmental quality of a park increases. Then, a WTP curve shifts upward. If admission fee of a park is p_N^0, people visit the park more than before, n^1 times. An increase in their willingness to pay for visiting is calculated as ΔB which measures the increase in the environmental quality.

C. Contingent valuation method

- Is it possible to make people express their willingness to pay for environmental quality?
- Well-designed questionnaire can satisfy some conditions which guarantee to elicit rather accurate expression of willingness to pay.
- This method is now widely utilized as a method of measurement of environmental quality. (*Eg*. The Exxon Valdes case.)

The Exxon Valdes case

- The Exxon Valdes which carried crude oil was stranded near Alaska, and spilt quite a big volume of oil in 1989.
- Roughly 1.1 million gallons of oil spilt and polluted the Prince Williams Bay.
- It is said that the nearby ecosystem was destroyed very seriously.
- The total damages were estimated by means of CVM.

The Exxon Valdes case

Recent situation

- In professional journals, many articles which deal with CV analysis have appeared.
- The method has been used for policy decision making in many countries.
- There are proponents for this method as well as opponents against it.
- The late Peter Bohm, a very famous Swedish environmental economist, had once told me that this method would die out soon.

What is the problem?

- Can people express their willingness to pay precisely or honestly?
- It is almost impossible for them to have sufficient information on the place for which they are asked to express their valuation.
- They cannot express the exact amount of money since they do not face real budget constraint.
- There is also a free-rider problem.

Willingness to pay vs. willingness to accept

- Sometimes, willingness to accept is used as valuation for environment.
- People are willing to accept some environmental degradation if they are compensated.
- This amount of money may be interpreted as environmental valuation.
- Willingness to accept is often much larger than willingness to pay, partly because there is no budget constraint for the former case.