

**ATOC 1060-002**  
**OUR CHANGING ENVIRONMENT**  
**Class 26 (Chp 16)**

**Objectives of Today's Class:**

- [1] Policies to slow global warming (continued);**
- [2] Economic consequences of global warming.**

# **[1] Policies to slow global warming**

**Specific policies that might be adopted to promote non-fossil energy sources:**

**a) Governmental regulations: USA, CAFÉ (Combined Automobile Fleet Emissions) - fuel efficiency requirement must be met.**

**b) A carbon tax on energy source that produces CO<sub>2</sub>.**

## **[2] Economic consequences of global warming**

**Previously, we focused on global warming; its effects on global climate, sea level, ecosystems.**

**Current policy debate: what possible economic consequences can be resulted from these changes.**

**Cost-benefit analysis: economic models**

**Benefit: example, CO<sub>2</sub> fertilization;**

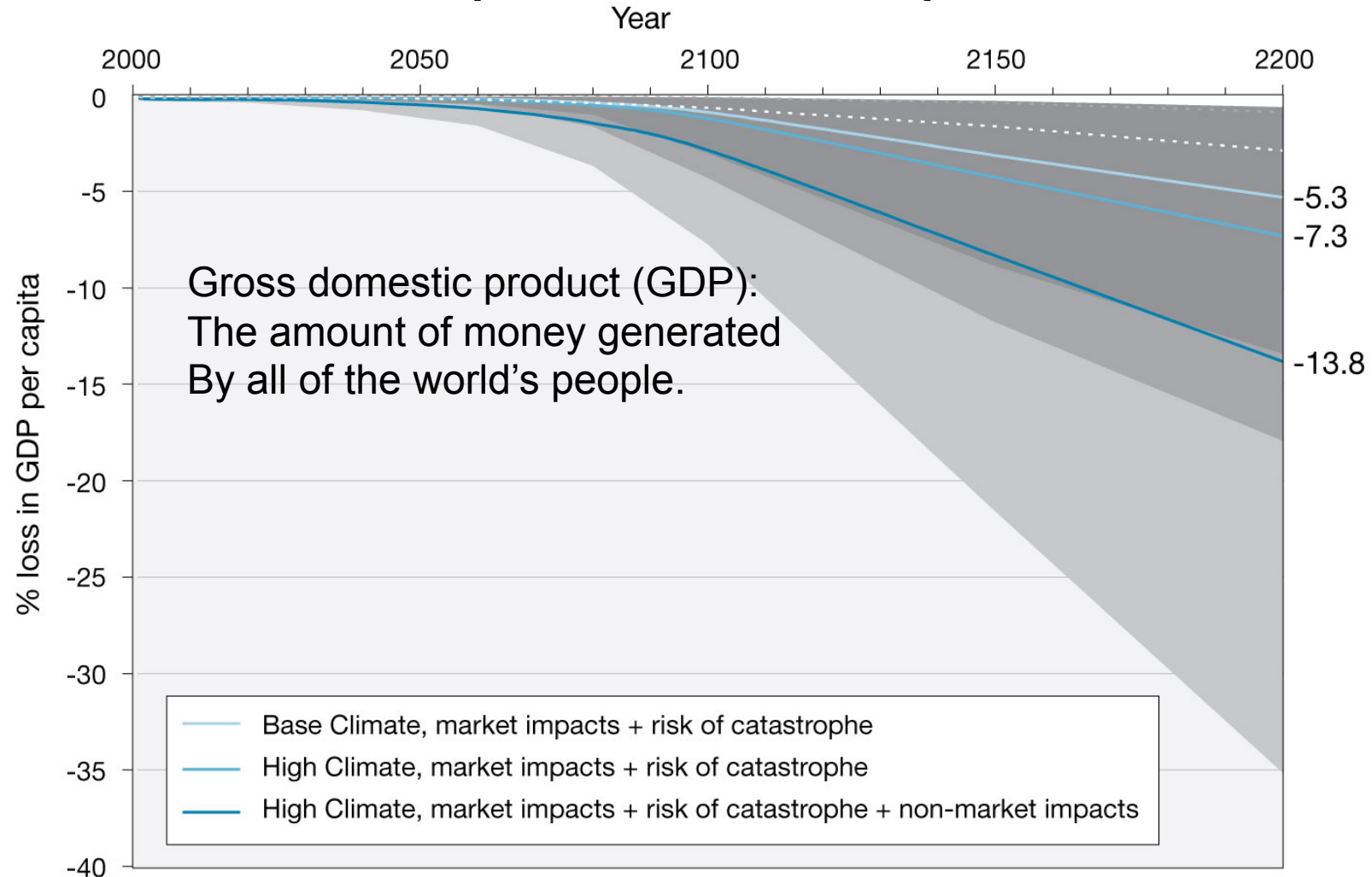
**Cost: sea level increase=> relocate population from coastlines; reducing CO<sub>2</sub> emission=> cost money.**

**=> Limiting climate change will cost.**

**Goal of economic models:  
(benefit - cost) reaches maximum  
Highly uncertain - more than climate  
models. Predicting human behaviors  
is more difficult than predicting  
physical systems. Includes value judgment.**

**Still can be used as a guide.**

# a) The Stern review on the economics of global warming



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British report: led by economist Nicholas Stern: 5-30% loss of GDP per capita.  
Yale: William Nordhaus disagrees with Stern: Economic discounting different!

## b) Economic Discounting

**In economic models of global warming, key question: How much should we pay now in order to avoid damages that may be incurred in future?**

**Global warming - slow process; large damage- more than 100 years later.**

**In a typical cost-benefit analysis, future damages or benefits are discounted at a rate of as much as 10%.**

**A benefit of \$100 that is realized 1 year from now is valued at only \$90.91 [= \$100/(1+0.1)].**

**Discount rate takes into account: (1) save, could invest to make a profit (called growth discounting); (2) would rather have a dollar today than a dollar 10 years later (after adjustment of inflation); called time preference discounting.**

**A typical cost-benefit analysis, future damages (or benefits) are discounted at ~3%/year. (some uses 7%~10%/year)**

**Use 3%, \$100 benefit (damage) now:  
1 year later, valued at  $100/(1+3\%) = \$97$ ;  
50 years later, valued at  $100/(1+3\%)^{50} = \$23$ ;  
200 years later, valued at \$0.27.**

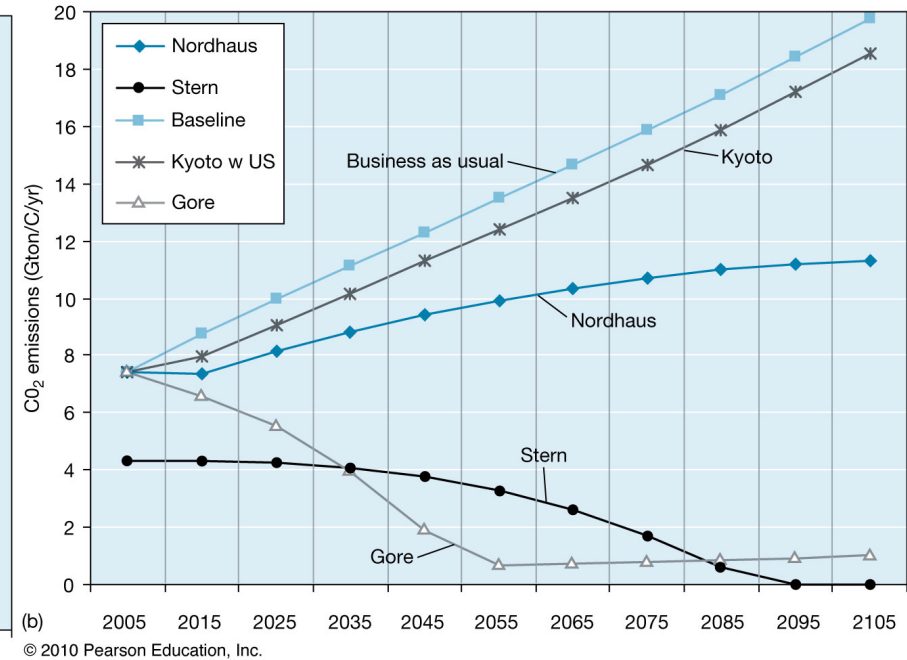
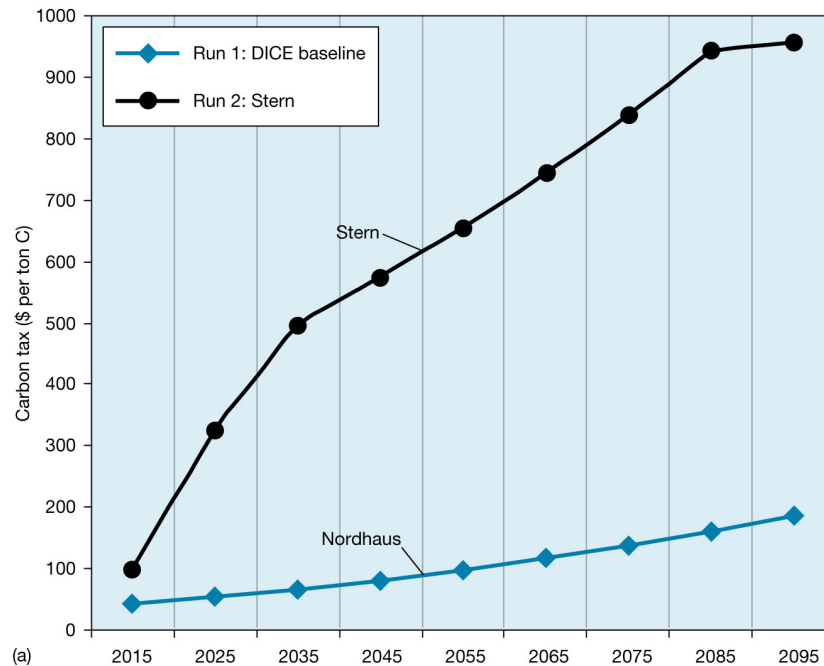
**Even catastrophic change were predicted 200 years later, and the damages could be real and could be large in real economic terms, but time preference discounting ensures that they would be **essentially neglected**.**

**Problems: time preference discounting ~ apply to short Term economy; Does it also apply for long term?**

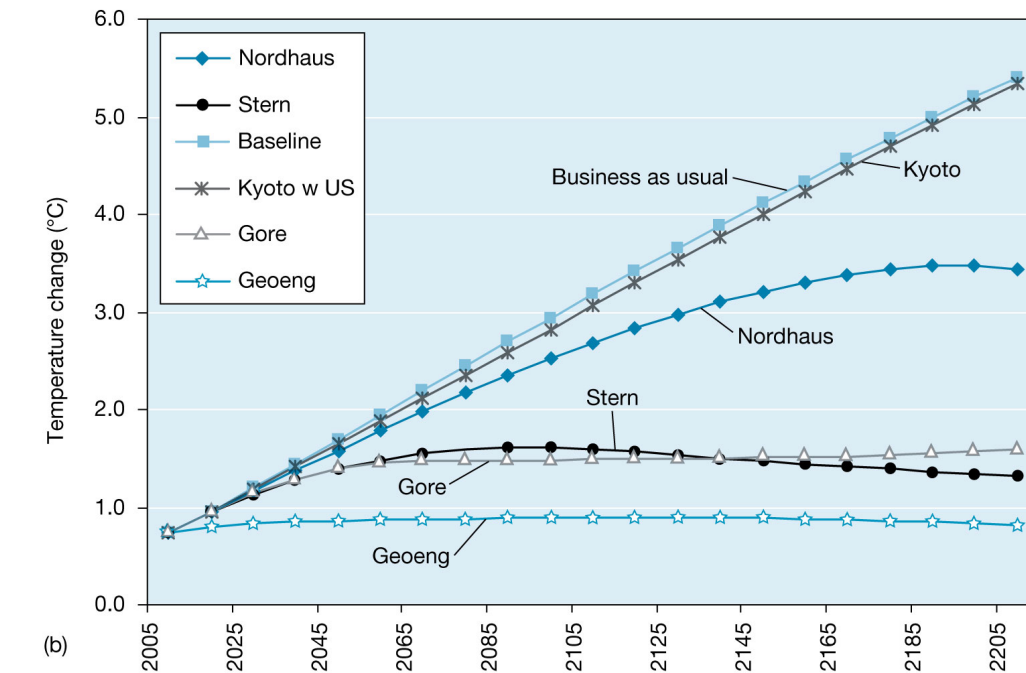
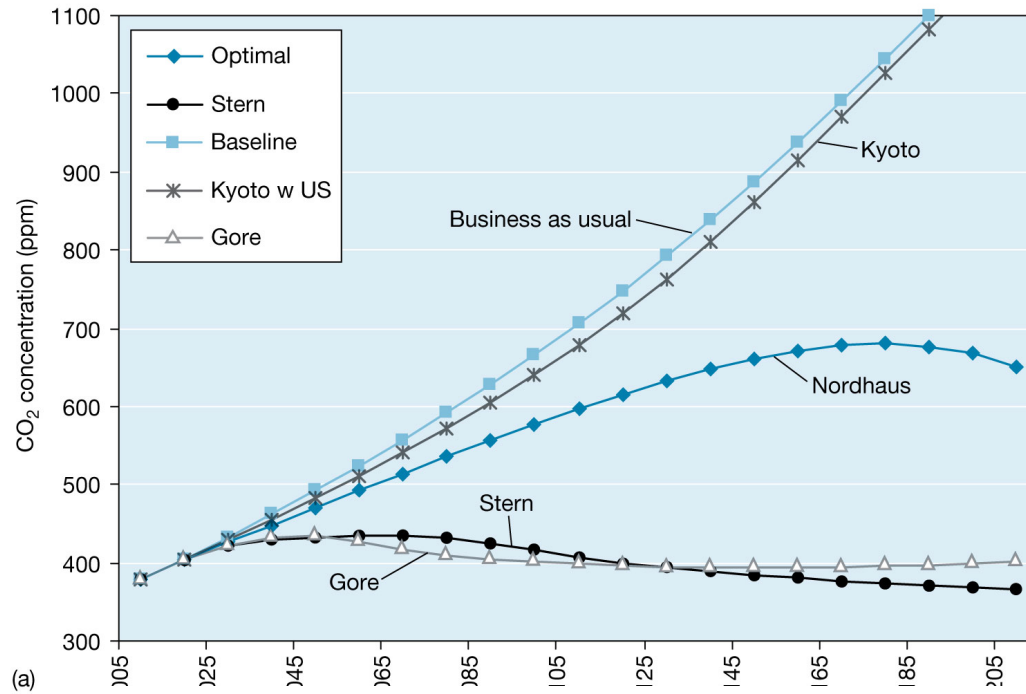
## c) cost-benefit calculations with different discount rates: Nordhaus versus Stern

**Nordhaus: Dynamic Integrated Climate-Economy (DICE)**

**Model: very simple economic model – includes factors such as population increase, new technology development, and climate change.**







Business-as-usual: CO<sub>2</sub> emission: 8Gton(C )/yr today to 20Gton(C )/yr in 2100;

Nordhaus's: holds to less than 10 Gton(C )/yr and declines back to 6Gton(C )/yr in 2100;

Gore's proposal: less than 1 Gton(C )/yr in 2050 and hold them there indefinitely;

Stern's: reduce emissions somewhat more slowly than Gore's, but achieve even lower emission levels than Gore's.

Policies to achieve Gore and Stern's proposals?

Is Nordhaus's proposal enough? Are the economic damages estimated correctly?

# Clicker question 1

**Choose the most accurate statement.**

- A. Economic models have larger uncertainties than the climate models;**
- B. Existing economic models quantitatively agree;**
- C. The maximum (benefit – cost) analysis based on economic models suggest that may be we should limit global warming by carbon tax;**
- D. Both A and C;**
- E. All of above.**

# Clicker question 1

Observations show that:

- (a) Atmospheric CO<sub>2</sub> has been increasing from 1850 to 1990 and then has kept constant since 1990;
- (b) Like CO<sub>2</sub>, the Earth's temperature has been persistently increasing from 1860 to present;
- (c) The Earth's temperature had decreased somewhat during the 1970s;
- (d) Both CO<sub>2</sub> and the Earth's temperature had decreased somewhat during the 1970s.

# Clicker's question 2

Choose the correct statement.

- (a) Our present climate is in glacial period;
- (b) Our present climate is in interglacial period;
- (c) Even before the industrial age, atmospheric  $\text{CO}_2$  concentration increased along with the increase of the Earth's temperature.
- (d) Both (b) and (c).

# Clicker's question 3

Generally, right after the large volcanic eruptions, the earth's surface temperature:

- (A) Increases due to increased CO<sub>2</sub>;
- (B) Decreases due to decreased CO<sub>2</sub>;
- (C) Stays unchanged;
- (D) Decreases due to increased SO<sub>2</sub>;
- (E) Increases due to increased SO<sub>2</sub>.

# Clicker's question 4

Choose the correct statement:

- A. The earth's atmosphere is an efficient absorber of visible light;
- B. The earth's atmosphere is an efficient emitter of visible light;
- C. The earth's atmosphere is an efficient emitter of infrared radiation;
- D. The earth's atmosphere is an efficient emitter of UV.

# Clicker question 5

**Increased sea ice formation in North Atlantic region**

- [a] decreases sea surface salinity and thus weakens global thermohaline circulation;**
- [b] increases sea surface salinity and thus enhances global thermohaline circulation;**
- [c] increases albedo and reduces ocean to atmosphere heat flux, therefore cools the earth and its atmosphere;**
- [d] does not affect salinity and thus does not change thermohaline circulation;**
- [e] both [b] and [c].**



# Clicker question 6

**Choose the correct statement:**

- (A) The warm mesozoic resulted mainly from the high concentration of atmospheric CO<sub>2</sub>;**
- (B) The warm mesozoic resulted mainly from the high concentration of atmospheric CH<sub>4</sub>;**
- (C ) The low polar-equator temperature contrast in mesozoic resulted partly from polarward extension of Hadley cell.**
- (D) Both (A) and (C ).**

# Clicker question 7

**Choose the correct statement:**

- A. The last major glaciation occurred in Pleistocene (1.8 m.y. ago);**
- B. The maximum extent of the last continental glaciation occurred in ~21,000y. Ago;**
- C. The Holocene climate is basically stable and had small amplitude variability;**
- D. In the past 100 years or so, global mean temperature increase generally agrees with the increase of CO<sub>2</sub>;**
- E. All of the above.**

# Clicker question 8

**Choose the correct statement.**

- a. Northern hemisphere reforestation reduces atmospheric CO<sub>2</sub> concentration;**
- b. Deforestation acts to reduce atmospheric CO<sub>2</sub> concentration;**
- c. Silicate weathering is the most permanent, slowest process that removes atmospheric CO<sub>2</sub>;**
- d. Both a and c.**

# Clicker question 9

**Choose the correct statement.**

- a. IPCC projection of future (next 100 years) atmospheric CO<sub>2</sub> concentration shows a decreasing trend;**
- b. IPCC projection of future atmospheric CO<sub>2</sub> concentration shows an increasing trend;**
- c. CO<sub>2</sub> is the only factor that affects future climate change;**
- d. Methane and nitrous oxide have negligible influences on radiative fluxes.**
- e. Both b and d.**

# Clicker question 10

**Global warming can**

- A. cause changes in speciation within forests;**
- B. increase the growth of certain types of plants;**
- C. cause the spreading of tropical insects and diseases to mid-latitudes;**
- D. all of the above.**