

## THE ECONOMICS OF CLIMATE CHANGE

### Questions

- What are the impacts of climate change?
- 2. How should they be addressed?
- 3. How will the magnitude and timing of climate change be affected?

### **(1) Studies on Economic Impacts of Climate Change On agriculture**

- Results of economic studies depend on scientific knowledge. Scientific uncertainties => economic impact uncertainties.
- There are several lines of modeling. They differ in:
  - Incorporation of uncertainty
  - Incorporation of variability and spatial heterogeneity.

### Modeling Approach

#### a. Hedonic Price Models (Mendelsohn, AER).

##### Premise:

- Impacts of climate change will be reflected in asset values.
- Current asset prices can be used to estimate the price sensitivity of land values to changes in climate parameters.

- Various assumptions about changes in climate conditions are used to estimate impacts of climate change on land values.

b. Programming Simulations (Adams, McCarl)

Premise:

- Agronomic estimates of impact on climate change on yields and cost at different locations under various conditions are used to estimate changes in land use choices at various locations.
- Optimal output supplies and input demands are computed using the land-use estimates.
- Equilibrium prices, output levels, and profits for different regions are then derived.
- Assumptions about international trade price supports vary among studies.

c. Stochastic Simulations (Segerson-Riley)

- Consider impacts of estimated changes in means and variability indicators (e.g., impacts of climate change on average temperature and distribution of seasonal and daily temperatures) on yields and profitability at various locations.

d. Regional Case Studies (Doering)

- Interdisciplinary--combine quantitative estimates with expert interviews to assess response to changes.

Lessons:

- Without considerations of variability, overall impacts of climate change are not overwhelming (a 5 to 15 percent increase or decrease in agricultural income and profitability of agriculture).
- Distributional impacts may be much more significant than overall effects.

- Production patterns will shift 100-200 miles northward.
- Impacts in the middle of regions will be smaller than in the periphery.
- The livestock sector is more likely to lose, while crops may gain.
- Water resources will become more valuable.
- Uncertainty about climate change will slow investment in vulnerable regions and enhance value of projects that will dampen the impact of climate change.
- The value of climate monitoring and predicting technologies as well as value of water-saving technology increases.
- Possible increases in seasonal and daily variation in weather may lead to significant income losses.
- Snowmelt will increase flood risks and worsen seasonal supply of water.
- Relocation and adjustment costs may be significant.
- The cost of adjustment depends on speed of change. Gradual changes can be handled easily; brisk changes are a source of concern.

#### Limitations of Current Research

- Underemphasis of research on global agricultural impacts of global climate change. How will climate change affect trade and LDCs?
- The interrelation between climate change and population growths has not been studied. The combined effects are especially worrisome. For example, water problems are a source of concern regardless of climate change.
- Shortages and crises lead to technological and institutional innovations. These cannot be foreseen, and they may lead to overestimation of some costs.

## **(2) How Climate Change Impacts Should Be Addressed**

- Major impacts:
  - Rising sea level
  - Desertification

There are understudied issues with many “thorny” problems, e.g., institutional and policy solutions to flooding and related problems.

Response to climate change will include:

- Changes in investment and capital formation policies.
- Investments that reduce negative impact of climate change should be encouraged.
- Investments that enhance negative impacts should be curtailed.
- Emphasis on increased R&D to develop resource-conserving technologies and improved monitoring technologies.
- Emphasis on adaptive management.
- Emphasis on policies aimed to delay climate change.
- No regret policies.

## **(3) Policies to Delay and Dampen Climate Change**

Premise:

(a) Individuals and firms respond to incentives.

-Shortages lead to innovation of resource-conserving technologies.

-Shortages lead to adoption of such technologies.

- Shortages lead to institutional innovations.

Examples:

(1) California droughts

- Adoption of modern irrigation technologies
- Introduction of water banks

(2) Energy crisis of 1970 leads to

- Improved fuel efficiency
- Smaller cars

(b) Three types of pollution control incentives:

- Taxes
- Subsidies
- Transferable permits

- Producers overwhelmingly object to taxes.
- Subsidies may be misused.
- Transferable permits are most acceptable politically.

They require:

- Establishing aggregate targets.
- Pollution reduction.
- Verifiable products to be traded.

- Initial allocation is a major issue.
- There is conflict between developing and developed countries.

Obstacles to Kyoto Agreement and Water Trading

- Developing countries (LDCs) foresee growth in their own emission and view curtailment of emissions as barriers on growth.
  - Developing countries may be more concerned with the present (higher discount rate) than the future and take higher future climate risks.
  - LDCs will refuse to cooperate early as part of a bargaining strategy. They want their effort to be subsidized.
  - Implementation of trading in carbon sequestration rights is difficult.
1. Monitoring of emissions is a major measurement problem. Proxies are needed.
  2. Proxies are not accurate. Relationships between practices and CO<sub>2</sub> emissions or sequestration's in random vary across locations.
  3. Determination of proxies is linked to other policy problems:
    - Political pressure to support agriculture.
    - Other environmental policy issues (waste management).
    - Transition to “landscape” incentives.
  4. Technological change and new knowledge may suggest frequent reassessment of proxies and their value.
  5. What about controlling methane and other substances?

### Conclusion

- Global change is a threat that needs to be monitored and controlled.
- Contingency responses and worst case scenarios have to be studied.
- New technologies have to be investigated.
- Flexible mechanisms for reduction of global change taxes have to be introduced as part of a larger environmental and resource policy framework.

- The cost of climate change is uncertain, but we can affect these by reasonable choices.

## **The Kyoto Protocol**

\* A framework to reduce global greenhouse gases

- Signing is voluntary.
- Enters into force when ratified by 55 countries.
- **Signatories** establish an upper bound on greenhouse gas emissions based on their 1990 emissions.
- The U.S. target is –7% of 1990 emissions.
- Japan’s target is –6% of 1990 emissions.
- EU target is –8% of 1990 emissions.
- **Russian and Ukrainian target is no reduction from 1990 emission level.**

Since the economies of these countries collapsed, their emissions are smaller than in 1990s. They have “hot air” that they can fill or sell.

- Costa Rica and Argentina and some Atlantic Ocean island countries are the only developing countries to sign the Kyoto Protocol. Many developing countries oppose it for several reasons.

-Some see it as “new colonialism.” They reason that they have not caused the mess and should not be constrained to repair it.

-They would like to establish clear criteria for emission limits that will be more favorable to lesser developed countries. For example:

-Each nation’s emissions limits would be proportional to its population.

-National emission limits are based on a formula that combines 1990 emission base and population size.

\* Trading in emission rights is allowed, although clarification of the rules of trading continues to be discussed. Some clearer rules were established at the Buenos Aires meeting. Some mechanisms of cooperation to reduce emissions include:

- Joint Implementation projects in countries that sign the agreement. Such projects may enable countries to invest in low cost emission reduction activities or provide a foundation for trading.
- Clean Development Mechanisms (CDMs) are emission reduction projects in LDCs that will provide credit to the developed nations that finance them.
- “Banking” is allowed but is limited to next period and restricted.
- Countries may form “Bubbles” to combine their targets. The U.S. and Russia may form a bubble. Obviously, the U.S. may pay Russia for its “hot air.”  
  
Russia and the Ukraine may receive tens of billions of dollars for their hot air.

\* Nations have sovereignty for domestic implementation. Nations are the basic accounting units, and they set appropriate strategies. Since nations are not cost minimizers, this may not lead to efficiency. Tools that may be used to reduce emissions include:

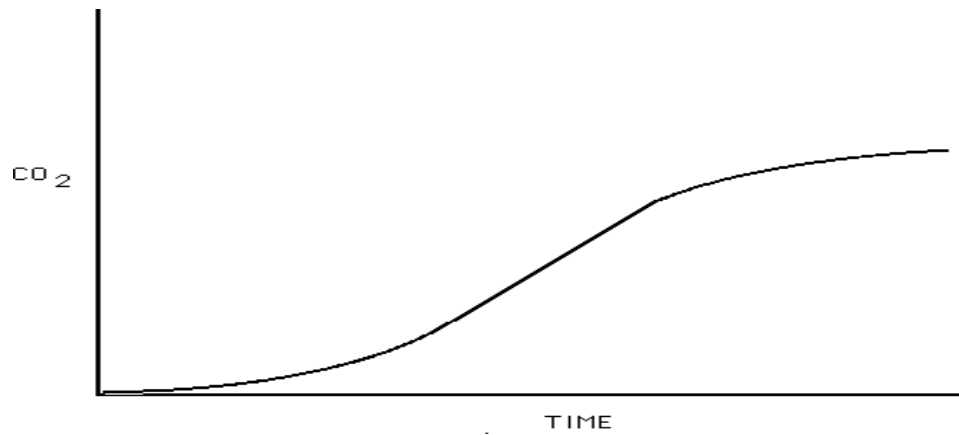
- Carbon tax.
- Internal tradable permits.
- Direct control of the technologies used by utilities.
- Subsidies for desirable activities.

\* Sink activities (that reduce  $\text{CO}_2$  in atmosphere) are subject to further discussion. They include:

4. Activities such as planting forests.
5. Activities of water resource management (feeding algae).
6. Activities of soil management

A key difficulty of implementation is establishing a benchmark (level in 1990). But when it comes to **sink** activities, measuring reduction is difficult.

The amount of  $\text{CO}_2$  a tree will absorb will change over time.



The tree may be cut—some of the CO<sub>2</sub> may return to the atmosphere.

- Accounting of CO<sub>2</sub> reduction based on individual activities is difficult. One needs accepted aggregate measures.
- The need for constant monitoring is also costly.
- In cases of soil management, there is five times more CO<sub>2</sub> in the soil than in the air (3 to 500 billion tons versus 700 billions tons). CO<sub>2</sub> is absorbed in the

soil (and plants) by planting grasses. Plowing releases soil CO<sub>2</sub> into the atmosphere. Such releases have been a major source of CO<sub>2</sub> emissions.

Remedies include:

- Reduction of intensive plowing.
- Transition to no tillage.
- Cover crops.

In addition to risk activities, there are “no regret” activities that improve environmental quality. Problems with such activities include:

1. Establishing formulas to translate action in the field to CO<sub>2</sub> reductions.
2. Establishing simple monitoring procedures.

The complexity of sink activities deters them from being included as part of the Kyoto Protocol calculations. But they provide many avenues to slow global warming.

- Without their inclusion, farmers (at least in the U.S.) will be against Kyoto.
- When farmers recognize green management activities such as CO<sub>2</sub> sequestration are legitimate, they will recognize another source of profit and will modify their behavior.
- The extent of modification depends on the price of sequestration. Some suggest it will be \$150/ton of CO<sub>2</sub>, while others think it will be \$10 to \$20/ton.

The high estimates based on reduction of CO<sub>2</sub> within existing **power**

technologies. Low estimates are based on marginal cost of alternative sequestration strategies (more to gain in energy production in many regions).

- Even with the low estimate, U.S. farmers may get \$3–5 billion a year for sequestration activities. Since commodity payments will disappear by 2002, and farmers will push for their continuation, a program of “green payments” for sequestration may be introduced.
- This may be a mechanism that will complement (or embody) the trading in CO<sub>2</sub> reduction.

\* Relevant Past Experience

- Trading in SO<sub>x</sub> and NO<sub>x</sub>. This seems a success, and it has led to technological change.
- Overreduction--40% below target level. The price of permits is much lower than expected.  
  
Trade in CO<sub>2</sub> is more complex because of difficulties in managing risk activities.
- Trading in wetlands has been a less successful program. It is difficult to define the unit of effective wetland and to monitor activities. Payment depends on approval by bureaucrats, and there is not much monitoring of outcomes at field level.

More complex situations than CO<sub>2</sub>, where the **derivate** product is well defined, but presents some possible pitfall.

\* Alternative procedure to enact CO<sub>2</sub> reduction

- Kyoto is the “trickle down” procedure that will lead to CO<sub>2</sub> reduction in atmosphere.
- A “bottom up” approach assures that regulation to reduce CO<sub>2</sub> occurs at one country. The success of such regulations will lead to their adoption internationally.
- Once CO<sub>2</sub> reductions become valuable
  - For-profit institutions to monitor CO<sub>2</sub> reduction will be established.
  - Exchange for trading in sequestration rights will be formed.
  - Futures and options markets will evolve.

Some organizations already buy sequestration rights (assuming the Kyoto-type regulations are likely and sequestration will be recognized as an approach to slow climate change). With the bottom-up approach, there will be actual implementation of sequestration before a formal detailed regulatory framework is established. This framework will evolve through exchanges of experiences of sequestration contracts and of sequesters.