Delayed Accession, Technology, and Industrial Leakage

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Research Question

- Likely that any future international climate agreement will involve differentiated mitigation responsibilities

- As seen in the Kyoto Protocol, this could mean the delayed participation of certain sets of countries; e.g., developing countries

- What will this differentiated responsibility mean for economic costs?

- In this study, we compare alternative participation scenarios to reach set CO$_2$ stabilization targets

- We find total economic costs to be higher in the delayed case, with much of the burden falling on countries that take early action
Motivation

- Differentiated responsibility can lead to “carbon leakage”—i.e., emissions reductions in participating countries are offset by emissions increases in non-participating countries.

- 3 channels through which “carbon leakage” can occur:
  1) Emissions reductions in participating countries → Fall in world energy prices → Rise in demand for energy in non-participating countries.
  2) Carbon policies → increased production costs in participating countries → shift in comparative advantage of carbon-intensive production to non-participating countries.
  3) Higher income in non-participating countries from effects (1) and (2) → higher demand for all goods including energy.
Most studies find that lower world energy prices (due to lower energy demand in participating countries) leads to higher energy demand in non-participating countries.

However, some have pointed out that it depends on relative energy prices; e.g., if oil prices fall more than coal prices, non-participating countries might switch from coal to oil, leading to negative carbon leakage.

Studies also find that the movement of carbon intensive production to non-participating countries will depend on how easily participating countries can substitute imported goods for domestic goods (i.e., the Armington assumption).

Although some studies find evidence of an income effect contributing to higher non-participating country emissions, other studies have shown the opposite—higher incomes lead non-participating countries to demand higher environment quality and thus lower emissions.
Second Generation Model (SGM)

- Dynamic recursive, computable general equilibrium model—interactions among the four economic agents (i.e., producers, households, government, and foreign sector) explicitly modeled over time.

- 16 production sectors:
  - Agriculture
  - Five energy sectors
  - Seven non-energy industrial sectors
  - Transportation
  - Two service sectors

- Eleven generating technologies explicitly represented in the electricity sector.

- Carbon emissions estimated based on the amount and type of fossil fuel consumed by each of the three domestic economic sectors.

- Carbon concentrations and radiative forcing from emissions estimates generated using the MAGICC model of coupled gas-cycle, climate, and ice-melt.

- Primary source of data is the social accounts of the Global Trade Analysis Project (GTAP)
Policy Scenarios—EMF 22 International Transition Subgroup

- Ten scenarios: five climate targets under two alternative international policy regimes

- Climate targets:
  - Not to exceed: 2.6 W/m², 3.7 W/m², 4.5 W/m²
  - Limits of 2.6 W/m² and 3.7 W/m², to be reached by end of 100 year period (“overshoot”)

- Policy regimes:
  - “Immediate accession:” full participation beginning in 2012
  - “Delayed accession:”
    - Group 1: US, EU, Rest of Annex 1 enter in 2012
    - Group 2: Brazil, Russia, India, China (BRICs) enter in 2031
    - Group 3: Rest of the World (ROW) enter in 2051

- Scenarios not included in analysis:
  - 2.6 W/m² climate target—impossible to achieve with technology options in SGM
  - Not to exceed 3.7 W/m²—identical to “overshoot 3.7 W/m²” since constraining to 3.7 W/m² by 2100 requires radiative forcing to stay below 3.7 W/m² in every previous year.
Carbon Taxes—Group 1

- Reference
- Immediate, 4.5 Not-to-Exceed
- Delay, 4.5 Not-to-Exceed
- Immediate, 3.7 Overshoot
- Delay, 3.7 Overshoot
THE ENERGY SYSTEM
Immediate & Delayed Accession, 3.7 W/m²

Primary Energy

Power Generation

Immediate Accession

Delay Accession
Present Discounted Policy Costs

Immediate Accession, 3.7 W/m²

- Group 1: 19%
- Group 2: 41%
- Group 3: 40%

Delayed Accession, 3.7 W/m²

- Group 1: 23%
- Group 2: 42%
- Group 3: 35%

Trillion 2005 Present Discounted USD at 5% Discount Rate
Technology’s role in shaping cost—Comparing SGM & MiniCAM

Immediate Accession, 3.7 W/m² Overshoot

- MiniCAM Hi Tech
- MiniCAM No CCS
- MiniCAM No CCS, No Bio
- MiniCAM No CCS, No Bio, No Elec/H2 Transportation
- SGM Core Model
ROW Emissions Leakage as Percentage of Total Global Emissions Reductions

If ROW never enters

Delayed Accession 3.7 W/m² Scenario
Decomposing Emissions Leakage in ROW in Delayed Case

- Changes in energy consumption in ROW induced by changes in world energy prices: 44.5%
- Changes in production of carbon-intensive goods in ROW: 52.7%
- Changes in scale of economy in ROW: 3.3%
Fuel Prices in ROW (2041)

- **Coal**
  - Reference: $2.00/GJ
  - Delay: $1.50/GJ

- **Oil**
  - Reference: $3.50/GJ
  - Delay: $3.00/GJ
LEAKAGE: Iron & Steel Imports into Group 1

From Group 2

- Reference
- Immediate Accession, 3.7
- Overshoot
- Delayed Accession, 3.7
- Overshoot

From Group 3

- Reference
- Immediate Accession, 3.7
- Overshoot
- Delayed Accession, 3.7
- Overshoot
Conclusions

- Delayed accession leads to higher total mitigation costs than immediate accession.

- Technology has a significant impact on the cost of mitigation—carbon taxes in a low technology scenario are five times higher than in an advanced technology scenario.

- Emission leakage in non-participating countries is mainly due to changes in world oil prices (inducing an increase in energy demand) and the migration of carbon-intensive production to these countries.