The Efforts of Taiwan to Achieve INDC Target: An Investigation on its Regional Carbon Trading System

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Yi-Hua WU, Industrial Technology Research Institute
Hancheng DAI, National Institute for Environmental Studies
Toshihiko MASUI, National Institute for Environmental Studies
Outline for Today’s Talk

1. Introductions
2. BaU Scenarios
3. Simulation for Taiwan’s INDC
4. Conclusions and Future Work
Introduction to Taiwan

- Locate in Southeast Asia
- Population: 23 millions
- Area: 35,883 km² (Japan 377,915 km², 10.53 times of Taiwan)
- Taiwan has a close relationship with the Japan.

Location of Taiwan
Introduction to GDP of Taiwan

- GDP growth slows down in recent years
- GDP growth is sensitive to the U.S. economy.
- 1 US dollar equal 32 NT dollars
Introductions

Introduction to CO₂ Emission in Taiwan

- Total CO₂ emission increases from 10.95 Millions Tone of CO₂ e in 1990 to 25.05 in 2015.
- Per capita CO₂ emission increases from 5.8 Tone of CO₂ e in 1990 to 10.7 in 2015.
- CO₂ emissions stabilize after 2010.
Share of Emissions by Sectors

- The largest emissions sector: Industry (46% in 1990 to 48% in 2015)
- Second largest sector: Transportation (18% in 1990 to 15% in 2015)
- Third largest sector: Energy (12% in 1990 to 10% in 2015)
Global Comparison of CO₂ Emission in Taiwan

- Taiwan’s total CO₂ emission ranks as 21 in the world. China (1), Japan (5), and Korea (7).
- Taiwan’s per capita CO₂ emission ranks 19 in the world. China (39), Japan (21), and Korea (18).

2014 Global Comparison: Total CO₂ Emissions

2014 Global Comparison: Per capita CO₂ Emissions

Source: IEA (2016)
Taiwan announced its INDC target in 2015

- The GHG emissions in **2030** should be reduced **50%** comparing with **BaU** level.
- **How** to achieve this target, at what **costs**, has **not been studied**.
Introductions

- **Purpose of this study**
  - Study **how Taiwan can achieve** INDC target, and at what cost.
  - We specify several issues:
    - Carbon cap without trade
    - Emission trade
    - How to allocate **allowance** for lower costs

- **Models**
  - We adopt **AIM model** to study such issue for Taiwan
  - Built this year by **NIES** and **ITRI**

- **Key findings**
  - INDC target **is achievable** but with economic costs
  - More participants in market **lower carbon price** and **less GDP loss**
Future Scenarios of Taiwan

- **Population** (official projection for Taiwan):
  - Taiwan population is expected to decline

- **Per capita GDP**:
  - Use **Vector Autoregressive Model** (VAR, an econometric model) to project Taiwan’s GDP.
  - We consider **Taiwan’s GDP**, Taiwan’s GDP **deflator**, and OECD’s GDP for projection.
  - Taiwan’s per capita GDP is expected to reach **$29,000 US dollars** in **2030**.

- **Primary Energy**:
  - Primary energy is expected to reach **6.43 EJ** in **2030**.
**Trend of Taiwan’s industries**
- Value added of industry expands faster than service sector

**Total CO₂**
- Increase from 272 Million T in 2011 to 450 Million T in 2030

**Trend of Power Demand**
- Increase from 265 TWh in 2011 to 439 TWh in 2030

**CO₂/ Per capita**
- Increase from 11.73 T in 2011 to 19.29 T in 2030
Share of Emissions

- Taiwan’s **power generation** sector constitutes a large share of emissions, followed by other petrol, other chemicals sectors, and combined HP.
- **Energy** and **chemical sectors** are main sources of emissions.
Simulation for Taiwan’s INDC

- Scenario for Cap: Base Year 2011
  - Base Year 2011 indicates that allowances are set according to the emissions share in Base Year 2011

- Scenario for Cap: BaU
  - BaU indicates that allowances are set according to the emissions in BaU
    - Calculate the reduction rate of BaU emission to INDC target
    - Emissions of detail sectors are capped according to the reduction rate of BaU.

**Scenario: Base Year 2011**

- Emissions of different sectors are shown for 2011, with various categories such as Others, Household, Aviation, Combined HP, Other chemicals, Other petrol Power generation, and Power generation.

**Scenario: BaU**

- Emissions for BaU, showing a reduction rate leading to a target in 2030.
Simulation for Taiwan’s INDC

- **Cap without trade**
  - Just restrict emission of each industry. But they are *not allowed to trade* if there is a surplus/deficit of allowance

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<thead>
<tr>
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- **Cap and trade**
  - Industries are *allowed to trade* if there is a surplus/deficit of allowance

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Simulation for Taiwan’s INDC

Outline for the policy scenarios

- Capped w/o Trade
  - Allowance: Bau
    - Partial Industries Capped
  - Allowance: Bau
    - All Industries Capped
  - Allowance: 2011
    - Partial Industries Capped
  - Allowance: 2011
    - All Industries Capped

- Emission Trading System
  - Allowance: Bau
    - Partial Industries Traded
  - Allowance: Bau
    - All Industries Traded
  - Allowance: 2011
    - Partial Industries Traded
  - Allowance: 2011
    - All Industries Traded

Emission Allowance
- 2011: set to 2011
- BaU: set to BaU
Simulation for Taiwan’s INDC

Pathways for Cap and Emission Trade
- All pathways achieve the INDC target
- The pathways are slightly different, depending on the scenarios

Total CO$_2$ Emissions in all Scenarios

Capped without Trade v.s. BaU (%)

Emission Trade v.s. BaU (%)

Carbon Price: Cap v.s. Emission Trade pathway

- Carbon cap without trade induces relative higher implicit carbon price. (shadow price, but not the market price)
- With emission trade, the implicit carbon price could be relative lower. (More tradable allowance in the carbon market)
- With all sectors participating the trade market, carbon prices are lower relative to partial trade.
Simulation for Taiwan’s INDC

- **Emission Trade pathway**
  - Carbon traded volume:
    - All sectors tradable implies higher traded volume, relative to partial trade

- **Market values of trade**
  - Market values:
    - All sectors tradable has large market value of trade
Simulation for Taiwan’s INDC

- **Scenario: Base year 2011 with Trade**
  - Major Buyer: Power generation sector
  - Major Seller: Other Petrol

- **Scenario: BaU with Trade**
  - Major Buyer: Power generation sector
  - Major Seller: Other Petrol
GDP loss

- **Capped without trade** induces *larger* GDP loss, relative to **Emission Trading System**
  - A sector with *lower emission* can *sell* its allowance in the market. ➔ Trade
  - *Without trade*, a sector *affordable for extra emissions* has to *reduce output*
  - **Market system** helps *reduce* GDP loss

![Capped without Emission Trade](chart1)

![Emission Trade](chart2)
Welfare loss (Measured by private consumption)

- Capped without trade induces larger welfare loss, relative to Emission Trading System
  - Market system helps reduce welfare loss
Conclusions

We build an AIM/CGE for Taiwan

- We study the consequence of launching Cap Without trade V.S. Emission Trading System
  - Taiwan’s largest emission sectors are power generation sector, followed by other petrol, other chemicals sectors, and combined HP.
- Trading system mitigates the negative impact on economy
  - Enlarge the trading market mitigates the negative impact on economy

Future work

- We will try to study the contribution of Taiwan’s effort to global warming reduction, using AIM/CGE
- Consider what would happen if Taiwan is allowed to trade allowance with other regions/countries