Energy and Climate Change in China
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1. Introduction

1. Historical and Business-as-Usual trend in the economy, energy sector and emissions.

2. Analysis of the carbon intensity target pledged in the Copenhagen Accord.

3. Emissions taxes scenarios.

4. Analysis of a realistic Chinese climate policy commitment.
Historic data and the Business-as-Usual Scenario
3. GDP, CO$_2$ and energy use: 1960-2009

Data from WB Development Indicators
4. Energy intensity and carbon intensity


Levine, Zhou and Price (2009); Data from WB Development Indicators
5. The WITCH model - www.witchmodel.org

WITCH: World Induced Technical Change Hybrid model

Hybrid I.A.M.:

- **Economy**: Ramsey-type optimal growth (inter-temporal)
- **Energy**: Energy sector detail (technology portfolio)
- **Climate**: Damage feedback (global variable)

- 13 Regions (“where” issues)
- Intertemporal (“when” issues)
- Game-theoretical set-up (free-riding incentives)

6 Distinguishing features of WITCH

- Focus on energy sector
- Focus on technological change:
  - Learning-by-Doing in W&S
  - Energy intensity R&D
  - Breakthrough Technologies (two factors learning curves)
- Focus on channels of interactions among regions:
  - Technological spillover
  - Environmental externality
  - Exhaustible common resources
  - Trade of emission permits
  - Trade of oil
- Focus on strategic behaviour (open loop Nash game)
7. Economic growth

- 1960-2005 14-fold expansion of GDP per capita
- Gap with OECD: 19 times lower in 2005, 3.5 times lower in 2050
8. **Energy use**

- 25% of global demand of energy in 2050 from China
- energy use per capita higher than global average, but lower than in OECD economies
9. **Energy intensity and carbon intensity**

- Strong energy efficiency improvements (back to "Classic period")
- Politburo: -20% reduction energy intensity in 2010 wrt 2005
- Energy intensity of GDP remains twice higher than in OECD
- Carbon intensity of GDP is more than twice than in OECD
10. China's share of global CO₂ emissions

- China: from 22% (2005) to 27% (2050)
- OECD: from 48% (2005) to 35% (2050)
- Global emissions: from 29.4 (2005) Gt to 62.4 Gt (2050)
11. The Copenhagen pledge

For a deeper analysis of Copenhagen Accord: Carraro and Massetti (2010), UNEP (2010)

- China pledged to reduce the emissions intensity of output by 40/45% wrt 2005
- EMF 22 data shows that target in BaU for 9 out of 15 models, median at -40%
The emissions tax scenarios
13. The emissions tax scenarios

- CTax4 is coherent with 535ppm target at 2100 (median +2.5°C)
- Lump-sum domestic rebate of emissions taxes
14. GHGs emissions in China

GHG Emissions (GtCO2-eq/year)

- BaU
- CTax1
- CTax2
- CTax3
- CTax4

GHG Emissions:
- 5.1 Gt
- 11.4 Gt
G8-MEF target for 2050: -50% global, -80% G8 (wrt 2005 ?)
Developing countries at least -25% wrt 2005.
16. Two main directions for change

- Upward (downward) movement signals reduction (increase) of carbon intensity of Energy
- Rightward movement signals reduction of energy intensity of GDP

Graph showing energy efficiency improvement and carbon intensity reduction with different scenarios labeled as BaU, CTax1, CTax2, CTax3, and CTax4.
17. Total primary energy supply

<table>
<thead>
<tr>
<th>COAL ( NO CCS )</th>
<th>GAS</th>
<th>OIL</th>
<th>NUCLEAR and SOLAR</th>
<th>TPES</th>
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<tbody>
<tr>
<td>2030-2005 (average per year)</td>
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<td></td>
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<tr>
<td>BaU</td>
<td>2.5%</td>
<td>3.9%</td>
<td>3.9%</td>
<td>4.6%</td>
</tr>
<tr>
<td>CTax1</td>
<td>1.8%</td>
<td>4.0%</td>
<td>3.9%</td>
<td>5.7%</td>
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<tr>
<td>CTax2</td>
<td>0.8%</td>
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<td>3.6%</td>
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<tr>
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<tr>
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<td>3.4%</td>
<td>3.1%</td>
<td>9.0%</td>
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<tr>
<td>2050-2005 (average per year)</td>
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</tr>
<tr>
<td>BaU</td>
<td>2.2%</td>
<td>2.8%</td>
<td>2.9%</td>
<td>3.8%</td>
</tr>
<tr>
<td>CTax1</td>
<td>1.3%</td>
<td>3.0%</td>
<td>2.7%</td>
<td>5.2%</td>
</tr>
<tr>
<td>CTax2</td>
<td>-0.5%</td>
<td>2.7%</td>
<td>2.2%</td>
<td>6.7%</td>
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<tr>
<td>CTax3</td>
<td>-1.2%</td>
<td>2.8%</td>
<td>1.8%</td>
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</tr>
<tr>
<td>CTax4</td>
<td>-1.4%</td>
<td>2.1%</td>
<td>1.2%</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

- Nuclear and renewables are the two fastest growing technologies in all scenarios
- Coal without Carbon Capture and storage has steepest decline
18. Marginal abatement cost curves

- Abatement potential expressed in percentage of emissions reductions in the BaU for comparability.
19. The cost of reducing GHGs emissions

Costs are expressed as the ratio between the discounted sum of GDP losses with respect to the BaU scenario and cumulative discounted GDP in the BaU scenario.

Bosetti and Frenkel (2009)

- Costs are expressed as the ratio between the discounted sum of GDP losses with respect to the BaU scenario and cumulative discounted GDP in the BaU scenario.
China’s emissions are likely to grow substantially in the next decades.

China will therefore be in the peculiar position of being the greatest emitter of GHGs but at the same time not rich enough to afford costly abatement measures.

The Chinese Cop15 pledge seems already embedded in reference scenarios that include strong energy efficiency improvements: domestic concerns higher than international ones.

Marginal abatement costs lower in China than in other economies. Higher aggregate costs.
A mild commitment to introduce some sort of emissions pricing in China is much needed in a post-2020 climate architecture.

If costs < 1%, China would accept only the lowest tax scenario.

Emissions decline by 25% wrt BaU, but still increase by 60% with respect to 2005.

Not compatible with G8 and MEF goal of -50% globally in 2050.

A tax starting from 50 US$ per ton of CO2-eq in 2020 would be needed to deliver the 25 percent reduction of emissions, but too costly for China (2.0/2.5 percent of GDP).