What can we learn about effectiveness of carbon reduction policies from interannual variability of carbon emissions? Applying ODIAC from East Asia of the 2010s


*Climate Research Division, National Institute of Meteorological Sciences (NIMS), Republic of Korea
PARIS AGREEMENT:

Decrease global warming via

- Apply energy and climate policies including 20/20/20 targets to reduce FFCO$_2^*$ emissions by 20%.
- Individual national reduction targets are defined in NDC (Nationally Determined Contribution)

“greater emission reduction efforts will be required in order to hold the increase in the global average temperature to below 2°C by reducing emissions to 40 gigatonnes or to 1.5°C.”
Lack of understanding what policies are effective in terms of carbon emission reduction under the announced pledges (Paris Agreement)

How effective current policy tools for decreasing carbon emissions within single national economy in East Asia (EA)

(a) What is the role of national environmental policies with carbon reduction goals in change of temporal dynamics of FFCO2 in EA?
(b) What are the most impactful policies in terms of slowing down FFCO2 emissions in EA?
(c) What are the future consequences of the policies in EA in FFCO2 reduction required by NDC?
### National Environmental Policies in East Asia

<table>
<thead>
<tr>
<th>Policy</th>
<th>Country</th>
<th>Start Year</th>
<th>End Year</th>
<th>Pledge (% decrease)</th>
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<tr>
<td>12th FYP</td>
<td>China</td>
<td>2011</td>
<td>2015</td>
<td>- 17% of carbon emission intensity (nationwide)- 10-18% of carbon emission intensity (in provinces)</td>
</tr>
<tr>
<td>ISEE*</td>
<td>Japan</td>
<td>2013</td>
<td>2020/2030(planned) 2017(considered)</td>
<td>- In 2020, decrease GHG emissions by 5-9% vs 1990 level- In 2030, decrease GHG emissions by 20% vs 1990 level</td>
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<tr>
<td>TMS</td>
<td>South Korea</td>
<td>2012</td>
<td>2020</td>
<td>- within 30% of GHG emission from business-as-usual scenario</td>
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<tr>
<td>1st NAP</td>
<td>Mongolia</td>
<td>2011</td>
<td>2015</td>
<td>- GHG emission mitigation (technological improvements)</td>
</tr>
</tbody>
</table>

Main Principle of filtering: Policy mentioned by NDC

✔ 12th FYP China
✔ TMS
✔ 1st NAP
✗ ISEE

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*ISEE was scratched out from the government with the ruling party of Japan leaving government. But we considered ISEE continued until 2017
12th FYP - Five Year Plan of China, ISEE - Innovative Strategy for Energy and Environment, TMS - Target Management System, 1st NAP - 1st Stage of National Action Program, North Korea+Taiwan - no plans under NDC is found
Main source: ODIAC (Open-Data Inventory for Anthropogenic Carbon Dioxide) fossil fuel carbon emissions (*doublechecked by EDGAR estimates)

\[
IAV(FFCO_2)_i = FFCO_2(i) - FFCO_2(i-1)
\]

\[CPG = \left( \frac{FFCO_{2f}}{FFCO_{2b}} \right)^{\frac{1}{n-1}} - 1\]

Compound Periodical Growth - Measure of relative growth of FFCO\(_2\) per year over given period (in %) [Sivaprasad 2012]

\[
FFCO_{2p} = FFCO_{2f} \ast (1 + CPG)^{\Delta n}
\]

FFCO\(_{2p}\) - For providing baseline scenario (by 2020, 2025, 2030) using last available year and CPG
• Two distinct periods in the 2010s.
• First period of 2010s -> strong deceleration in FFCO$_2$ growth (IAV from 10% in 2011 to -1.4% in 2015).
• Deceleration period ended -> 2015-2017, the latest stage of FFCO$_2$ rebound
• These patterns-> footprint of changed anthropogenic activity since the 2010s (see cement and coal)
• Do policies play role in the post-2010 period?
**DYNAMICS OF FFCO2 WHEN CARBON REDUCTION POLICIES ENACTED**

- **China** -> 12\textsuperscript{th} FYP (2011-2015), IAV goes down from 10.9\% (2011) to the observed minimum of -1.4\% (2015).
- Lagged FFCO\textsubscript{2} growth in China -> drop in national coal use (IAV of FFCO\textsubscript{2} and coal r = 0.76)
- **Japan**, both FFCO\textsubscript{2} and IAV have complex patterns. The median IAV of FFCO\textsubscript{2} is \sim 0, rebound in FFCO\textsubscript{2} emissions after 2016.
- **South Korea**, FFCO\textsubscript{2} growth is complex -> IAV of FFCO\textsubscript{2} of TMS varies -0.8 to 3.7\% -> the lowest variability of FFCO\textsubscript{2} growth among all EA countries during policy-on period.

*Shaded zones - “Policy-on” periods*
EAST ASIA: Policy-on periods cause promising shifts in FFCO₂
- Policy-on periods -> \textbf{FFCO}_2 \textbf{growth slowed down in all large EA emitters} (in Japan, Taiwan FFCO₂ decrease)

CHINA: Significant deceleration of FFCO₂
- CPG of FFCO₂ down from 8.7% (policy-off) to 1.0% (policy-on) -> coal and cement role approved
- In Taiwan - different pattern

JAPAN: Decrease of FFCO2 no matter to policy
- Weak FFCO₂ growth in policy-off (CPG = 0.1%) -> to decrease in policy-on (CPG = -0.3% per year).
- Coal use -> from weak growth (CPG = 0.1%) to decline (CPG = -0.8%).

SOUTH KOREA: Small deceleration of FFCO₂ growth
- Weakest decrease of CPG from policy-off to policy-on period (decreased from 2.5% to 1.3% per year). No progress due to ongoing coal use growth

MONGOLIA: Strong deceleration of FFCO₂
- CPG of FFCO₂ decreased from 6.6% (policy-off) to 2.0% (policy-on) (also decline of cement production observed by CPGs of 11.2% (policy-off) and -0.5% (policy-on).
Baseline scenarios:

• Policy-off -> FFCO\textsubscript{2} of EA 24%, 80%, 166% increase (2020, 2025, 2030)
• Policy-on -> FFCO\textsubscript{2} are lower and will be 3%, 7%, 12% increase (same years)

Highly-emitting cluster (Eastern Provinces of China):

• Policy-off -> Role of the cluster is enhanced -> share in total EA emissions will grow on 44%, 48%, 52% by 2020, 2025 and 2030
• Policy-on -> Distribution of FFCO\textsubscript{2} is more even (cluster will have ~42-43% to total EA emissions by 2030)

NDC progress: likely fail at current projection

• China -> Unable to check
• Mongolia, S. Korea -> FFCO\textsubscript{2} growing versus expected reduction
• Japan -> Insufficient reduction
• Best scenario -> Pure policy-on projection (2%, 7%, 12% increase by 2020, 2025, 2030)
• Worst scenario -> Pure policy-off projection (26%, 87%, 180% increase by 2020, 2025, 2030)
• The role of Chinese policies determine the whole pattern sensitivity (without China difference < 1%)
• Policy-on scenario hard to sustain for many years (very fragile)
Carbon reduction policies in EA of 2010s -> beneficial (less FFCO₂ growth, more even distribution)

Even most optimistic scenario -> NDC goals likely fail by 2030 in EA

FFCO₂ decreased in Japan and Taiwan, decelerated in China and Mongolia, small progress in S. Korea

Progress fragmented and very fragile -> rebound of FFCO₂ growth already occurred

China -> most influential and sensitive -> most trends in EA due to concurrent deceleration of FFCO₂, coal and cement (driven by 12th FYP of China)

China typical feature -> very high agreement between FFCO₂, economy, carbon rich production and policy measures

Accuracy of reported data is hard to check -> observational support needed (OCO-3)

If emissions underreported -> The NDC progress is HARDER to achieve

[Labzovskii et al., 2019] - Environmental Science & Policy, 96C
Supranational framework for controlling FFCO$_2$ reduction progress is crucial

(a) assign operative status of national environmental plans with carbon abatement goals based on numerical criteria.

(b) linking a national-scale policy with key local measures for reaching carbon abatement goal (energy sector transformation, decarbonization of cities, introducing renewables)

(c) implementing flexible region-specific carbon abatement goals developed specifically for the carbon abatement in the challenging geographic regions

(d) assisting governmental transitions from one party (or elite) to another within one country by re-evaluating new environmental policies that should not harm compliance of the international pledges

(e) tracking dynamic changes of the carbon-driven output of economy such as energy consumption, transportation and industrial activities

(f) evaluating quality of the submitted data from the country parties and require validation for compliance if needed.
THANK YOU FOR ATTENTION!