



Emission Reductions and “Leakage” from US State Cap-and-Trade Programs

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Emission Reductions and “Leakage” from US State Cap-and-Trade Programs

OUTLINE

1. Theory
2. Simulation results
3. Empirical analysis of RGGI leakage
4. Data needed to measure emission reductions and leakage
5. CA and RGGI measures to prevent leakage

1. Theory

Environmental Effectiveness of Regional Cap-and-Trade Policies

Emission reductions through

1. Supply-side reduction effect:
Emission price → Shift to less emitting generation
2. Demand-side reduction effect:
Higher generation costs → Lower consumption
3. Potential use of allowance auction proceeds for emission reduction (energy efficiency and low-emitting supply)

Emission Leakage Definitions

Definition: Increase in emissions by entities not subject to a regulation, due to increases in costs for generators subject to the regulation

Explanation: If the regulation increases costs for entities subject to the regulation, they may lose market share to competitors, who may therefore produce more and, as a by-product, emit more.

Definition: “Leakage ratio” or “leakage percentage”

$$= \frac{\textit{Leakage}}{\textit{Regulation – induced emission reduction among entities subject to the regulation}}$$

Example: Leakage percentage of 100% means no net change in emissions.

Reasons to Measure Environmental Effectiveness and Leakage

1. Help inform decisions about whether policy should be discontinued, reformed, or neither
2. Determine if more action is needed to reduce leakage
3. Inform predictions of the effects of future policies (regional or single-country, CO₂ or another pollutant)
4. Check performance of simulation models

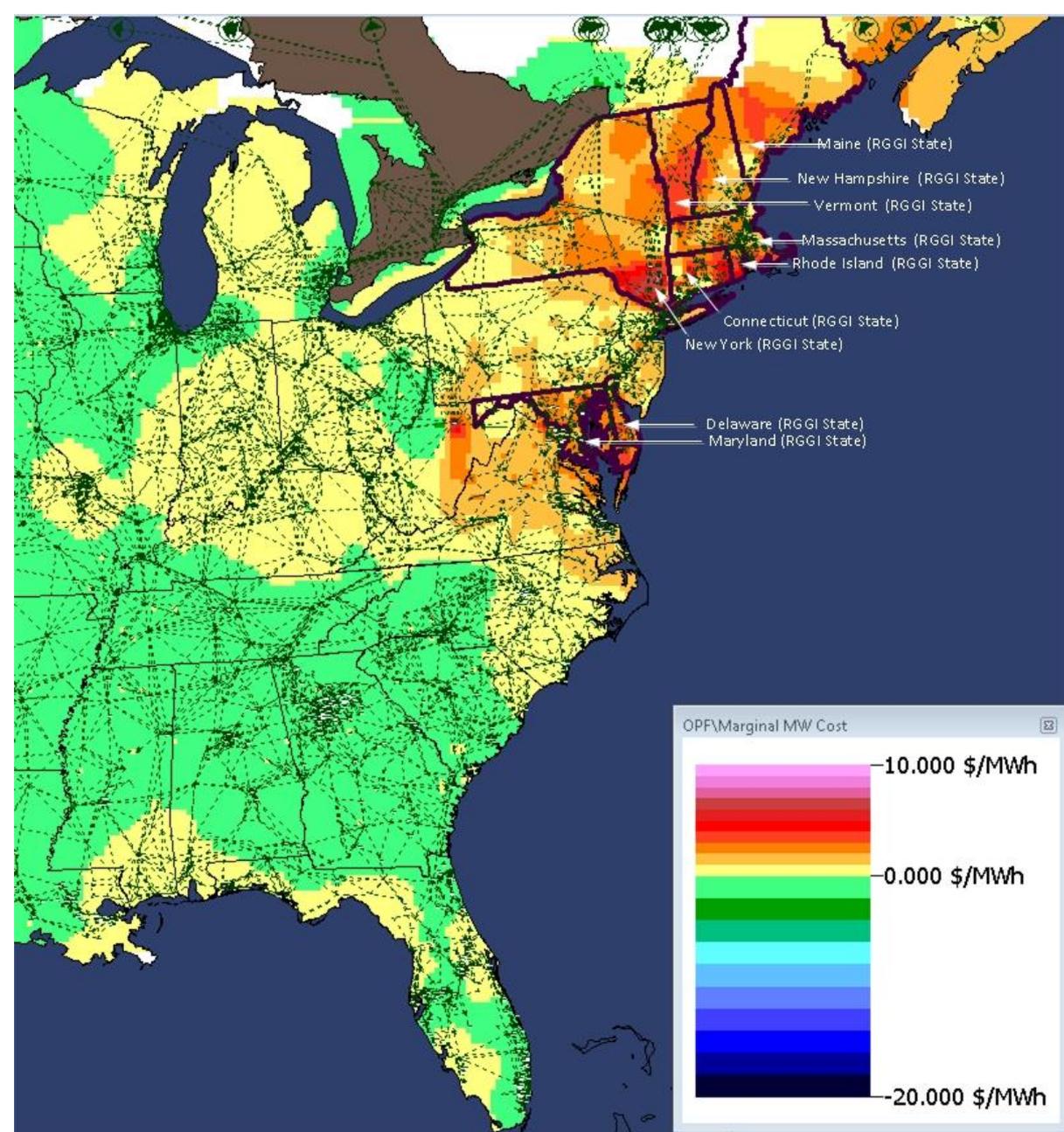
2. Simulation results

RGGI raises electricity price in participating states

Parts of them near non-participating states have smaller price increases

RGGI raises prices in nearby non-participating states (>\$1 in parts of NC, VA, WV, PA, Canada)

Source of map: Simulation using SuperOPF Planning Tool and 5000-node transmission model, reported in Shawhan et al, submitted to *Resource and Energy Economics*



**Effect of \$10 RGGI Price on Electricity Prices (vs. \$0 RGGI price),
Ten Years After Policy Goes Into Effect (Simulation Results)**

Prospective studies have predicted RGGI emission reductions and leakage

- Scenario Analysis
 - Rogers et al. 2008
- Supply and Demand Curve Simulations
 - Burtraw et al. 2005
 - Chen 2009
- Network simulations
 - Ruth et al. 2008
 - Shawhan et al. 2008 and 2013
 - ICF Consulting 2006

Prospective studies have predicted RGGI emission reductions and leakage

- Predictions have varied widely
- Most have not accounted for use of allowance proceeds to reduce emissions, some have not assumed for use of offsets

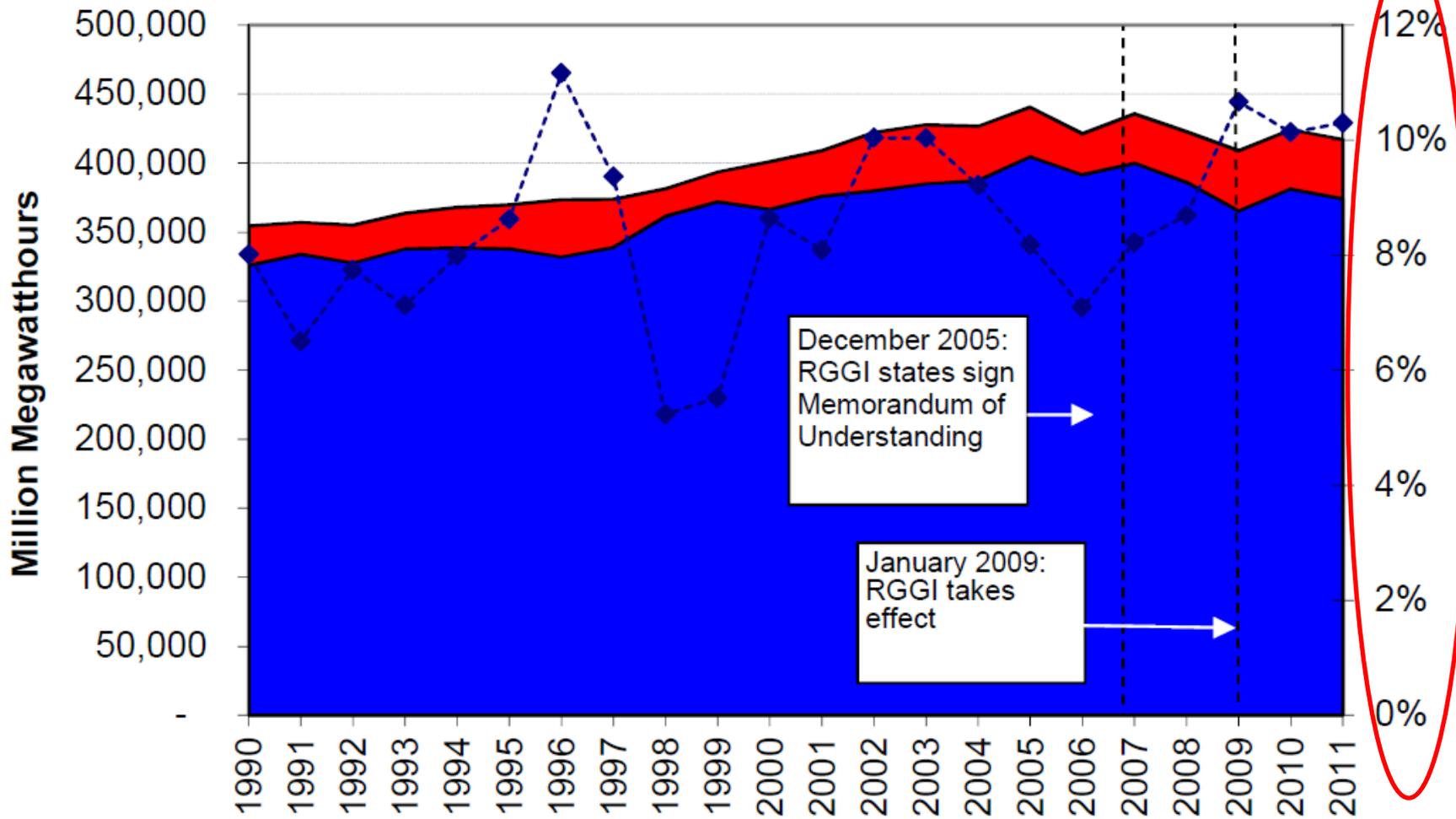
RGGI Simulation Predictions with ICF IPM Model, 2006

- With allowance price ~\$3.25/ton,
 - net CO₂ emission reductions of about 10% of RGGI states' power generation emissions,
 - after leakage and offsets but before accounting for use of allowance proceeds to fund emission reductions.
- Offsets make up ~ half of net reductions
- Offsets reduce leakage from ~50% to ~30%

3. Empirical analysis of RGGI leakage

Andrew Kindle, Daniel Shawhan, and Michael Swider,
“An Empirical Test for Inter-State Carbon Dioxide
Emissions Leakage from the Regional Greenhouse Gas
Initiative,” work in progress

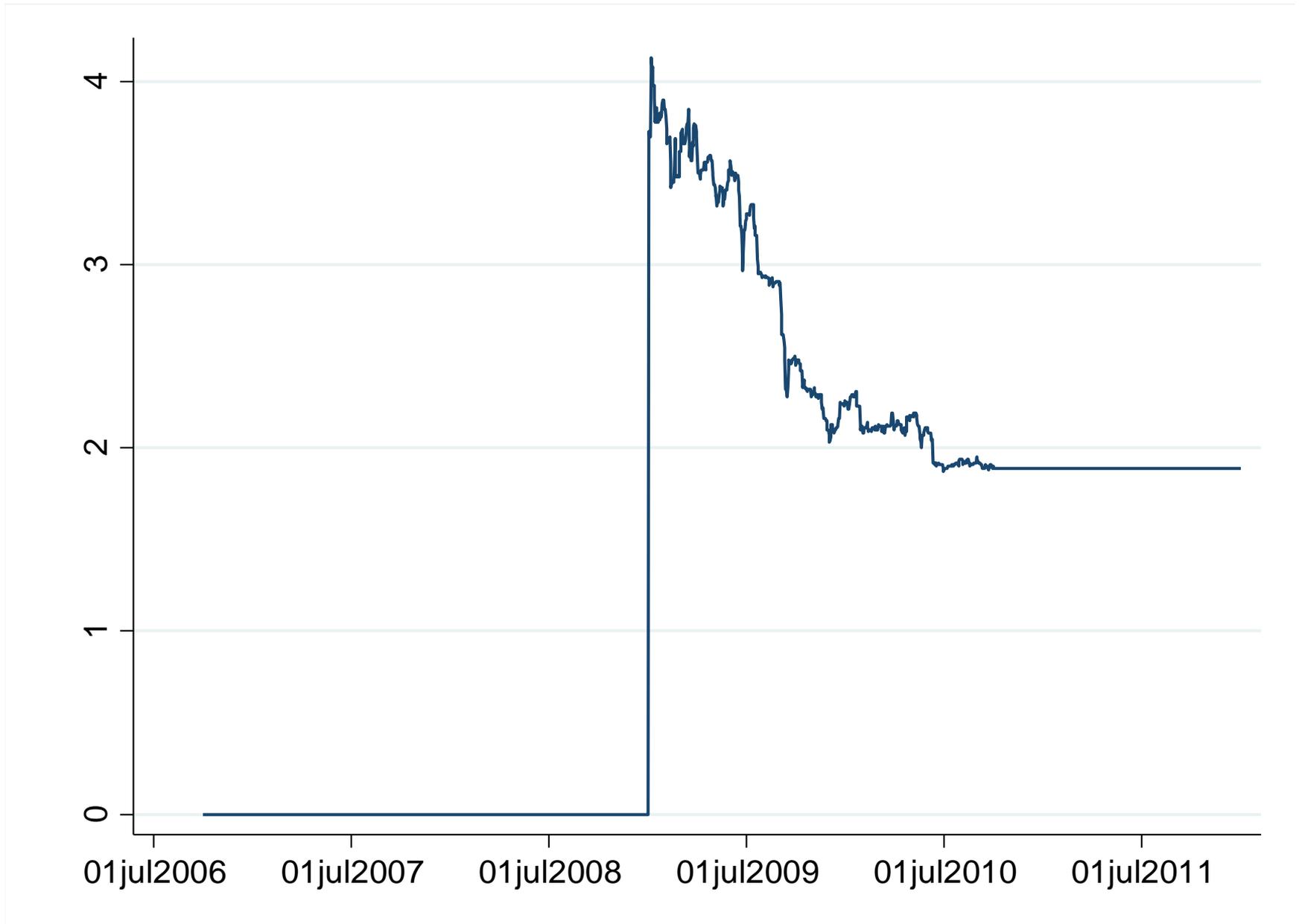
Anecdotal Background: RGGI Region Electricity Imports, 1990-2011



- Imported Electricity
- Electricity Generated by RGGI States
- ◆ Percentage of Electricity Sales from Imported Electricity



RGGI Allowance Price During Regression Period



How we test for leakage

- We test for an impact of the RGGI allowance price on daily PA CO₂ emissions and PA-NY electricity flows
- Either would indicate leakage, specifically short-term, supply-side leakage
- Why PA to NY?
 - PA not in RGGI, NY is
 - Share a large border
 - Abundance of high emitting generation capacity in PA
 - Necessary confidential data are available

Regression to Explain PA CO₂ emissions

- Associated with higher PA CO₂ emissions:
 - PJM load
 - Natural gas spot price
- Associated with lower PA CO₂ emissions:
 - Coal price
 - PA nuclear generation
- No statistically significant relationship with PA CO₂ emissions:
 - RGGI allowance price ($p > 0.3$)
 - NOX allowance price
 - SO₂ allowance price
 - Retirements and additions

Regression to Explain PA-NY electricity flow

- Associated with higher flows from PA to NY:
 - NY load
 - Natural gas spot price
- Associated with lower flows from PA to NY:
 - PJM load
 - Coal price
 - NY nuclear generation
 - NY hydro generation
- No statistically significant relationship with flows from PA to NY:
 - RGGI allowance price ($p > 0.3$)
 - Retirements and additions

Conclusions

- We do not detect leakage from RGGI
 - The leakage may be too small to detect
 - Or the flows from PA to RGGI states may be unaffected by prices

4. Data needed to measure emission reductions and leakage

Data needed to evaluate effects of regional cap-and-trade policies

- General suggestion for data to collect from all significantly emitting sectors
 - Emissions and production by facility
 - The variables other than the policy that affect the production and emission decisions of the emitters. Vary by sector.
 - All of this in both the regulated and unregulated states
- Electric sector (40% of US net GHG emissions)
 - Data needed: Already collected by system operators and data clearinghouses
 - Exception: Marginal prices of fuel are subject to plant-specific contracts
 - Higher allowance prices will help detect and measure leakage

5. CA and RGGI measures to prevent leakage

California Leakage Prevention 1: Free Allowances to Leakage-Prone Businesses

From the leakage risk classification, an industry assistance factor (AF) is determined for use among other factors in calculating free allocations

Leakage Risk	Industry Assistance Factor (AF)		
	Compliance Period *		
	1st	2nd	3rd
High	100%	100%	100%
Medium	100%	75%	50%
Low	100%	50%	30%

*1st compliance period: 2013–2014
2nd compliance period: 2015–2017
3rd compliance period: 2018–2020

Leakage Risk is based on energy intensity and on trade as share of sector's sales in California.

California Leakage Prevention 2: Power Imports Must Buy Allowances

“Importa mucho porque California importa mucho.”

- Important because CA imports much power, including its coal-fired power
- Disagreement about extent to which out-of-state suppliers will be able to “contract shuffle” — allocate clean power to CA contracts
- Future new contracts are subject to low emission limit, so any contract shuffling should decline as today’s contracts expire

RGGI Leakage Prevention

- RGGI states have agreed to work on plan for tracking and reducing leakage

CONTINGENCY SLIDES

Alternative definition

- The “leakage” from an emission regulation is the effect of the regulation on the emission quantity produced by entities exempt from the regulation.

Demand Slope Reduces Leakage

- Supply-side leakage effect: Emission change from shift of production to exempt, emitting producers. Could be around 100%, could be much less.
 - Depends on transmission constraints, relative emission intensities of generation changes, and share of reductions that come from indirect effects (allowance proceed use, offsets).
- Demand-side leakage effect: Emission change from consumption reduction outside regulated region, because of higher price there. Is “negative leakage” and is smaller than supply-side leakage.

