The Marginal Effects of the Price for Carbon Dioxide: Quantifying the Effects on Electric Generation

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Research
Expanding the body of knowledge in public utility regulation, market reform, and infrastructure operations (e.g. benchmarking studies of Peru, Uganda, Brazil and Central America)

Education
Teaching the principles and practices that support effective utility policy and regulation (e.g. PURC/World Bank International Training Program on Utility Regulation and Strategy offered each January and June)

Service
Engaging in outreach activities that provide ongoing professional development and promote improved regulatory policy and infrastructure management (e.g. in-country training and university collaborations)
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Acknowledgements

This presentation is based on material from my papers with Julie Harrington at Florida State University.

We wish to thank Julie Ferris, Tom Rogers, Larry George, and everyone at the Florida Department of Environmental Protection for their invaluable assistance and funding for this project.
Summary

• Current state of carbon cap and trade policy and legislation
• Modeling the effects of CO$_2$ pricing
• Marginal effects of CO$_2$ pricing on electric generation emissions, costs, and cost structure
Cap and Trade in the U.S.

• Governor Crist proposed reduction targets for Florida in 2007 Executive Order


• Waxman-Markey Bill proposed the framework for a nationwide cap and trade program for CO\textsubscript{2}

• Kerry-Boxer Bill refined the framework
# Cap and Trade Emissions Targets

<table>
<thead>
<tr>
<th>Florida Executive Order</th>
<th>Waxman-Markey</th>
<th>Kerry-Boxer</th>
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<tbody>
<tr>
<td><strong>Year</strong></td>
<td><strong>Emissions Level</strong></td>
<td><strong>Year</strong></td>
</tr>
<tr>
<td>2012</td>
<td>2005 (100% of 2005)</td>
<td>2012</td>
</tr>
<tr>
<td>2017</td>
<td>2000 (~95% of 2005)</td>
<td>2020</td>
</tr>
<tr>
<td>2025</td>
<td>1990 (~70% of 2005)</td>
<td>2030</td>
</tr>
<tr>
<td>2050</td>
<td>20% of 1990 (~14% of 2005)</td>
<td>2050</td>
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Cap and Trade Analysis in Florida

• Project for the Department of Environmental Protection under Florida’s Energy Systems Consortium
  – Julie Harrington, FSU
  – Ted Kury, UF
• Quantification of the impact of meeting emissions goals in Executive Order
• Provisions of state cap and trade program
• Initial impact on electric generation, with expansion of scope to other sectors
Economic Dispatch Model

- Transparent framework and logic
- Quantify the balance between level of the carbon cap and the shadow (or market) price of carbon
- Quantify the impact of RPS, energy efficiency, carbon offsets, and generation additions
- Supply stack dispatch methodology
  - State-wide scope
  - Monthly resolution of hourly load
  - Individual generating units (over 500 in FL, AL, GA)
  - Key operating characteristics for each unit
  - Ability to shape load for growth or DSM
Model Data

• Generating unit data from utilities and public reports
  – Generating capacity
  – Fuel sources (and dual fuel capability)
  – Thermal efficiency
  – Retirement dates

• System data from state reliability council
  – Retail electric loads
  – Generating unit additions

• Annual load shape from federal reports
Marginal Effects of CO$_2$ Price
CO₂ Price and Energy Costs
2012 Fuel Mix

![Graph of 2012 Fuel Mix showing CO₂ Price per Ton against Millions of MMBtu with three categories: PC, NG, and BIT.](image-url)
Marginal Effects on Generation

• Marginal effects of increasing emissions costs on variable costs are fairly constant
• Marginal effects on emissions vary widely
• ‘Flat spots’ on emissions surfaces denote areas where significant increases in emissions costs have very little effect on emissions, but drastic effects costs to producers or consumers
• These emissions curves will change over time
Conclusions

• Still much uncertainty surrounding climate and energy legislation

• Marginal effects of CO$_2$ pricing are dynamic
  – Vary across years
  – Vary depending on price
  – Vary depending on generation mix

• Modeling needs to address these marginal effects
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