Consequences of Cap and Trade

Warwick McKibbin
Nonresident Senior Fellow, Global Economy and Development, Brookings
Australian National University

Pete Wilcoxen
Nonresident Senior Fellow, Global Economy and Development, Brookings
Syracuse University

Adele Morris
Deputy Director for Climate and Energy Economics, Brookings

June 8, 2009
Analysis

• Not an analysis of particular bills

• Not a cost-benefit analysis
  » Looking only at mitigation costs and emissions reductions.

• Looking for ways to pursue environmental goals at lower cost
Scenarios

- Two Reference Scenarios
  - No countries adopt a price on carbon ("take action")
  - All countries except the U.S. take action

- Four Policy Scenarios
  - "Obama" based loosely on Administration proposal
  - "Waxman-Markey" based loosely on draft targets
  - "Hotelling 2050" cost-minimizing with same 2050 emissions
  - "Hotelling Cumulative" cost-minimizing with same total emissions
U.S. Reference Emissions Levels

CO2 Emissions with Alternative Non-US Actions

- Historical CO2
- No Action Anywhere
- No US Action

Year

Million Metric Tons of CO2


4,000 4,500 5,000 5,500 6,000 6,500 7,000 7,500 8,000 8,500
Reference Emissions and GDP
All US Policy Scenarios

- Targets relative to 2005 emissions levels
- Emissions reduced 83% by 2050
Scenario Differences

• Obama
  » 14% lower by 2020

• Waxman-Markey
  » 20% lower by 2020
  » 40% lower by 2030

• Hotelling 2050
  » Least cost path to 83% reduction by 2050

• Hotelling Cumulative
  » Least cost path with same cumulative emissions as Obama
U.S. Emissions With Action
Assumptions

• No banking or borrowing in Obama and Waxman-Markey scenarios
• Caps apply only to fossil energy sectors
• No offsets
• Allowance value finances additional government spending
• Results relative to other countries taking action without the US
The G-Cubed Model

- General equilibrium model with 9 Regions, 12 sectors in each
- Forward looking – firms see a carbon constraint coming
- Financial capital is fully mobile, but physical capital isn’t
- Reports trade and investment flows
- Employment adjusts gradually to new policies
- Includes only CO₂ from fossil energy, about 85% of total U.S. greenhouse emissions
Emissions trajectories

Effect of Alternative Policies on US CO2 Emissions

Percentage Change from Reference

Year

Obama  Waxman-Markey  Hotelling 2050  Hotelling Cumulative
## Cumulative US Emissions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Billion Metric Tons of CO₂</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>288</td>
<td>N/A</td>
</tr>
<tr>
<td>Obama</td>
<td>154</td>
<td>47%</td>
</tr>
<tr>
<td>Waxman-Markey</td>
<td>148</td>
<td>49%</td>
</tr>
<tr>
<td>Hotelling 2050</td>
<td>176</td>
<td>39%</td>
</tr>
<tr>
<td>Hotelling Cumulative</td>
<td>154</td>
<td>47%</td>
</tr>
</tbody>
</table>
### Present Discounted Personal Consumption 2010 to 2050 in 2008 dollars

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2.2% discount rate</th>
<th>4% discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obama</td>
<td>-0.45%</td>
<td>-0.36%</td>
</tr>
<tr>
<td></td>
<td>$1.9 trillion</td>
<td>$1.1 trillion</td>
</tr>
<tr>
<td>Waxman-Markey</td>
<td>-0.49%</td>
<td>-0.39%</td>
</tr>
<tr>
<td></td>
<td>$2.0 trillion</td>
<td>$1.3 trillion</td>
</tr>
<tr>
<td>Hotelling 2050</td>
<td>-0.28%</td>
<td>-0.23%</td>
</tr>
<tr>
<td></td>
<td>$1.1 trillion</td>
<td>$0.6 trillion</td>
</tr>
<tr>
<td>Hotelling Cumulative</td>
<td>-0.38%</td>
<td>-0.31%</td>
</tr>
<tr>
<td></td>
<td>$1.6 trillion</td>
<td>$0.9 trillion</td>
</tr>
</tbody>
</table>
Allowance Prices

Carbon Prices Under Alternative Policies

2008 $US per ton of CO2

Year

Obama  Waxman-Markey  Hotelling 2050  Hotelling Cumulative
Total Value of Allowances

Allowance Values Under Alternative Policies

Billions of 2008 $US

Year

2010 2015 2020 2025 2030 2035 2040 2045 2050

Obama Waxman-Markey Hotelling 2050 Hotelling Cumulative
Cumulative Undiscounted Allowance Value 2012 to 2050 in 2008 dollars

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2012 to 2050</th>
<th>2012 to 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obama</td>
<td>$8.9 trillion</td>
<td>$1.3 trillion</td>
</tr>
<tr>
<td>Waxman-Markey</td>
<td>$9.2 trillion</td>
<td>$1.5 trillion</td>
</tr>
<tr>
<td>Hotelling 2050</td>
<td>$9.2 trillion</td>
<td>$1.6 trillion</td>
</tr>
<tr>
<td>Hotelling Cumulative</td>
<td>$9.0 trillion</td>
<td>$1.9 trillion</td>
</tr>
</tbody>
</table>
US GDP Under Different Policies and Scenarios

- Historical GDP
- No US Action
- Obama
- Waxman-Markey
- Hotelling 2050
- Hotelling Cumulative

Year: 1990 to 2050

Trillions of $2000 US

Graph showing projected GDP under different scenarios compared to historical data.
Effect of Alternative Policies on US GDP

Percent Change from Reference

Year

Obama  Waxman-Markey  Hotelling 2050  Hotelling Cumulative
Effect of Alternative Policies on US GDP Through 2032

- Percent Change from Reference
- Year

Lines represent:
- Obama
- Waxman-Markey
- Hotelling 2050
- Hotelling Cumulative
Effect of Alternative Policies on US Inflation
Effect of Alternative Policies on US Trade Balance to GDP Ratio

Change from Reference in Ratio of Trade Balance to GDP

Year

-0.3 -0.2 -0.1 0.0 0.1


- Obama - Waxman-Markey - Hotelling 2050 - Hotelling Cumulative
Effect of Alternative Policies on US Real Effective Exchange Rate

Percentage Point Change from Reference

Year

Obama  Waxman-Markey  Hotelling 2050  Hotelling Cumulative
## Effects on Sectors

<table>
<thead>
<tr>
<th>Num</th>
<th>Name</th>
<th>Num</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electricity</td>
<td>7</td>
<td>Agriculture</td>
</tr>
<tr>
<td>2</td>
<td>Natural Gas</td>
<td>8</td>
<td>Forestry</td>
</tr>
<tr>
<td>3</td>
<td>Petroleum Refining</td>
<td>9</td>
<td>Nondurables</td>
</tr>
<tr>
<td>4</td>
<td>Coal</td>
<td>10</td>
<td>Durables</td>
</tr>
<tr>
<td>5</td>
<td>Crude Oil</td>
<td>11</td>
<td>Transportation</td>
</tr>
<tr>
<td>6</td>
<td>Mining</td>
<td>12</td>
<td>Services</td>
</tr>
</tbody>
</table>
Effect on Production in 2025

Percentage Change from Reference

Sector

- Electricity
- Nat Gas
- Refining
- Coal
- Crude Oil
- Mining
- Agriculture
- Forestry
- Nondurables
- Durables
- Trans
- Services

Legend:
- Obama
- Waxman-Markey
- Hotelling 2050
- Hotelling Cumulative
Effect on Employment in 2025

Percentage Change from Reference

Sector

Electrify, Nat Gas, Refining, Coal, Crude Oil, Mining, Agriculture, Forestry, Nondurables, Durables, Trans, Services

Legend:
- Obama
- Waxman-Markey
- Hotelling 2050
- Hotelling Cumulative
Summary

• Emissions effects
  » All policies reduce cumulative US emissions 38% to 49%
  » 110 to 140 billion metric tons CO₂ fewer emissions

• Welfare effects
  » Loss in Personal Consumption of $1 to $2 trillion present value
  » Incremental stringency produces high incremental cost, e.g. extra 8% reduction increases costs 45%
Summary, continued

• US GDP in 2050 lower by 2.5%

• Employment effect
  » -0.5% at peak in first decade

• Allowance value
  » About $300 billion at peak during 2030-2040
  » $9 trillion in total

• Obama and Waxman-Markey targets
  » Without banking, CO₂ prices rise more gradually than least-cost
  » More stringent in medium run