Insights from Modeling on Sectors of the US Economy

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Industrial Competitiveness

- Concerns with non-global GHG emissions reductions
  - Sacrifices "where" flexibility
    - Increases allowance prices and costs
  - Affects competitiveness (comparative advantage) of US industries
  - And thus, JOBS!!

    (especially in energy-intensive, trade-exposed, EITE, industries)
  - Emissions leakage and relocation of industries to regions with fewer (or no) limits on GHG
- Response to concerns:
  - Start handing out allowance allocations…
  - What is the best (or less inefficient) way of doing this?
  - What metrics to use to measure success?
    - Industrial output, profit, employment, GDP, trade, etc.

Allowance Allocation Issues

- "Coase Theorem" – Market equilibrium in cap-and-trade will be cost effective and is *independent* of initial allocation, under certain conditions (see Hahn and Stavins, 2010)
  - i.e., allowance price is not affected by allocation since allocation doesn't affect firms' marginal abatement costs (thus, cap = equivalent tax)
  - Some conditions can break this independence, but Hahn & Stavins find that it generally holds when looking at past and present trading systems
- Of interest for policy: options for directed allocations
  - Output-based allocations (or production subsidies)
    - Usually for EITE industries
    - Proposed in several pieces of U.S. legislation – modeling discussed next
  - Border carbon adjustments (discussed in context of EMF 29)
    - Import tariffs / export subsidies apply domestic carbon price to trade goods
  - Industry exemptions
    - EITE or could be personal vehicles already affected by CAFE MPG rules

RTI ADAGE Model

- Dynamic, intertemporally-optimizing CGE model
  - Forward-looking: households and businesses plan ahead to limit costs
- Production functions based on related models (MIT EPPA)
- Includes international and US regional components
  - Regional differences in production technologies, growth, etc.
- Economic data from GTAP and U.S. IMPLAN
- Energy data and forecasts from IEA and EIA
  - Energy production, consumption, and prices
- CO_2 emissions from energy use (reductions controlled by structure)
- Non-CO_2 emissions (endogenous modeling, EPA abatement costs)
- Can model individual technologies (generation, PHEV)
- Linked to detailed LP model of US electricity generation

Electricity ("Bottom-Up") LP Model

- Dynamic cost minimization subject to meeting demand
- A data-driven approach:
  - What are characteristics of existing units
  - Operating costs
  - Fuel prices
  - New unit costs and characteristics (and how fast can you build)
  - Annual demand growth (separated by season and time of day)
- Benefits of Detailed Model:
  - Demand characteristics
  - Disaggregated options for existing and new generating units
- Linkage to CGE model – see Bohringer & Rutherford and Rausch & Mowers
- Allocation of allowances can matter in U.S. because of regions with regulated prices (see Burtraw et al.)

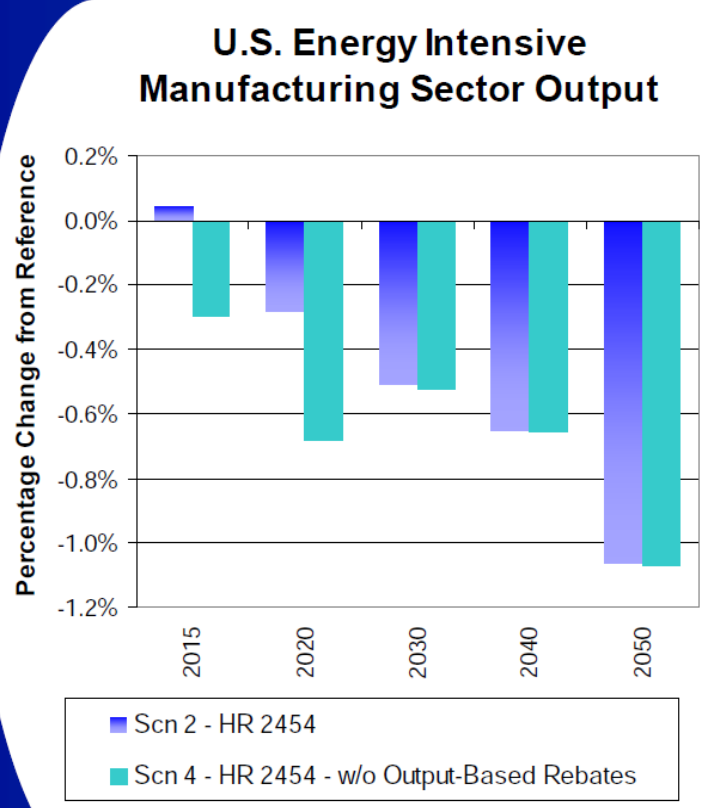
American Clean Energy and Security Act

- Cap & Trade System for GHG Emissions
  - 17% below 2005 by 2020, 83% below by 2050
  - Up to two billion tons of offsets each year
  - Estimated price of \$13/mtCO_2e in 2015, rising at 5% per year
- Incorporated output-based allowance allocation system
  - Similar to other US bills, designed to improve competitiveness
  - Provided to energy-intensive manufacturing only
    - Energy intensity of 5% - energy purchases as % of value of shipments
    - Trade intensity of 15% - imports/exports as % of value of shipments

    (primary metals, cement, glass, paper, chemicals, ceramics)
  - Amount starts at 15% of allowances, declines to zero by 2035
- Kyoto nations reduce emissions to 50% below 1990 by 2050
- Rest of world reduces emissions in 2025, constant after 2035

Summary of Trade Impacts and Output-Based Rebate Provisions

(ADAGE)



- The output-based rebate provision specified in Title IV of H.R 2454 is similar to H.R. 7146 (Inslee - Doyle).
  - Applies to energy- or GHG-intensive industries that are also trade-intensive.
  - Rebates on average 100 percent of the direct and indirect cost of allowances, based on an individual firm's output and the average GHG and energy intensity for the industry.
  - Gradually phases out between 2025 and 2035, or when other countries take comparable action on climate change.
- Without output-based rebate provision, energy intensive manufacturing output decreases by 0.3% in 2015 and by 0.7% in 2020. With the output-based rebates, energy intensive manufacturing output *increases* by 0.04% in 2015 and only falls by 0.3% in 2020.
- The output-based rebate provisions have little impact on allowance prices, and thus, in later years after the rebates are phased out, the energy intensive manufacturing sector output losses are similar in the two scenarios.
- More detailed results are presented in Appendix 5.

http://www.epa.gov/climatechange/EPAactivities/economics/legislativeanalyses.html

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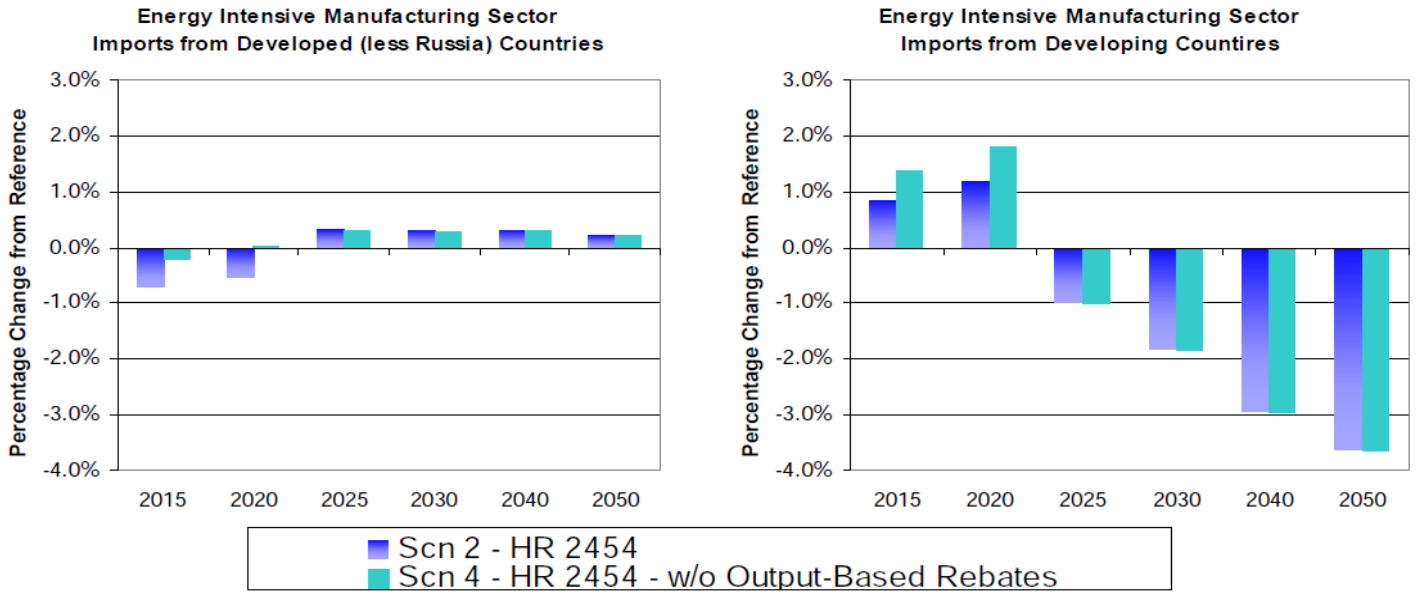

- Imports of energy intensive manufacturing goods from developing countries increase in 2015 and 2020, then decrease in 2025 and after as the developing countries are assumed to adopt climate policies.
- In 2015 and 2020, the output-based rebate provisions decrease imports from both developed and developing countries.
- More detailed results are presented in Appendix 5.

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Issues with Industry Modeling

- Model has aggregated Energy-Intensive Manufacturing
  - Spreads output-based rebates across too large a base
- Legislation specifies amount of allowances used to subsidize industry => can't adjust to correct % subsidy
- Legislation chose to use domestic subsidies instead of border carbon adjustment => affects domestic allowance price, forces burden onto domestic energy users more than trade partners
- Model structure controls global emissions leakage
  - Armington trade elasticities

    (regions produce distinctive good and thus have market power)
  - ADAGE, MIT EPPA and others use high elasticities => little power

    => Also should be a lot of leakage since people don't care where they purchase from
  - Other models (GTAP, G-Cubed) use low elasticities => high power

EMF 29: The Role of Border Carbon Adjustment (BCA) in Unilateral Climate Policy

- 12 multi-sector, multi-region CGE models running same policy
  - 20% reduction of emissions from 2004 by Annex 1 countries (U.S., no Russia)
- Examine impacts of BCA for EITE industries on emissions leakage
  - Without BCA is 12%, with BCA is 8%
  - BCA has little impact on global GDP loss
  - Gains in terms of trade from BCA depend on Armington elasticities in model
- In general, BCA:
  - Has efficiency benefits (reduced global costs – welfare or GDP)
  - Protects output of domestic industries
  - Causes distributional impacts by shifting burden to non-abating countries
  - Energy exporters are negatively affected since BCA lowers fossil fuel prices
  - Energy importers are better off
  - Dropping export subsidies part of BCA (keeping import tariffs) doesn't affect results much since Annex I countries are net importers of embodied carbon

EMF 29: Additional Modeling Issues

- Disaggregation of EITE industries in models
  - Usually CGE models have relatively aggregated EITE
  - Caron and also Alexeevar-Talebi et al. find aggregated models overestimate industrial output losses and underestimate leakage
- Models that do not include process emissions in production (which are harder to reduce than combustion-related CO2) will underestimate leakage (Bednar-Friedl et al.)
- CGE models normally represent an industry as single, homogenous firm. Modeling instead through heterogeneous, monopolistically competitive firms leads to larger competitiveness effects and more leakage (Balistreri & Rutherford)
- Output-based subsidies of allowances to EITE industries are less effective at reducing output losses and leakage than BCA (Bohringer et al.)

Thank you!