The Effects of Restricting Coal Consumption on Coal Exports and Greenhouse Gas Emissions

Andre Barbe

USAEE Annual Conference

November 14, 2017

Disclaimer

This article represents solely the views of the author and not the views of the United States International Trade Commission or any of its individual Commissioners.

This article should be cited as the work of the author only, and not as an official Commission document.

Motivation

- Reducing coal consumption is a frequent policy goal
  - Climate change
  - Health
- However, restricting coal consumption has unintended consequences
  - Fuel switching
  - Carbon leakage
- These spillovers could change the sign of the effect of the policy on world emissions

Summary of this Paper

- Research question
  - What happens if the U.S. restricts coal consumption?
- My contribution
  - Estimate policy impact using a model that includes aforementioned spillovers
  - Modify GTAP-E to allow for binding constraints on cost function
- Results
  - A U.S. restriction reduces world emissions
  - Foreign carbon leakage is negligible
  - Restrictions greater than 30% do not reduce emissions much more than the 30% restriction does

Agenda

- Background
  - Coal policies
  - Spillovers
  - Literature
- Methodology
  - GTAP
  - Policy shocks
- Results

BACKGROUND

Coal Emissions and Policy

- Coal and greenhouse gas emissions
  - 95% of U.S. coal CO_2 emissions are from power generation
  - Coal produces 75% more CO_2 per kWh than natural gas
  - Coal power plants are 21% of all U.S. greenhouse gas emissions

- Policies to phase out coal power plants
  - 2014: Ontario
  - 2030: Canada, France, UK
  - 2035: Oregon

- Clean Power Plan in United States would have required generators to reduce their coal intensity

Unintended Consequences

- Restricting coal consumption has spillover effects
  - Domestic fuel switching
    - Increased domestic natural gas emissions
  - Foreign carbon leakage
    - Increased coal exports
    - Energy-intensive industries move abroad

- When you include spillovers, what is the effect of restricting coal consumption?

METHODS

Overview of GTAP-E

- GTAP-E is a computable general equilibrium model of world economy
  - 8 sectors and 9 regions
  - Can describe how trade, consumption, and production of different goods respond to policy changes

- Model specializes in energy and international trade
  - Fuel switching
  - Foreign carbon leakage

Description of the Policy

- Policy: U.S. government mandates that coal intensity in power generation sector falls by X%
  - Coal intensity = use of coal / use of all fuels
  - 4 scenarios where X ranges from 10% to 40%

- Calculate impact of policy by comparing
  - Baseline business as usual
  - Scenarios were various coal policies are implemented

My Modifications to GTAP-E

- Policy adds a binding constraint to the firm cost minimization problem
- However, GTAP-E does not allow for such constraints
- I modify the firm cost equation to allow for binding constraints

RESULTS

Policy's Effects on U.S. Electricity Generation

	Coal Intensity Reduction (%)			
Change in Economic Variable (%)	**10**	**20**	**30**	**40**
Demand for Gas for Generation	13	32	64	135
Demand for Coal for Generation	-11	-23	-39	-62

- Policy leads to substantial fuel switching

- Large changes lead to uncertainty
  - Results driven by model parameters
  - GTAP's parameter values are intended to reflect actual 2011
  - 30% and 40% policies look very different from actual 2011
  - Parameter values might be different in such a world
  - So the estimated effects of those policies have large error bars

Policy's Effects on Coal Trade

	Coal Intensity Reduction (%)			
Change in Economic Variable (%)	**10**	**20**	**30**	**40**
U.S. Coal Production	-8	-17	-28	-44
U.S. Coal Imports	-5	-10	-17	-26
U.S. Coal Exports	3	7	14	29
World Coal Production	-1	-3	-5	-9

- U.S. coal production, consumption, and imports decrease
- U.S. coal exports increase
- World coal production decreases

Policy's Effects on Carbon Emissions

	Coal Intensity Reduction (%)			
Change in Emissions (million MT)	**10**	**20**	**30**	**40**
U.S. Coal	-181	-396	-667	-1,061
U.S. Gas	60	148	298	634
Non-U.S. Total	-1	-3	-6	-13
World Total	-119	-239	-350	-377

- Domestic fuel switch (to gas) offsets much of the coal emissions reduction
- International carbon leakage is negligible
- World emissions decrease
- 30% policy reduces emissions by about as much as 40% does

CONCLUSIONS

Summary

- Some countries are phasing out coal
- But coal restrictions may have spillover effects
  - Fuel switching
  - Foreign carbon leakage
- This paper analyzes the effect of coal restrictions
  - Include these spillovers
  - Modify GTAP-E to allow for constrained optimization

Conclusions

- Restricting U.S. coal consumption reduces world carbon emissions
- There is little carbon leakage to foreign countries
- Domestic fuel switching to gas is substantial and offsets almost all of the incremental reduction for restrictions greater than 30%

APPENDIX

Contact Information

Andre Barbe

U.S. International Trade Commission

andre.barbe@usitc.gov

Future Work

- Use a partial equilibrium model focused on the choice of generation technology

Comprehensive carbon policies have small spillovers

- "Comprehensive" means it applies to all emissions
  - Cap and trade
  - Carbon tax
- Böhringer, Balistreri, and Rutherford (2012)
  - Foreign carbon leakage offsets 5-20% of domestic emissions reduction
- Arlinghaus (2015)
  - Competitive losses and distributional impact not significant

Spillovers in Coal vs. Comprehensive

- Policies focused on a particular input can have much larger spillovers
  - Biofuel mandates may increase global emissions
- Coal
  - If policy restricts coal consumption, increased exports could offset 47% of restriction (Riker, 2012)
  - Australian coal export tax could reduce Australian welfare and increase world emissions (Richter, Mendelevitch, and Jotzo, 2015)

Figure 16 GTAP–E Production Structure

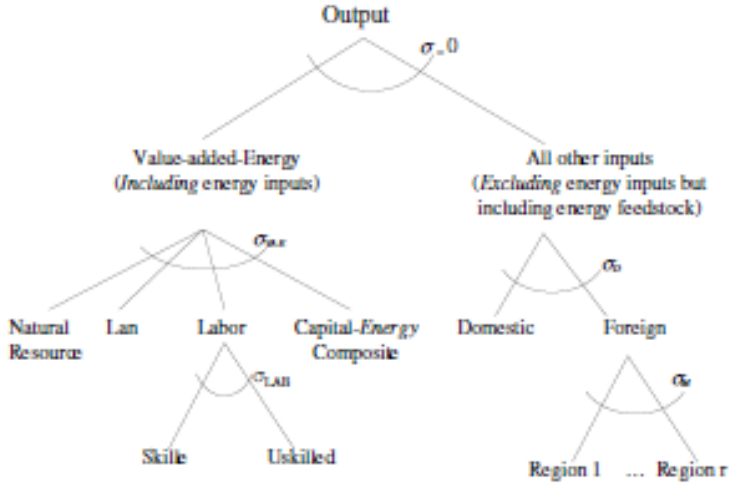

Figure 17 GTAP–E Capital-Energy Composite Structure