Ongoing Model and Dataset Development at EPA: NCEE

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DRAFT

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Agenda

- Past role of CGE models in regulatory impact analysis (RIAs)
- SAGE model and applications
- Other ongoing/future work

Past Role of CGE Models in RIAs

- Particularly useful for *"policies that have large economy-wide impacts, especially when indirect and interaction effects are expected to be significant …[and] generally more appropriate for analyzing medium- or long-term effects of policies or regulations"* (EPA Economic Guidelines).

- Typically, only characterize costs (not benefits)

- EPA has rarely used CGE analysis in regulatory analysis (~6 times)
  - Regulations not like taxes; do not simply introduce a wedge between unregulated and regulated market price
  - Difficult to adequately represent some types of costs (e.g., fuel savings in transportation; extrapolated costs in NAAQS regulations)
  - EPA usually relies on detailed engineering or partial equilibrium compliance cost estimates as inputs into CGE model
  - Effects of regulation are often quite small expressed in terms of changes in household consumption or industry output

Role of CGE models in RIAs

- SAB process launched in 2015 on use of CGE models for analyzing economic effects of environmental regulations
- SAB Final Report released in 2017
  - CGE analysis worthwhile when both are present:
    - Significant cross-price effects in markets outside regulated sector
    - Significant distortions in other markets (e.g., market power, taxes, regulation)
  - Complement to (not replacement for) engineering/PE analysis
    - Lack of representation of benefits does not mean CGE models cannot be informative on cost side

NCEE CGE Modeling Work

- NCEE tasked with leading development of EPA CGE modeling capacity

- Main advantages of centralized development:
  - Greater quality control and consistency in analyses
  - Minimize duplicative modeling efforts across offices
  - Increase transparency of CGE analyses for general public and key stakeholders

- Highlighted intention to coordinate with program offices to ensure CGE capabilities meet EPA needs

SAGE CGE Model

- SAGE is an Applied General Equilibrium model

- Key model features:
  - Dynamic inter-temporal model with perfect foresight-- default version covers 2016 to 2061 in 5 year steps
  - Small open economy
  - Putty-Clay capital in non-resource sectors
  - Sub-national spatial resolution
  - Greater sectoral disaggregation of manufacturing and energy
  - Household impacts resolved across income quintiles
  - Baseline calibrated to EIA's Annual Energy Outlook
  - Estimated elasticities taken from the literature

- Current version is based on 2016 IMPLAN data.

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Spatial and Sectoral Resolution

- Regions are characterized by the 9 census divisions. Pooled national market and Armington assumption.
- Sectors:

Manufacturing

bom	Balance of manufacturing
cem	Cement, concrete, & lime manufacturing
chm	Chemical manufacturing
con	Construction
cpu	Electronics and technology
fbm	Food & beverage manufacturing
fmm	Fabricated metal product manufacturing
pmm	Primary metal manufacturing
prm	Plastics & rubber products manufacturing
tem	Transportation equipment manufacturing
wpm	Wood & paper product manufacturing
wsu	Water, sewage, & other utilities

Energy

col	Coal mining
cru	Crude oil extraction
ele	Electric power
gas	Natural gas extraction & distribution
ref	Petroleum refineries

Other

agf	Agriculture, forestry, fishing & hunting
hlt	Healthcare services
min	Metal ore & nonmetallic mineral mining
srv	Services
trn	Transportation
ttn	Truck transportation

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Households and Government

- Households:
  - Each region has 5 households
  - Maximize inter-temporal welfare based on isoelastic utility function over full consumption (consumption & leisure)
  - Intra-temporal preferences based on nested CES function

Household	Benchmark Year Income [2016$]
hh1	< $30,000
hh2	$30,000 - $50,000
hh3	$50,000 - $70,000
hh4	$70,000 - $150,000
hh5	> $150,000

- Government:
  - Single government agent representing federal, state, and local governments
  - Levies ad valorem taxes on:
    - Labor earnings
    - Capital earnings
    - Production
    - Consumption

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Ongoing Development

- Plans to peer review SAGE for potential use in regulatory analysis
- Code is being developed using GitHub platform
  - Allows for easy collaboration and eventual transition to open source project
- Versioning
  - Come up with systematic approach to versioning which codifies model dependencies.
  - Anticipated system based on *semantic versioning*: MAJOR.MINOR.PATCH.
    - Major versions reflect fundamental updates. Incompatible with older versions.
    - Minor versions add features which are backward compatible.
    - Patches fix bugs and should also be backward compatible.
  - Determining how to characterize major and minor updates is important for peer review of the model.
  - Important feature in regulatory analysis. Point to a particular instance of the model which generates used cost estimates in RIAs.

Evaluating Regulatory Costs

- **When do GE cost estimates differ significantly from engineering cost estimates?**
  - Are there sectors where a simple scaling factor might apply to approximate the GE costs relative to engineering estimates?

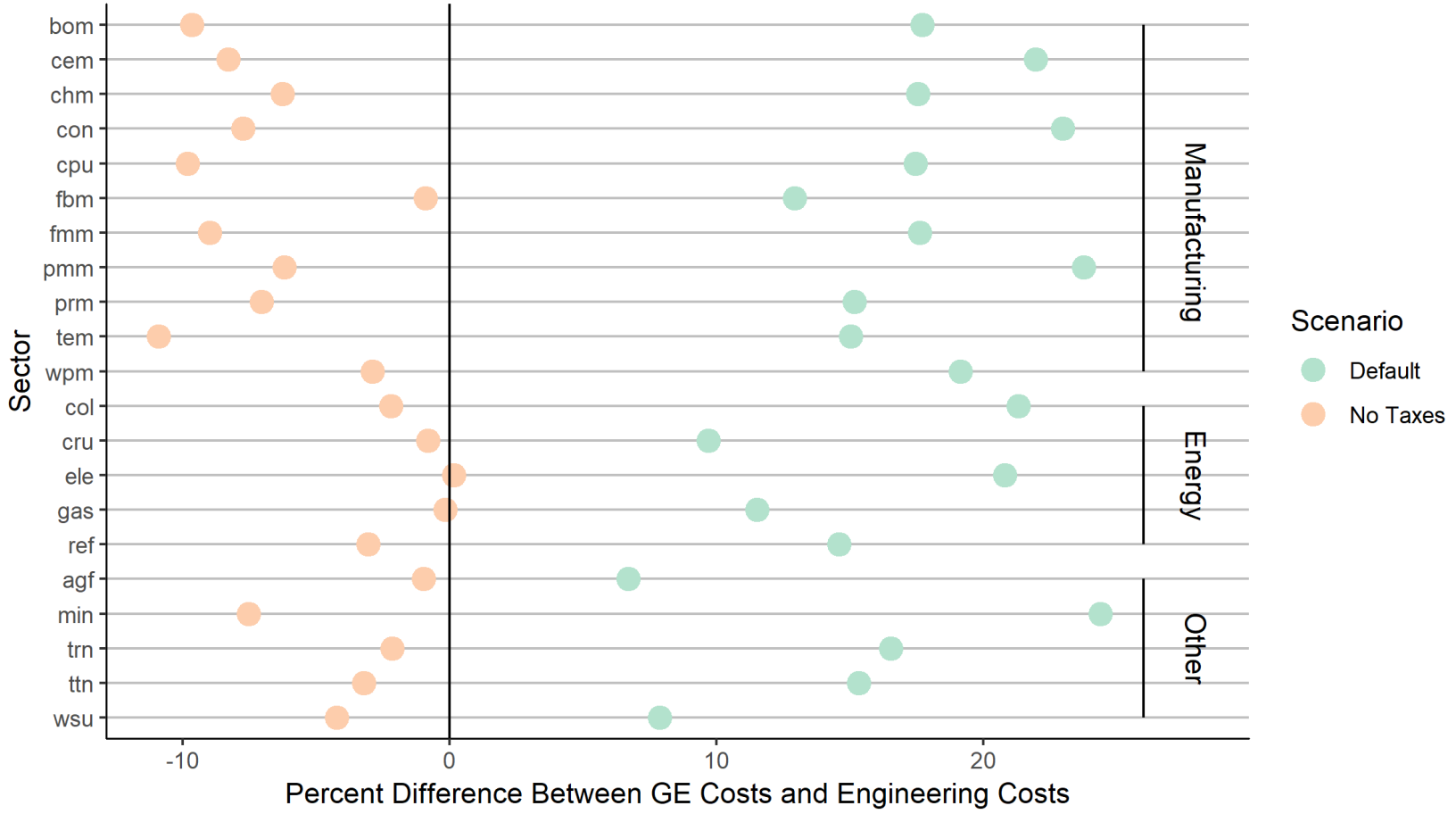
- Basic experiment:
  - Sector-specific regulatory shock with engineering costs of $100 million in the initial year
  - Modeled as a productivity shock -> more inputs required to produce a unit of output
    - Inputs required for pollution abatement based on Nestor & Pasurka (1995)
  - Scaled over time based on holding the compliance cost per unit output constant at the initial level

GE vs. Engineering Cost Estimates

- GE estimates capture at least three characteristics that engineering cost estimates don't:
  1. Interconnections between sectors of the economy
  2. Substitution possibilities in production, consumption, and trade
  3. Interactions with pre-existing distortions (e.g., taxes)

- To differentiate between the first two effects and the third we run the model w/ and w/o taxes
  - I.E., value of GE analysis in a first best vs. second best setting

Tax Sensitivity



Additional Sensitivities

- Are these results specific to SAGE? General results still hold with simplified model.
- Results are sensitive to:
  - Regulated sector
  - Regulated sources: New vs. Existing
  - Size of regulation
  - Compliance input requirements
  - Inclusion of dynamics
- Can't apply ad-hoc scaling factor to engineering costs. Likely no easy way to rule out sectors ex-ante.
- Paper highlights the importance of modeling explicit taxes in CGE models.

IMPLAN vs. WiNDC

- Cursory effort to use WiNDC in the SAGE framework. SAGE has its own build routine.
- Changes to the WiNDC dataset to work in the current version of SAGE:
  - Household disaggregation: use state level CEX and CPS data from Census to come up with rough disaggregation routine.
  - Sectoral aggregation
  - Convert byproducts into primary production sectors
  - Shift household production into primary production sectors
  - Move margin demands to intermediate inputs
  - Pass goods taxes in the Armington nest to output taxes
- Policy analysis – compare results from IMPLAN based GE vs. PE simulations from WiNDC based results (preliminary).

IMPLAN vs. WiNDC (Preliminary)

		activity	comm.	labor	capital	household	gov.	invest.	national	foreign
activity	implan		33090.5							
	windc		34886.2							
commodity	implan	14762.9				12233.4	3129.6	3505.4	7821.2	1988.6
	windc	16735.5				11759.0	3057.5	3846.3	20140.3	1786.9
labor	implan	7522.5								
	windc	8008.3								
capital	implan	4879.2								
	windc	5353.6								
household	implan			7522.5	4879.2		3672.4			540.8
	windc			8008.3	5353.6		2575.0			512.1
government	implan	5925.9				876.1				
	windc	4788.7				843.8				
investment	implan					3505.4				
	windc					3846.3				
national	implan		7821.2							
	windc		20140.3							
foreign	implan		2529.4							
	windc		2299.0							

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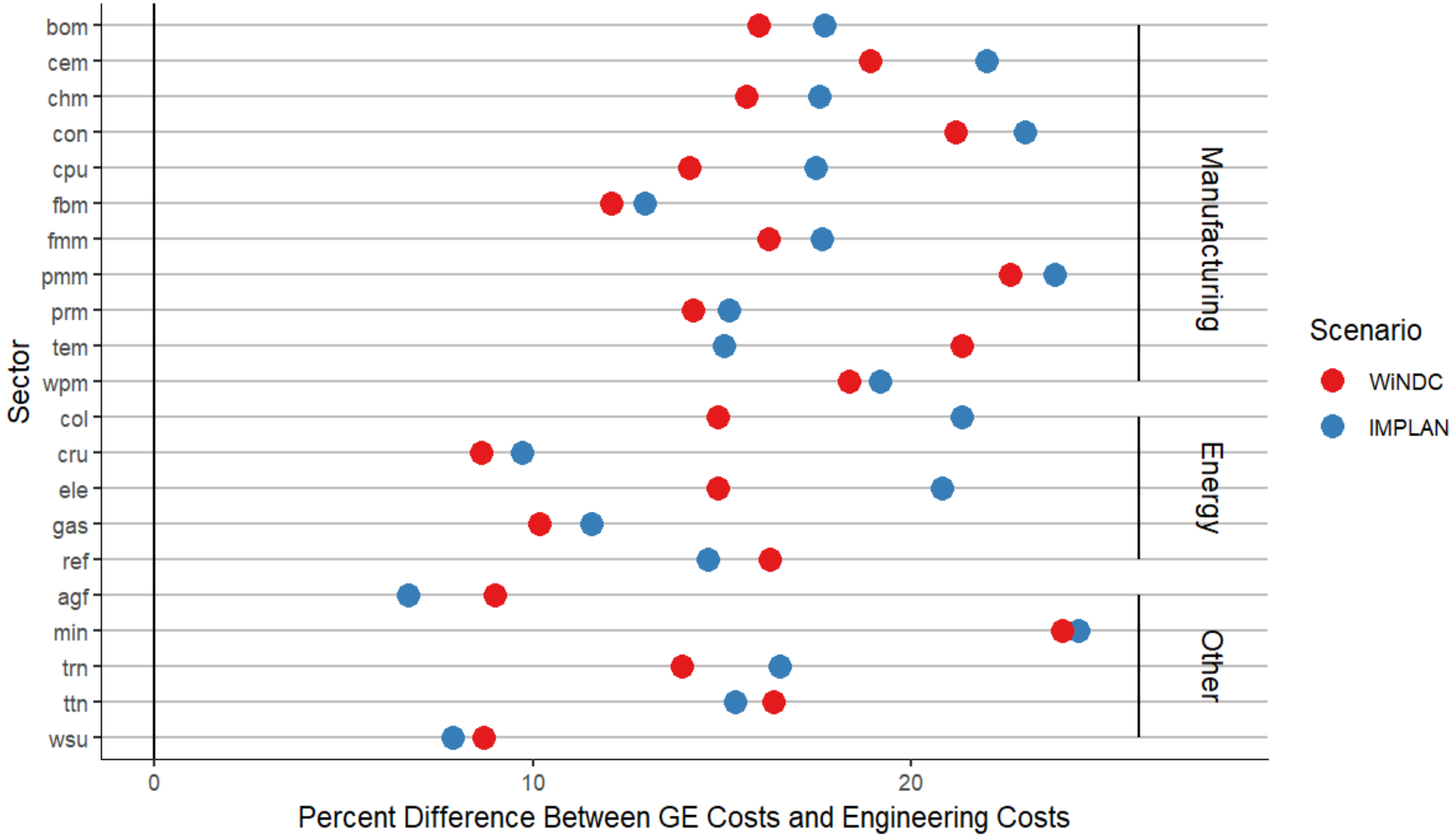
IMPLAN vs. WiNDC (Preliminary)



Expected NCEE CGE Work

- Ongoing:
  - Explore transitional labor dynamics in CGE models
  - Explore using Rutherford and Bohringer's decomposition technique to begin linking SAGE with sector level models
  - Characterizing source and use side determinants of welfare costs
- Future:
  - Transition to open source system with open source database
  - Further work on how to represent regulations in CGE models
  - Compare other tools to CGE models in household distributional analysis
  - Empirically estimate parameters to better inform consumer behavior