Comparing WiNDC with IMPLAN

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NATIONAL CENTER FOR ENVIRONMENTAL ECONOMICS

WiNDC Board Meeting

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Outline

1. Basic Data Comparison

2. SAGE Application

3. Leakage Application

Basic Data Comparison

Overview

Datasets used in this comparison:

- Core WiNDC build for 2016.
- State level IMPLAN files for 2016.
  - Build stream for IMPLAN data is based on SAGE (which uses Tom's IMPLANinGAMS).

Fundamental differences between datasets:

- Margins, dwellings, diagonal byproducts matrix, and restructured retail sectors.

Approach used here was to produce a "core" dataset with all of the same WiNDC parameters populated with IMPLAN data. Note that some of the parameters will be zeroed out (for instance, margin demands).

Data sources for WiNDC

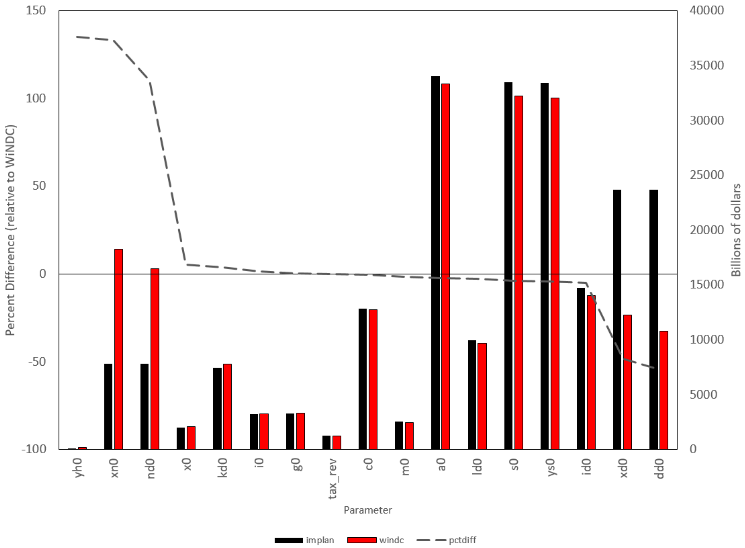
As a frame of reference, here are a listing of underlying datasets used to disaggregate the national accounts:

Source	Description	ID	URL	Years
Bureau of Economic Analysis	Supply and Use Tables	*BEA*	https://www.bea.gov/industry/io_annual.htm	1997-2017
	Gross State Product	*GSP*	https://www.bea.gov/newsreleases/regional/gdp_state/qgsp_newsrelease.htm	1997-2016
	Personal Cosumer Expenditures	*PCE*	https://www.bea.gov/newsreleases/regional/pce/pce_newsrelease.htm	1997-2017
Census Bureau	Commodity Flow Survey	*CFS*	https://www.census.gov/econ/cfs/	2012
	State Government Finance	*SGF*	https://www.census.gov/programs-surveys/state/data/tables.All.html	1997-2016
	State Exports/Imports	*UTD*	https://usatrade.census.gov	2002-2016
Energy Information Administration	State Energy Data System	*SEDS*	https://www.eia.gov/state/seds/	1963-2016

Listing of WiNDC parameters

Parameter	GAMS Code	Description
$\bar{ys}_{yr,r,s,g}$	`ys0(yr,r,s,g)`	Sectoral supply (with byproducts)
$\bar{id}_{yr,r,g,s}$	`id0(yr,r,g,s)`	Intermediate demand
$\bar{ld}_{yr,r,s}$	`ld0(yr,r,s)`	Labor demand
$\bar{kd}_{yr,r,s}$	`kd0(yr,r,s)`	Capital demand
$\bar{cd}_{yr,r,g}$	`cd0(yr,r,g)`	Final demand
$\bar{yh}_{yr,r,g}$	`yh0(yr,r,g)`	Household production
$\bar{g}_{yr,r,g}$	`g0(yr,r,g)`	Government demand
$\bar{i}_{yr,r,g}$	`i0(yr,r,g)`	Investment demand
$\bar{s}_{yr,r,g}$	`s0(yr,r,g)`	Aggregate supply
$\bar{xn}_{yr,r,g}$	`xn0(yr,r,g)`	National supply
$\bar{xd}_{yr,r,g}$	`xd0(yr,r,g)`	State level supply
$\bar{x}_{yr,r,g}$	`x0(yr,r,g)`	Foreign exports
$\bar{a}_{yr,r,g}$	`a0(yr,r,g)`	Armington supply
$\bar{m}_{yr,r,g}$	`m0(yr,r,g)`	Imports
$\bar{nd}_{yr,r,g}$	`nd0(yr,r,g)`	National demand
$\bar{dd}_{yr,r,g}$	`dd0(yr,r,g)`	State level demand
$\bar{bop}_{yr,r}$	`bopdef0(yr,r)`	Balance of payments
$\bar{ta}_{yr,r,g}$	`ta0(yr,r,g)`	Tax net subsidy rate on intermediate demand
$\bar{tm}_{yr,r,g}$	`tm0(yr,r,g)`	Import tariff
$\bar{md}_{yr,r,m,g}$	`md0(yr,r,m,g)`	Margin demand
$\bar{nm}_{yr,r,g,m}$	`nm0(yr,r,g,m)`	National margin supply
$\bar{dm}_{yr,r,g,m}$	`dm0(yr,r,g,m)`	State level margin supply

Aggregate parameter totals



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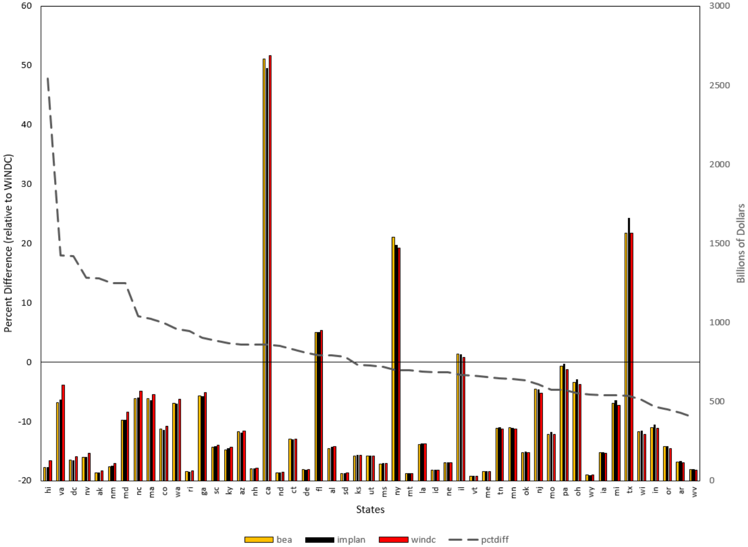
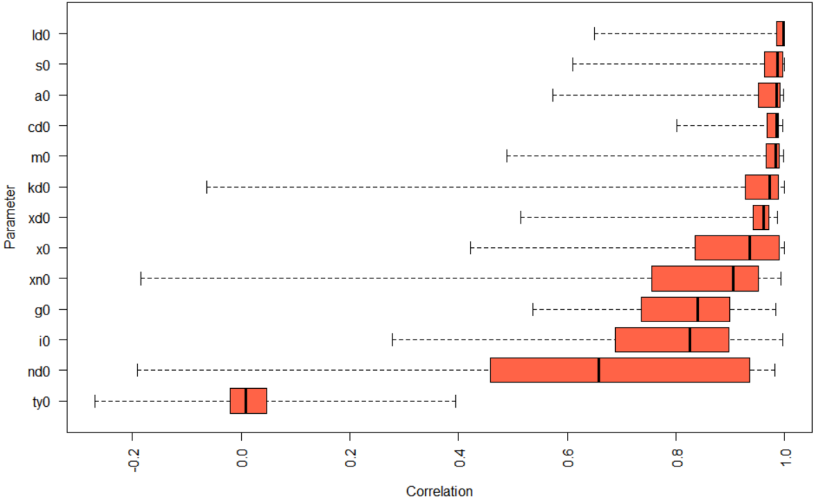
Gross state product



Correlations



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Basic findings

- Many similarities.
- Regional purchase coefficients differ for many sectors. Hard to determine what is more desirable. CFS includes transhipments, but IMPLAN gravity model values are not publicly available.
- Retail sector restructuring throw off consumption comparisons.
- Export and Import regional disaggregation needs investigating.
- Total investment is similar across datasets, but IMPLAN has investments for commodities inconsistent with national input output tables (e.g. retail, agriculture).

SAGE Application

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JAERE simulations

Exploring the General Equilibrium Costs of Sector-Specific Environmental Regulations

Alex L. Marten, Richard Garbaccio, Ann Wolverton

Abstract: The requisite scope of analysis to adequately estimate the social cost of environmental regulations has been subject to much discussion. The literature has demonstrated that engineering or partial equilibrium cost estimates likely underestimate the social cost of large-scale environmental regulations and environmental taxes. However, the conditions under which general equilibrium (GE) analysis adds value to welfare analysis for single-sector technology or performance standards, the predominant policy intervention in practice, remains an open question. Using a numerical computable general equilibrium (CGE) model, we investigate the GE effects of regulations across different sectors, abatement technologies, and regulatory designs. Our results show that even for small regulations GE effects are significant, and engineering estimates of compliance costs can substantially underestimate the social cost of single-sector environmental regulations. We find that the downward bias from using engineering costs to approximate social costs depends on the input composition of abatement technologies and the regulated sector.

JEL Codes: D58, Q52, Q58

Keywords: environmental regulation, general equilibrium, social costs

SAGE CGE Model

SAGE is an **A**pplied **G**eneral **E**quilibrium model.

Dynamic inter-temporal model with perfect foresight. Covers 2016 to 2061 in 5 year steps. 9 census divisions and 23 sectors following EIA's energy outlook.

Manufacturing		**Energy**	
bom	Balance of manufacturing	col	Coal mining
cem	Cement, concrete, & lime manufacturing	cru	Crude oil extraction
chm	Chemical manufacturing	ele	Electric power
con	Construction	gas	Natural gas extraction & distribution
cpu	Electronics and technology	ref	Petroleum refineries
fbm	Food & beverage manufacturing		
fmm	Fabricated metal product manufacturing	**Other**	
pmm	Primary metal manufacturing	agf	Agriculture, forestry, fishing & hunting
prm	Plastics & rubber products manufacturing	hlt	Healthcare services
tem	Transportation equipment manufacturing	min	Metal ore & nonmetallic mineral mining
wpm	Wood & paper product manufacturing	srv	Services
wsu	Water, sewage, & other utilities	trn	Transportation
		ttn	Truck transportation

For more on the model, see: `https://www.epa.gov/environmental-economics/cge-modeling-regulatory-analysis`.

Aligning WiNDC database with SAGE build stream

- *These modeling results do not use household disaggregation. Models using both IMPLAN and WiNDC have a single regional representative agent.*
- Sectoral aggregation – required disaggregation routine in WiNDC package.
- Remove byproducts by moving secondary production into primary production sectors.
- Move household production into primary production sectors.
- Move margin demands to intermediate inputs.
- Pass import duties and sales taxes through to production taxes.

All above changes maintain micro-consistency of the data. Rebalancing was required to remove re-exports and disaggregate the oil and gas extraction sectors to follow SAGE build.

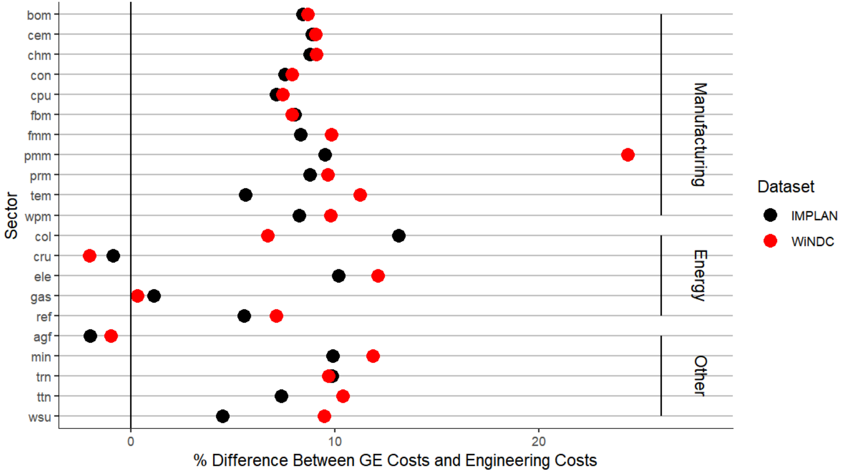
Sample of simulations

Assume $100 million direct compliance costs for a given sector to comply with an illustrative environmental regulation. Two sample methods for incorporating this shock:

1. Hick's neutral
   - divide the shock in proportion to sectoral production input shares
2. Labor bias
   - assume the full compliance cost requires additional labor only

See the paper for the whole suite of simulation exercises.

Hick's neutral policy shock



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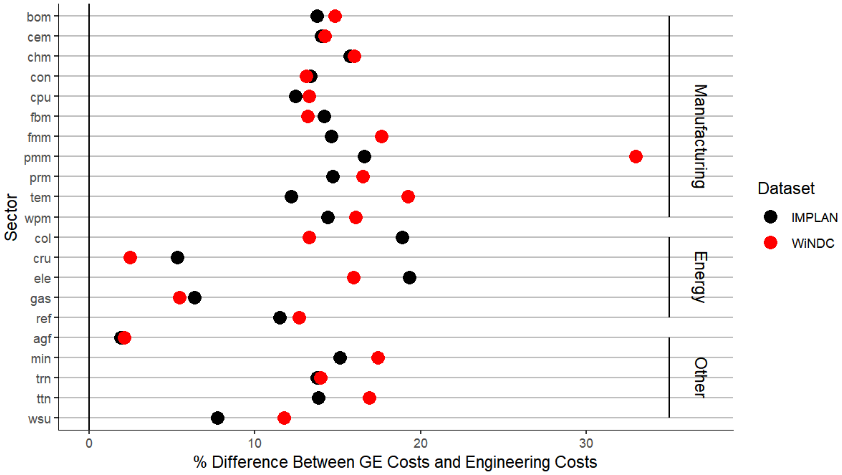
Labor bias policy shock



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Leakage Application

JGEA simulations

Tools for Open Source, Subnational CGE Modeling with an Illustrative Analysis of Carbon Leakage

By Thomas F. Rutherford[a] and Andrew Schreiber[b]

This paper introduces the Wisconsin National Data Consortium (WiNDC) framework for producing self-consistent accounts based on publicly available datasets that can be used in sub-national economic equilibrium analysis in the United States. We describe the process used to generate regional social accounting matrices and a calibrated static multi-regional, multi-sectoral computable general equilibrium model conformal with the constructed dataset. As illustration, we show how the core model can be applied for the analysis of energy-environment issues. We use an energy-economy extension of the core model to assess the effectiveness of several state level greenhouse gas mitigation proposals. Sub-national abatement measures result in carbon leakage – mandated reductions in controlled areas may be vitiated by increased emissions in uncontrolled jurisdictions. Using a WiNDC-based model, we calculate leakage rates and show how these depend on the underlying trade model. Our calculations demonstrate the importance of both data and modeling assumptions for the simulation of policy experiments.

JEL codes: C6, C8, D5, Q5, R1.

Keywords: Computable General Equilibrium Models; Applied Economic Analysis; Multi-regional Models; Air Pollution; Regional Economies.

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Recalibrating the energy-economy datasets: blueNOTE

blueNOTE: blue **N**ational **O**pen source **T**ools for general **E**quilibrium modeling

Matrix balancing routines are provided (similar to those in the national case) which can enforce certain totals in the dataset if needed. For energy applications we use the State Energy Data System (SEDS) data to:

- impose both energy demands (which match emission levels) and supplies
- separate oil and natural gas extraction sector
- generate carbon emissions
- adjust trade margins to be in tune with electricity mark ups

Model

The framework for analysis is static, with:

- 50 states (plus D.C.)
- KLEM production structure
- Regional representative agent
- Estimated bilateral trade flows via a gravity model
- 11 sectors, defined based on carbon intensity

Symbol	Description
oil	Petroleum refineries
cru	Crude oil extraction
gas	Natural gas extraction
col	Coal mining
ele	Electric power generation, transmission, and distribution
trn	Transportation
con	Construction
eint	Energy/Emission intensive sectors (embodied carbon ¿ .5 kg per $)
omnf	Other manufacturing sectors
osrv	Other services
roe	Rest of the economy

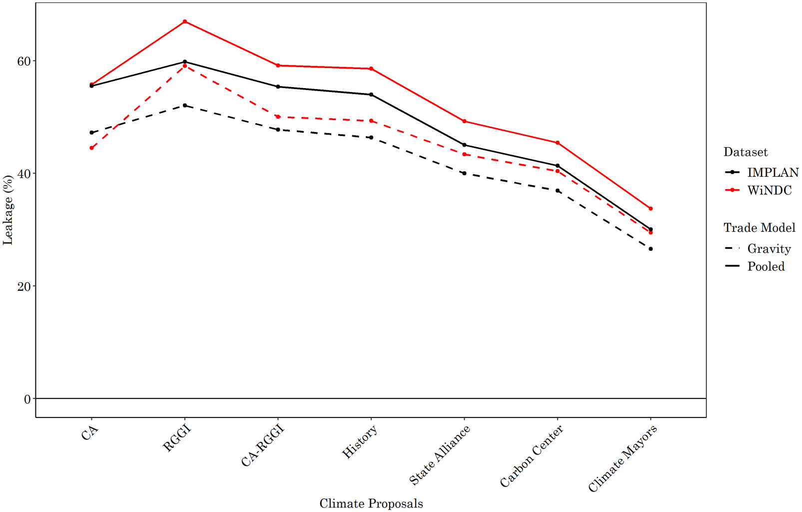
Scenarios

Application: Study the effectiveness of state level interest in climate action. Carbon leakage will determine effectiveness of state level action in reducing national emissions.

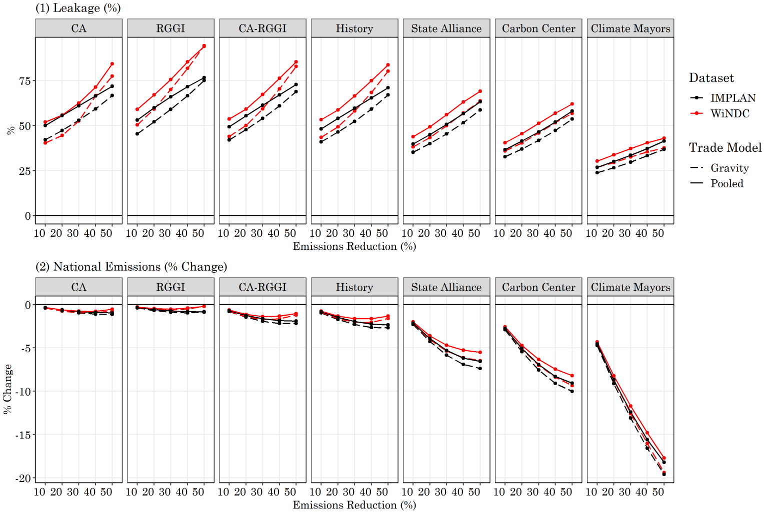
Name	Description	Included States
CA	California	CA
RGGI	Regional Greenhouse Gas Initiative States	CT, DE, MA, MD, ME, NH, NY, RI, VT
CA-RGGI	California and RGGI States	CA, CT, DE, MA, MD, ME, NH, NY, RI, VT
History	States with a history of attempted climate action	CA, CT, DE, MA, MD, ME, NH, NY, RI, VT, WA, OR
State Alliance	States with attempted past action and those in the State Alliance	CA, CT, DE, MA, MD, ME, NH, NY, RI, VT, WA, OR, CO, HI, IL, MI, MN, NM, NJ, NC, VA, WI
Carbon Center	States with attempted past action those in the State Alliance, or those deemed with some potential or challenging per the Carbon Tax Center's report	CA, CT, DE, MA, MD, ME, NH, NY, RI, VT, WA, OR, CO, HI, IL, MI, MN, NM, NJ, NC, VA, WI, DC, FL, NV, AR, SC
Climate Mayor	States with attempted past action, in the State Alliance, in the Carbon Tax Center report, or have at least 20% of their population in cities with mayors joining Climate Mayors	CA, CT, DE, MA, MD, ME, NH, NY, RI, VT, WA, OR, CO, HI, IL, MI, MN, NM, NJ, NC, VA, WI, DC, FL, NV, AR, SC, TX, AZ, TN, AK

Reference application is a 20% reduction in regional emissions.

Leakage rates across policy proposals (%)



Sensitivity on emission cutbacks



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