Price Elasticity of Demand

State and Sector Comparison

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Background

- Electricity demand estimates by end-use customer class (residential, commercial, industrial) help inform energy policy making, resource planning, and electricity pricing.
- Elasticity is often used in IO literature to infer marginal costs, given certain assumptions on how firms set their prices.
- We estimated price elasticity of demand for a single state’s residential use

How price elasticity of demand for electricity vary by state and end use (residential, commercial, industrial)?

- What state/end use characteristics explain these differences?
- Can these price elasticities help us infer marginal cost of generation? output?

Data

- 3 state-month panels (residential, commercial, industrial) 2010-2021
  - State electricity sales
  - State electricity prices
  - State personal income per capita
  - Region Heating/Cooling degree days (H/CDD)
  - US natural gas prices

Model: 3 models, one for each end use

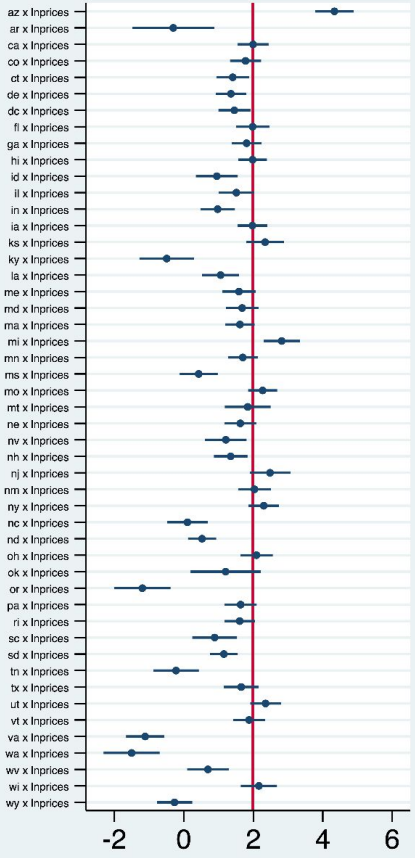
$$ln(sales)_{it} = \beta_0 + \beta_1 ln(price)_{it} + \beta_2 ln(inc)_{it} + \beta_3 HDD_{it} + \beta_4 CDD_{it} + \beta_5 ln(price)_{it-1} + \sum_{k=2}^{51} [\gamma_k state_{ki}] + \sum_{k=2}^{51} [\delta_k state_{ki} \times ln(price)_{it}]$$

- Extend HW1's log-log regression to include 50 state indicators and 50 stateXln(price) interactions.
- Our elasticity estimate is given by the sum of the ln(price) and interaction coefficients.

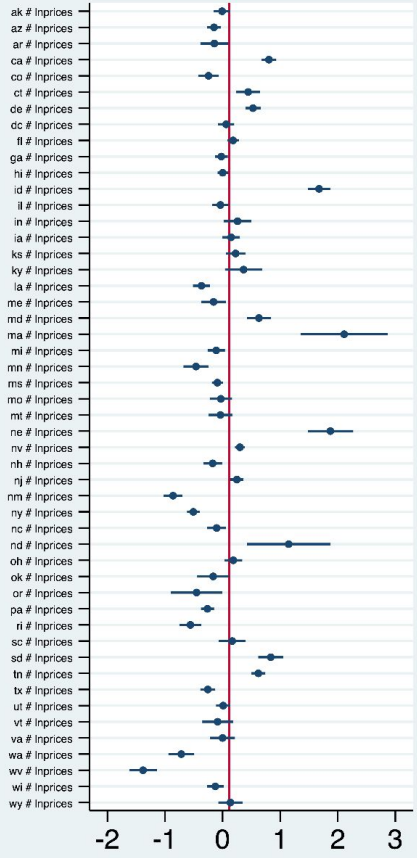
$$\text{Price Elasticity of Demand for } state_k = \beta_1 + \delta_k$$

Price Elasticities

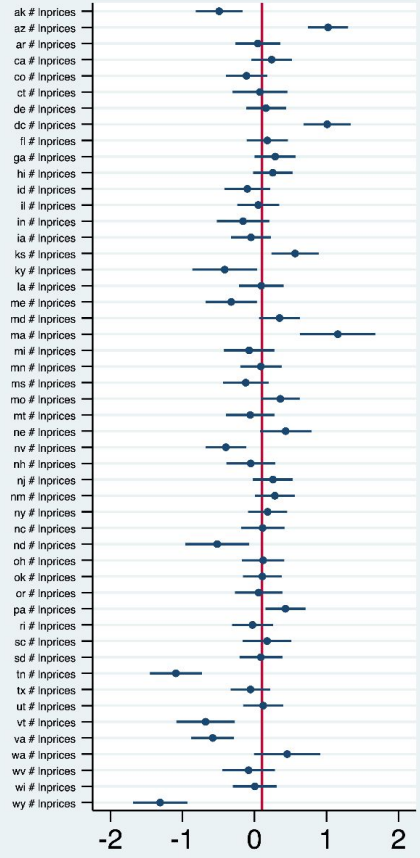
Residential



Industrial



Commercial



Price Elasticities

- Pairwise Wald Testing
  - $H^0: \quad \delta_i = \delta_j \text{ for each state } i, j$ Reject if p < .05
  - Rejection implies the states' elasticities are significantly different
  - The result is a 51 x 51 matrix of p-values that reject/fail to reject for each pair of states
- Ask: do states differ by:
  - Market (ERCOT, PJM, MISO, etc.)
  - Interconnection group
  - Major industries
- Pick a few interesting cases and discuss

Marginal Cost Estimation

- Lerner Index

$$\frac{p - mc}{p} = \frac{1}{|\varepsilon|}$$

- Solve for MC

$$mc = p\left[1 + \frac{1}{|\varepsilon|}\right]$$

Natural Gas as a Proxy for Generator MC

- Natural gas is the leading energy source for generation in the US and for many states it makes up more than half of total generation by kwh
- Using 0.13 kwh per cubic ft, I converted natural gas prices into prices per kwh of generation

Marginal Cost Estimation

- Lerner Index

$$\frac{p - mc}{p} = \frac{1}{|\varepsilon|}$$

- Natural Gas Proxy

$$mc_{proxy} = \frac{ng}{0.13}\left[\frac{\$}{ft^3}\frac{ft^3}{kwh}\right]$$

- Solve for MC

$$mc = p\left[1 + \frac{1}{|\varepsilon|}\right]$$

- Check

$$mc_{proxy} - mc$$

Marginal Cost Estimation

	Est. MC	Natural Gas
com	2.010	0.030
ind	0.573	0.030
res	2.948	0.030
Total	1.836	0.030

Marginal Cost Estimation: Significant Industrial Estimates

	Est. MC - Nat. Gas
ca	-.2632268
ct	-.505502
de	-.2512463
fl	-1.241958
id	-.066249
in	-.5153802
ks	-.7104632
ky	-.2462336
ma	-.1736322
md	-.2162889
nd	-.1142424
ne	-.1656643
nj	-.8732309
nv	-.3754437
oh	-.973889
sd	-.1423719
tn	-.1527383
Total	-.4110447

- Pretty close results to start
- Could improve by more accurate market structure/ price setting assumptions than monopoly
- Could also use % natural gas generation for each state to scale my mc estimate and then compare to natural gas price

That’s All