



Carbon Price Pass-Through in Alberta's Electricity Market

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Carbon Pricing's Effect on Electricity Markets

- We want to understand how firms react to carbon pricing: do they pass through marginal prices as our models assume?
- Electricity markets are a real-life supply and demand model
- Alberta GHG policies changed carbon prices and output-based credit allocations across time and facilities
- We build a rich data set of relevant firm and market covariates
- Our results show weaker pass through than seen in Fabra and Reguant (2014) or Hintermann (2016) which each find near-complete pass-through of emissions costs
- We are left with the question of why costs might not be fully passed-through to market offer curves, at least for marginal blocks of power

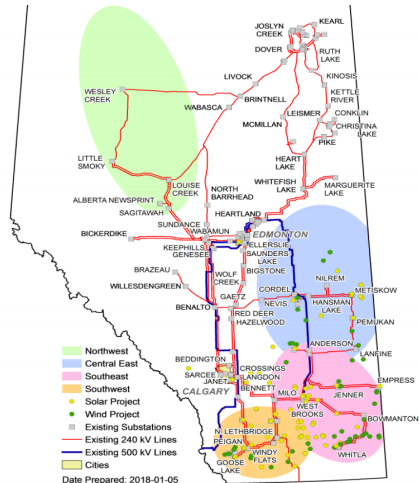


Alberta's Power Market is an Ideal Laboratory

- Alberta's power market is relatively small, isolated, with minimal intertie capacity:
 - WECC (1325 MW export and 1500 MW import) and Saskatchewan (150 MW)



Alberta Power Market



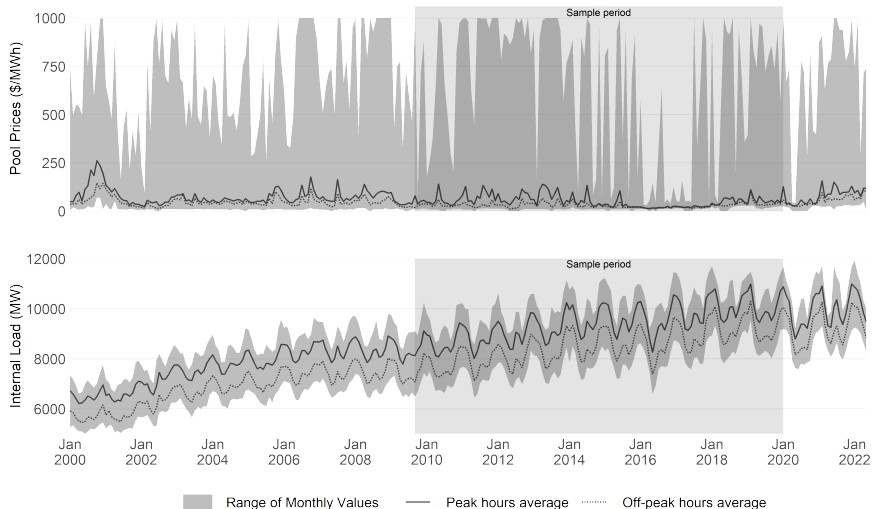


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Alberta Power Market Prices and Loads



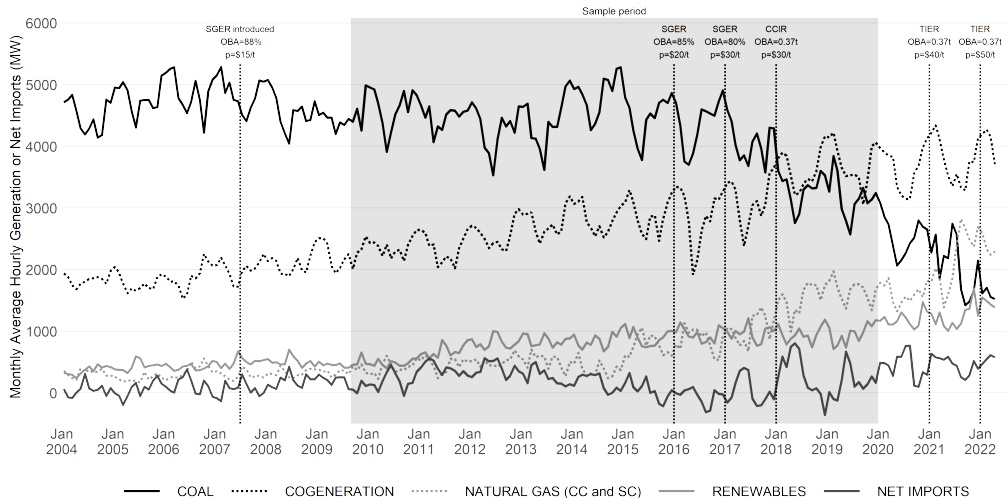


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Alberta Power Generation Sources





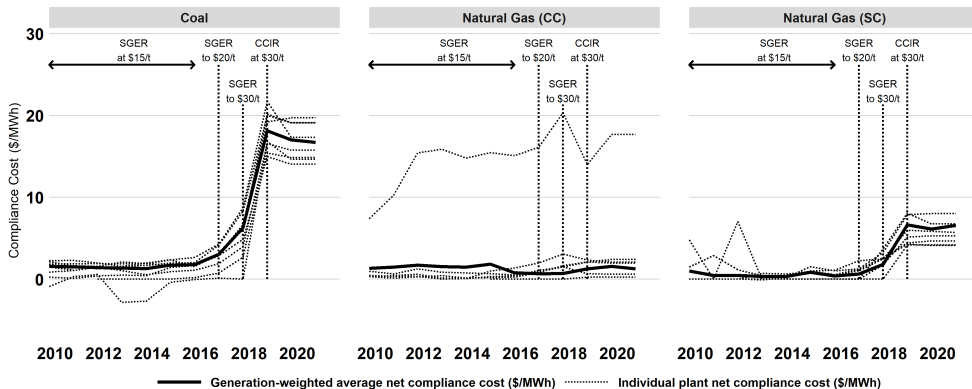
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 - WECC (1325 MW export and 1500 MW import) and Saskatchewan (150 MW)
- Alberta's market is winter-peaking (load) but often has high summer prices
- Alberta's market has a wide variety of sources of generation
- Carbon emissions reporting covers most facilities in the market
 - Carbon pricing has been in place since 2007
 - Carbon pricing design changed repeatedly from 2015-2022

Alberta's Policy Changes as Treatments

- 2007-2015: *Specified Gas Emitters Regulation (SGER)*
 - Price of \$15/t, OBAs at 88% of historic GHG/MWh
 - Covered only large (>100kt/yr) facilities
- 2016-2017: *Specified Gas Emitters Regulation (SGER)*
 - 2016: price \$20/t, OBAs at 85% of historic GHG/MWh
 - 2017: price \$30/t, OBAs at 80% of historic GHG/MWh
 - Covered only large (>100kt/yr) facilities
- 2018-2019: *Carbon Competitiveness Incentive Regulation (CCIR)*
 - 2018-19: price \$30/t, OBAs at 0.37t/MWh for all facilities
 - Covered large (>100kt/yr) facilities, with opt-in provision
- 2019-present: *Technology Innovation and Emissions Reduction Regulation (TIER)*
 - 2020: price \$30/t, OBAs at 0.37t/MWh for all facilities
 - 2021: price \$40/t, OBAs at 0.37t/MWh for all facilities
 - 2022: price \$50/t, OBAs at 0.37t/MWh for all facilities
 - Covers large (>100kt/yr) facilities, with opt-in provision

Carbon pricing impacts across facilities over time



- different impacts of carbon pricing on plants of the same type at the same time, and changes in pricing for the same plants over time combine to allow us to identify expected pass-through of carbon tax costs and OBA value

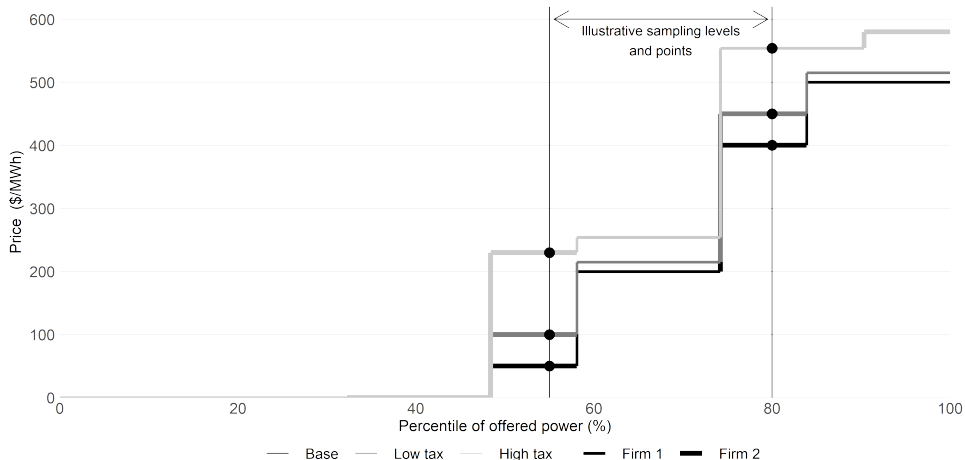
Empirical Framework

- We estimate GHG cost pass through using samples drawn from merit orders at each hour t at each of J percentile support points to estimate:

$$\underbrace{P_{j,t}}_{\substack{\text{Offer value} \\ \text{at percentile } j \\ \text{at time } t}} = \underbrace{\alpha_j}_{\substack{\text{Constant for} \\ \text{percentile } j}} + \underbrace{\beta_j M_t}_{\substack{\text{Market, policy, and} \\ \text{climate variables} \\ \text{at time } t}} + \underbrace{\delta_j F_{j,t}}_{\substack{\text{Facility} \\ \text{characteristics} \\ \text{at percentile } j \\ \text{at time } t}} + \\
 \underbrace{\zeta_j t_{j,t}}_{\substack{\text{Carbon cost} \\ \text{at percentile } j \\ \text{at time } t}} + \underbrace{\kappa_j O_{j,t}}_{\substack{\text{OBA value} \\ \text{at percentile } j \\ \text{at time } t}} + \underbrace{\epsilon_{j,t}}_{\text{Error term}}$$

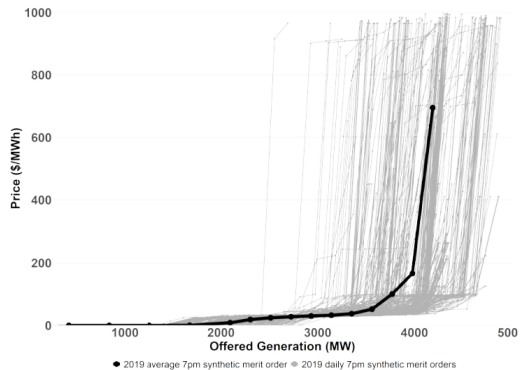
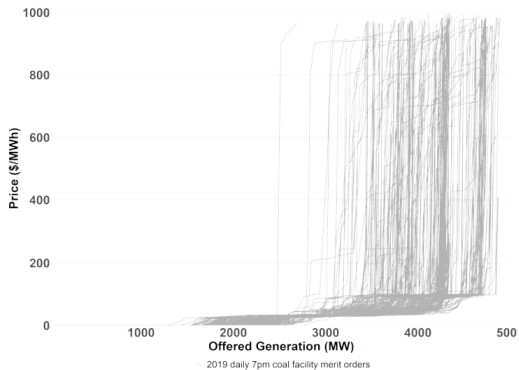


Empirical Framework





Empirical Framework



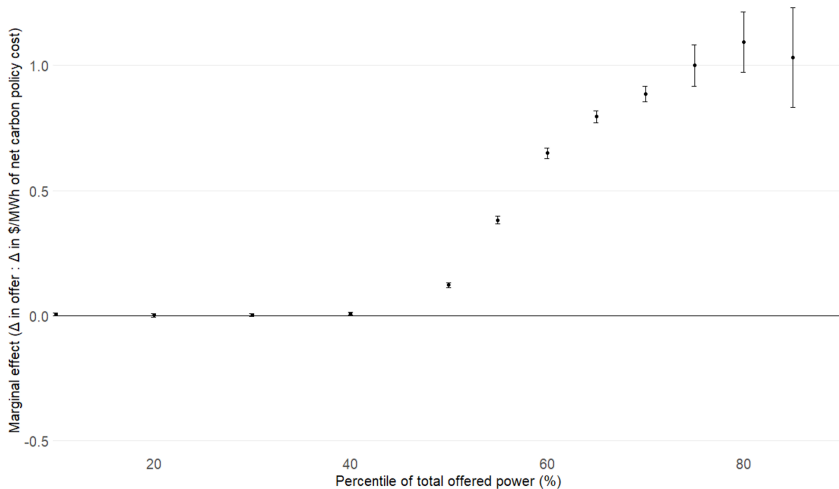
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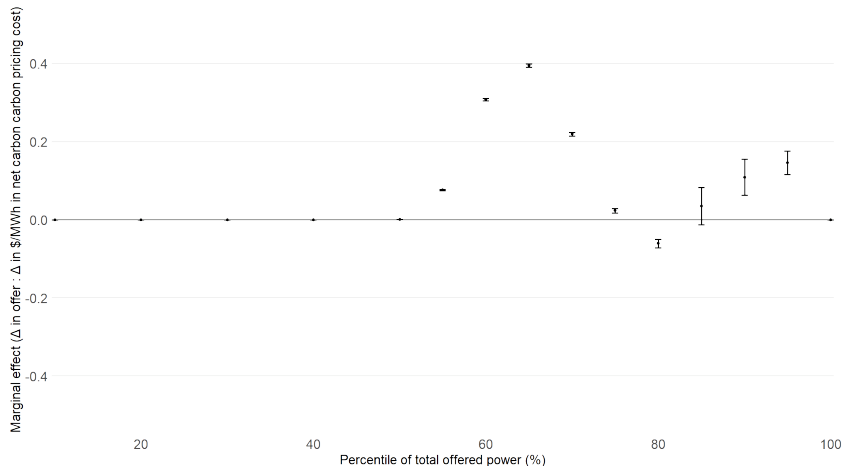
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- The estimated values of parameters ζ_j and κ_j will tell us the degree of pass-through of carbon tax costs and OBA values at each percentile j of each merit order we examine.

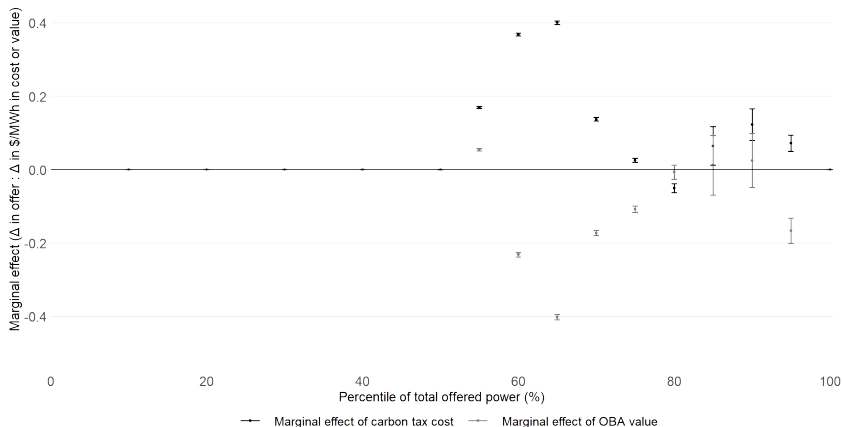
Expected Estimates of ζ_j



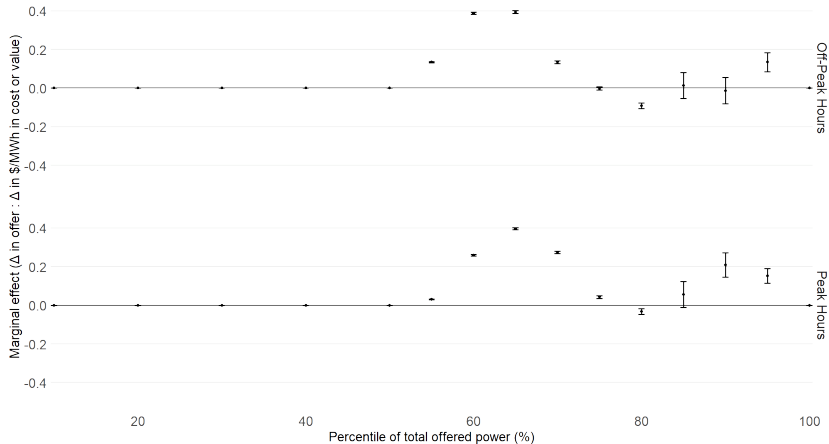
Carbon pricing pass through, full market



Carbon pricing pass through, full market



Carbon pricing pass through, full market



Discussion

- Alberta's energy-only power market provides an ideal environment to study carbon price pass-through
- Alberta policy changes alter both carbon prices and output-based credit allocations provide facility-specific treatment
- Results imply much lower pass-through rates than previous work in this area
- The question is why this would be the case?
 - Coal-to-gas price ratios (Cullen and Mansur (2017))
 - Strategic behaviour
 - Omitted variables (facilities with invariant bids)
 - Changes in ownership and the role of the Balancing Pool during our sample period



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