Market Power in the New Zealand Electricity Market 2010-2016

Stephen Poletti

University of Auckland
Background

- New Zealand wholesale market is ENERGY ONLY.
- Light handed regulation. No price cap.
- “Exercise of market power is allowed and is widely seen as a way for generators to recover their fixed costs (Philpott, Read, Batstone and Millar, 2018)”
- Energy Only market, single price,
60-70% Hydro Dry Year Problem. Only 6 weeks hydro storage.....some years low inflows.....=LOW lake levels, high prices and possible rationing. Come back to this
Background – concern at rising prices

Figure 5: Average electricity prices between 1990 and 2018

- Residential
- Commercial
- Industrial
- Total
Residential – International comparison

Index 1986=100

- New Zealand
- Australia
- Canada
- France
- Germany
- Japan
- OECD Europe
- United Kingdom
- United States of America
- Republic of Korea
Electricity Price Review 2018-2019

The Electricity Price Review is investigating whether the current electricity market delivers a fair and equitable price to consumers. This includes considering improvements to future-proof the sector and its governance structures.

On this page
Background

- Earlier - Commerce Commission concerned about market power. Wolak (2009)
Wolak report. May 2009

• Found “exercise of unilateral market power has resulted in substantial wealth transfers from consumers to producers.”

• Wolak concluded in the report that market power rents over the seven year period he studied amounted to 4.3 billion dollars.
An important critique

- NZ has a lot of HYDRO 60-70%.
- **Water values.** Hydro water has an opportunity cost. If I generate now and get $50/MWh I may not have water in the dam in 30 days time when price is $500/MWh.
- Wolak assumes opportunity cost is that of the highest priced thermal. Implicitly assumes away risk that hydro lakes go dry.
- Really need to solve dynamic stochastic optimisation program scheduling hydro dispatch using historical inflow sequences to work out risk.
Methodology

• Water values important but private knowledge of firms.
• Need to estimate as function of lake levels.
• We use a computer agent based model which allows for market power.
• Calibrate when water values are zero (lots of water in lakes)
• Then estimate water value curve.
• Competitive benchmark by forcing firms to bid in at MC with the MC for hydro equal to water value.
Fitted Watervalue Curves

**Summer**
August - February

\[ WV_{Summer} = 130e^{-0.0017D} - 45 \]

![Graph of Summer Water Value](image1)

**Winter**
March - July

\[ WV_{Winter} = 185e^{-0.0018D} - 28 \]

![Graph of Winter Water Value](image2)

Plot water value which best matches prices
Fit Exponential function
Agent-Based Modelling

- Agent-based models are simulation models
  - Allows for very realistic network representations
- Each player in the model is represented by an agent
  - Usually some type of learning algorithm

- Agents try different actions. Actions which yield “high profit” are more likely next round
Erev-Roth Algorithm

- Say the firm chooses $20, all the other firms independently choose an action, and the market is then cleared.
Agent Based Model

- If profit from an action is “good” then action more likely next round.
- Action here is to specify price for the generation capacity of plant to be offered into the wholesale market.
- Typically 1500 rounds for agents to learn.
- Computers not very smart!
Erev-Roth Algorithm

- Algorithm repeats for a specified number of periods. Often every generator will converge to a single action.
E-R model of NZ market

- Firms have portfolio of generators. Usually choose different price to offer capacity of each generators to the wholesale market. So firm step function supply curve.

- Simplified 19 node network. Market solver similar to one used by ISO.

- Line losses and line capacity.

- Must runs bid in at ZERO cost such. First to be dispatched

- RR hydro, and min flow rates on rivers downstream of dams, geothermal.

- 2000MW is must run (1/4 of peak demand)
Young et. al. (2011) Calibration and validation. Much better than comp model.

• Calibrates E-R parameters
• Hydro key feature. Calibrates water value curve. Less water in lakes more valuable water is.
Dynamic model with Dispatch

• Computer agent model tends to dispatch more hydro than observed.
• Keep track of hydro dispatch each period and update lake level over the simulated year.
• Dynamically consistent but difficult.
• Also simulations using actual lake levels.
• All simulations. 12 trading periods a day for a year
RESULTS – Simulations for each year 2010-2016. Actual lake levels

Figure 1: 2010 Running average 7 day actual and simulated prices and water values.
Price spike December 2010

• Electricity Authority concerned
• “the publicly available information at the end of November 2010 made it difficult to determine why the wholesale spot price increased so rapidly in December.”
• Report says “price spike was due to a number of factors, principally uncertainly surrounding hydrology with; an early snow melt; a strong emerging La Niña weather pattern; uncertainty surrounding the planned Maui outage in February 2011; and uncertainty surrounding thermal plant availability”
AND Dynamic simulations where lake levels updates using simulated dispatch

Dynamic simulations. Actual and simulated lake levels for 2010
Dynamic prices
Simulated and actual prices

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Historic lake levels</th>
<th>Dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>60.1</td>
<td>56</td>
<td>65.5</td>
</tr>
<tr>
<td>2011</td>
<td>63.1</td>
<td>58.1</td>
<td>67.8</td>
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<tr>
<td>2012</td>
<td>84.8</td>
<td>84.3</td>
<td>84.3</td>
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<tr>
<td>2013</td>
<td>65.9</td>
<td>59.1</td>
<td>52.3</td>
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<tr>
<td>2014</td>
<td>76.7</td>
<td>60.3</td>
<td>63.7</td>
</tr>
<tr>
<td>2015</td>
<td>69.1</td>
<td>70.3</td>
<td>57.0</td>
</tr>
<tr>
<td>2016</td>
<td>56.6</td>
<td>47.8</td>
<td>49.9</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>68.0</strong></td>
<td><strong>62.3</strong></td>
<td><strong>62.9</strong></td>
</tr>
</tbody>
</table>
# Market Rents -39% of Revenue

<table>
<thead>
<tr>
<th>Year</th>
<th>Simulated Competitive Benchmark Revenue ($million)</th>
<th>ACTUAL Market rents ($ million)</th>
<th>% of total</th>
<th>ACTUAL Wholesale Revenue ($million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1861</td>
<td>333</td>
<td>15%</td>
<td>2194</td>
</tr>
<tr>
<td>2011</td>
<td>1668</td>
<td>393</td>
<td>19%</td>
<td>2061</td>
</tr>
<tr>
<td>2012</td>
<td>1569</td>
<td>1077</td>
<td>41%</td>
<td>2646</td>
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<tr>
<td>2013</td>
<td>1146</td>
<td>1003</td>
<td>47%</td>
<td>2145</td>
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<tr>
<td>2014</td>
<td>1290</td>
<td>1136</td>
<td>47%</td>
<td>2426</td>
</tr>
<tr>
<td>2015</td>
<td>1142</td>
<td>1044</td>
<td>48%</td>
<td>2186</td>
</tr>
<tr>
<td>2016</td>
<td>856</td>
<td>1058</td>
<td>56%</td>
<td>1878</td>
</tr>
<tr>
<td>SUM</td>
<td>9532</td>
<td>6044</td>
<td>39%</td>
<td>15536</td>
</tr>
</tbody>
</table>
Response from review

• Our first report’s analysis of generators’ profits found no evidence they were excessive, although submitters had mixed views about our analysis. Some challenged long run marginal costs as a benchmark for determining excessive profits.
Figure 14: Wholesale contract prices versus cost of building new power stations
RESPONSE

• Economist Stephen Poletti preferred short-run marginal costs, saying “generator profits on the spot market are excessive compared to underlying costs”.

• Other submitters supported our analysis. Meridian said “profits above short-run marginal costs are entirely expected in an energy-only market and are necessary otherwise no one would ever invest”.
THE END