Benchmarking Electricity Distribution Networks

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Overview

- Background to benchmarking
- Methods and applications
- Strategic behaviour
- Lessons
- Conclusions
(Incentive) Regulation - History

- Regulation of licensing, obligation to serve, pricing, reliability, safety, theft, etc. date back to early years of the industry (House of Commons, 1882).

- First (incentive) regulations - UK
  - In 1855 - Sliding scale in the Sheffield Gas Act for Sheffield Company, a town gas supplier.
  - A similar plan in 1893 for the electricity industry.

- Canada - In 1887 - Cost-At-Service plan for Consumers’ Gas Company of Toronto.

Incentive Regulation

- Renewed interest after liberalisation
- Efficiency improvement – through penalty/reward

- **Benchmarking** – as a tool for incentive regulation
  - Information asymmetry
  - Mimic market mechanisms / non-intervention

- Incentives are strong and work

- But, Concerns about unintended consequences, e.g.
  - Fairness
  - Investments
  - Quality of service
  - Innovation
  - Security etc.
Uses of Benchmarking

- **Academic research**
  - We do efficiency / productivity analysis to try new techniques, investigate features of the sector, and suggest new approaches
  - Regulators do benchmarking to measure an X-factor or to inform the decision process

- **Regulators**
  - Direct input in IR benchmarking
  - Informing incentive regulation more broadly

- **Self benchmarking**
  - Firms benchmarking themselves

- **Third parties**
  - To inform, and name and shame
Benchmarking Methods

Source: Khetrapal and Thakur (2014)
SFA efficiency score of B, approximately = GF/BF

COLS efficiency of B = FE / FB
DEA in Practice

Firm R: Techn. eff. = OJ/OR   Alloc. eff. = OM/OJ   Tot. econ. eff. = OM/OR
Reference Model - Sweden

• Several critical parameters derived from hyperbolic tangent functions based on customer density and 5 constants to resemble empirical data.

• Paras dependent on customer density:


• For each parameter at each voltage level, functions are estimated using “reference values”.

\[ \text{ModTanh}(x) = \left( k_1 + k_2 \cdot \tanh(k_3 \cdot (x - k_4)) \right)^{k_0} \]

→x density (meters of line/customer)
→k0, ..., k4  constants

Source: Larsson (2004)
Table 1: Some European regulation regimes and cost function methodologies for electricity DSOs

<table>
<thead>
<tr>
<th>Code</th>
<th>Country</th>
<th>Regulation</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Austria</td>
<td>Revenue cap</td>
<td>DEA-SFA, best-off</td>
</tr>
<tr>
<td>BE</td>
<td>Belgium</td>
<td>Revenue cap</td>
<td>DEA</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
<td>Cost recovery</td>
<td>Ad hoc</td>
</tr>
<tr>
<td>DE</td>
<td>Germany</td>
<td>Revenue cap</td>
<td>DEA-SFA best-off</td>
</tr>
<tr>
<td>DK</td>
<td>Denmark</td>
<td>Revenue cap</td>
<td>COLS-MOLS</td>
</tr>
<tr>
<td>ES</td>
<td>Spain</td>
<td>Revenue cap</td>
<td>Engineering</td>
</tr>
<tr>
<td>FI</td>
<td>Finland</td>
<td>Revenue cap</td>
<td>DEA w. SFA back-up</td>
</tr>
<tr>
<td>FR</td>
<td>France</td>
<td>Cost recovery</td>
<td>Ad hoc</td>
</tr>
<tr>
<td>GB</td>
<td>Great Britain</td>
<td>Revenue cap</td>
<td>COLS and Ad hoc</td>
</tr>
<tr>
<td>GR</td>
<td>Greece</td>
<td>Cost recovery</td>
<td>Ad hoc</td>
</tr>
<tr>
<td>HU</td>
<td>Hungary</td>
<td>Price cap</td>
<td>Ad hoc</td>
</tr>
<tr>
<td>IRL</td>
<td>Ireland</td>
<td>Price cap</td>
<td>Ad hoc</td>
</tr>
<tr>
<td>NL</td>
<td>Netherlands</td>
<td>Yardstick comp</td>
<td>DEA-OLS-MOLS</td>
</tr>
<tr>
<td>NO</td>
<td>Norway</td>
<td>Yardstick comp</td>
<td>DEA</td>
</tr>
<tr>
<td>SE</td>
<td>Sverige</td>
<td>Revenue cap</td>
<td>Engineering and DEA</td>
</tr>
</tbody>
</table>

Source: Benchmarking and regulation, Per J. Agrella, Peter Bogetoftb, Preprint submitted to DEA Journal November 14, 2012
Evolution of Regulation & Benchmarking

Source: Viljainen (2005)
# BM Example – Norway 1

<table>
<thead>
<tr>
<th><strong>Input</strong></th>
<th><strong>Output</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Totex</strong></td>
<td></td>
</tr>
<tr>
<td>o O&amp;M</td>
<td>v No. of customers</td>
</tr>
<tr>
<td>o CENS - Cost of energy not supplied</td>
<td>v Leisure homes</td>
</tr>
<tr>
<td>o Interest on capital</td>
<td>v Energy delivered</td>
</tr>
<tr>
<td>o Depreciation</td>
<td>v HV lines</td>
</tr>
<tr>
<td>o Cost of network energy los</td>
<td>v Network stations</td>
</tr>
<tr>
<td></td>
<td>v Forest</td>
</tr>
<tr>
<td></td>
<td>v Snow</td>
</tr>
<tr>
<td></td>
<td>v Wind / coast</td>
</tr>
</tbody>
</table>
## BM Example – Norway 2

<table>
<thead>
<tr>
<th>Second Stage</th>
<th>Incentive Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency scores =</td>
<td>Revenue cap =</td>
</tr>
<tr>
<td>$b_1$*Island connections</td>
<td>$\text{Cost Norm} \cdot p + \text{Cost Base} \cdot (1-p)$</td>
</tr>
<tr>
<td>$b_2$*Transmission interfaces</td>
<td></td>
</tr>
<tr>
<td>$b_3$*Distributed generation</td>
<td></td>
</tr>
</tbody>
</table>
Regulator’s Background and BM Approach

- IR/BM as an “economic” programme, not a financial or engineering exercise

- But, the regulator’s institutional background matters
  - LAC and Sweden: Engineering $\rightarrow$ norm/reference models
  - UK: Financial, accounting, auditing $\rightarrow$ BM as support
  - Norway: Economics $\rightarrow$ “Sotex” benchmarking

- Example - Norm model vs. DEA in Chile
Strategic Behaviour in Benchmarking

- **Method** - e.g. parametric vs. non-parametric
- **Model** - specification

- **Inputs** - which
- **Outputs** - which
- **Variables** – definitions, e.g. Opex

- **Accounting rules** - e.g. asset depreciation period

- **Contextual variables** - e.g. geography, weather, density, features of service area
Survey: What Did Regulators Say?

Costs
- Shifting assets/costs between gas and power (Netherl.)
- Including customer contributions in RAB (Netherl., Ireland)
- Shifting assets/costs from S to D (Netherlands, UK)
- Shifting assets/costs from G to D (Norway)
- Definition of OPEX and accounting rules - e.g. depr. (UK)

Outputs
- Circuit vs. route network length (Netherlands)
- No. of customers vs. no. of meters (Denmark)
- Uniqueness “comparators are inherently different” (Ireland)
- Relative weights of output variables (UK)

Mergers
- Split into several firms and then back (Netherlands)
Other Strategic Behaviour

- Mergers
- R&D cutbacks to improve short term performance
- Court cases and appeals
- Information overload

“Every four years, you feel you are going to war.”
Alejandro Jadresic, former Minister of Energy of Chile
Strategic Behaviour – Information Overload

The CEO of a distribution utility:

“In the technical studies, both sides cheat - everyone does this. If you didn’t cheat then you would be stuck with the superintendent’s numbers which aren’t fair. ... But the superintendence has poor people who don’t like to do much work, so it works out. When Chilectra delivers information they use a freight truck. The guys in the regulator’s office get depressed when it comes.”

Di Tella and Dyck (2001)
Strategic Behaviour

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Benchmarking – Evaluation Criteria

- Model variables
- Efficient comparators
- Consistency of results
- Quality of service
- Sufficient investments
- Long-term innovation
- Uncertainty
- Transparency
Lessons for Regulators

- Determination of costs at unbundling is crucial (audits, technical studies, adjustments)

- Compare cost patterns in review vs. non-review periods

- Conduct sensitivity analysis of benchmarking models

- But, can motivate desirable behaviour (e.g. mergers)

- Transparency – Cheap and helpful!

Proof of effective benchmarking is in the outcome
Lessons for Utilities

- Examine the effect of regulator’s choice of method, variables, X-factors for your firm.

- Determine effect of possible gaming by other firms on your revenues.

- Evaluate benefits and losses of M&A strategies of own and competitors.

- Do your own benchmarking!
References


Thank you!