Benchmarking Parameters and Controllable Costs

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“Incentive regulation in the German electricity and gas sector”

Outline

Project overview
Data issues
Model structure
Specific challenges
  – Dimensionality

Conclusions
Mission

Find models to determine
- Efficient costs for structurally comparable operators in electricity and gas distribution.

The modus operandi of the models should be objective, non-discriminatory, and transparent.

Modeling steps

Descriptive statistical models
- Significance test for technically and empirically relevant variables on BNA data

Benchmarking models (ex post)
- Determine best practice performance for the past period using hindsight

Benchmarking models (ex ante)
- Provide improvement targets through best practice based on a long-term robust specification.
Robustness

Robustness of efficiency estimates
- Invariance of estimates to stochastic influences

Robustness of model specification
- Invariance to changes in accounting reporting standards
- Invariance to changes in operating standards
- Invariance to changes in financing policy

Process

- Preference analysis
- Institutional context

- Model structure, orientation, evaluation horizon

- Production technology

- Variable selection
- Environmental proxies

- Estimation approach

regulatory application
controllability principle
 convexity, disposability, preference information
Relevance, completeness, operationality, non-redundancy.
Data quality, techn. complexity
Tradeoffs

SFA

COLS

Noise separation

RISK OF SPECIFICATION ERROR

Flexible

Mean structure

SDEA

RISK OF DATA ERROR

DEA

Average (OLS)

Costs x

Output y

C(y, )

x1

x2

y1

y2
Deterministic frontier

SFA
Primary variable selection

- Expert assessment of cost-drivers
- Empirical validation OLS
- Analytical derivation of cost-drivers from MNA

Performance dimensions - outputs

- Model specification DEA
- Model specification SFA

Structural variables - noncontrollable inputs

Model structure

- Controllable resources
- Exogenous demand (task)

X Inputs → DSO → Y Outputs

- Totex "Direct cost"
- Proxies for
  - Geography, climate, soil type,
  - Complexity, density
- Z Environment
  - Transport work
  - Capacity provision
  - Service provision

Structural factors
- …
Environmental factors under test

Structural factors
- Urbanization
  - \textit{zArea.city}, \textit{zArea.green}, \textit{zArea.industry}
- Soil type
  - \textit{zSoil.0}, \textit{zSoil.1}, \textit{zSoil.2}, \textit{zSoil.3}
- Topology
  - \textit{zSlope}, \textit{zHeight.average}, \textit{zHeight.diff}
- Asset age
  - \textit{zAge}
- Location
  - East/West

Estimation approach

1. \begin{align*}
\text{Costs} & : C(X) \\
\text{Resources} & : X
\end{align*}

2. \begin{align*}
\text{Resources} & : X(Y) \\
\text{Delivery task} & : Y
\end{align*}

3. \begin{align*}
\text{Costs} & : C(Y) \\
\text{Delivery task} & : Y
\end{align*}

4. \begin{align*}
\text{Costs} & : C(Y|Z) \\
\text{Delivery task} & : Y \\
\text{Environment} & : Z
\end{align*}
Separable model

Integrated model
Challenges

Data validation….
  – Reporting (units, scope, omitted values)

Capital expenditure
  – Activation policy
  – Depreciation policy
  – East/West

Age effects
  – Investment cycle effects on book value

Environmental variables
  – Definition, access, data collection

Capital cost approach

Problem:
  – The incumbent inefficiency in grid asset valuation (capex) is driven by past investments
  – Reductions require reassessment of assets

Bottom-up approach:
  – Nominal investment stream 1955-2004
  – Lines, cables, TS equipment, DS equipment
  – Real annuities for electricity sample (223 DMU)
  – PPI adjustment 1955-2004
  – Technical lifelengths 40, 45, 50 years
  – Real interest rate

Testing
  – Second-stage on SFA and DEA scores
  – Parallel tests for "real" TOTEX in DEA-SFA
Age effect approach

Problem:
- Accounting measures (investment cycle) give bias in favour of older networks in capex
- Operating cost may have an age bias in favour of newer grids

Age proxies
- Creation of economically weighted age proxies for electricity data based on 4 asset categories.
- Creation of physically weighted age proxies for gas pipelines.

Testing
- Second-stage on SFA and DEA scores
- Candidate for structural variable (Z) in OLS

Electricity data sets

<table>
<thead>
<tr>
<th>Available DMU</th>
<th>1st Validated DMU</th>
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<tbody>
<tr>
<td>Ultra high-voltage level (UHS)</td>
<td>5</td>
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<tr>
<td>High-voltage level (HS)</td>
<td>96</td>
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<tr>
<td>Medium-voltage level (MS)</td>
<td>853</td>
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<tr>
<td>Low-voltage level (NS)</td>
<td>886</td>
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<td>Medium-voltage level/low-voltage level (Tr MS/NS)</td>
<td>862</td>
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Gas data sets

<table>
<thead>
<tr>
<th></th>
<th>Available DMU</th>
<th>1st Validated DMU</th>
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<tbody>
<tr>
<td>High Pressure</td>
<td>616</td>
<td>563</td>
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<tr>
<td>(HD)</td>
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<td></td>
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<tr>
<td>Medium Pressure</td>
<td>648</td>
<td>605</td>
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<tr>
<td>(MD)</td>
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<tr>
<td>Low Pressure</td>
<td>595</td>
<td>549</td>
</tr>
<tr>
<td>(NS)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Electricity results

(On-going)
Joint electricity model

Input
- Total costs (xCostDIR)

Output
- Service provision
  - yMeters.hs, yMeters.ms, yMeters.ns
  - yArea.hs, yArea.ms, yArea.1.ns
- Capacity provision
  - yPeakload.hs, yPeakload.ms, yPeakload.ns,
    yPeakload.hs_ms, yPeakload.ms_ns,
  - yDg.power.hs, yDg.power.ms, yDg.power.ns
- Transportation work
  - yEnergy.del.hs

Results ELEC – DEA(CRS)
Scale efficiency ELEC-SE

Average SE = 0.93

Biascorrected results ELEC-DEA
Results ELEC-SFA

Model consistency SFA-DEA (NDRS/CRS)

Rank order correlation =
### Correlation ELEC

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pearson Correlation</th>
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<tr>
<td>d_dea_far_vrs</td>
<td>0.96 0.91 0.99 0.90 0.96 0.89 1.00 0.66</td>
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<tr>
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<tr>
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<td>0.91 0.88 1.00 0.98 0.91 0.88 0.91 0.71</td>
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<td>d_dea_far_biascorr</td>
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<td>0.89 0.88 0.88 0.88 0.98 1.00 0.90 0.78</td>
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<td>sfa_linear_far</td>
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### International comparison

- **DEA-VRS Sweden 2001**

- **OPEX + Adj Netloss cost**
- **Network total (km)**
- **# transformers/installed power (MVA)**
- **Climate zone**
## Correlation in Sweden 2001

### PEARSON

<table>
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<tr>
<th></th>
<th>fdh</th>
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<th>bias.corr</th>
<th>biascorr.c1</th>
<th>biascorr.c2</th>
<th>orderm</th>
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<tr>
<td>orderm</td>
<td>0.84</td>
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<tr>
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<td>0.24</td>
<td>0.41</td>
<td>0.40</td>
<td>0.43</td>
<td>0.27</td>
</tr>
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</table>

### Dimensionality and model correlation

**ELEC**

![Graph showing dimensionality and model correlation](image-url)
Conclusions

German electricity reform relies on benchmarking models
- Structured, but intensive, model specification phase
- Strict application of exogeneity principle for controllability
- Large data sets, but data validation is paramount…
- Intention to work on integrated models for consistency with regulation

Preliminary results
- Joint model development assures techno-economical feasibility
- Already conceptually reasonable and statistically stable models in electricity
- Model results as good as incumbent models in other countries
- Considerable possibilities to refine data and models

Challenges include
- Potential future reconstruction of the capital expenditure investigated
- Age effects, investment cycles, still unclear impact
- Urbanization and connection potential in gas may need more work