Benchmarking models:
German electricity and gas system operators

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Summary (1)

Benchmarking
- Relative performance evaluation

Need
- Substitute for market competition
- Guide informed decisions by a regulator

Possibilities
- Partial approaches
  Key ratios (cost/customer)
- Comprehensive approaches
  DEA, SFA, Order-m, COLS, SDEA etc

German data
- Tons of data already
- Improving week by week

Summary (2)

Preliminary results based on prevailing semi-cleaned data
- Surprisingly good data
- Already conceptually reasonable and statistically stable models
- Model results as good as incumbent models in other countries
- Considerable possibilities to refine data and models

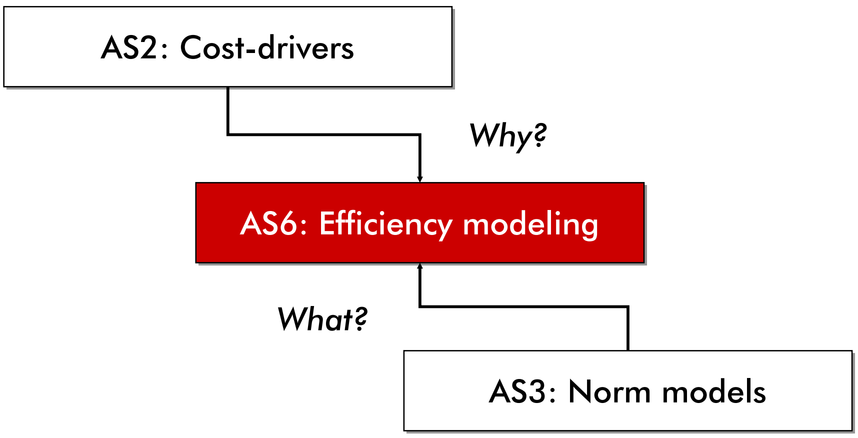
Recommendations
- Continue the data refinement and benchmarking process
- Investigate more model specifications (variable choices) using more estimation approaches
- Agree and make laws based on general principles (variable classes and perhaps classes of estimation techniques to use)
- Let the regulator choose specific implementation (variables and methods) later.

Outline

Process
Taxonomy
DEA
SFA
Model specification
Electricity results
Gas results
Appendix: Data

Process

Project integration



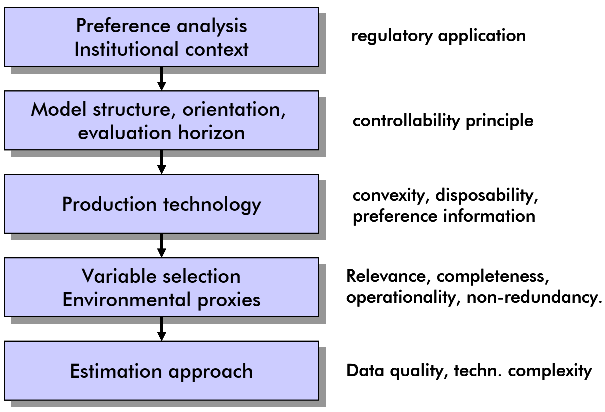
Modeling steps

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

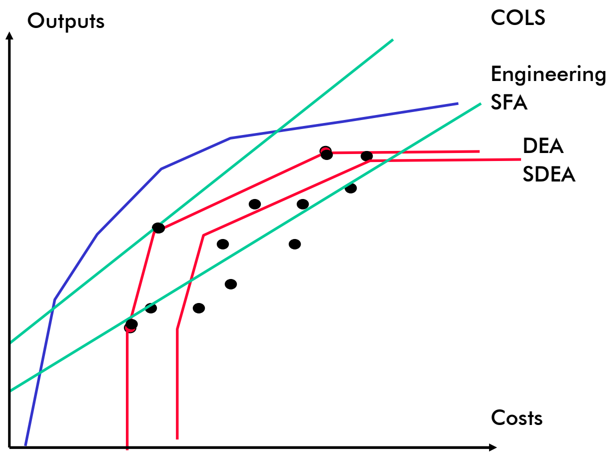
Benchmarking models (ex ante)
- Provide improvement targets through best practice based on a long-term robust specification.

Process



Taxonomy

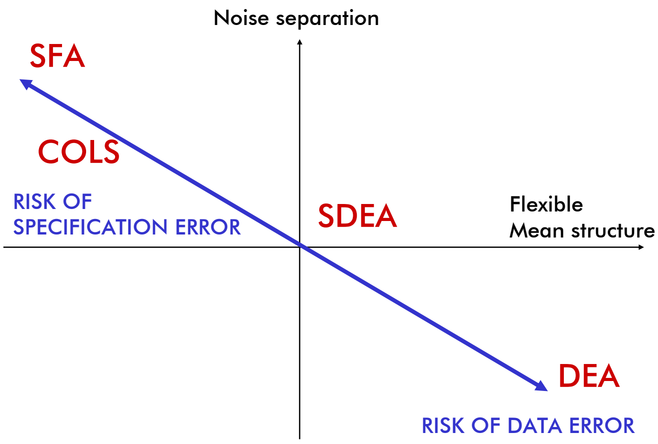
Benchmarking methods



Model taxonomy

	Deterministic	*Stochastic*
Parametric	Corrected Ordinary Least Square (COLS) Greene(1997), Lovell(1993), Aigner and Chu(1968)	Stochastic Frontier Analysis (SFA) Aigner, Lovel and Schmidt (1977), Batesee and Coelli (1992), Coelli, Rao and Battesee (1998)
Non-Parametric	Data Envelopment Analysis (DEA) Charnes, Cooper and Rhodes(1978), Deprins, Simar and Tulkens(1984)	Stochastic Data Envelop-ment Analysis (SDEA) Land, Lovell and Thore(1993), Petersen and Olsen(19xx), Weyman-Jones(2001)

Tradeoffs



DEA versus SFA

DEA

- Ignores noise in data and model
- Compensates with a very flexible (non-par) strucure
- Invokes limited assumptions about distr. of inefficiencies
- Makes testing a little complicated (bootstrapping)

SFA

- Allows noise in data
- Impose restirctions (par) on structure
- Invokes distributional assumptions
- Makes testing easy (likelihood ratio testing)

Ex. International diversity

Country	Regime	Informa tion	Model	Opera tion
Sweden	Lighthanded	Ex post	DEA/ideal grid	1996-
Norway	Revenue cap	Ex ante	DEA	1992-
Finland	Lighthanded	Ex post	DEA	1998-
Denmark	Revenue cap	Ex ante	COLS	2000-
Netherlands	Revenue cap	Ex ante	DEA/cost	1999-
Austria	Revenue cap	Ex post	DEA/Ideal	2003-
Spain	Revenue cap	Ex ante	Ideal grid	2000-
Chile	Price cap	Ex ante	Ideal grid	1982-
New Zealand	Revenue cap	Ex ante	DEA/SFA,..	199x-

Hybrid models

Multiple models
- Right info for right question
- Putting everybody in the best light

Combined models
- DEA-SFA: hedging for both data error and specification errors
- SR-LR: giving information about catch-up possibilities (see also T3)

DEA

DEA – A Popular Approach

NUMEROUS STUDIES

Charnes, Cooper and Rhodes (1978)
1340 studies (-2000)

PUBLIC SECTOR

Gas, water, heat, roads, police, firefighters, schools, universities, hospitals, courts, …

PRIVATE SECTOR

Banks, insurance, mail, railroads, industries, farms, service providers, consultancy firms, sports…

Basic Estimation Principle

MINIMAL EXTRAPOLATION PRINCIPLE:

T* is smallest subset of that contains data and satisfy certain regularity assumptions

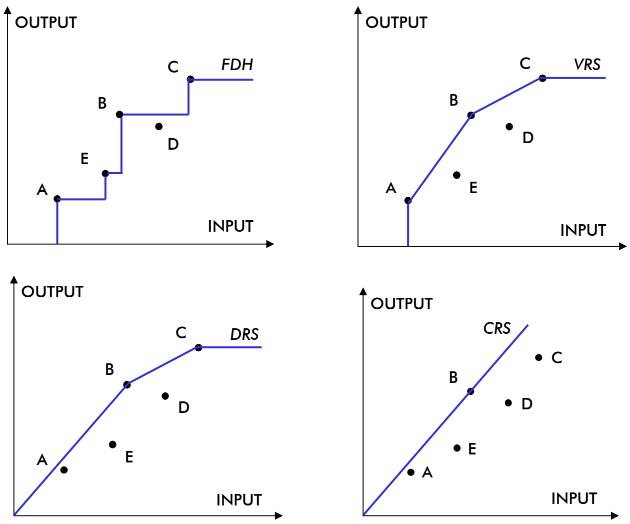
Leads to

- Inner approximation
- Cautious evaluations
- Conservative estimates of improvement potentials

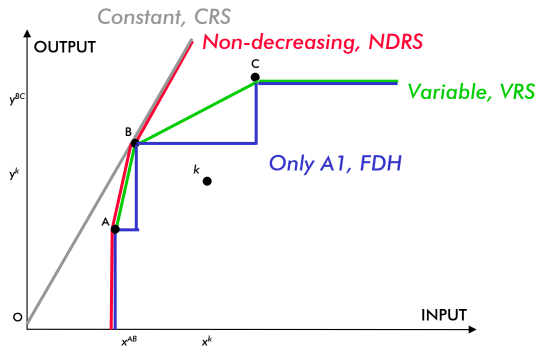
Structural choices

Disposability
Convexity
Scale
Partial pricing
Orientation

Classical DEA models



Economies of scale



r returns to scale

$r = \{fdh, crs, vrs, ndrs\}$

Basic Efficiency Measures

Farrell (1957)

INPUT BASED :
E = find largest proportional contractions of all inputs
E = minimal input/actual inputs
E = 0.6 means that all inputs could be reduced by 40%

COST EFFICIENCY:
E = Minimal costs / Actual costs
DSO controls and is responsible for both procedures (technical efficiency) and factor achoice (allocative efficiency)

SCALE EFFICIENCY
SE = Minimal cost under CRS / Minimal cost under VRS
DSO responsible for choosing right size also
NDRS attractive
VRS cautions and/or reflects structural frictions

Pros and Cons of DEA

PROS

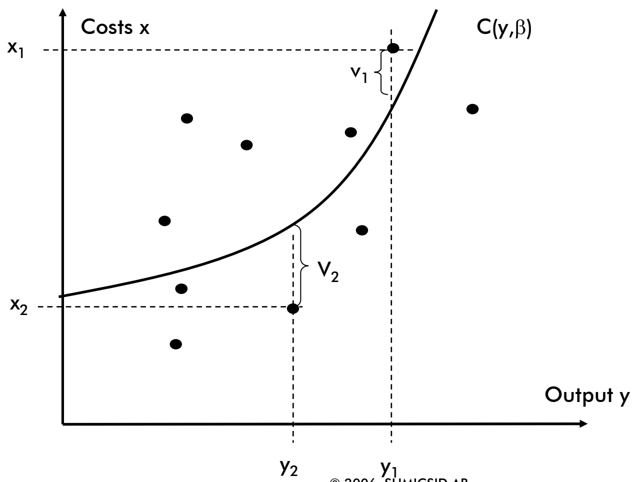
- Requires no or little price or priority information
- Requires no or little technological information
- Makes weak a priori assumptions
- Handles multiple inputs and multiple outputs
- Provides reel peers
- Identifies best practice
- Cautious or conservative evaluations (minima extrapolation)
- Supports learning, planning, motivation

CONS

- Weaker theory of significance testing (sensitivity, resampling, bootstrapping, asymp theory)
- One should discuss goals – moving slowly in the right direction may be better than running fast in the wrong direction

SFA

Average (OLS)



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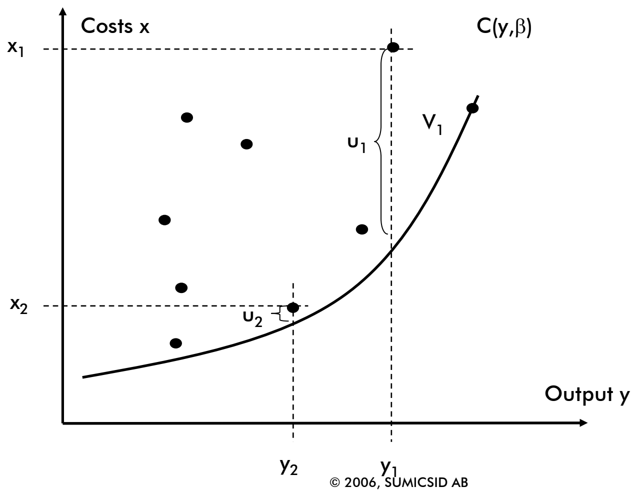
Deterministic frontier



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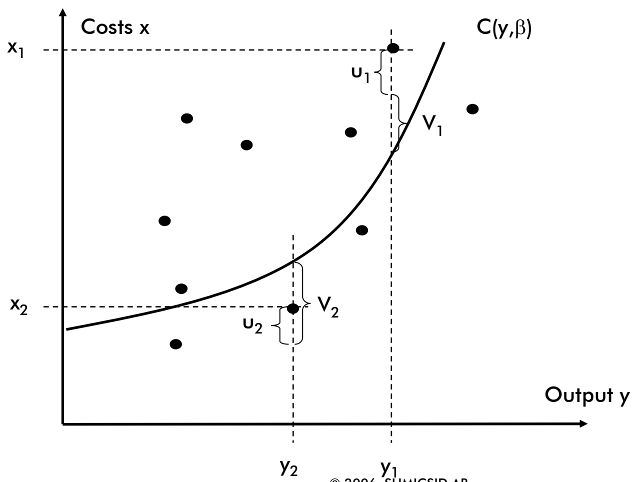
SFA



Basic idea

Aigner, Lovell and Smith(1977), Meuser and Van den Broeck(1977)

Specification

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + .. + \beta_n x_{in} + v_i - u_i$$

where

v_i is normal $N(0, \sigma_v^2)$

u_i is truncated normal $N_+(\mu, \sigma_u^2)$

Estimation

– Maximum likelihood estimation

Pros and Cons

Pros

- Nice idea
- Separate noise and inefficiency
- MLE is consistent (|Estimate-True|->0)
- MLE is asymptotic efficient (Smallest variance)
- Testing etc – see below.

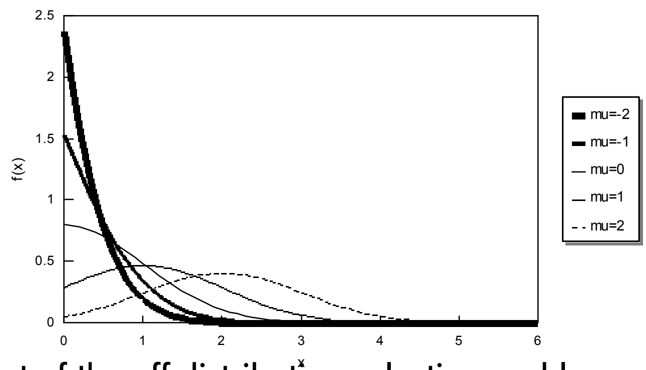
Drawbacks

- How to find functional form
- How to justify distribution for inefficiency a priori

Different normal distributions

Trucated normal in error component model

$u_i \sim N_+(\mu,\sigma^2)$



Solves part of the eff distribution selection problem

Cobb-Douglas or Translog

Cobb-Douglas:

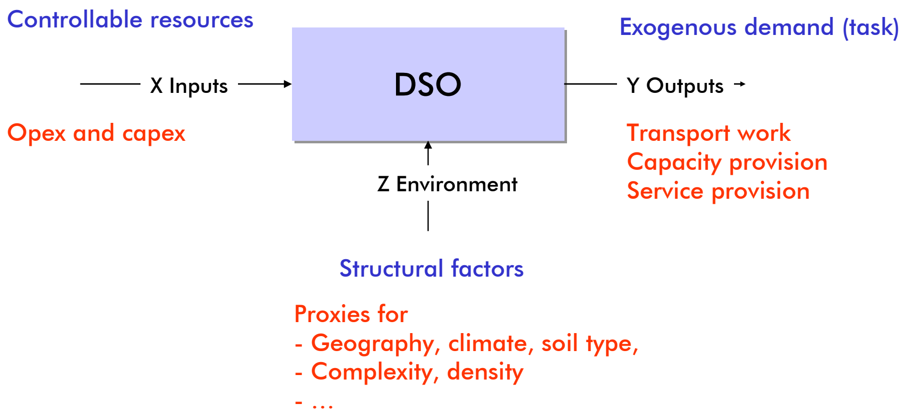
$$\ln y_i = \beta_0 + \beta_1 \ln x_{1i} + \beta_2 \ln x_{2i}$$

Translog:

$$\ln y_i = \beta_0 + \beta_1 \ln x_{1i} + \beta_2 \ln x_{2i} + 0.5\beta_{11}(\ln x_{1i})^2 + 0.5\beta_{22}(\ln x_{2i})^2 + \beta_{12} \ln x_{1i} \ln x_{2i}$$

Model specification

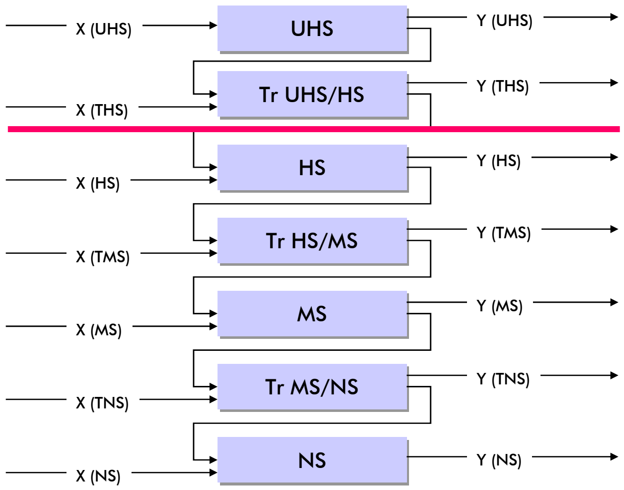
Model structure



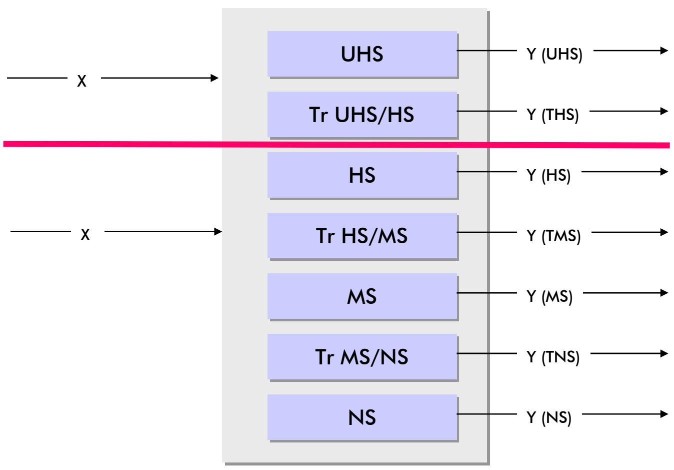
Estimation approach

1. Costs C(X) | Resources X
2. Resources X(Y) | Delivery task Y
3. Costs C(Y) | Delivery task Y
4. Costs C(Y|Z) | Delivery task Y | Environment Z

Separable model



Integrated model



T1: Subadditivity test

Choice of separable model

- $C(x,y_1,y_2,\ldots)$ = Integrated cost function
- $C_1(x_1,y_1,w_1)$ = Voltage level cost function, intermediate output w_1

Subadditivity

- $C(x,y_1,y_2,\ldots) \leq C_1(x_1,y_1,w_1) + C_2(x_2,y_2,w_2) + \ldots$

T1: Testing integrated and separable sets

- If subadditivity is not rejected, run integrated model

T2: Age effect test

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

T2: Testing C(y|z) with age proxies

- If age hypothesis is not rejected, one may add age to Z

T3: Decomposition tests

Problem:

- The incumbent inefficiency in grid asset valuation (capex) is driven by past investments
- Reductions require reassesment of assets

T3: Testing models EOpex(y|z), ECapex(y|z)

- If EOpex(y|z) >> ECapex(y|z) then different proportions of short run and long run targets can be used

Guidance

- Cost drivers according to experts
- Cost drivers according to analytical model
- Cost drivers according to econometric analysis and hypothesis tests
- Conceptually (complete, minimal etc)
- Data availability

Electricity results (Ongoing)

Joint electricity model

Input
- Total costs (xCostDIR)

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

Joint electricity model (2)

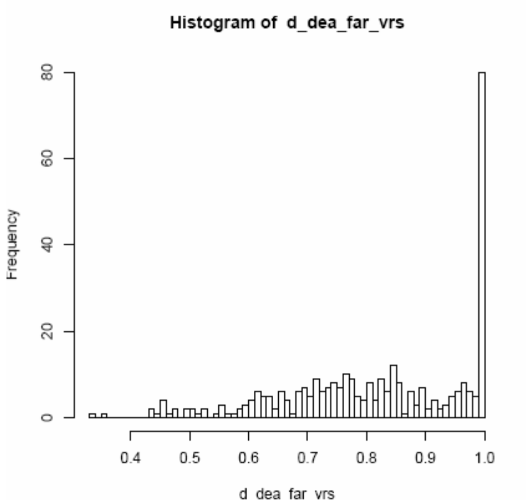
Output (ctd)

- Transportation work
  - yEnergy.del.ns, yEnergy.del.hs,yEnergy.del.hs_ms, yEnergy.del.ms, yEnergy.del.ms_ns, yEnergy.del.no_metering.ns

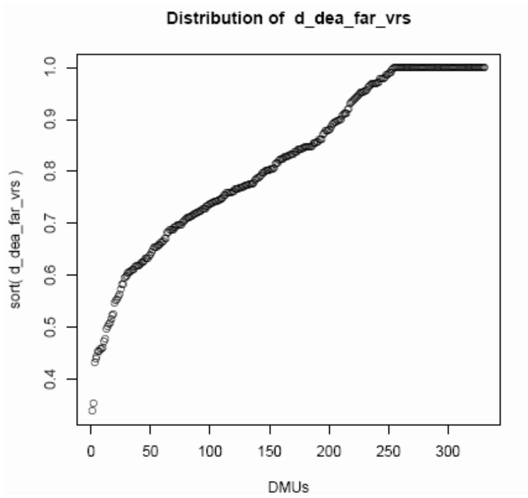
Structural factors

- Urbanization
  - zArea.city, zArea.green, zArea.industry
- Soil type
  - zSoil.0, zSoil.1, zSoil.2, zSoil.3
- Topology
  - zSlope, zHeight.average, zHeight.diff

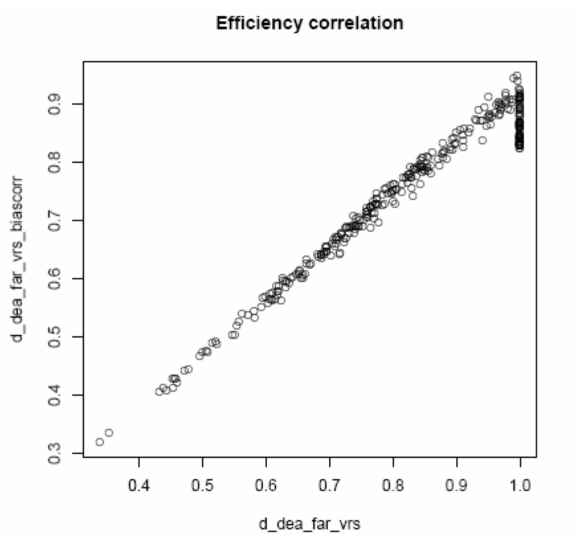
Distribution DEA VRS



DEA VRS cumulative

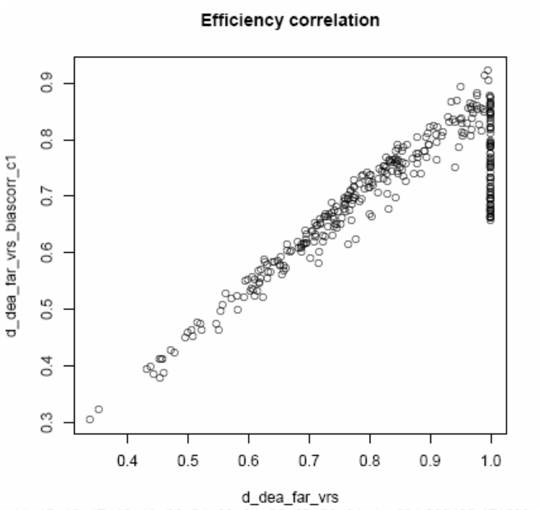


Bias correction

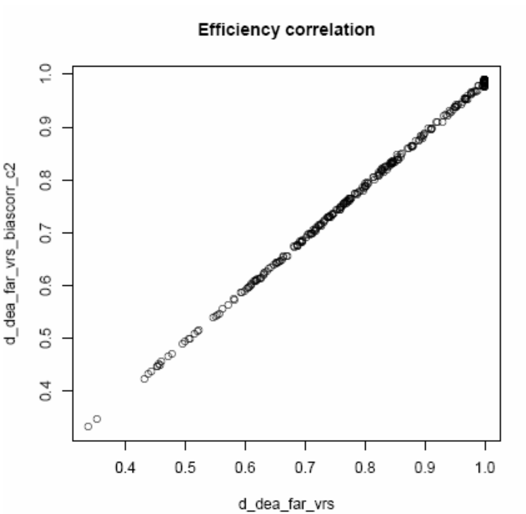


DEA bias corrected eff destribution

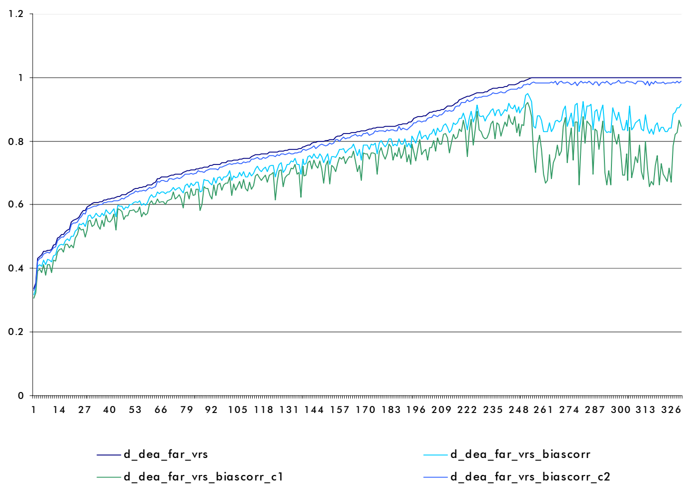
DEA bias correction confidence L



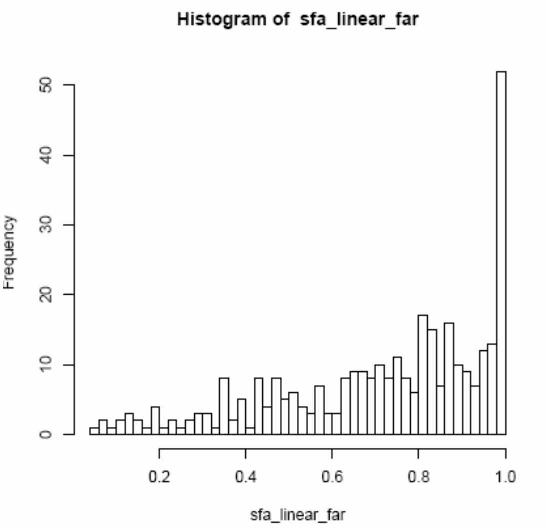
DEA bias correction confidence H



Bias corrections



SFA distribution



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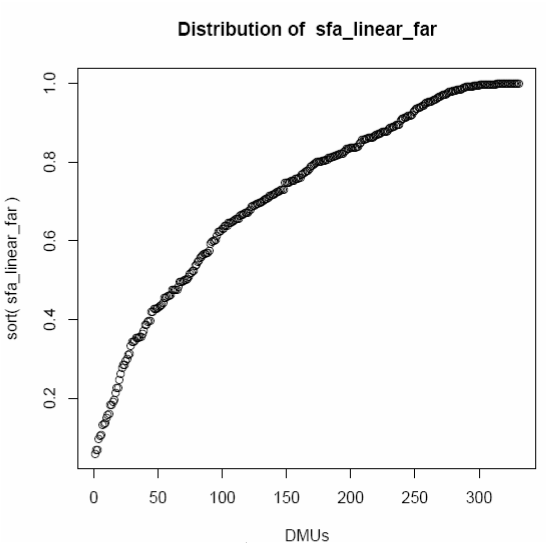
SFA cumulative



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Efficiency levels

	fdh	dea.vrs	dea.drs	dea.ndrs	dea.crs	sfa. linear	dea.vrs. bias.corr	se
Average	0.99	0.82	0.81	**0.74**	**0.74**	**0.72**	**0.75**	**0.91**
Variance	0.00	0.03	0.03	0.02	0.02	0.06	0.02	0.01
Median	1.00	0.83	0.82	0.74	0.74	0.78	0.77	0.93
Min	0.60	0.34	0.34	0.32	0.32	0.06	0.32	0.57
Max	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00

	cols	sup. dea.vrs	sup. dea.drs	sup. dea.ndrs	sup. dea.crs	dea.vrs. bias.corr	dea.vrs. biasc.1	dea.vrs. biasc.2	orderm
Average	-21.18	1.00	0.94	2.22	2.22	**0.75**	0.70	0.80	1.01
Variance	2457.55	2.58	1.78	658.79	658.80	0.02	0.01	0.02	0.00
Median	-9.49	0.82	0.81	0.74	0.74	0.77	0.71	0.82	1.00
Min	-594.95	0.34	0.34	0.32	0.32	0.32	0.30	0.33	0.61
Max	1.00	23.95	23.95	466.95	466.95	0.95	0.92	0.99	1.21
	outliers and linearity			outliers	outliers				

Efficiency correlations

PEARSON

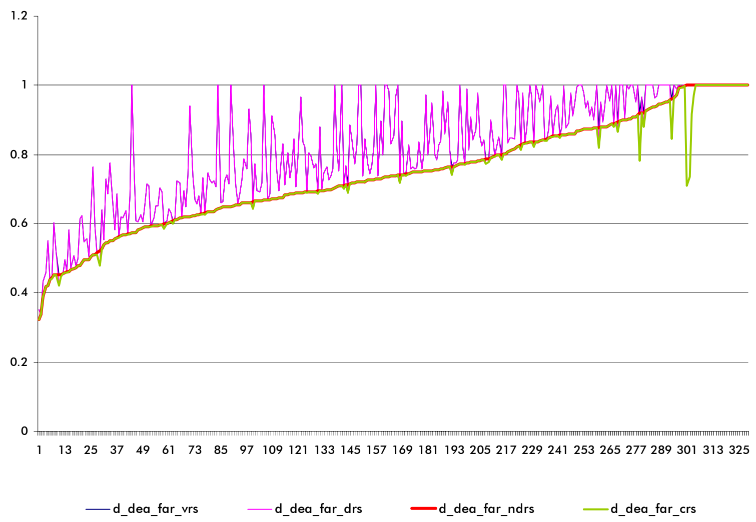
	fdh	dea.vrs	dea.drs	dea.ndrs	dea.crs	sup.dea.vrs	sup. dea.drs	sup. dea.ndrs	sup. dea.crs	dea.vrs. bias.corr	dea.vrs. biascorr.c	dea.vrs. biascorr.c	orderm	sfa. linear
fdh	1.00	0.31	0.31	0.26	0.27	0.05	0.05	0.19	0.20	0.32	0.33	0.31	0.71	0.11
dea.vrs	0.31	1.00	0.99	0.88	0.88	0.24	0.24	0.71	0.71	0.98	0.91	1.00	0.20	0.49
dea.drs	0.31	0.99	1.00	0.85	0.88	0.24	0.24	0.69	0.71	0.97	0.90	0.99	0.14	0.48
dea.ndrs	0.26	0.88	0.85	1.00	0.99	0.26	0.26	0.84	0.82	0.86	0.79	0.88	0.28	0.32
dea.crs	0.27	0.88	0.88	0.99	1.00	0.27	0.27	0.83	0.84	0.86	0.79	0.88	0.22	0.31
sup.dea.vrs	0.05	0.24	0.24	0.26	0.27	1.00	1.00	0.37	0.38	0.19	0.11	0.24	0.01	0.15
sup.dea.drs	0.05	0.24	0.24	0.26	0.27	1.00	1.00	0.37	0.38	0.19	0.11	0.24	0.00	0.15
sup.dea.ndrs	0.19	0.71	0.69	0.84	0.83	0.37	0.37	1.00	0.99	0.66	0.55	0.71	0.20	0.26
sup.dea.crs	0.20	0.71	0.71	0.82	0.84	0.38	0.38	0.99	1.00	0.65	0.54	0.71	0.15	0.25
dea.vrs.biascorr	0.32	0.98	0.97	0.86	0.86	0.19	0.19	0.66	0.65	1.00	0.97	0.98	0.23	0.47
dea.vrs.biascorr.c1	0.33	0.91	0.90	0.79	0.79	0.11	0.11	0.55	0.54	0.97	1.00	0.91	0.25	0.42
dea.vrs.biascorr.c2	0.31	1.00	0.99	0.88	0.88	0.24	0.24	0.71	0.71	0.98	0.91	1.00	0.20	0.49
orderm	0.71	0.20	0.14	0.28	0.22	0.01	0.00	0.20	0.15	0.23	0.25	0.20	1.00	-0.15
sfa.linear	0.11	**0.49**	**0.48**	**0.32**	**0.31**	0.15	0.15	0.26	0.25	**0.47**	**0.42**	**0.49**	-0.15	1.00

Efficiency correlations

SPEARMAN

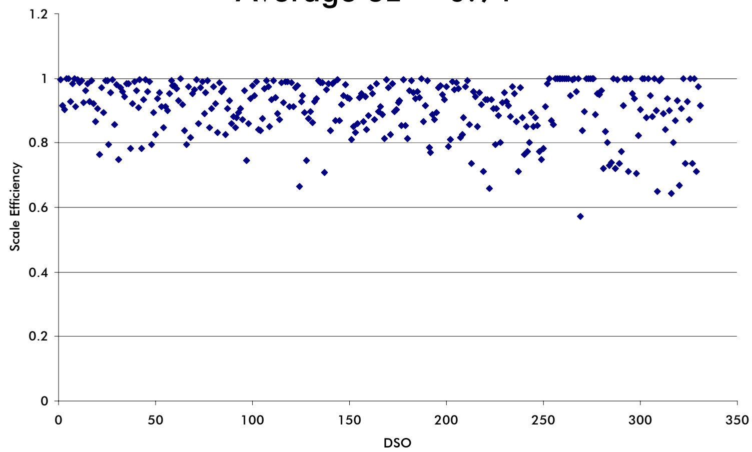
	fdh	dea.vrs	dea.drs	dea.ndrs	dea.crs	sup.dea.vrs	sup. dea.drs	sup. dea.ndrs	sup. dea.crs	dea.vrs. bias.corr	dea.vrs. biascorr.c	dea.vrs. biascorr.c	orderm	sfa. linear
fdh	1.00	0.25	0.26	0.24	0.24	0.24	0.26	0.22	0.22	0.25	0.25	0.25	0.26	0.11
dea.vrs	0.25	1.00	**0.98**	0.86	0.86	1.00	0.98	0.86	0.86	0.94	0.80	0.99	-0.24	0.54
dea.drs	0.26	0.98	1.00	0.83	0.86	0.98	1.00	0.83	0.86	0.92	0.79	0.97	-0.29	0.51
dea.ndrs	0.24	0.86	0.83	1.00	**0.99**	0.88	0.85	1.00	0.99	0.83	0.75	0.85	-0.03	0.35
dea.crs	0.24	0.86	0.86	0.99	1.00	0.88	0.88	0.99	1.00	0.83	0.75	0.85	-0.08	0.34
sup.dea.vrs	0.24	1.00	0.98	0.88	0.88	1.00	0.99	0.88	0.88	0.93	0.82	0.99	-0.24	0.53
sup.dea.drs	0.26	0.98	1.00	0.85	0.88	0.99	1.00	0.85	0.88	0.92	0.81	0.97	-0.27	0.49
sup.dea.ndrs	0.22	0.86	0.83	1.00	0.99	0.88	0.85	1.00	0.99	0.83	0.74	0.85	-0.05	0.35
sup.dea.crs	0.22	0.86	0.86	0.99	1.00	0.88	0.88	0.99	1.00	0.83	0.74	0.85	-0.09	0.34
dea.vrs.biascorr	0.25	0.94	0.92	0.83	0.83	0.93	0.92	0.83	0.83	1.00	0.94	0.94	-0.20	0.51
dea.vrs.biascorr.c1	0.25	0.80	0.79	0.75	0.75	0.82	0.81	0.74	0.74	0.94	1.00	0.80	-0.10	0.39
dea.vrs.biascorr.c2	0.25	0.99	0.97	0.85	0.85	0.99	0.97	0.85	0.85	0.94	0.80	1.00	-0.24	0.55
orderm	0.26	-0.24	-0.29	-0.03	-0.08	-0.24	-0.27	-0.05	-0.09	-0.20	-0.10	-0.24	1.00	-0.47
sfa.linear	0.11	**0.54**	**0.51**	0.35	0.34	**0.53**	**0.49**	0.35	0.34	**0.51**	0.39	0.55	-0.47	1.00

Return to scale



Scale efficiency SE

Average SE = 0.91



Optimal scale sizes

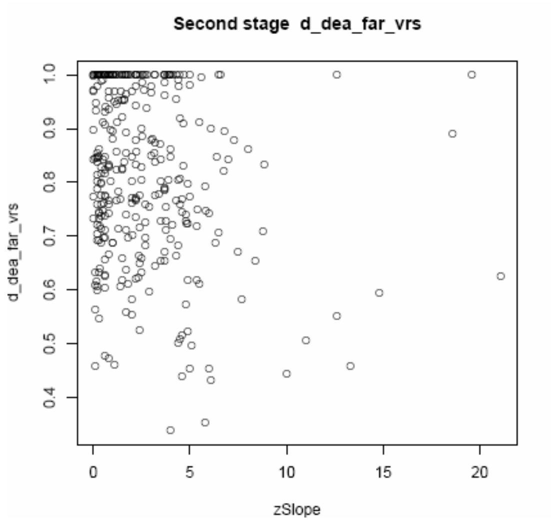
Quite a linear technology

- Some most productive scale sizes

	xCosts. dir	xCables. circuit.hs	xCables. circuit.ms	xTowers. hs	xTowers. ms	yMeters. hs	yMeters. ns	yEnergy. del	yEnergy. del.ns
Average	3.7E+07	29.5926	572.963	1526.93	1427.52	65.8889	81308.22	4318899	305229
Variance	7.7E+15	17136.8	1681720	2.9E+08	3.9E+07	64866.4	2.91E+10	2.8E+14	4.5E+11
Median	2754608	53	76	102	84.5	0	9860	117847	40335
Min	52309	6	6	8	2	0	0	5771	0
Max	4.2E+08	370	5838	38545	24000	1276	756978	8.7E+07	3164416

	yPeakload . hs	yPeakload .ns	yDg. power	yArea. hs	yArea.1. ns	yPopulati on. Ns	zSlope	zHeight. average	zHeight. diff	zNumber. ags
Average	680.815	248.259	357.963	4985.26	286.013	64455.1	2.69769	314.076	187.312	13.6667
Variance	7652624	854101	880329	6.6E+08	753081	2.2E+10	14.8774	92557	91785.9	2094.54
Median	0	12	9	0	59.88	7541	1.8	278.657	138.811	1
Min	0	0	0	0	0	0	0	0	0	0
Max	14418	4817	4749	133867	4483.24	568952	19.6	1353.3	1631	211

Impact of Slope



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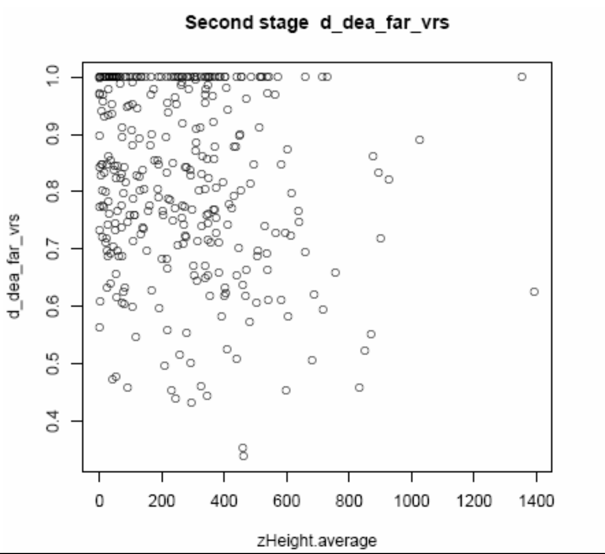
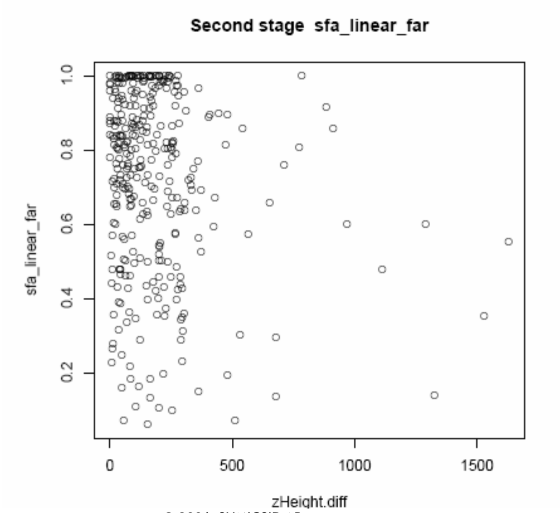
Impact of height

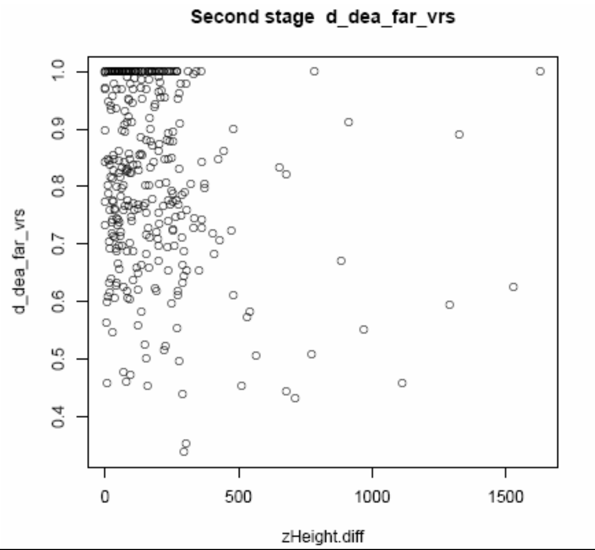


60

Impact of hight difference (2)



Impact of height difference



Illustrative test

```
Call:
lm(formula = d_dea_far_vrs ~ zSlope + zHeight.average + zHeight.diff)

Residuals:
       Min         1Q     Median         3Q        Max
-4.600e-01 -1.040e-01 -1.266e-05  1.543e-01  4.002e-01

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      8.502e-01  1.328e-02  64.044   <2e-16 ***
zSlope          -2.878e-03  7.812e-03  -0.368    0.713
zHeight.average -2.577e-05  5.514e-05  -0.467    0.641
zHeight.diff    -9.755e-05  1.002e-04  -0.973    0.331
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

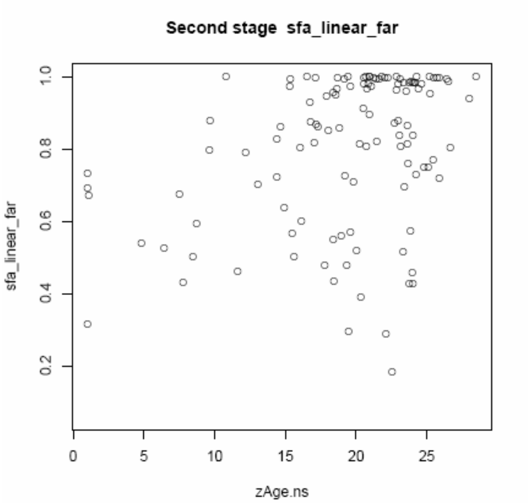

Illustrative test (2)

```
Call:
lm(formula = sfa_linear_far ~ zSlope + zHeight.average + zHeight.dif

Residuals:
     Min       1Q   Median       3Q      Max
-0.64074 -0.13310  0.04061  0.18785  0.43422

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      7.888e-01  2.029e-02  38.879   <2e-16 ***
zSlope          -1.523e-02  1.194e-02  -1.275   0.2031
zHeight.average -2.115e-04  8.426e-05  -2.510   0.0125 *
zHeight.diff     1.382e-04  1.531e-04   0.903   0.3674
```

Age impact ?



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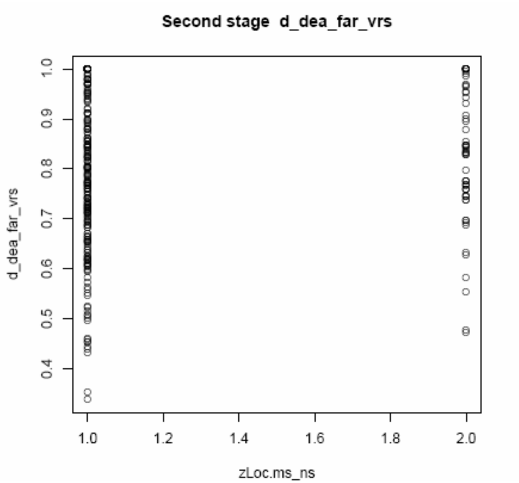
West-East impact ?



66

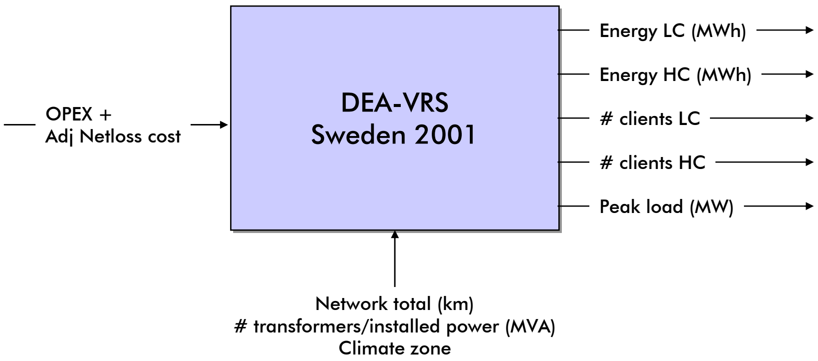
Excluded anything significant ?

```
Call:
lm(formula = sfa_linear_far ~ cbind(y, mz))

Residuals:
       Min         1Q     Median         3Q        Max
-4.637e-01 -4.538e-02  8.262e-05  7.890e-02  3.722e-01

Coefficients: (3 not defined because of singularities)
                                            Estimate Std. Error   t value Pr(>|t|)
(Intercept)                                4.860e-01  1.296e-01     3.751 0.000374 ***
cbind(y, mz)yMeters.hs                    -2.627e-03  6.637e-03    -0.396 0.693502
cbind(y, mz)yMeters.hs_ms                 -1.835e-03  1.884e-03    -0.974 0.333514
cbind(y, mz)yMeters.ms                     7.049e-04  5.824e-04     1.210 0.230483
cbind(y, mz)yMeters.ms_ns                 -2.421e-04  3.789e-04    -0.639 0.525117
cbind(y, mz)yMeters.ns                    -1.424e-09  2.873e-06 -0.000495 0.999606
cbind(y, mz)yEnergy.del.lower_grid.hs     -4.992e-07  4.806e-07    -1.039 0.302769
cbind(y, mz)yEnergy.del.lower_grid.hs_ms  -4.195e-07  4.767e-07    -0.880 0.382130
cbind(y, mz)yEnergy.del.lower_grid.del.ms -8.557e-08  2.034e-06    -0.042 0.966572
cbind(y, mz)yEnergy.del.lower_grid.ms_ns   4.073e-07  1.226e-06     0.332 0.740775
cbind(y, mz)yEnergy.del                    1.431e-06  2.563e-06     0.558 0.578509
cbind(y, mz)yEnergy.del.ns                -1.007e-06  1.382e-06    -0.728 0.468929
cbind(y, mz)yEnergy.del.hs                -2.070e-06  2.454e-06    -0.844 0.401970
cbind(y, mz)yEnergy.del.hs_ms             -2.268e-06  2.619e-06    -0.866 0.389570
cbind(y, mz)yEnergy.del.ms                -1.249e-06  2.424e-06    -0.515 0.608073
cbind(y, mz)yEnergy.del.ms_ns             -7.683e-07  3.610e-06    -0.213 0.832102
cbind(y, mz)yEnergy.del.no_metering.ns            NA         NA        NA       NA
cbind(y, mz)yPeakload.hs                   1.085e-03  3.139e-03     0.346 0.730745
cbind(y, mz)yPeakload.hs_ms                2.478e-03  2.792e-03     0.888 0.377960
cbind(y, mz)yPeakload.ms                   1.054e-03  3.200e-03     0.330 0.742807
cbind(y, mz)yPeakload.ms_ns                1.153e-03  3.556e-03     0.324 0.746796
cbind(y, mz)yPeakload.ns                  -3.318e-03  3.427e-03    -0.968 0.336482
cbind(y, mz)yDg.power                     -1.365e-04  1.323e-04    -1.032 0.305898
cbind(y, mz)yDg.power.hs                   5.447e-04  7.695e-04    -0.708 0.481509
cbind(y, mz)yDg.power.ms                   7.553e-04  4.295e-04     1.759 0.083295 .
cbind(y, mz)yDg.power.ns                          NA         NA        NA       NA
```



```
cbind(y, mz)yArea.max              -1.499e-03  7.024e-04   -2.135 0.036506 *
cbind(y, mz)yArea.hs               -4.007e-05  2.448e-04   -0.164 0.870493
cbind(y, mz)yArea.hs_ms             2.325e-04  2.876e-04    0.809 0.421655
cbind(y, mz)yArea.ms                1.227e-04  2.294e-04    0.535 0.594461
cbind(y, mz)yArea.ms_ns             1.264e-04  2.382e-04    0.531 0.597307
cbind(y, mz)yArea.1.ns              1.379e-04  2.344e-04    0.588 0.558488
cbind(y, mz)yArea.2.ns             -1.165e-04  1.595e-03   -0.073 0.942009
cbind(y, mz)yArea.3.ns             -4.240e-04  5.313e-04   -0.798 0.427652
cbind(y, mz)yArea.4.ns              3.180e-04  2.645e-04    1.202 0.233552
cbind(y, mz)yArea.5.ns              3.844e-04  1.874e-04    2.051 0.044255 *
cbind(y, mz)yPopulation.ns          3.863e-07  1.915e-06    0.202 0.840754
cbind(y, mz)yPopulation.ms_ns      -1.436e-07  1.846e-06   -0.078 0.938214
cbind(y, mz)yPopulation.ms         -1.093e-06  1.098e-06   -0.995 0.323250
cbind(y, mz)yPopulation.hs_ms      -1.045e-06  8.711e-07   -1.200 0.234550
cbind(y, mz)yPopulation.hs          1.826e-06  9.494e-07    1.924 0.058695 .
cbind(y, mz)zLoc.ns                 2.887e-02  6.179e-02    0.467 0.641819
cbind(y, mz)zAge.ns                 5.517e-03  3.839e-03    1.437 0.155385
cbind(y, mz)zArea.total             7.305e-04  7.064e-04    1.034 0.304885
cbind(y, mz)zArea.city             -1.007e-01  4.851e-02   -2.075 0.041866 *
cbind(y, mz)zArea.green             1.114e-03  3.138e-03    0.355 0.723746
cbind(y, mz)zArea.industry         -2.858e-04  1.092e-02   -0.026 0.979194
cbind(y, mz)zSoil.0                -5.932e-03  7.698e-03   -0.771 0.443695
cbind(y, mz)zSoil.1                        NA         NA       NA       NA
cbind(y, mz)zSoil.2                 2.932e-04  4.382e-04    0.669 0.505811
cbind(y, mz)zSoil.3                 2.705e-05  2.579e-04    0.105 0.916782
cbind(y, mz)zSlope                 -1.067e-02  1.973e-02   -0.541 0.590233
cbind(y, mz)zHeight.average        -3.459e-06  1.407e-04   -0.025 0.980462
cbind(y, mz)zHeight.diff            2.512e-04  2.395e-04    1.049 0.297994
cbind(y, mz)zNumber.ags            -7.051e-04  2.490e-03   -0.283 0.777924
```


International comparison



Correlation in Sweden 2001

PEARSON — Sweden 2001 data

	fdh	dea.vrs	sup.dea.vrs	dea.vrs. bias.corr	dea.vrs. biascorr.c1	dea.vrs. biascorr.c2	orderm	sfa. linear
fdh	1.00	0.59	0.40	0.60	0.60	0.59	0.84	0.26
dea.vrs	0.59	1.00	0.78	0.99	0.95	1.00	0.57	0.43
sup.dea.vrs	0.40	0.78	1.00	0.72	0.65	0.78	0.37	0.24
dea.vrs. bias.corr	0.60	0.99	0.72	1.00	0.99	0.99	0.59	0.41
dea.vrs. biascorr.c1	0.60	0.95	0.65	0.99	1.00	0.95	0.59	0.40
dea.vrs. biascorr.c2	0.59	1.00	0.78	0.99	0.95	1.00	0.57	0.43
orderm	0.84	0.57	0.37	0.59	0.59	0.57	1.00	0.27
sfa. linear	0.26	0.43	0.24	0.41	0.40	0.43	0.27	1.00

Tentative conclusions

- No obvious omissions from joint model
- Sub-additivity weakly confirmed
- Possibly a weak age effect (book-value problem?)
- Perhaps weakly lower costs in East ?
- Perhaps weakly more costly when more hilly and more urban
- Joint model as good as international best practice – even with the existing data
- Lots of possibilities to improve data and models
- Additional protection possible by using best-off models

Gas results (Ongoing)

Joint gas model 3

Input
- Total costs (xCostDIR)

Output
- Service provision
  - yl.yMeters_md.yMeters_nd
  - yl.yCustDSO_md.yCustDSO_nd
  - yMeters_hd
  - yCustTSO_hd
  - yAreaPropS
- Capacity provision
  - yPeakLoadIN
  - yMaxEnergyOUT
  - yStorageUsed
- Transportation work
  - yEnergyOUT

Joint gas model 3 (2)

Output (ctd)
- Quality
  - yQLeakage_md, yQLeakage_nd, yQLeakage_hd
  - yQDisturbance_nd

Structural and other factors considered
- LoadFactor
- Customer density
- zAge

Joint gas model 4

Input

- Total costs (xCostDIR)

Output

- Service provision
  - yl.yMeters_md.yMeters_nd
  - yCustDSO
  - yArea
  - yAreaPropS
- Capacity provision
  - yPeakLoadIN
  - yPeakLoadOUT
- Transportation work
  - yEnergyIN
  - yEnergyOUT

Joint gas model 4 (2)

Output (ctd)

- Quality
  - yQLeakage_md, yQLeakage_nd, yQLeakage_hd
  - yQDisturbance_nd

Structural and other factors considered

- LoadFactor
- Customer density
- zAge

Working in progress!

- Levels and correlations not stable yet
- Just changed data set
- Cleaning via shells
- Illustrations Model 4

	vrs shell 1	vrs shell 2	vrs shell 3
Ave eff	0.39	0.76	0.91
Units on front	21	59	93
Total units	614	614	614
Fraction	0.03	0.10	0.15

Correlation Model 3 (uncleaned)

PEARSON

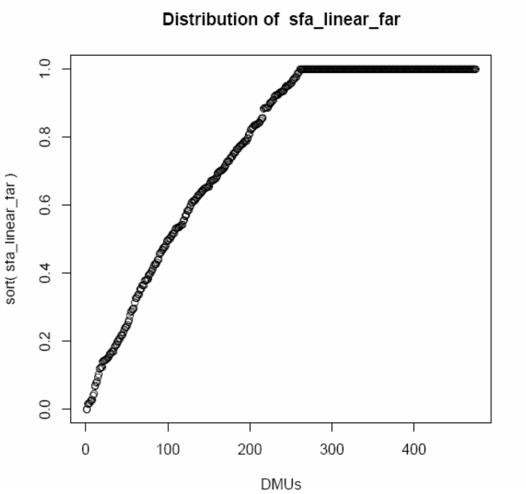
	fdh	dea.vrs	sup.dea. vrs	dea.bias. corr	dea.bias. cor.L	de.bias. cor.U	orderm	sfa_linear _far
fdh	1.00	0.59	0.56	0.48	0.45	0.11	0.11	0.09
dea.vrs	0.59	1.00	0.98	0.83	0.83	0.28	0.28	0.25
sup.dea. vrs	0.56	0.98	1.00	0.78	0.83	0.28	0.28	0.24
dea.bias. corr	0.48	0.83	0.78	1.00	0.96	0.31	0.31	0.32
dea.bias. cor.L	0.45	0.83	0.83	0.96	1.00	0.32	0.32	0.32
de.bias. cor.U	0.11	0.28	0.28	0.31	0.32	1.00	1.00	1.00
orderm	0.11	0.28	0.28	0.31	0.32	1.00	1.00	1.00
sfa_linear_far	0.09	0.25	0.24	0.32	0.32	1.00	1.00	1.00
sup.dea.crs	0.09	0.25	0.25	0.31	0.33	1.00	1.00	1.00
d_orderm_far	0.96	0.59	0.51	0.54	0.46	0.11	0.10	0.10
sfa_linear_far	0.36	0.21	0.15	0.08	0.02	0.06	0.06	0.05

Correlation Model 4 (uncleaned)

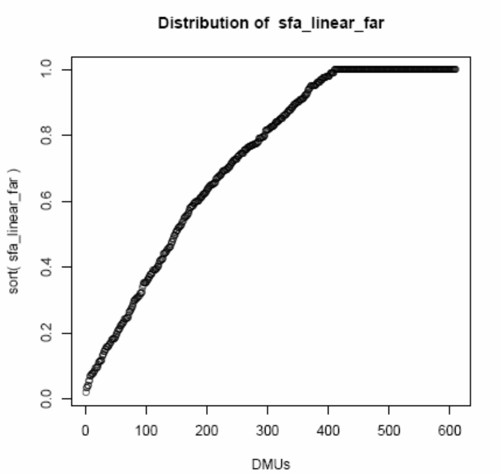
PEARSON

	fdh	dea.vrs	dea.drs	dea.ndrs	dea.crs	sup.dea.vrs	sup. dea.drs	sup. dea.ndrs	sup. dea.crs	d_orderm _far	sfa_linear _far
fdh	1.00	0.59	0.56	0.48	0.45	0.11	0.11	0.09	0.09	0.96	0.36
dea.vrs	0.59	1.00	0.98	0.83	0.83	0.28	0.28	0.25	0.25	0.59	0.21
dea.drs	0.56	0.98	1.00	0.78	0.83	0.28	0.28	0.24	0.25	0.51	0.15
dea.ndrs	0.48	0.83	0.78	1.00	0.96	0.31	0.31	0.32	0.31	0.54	0.08
dea.crs	0.45	0.83	0.83	0.96	1.00	0.32	0.32	0.32	0.33	0.46	0.02
sup.dea.vrs	0.11	0.28	0.28	0.31	0.32	1.00	1.00	1.00	1.00	0.11	0.06
sup.dea.drs	0.11	0.28	0.28	0.31	0.32	1.00	1.00	1.00	1.00	0.10	0.06
sup.dea.ndrs	0.09	0.25	0.24	0.32	0.32	1.00	1.00	1.00	1.00	0.10	0.05
sup.dea.crs	0.09	0.25	0.25	0.31	0.33	1.00	1.00	1.00	1.00	0.09	0.04
d_orderm_far	0.96	0.59	0.51	0.54	0.46	0.11	0.10	0.10	0.09	1.00	0.38
sfa_linear_far	0.36	0.21	0.15	0.08	0.02	0.06	0.06	0.05	0.04	0.38	1.00

Model 3 SFA



Model 4 SFA



Conclusions

Conclusions

Regulation requires benchmarking
Germany data large sets of data
Preliminary results suggest

- Surprisingly good data at this stage
- Already conceptually reasonable and statistically stable models
- Model results as good as incumbent models in other countries
- Considerable possibilities to refine data and models

Therefore, BNetzA shall

- Continue the data refinement and benchmarking process
- Investigate more model specifications (variable choices) using more estimation approaches
- Fix general principles (variable classes and perhaps classes of estimation techniques to use)
- Leave specific implementation (variables and methods) to regulatory discretion (avoid DK mistake?)

Appendix: Data

Electricity data sets

	Available DMU	1st Validated DMU
Ultra high- voltage level (UHS)	5	
High-voltage level (HS)	96	38
Medium-voltage level (MS)	853	327
Low-voltage level (NS)	886	328
Ultra high-voltage level/high-voltage level (TrUHS/HS)	18	
High-voltage level/medium-voltage level (Tr HS/MS)	184	78
Medium-voltage level/low-voltage level (Tr MS/NS)	862	327

Gas data sets

	Available DMU	1st Validated DMU
High Pressure (HD)	616	563
Medium Pressure (MD)	648	605
Low Pressure (NS)	595	549

Primary electricity variables

dmu	DMU Nr	
dmu.name	DMU Name	
xCables.circuit.hs	CablesCircuit HS	Stromkreislänge Kabel HS
xCables.circuit.ms	CablesCircuit MS	Stromkreislänge Kabel MS
xCables.circuit.ns	CablesCircuit NS	Stromkreislänge Kabel NS
xLines.circuit.hs	Lines Circuit HS	Stromkreislänge Freileitung HS
xLines.circuit.ms	Lines Circuit MS	Stromkreislänge Freileitung MS
xLines.circuit.ns	Lines Circuit NS	Stromkreislänge Freileitung NS
yMeters.hs	Meters HS	Zählpunkte HS
yMeters.hs_ms	Meters HS/MS	Zählpunkte HS/MS
yMeters.ms	Meters MS	Zählpunkte MS
yMeters.ms_ns	Meters MS/NS	Zählpunkte MS/NS
yMeters.ns	Meters NS	Zählpunkte NS
xCable.route.hs	CableRoute HS	Trassenlänge Kabel HS
xCable.route.ms	CableRoute MS	Trassenlänge Kabel MS
xCable.route.ns	CableRoute NS	Trassenlänge Kabel NS

Primary electricity variables 2

xLines.route.ns	LinesRoute HS	Trassenlänge Freileitung HS
xLines.route.ms	LinesRoute MS	Trassenlänge Freileitung MS
xLines.route.ns	LinesRoute NS	Trassenlänge Freileitung NS
xCosts.dir	Sum of all direct costs	Direkte Kosten über alle Netzebenen
xCosts.dir.hs	DirCosts HS	Direkte Kosten HS
xCosts.dir.hs_ms	DirCosts HS/MS	Direkte Kosten hS/MS
xCosts.dir.ms	DirCosts MS	Direkte Kosten MS
xCosts.dir.ms_ns	DirCosts MS/NS	Direkte Kosten MS/NS
xCosts.dir.ns	DirCosts NS	Direkte Kosten NS
xCosts.in.hs	CostIn HS	Gewälzte Kosten HS
xCosts.in.hs_ms	CostIn HS/MS	Gewälzte Kosten HS/MS
xCosts.in.ms	CostIn MS	Gewälzte Kosten MS
xCosts.in.ms_ns	CostIn MS/NS	Gewälzte Kosten MS/NS
xCosts.in.ns	CostIn NS	Gewälzte Kosten NS

Primary electricity variables 3

xRevenues.hs	Revenues HS	Erlöse HS
xRevenues.hs_ms	Revenues HS/MS	Erlöse HS/MS
xRevenues.ms	Revenues MS	Erlöse MS
xRevenues.ms_ns	Revenues MS/NS	Erlöse MS/NS
xRevenues.ns	Revenues NS	Erlöse NS
xPower.inst.ms_ns	Installed Power HS/MS	Installierte Leistung (Umspannebene)
xPower.inst.hs_ms	Installed Power HS/MS	Installierte Leistung (Umspannebene)
xSubstations.hs_ms	Substations HS/MS	Anzahl Umspannstationen
xSubstations.ms_ns	Substations MS/NS	Anzahl Umspannstationen
xTowers.hs	Towers HS	Anzahl Masten HS
xTowers.ms	Towers MS	Anzahl Masten MS
xTowers.ns	Towers NS	Anzahl Masten NS

Primary electricity variables 4

yEnergy.del	sum of energy deliverd	Summe Entnahmen
yEnergy.del.hs	Energy delivered to customers HS	Entnahme (Jahresarbeit) durch leistungsgemessene Kunden
yEnergy.del.hs_ms	Energy delivered to customers HS/MS	Entnahme (Jahresarbeit) durch leistungsgemessene Kunden
yEnergy.del.ms	Energy delivered to customers MS	Entnahme (Jahresarbeit) durch leistungsgemessene Kunden
yEnergy.del.ms_ns	Energy delivered to customers MS/NS	Entnahme (Jahresarbeit) durch leistungsgemessene Kunden
yEnergy.del.ns	Energy delivered with metering NS	Entnahme (Jahresarbeit) durch leistungsgemessene Kunden
yEnergy.del.ownlower_grid.hs	Energy delivered to the own lower net HS	Entnahme (Jahresarbeit) durch eigene nachgelagerte Netz- oder Umspannebene
yEnergy.del.ownlower_grid.hs_ms	Energy delivered to the own lower net HS/MS	Entnahme (Jahresarbeit) durch eigene nachgelagerte Netz- oder Umspannebene
yEnergy.del.ownlower_grid.del.ms	Energy delivered to the own lower net MS	Entnahme (Jahresarbeit) durch eigene nachgelagerte Netz- oder Umspannebene
yEnergy.del.ownlower_grid.ms_ns	Energy delivered to the own lower net MS/NS	Entnahme (Jahresarbeit) durch eigene nachgelagerte Netz- oder Umspannebene
yEnergy.del.no_metering.ns	Energy delivered without metering NS	

Primary electricity variables 5

yPeakload.hs	Peakload HS	Zeitgleiche Jahreshöchstlast
yPeakload.hs_ms	Peakload HS/MS	Zeitgleiche Jahreshöchstlast
yPeakload.ms	Peakload MS	Zeitgleiche Jahreshöchstlast
yPeakload.ms_ns	Peakload MS/NS	Zeitgleiche Jahreshöchstlast
yPeakload.ns	Peakload NS	Zeitgleiche Jahreshöchstlast
yArea.hs	Area HS	Fläche in km2
yArea.hs_ms	Area HS/MS	Fläche in km2
yArea.ms	Area MS	Fläche in km2
yArea.ms_ns	Area MS/NS	Fläche in km2
yArea.1.ns	Area 1NS	Fläche in km2
yArea.2.ns	Area 2 NS	Fläche in km2
yArea.3.ns	Area 3 NS	Fläche in km2
yArea.4.ns	Area 4 NS	Fläche in km2
yArea.5.ns	Area 5 NS	Fläche in km2

Primary electricity variables 6

yPopulation.ns		Einwohner
yPopulation.ms_ns		Einwohner
yPopulation.ms		Einwohner
yPopulation.hs		Einwohner
yPopulation.hs_ms		Einwohner
zLoc.hs	Belegenheit HS	Belegenheit HS
zLoc.hs_ms	Belegenheit HS/MS	Belegenheit HS/MS
zLoc.ms	Belegenheit MS	Belegenheit MS
zLoc.ms_ns	Belegenheit MS/NS	Belegenheit MS/NS
zLoc.ns	Belegenheit NS	Belegenheit NS
zDg.power.hs	DecInstalled Power HS	Installierte dezentrale Erzeugungsleistungen
zDg.power.ms	DecInstalled Power MS	Installierte dezentrale Erzeugungsleistungen
zDg.power.ns	DecInstalled Power NS	Installierte dezentrale Erzeugungsleistungen
zAge.ns		
zAge.ms_ns		
zAge.ms		
zAge.hs		
zAge.hs_ms		

Primary electricity variables 7

capital expenditures		Kapitalkosten
operation expenditures		Betriebskosten
zArea.city	continuously urbanized area (in qkm)	durchgängig städtische Prägung (in qkm)
	not continuously urbanized area (in qkm)	nicht durchgehend städtische Prägung (in qkm)
	industrial area (in qkm)	Industrie- und Gewerbeflächen
zArea.total	total area of the AGS (in qkm)	Gesamtfläche der Gemeinde (in qkm)
	percentage of continuously urbanized area (in qkm)	% Anteil der Flächen durchgängig städtischer Prägung
	percentage of not continuously urbanized area (in qkm)	% Anteil der Flächen nicht durchgehend städtischer Prägung
	percentage of industrial area (in qkm)	% Anteil der Industrie- und Gewerbeflächen
	mininmal height (in m over sea level)	minimale Höhe (in m über NN)

Primary electricity variables 8

	maximal height (in m over sea level)	maximale Höhe (in m über NN)
	differential of height (in m)	Höhendifferenz innerhalb der Gemeinde (in m)
	mean height of the AGS	durchschnittliche Höhe der Gemeinde (in m über NN)
	mean slope of the AGS	durchschnittliche Neigung der Gemeinde (in %)
	predominant possibility of digging within the AGS - 0 (not clearly identifiable) - 1 (easy) - 2 (medium) - 3 (heavy)	vorherrschende Grabbarkeit innerhalb der Gemeinde (0 - nicht eindeutig bestimmbar, 1 - leicht, 2 - mittel, 3 – schwer)

Primary gas variables

Dmu		sumic_bnr
yPeakload.in	peak load feeding (nm3/h)	Jahreshöchslast Einspeisungen (nm3/h)
yEnergy.in	energy in (nm3)	Eingespeiste Jahresarbeit (nm3)
yEnergy.in.point	energy in, number of points model	davon nach Punktzahlmodell
yEnergy.in.ee	energy in, entry-exit model	davon nach Entry-Exit
yPeakload.async.out	asynchronous peak load unfeeding	Jahreshöchslast Ausspeisungen (nm3/h)
yEnergy.out	energy out (nm3)	Ausgespeiste Jahresarbeit (nm3)
yEnergy.out.point	energy out, number of points model (nm3/h)	davon nach Punktzahlmodell
yEnergy.out.ee	energy out, entry-exit model (nm3/h)	davon nach Entry-Exit Modell
xCost.mat	material cost	Materialaufwand
xCost.pers	personnel expenditures	Personalaufwand
xCost.depr.imm	depreciation of immaterial assets	Abschreibungen immatrielle Gegenstände und Sachanlagen
xCost.depr.fin	depreciation of financial assets	Abschreibungen auf Finanzanlagen
xCost.other	further operational costs	Sonstige betriebliche Aufwendungen
xCost.dir	direct costs	Direkte Kosten

Primary gas variables 2

yPeakload.async.out	asynchronous peakload	Zeitungleiche JHL Ausspeisungen (n-m3/h)
yConnectpoint.out.tso	customers TSO	TSO Anzahl Ausspeisepunkte Gesamt
yConnectpoint.out.dso	customers DSO	DSO Anzahl Ausspeisepunkte
zOperator.water	Operator water	Betreiber von Wassernetzen
zOperator.dis.heat	Operator district heating	Betreiber von Fernwärmenetzen
zOperator.sew.net	Operator sewage	Betreiber von Abwassernetzen
zOperator.gas.hol	Operator gasholder	Betreiber von Gasspeichern
xStorage	own storage capacity	Eigene Speicherkapazität
xBuffer	network buffer	Netzpuffer
yLoad.out.poss.max	max possible load out	Max Ausspeiseleistung
yStorage.needed	needed storage	Benötigte Speicherleistung
yMeters.hd	meters in HD	Anzahl Zählpunkte HD

Primary gas variables 3

xLength.dia.a.hd	Length diameter class A	Länge HD Durchmesserklasse A
xLength.dia.b.hd	Length diameter class B	LÄnge HD Durchmesserklasse B
xLength.dia.c.hd	Length diameter class C	LÄnge HD Durchmesserklasse C
xLength.dia.d.hd	Length diameter class D	LÄnge HD Durchmesserklasse D
xLength.dia.e.hd	Length diameter class E	LÄnge HD Durchmesserklasse
xLength.dia.f.hd	Length diameter class F	LÄnge HD Durchmesserklasse F
xLength.dia.g.hd	Length diameter class G	LÄnge HD Durchmesserklasse G
xLength.sum.hd	sum Length HD	Länge HD gesamt
xCompressors.hd	number of compressors	Anzahl Verdichterstationen HD
xCompressors.power.hd	sum of installed compressor power HD	Summe installierte Verdichterleistung HD
xDecompressors.hd	number of decompressors MD	Anzahl Druckminderungsstationen
zStations.power.hd	number of installed stations HD	Summe installierte Anlagenleistung HD

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Primary gas variables 4

yConnectpoint.out.tso.hd	connection points out TSO HD	TSO Ausspeisepunkte HD
yConnectpoint.out.dso.hd	connection points out DSO HD	DSO Ausspeisepukte HD
yQ.leakage.hd	number of leakages	Anzahl Leckagen HD
zConduit.age.5.hd	Percentage of length of conduits up to 5 years relative to length of all conduits.	Anteil Alter Rohrleitung HD bis 5 Jahre
zConduit.age.6_20.hd	Percentage of length of conduits between 6 and 20 years relative to length of all conduits.	Anteil Alter Rohrleitung HD 6 bis 20 Jahre
zConduit.age.21_45.hd	Percentage of length of conduits between 21 and 45 years relative to length of all conduits.	Anteil Alter Rohrleitung HD 21 bis 45 Jahre
zConduit.age.above45.hd	Percentage of length of conduits older than 45 years relative to length of all conduits.	Anteil Alter Rohrleitung HD größer 45 Jahre
yQ.Disturbance.hd	number of disturbances	Anzahl Störungen HD
xCapex.hd	capital expenditures	Kapitalkosten
xOpex.hd	operation expenditures	Betriebskosten

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Primary gas variables 5

yMeters.md	number of meters HD	Zählpunkte MD
xLength.md	length MD	Länge MD-Netz ohne HAL
xLength.hal.md	length HAD MD	Länge HAL im MD
xCompressors.md	number of compressors MD	Anzahl Verdichterstationen MD
xCompressors.power.md	sum of installed compressor power MD	Summe installierte Verdichterleistung MD
xDecompressors.md	number of decompressors MD	Anzahl Druckminderungsstaionen MD
xStations.power.md	Sum of power of installed stations MD	Summe installierte Anlagenleistung MD
yConnectpoint.out.dso.md	number of connection points out DSO MD	DSO Anzahl Ausspeisepunkte MD
zConduit.age.5.md	Percentage of length of conduits up to 5 years relative to length of all conduits.	Anteil Alter Rohrleitung bis 5 Jahre
zConduit.age.20.md	Percentage of length of conduits between 6 and 20 years relative to length of all conduits.	Alter Rohrleitung 5 bis 20 Jahre
zConduit.age.45.md	Percentage of length of conduits between 21 and 45 years relative to length of all conduits.	Alter Rohrleitung 21 bis 45 Jahre
zConduit.age.above45.md	Percentage of length of conduits older than 45 years relative to length of all conduits.	Alter Rohrleitung größer 45 Jahre

Primary gas variables 6

yLeakage.q.md	number of leakages MD	Anzahl Leckagen MD
yDisturbance.q.md	number of disturbances MD	Anzahl Störungen MD
xCapex.md	capital expenditures MD	
xOpex.md	operation expenditures MD	
yMeters.nd	number of meters ND	Anzahl Zählpunkte ND
xLength.nd	length ND	Länge ND Netz ohne HAL
xLength.hal.nd	length HAL ND	Länge HAL ND
yConnectpoint.out.dso.nd	connection points out DSO ND	DSO Anzahl Ausspeisepunkte ND
yLeakage.q.nd	number of leakage ND	Anzahl Leckagen ND
zConduit.Age.5.nd	Percentage of length of conduits up to 5 years relative to length of all conduits.	Anteil Alter Rohrleitung ND bis 5 Jahre
zConduit.Age.6_20.nd	Percentage of length of conduits between 6 and 20 years relative to length of all conduits.	Anteil Alter Rohrleitung ND 5 bis 20 Jahre
zConduit.Age.21_45.nd	Percentage of length of conduits between 21 and 45 years relative to length of all conduits.	Anteil Alter Rohrleitung ND 21 bis 45 Jahre
zAge.conduit.above45.nd	Percentage of length of conduits older than 45 years relative to length of all conduits.	Anteil Alter Rohrleitung ND göße 45 Jahre

Primary gas variables 7

yDisturbance.q.nd	number of disturbances ND	Anzahl Störungen ND
xCapex.nd	capital expenditures ND	
xOpex.nd	operation expenditures ND	
yArea	area	Fläche DSO (km2)
yPop.area.served	Population living in total domain of operator.	Einwohner DSO
yEnergy.in.2004	energy in 2004	Eingespeiste Jahresarbeit letztes Jahr minus 1
zEnergy.in.2003	energy in 2003	Eingespeiste Jahresarbeit letztes Jahr minus 2
zEnergy.in.2002	energy in 2002	Eingespeiste Jahresarbeit letztes Jahr minus 3
zEnergy.in.2001	energy in 2001	Eingespeiste Jahresarbeit letztes Jahr minus 4
yEnergy.out.2004	energy out 2004	Ausgespeiste Jahresarbeit letztes Jahr minus 1
zEnergy.out.2003	energy out 1999	Ausgespeiste Jahresarbeit letztes Jahr minus 2
zEnergy.out.2002	energy out 2000	Ausgespeiste Jahresarbeit letztes Jahr minus 3
zEnergy.out.2001	energy out 2001	Ausgespeiste Jahresarbeit letztes Jahr minus 4

Primary gas variables 8

yPeakload.sync.in.2004	synchronous peakload in 2004	Zeitgleiche Jahreshöchstlast Einspeisungen letztes GJ minus 1
zPeakload.sync.in.2003	synchronous peakload in 2003	Zeitgleiche Jahreshöchstlast Einspeisungen letztes GJ minus 2
zPeakload.sync.in.2002	synchronous peakload in 2002	Zeitgleiche Jahreshöchstlast Einspeisungen letztes GJ minus 3
zPeakload.sync.in.2001	synchronous peakload in 2001	Zeitgleiche Jahreshöchstlast Einspeisungen letztes GJ minus 4
yPeakload.out.async.2004	asynchronous peakload out 2004	Zeitungleiche Jahreshöchstlast Ausspeisungen letztes GJ minus 1
zPeakload.out.async.2003	asynchronous peakload out 2003	Zeitungleiche Jahreshöchstlast Ausspeisungen letztes GJ minus 2
zPeakload.out.async.2002	asynchronous peakload out 2002	Zeitungleiche Jahreshöchstlast Ausspeisungen letztes GJ minus 3
zPeakload.sync.out.2001	asynchronous peakload out 2001	Zeitungleiche Jahreshöchstlast Ausspeisungen letztes GJ minus 4
xLengthHALhd	length HAD MD	Länge HAL im HD-Netz

Primary gas variables 9

y.Disturbance.number.GDRM_hd	number of disturbance GDRM HD	Anzahl Störungen an GDRM HD
y.Disturbance.duration.GDRM_hd	Duration of disturbance GDRM HD	Dauer Störungen GDRM HD
y.Disturbance.number.GDRM_md	number of disturbance GDRM MD	Anzahl Störungen an GDRM MD
y.Disturbance.duration.GDRM_md	Duration of disturbance GDRM MD	Dauer Störungen GDRM MD
y.Disturbance.number.GDRM_nd	number of disturbance GDRM ND	Anzahl Störungen an GDRM ND
y.Disturbance.duration.GDRM_nd	Duration of disturbance GDRM ND	Dauer Störungen GDRM ND
z.Loc		Belegenheit des Netz

Primary gas variables 10

xCost.mat.total	Material costs	Materialkosten gesamt
xCost.material.upper	Material costs by the upper net	Materialkosten Aufwendungen an vorgel. NB
xCostStaff	staff costs	Personalkosten
xCost.ex.cap.	outside capital interests	FK Zinsen
x.Cost.op.taxes	operational taxes	Betriebliche Steuern
xCost.add.opex	further operational costs	sonst. Betriebliche Kosten
xCost.depr.gf	calculatory depreciation: general facilities	Kalk. Abschreibungen: Allgemeine Anlagen
xCos.dep.gt	calculatory depreciation: gas tanks	Kalk. Abschreibungen: Gasbehälter
xCost.depr.comp	calculatory depreciation: compressors	Kalk. Abschreibungen: Gasverdichterlangen
xCost.depr.pl	calculatory depreciation: pipe line	Kalk. Abschreibungen: Rohrleitungen/HAL
xCost.depr.mf	calculatory depreciation: measurement facilities	Kalk. Abschreibungen: Mess-,Regel u. Zählanlagen
xCost.depr.fw	calculatory depreciation: Fernwirkanlagen (whatever this is)	Kalk. Abschreibungen: Fernwirkanlagen
xCost.depr.in	calculatory depreciation: intangible goods	Kalk. Abschreibungen: Immatrielles AV
xCost.depr.fa	calculatory depreciation: financial assets	Kalk. Abschreibungen: Finanzanlagen
xCost.ei	equity capital interests	EK-Zinsen
xCost.calc.taxes	calculatory taxes	Kalk. Gewerbesteuer
xCost.rev	cost-reducing revenues and returns	Kostenmindernde Erlöse und Erträge

Primary gas variables 11

I_R_YEAR	Investment costs for pipelines in year YEAR. Data for 1940-2004.	Investitionskosten für Rohleitung im Jahr 1940-2004
I_ZuM_YEAR	Investment costs for measurement facilities in year YEAR. Data for 1940-2004.	Investitionskosten für Zähl- und Messanlagen im Jahr YEAR. Daten für 1940-2004
	continuously urbanized area (in qkm)	durchgängig städtische Prägung (in qkm)
	not continuously urbanized area (in qkm)	nicht durchgehend städtische Prägung (in qkm)
	industrial area (in qkm)	Industrie- und Gewerbeflächen
	total area of the AGS (in qkm)	Gesamtfläche der Gemeinde (in qkm)
	percentage of continuously urbanized area (in qkm)	% Anteil der Flächen durchgängig städtischer Prägung
	percentage of not continuously urbanized area (in qkm)	% Anteil der Flächen nicht durchgehend städtischer Prägung
	percentage of industrial area (in qkm)	% Anteil der Industrie- und Gewerbeflächen

Primary gas variables 12

	mininmal height (in m over sea level)	minimale Höhe (in m über NN)
	maximal height (in m over sea level)	maximale Höhe (in m über NN)
	differential of height (in m)	Höhendifferenz innerhalb der Gemeinde (in m)
	mean height of the AGS	durchschnittliche Höhe der Gemeinde (in m über NN)
	mean slope of the AGS	durchschnittliche Neigung der Gemeinde (in %)
	predominant possibility of digging within the AGS - 0 (not clearly identifiable) - 1 (easy) - 2 (medium) - 3 (heavy)	vorherrschende Grabbarkeit innerhalb der Gemeinde (0 - nicht eindeutig bestimmbar, 1 - leicht, 2 - mittel, 3 – schwer)

