

Productivity and Efficiency Analysis

4) Unified approach: StoNED

a) Application of StoNED

Timo Kuosmanen

Aalto University School of Business

<https://people.aalto.fi/timo.kuosmanen>

Unified cost frontier model (2012-2015)

$$\ln x = \ln C(y_1, y_2, y_3) + \delta z + u + v$$

- x is the total cost
- C is the frontier cost function that satisfies free disposability, convexity, and CRS
- y_1 is the energy transmission (GWh of 0.4 kV equivalents)
- y_2 is the total length of the network (km)
- y_3 is the number of customers connected to the network
- z is the proportion of underground cables (%)
- u is an asymmetric inefficiency term
- v is a random noise term

Source: Kuosmanen (2012) Stochastic semi-nonparametric frontier estimation of electricity distribution networks: Application of the StoNED method in the Finnish regulatory model, *Energy Economics*

Marginal costs of outputs $\partial C/\partial y$ (Shadow prices / multiplier weights γ)

Descriptive statistics of the distribution of the estimated firm-specific marginal costs of outputs.

	Energy transmission (c/kWh)	Length of network (€/km)	Number of customers (€/customer)
Average	0.4773	930.09	12.94
St. dev.	0.1222	172.09	18.33
Median	0.5686	985.44	0.00
Mode	0.6072	912.12	0.00
Min	0.0518	0.00	0.00
Max	0.6126	1045.25	76.36

Estimated cost frontier C

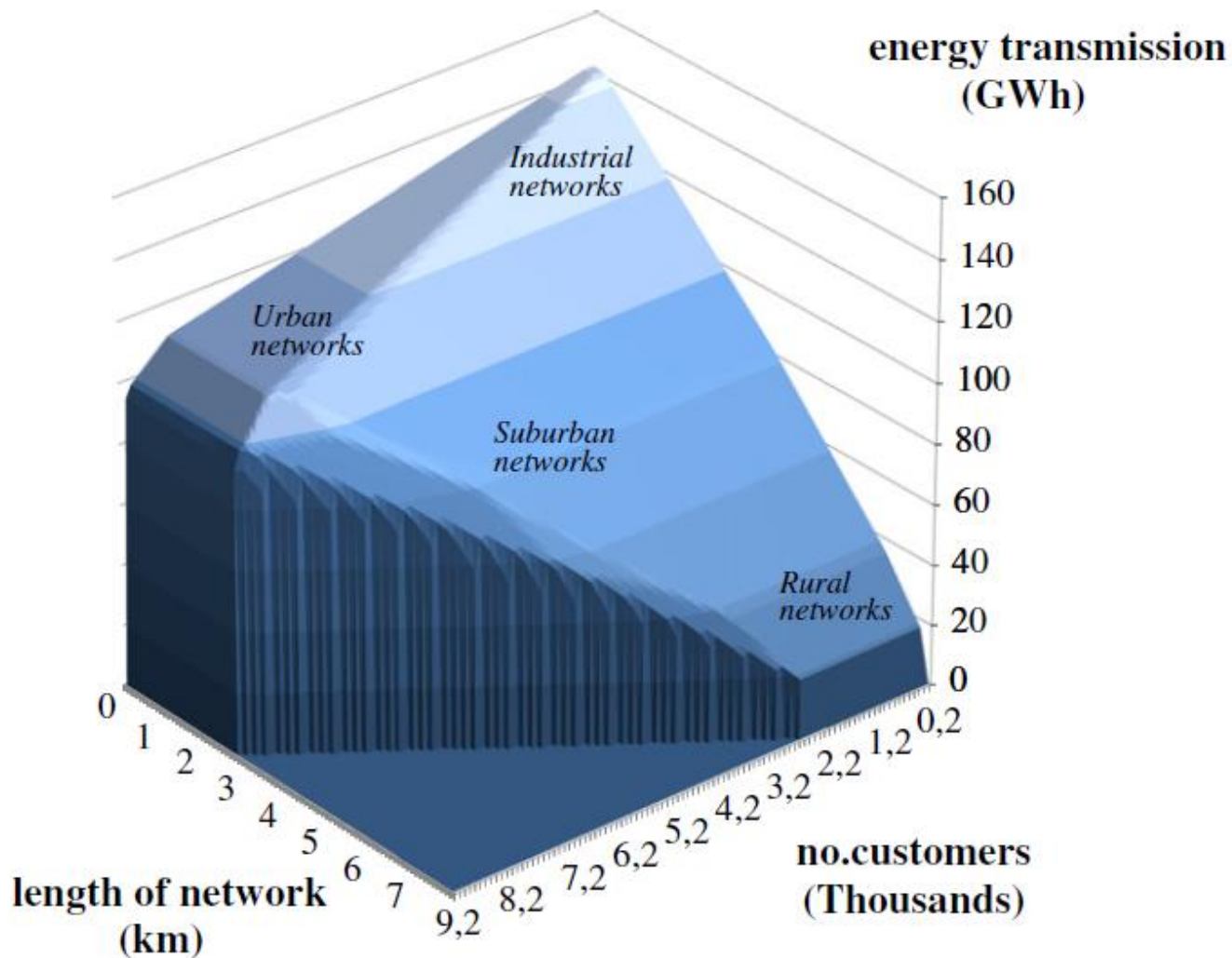
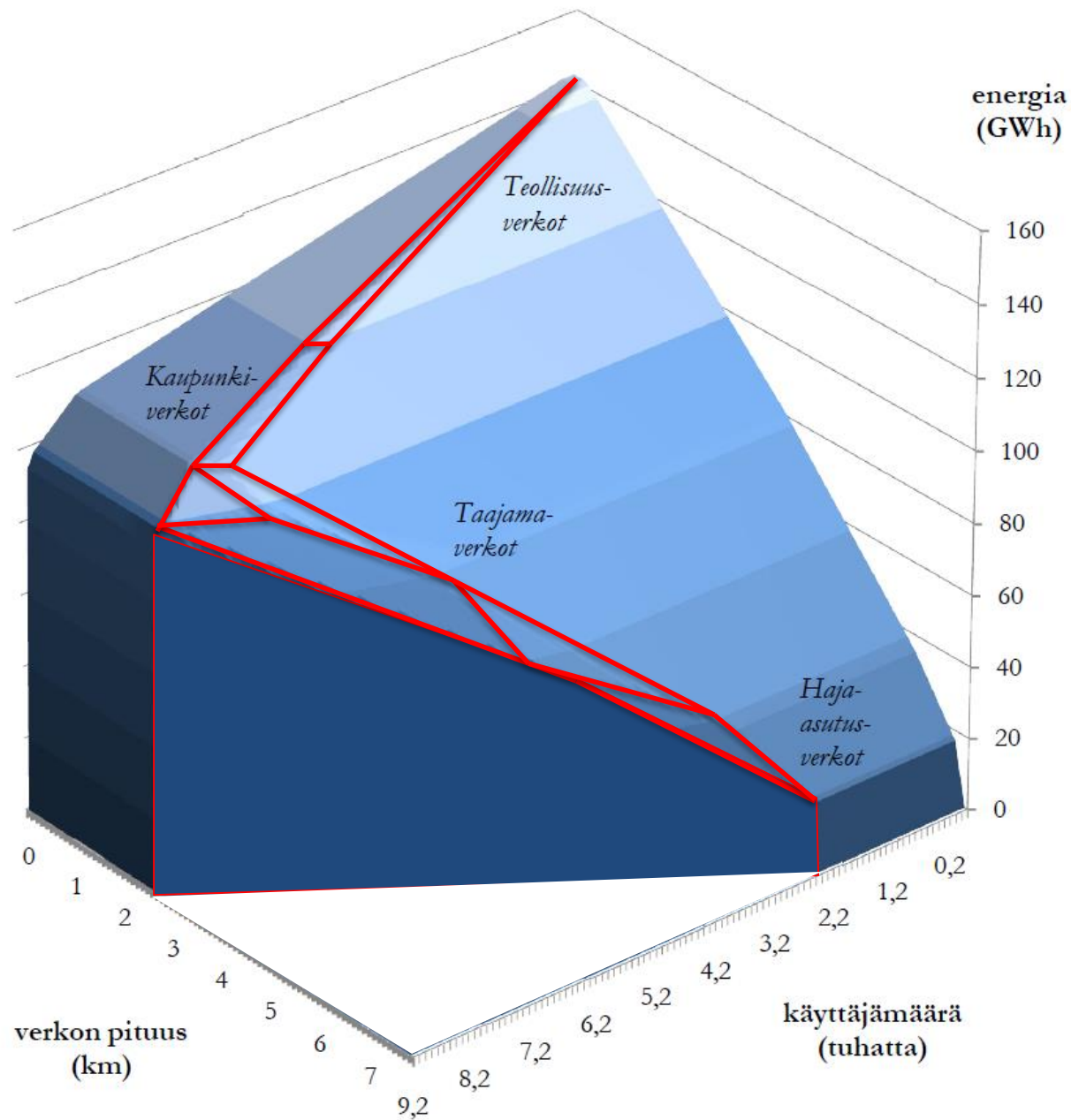


Fig. 1. Three-dimensional illustration of the output set of the estimated StoNED frontier at the total cost of 1 million €.



Kuvio 6.1: Estimoidun StoNED-rintaman tuotusmahdollisuuksien joukko kolmiulotteisesti kuvattuna kiinteällä kustannustasolla (TOTEX = 1 Milj. €).

Marginal costs of outputs $\partial C/\partial y$ (Shadow prices / multiplier weights γ)

Classification of networks to 10 groups according to the estimated marginal costs.

Group	No. of firms	Energy transm. (c/kWh)	Length of network (€/km)	No. of users (€/user)	Average efficiency
1	11	0.6043	876.74	0.87	92%
2	36	0.5597	984.94	1.23	92%
3	3	0.4434	908.77	22.25	94%
4	10	0.4566	1038.81	1.86	93%
5	3	0.4200	970.69	21.00	92%
6	4	0.3662	964.71	27.86	95%
7	3	0.2929	232.21	60.11	92%
8	7	0.3493	930.93	33.43	91%
9	6	0.3324	983.05	29.61	90%
10	6				96%
Average		0.4773	930.09	12.94	92%

Inefficiency and noise

(Half-normal inefficiency / normal noise)

Parameter estimates related to the inefficiency and the noise terms and the expected value of inefficiency.

Parameter	Estimate
σ^2 (variance of the composite error term)	0.03239
σ_u^2 (variance of the inefficiency term)	0.02064
σ_v^2 (variance of the noise term)	0.01175
μ (expected value of the inefficiency term)	0.11464
Expected value of cost efficiency	89%

Firm-specific efficiency estimates (JLMS)

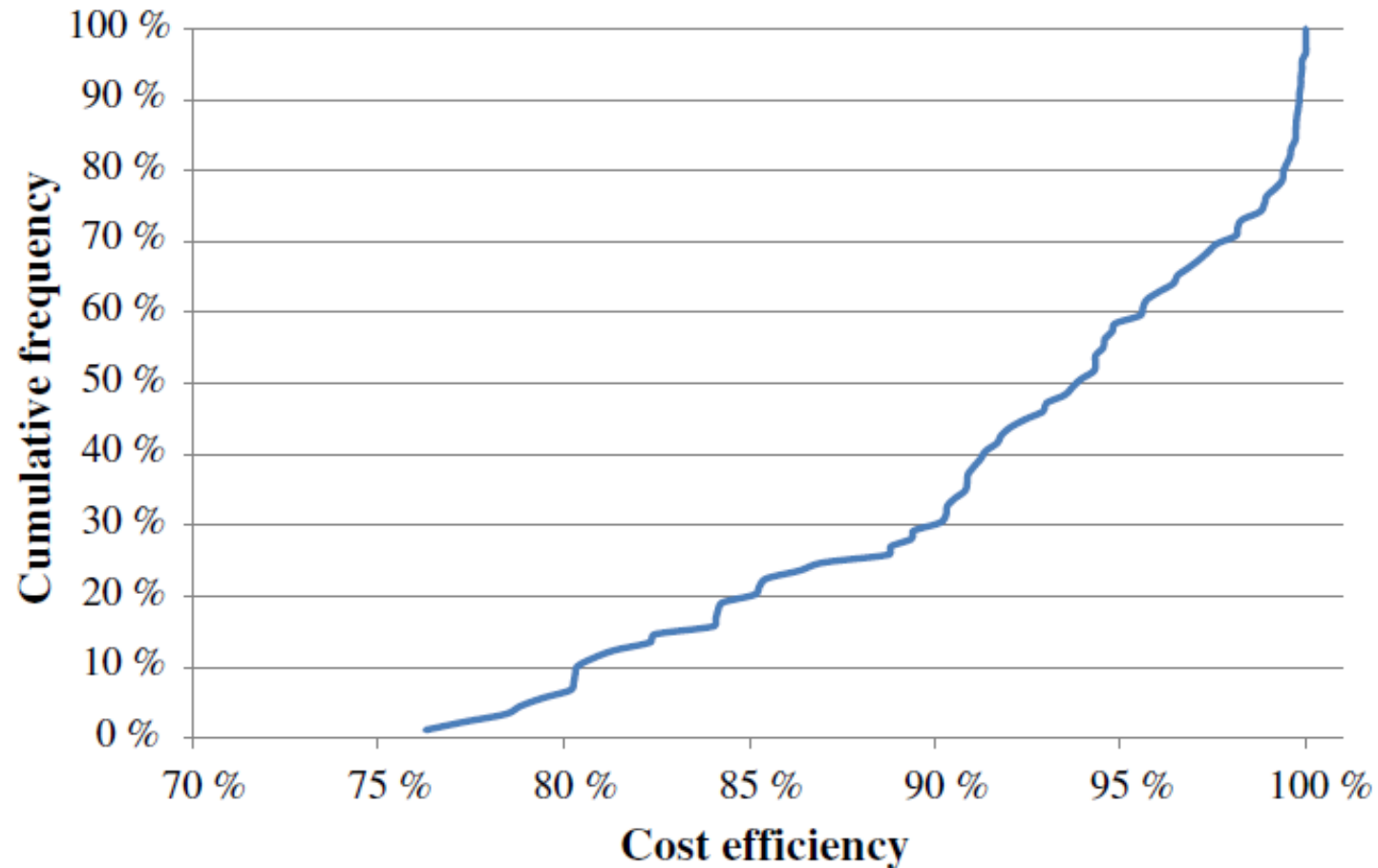


Fig. 2. Cumulative frequency distribution of the cost efficiency estimates.

Advantages of StoNED

- A natural way to combine an axiomatic, nonparametric DEA-style frontier with probabilistic SFA model of inefficiency and noise
- Classic DEA and SFA models are restricted special cases of the encompassing unified model
- Opens door to combine insights and tools from the Econometrics and OR streams of literature

Disadvantages of StoNED

- More demanding for the user
- Heavier computational burden
- Silly acronym?
 - “**Stoning** is a method of capital punishment where a group throws stones at a person until the subject dies from blunt trauma. It has been attested as a form of punishment for grave misdeeds since ancient times.”

Next lesson

4b) StoNED estimation