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Network Utilities Performance and Institutional Quality:
Evidence from the Italian Electricity Sector

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OVERVIEW

- Background
- Methodology
- Data
- Results
- Conclusions

BACKGROUND

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- Despite almost three decades of electricity sector reforms, the **performance** of utilities across **different regions** of countries around the world seems to be diverse and **non-homogenous**.
- **Sources:**
  - Geographical differences;
  - Diverse weather conditions;
  - Economic development.
- However, **regional and local institutional settings,** in which regulated firms operate, might also influence firms' overall performance.

The Italian electricity sector and institutional context

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- **ARERA** (the Italian Regulatory Authority for Energy, Networks and the Environment) has applied **incentive-based mechanisms** since 2002 to improve **productive efficiency and service quality measures** (such as continuity of supply).
- In Italy, there is a **wide gap** between performance of utilities located in **northern and southern regions** (Cambini et al., 2014; Capece et al., 2013). The sector also suffers from **high number of interruptions**, in particular in the southern part of the country (ARERA, 2017).
- Italy has the **largest regional disparity** among OECD countries (OECD, 2018).
- Historical differences between northern and southern regions raise the question whether the dissimilar levels of economic development and differences in quality of institutions, also affect the performance of electricity distribution utilities.

METHODOLOGY

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- Identifying determinants of cost inefficiency for electricity distribution utilities;
- **Stochastic Frontier Analysis (SFA)** approach;
- A set of **cost functions** estimated (three models);
- **Inefficiency determinants** are modelled as:
  - Regional-level **economic** factors:
    - Gross Value Added (GVA)
    - Employment rate
  - Regional-level **institutional quality** measures:
    - Government effectiveness
    - Responsiveness towards citizens
    - Control of corruption
    - Rule of law

ESTIMATED MODELS

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- Three cost functions are estimated: **Cobb-Douglas, Translog (ALS), Translog w. Modelled inefficiency term (RSCFG)**
- The general form of a stochastic cost frontier (ALS - Aigner et al. (1977)) can be presented as:

$$\ln TC_{it} = \ln f(y_{it}, p_{it}, x_{it}, \beta) + v_{it} + u_{it}$$

- RSCFG - Reifschneider & Stevenson (1991), Caudill & Ford (1993), Caudill *et al.* (1995)

$$\ln TC_{it} = \ln f(y_{it}, p_{it}, x_{it}, \beta) + v_{it} + \exp(z_{it}'\delta) \cdot u_{it}^{*}$$

→ **Scaling Property**

where '*TC*' is total utility cost, '*y*' is a set of outputs (energy delivered, number of customers, SAIDI), '*p*' prices of labour and capital inputs, '*x*' are control variables (mountainside, area dummies), 'β' are parameters to be estimated, 'z_{it}'' is a set of environmental variables, 'δ' is a set of parameters to be estimated, and 'u_{it}^{*}' is a measure of "raw" inefficiency that does not depend on z_{it}' .

DATA

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- Unique dataset constructed together with the Italian Authority (ARERA)
- 107 electricity distribution companies (excluding *Enel*)
- 15 regions in 3 areas (north, south, center)
- Period of analysis: 2011 to 2015
- Panel dataset, unbalanced, 237 Observations
- Sources:
  - Utilities' annual regulatory accounting data reported by the utilities to ARERA;
  - ISTAT;
  - Nifo and Vecchione (2014) dataset of institutional quality measures of Italian regions (based on World Governance Indicators).

RESULTS/1

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	ALS (Cobb-Douglas)			ALS (translog)			RSCFG (translog)		
Variable	*Est.*		*Std. Err.*	*Est.*		*Std. Err.*	*Est.*		*Std. Err.*
Frontier									
Intercept	-1.737	***	0.157	-1.898	***	0.160	-1.971	***	0.078
ln ENED	0.439	***	0.067	0.528	***	0.078	0.405	***	0.040
ln CUST	0.352	***	0.073	0.224	***	0.078	0.426	***	0.046
ln SAIDI	-0.040		0.025	-0.049	*	0.027	-0.080	***	0.011
ln (KPR/LPR)	0.293	***	0.032	0.412	***	0.031	0.442	***	0.025
$^1/_2$ (ln ENED)^2				-0.026		0.170	-0.117		0.118
$^1/_2$ (ln CUST)^2				0.108		0.228	-0.101		0.149
$^1/_2$ (ln SAIDI)^2				0.012		0.012	0.009		0.015
$^1/_2$ [ln (KPR/LPR)^2]				0.130	***	0.024	0.151	***	0.012
ln ENED · ln CUST				-0.025		0.195	0.118		0.132
ln ENED · ln SAIDI				-0.013		0.048	0.050		0.037
ln ENED · ln (KPR/LPR)				-0.041		0.079	-0.043	**	0.039
ln CUST · ln SAIDI				0.054		0.051	-0.023		0.044
ln CUST · ln (KPR/LPR)				0.034		0.092	0.046	*	0.047
ln SAIDI · ln (KPR/LPR)				0.025		0.025	0.061	***	0.015
Centre	0.462	***	0.105	0.521	***	0.103	0.594	***	0.032
South	0.203		0.205	0.196		0.206	0.550	***	0.035
Mount	0.193	**	0.092	0.293	***	0.091	0.229	***	0.061
Corp	-0.064		0.078	0.024		0.071	-0.067	***	0.026

RESULTS/2

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Noise term (σ_v^2)	-2.864	***	0.404	-3.171	***	0.500	-8.929	***	0.505
Inefficiency term (variance)									
Intercept	-0.614	***	0.194	-0.874	***	0.224	24.868	***	5.612
ln GVA							-4.972	*	2.697
Emp_Rate							55.97	***	8.211
Voice							-6.656	***	2.646
RoL							-4.545	**	2.233
Gov_Eff							-5.992	*	3.168
Corru_Ctrl							-17.15	***	4.044
North							-1.321	**	0.572
T							0.030		0.079
Observations	237			237			237		
Log-likelihood	-163.314			-131.116			-94.630		
Chi-squared LR test	64.40 ***			72.97 ***			-		
Degrees of freedom	(10)			(8)			-		

RESULTS/3

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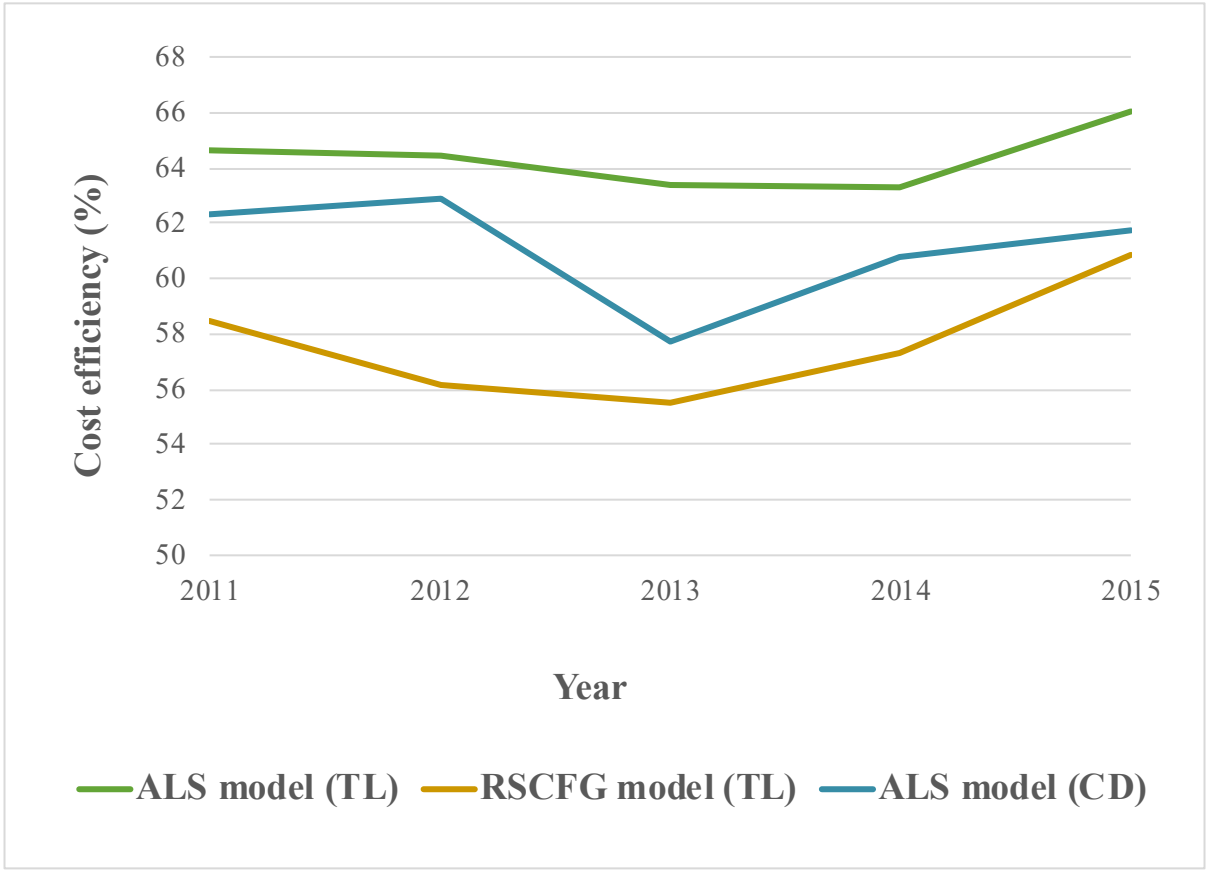
- A similar pattern but a wide gap in the efficiency scores of ALS and RSCFG.
- For RSCFG, the preferred model, the average efficiency score is equal to 58%.



CONCLUSIONS

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- Regional-level **macroeconomic factors** and **quality of regional institutions** have **significant impact** on the cost efficiency of distribution utilities.
- Utilities located in regions with **better institutional endowments** show **better performance scores**.
- If any of the **institutional quality** measures is weakened, how **resources** are allocated and how utilities decide to use their available resources are impacted as well.
- Current regulatory approaches do not take this into account.
- To compare performance of utilities on a **fair** basis when applying **benchmarking methods, regional diversity** in terms of institutional quality should be considered as well.

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Thank you!

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Appendix

MICRO REGIONS IN ITALY: REGIONAL SOCIO-ECONOMIC DISPARITY

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Source: Usseglio (2016)

DESCRIPTIVE STATISTICS

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Variable	*Unit*	*Min.*	*Max.*	*Mean*	*Std. Dev.*
Totex	Euros (2010)	5,656	315,185,156	11,209,170	39,082,340
ENED	MWh	673	11,334,422	393,498	1,573,321
CUST	No of Customers	10	1,626,019	51,661	206,264
SAIDI	Minutes	0.01	8,067	125.84	429.86
LPR	Euros (2010)	200	265,430	52,935	28,226
KPR	Euros (2010)	0.01	21,466	1,871	1,811
North	Dummy	0	1	0.87	0.33
Centre	Dummy	0	1	0.08	0.27
South	Dummy	0	1	0.05	0.21
Mount	Dummy	0	1	0.78	0.41
Corp	Dummy	0	1	0.78	0.41
Emp_Rate	%	39	68.72	65.58	5.28
GVA	Euros (2010)	14,295	33,822	30,273	4,854
Voice	Index	23	65	48.62	7.44
RoL	Index	30	81.70	69.84	12.17
Gov_Eff	Index	17.40	61.40	46.50	7.46
Corru_Ctrl	Index	61.40	97.30	90.43	5.86

ROBUSTNESS CHECK WITH ENEL

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	ALS (Cobb-Douglas)			ALS (translog)			RSCFG (translog)		
Variable	*Est.*		*Std. Err.*	*Est.*		*Std. Err.*	*Est.*		*Std. Err.*
Frontier									
Intercept	-1.737	***	0.157	-1.888	***	0.127	-2.032	***	0.060
ln ENED	0.415	***	0.065	0.514	***	0.073	0.407	***	0.046
ln CUST	0.406	***	0.070	0.243	***	0.074	0.418	***	0.049
ln SAIDI	-0.033		0.026	-0.042		0.027	-0.069	***	0.012
ln (KPR/LPR)	0.286	***	0.033	0.410	***	0.031	0.424	***	0.025
$^1/_2$ (ln ENED)^2				-0.061		0.165	-0.187		0.152
$^1/_2$ (ln CUST)^2				0.048		0.219	-0.058		0.173
$^1/_2$ (ln SAIDI)^2				0.013		0.013	0.007		0.012
$^1/_2$ [ln (KPR/LPR)^2]				0.134	***	0.022	0.154	***	0.011
ln ENED · ln CUST				0.019		0.189	0.028		0.161
ln ENED · ln SAIDI				-0.005		0.047	0.004		0.037
ln ENED · ln (KPR/LPR)				-0.059		0.069	-0.056		0.040
ln CUST · ln SAIDI				0.043		0.049	-0.035		0.041
ln CUST · ln (KPR/LPR)				0.060		0.078	0.064		0.047
ln SAIDI · ln (KPR/LPR)				0.028		0.024	0.042	***	0.014
Centre	0.526	***	0.098	0.513	***	0.102	0.595	***	0.037
South	0.206		0.201	0.162		0.204	0.546	***	0.043
Mount	0.206	**	0.093	0.285	***	0.091	0.182	***	0.054
Corp	-0.091		0.079	0.024		0.071	-0.069	***	0.027
Noise term (σ_v^2)	-2.947	***	0.460	-3.168	***	0.490	-8.833	***	0.488
Inefficiency term (variance)									
Intercept	-0.573	***	0.198	-0.901	***	0.224	19.605	***	5.431
ln GVA							-7.348	***	2.586
Emp_Rate							57.74	***	7.961
Voice							-4.151		2.587
RoL							-3.186		2.195
Gov_Eff							-4.954		3.013
Corru_Ctrl							-14.96	***	4.155
North							-0.709		0.580
T							0.028		0.077
Observations	242			242			242		
Log-likelihood	-167.480			-131.664			-91.542		
Chi-squared LR test	71.63 ***			80.24 ***			-		
Degrees of freedom	(10)			(8)			-		