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3rd International Workshop on Empirical Methods in Energy Economics (EMEE2010)

Surrey Energy Economics Centre (SEEC)

University of Surrey, UK

24th – 25th June 2010

NOTE:

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The Economies of Scale in The French Power Distribution Utilities

3rd International Workshop on

Empirical Methods in Energy Economics

University of Surrey, Guildford, UK, 24-25 June 2010

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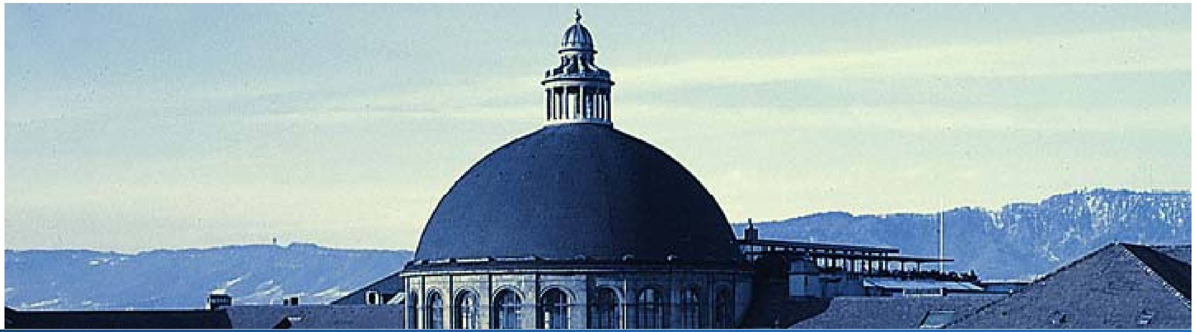

Outline

- **Introduction**
- Model Specification and Data
- Econometrics
- Estimation Results
- Conclusion

A. Introduction

- In the last two decades several countries have introduced a reform of the electricity sector
- Competition in production and new regulation instruments in the distribution (still a natural monopoly).
- For the design of these reforms **as well for business decisions,** the empirical understanding on different efficiency concepts (***scale efficiency, scope efficiency, and cost efficiency***) is relevant
- In France a reform has been introduced in 2003 ➔ Important effects for EDF

Introduction

- France: EDF vertical integrated company
- EDF is in charge of 95% of total electricity distribution in France.
- Reorganization of EDF: unbundling, reorganization of the distribution….

Electricité de France

- EDF is one the world's largest utility company (>120 Giga watts generation capacity and €66 billion revenue in 2009)
- Created in 1946, by nationalizing a number of small utilities and has been a gov't corporation until privatization in 2005 (85% ownership retained by French gov't).
- Mainly led by elite engineers, EDF has undergone several reforms

Electricité de France (distribution)

- Until the 1990's power distribution was organized in 8 large regional units. m1
- Gradual decentralization in the 1990's resulted in 102 independent distribution centers.
- A reversal starting from 2005: re-grouping certain activities across several neighboring units up to consolidating back to regional level.

m2

Slide 6

m1 reamining 5% is distributed by about 160 small municial utilities.

Today about 19 other suppliers compete with EDF.
mfarsi, 11/06/2010

m2 depending on the function:

customer services are consolidated at regional level, but technical maintenance at 2-3 neighboring units.
mfarsi, 11/06/2010

In this paper

- We estimate the economies of scale in a sample of 93 EDF distribution units from 2003 to 2005, prior to re-structuring measures.
-
- We account for unobserved heterogeneity and try to assess the unexploited economies of scale prior to reforms.

Some problems

Heterogeneity

- **Observed**
- **Unobserved**

- **Long-run: TC**
- **Short-run: VC**

.....

- **Using a VC: computation of the economies of scale**

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Model specification (variable cost function)

$$C = C(CU, AS, K, D_t)$$

m8

C: Total OPEX for networks and customer-service activities

CU: Total number of low-voltage customers

AS: Service area size (km^2)

K: Distributor's assets book value (capital stock)

D_t: Vector of year dummies

m8 We tried several models, but found that a oparsimonious model works better in terms of plausibility and signifcance
mfarsi, 17/06/2010

Cobb-Douglas function

$$\ln C_{it} = \alpha_i^{(CU)} \ln CU_{it} + \alpha_i^{(AS)} \ln AS_{it} + \alpha_i^{(K)} \ln K_{it} + \sum_{t=2004}^{2005} \delta_i^{(t)} D_t + \alpha_i^{(0)} + \varepsilon_{it}$$

$$\varepsilon_{it} \sim \mathrm{N}(0, \sigma_i^2)$$

Economies of scale and density

m18

$$ES = \left(1 - \frac{\partial \ln C}{\partial \ln K}\right) \cdot \left(\frac{\partial \ln C}{\partial \ln CU} + \frac{\partial \ln C}{\partial \ln AS}\right)^{-1}$$

$$ED = \left(1 - \frac{\partial \ln C}{\partial \ln K}\right) \cdot \left(\frac{\partial \ln C}{\partial \ln CU}\right)^{-1}$$

- Sign of the coefficient for K
- Actual or optimal K ?

Slide 12

m18 these are long run Economies of Scale
mfarsi, 17/06/2010

Properties variable cost function

- If the firm minimizes the variable costs of producing a given output, subject to quasi-fixed inputs, the variable cost function, VC(Q,$\mathbf{p}_g$,**k**) has the following properties (regularity conditions):

1. VC(Q, **pg**, **k**) > 0 for **p** > 0 and Q > 0 (non-negativity)

2. if **pg**' > **pg**, then VC(Q , **pg**', **k**) VC(Q , **pg**, **k**) (non-decreasing in **pg**)

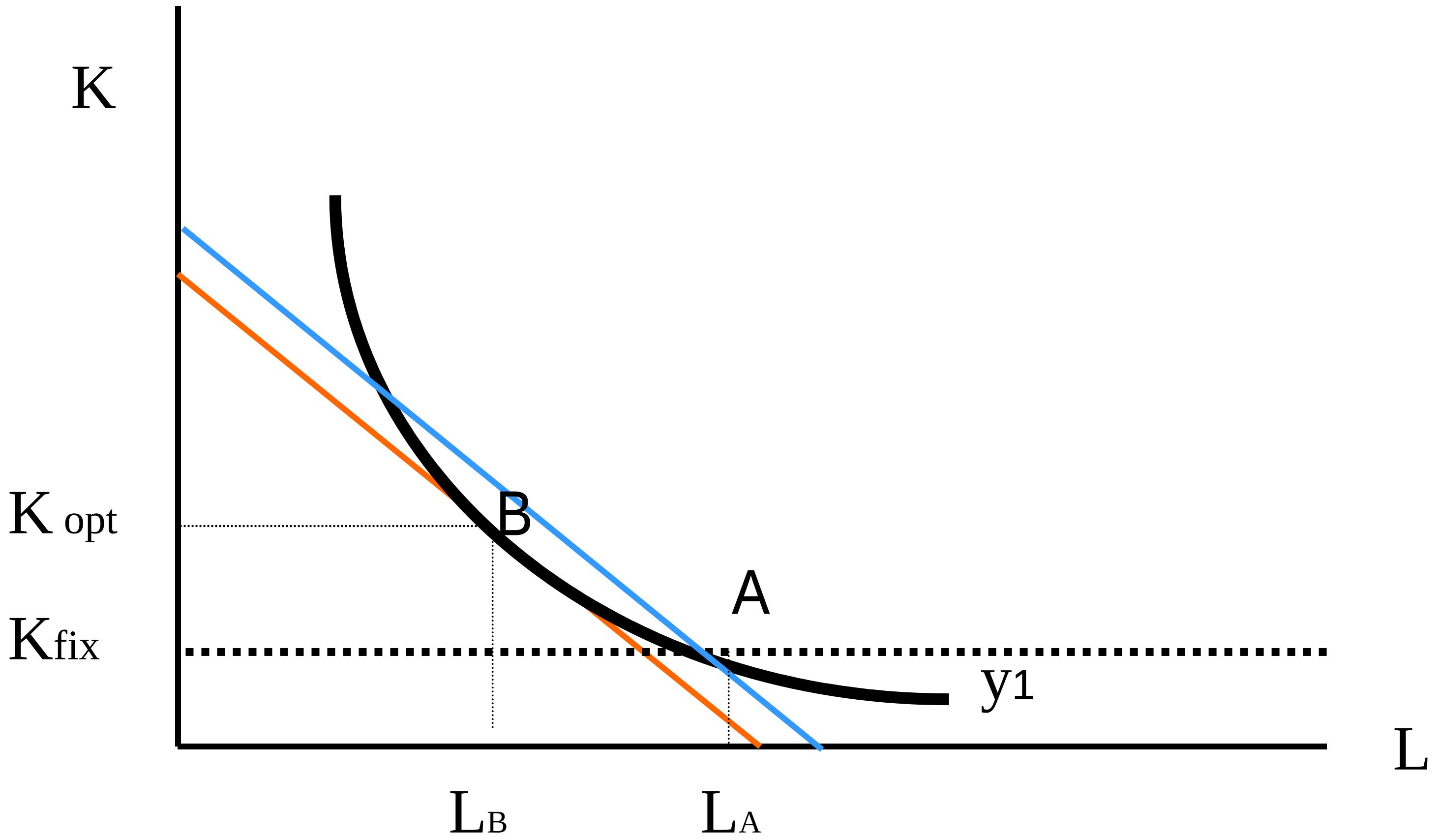
3. concave and continuous in **pg**

4. VC(Q , **pg**, **k**) is homogeneous of degree one in input prices:
   VC(Q, t**pg**, **k**) = t VC(Q, **wg**, **k**) for t > 0

5. if Q > Q ', then VC(Q , **pg**, **k**) < VC(Q ', **pg**, **k**) (non-decreasing in Q

6. if **k**' > **k** then VC(y , **pg**, **k**') < VC(y **, pg, k**) (non-increasing in **k**)

if k' > k then VC(y , pg, k') < VC(y , pg, k) (non-increasing in k)



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Data (279 observations from 93 units, 2003-2005)

Variable		Mean	Std Dev	Min.	Max.
C	OpEx (€ million)	23.49	12.03	10.58	115.55
CU	# of customers	338'437	186'637	109'435	1'596'126
NT	Network Length (km)	13'320	6'143	4'060	32'743
K	Assets (€ million)	342.71	143.55	128.92	937.12
AS	Service Area Size (km^2)	5'473.46	3'158.07	107	1'3871
CA	Transformer Capacity (MVA)	1442	613	412	4526
Q	Distributed electricity (GWh)	3'673	1'845	1'001	14'364
CD	Customer density /km^2	445	1'663	17	14'917

All monetary values are in terms of 2005 Euros based on French CPI.

Empirical question

- Here we use a finite number of technology classes that can be modeled with a latent class model.

Econometric approach

- Latent class model has been used (eg. Orea-Kumbhakar, 2004) to model technological differences.
- In latent class models, parameters are assumed to be discrete random variables in *J* classes distributed across companies.
- In the first step, the sample is split into several groups
- Splitting can be based on some a priori information about companies,
- In the second stage different functions are estimated for each group

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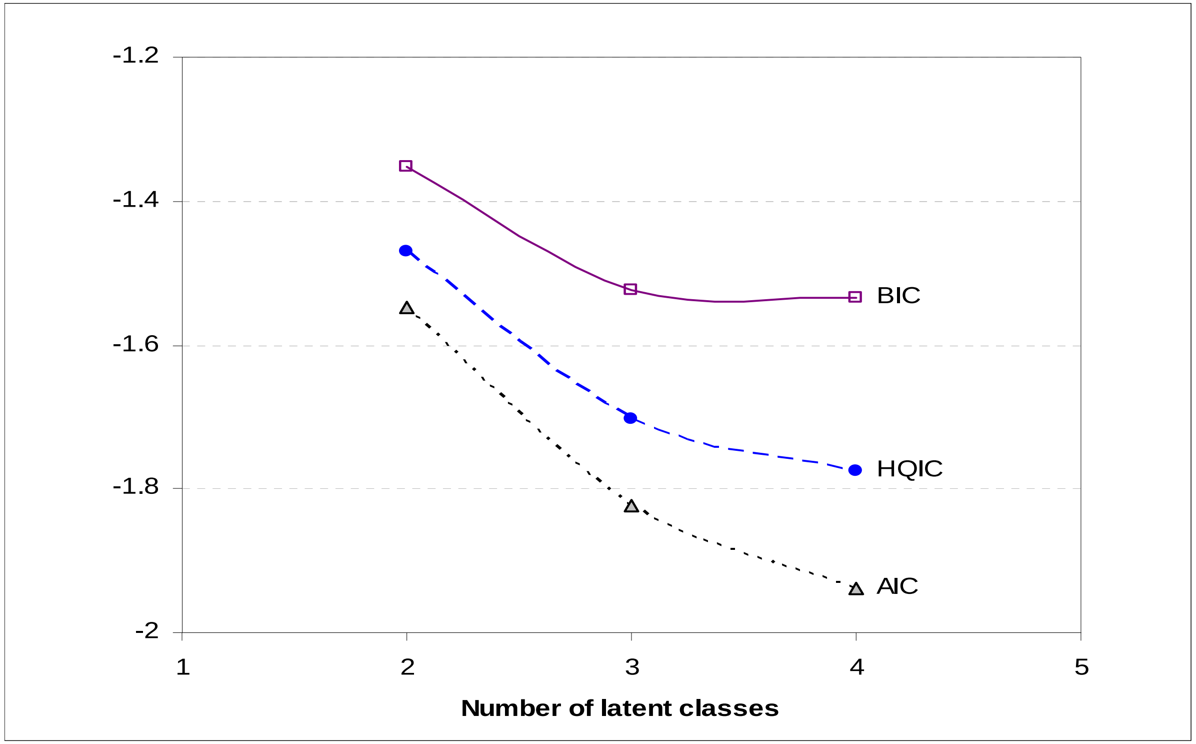
Specification of number of classes



With *J*>4, additional classes become almost degenerate (very small prior probability).

Estimation Results (LC)

	Class 1	Class 2	Class 3	Class 4
Number of customers (*CU*)	1.285	0.644 **	0.674 **	0.470 **
	(0.797)	(0.039)	(0.038)	(0.066)
Service area size (*AS*)	0.063	0.080 **	0.084 **	0.057 **
	(0.089)	(0.008)	(0.015)	(0.026)
Assets book value (*K*)	-0.400	0.183 **	0.088 *	0.331 **
	(0.820)	(0.039)	(0.047)	(0.099)
Year 2004	0.048	-0.067 **	-0.027	-0.125 **
	(0.344)	(0.028)	(0.029)	(0.040)
Year 2005	0.472 **	-0.191 **	-0.115 **	-0.253 **
	(0.179)	(0.015)	(0.016)	(0.073)
Constant	5.086 **	5.775 **	6.635 **	6.532 **
	(1.516)	(0.201)	(0.209)	(0.441)
Std. dev. of the stochastic term (σ_j)	0.119 **	0.060 **	0.049 **	0.048 **
	(0.034)	(0.004)	(0.004)	(0.008)
Prior class probability (P_j)	0.086 **	0.452 **	0.348 **	0.114 **
	(0.029)	(0.058)	(0.060)	(0.038)

Standard errors are given in parentheses. * p<.1; ** p<.05

Economies of Scale and Customer Density (LC)

	Class 1	Class 2	Class 3	Class 4
Economies of Scale (*ES*)	1.039 (.109)	1.129 ** (.029)	1.203 ** (.031)	1.270 ** (.071)
Economies of Density (*ED*)	1.089 (.087)	1.269 ** (.028)	1.353 ** (.028)	1.424 ** (.083)

Significantly different from 1 at: * p<.1; ** p<.05
Standard errors (given in parentheses) are computed using delta method.

Identifying latent classes

	Class 1	Class 2	Class 3	Class 4
CU ('000)	598 (421)	317 (110)	312 (135)	306 (187)
AS (km^2)	2844 (3005)	5759 (2763)	5060 (2611)	7741 (4877)
CD (per km^2)	2399 (5086)	186 (575)	333 (853)	338 (701)
CA (MVA)	2021 (1067)	1419 (401)	1379 (600)	1277 (725)
K (€ million)	453 (221)	333 (116)	323 (131)	358 (151)
NT (km)	10823 (6276)	13065 (5520)	12963 (6072)	17566 (7849)
Q (GWh)	5778 (3710)	3589 (1220)	3449 (1550)	3077 (2060)
Posterior P_j	1.000 (.000)	0.964 (.087)	0.926 (.100)	0.973 (.073)

Standard deviations are given in parentheses.

Roughly speaking:

- Class 1: High customer density (CD)
- Class 2: Medium network (medium CD)
- Class 3: Medium network (low CD)
- Class 4: Large networks (medium CD)

Conclusion

- Many (natural monopoly) industries inherit their organization from the past, entailing potential scale inefficiency.
- A few examples of restructuring and policy discussions shows that optimal scale is still a relevant issue.
- Analysis of costs and the economies of scale can be used to assess the efficiency of the electricity distribution sector, provided that unobserved heterogeneity is taken into account.
- Latent-class models are sensible tools that could be used.

Thank you for your attention!