

The Electricity Industry Reform Paradigm in the EU15: Impact on Consumers

*Carlo V. Fiorio, Massimo Florio
University of Milan*

**EPRG Spring Research Seminar
Friday 16th May 2008**

The electricity industry

The electricity industry can be described as including four different activities:

1. generation,
2. transmission (the high voltage network),
3. distribution (the middle and low voltage network),
4. retail (supply to final consumers).

Only transmission and distribution are natural monopolies, at the national and regional level, because of the high network fixed sunk costs.

The new paradigm

The **new paradigm** is usually simplified as suggesting three parallel reforms:

1. *privatization* (sale of existing publicly owned firms and licensing of private entrants),
2. *unbundling* (associated with incentive regulation of the networks, third-party-access, establishing and independent regulator)
3. *liberalization* (i.e. allowing entry and competition in generation and retail).

However...

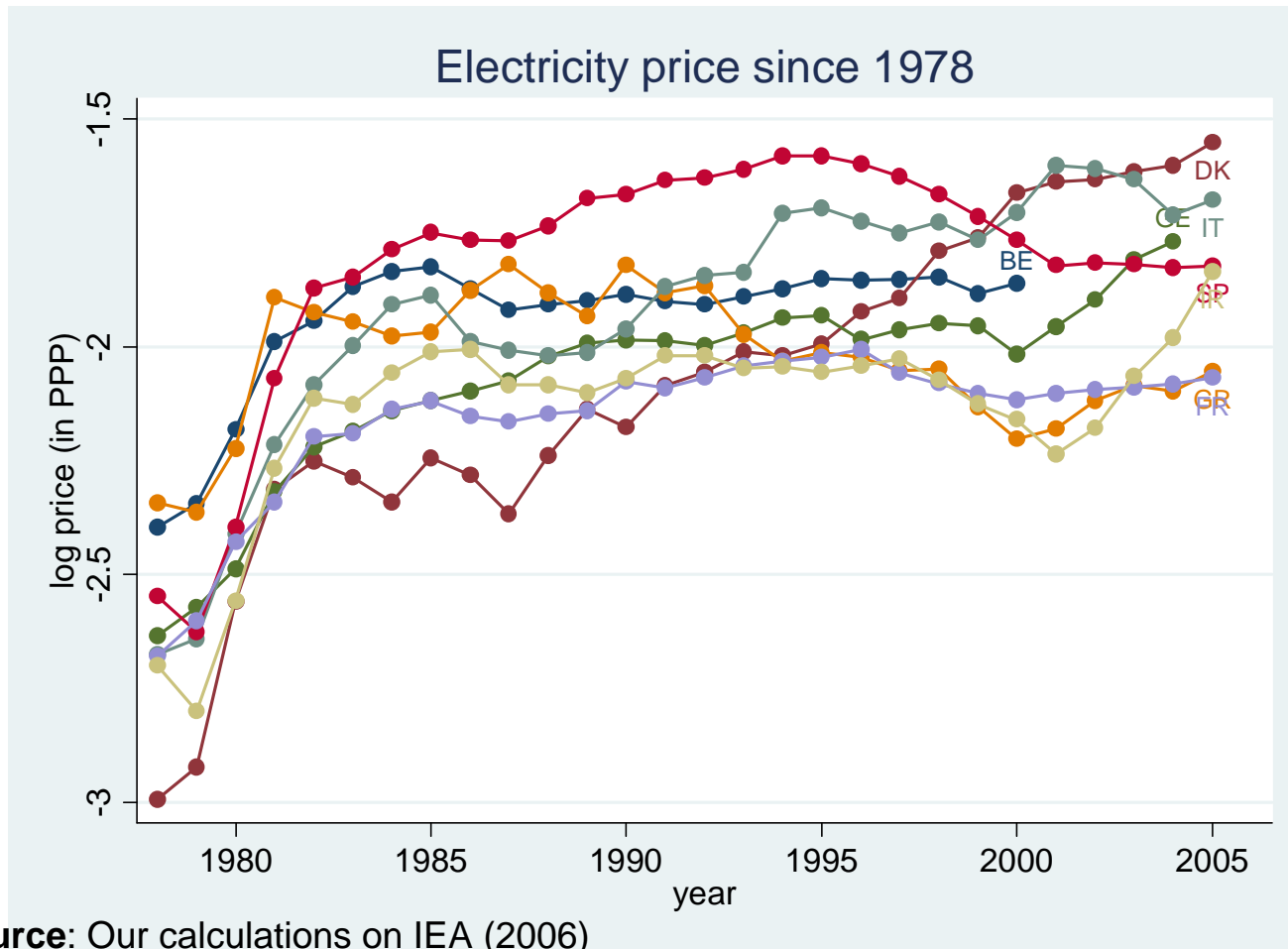
- many items are not strongly correlated, can be implemented under a variety of industry structures and government interventions, thus the degrees of freedom in the reform design are higher than sometimes is suggested.
- Without empirical testing, however, some of the tenets of the reform paradigm are questionable

Our empirical approach

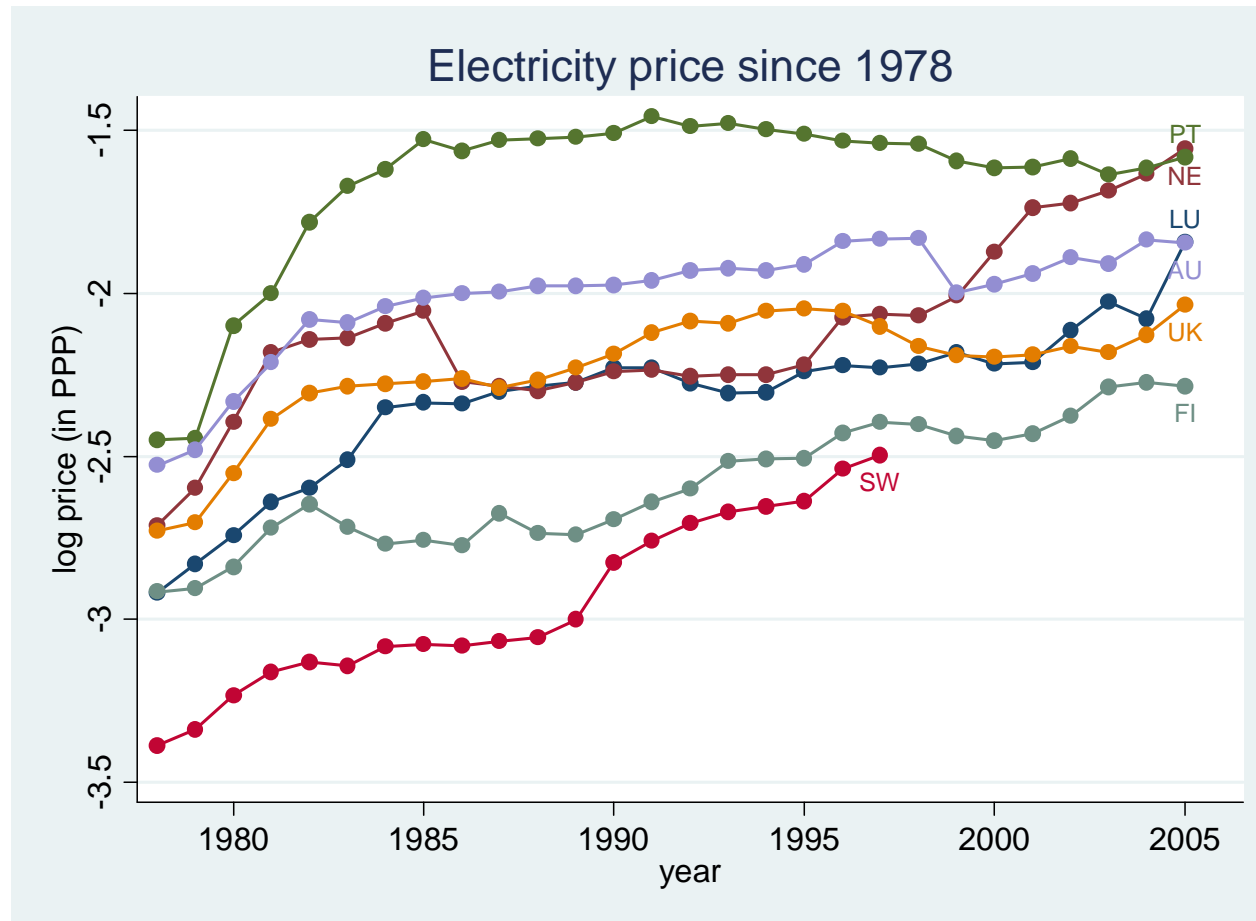
Our empirical approach is to take advantage of the diversity in European electricity reform patterns and to control for a number of potential explanatory variables to predict two simple performance indicators:

1. **prices of electricity** for households (source: IEA),
2. **satisfaction of consumers** with prices they pay and quality of service provided (source: Eurobarometer).

Electricity (log) price for households (in PPP per *KW/Hour*)



Electricity (log) price for households (in PPP per *KW/Hour*)



Source: Our calculations on IEA (2006)

Summary statistics of some relevant variables

Variables	Obs	Mean	Std. Dev.	Min	Max
Household price (Kw/h in nat. curr.)	408	0.24	0.33	0.07	1.60
<i>Energy sources</i>					
Source Hydro. (GWh/Tj)	394	18274.31	21007.10	0.00	73668.00
Source Comb. Fuel (GWh/Tj)	394	69179.42	88650.60	29.00	349166.00
Imports (GWh/Tj)	394	9479.15	10940.37	0.00	51519.00
Energy Distribution Loss (GWh)	394	9255.65	9624.75	24.00	34185.00
<i>Macro-economic variables</i>					
Population (Milions)	406	24.95	25.52	0.36	82.52
GDP (nat. curr. Billions)	406	478.29	493.49	5.09	2148.89
Residential Consumption (GWh)	394	36373.66	40740.92	394.00	146744.00
<i>Cost variables</i>					
Cost Comb. Oil (nat.curr./TOE)	287	154.39	46.99	67.09	400.57
Cost Coal (nat.curr./TOE)	266	96.71	37.30	47.41	258.82
Cost Gas (nat.curr./TOE)	196	155.70	42.64	71.87	324.26

Source: Our calculations on IEA (2006)

The REGREF data

- Variables from the OECD's REGREF dataset are:
 - “**public ownership**”, which measures the public ownership of each SGI and is coded from 0 (private ownership) to 6 (public ownership),
 - “**vertical integration**”, which is an indicator of vertical separation in different industries and is coded from 0 (ownership separation) to 6 (integration),
 - “**entry regulation**”, which is a weighted average of legal conditions of entry in a market and is coded from 0 (free entry) to 6 (franchised to one firm).

Some regulatory indices about the electricity industry

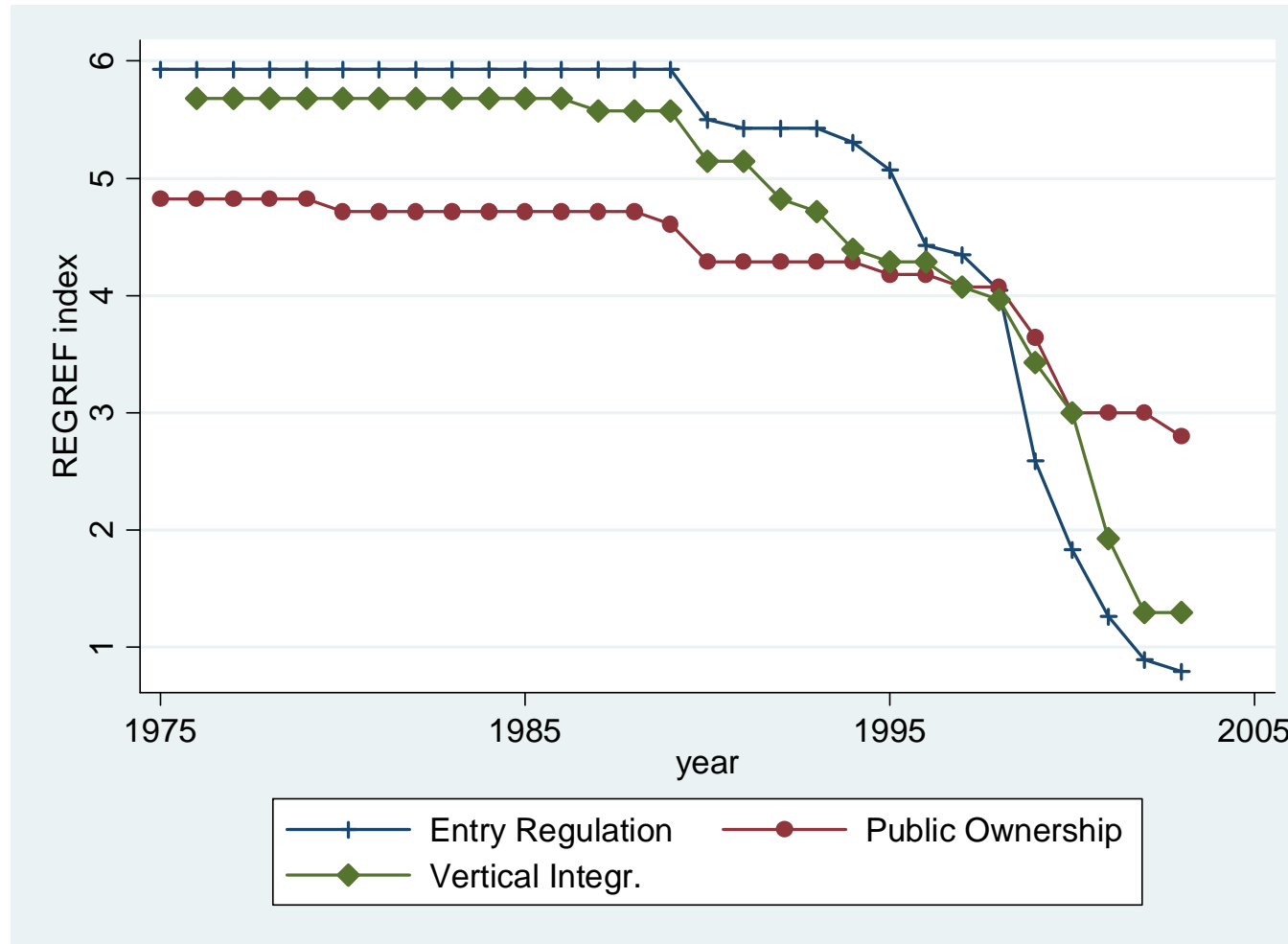
	Public Ownership			Entry regulation			Vertical integration		
	1999	2001	2003	1999	2001	2003	1999	2001	2003
Belgium	1.50	1.50	1.50	5.00	2.30	2.30	6.00	1.50	0.00
Denmark	3.00	3.00	3.00	0.30	0.30	0.00	6.00	1.50	0.00
Germany	3.00	3.00	3.00	3.00	1.00	1.00	3.00	3.00	1.50
Greece	6.00	6.00	6.00	6.00	2.30	2.30	4.50	4.50	1.50
Italy	6.00	3.00	3.00	4.00	2.30	0.30	4.50	1.50	0.00
Spain	1.50	1.50	1.50	0.30	0.30	0.00	1.50	1.50	0.00
France	6.00	6.00	6.00	4.30	2.30	0.30	6.00	4.50	4.50
Ireland	6.00	6.00	6.00	4.80	2.30	2.30	4.50	1.50	1.50
Luxembourg			0.00						4.50
Netherlands	6.00	0.00	0.00	0.30	0.30	0.30	1.50	1.50	1.50
Portugal	3.00	3.00	3.00	4.30	2.30	2.30	3.00	1.50	1.50
Great Britain	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	3.00	3.00	3.00	0.00	0.00	0.00	1.50	1.50	1.50
Sweden	3.00	3.00	3.00	0.00	0.00	0.00	1.50	1.50	0.00
Austria	3.00	3.00	3.00	4.00	2.00	0.00	4.50	1.50	1.50

Source: our calculations on REGREF (Conway and Nicoletti, 2006).

A "steam-and-leaf" plot of REGREF

ELECTRICITY			1975	1985	1990	1993	1995	1998	1999	2001	2003
Public	Integrated	No TPA	France Greece Ireland Italy Netherlands Portugal UK	France Greece Ireland Italy Netherlands Portugal UK	France Greece Ireland Italy Netherlands	France Greece Italy Netherlands	France Greece Italy Netherlands	France Greece Italy Netherlands	France		
	Accounting Separation	No TPA Regulated TPA				Ireland	Ireland	Ireland	Greece Italy	France Greece	France
	Separate Companies	Regulated TPA							Netherlands	Ireland	Greece Ireland
Mostly Public	Integrated	No TPA	Austria Denmark Finland	Austria Denmark Finland	Austria Denmark Finland Portugal	Austria Denmark Finland Portugal	Austria Denmark	Austria Denmark			
	Accounting Separation	No TPA Regulated TPA					Portugal Finland	Portugal			
	Separate Companies	Regulated TPA					Finland				
Mixed	Integrated	No TPA	Germany Spain Sweden	Germany Spain Sweden	Spain Sweden	Spain					
		Negotiated TPA			Germany	Germany	Germany				
		Regulated TPA							Austria Denmark		
	Accounting Separation	No TPA							Portugal		
		Negotiated TPA						Spain	Germany	Germany	Germany
		Regulated TPA									
Separate Companies	Negotiated TPA				Sweden	Sweden					Germany
	Regulated TPA							Sweden	Finland Sweden	Austria Denmark Finland Italy Portugal Sweden	Austria Denmark Finland Italy Portugal Sweden
Mostly Private	Integrated	No TPA	Belgium	Belgium	Belgium	Belgium	Belgium	Belgium	Belgium		
	Accounting Separation	Regulated TPA									
	Separate Companies	No TPA Regulated TPA				UK	UK		Spain	Belgium Spain	Belgium Spain
Private	Accounting Separation	Regulated TPA									Luxembourg
	Separate Companies	Regulated TPA					UK	UK	UK	Netherlands UK	Netherlands UK

Trends of mean of regulatory indices across EU15



Explaining electricity price dynamics

- p_{it} is the log of household electricity prices for country i at time t
- R_{it} is the vector of regulatory variables for country i at time t , which includes vertical integration, public ownership and entry regulation
- t is the deterministic time trend
- X a set of controls including production costs.

$$p_{it} = c + p_{i(t-1)} \lambda + R_{it} \beta + X_{it} \phi + \alpha_i + t\gamma + \varepsilon_{it}$$

Static and dynamic panel estimation

- Static & dynamic panel estimation

STATIC PANEL (dep. var.: net price (log))

D.VI: Vert. Integr.	-0.001	0.001	0.007
D.PU: Publ. Owner.	0.011	-0.005	0.017
D.ER: Entry Regul.	0.006	0.000	0.009
Year	-0.002**	-0.009***	-0.008***
D.Source Hydro. (log)		0.002	-0.042
D.Source Comb. Fuel (log)		0.030	-0.006
D.Imports (log)		0.011	0.011
D.Energy Distribution Loss (log)		0.026	-0.022
D.GDP (log)		-0.865***	-1.036***
population (log)		1.183***	1.073**
D.Resid. consumpt. (log)		-0.199*	-0.062
D.Cost Comb. Oil (log)			0.045*
D.Cost gas (log)			0.089***
Constant	4.739**	15.240***	12.088***
Obs.	339	309	144
Log likelihood	248.026	414.946	237.914

* p<.10, ** p<.05, *** p<.01

DYNAMIC PANEL (dep. var.: net price (log))

LD.net price (log)	0.750***	0.628***	0.618***	0.357***
D.VI: Vert. Integr.	-0.009	-0.012*	-0.009	-0.037
D.PU: Publ. Owner.	0.003	0.001	0.002	0.028
D.ER: Entry Regul.	0.014**	0.021***	0.016***	0.029**
D.Source Hydro. (log)		-0.039***	-0.036**	-0.074*
D.Source Comb. Fuel (log)		0.079***	0.065***	0.015
D.Imports (log)		0.035***	0.032***	0.076***
D.Energy Distribution Loss (log)		0.185***	0.128**	0.072
D.GDP (log)		-0.284***	-0.310***	-0.534***
D.Resid. consumpt. (log)			0.241***	-0.106
D.Cost Comb. Oil (log)				-0.079**
D.Cost gas (log)				0.069*
D.Year	0.004**	0.012***	0.007**	0.035***
D.population (log)		-0.264	-0.219	-1.183*
D.Cost coal (log)				0.162***
Constant	0.000	0.000	0.000	0.000
Obs.	325	297	297	123
chi-squared	1349.186	1830.588	1907.75	1368.603

* p<.10, ** p<.05, *** p<.01

Consumer's satisfaction with electricity prices

- Dataset: Eurobarometer (waves 2000, 2002, 2004)
- Consumer satisfaction is dichotomized:
 - Satisfied about prices paid is considered *fair*
 - Satisfied about quality consumer is *very satisfied*

Unconditional satisfaction with electr. supply

Average (s.e.) of consumer satisfaction with electricity prices

Country	Year 2000	Year 2002	Year 2004
Belgium	0.442	0.637	0.765
Denmark	0.714	0.678	0.849
Germany	0.602	0.584	0.692
Greece	0.538	0.379	0.32
Italy	0.465	0.367	0.48
Spain	0.483	0.512	0.661
France	0.559	0.558	0.654
Ireland	0.793	0.623	0.703
Luxembourg	0.823	0.789	0.784
Netherlands	0.747	0.724	0.833
Portugal	0.38	0.445	0.544
UK	0.757	0.776	0.888
Finland	0.639	0.602	0.385
Sweden	0.653	0.607	0.5
Austria	0.591	0.646	0.764
EU15	0.608	0.592	0.656

Note: Consumers' satisfaction with electr. price (0 means dissatisfied and 1 means satisfied).

Consumer's satisfaction with electricity prices

- Model with cluster correction:

$$\Pr(S = 1 \mid \mathbf{x}) = \Pr(e > -\mathbf{x}\boldsymbol{\beta} \mid \mathbf{x}) \equiv p(\mathbf{x})$$

Marginal effects of consumers' satisfaction with electricity prices

- [ConsumerSatisfactionTables](#)

Table S1: Electricity price fairness: probit estimation, marginal effects

	(A)	(B)	(C)	(D)
	<i>Individual characteristics (1)</i>			
Female	-0.017**	-0.007**	-0.005**	-0.003*
30< Age <= 45	-0.022*	-0.008*	-0.006*	-0.004
45< Age <= 60	-0.012	-0.005	-0.003	-0.002
60< Age <= 75	0.007	0.002	0.002	0.002
Age < 75	0.058**	0.020**	0.014***	0.011***
Age when stop. educ.: 16-19	0.023**	0.008**	0.006**	0.004**
Age when stop. educ.: 20+	0.045***	0.016***	0.011***	0.009***
Single	0.010	0.004	0.002	0.002
Managers	0.055***	0.020***	0.013***	0.010***
Other white collars	0.016	0.006	0.004	0.003
Manual worker	0.006	0.002	0.002	0.001
House person	0.039**	0.014**	0.010**	0.007**
Unemployed	-0.038**	-0.015*	-0.010*	-0.009*
Retired	0.030*	0.012*	0.008*	0.006*
Students	0.097***	0.034***	0.023***	0.017***
Political views: centre	0.021**	0.008**	0.005**	0.004**
Political views: right	-0.002	-0.001	-0.001	0.000
Political views: DK/NA	-0.009	-0.004	-0.003	-0.002
Resp. cooper.: average/bad	-0.056***	-0.022***	-0.015***	-0.013***
	<i>Macroeconomic variables and time dummies (2)</i>			
Population density		0.005*	0.007***	0.004
GDP per capita		0.000	0.000	0.002
Gini		-0.007	-0.011***	-0.001
GDP growth rate		-0.005		
Employment growth rate		0.007*		
Electricity av. price (US\$/KWh in PPP)				-1.011**
Consumer price index				0.027***
Country dummies	yes	yes	yes	Yes
Year: 2002	-0.005	-0.014	-0.001	-0.002
Year: 2004	0.092***	0.028***	0.021***	0.017***
Obs.	43333	42366	43333	38673
Log likelihood	-2.70E+04	-2.63E+04	-2.70E+04	-2.40E+04
\chi-squared	4520.627	4669.873	4538.013	4339.883

Notes: * p<.10, ** p<.05, *** p<.01

(1) Omitted categories are: Male, 14< Age <=30, Age when stopped education: <15/NA, Married/in couple, Self-employed, Political views: left, Respondent's co-operation: excellent/fair.

(2) Omitted category is Year: 2000.

Table S2: Electricity price fairness: probit estimation, marginal effects including REGREF variables

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
<i>Individual characteristics (1)</i>							
Female	-0.014*	-0.014*	-0.014*	-0.014*	-0.014*	-0.016**	-0.016**
30< Age <= 45	-0.020*	-0.020*	-0.020*	-0.020*	-0.020*	-0.021*	-0.021*
45< Age <= 60	-0.012	-0.012	-0.012	-0.012	-0.012	-0.011	-0.011
60< Age <= 75	0.004	0.004	0.004	0.005	0.004	0.006	0.006
Age < 75	0.053**	0.053**	0.053**	0.053**	0.054**	0.055***	0.054**
Age when stop. educ.: 16-19	0.019*	0.019*	0.019*	0.019*	0.019*	0.021**	0.021**
Age when stop. educ.: 20+	0.039***	0.040***	0.039***	0.039***	0.039***	0.042***	0.043***
Single	0.006	0.007	0.007	0.007	0.008	0.01	0.01
Managers	0.050***	0.050***	0.050***	0.050***	0.051***	0.051***	0.051***
Other white collars	0.012	0.011	0.011	0.011	0.01	0.017	0.016
Manual worker	0.001	0.001	0.001	0.001	0.001	0.008	0.007
House person	0.035**	0.034**	0.034**	0.034**	0.034**	0.038**	0.036**
Unemployed	-0.039**	-0.039**	-0.039**	-0.039**	-0.039**	-0.036*	-0.037**
Retired	0.030*	0.030*	0.030*	0.030*	0.030*	0.030*	0.030*
Students	0.088***	0.088***	0.088***	0.088***	0.086***	0.092***	0.092***
Political views: centre	0.018*	0.018*	0.018*	0.018*	0.018*	0.019**	0.018**
Political views: right	-0.004	-0.005	-0.005	-0.005	-0.004	-0.003	-0.003
Political views: DK/NA	-0.01	-0.01	-0.011	-0.01	-0.011	-0.009	-0.009
Resp. cooper.: average/bad	-0.049***	-0.049***	-0.049***	-0.049***	-0.050***	-0.055***	-0.057***
<i>Macroeconomic variables and time dummies (2)</i>							
Population density	0.019***	0.026***	0.025***	0.025***	0.022***	0.018***	0.021***
GDP per capita	-0.003	-0.001	-0.001	-0.002	0.004*	-0.004**	-0.003
Gini	-0.011**	-0.005	-0.008	-0.009**	-0.041***	-0.015***	-0.031***
Country dummies	yes	yes	yes	yes	yes	yes	yes
Year: 2002	0.018	0.007	0.008	0.009	0.018	0.027**	0.016
Year: 2004	0.118***	0.084***	0.082***	0.086***	0.045***	0.102***	0.045**
<i>Regref aggregate indicators</i>							
SEC (c)	0.039***						
ER (c)		0.012**	0.001				
VI (c)		-0.002	-0.004				
PO (c)		0.037***	0.036***	0.034***			
Interaction: ERxVI			0.002	0.002**			
<i>Regref subindicators</i>							
ER1: TPA (c)					0.023***		
ER2: in wholesale market (c)					-0.022***		
ER3: Min. threshold (c)					-0.003		
VII: in transm/generation (c)					-0.008*		
VI2: overall degree (c)					-0.003		
PO: (c)					0.033***		
<i>Regref discrete subindicators</i>							
ER1: No TPA (d)(3)						0.081***	
VI: Integrated industry (d)(3)						-0.026	0.023
PO: public (d)(3)						0.135***	0.104***
ER1: no TPA (d)(4)							0.058***
ER2: no lib. wholesale mkt (d)(4)							-0.093***
ER3: no consumer choice (d)(4)							-0.114***
Obs.	37176	37176	37176	37176	37176	42244	37176
Log likelihood	-2.32E+04	-2.31E+04	-2.31E+04	-2.31E+04	-2.31E+04	-2.62E+04	-2.31E+04
\chi-squared	3532.156	3556.286	3564.133	3559.08	3611.798	4239.194	3642.967

Notes: * p<.10, ** p<.05, *** p<.01. (c) stands for continuous variable, (d) for dummy variable.

(1) Omitted categories are: Male, 14< Age <=30, Age when stopped education: < 15/NA, Married/in couple, Self-employed, Political views: left, Respondent's co-operation: excellent/fair. (2) Omitted category is Year: 2000. (3) Omitted category are: ER1: regulated or negotiated TPA, VII: separate companies and accounting companies or VI2: Unbundles and Mixed, PO: Private, Mostly private, Mixed or Mostly public. (4) Omitted category are: ER1: regulated or negotiated TPA, ER2: liberalised wholesale market, ER2: some consumer choice.

Table S3: Electricity price fairness: pseudo-panel estimation, marginal effects including REGREF variables

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
	Macroeconomic variable and time dummies						
Population density	0.023***	0.050***	0.050***	0.051***	0.043***	0.027***	0.034***
GDP per capita	-0.007*	-0.004	-0.004	-0.007**	0.004	-0.008***	-0.001
Gini	-0.021***	-0.005	-0.005	-0.009	-0.039***	-0.006	-0.026***
Year: 2002 (d)(1)	-0.049**	-0.062***	-0.062***	-0.052***	-0.034*	-0.059***	-0.049***
Year: 2004 (d)(1)	-0.009	-0.063**	-0.064**	-0.04	-0.064**	-0.026	-0.088***
	Regref aggregate indicators						
SEC (c)	-0.016						
ER (c)		-0.001	-0.004				
VI (c)		-0.015**	-0.015*				
PO (c)		0.047***	0.046***	0.047***			
Interaction: ERxVI			0.001	-0.001			
	Regref subindicators						
ER1: TPA (c)					0.026***		
ER2: in wholesale market (c)					-0.025***		
ER3: Minimum threshold for consumers (c)					-0.008		
VI1: in transm/generation (c)					-0.016**		
VI2: overall degree (c)					-0.001		
PO: (c)					0.043***		
	Regref discrete subindicators						
ER1: No TPA in electricity (d) (2)						-0.004	
VI: Integrated electricity industry (d) (2)						-0.100***	-0.016
PO: public (d) (2)						0.125***	0.129***
ER1: no TPA (d) (3)							-0.01
ER2: no liberal. wholesale mkt (d) (3)							-0.144***
ER3: no consumer choice (d) (3)							-0.177***
constant							
Obs.	507	507	507	507	507	588	560
Log likelihood	457.299	480.957	480.979	477.681	499.584	571.038	577.56

Notes: Omitted categories are: Male, 14\$<\$ Age \$<=\$30, Age when stop. educ.: \$<\$ 15/NA, Married/in couple, Self-employed, Political views: left, Resp. cooper.: eccel./fair

(d) for discrete change of dummy variable from 0 to 1

* p<.10, ** p<.05, *** p<.01

(1) Omitted category is Year: 2000.

(2) Omitted category are: ER1: regulated or negotiated TPA, VI1: separate companies and accounting companies or VI2: Unbundles and Mixed, PO: Private, Mostly private, Mixed or Mostly public.

(3) Omitted category are: ER1: regulated or negotiated TPA, ER2: liberalised wholesale market, ER2: some consumer choice

Main empirical findings

1. panel estimation of prices tend to reject the prediction that privatization per se leads to lower electricity prices, after controlling for other reforms, and other industry and country-specific variables;
2. customer satisfaction for prices is correlated to observed prices, confirming that perceptions by consumers are broadly consistent with the objective evidence
3. customer satisfaction about prices and quality of services is higher with public ownership than under private ownership.

To start discussing...

- No evidence that a unique reform paradigm is dominant in terms of welfare changes across EU15.
- If you have very strong prior beliefs that the paradigm must work, you may object that:
 1. the data do not capture adequately the benefits of reforms,
 2. the indexes supplied by the OECD's REGREF database do not capture all the subtle dynamics involved.
 3. One can also think that in some countries it is too early to draw conclusions.

To start discussing...

- An integrated EU energy strategy, with its incentives and disincentive mechanisms, should replace the idea (obsession?) with dictating a uniform industry reform paradigm.