Performance and efficiency of Colombia's energy distribution system

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Main goal

Evaluate changes on Performance and efficiency for Colombia's Energy distribution system after the industry reform in 1994. We assess this changes for 12 electricity distribution firms using data from 1986 – 2001.

- Financial indicators (Non-parametric test)

- Data Envelopment Analysis (DEA) frontier estimation.
  - ✓Efficiency
  - ✓Scale effects
  - ✓Malquist productivity index
  - ✓Policy effects

Related works

On financial indicators to assess performance changes

La Porta and López-de-Silanes. (1999). "The Benefits of Privatization: Evidence from Mexico." *Quarterly Journal of Economics*.

Megginson, Nash, and Van-Randenborgh. (1994). "The Financial and Operating Performance of Newly Privatized Firms: An International Empirical Analysis." *The Journal of Finance*, Vol. 49:2, pp. 403-451.

Related works

On frontier cost or production functions

Hjalmarsson, and Veiderpass. (1992). "Productivity in Swedish Electricity Retail Distribution." *Scandinavian Journal of Economics*.

Miliotis. (1992). "Data envelopment Analysis Applied to Electricity Distribution Districts." *Journal of Operational Research Society*.

Weyman-Jones. (1995). "Problems of Yardstick Regulation in Electricity Distribution," in *The Regulatory Challenge*.

Bagdadioglu, Waddams, Weyman-Jones. (1996). "Efficiency and Ownership in Electricity Distribution: A Non-Parametric Model of the Turkish Experience." *Energy Economics*.

Pacudan and De Guzman. (2002). "Impact of Energy Efficiency Policy to Productive Efficiency of Electricity Distribution Industry in the Philippines." *Energy Economics*.

Performance

Financial variables

Table 1
Financial indicators

Financial indicator	Description
Profitability	
Return on Assets (ROA)	ROA = Income / Total Assets
Real Profits (RP)	RP = Profits / CPI base 1998
Equities	Requity = Pequity / CPI base 1998
Operating Efficiency	
Sales Efficiency (SALEFF01)	SALEFF01 = Total real sales ($) / Number of employees
Sales Efficiency (SALEFF02)	SALEFF02 = Total sales (GWh) / Number of employees
Users Efficiency (USERSEFF)	USERSEFF = Total users / Number of employees
Output	
Sales	Rsales = Sales / CPI base 1998
Employment	
Employees	Employees

Performance

Statistical non – parametric test

Wilcoxon Rank-sum and Pearson Media tests

We are finally testing the existence of differences in management and performance after the industry regulatory reform.

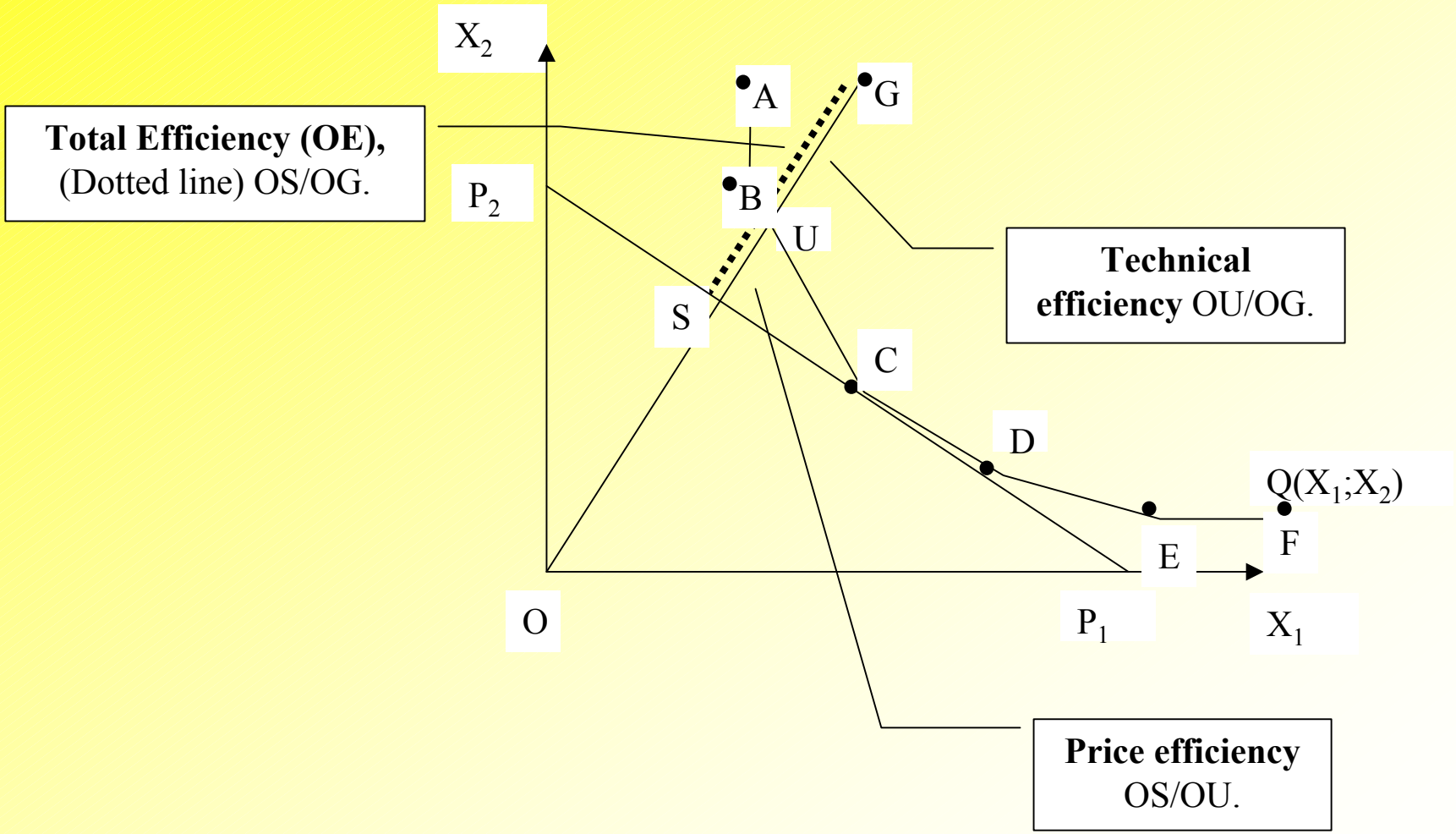
Table 2
Summary statistics and tests

		Employees	Requity	ROA	SALEFF01	SALEFF02	USERSEFF	Rsales	RP
Pre-reform	**Mean**	1109.81	482134.4	0.3461848	108.9098	0.956028	225.544	150849.5	27140.8
Post reform	**Mean**	928.3036	702473.5	1.35032	195.9116	1.466061	415.1427	195812.9	30335.31
Total sample	**Mean**	1024.395	585823	0.818719	149.8518	1.196043	314.7669	172008.7	28644.1
Wilcoxon Rank-sum test	**Z Statistic**	0.919	-0.179	-5.578	-6.428	-4.589	-9.409	-2.946	-2.843
	Prob > z	0.3583	0.8578	0	0	0	0	0.0032	0.0045
Pearson Median test	**chi2(1)**	1.6865	0.0675	38.8571	32.6508	13.2222	77.9841	11.4008	8.1627
	Probability	0.194	0.795	0	0	0	0	0.001	0.004

The test reveals changes on most of the indicators, besides number of employees and Real equities, ROA and sales indicators show a change in sample structure and median.

Efficiency

Data Envelopment Analysis (Input-oriented)



Efficiency

Data Envelopment Analysis

Table 3
Variables classification

Variable	Measure units	Input / Output	Production function character
Employees generation	Number of	Input	Labor
Employees transmission	Number of	Input	
Employees distribution and commercialization	Number of	Input	
Employees total	Number of	Input	
Transformers	Number of	Input / Environmental	Capital
Distribution net	Km	Input / Environmental	
Sales (Total)	GWh	Output / Environmental	Output
Sales domestic	GWh	Output / Environmental	
Sales commerce	GWh	Output / Environmental	
Sales industry	GWh	Output / Environmental	
Sales government	GWh	Output / Environmental	
Customers (Total)	Number of	Output	Output
Customers domestic	Number of	Output	
Customers commerce	Number of	Output	
Customers industry	Number of	Output	
Customers government	Number of	Output	
Urban Area served	Km^2	Environmental	Output
Regional Real GDP per-capita	Thousands of millions	Environmental	--
National installed capacity in electricity generation	MW	Environmental	--

Efficiency

Data Envelopment Analysis

Table 4
DEA model specification

Model 1		
	Input	**Output**
Discretionary variables	Employees distribution commercialization	Sales domestic
	Transformers	Sales commerce
	Distribution net	Sales industry
		Sales government
		Customers domestic
		Customers commerce
		Customers government
		Customers industry
Environmental	Regional Real GDP per-capita	Urban area served
	National installed capacity in electricity generation	
Model 1a		
	Input	**Output**
Discretionary variables	Employees distribution commercialization	Total Sales
	Transformers	Total Customers
	Distribution net	
Environmental	Regional Real GDP per-capita	Urban area served
	National installed capacity in electricity generation	

Efficiency

Data Envelopment Analysis

Table 5
Summary statistics for variables in DEA estimation

DMU	Total sales	Total Users	Urban Area served	Number of employees in distribution	Number of transformers	Distribution net	Regional GDP per-capita
CEDELCA	268	114111	445	314	7344	4771	0.8355
CEDENAR	352	160918	1116	416	662	2421	0.8004
CENS	614	193984	1087	483	6572	1328	1.0665
CHEC	909	259701	459	959	12663	6936	1.4094
EEB	6133	1291978	290	2135	40167	14924	2.5869
ELECTRICARIBE	2557	534339	12080	2101	17358	5453	1.3964
ELECTROCOSTA	1602	391320	3706	1568	9691	8640	1.1390
EMCALI	2554	374026	529	764	14015	2078	1.9561
EPM	4704	630480	368	1128	31553	4719	1.9831
ESSA	935	317452	1382	794	12167	9000	1.9594
HUILA	327	142595	1407	435	4789	3338	1.3998
TOLIMA	572	185974	1424	548	1817	781	1.4046
Total	1794	383073	2024	970	13233	5366	1.4947

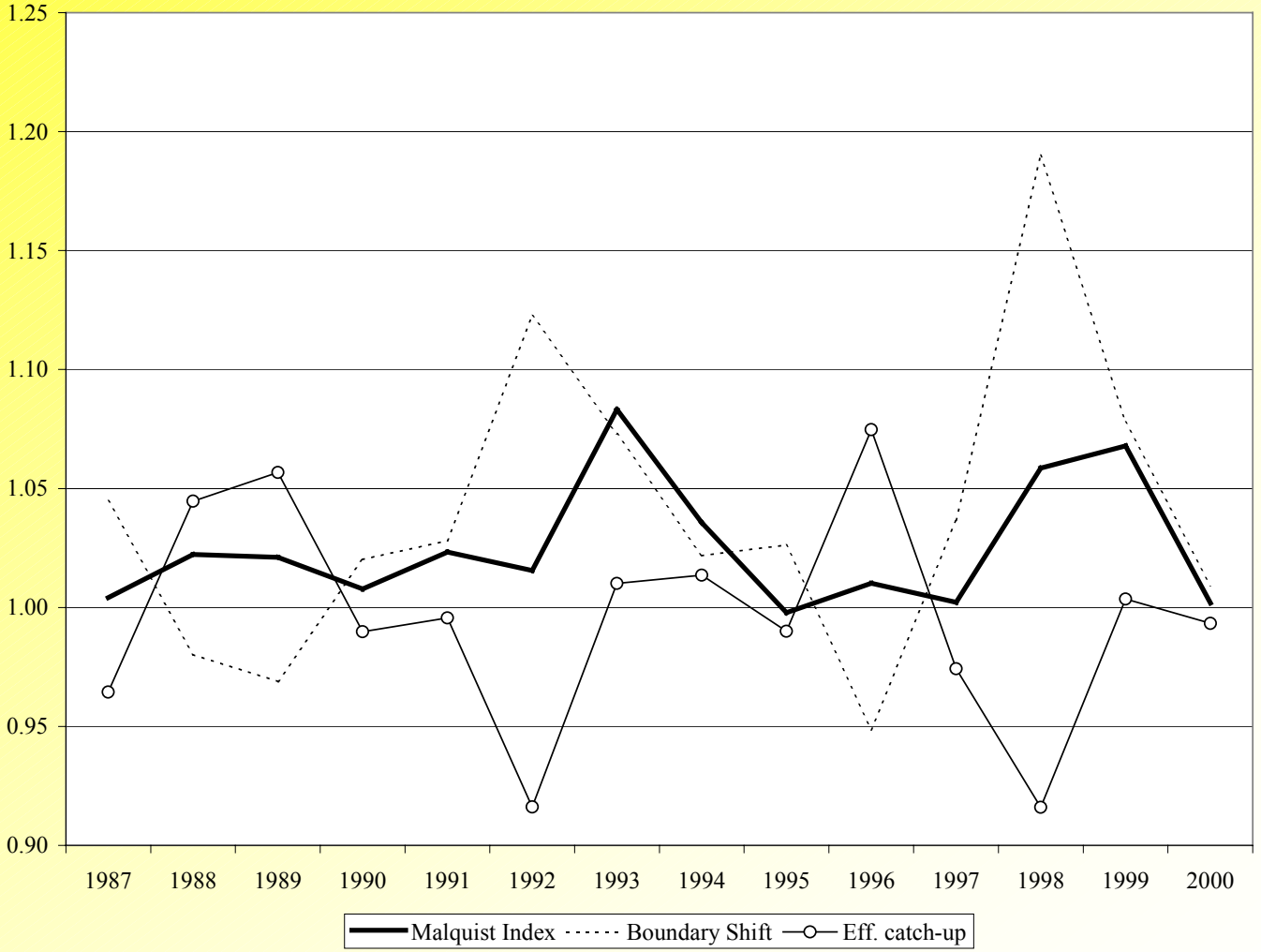
Efficiency

Data Envelopment Analysis

	CRS efficiency	VRS efficiency	Scale efficiency CRS/VRS
1. CEDELCA	0.3231	0.9176	0.3590
2. CEDENAR	0.9971	0.9987	0.9984
3. CENS	0.6204	0.9443	0.6535
4. CHEC	0.3175	0.3902	0.8281
5. EEB	0.9646	0.9832	0.9809
6. ELECTRICARIBE	0.9907	0.9970	0.9936
7. ELECTROCOSTA	0.8784	0.9016	0.9757
8. EMCALI	0.8907	0.9746	0.9123
9. EPM	0.9645	0.9726	0.9916
10. ESSA	0.4314	0.5152	0.8567
11. HUILA	0.5015	0.7831	0.6426
12. TOLIMA	0.9778	0.9987	0.9790

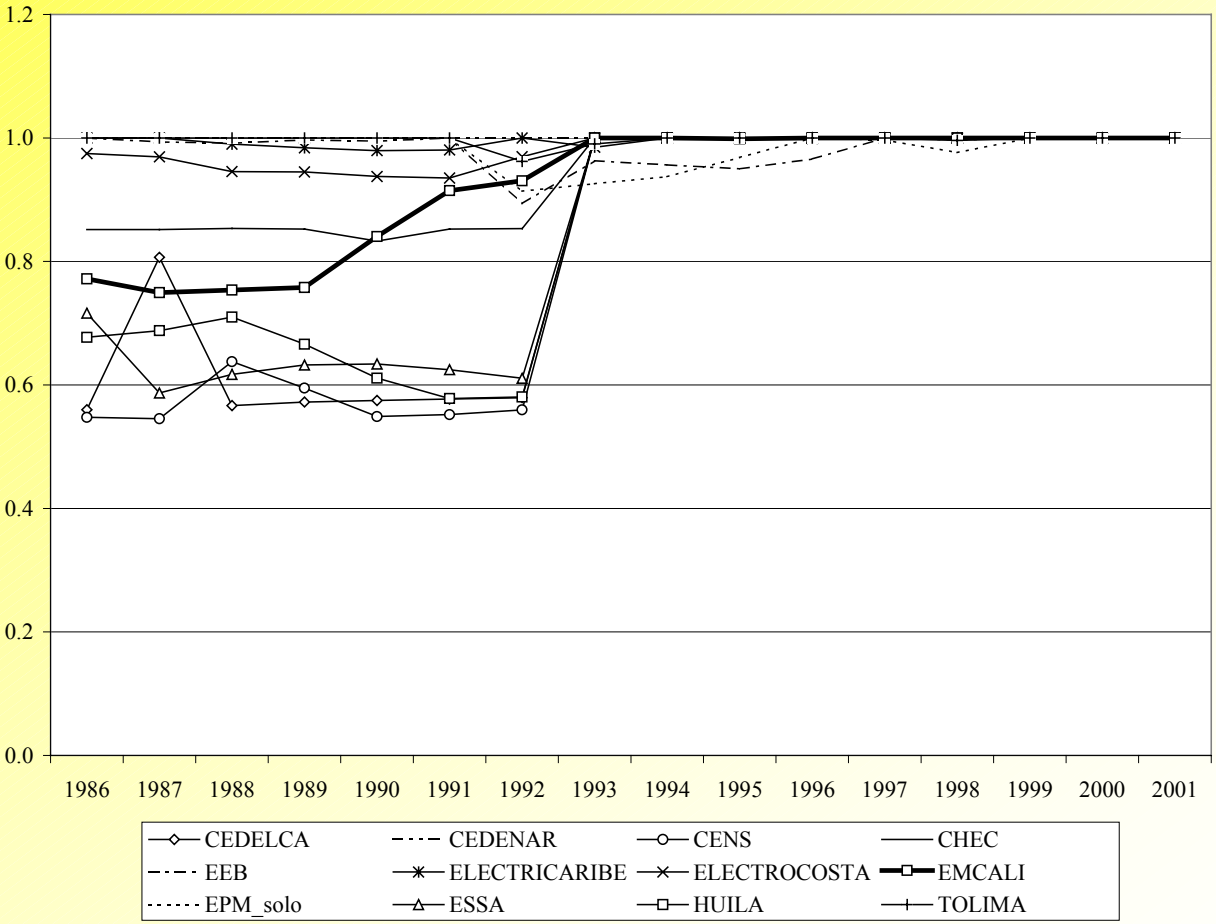
Efficiency

Data Envelopment Analysis
Malmquist Productivity Index (Industry average)



Efficiency

Data Envelopment Analysis
Policy analysis



Concluding remarks

- We have shown important changes on performance and efficiency for the electricity distribution firms in Colombia, associated with the introduction of a different organization and regulatory regime
- On performance there is a positive change on sales and financial indicators
- Efficiency is primarily driven by economies of scale, either on efficient and un-efficient firms
- Productivity increments are around 4% pre and post regulatory changes
- There is consistent evidence of effect of policy on efficiency.