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Is Privatization enough? Finding Performance Breaks for UK Power Plants

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Motivation

- UK electricity restructuring and privatization was followed by ten years of trial and error to find good institutional design.
- Most of the literature ignores the effect of restructuring and privatization on emissions.
- Neoclassical models assert that competition increases allocative efficiency but largely ignore productive efficiency (and ignore ownership).
- Agency models assert that changes in ownership and competition also change technical efficiency (Laffont & Tirole, 1993) but not clear how and when.

Research Question

Which institutional changes around privatization had the greatest impact on efficiency including emissions?

Literature

- UK electricity privatization was beneficial socially (Newbery & Pollitt, 1997).
- Privatization necessary but not sufficient for performance improvements for other UK industries (Pollitt 2000; Green & Haskel 2004).
- US restructuring increases generation plant efficiency (Fabrizio et al 2007).

Background - privatization

- Define 4 periods:
  - Pre-privatization (-1990): state-ownership, vertical and horizontal integration.
  - Privatization (1990-1994): privatization, restructuring, effective duopoly.
  - Restructuring (1995-1998): full privatization further restructuring, increasing retail competition.
  - Competition (1999-): stronger competition, new wholesale regime, entry, full opening of the retail market.

Background - environment

- Pearson (2000, p. 291): “Environmental policy considerations do not appear to have formed any significant part of the objectives that underlay privatization […]”.
- Regulation of SO2 and NOx but not CO2. Limits might not binding at plant-level due to dash for gas.
- Three ways to abate (while operating): change fuel (quality), install abatement technology, or increase efficiency.
- Physical trade-offs between different pollutants (e.g. SO2 and CO2).

Technology and Efficiency

- Leontief, short-run production function (Fabrizio et al., 2007).
  - Distinction between probable and actual output.
- Efficiency is modelled as input demands for: fuel, labour, CO2, SO2, and NOx.
  - Plant-level operating efficiency a proxy for management performance.
- Structural change is modelled as a single, common, abrupt intercept break at an *unknown* date.

Technology

$$Q_{it}^{A} = \min\left[\begin{array}{l} g\left(E_{it},\Gamma^{E},\varepsilon_{it}^{E}\right), f\left(C_{it},\Gamma^{C},\varepsilon_{it}^{C}\right), h\left(S_{it},\Gamma^{S},\varepsilon_{it}^{S}\right), q\left(X_{it},\Gamma^{X},\varepsilon_{it}^{X}\right), \\ , Q_{it}^{P}\left(K_{i},L_{it},M_{it},\Gamma^{P},\varepsilon_{it}^{P}\right)\exp\left(\varepsilon_{it}^{A}\right) \end{array}\right]$$

Derived Input Demands

$$\log(N_{irt}) = \beta_1^N \log(NET\ MWH_{irt}) + \beta_2^N \log(PRICE_{irt}^N) + \beta_3^N \log(FGD_{irt}) + \beta_4^N AGE_{irt}$$
$$+ \beta_5^N POST_{irt} + \alpha_i^N + t^N + \varepsilon_{irt}^N$$

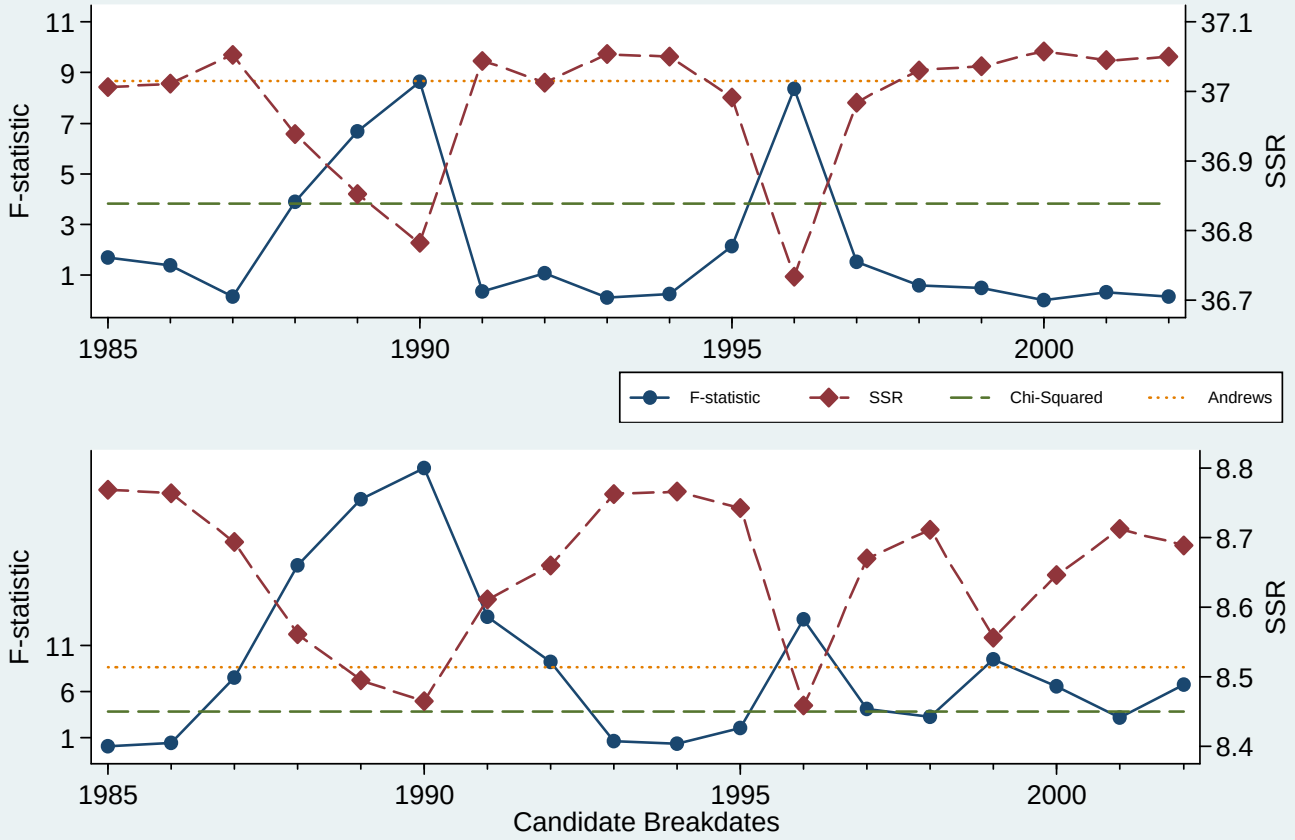
Estimation

- Estimators
  - OLS (including FE) for break
  - IV for break coefficient (as input demands are endogenous).
- Inference for breaks
  - window 1985-2002.
  - F-test (Chow) for known breaks, chi-squared distribution
  - Maximum F-test (Quandt) for unknown breaks, Andrews (1993) distribution
- Inference for break dates
  - Global minimum of SSR (Bai, 1994), local minima for secondary breaks (Hansen, 1997)

Data

- Unbalanced panel of ~60 UK power stations for the years 1980-2004.
- Number of observations between 445 (labour) and 1179 (CO2)
- Data sources: government, company reports, private communication.
- Restricted and unrestricted sample to control for industry-level fuel mix (at least 19 out of 25 years).

Test for Structural Change: Fuel Demand



Critical values at 5% level. Common legend. Upper panel: all observations, lower panel: balanced panel.

Results

Input (Full/Restricted sample)	Breakdates (min. SSR)			Intercept change at breakdates (%)		
	Global	Local 1	Local 2	Global	Local 1	Local 2
Fuel	1996'	1990'		-5.60*	8.11**	
	1996''	1990''	1999''	-4.88**	11.20***	-5.93*
Labour	1992''	2001''		-30.39***	18.73**	
	1992''	1994''	1999''	-23.06***	-23.91***	34.02***
CO2	1990''	1995'		7.19***	-4.03	
	1990''	2000'	1995''	6.52*	-5.31	0.63
SO2	1994''	2000''		48.28**	-22.55*	
	1991''	2001''		52.98***	-25.78***	
NOx	1993''	1996'	2001'	-23.03***	-14.35**	13.00***
	1996''			-4.79		

' F > 5% Andrews, ' F > 5% Chi-squared

Robust p-values: *** p<0.01, ** p<0.05, * p<0.1

Results

- Pre-privatization (-1990): no break.
- Privatization (1990-1994): increase for labour but decrease for fuel and CO2. Decrease for SO2 but increase for NOx.
- Restructuring (1995-1998): increase for fuel and CO2, further increase for NOx.
- Competition (1999-): minor increase for fuel, decrease for labour, increase for SO2 but decrease for NOx.

Discussion

- No anticipation.
- Privatization necessary but not sufficient (at least for fuel).
- Mixed results for emissions. Fuel mix and fuel efficiency important.
- Emission increases at plant level when overall caps not binding.
- Trade-offs between SO2 and CO2, and NOx and fuel efficiency (at least for gas).

Conclusion

- First study of plant level efficiency.
- Institutional design important.
- Shortcomings
  - Only past performance as counterfactual.
  - Difficult to establish causality between events and breaks.
  - Short-run only which might underestimate the effects (Arocena & Waddams Price 2002)
  - Data does not allow controlling for all abatement technologies.

Thank you!

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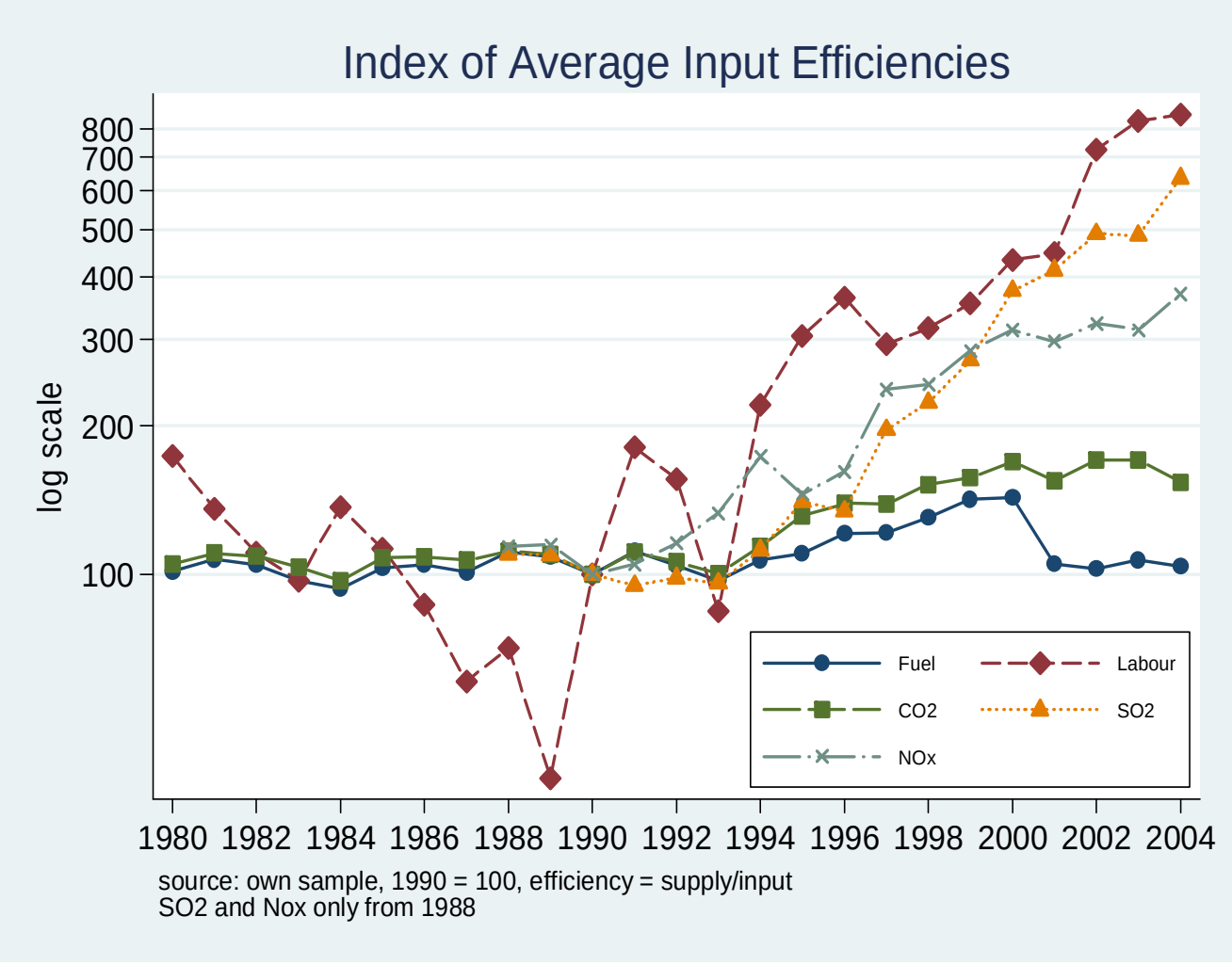
Index of Average Input Efficiencies
log scale
800
700
600
500
400
300
200
100
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004
Fuel
Labour
CO2
SO2
NOx
source: own sample, 1990 = 100, efficiency = supply/input
SO2 and Nox only from 1988