

OWNERSHIP AND COMPETITION: FINDING PERFORMANCE BREAKS FOR GREAT BRITAIN'S POWER PLANTS

Thomas P. Triebs

Ifo Institute, Munich

Michael G. Pollitt

University of Cambridge

Infraday, Berlin, 2014

Motivation: public ownership + no competition = waste?

“The coal stations were even worse as I found out when my company became vertically integrated. Golf courses, gymnasiums, subsidised bars, countless luxuries were lavished on the bloated work force. Corruption was rife, Procurement Manager was the best job at the station, I knew one such on £25k who wore a gold Rolex and boasted of having a whole draw full of the them. **Managers treated the stations as their personal fiefdoms.**”, anonymous comment, ft.com, 30 October 2013.

- Competition and ownership are important drivers of firm performance.
- Changes to competition and ownership in utility industries offer a unique opportunity to study effects on performance (Fabrizio et al, 2007; Gao and Van Biesebroeck, 2014).
- Agency models predict that private ownership and competition increase technical efficiency via management.

- Competition and ownership are important drivers of firm performance.
- Changes to competition and ownership in utility industries offer a unique opportunity to study effects on performance (Fabrizio et al, 2007; Gao and Van Biesebroeck, 2014).
- Agency models predict that private ownership and competition increase technical efficiency via management.

- Competition and ownership are important drivers of firm performance.
- Changes to competition and ownership in utility industries offer a unique opportunity to study effects on performance (Fabrizio et al, 2007; Gao and Van Biesebroeck, 2014).
- Agency models predict that private ownership and competition increase technical efficiency via management.

- Did changes to ownership (privatization) and competition increase **technical efficiency** at UK generation plants?
 - When and by how much?
 - For fuel and labour.
 - For air pollutants (CO₂, SO₂, NO_x).

- Did changes to ownership (privatization) and competition increase **technical efficiency** at UK generation plants?
 - When and by how much?
 - For fuel and labour.
 - For air pollutants (CO₂, SO₂, NO_x).

- Did changes to ownership (privatization) and competition increase **technical efficiency** at UK generation plants?
 - When and by how much?
 - For fuel and labour.
 - For air pollutants (CO₂, SO₂, NO_x).

- Did changes to ownership (privatization) and competition increase **technical efficiency** at UK generation plants?
 - When and by how much?
 - For fuel and labour.
 - For air pollutants (CO₂, SO₂, NO_x).

- First plant-level analysis of UK restructuring and privatization.
 - We can compare the effects of competition and ownership for the same country and industry.
 - Timing of the reforms allows us to draw conclusions about the relative importance of changes to competition and ownership.
 - We distinguish incentive and selection effects.
 - We analyse an actual privatization. Privatized is not necessarily the same as private!
 - Pollutants (bad inputs) are often neglected in the analysis of regulatory reform.

- First plant-level analysis of UK restructuring and privatization.
 - We can compare the effects of competition and ownership for the same country and industry.
 - Timing of the reforms allows us to draw conclusions about the relative importance of changes to competition and ownership.
 - We distinguish incentive and selection effects.
 - We analyse an actual privatization. Privatized is not necessarily the same as private!
 - Pollutants (bad inputs) are often neglected in the analysis of regulatory reform.

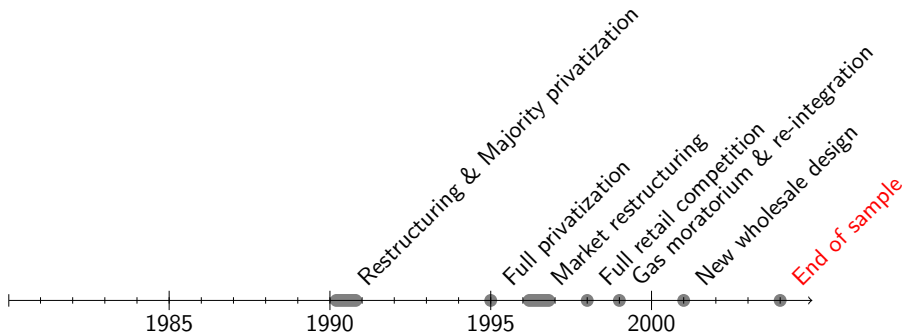
- First plant-level analysis of UK restructuring and privatization.
 - We can compare the effects of competition and ownership for the same country and industry.
 - Timing of the reforms allows us to draw conclusions about the relative importance of changes to competition and ownership.
 - We distinguish incentive and selection effects.
 - We analyse an actual privatization. Privatized is not necessarily the same as private!
 - Pollutants (bad inputs) are often neglected in the analysis of regulatory reform.

- First plant-level analysis of UK restructuring and privatization.
 - We can compare the effects of competition and ownership for the same country and industry.
 - Timing of the reforms allows us to draw conclusions about the relative importance of changes to competition and ownership.
 - We distinguish incentive and selection effects.
 - We analyse an actual privatization. Privatized is not necessarily the same as private!
 - Pollutants (bad inputs) are often neglected in the analysis of regulatory reform.

- First plant-level analysis of UK restructuring and privatization.
 - We can compare the effects of competition and ownership for the same country and industry.
 - Timing of the reforms allows us to draw conclusions about the relative importance of changes to competition and ownership.
 - We distinguish incentive and selection effects.
 - We analyse an actual privatization. Privatized is not necessarily the same as private!
 - Pollutants (bad inputs) are often neglected in the analysis of regulatory reform.

- First plant-level analysis of UK restructuring and privatization.
 - We can compare the effects of competition and ownership for the same country and industry.
 - Timing of the reforms allows us to draw conclusions about the relative importance of changes to competition and ownership.
 - We distinguish incentive and selection effects.
 - We analyse an actual privatization. Privatized is not necessarily the same as private!
 - Pollutants (bad inputs) are often neglected in the analysis of regulatory reform.

Background: timeline of UK reforms

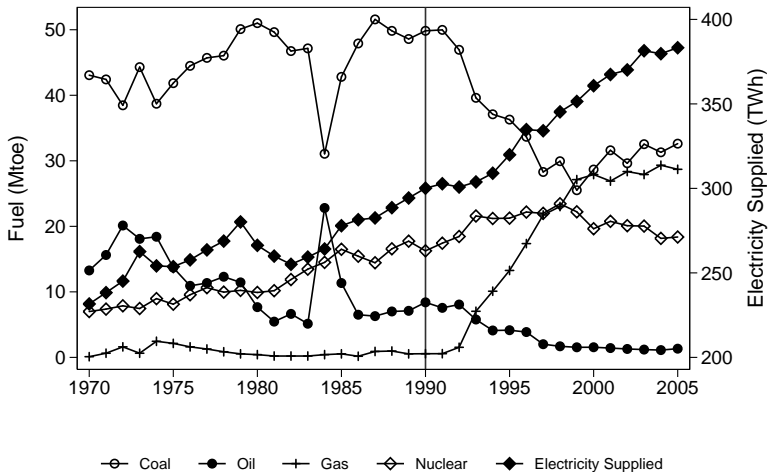


- Economic reforms not aimed at environmental performance (Pearson 2000).
 - But public owners might internalize pollution more.
- Environmental regulation of SO₂ and NO_x but not CO₂. Limits might not bind at plant-level due to switch to low emission fuels after privatization.

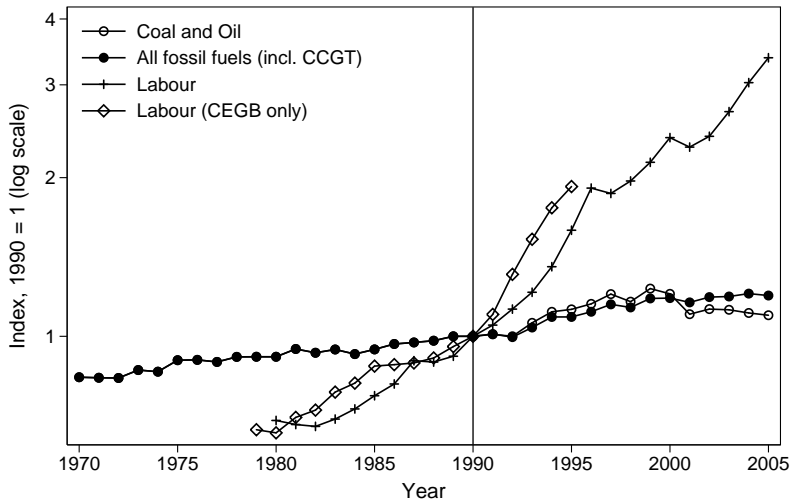
- Economic reforms not aimed at environmental performance (Pearson 2000).
 - But public owners might internalize pollution more.
- Environmental regulation of SO₂ and NO_x but not CO₂. Limits might not bind at plant-level due to switch to low emission fuels after privatization.

- Economic reforms not aimed at environmental performance (Pearson 2000).
 - But public owners might internalize pollution more.
- Environmental regulation of SO₂ and NO_x but not CO₂. Limits might not bind at plant-level due to switch to low emission fuels after privatization.

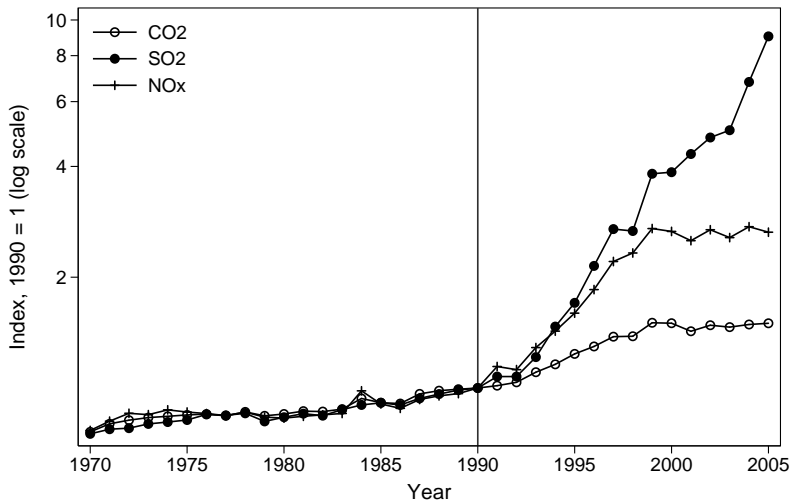
Background: Fuel Shares



Background: Aggregate single factor productivity



Background: Aggregate single factor productivity



Analytical Approach: summary

- Derive factor demands from a behavioural model of cost minimization (Fabrizio et al, 2007; Gao and Van Biesebroeck, 2014).
- Estimate break dates and effect sizes.
 - Caveat: impossible not to find a break!
 - Cannot identify causality.

Analytical Approach: summary

- Derive factor demands from a behavioural model of cost minimization (Fabrizio et al, 2007; Gao and Van Biesebroeck, 2014).
- Estimate break dates and effect sizes.
 - Caveat: impossible not to find a break!
 - Cannot identify causality.

Analytical Approach: summary

- Derive factor demands from a behavioural model of cost minimization (Fabrizio et al, 2007; Gao and Van Biesebroeck, 2014).
- Estimate break dates and effect sizes.
 - Caveat: impossible not to find a break!
 - Cannot identify causality.

Analytical Approach: summary

- Derive factor demands from a behavioural model of cost minimization (Fabrizio et al, 2007; Gao and Van Biesebroeck, 2014).
- Estimate break dates and effect sizes.
 - Caveat: impossible not to find a break!
 - Cannot identify causality.

- We find large improvements to labour productivity right after restructuring and privatization (R&P).
 - Ownership effect dominates.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
 - Competition effect dominates.
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency

Preview of Results

- We find large improvements to labour productivity right after restructuring and privatization (R&P).
 - Ownership effect dominates.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
 - Competition effect dominates.
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency

Preview of Results

- We find large improvements to labour productivity right after restructuring and privatization (R&P).
 - Ownership effect dominates.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
 - Competition effect dominates.
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency

Preview of Results

- We find large improvements to labour productivity right after restructuring and privatization (R&P).
 - Ownership effect dominates.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
 - Competition effect dominates.
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency

Preview of Results

- We find large improvements to labour productivity right after restructuring and privatization (R&P).
 - Ownership effect dominates.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
 - Competition effect dominates.
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency

Preview of Results

- We find large improvements to labour productivity right after restructuring and privatization (R&P).
 - Ownership effect dominates.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
 - Competition effect dominates.
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency

- We find large improvements to labour productivity right after restructuring and privatization (R&P).
 - Ownership effect dominates.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
 - Competition effect dominates.
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency

Analysis: Production function

- Leontief production function to capture sequence of input decisions at plant level (capital before labour, labour before fuel).
- Actual output for plant i in year t is:

$$Q_{it}^A = \min[g(E_{it}, \Gamma^E, \epsilon_{it}^E), f(C_{it}, \Gamma^C, \epsilon_{it}^C), h(S_{it}, \Gamma^S, \epsilon_{it}^S), q(X_{it}, \Gamma^X, \epsilon_{it}^X), Q_{it}^P(K_i, L_{it}, \Gamma^P, \epsilon_{it}^P) \exp(\epsilon_{it}^A)]$$

Analysis: Production function

- Leontief production function to capture sequence of input decisions at plant level (capital before labour, labour before fuel).
- Actual output for plant i in year t is:

$$Q_{it}^A = \min[g(E_{it}, \Gamma^E, \epsilon_{it}^E), f(C_{it}, \Gamma^C, \epsilon_{it}^C), h(S_{it}, \Gamma^S, \epsilon_{it}^S), q(X_{it}, \Gamma^X, \epsilon_{it}^X), Q_{it}^P(K_i, L_{it}, \Gamma^P, \epsilon_{it}^P) \exp(\epsilon_{it}^A)]$$

Analysis: Derivation of Input demand

- Assuming cost minimization constraint by $Q_{it}^P = Q_0 (K_i) L_{it}^\rho \exp(\epsilon_{it}^P)$ we get:

$$\ln L_{it} = \ln(\lambda\rho) + \ln Q_{it}^A - \ln W_{it} - \epsilon_{it}^A$$

- Adding regime subscripts r and capturing the unobserved multiplier by controls and the restructuring effect:

$$\ln L_{irt} = \alpha_{ip}^L + \ln Q_{irt}^A - \ln W_{irt} - \epsilon_{irt}^A + \delta_r^L + \tau^L t + \epsilon_{irt}^L$$

- Derivations for fuel and pollutants use monotonicity.

Analysis: Derivation of Input demand

- Assuming cost minimization constraint by $Q_{it}^P = Q_0(K_i) L_{it}^\rho \exp(\epsilon_{it}^P)$ we get:

$$\ln L_{it} = \ln(\lambda\rho) + \ln Q_{it}^A - \ln W_{it} - \epsilon_{it}^A$$

- Adding regime subscripts r and capturing the unobserved multiplier by controls and the restructuring effect:

$$\ln L_{irt} = \alpha_{ip}^L + \ln Q_{irt}^A - \ln W_{irt} - \epsilon_{irt}^A + \delta_r^L + \tau^L t + \epsilon_{irt}^L$$

- Derivations for fuel and pollutants use monotonicity.

Analysis: Derivation of Input demand

- Assuming cost minimization constraint by $Q_{it}^P = Q_0(K_i) L_{it}^\rho \exp(\epsilon_{it}^P)$ we get:

$$\ln L_{it} = \ln(\lambda\rho) + \ln Q_{it}^A - \ln W_{it} - \epsilon_{it}^A$$

- Adding regime subscripts r and capturing the unobserved multiplier by controls and the restructuring effect:

$$\ln L_{irt} = \alpha_{ip}^L + \ln Q_{irt}^A - \ln W_{irt} - \epsilon_{irt}^A + \delta_r^L + \tau^L t + \epsilon_{irt}^L$$

- Derivations for fuel and pollutants use monotonicity.

- Estimate a common break date across panels (Bai, 2010).
 - Estimator for break date: min SSR in a least squares framework.
- Estimator for effect size: δ (regime shift approximated by indicator).

Structural break estimation

- Estimate a common break date across panels (Bai, 2010).
 - Estimator for break date: min SSR in a least squares framework.
- Estimator for effect size: δ (regime shift approximated by indicator).

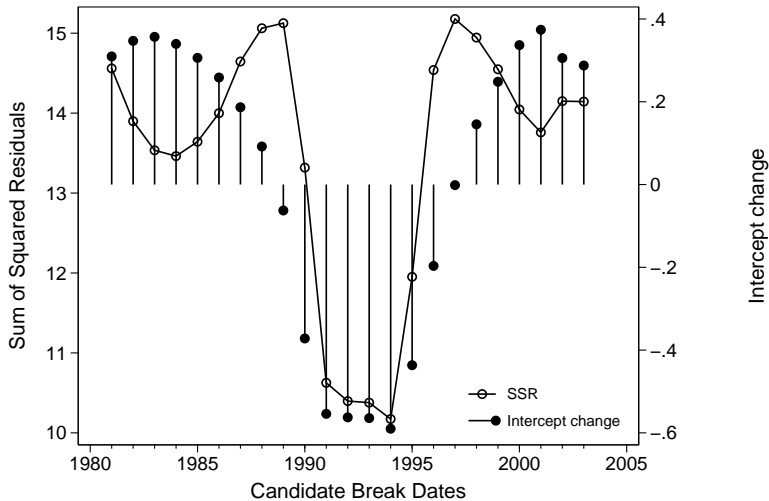
- Estimate a common break date across panels (Bai, 2010).
 - Estimator for break date: min SSR in a least squares framework.
- Estimator for effect size: δ (regime shift approximated by indicator).

- Novel data for about 60 UK power plants (1980-2004).
- Physical measures for output, labour, fuel, CO₂, SO₂, NO_x.
- Different sources: CEGB Yearbooks, government, companies

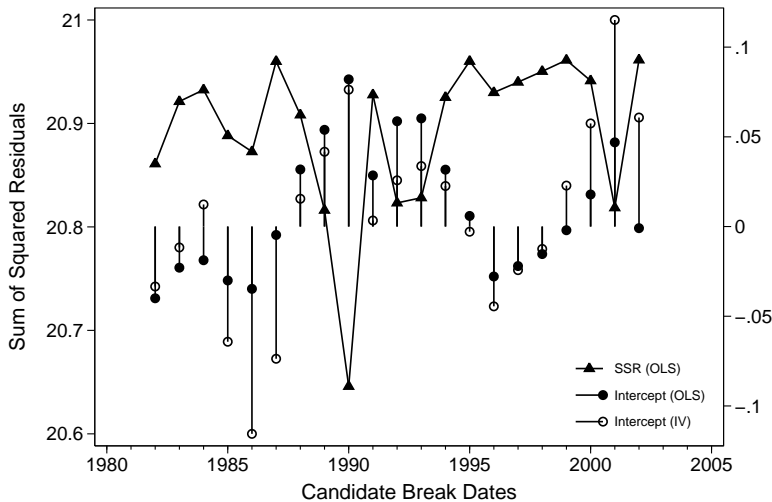
- Novel data for about 60 UK power plants (1980-2004).
- Physical measures for output, labour, fuel, CO₂, SO₂, NO_x.
- Different sources: CEGB Yearbooks, government, companies

- Novel data for about 60 UK power plants (1980-2004).
- Physical measures for output, labour, fuel, CO₂, SO₂, NO_x.
- Different sources: CEGB Yearbooks, government, companies

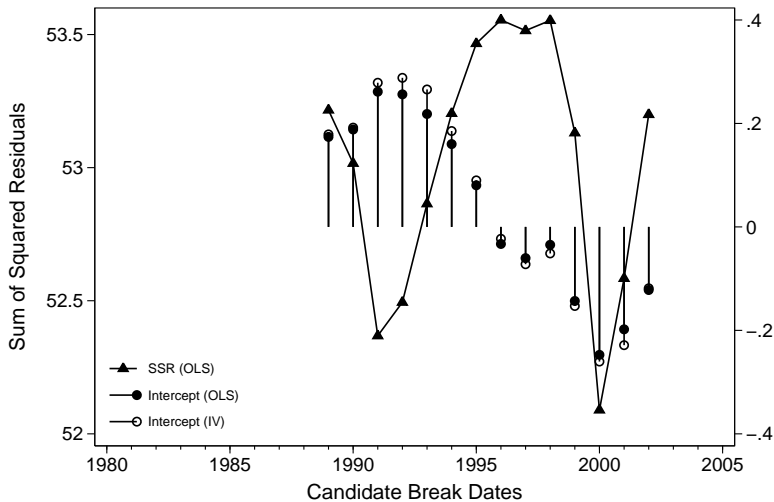
Results: Labour Efficiency



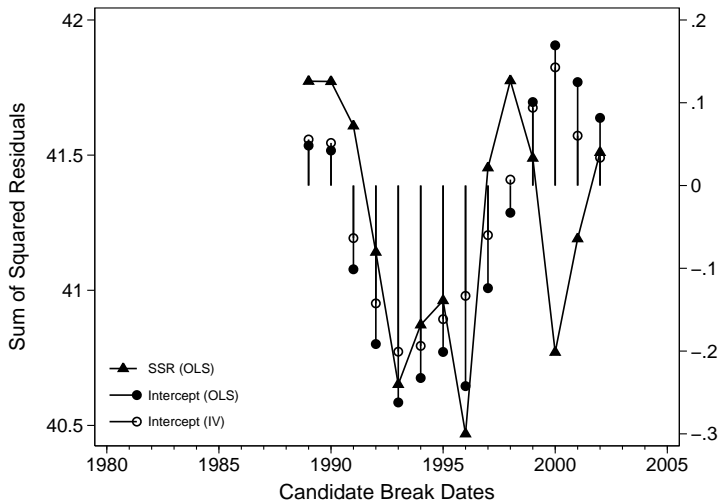
Results: Fuel Efficiency



Results: SO2 emissions



Results: NO_x emissions



- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

- Large improvements to labour productivity right after restructuring and privatization.
 - Strong effect of ownership change.
 - Other factors: reduced union power, generous redundancy packages.
 - No additional effect from competition.
- No (positive) ownership effect for fuel. But positive correlation with competition (positive and negative).
- For the air pollutants we find only some evidence for breaks that are independent of fuel efficiency.
 - Weak evidence that ownership change decreases pollution efficiency.
 - Strong evidence that competition reduces pollution via changes in fuel efficiency.
 - Difficult to apportion effects to economic and environmental regulation.

OWNERSHIP AND COMPETITION: FINDING PERFORMANCE BREAKS FOR UK POWER PLANTS

triebs@if0.de

$$\begin{aligned}\ln N_{irt} &= \beta_1^N \ln NET\ GWH_{irt} + \beta_2^N \ln PRICE_{irt}^N + \beta_3^N FGD_{irt} \\ &+ \beta_4^N AGE_{irt} + \beta_5^N POST_{irt} + \alpha_{ip}^N + t^N + e_{irt}\end{aligned}$$

Results: CO2 emissions

