The Endowment Effect in Cap-and-Trade Systems: Evidence from the European Electricity Sector

Aleksandar ZAKLAN
DIW Berlin

7th Atlantic Workshop on Energy and Environmental Economics

June 27, 2016

Agenda

Introduction

Independence Property vs. Endowment Effect

- In stylized settings the outcome of bargaining approaches to regulating externalities is invariant to the allocation of property rights (Coase, 1960)
- Independence property translates to cap-and-trade systems under certain conditions (Montgomery, 1972; Hahn and Stavins, 2011)
- Independence gives way to endowment effect in the presence of, e.g.:
  - Transaction costs (Coase, 1960; Stavins, 1995)
  - Market power (Hahn, 1984; Liski and Montero, 2011)
  - Disparities between willingness to accept and to pay (Kahneman, Knetsch and Thaler, 1990; Hanemann, 1991)
  - By construction, e.g. dynamic rules in EU ETS

Introduction

Motivation / Research Question

- Independence is attractive as even extreme distributions of allocations have no impact on cost-effectiveness of a cap-and-trade scheme
- Relevant to evaluate if independence holds as existence of an endowment effect is an indication of loss of cost-effectiveness
- Little empirical evidence on independence for existing cap-and-trade systems
- Research Question: Does the way in which allowances are allocated to power plants affect plant-level emission outcomes under the EU ETS?

Introduction

Literature and Contribution

- Available empirical evidence (Reguant and Ellerman, 2008; Fowlie and Perloff, 2013) fails to reject independence of allocations and emissions in Spanish power sector under the EU ETS and in California's RECLAIM Program, respectively
- Some experimental literature finds an endowment effect in lab settings designed to mimic a cap-and-trade market (e.g. Kahneman, Knetsch and Thaler (1990))
- Contribution:
  - Provide further empirical evidence on independence vs. endowment effect using a quasi-experimental approach
  - Add to empirical literature evaluating European climate policy at the micro level, e.g. Martin et al. (2014); Calel and Dechezlepretre (2015)

Agenda

Empirical Strategy

Exploiting a Policy Change

- A naive regression of emissions on allocation would likely suffer from endogeneity
- Exploit variation in allocation induced by a policy change:
  - Expiration of free allocation for power generation in most EU countries at the start of Phase III, i.e. beginning with 2013 compliance year (treatment group)
  - Continuing free allocation to electricity generation in 8 new EU member states based on so-called 10c rule (control group)

Agenda

Research Design

Outcome Variable

- Use normalized emissions growth rate (Davis and Haltiwanger, 1992; Greenstone, 2002)

$$y_{it} = \frac{e_{it} - e_{it-1}}{\frac{e_{it}+e_{it-1}}{2}}$$

- Similar to using log differences
- Prevents overweighting of plants with large emissions in regression analysis

Research Design

Difference-in-Differences on unmatched/matched samples

- Diff-in-diff regression in installation-year panel:

$$y_{it} = const + \boldsymbol{\rho}(treated \times auctioning)_{it} + \alpha_i + \alpha_i \cdot t + \lambda_t + \epsilon_{it}$$

  - ρ: ATT of switching from free allocation to full auctioning on emissions growth

- Match on pre-treatment emissions, nominal capacity, share of CHP to account for selection on observables using entropy balancing (Hainmueller, 2012)
  - Re-weight observations in control group to balance covariates across groups while staying as close as possible to uniform weights
  - Similar to propensity score matching but more convenient

Agenda

Data

- Strongly balanced panel of power producing plants in Europe drawn from EU Transaction Log (EUTL)
  - Sample period: 2008-2014
  - 1,032 (410) treated and 159 (39) control plants in full (small plant) sample
- Match with Platts power plant database, combined with manual search provides information on plant characteristics
  - Used to get technical characteristics used in matching procedure

Summary Statistics

	Full Sample		Small Plants Sub-Sample	
	Treatment	Control	Treatment	Control
Verified Emissions (1,000 mt)	764	1,619	42	194
Capacity (MW)	328.9	384.2	19.0	20.95
Small plants (<50MW), share in %	39.7%	24.5%	100%	100%
Medium plants (51-200MW), share in %	23.1%	35.8%	0%	0%
Large plants (>201MW), share in %	37.2%	39.6%	0%	0%
Gas-fired, share in %	53.1%	18.8%	54.8%	25.6%
Coal-fired, share in %	12.5%	69.8%	2.68%	64.1%
Oil-fired, share in %	17.9%	6.2%	19.02%	7.6%
Combined heat and power, share in %	55.5%	67.2%	71.4%	92.3%
Observations	6,192	954	2,460	234

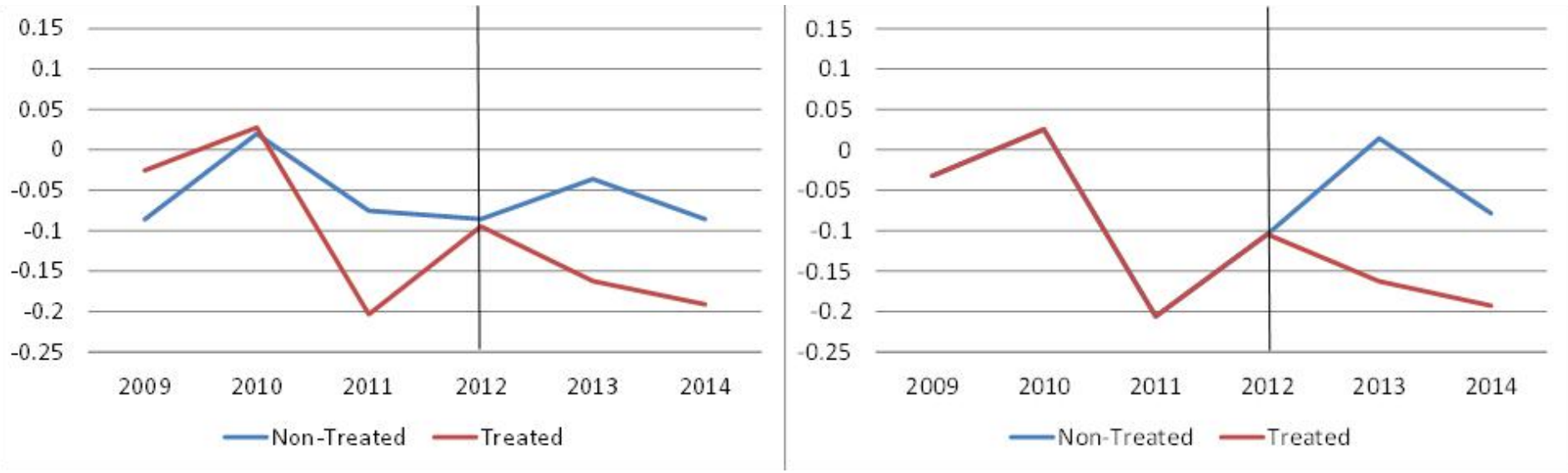
Matching

Comparing Means, Treatment and Control Groups (Full Sample)

	Treatment	Control	
		Non-Matched	Matched
Emissions Growth 2009	-0.032	-0.085	-0.032
Emissions Growth 2010	0.025	0.019	0.025
Emissions Growth 2011	-0.205	-0.075	-0.205
Emissions Growth 2012	-0.104	-0.085	-0.104
Combined Heat and Power	55.5%	67.2%	55.5%
Capacity (MW)	329.0	384.3	329.0
No. installations	1,032	159	

Parallel Trends

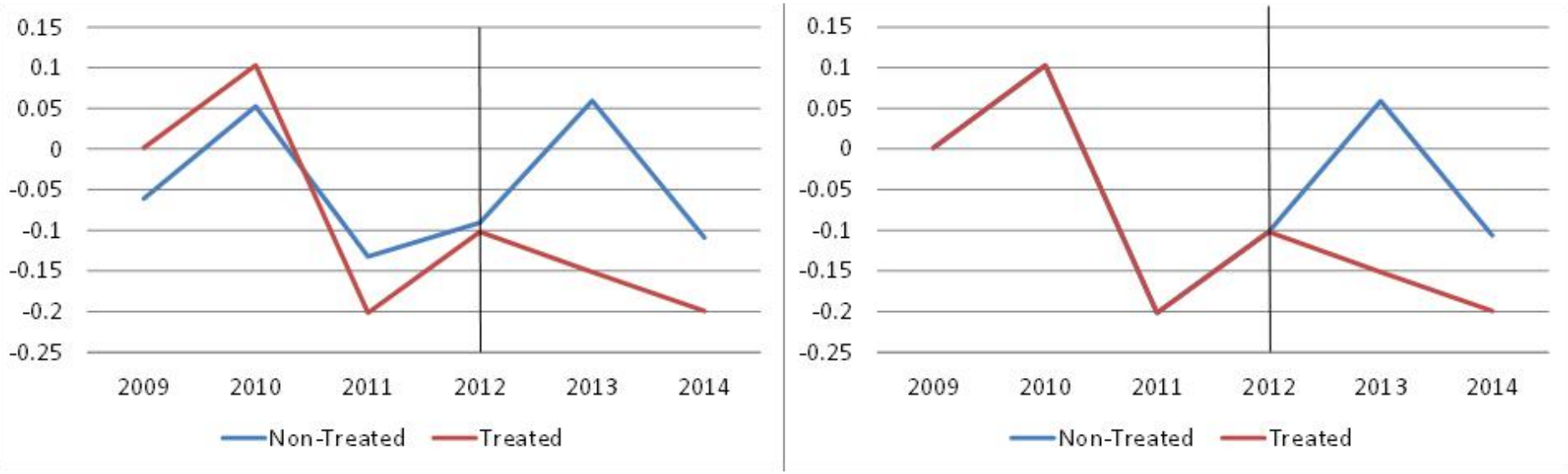
Full Sample



Source: EUTL and own calculations.

Parallel Trends

Small Plants Sub-Sample



Source: EUTL and own calculations.

- Formal diagnostics (including leads/lags of treatment indicator) confirm doubt on parallel trends for full sample and confidence for small plants sample

Agenda

Results

ATT - Full Sample

	Unmatched sample		Matched sample	
	(1)	(2)	(3)	(4)
ATT	-0.094***	-0.003	-0.145**	-0.162
	(0.027)	(0.054)	(0.061)	(0.128)
Year fixed effects	x	x	x	x
Installation fixed effects	x	x	x	x
Installation-level trends		x		x
R^2	0.18	0.35	0.18	0.34
Obs.	7,146	7,146	7,146	7,146

Note: Robust s.e. clustered at firm level in parentheses. *, **, *** indicate significance at 10%, 5% and 1% levels, respectively.

Results

ATT - Small Plants ($<$ 50 MW) Sub-Sample

	Unmatched sample		Matched sample	
	(2)	(3)	(5)	(6)
ATT	-0.158**	-0.098	-0.151	-0.183
	(0.069)	(0.134)	(0.093)	(0.193)
Year fixed effects	x	x	x	x
Year FE	x	x	x	x
Installation fixed effects		x		x
R^2	0.19	0.36	0.19	0.36
Obs.	2,694	2,694	2,694	2,694

Note: Robust s.e. clustered at installation level in parentheses. *, **, *** indicate significance at 10%, 5% and 1% levels, respectively.

Agenda

Conclusions

- No evidence of endowment effect for full sample, in line with the literature (Reguant and Ellerman, 2008; Fowlie and Perloff, 2013)
- (Potentially some) evidence of an endowment effect for small plants
  - Consistent with findings that small emitters do not fully exploit potential of EU ETS, e.g. Naegele (2015)
- Study this effect for plants for own-power production by manufacturing firms

Thank you for your attention!

Aleksandar Zaklan
azaklan@diw.de

References I

Calel, R., and A. Dechezlepretre. 2015. "Environmental Policy and Directed Technological Change: Evidence from the European Carbon Market." *Review of Economics and Statistics*, Forthcoming: .

Coase, R. H. 1960. "The Problem of Social Cost." *Journal of Law and Economics*, 3: 1–44.

Davis, S. J., and J. Haltiwanger. 1992. "Gross Job Creation, Gross Job Destruction, and Employment Reallocation." *Quarterly Journal of Economics*, 107(3): 819–863.

Fowlie, M., and J. M. Perloff. 2013. "Distributing Pollution Rights in Cap-and-Trade Programs: Are Outcomes Independent of Allocation?" *Review of Economics and Statistics*, 95: 1640–1652.

Greenstone, M. 2002. "The IImpact of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures." *Journal of Political Economy*, 110(6): 1175–1219.

Hahn, R. W. 1984. "Market Power and Transferable Property Rights." *Quarterly Journal of Economics*, 99: 753–765.

References II

Hahn, R. W., and R. N Stavins. 2011. "The Effect of Allowance Allocations on Cap-and-Trade System Performance." *Journal of Law and Economics*, 54: 267–294.

Hainmueller, J. 2012. "Entropy Balancing for Causal Effects: A Multivariate Reweighting Method to Produce Balanced Samples in Observational Studies." *Political Analysis*, 20(1): 25–46.

Hanemann, W. M. 1991. "Willingness to Pay and Willingness to Accept: How Much Can They Differ?" *American Economic Review,*, 81(3): 635–647.

Kahneman, D., J. L Knetsch, and R. H. Thaler. 1990. "Experimental Tests of the Endowment Effect and the Coase Theorem." *Journal of Political Economy*, 98(6): 1325–1348.

Liski, M., and J. P. Montero. 2011. "Market Power in an Exhaustible Resource Market: The Case of Storable Pollution Permits." *The Economic Journal*, 121: 116–144.

Martin, R., M. Muuls, L.B. de Preux, and U.J. Wagner. 2014. "Industry Compensation under Relocation Risk: A Firm-Level Analysis of the EU Emission Trading Scheme." *American Economic Review*, 104(8): 2482–2508.

References III

Montgomery, W. D. 1972. "Markets in Licenses and Efficient Pollution Control Programs." *Journal of Economic Theory*, 5: 395–418.

Naegele, H. 2015. "Offset Credits in the EU ETS: A Quantile Estimation of Firm-Level Transaction Costs." *DIW Discussion Paper 1513*.

Reguant, M., and D. Ellerman. 2008. "Grandfathering and the Endowment Effect: An Assessment in the Context of the Spanish National Allocation Plan." *MIT CEEPR Working Paper*, 08-018: .

Stavins, R. N. 1995. "Transaction Costs and Tradeable Permits." *Journal of Environmental Economics and Management*, 29: 133–148.