

Energy Taxes and Manufacturing Firm Performance: Evidence from Finland's Green Tax Reform

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Environmental regulation and manufacturing firm performance

- Other things equal, environmental regulation increases firms' costs and thus reduces their cost competitiveness.
- This may harm regulated firms' performance and push them to shift production to locations with laxer environmental policies.
- On the other hand, environmental regulation may push regulated firms to engage in “clean” innovation and technology adoption and enhance competitiveness.
- Another sparsely studied question: do price-based environmental policy instruments deliver in practice?

Finland's "green" tax reform

- We examine the impacts of energy taxes on firms' economic and environmental performance and in the context of Finland's 2011 "green" energy tax reform.
- The reform increased the excise taxes on energy inputs notably, with the aim of promoting energy efficiency and reducing CO₂-emissions.
- An exemption scheme already in place was extended to a larger set of firms in 2012. Firms above a certain energy tax threshold were granted an exemption from energy taxes.
- Exempt and non-exempt firms, and in particular plants within these firms, can be otherwise very similar, but subject to different effective tax rates.

Data and research design

- We use a detailed data set on the universe of Finnish manufacturing plants, for years 2007-2016.
- The data are representative of manufacturing in Finland and comprise a wide range of financial variables as well as energy use.
- List of tax exempt firms was obtained from the Finnish tax authority and combined to the financial data.
- We estimate the impact of the energy tax exemption by combining a difference-in-differences approach with semiparametric matching techniques.

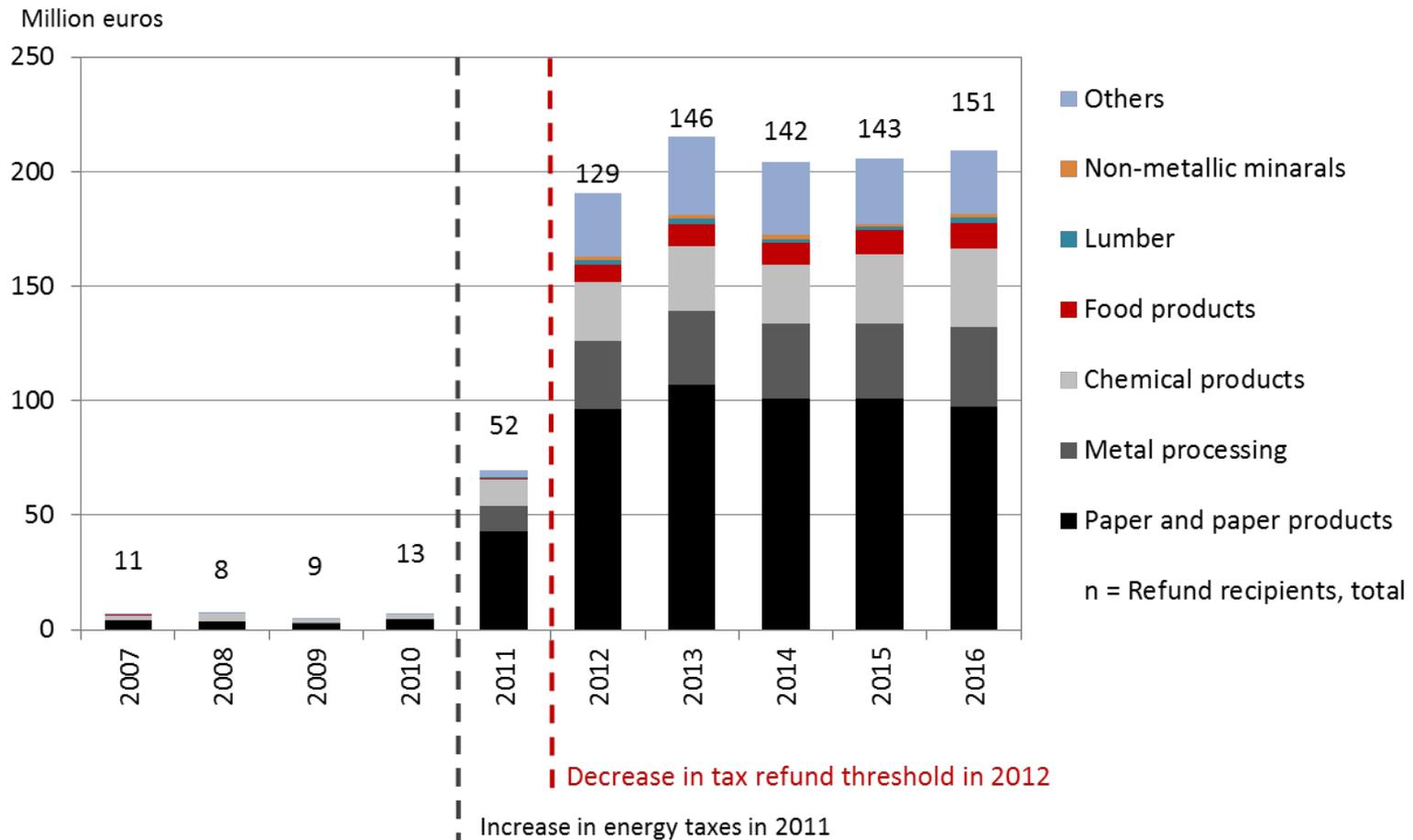
Institutional background

- Energy taxes include excise taxes on electricity, district heat and process steam, and carbon and energy content based taxes on heating fuels.
- The tax exemption rule is as follows (with euros as units)

$$\text{Energy Taxes Paid} - A * \text{Value Added} \geq B$$

- Value added \approx operating profit and labor costs.
- In 2012, the value added threshold A was changed: 3,7% \rightarrow 0,5%.

The change in the exemption rule increased the number of beneficiaries



Expected impacts

- **Economic outcomes**

Higher output (as compared to non-exempt plants) –
we measure gross output, revenue and value added

Higher employment

Higher wages?

- **Energy use**

Higher energy use (as compared to non-exempt plants)

Less incentive to improve energy efficiency

Difference-in-differences matching estimator

- We seek to identify the average effect of energy tax exemption on plants within firms that qualified for the exemption following the 2011-2012 energy tax reform.
- We adopt the difference-in-differences matching approach suggested by Heckman, Ichimura and Todd (1997).
- The matching approach constructs estimates of counterfactual outcomes for treated plants using outcomes for untreated plants that are observationally similar to the to the treated plant.
- We focus on differences-in-differences (DiD) outcomes (the ATT can be identified under weaker assumptions).

Matching

- We use nearest neighbor matching to construct the sample of plants that we use in the DiD matching analysis
- The counterfactual estimate for each tax exempt plant is constructed using the non-exempt plants that most closely resemble the treated plants in terms of selected covariates.
- Base case specification uses 5 nearest neighbors.
- Exact matching at the two-digit industry level.
- Continuous matching variables are plant's total energy use and share of electricity in total energy use in the pre-treatment period.

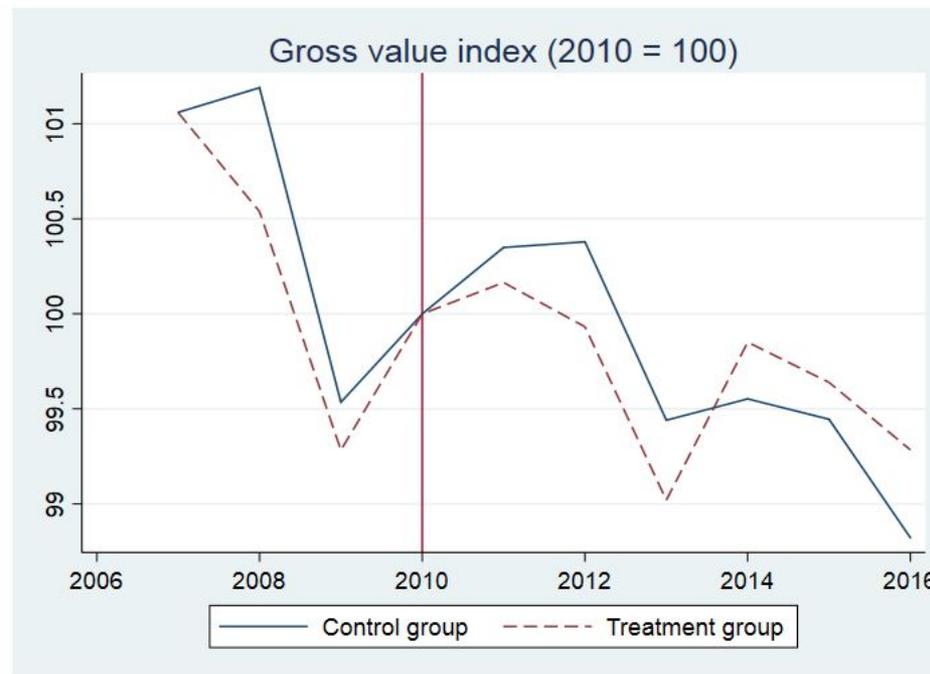
Matching sample construction

- Use plants that were in the data set in 2010, the last year before the energy tax reform, and in at least one of the years 2012-2016 that followed the reform.
- The treatment group includes the plants that first qualified for the exemption in 2011 or 2012, and remained tax exempt through 2016.
- The comparison group only includes plants that never were tax exempt. That is, we remove plants that were exempt from energy taxes already prior to the 2011 energy tax reform, and plants that first became exempt after the tax reform but did not qualify in one or more consecutive year.

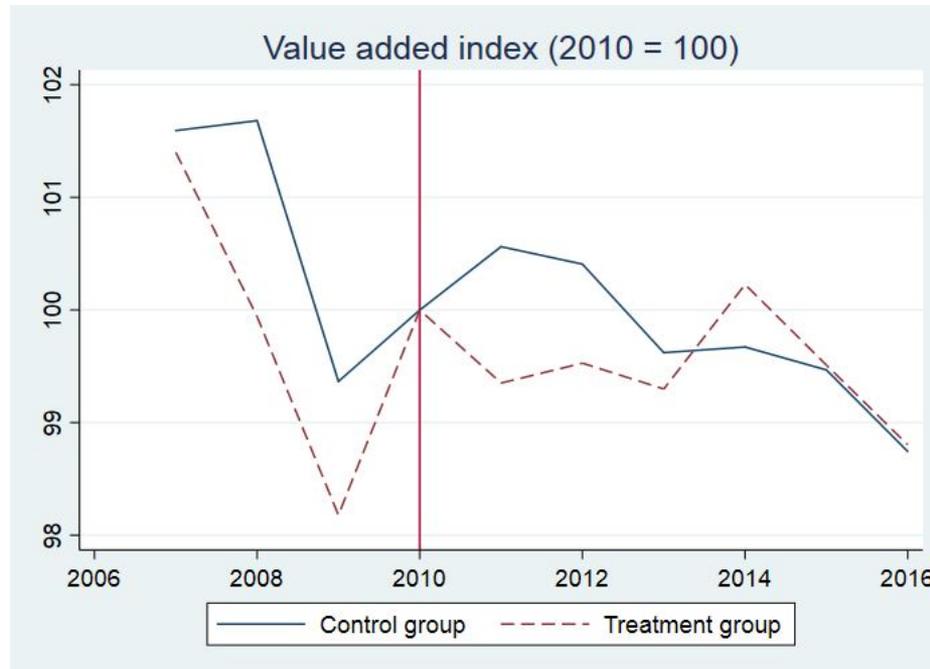
Identifying assumptions

- Counterfactual trends in the outcomes of the tax exempt plants do not systematically differ from those in the group of matched control plants.
- Matching is performed on a common support where the distributions of the covariates in the treatment and control groups overlap.
- The potential outcomes at one plant are independent of the treatment status of other plants.

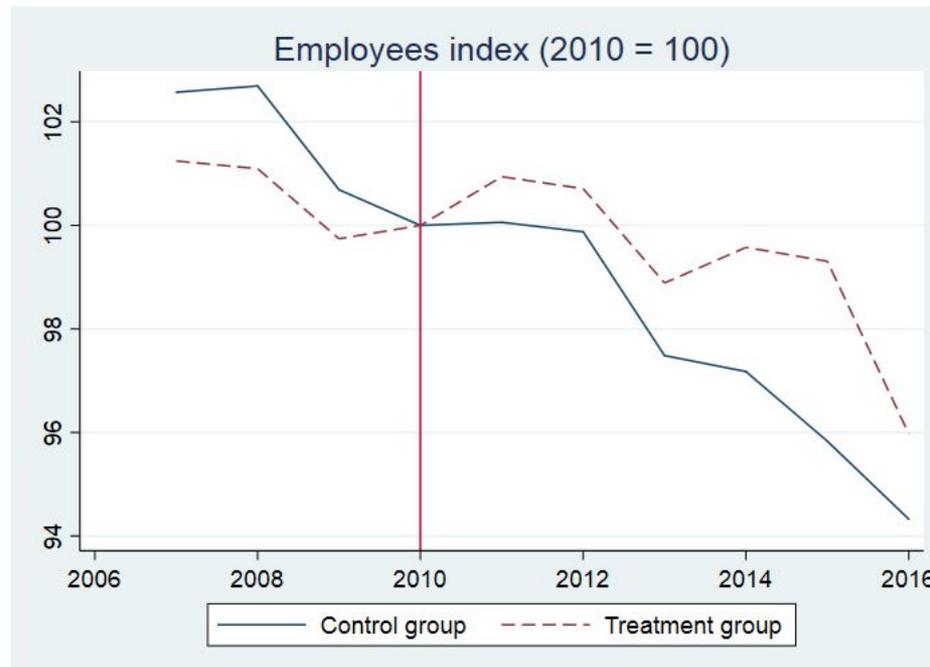
Pre-treatment trends for the treatment group and the matched control



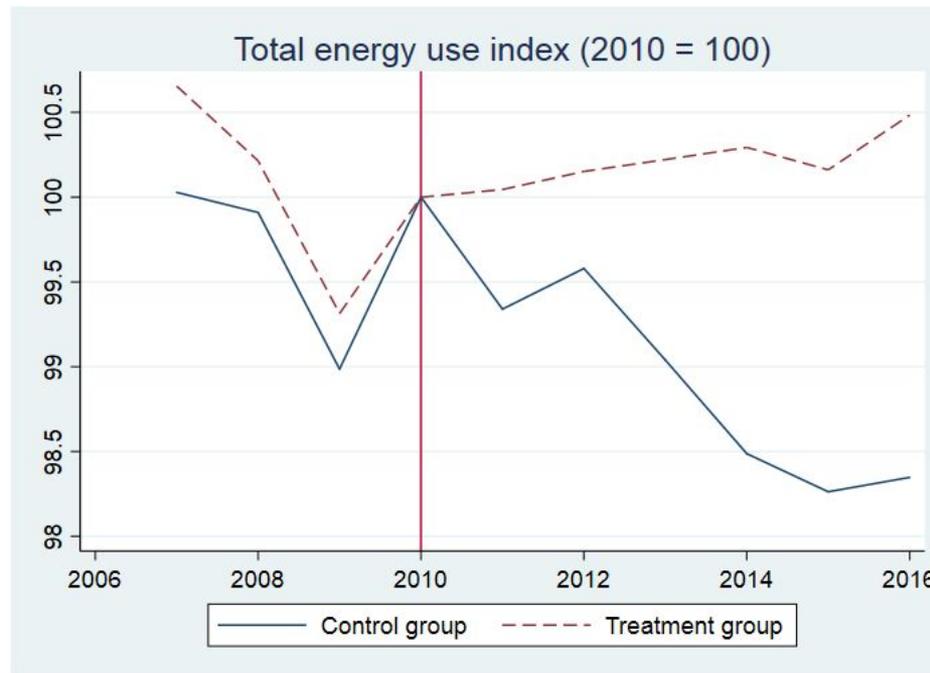
Pre-treatment trends for the treatment group and the matched control



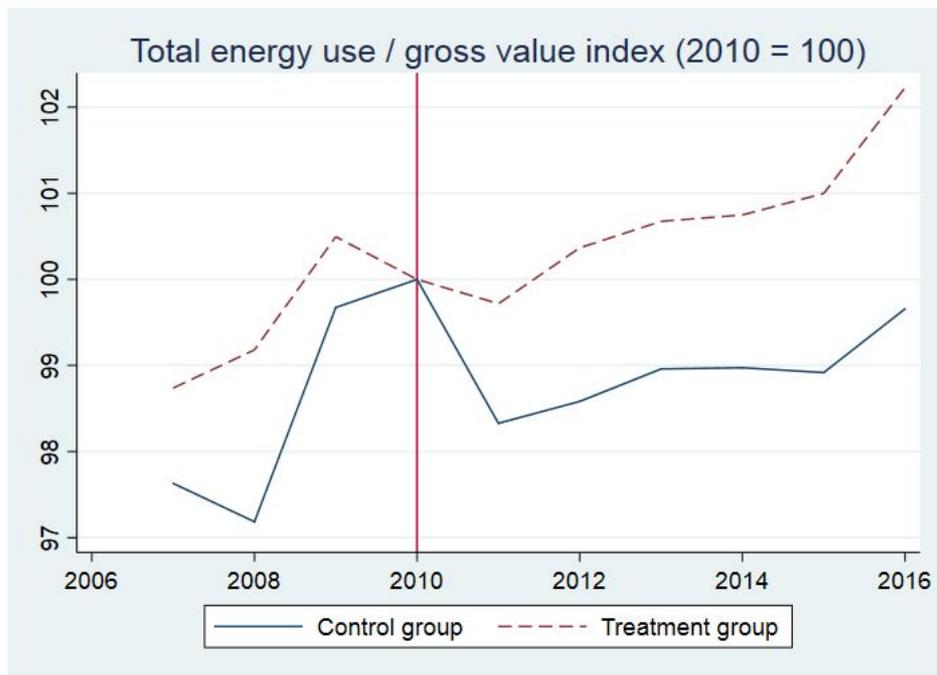
Pre-treatment trends for the treatment group and the matched control



Pre-treatment trends for the treatment group and the matched control



Pre-treatment trends for the treatment group and the matched control



Results - 2016 to 2010 comparison

Dependent variable (in Log)	Gross output	Revenue	Value added	Wages/employee	Employees	Total energy use	Energy efficiency
Coefficient	-0,39***	-0,18	0,03	-0,03	0,01	-0,08	-0,52***
SE	0,10	0,16	0,16	0,05	0,07	0,08	0,11
<i>p</i>	0,00	0,26	0,87	0,53	0,89	0,31	0,00
Number of observations	244	243	236	244	246	246	245
Number of treated	128	127	119	127	129	129	128
Number of controls	116	116	117	117	117	117	117

*** Significant at the 1 percent level.

Results

- The results are most compatible with
 - No important effect on revenue, value added, wages, number of employees or total energy use
 - Negative effect on output and energy efficiency
- The results suggest that that between 2010 and 2016 output grew on average 39 percentage points less in beneficiary plants than in non-beneficiary plants.
- We do not observe plants' physical output, only the value of output. Thus, the negative effect on output is consistent both with plants producing less, and with plants charging lower prices.

Discussion and conclusions

- The scheme may be counterproductive in terms of energy efficiency, and does not appear to be economically important on average
- Caveat: there is substantial year-to-year variation in output so magnitude should be interpreted with care.
- The number of plants available for the econometric analysis is quite small.
- However, the results are in line with other empirical papers on the impact of energy prices differences and energy tax exemptions on manufacturing firm performance.
- Comparison of investment behavior among beneficiary and non-beneficiary plants would be an interesting extension.

Krugman (1990):

Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.