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Climate Policy and Corporate Behaviour

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Abstract: In this paper, we study the impact of energy taxes and the EU ETS on a large number of firms in Europe between 1996 and 2007. Using company level micro-data, we examine how firms in different sectors were affected by environmental policies. Aspects of behaviour and performance studied include total factor productivity, employment levels, investment behaviour and profitability. On the whole, energy taxes increased total factor productivity and returns to capital but decreased employment, with a mixed effect on investment, for the sectors included in our analysis. However, large sectoral variation is observed, with some industries losing out in terms of productivity and profitability when faced with increased energy taxes, while others benefitted.

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Key words: energy taxes, productivity, investment, firm performance

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Climate Policy and Corporate Behaviour

1. Introduction

With increasing emphasis on environmental regulation in the industrial sector in recent years, it is important to understand the impacts of such measures on firm productivity and investment behaviour. While much attention has been focused on the environmental benefits of differing climate policies, there is relatively little empirical evidence of their impact on company behaviour.

In this paper, we are interested in the effect of energy and carbon taxes on various measures of corporate behaviour and performance. Using firm level micro-data, we focus on the influence of these taxes on the employment levels, investment behaviour and productivity of European companies for the years 1996 to 2007.

Theory provides conflicting guidance as to the likely effects of environmental regulation and taxes on firm behaviour and performance. Taxes represent additional costs for a firm, and as such would be expected to be a constraint on their production possibilities and thus reduce profits. However, when faced with higher environmental taxes, firms may seek to reduce their costs by locating in "pollution havens" or countries where environmental standards or regulatory costs are relatively low. This is known as the pollution haven hypothesis.

Other models stress the importance of the availability of clean natural resources as factor inputs, which could help to improve the production possibilities of firms (factor endowment hypothesis). Equally, technology innovation as a result of increased regulation is also considered a potential outcome. According to the Porter Hypothesis (Porter 1991; Porter & van der Linde 1995), environmental regulation provides incentives for companies to innovate, which can increase competitiveness and productivity. Both the factor endowment and Porter Hypotheses imply that environmental stringency may lead to improvements in the performance of firms as well as advancing environmental goals (Wagner 2003)

There is also some previous empirical research into the impact of environmental regulation on company behaviour and performance. Leiter *et al.* (2009) study firm investment decisions in response to environmental protection measures. Using European industry-level panel data, they find a positive but diminishing impact of environmental stringency on investment. Average elasticities of around 0.15 for industry expenditure on environmental protection and 0.06 for country revenue from environmental taxes are found.

Veith *et al*. (2008) examine the impact of the EU ETS on capital market responses in the power generation sector. Returns on common stock in this sector are found to be positively correlated with rising prices for emissions rights. This indicates that the ETS increases profits, as firms pass on or even overcompensate for regulation costs in prices charged to customers, thus increasing their profitability.

A study undertaken as part of the EU COMETR study, Enevoldsen (2007), includes an analysis of eight sectors in seven European countries. The results show a slightly negative effect of energy taxes on competitiveness and output. However, Henderson and Millimet (2005), using a US sample, find insignificant effects of environmental stringency on state-level output.

While most of the previous literature is undertaken at country or industry level, there has been relatively little research undertaken using firm level micro-data. Anger and Oberndorfer (2008) assess the impact of the EU ETS on firm performance and employment. Using a sample of German firms, they do not find an effect of the relative allocation of emission allowances on firm revenue and employment in 2005. Martin *et al.* (2009) investigate the effect of a UK energy tax, the climate change levy, on the manufacturing sector using firm panel data. However, they find no significant impacts on employment, gross output or total factor productivity (TFP).

Economic theory and previous empirical research suggests conflicting or ambiguous outcomes of environmental policies on corporate performance. The pollution haven hypothesis would suggest decreased employment in more stringently regulated sectors, and the assumption that taxes cause additional cost burdens on firms would equally point to decreased productivity and profitability. However, the Porter Hypothesis and Factor Endowment theory suggest otherwise. They indicate the potential for increased output and TFP due to the availability of clean natural resources, or to increased innovation.

However, we can see from previous empirical work that these findings vary widely, based on which sectors and countries are included in the analysis. The literature finds conflicting or insignificant results for competitiveness, employment and investment amongst different country and industry samples. The type of regulation is also important to take into consideration, as energy taxes are expected to be more efficient than some other forms of regulation, such as command-and-control approaches. For this reason it is important to utilise data at the most disaggregated firm level, and to undertake cross-country and cross-industry analysis in order to examine the validity of these conflicting viewpoints.

In this paper, we make use of cross-country firm level panel data, for a large sample of European companies. In order to test the differing hypotheses, we examine how firms in different industries adapt their structure and behaviour in response to energy taxes and the introduction of the EU Emissions Trading Scheme. We assess the effects of such environmental policies on employment, investment and productivity over a twelve year period.

2. Data

The data employed in this paper is firm-level panel data for a range of European firms across various sectors, provided in the AMADEUS database. This database contains financial and economic information for approximately 11 million firms across Europe. The dataset we used covered the years 1996 to 2007.

From this we construct four dependent variables, representing several measures of corporate performance. These include:

- Total Factor Productivity (TFP)
- Number of employees
- Investment (calculated as change in tangible fixed assets minus depreciation)
- Return on capital employed

While our main data source is the Amadeus database, additional industry and country level variables are collected from a range of sources, such as the OECD, Eurostat and the International Energy Agency.

Energy tax data is sourced from the Eurostat environmental accounts. These consist of taxes on energy products such as petrol, diesel, fuel oils, natural gas, coal and electricity. CO_2 taxes are also included where applicable. Both energy taxes at time *t*, as well as lagged energy taxes, are incorporated into each model. Firms covered under the EU Emissions Trading Scheme are indicated by a binary variable, given a value of 1 for all sectors included in the scheme since its introduction in 2005, and 0 for all other sectors.

In addition, labour cost shares at country level, calculated as total country labour costs as a proportion of output, are collected from the OECD and included as independent variables in both the employment and TFP models. Other determinants of TFP are also included as controls. Educational attainment at country level (the proportion of people aged 25-64 with a third level education), national output gap, and the import intensity of each industry were obtained from the OECD. Electricity prices per country, from the International Energy Agency, are also included.

We use TFP as our productivity measure since changes in TFP directly reflect efficiency gains due to the reorganization of production processes (Factor Endowment Hypotheses) as well as the introduction of new technologies or innovations related to improvements of a firm's energy efficiency (Porter Hypotheses). We derive TFP of firm *j* in sector *s* at time *t* as a residual from a production function in logs:

$$y_{jst} = \beta_s^k k_{jst} + \beta_s^l l_{jst} + \alpha_i + \eta_s + \mu_t + \varepsilon_{jst} \qquad (2)$$

where y_{jst} denotes a firm's real value added, k_{jst} the real physical capital stock and l_{jst} the labour input, α_i is a vector of country specific effects, η_s a vector of industry specific effects, μ_t a vector of year specific effects, $\beta = (\beta^k \beta^l)$ a vector of average input elasticities, and ε_{jst} an error term.[1]

We estimate (2) to obtain empirical measures of the average input elasticities β from firm level data. We account for heterogeneous input elasticities across three-digit (NACE) industry levels in that we estimate the marginal input effects separately for each of the three-digit industries. Note, however, that we pool the observations in each three-digit industry across countries in order to obtain sufficient information for robust production function estimations per industry. We believe that this is a relatively minor restriction on the data since average input elasticities for three-digit industries are typically found to be relatively homogeneous across European countries. Obtaining the estimates for the average input elasticities for each three-digit industry allows us, together with the information on *y*, *k*, and *l* of each individual firm, to compute residual TFP measures at the firm-level. However, the estimation of (2) involves an endogeneity problem which is well-known in the literature on production functions estimation. That is, a firm's demand for labour is expected to depend on its contemporaneous productivity level which is unobserved and hence captured in the error term. In such a case, the estimated input elasticities would be biased. Appropriate instruments for labour services that are uncorrelated with productivity are typically not available. Being aware of this problem, we consistently estimate (2) following Olley and Pakes (1996) who propose a semi-parametric estimator to correct for this simultaneity bias by imposing additional restrictions on the data. In particular, the authors use changes in firm’s investment decision as a proxy for the productivity shock. The method supposes that a firm's investment decision is a function of its capital stock, age, and its unobserved productivity. Hence, the unobserved productivity parameter can be modeled as some (inverse) function of investments, capital, and age given the assumption of a monotonic relationship between investment and productivity. We apply this methodology to derive consistent estimates of the average input elasticities in our sample.

Variable definitions and sample means are presented in Tables 2 and 3 below.

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[1] Real variables are obtained deflating by the national output price deflators. Unfortunately, price deflators were not available at the industry level for most of the countries.

3. Methodology

We have estimated four models, each exploring a different aspect of company behaviour or performance. First, our model of employment tests the suggestion that these taxes weaken the incentive to use capital due to high energy-capital complementarity, with firms switching to more labour-intensive activities. However, decreased employment may also be observed in heavily regulated sectors, as firms seek to minimise their costs by moving towards countries or industries with lower levels of stringency. Labour costs are included in this model, to control for differing labour costs across countries over time, which may otherwise be driving the change in a firm's number of employees.

Total factor productivity measures the component of output that arises from factors other than capital and labour. This is often regarded as the impact of technology innovation on firm performance. In this case, energy taxes may have a positive or negative effect, depending on which of the previously outlined theories of environmental regulation are seen to hold. This model controls for additional TFP determinants such as education levels, the gap between actual and potential GDP (output gap), and the import intensity of the specific sector. While import intensity and education, representing higher human capital levels, would be expected to increase TFP, we expect the output gap variable to have a negative sign. Although firms may be expected to innovate and reorganise when operating in a country with an increasing output gap, there may be a loss of knowledge capital in such countries, which tend also to have high unemployment levels. Moreover, some forms of labour input that tend to increase in a capacity-constrained economy (e.g. overtime working) may be omitted from the measure of labour inputs and thereby boost TFP when the output gap is shrinking. On balance, these effects are likely to imply that increasing the output gap will negatively influence firms' TFP levels. Electricity prices are also included and are expected to have a negative effect on TFP.

Return on capital employed is included as a profitability indicator. Energy taxes would be expected to decrease profitability under the assumption that taxes act as an additional costs on doing business. Finally, our fourth company behaviour variable is investment. If energy taxes have similar effects to taxes on capital, there would be an expected negative sign on these coefficients in the investment model, as firms substitute capital for labour. The pollution haven hypothesis also points towards negative effects on investment. However, the Porter Hypothesis would suggest that firms facing increased regulation would have an incentive to innovate and invest in new technology in order to improve productivity. This would suggest increases in investment due to energy taxes. However, it is necessary to empirically examine these in further detail in order to test the competing theoretical stories.

In order to control for unobserved time- and company-specific heterogeneity, we use panel regression analysis. We allow for sectoral variations in energy tax effects by including sector-tax interaction terms for energy tax levels and lagged tax levels.

Many of the variables included exhibit some intertemporal persistence or are non-stationary (e.g. investment, employment), so estimating the models in levels would be expected to lead to substantial residual serial correlation. To avoid this, we estimate the regressions in first differences. The coefficients may thus be viewed as representing equilibrium values.

4. Results

Since the focus of interest for this research is on tax effects, we first present estimates of the tax effects by sector for each model. Later in the section we discuss other explanatory variables.

Tax effects

Sectoral variations in tax effects feature prominently in all four models. These are calculated for each sector by adding the tax coefficients and the tax-sector interaction coefficients for both the current period and lagged taxes. The results for TFP are shown in Figure 1 below. The figure shows the percent change in the TPF growth rate for each sector associated with a 1% tax increase. Thus a 10% tax increase would be associated with a 10% fall in the TFP growth rate for the tobacco sector. If TFP in this sector would otherwise grow by 2%, this implies a lower growth rate of 1.8% due to the tax change.

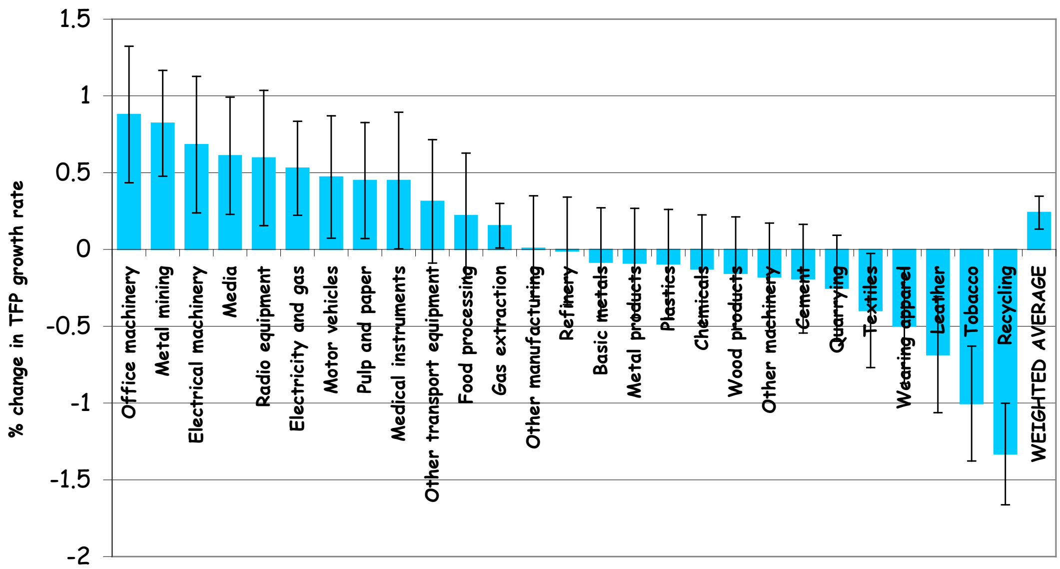

Figure 1: Average partial effect of 1% rise in energy taxes on TFP growth by sector

TFP growth is positively associated with energy taxes in some sectors, but reduced in others. This provides some evidence for Porter Hypothesis effects, but only for selected sectors. Primary resource sectors such as coal, metal, oil and gas extraction benefited from higher TFP growth, along with a range of manufacturing sectors producing energy-using goods (e.g. office machinery, electrical machinery, radio equipment). Electricity and gas generation and the media sector also showed a positive effect. Many sectors showed no statistically significant effect (standard errors were relatively high in this model), but wearing apparel, leather, tobacco and recycling showed a negative association with energy taxes. The average effect of a tax change on TFP growth, weighting sectoral effects by the output shares of these sectors in Europe, is positive.[2] This suggests that *ceteris paribus* a marginal tax increase would lead to a small but statistically significant improvement in TFP growth for these sectors in Europe.

[2] The sector shares were obtained from the OECD STAN database.

The relationship between energy taxes and employment for different sectors is set out in Figure 2 below.

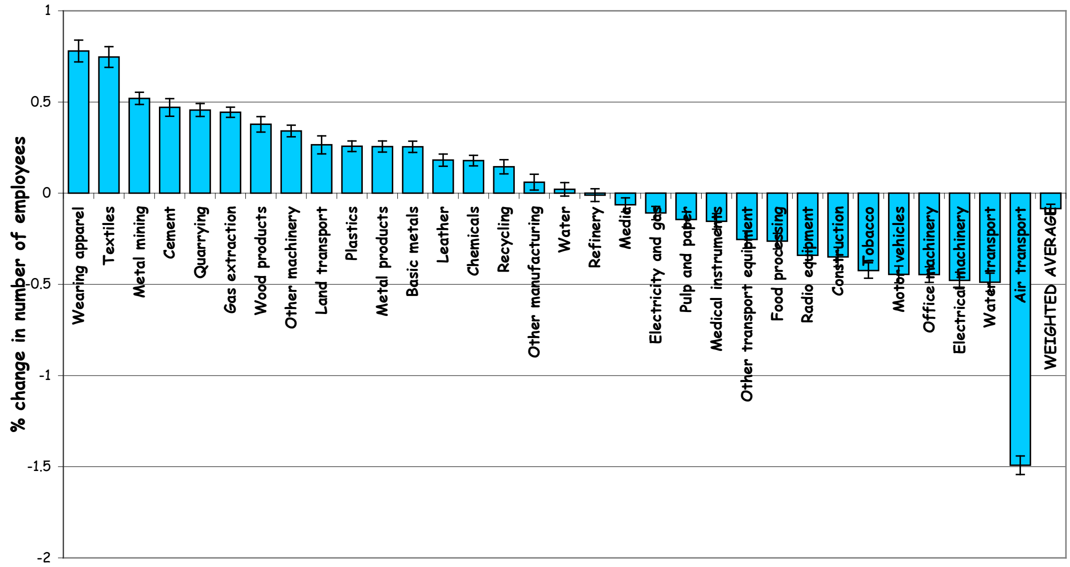

Figure 2: Average partial effect of 1% rise in energy taxes on firms' employment by sector

In this case, standard errors are much lower and most sectors exhibit a significant effect. Some sectors show a positive employment effect relating to energy taxes; notably wearing apparel, textiles, and primary resource sectors. Air transport shows a strongly negative association, with a 10% tax rise being associated with a 15% reduction in employment. Other sectors exhibit weaker positive or negative effects. In this case, the average effect (weighted by sectoral employment shares in Europe) is negative. Overall, then, a marginal increase in energy taxes is associated with lower employment for this set of sectors in Europe.

Air transport also features a large and significant effect in relation to corporate investment (Figure 3 below). In this case the effect is positive, with a hypothetical 10% tax rise being associated with a 20% increase in fixed investment. Basic metals, refining and water transport also have relatively large positive coefficients, while tobacco has a very large negative association and the recycling and leather sectors have smaller negative coefficients. The average effect, weighted by total sectoral investment, is not significantly different from zero. This implies that energy taxes at the margin do not have a statistically significant effect on total investment levels in this sample.

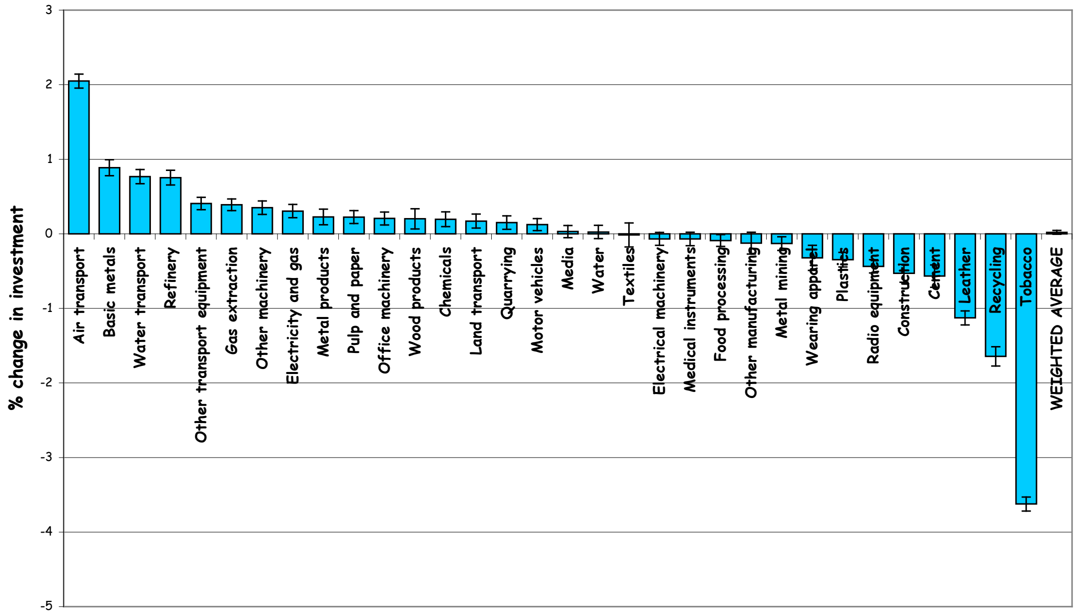

Figure 3: Average partial effect of 1% rise in energy taxes on firms' investment by sector

Our final model examined the association between energy taxes and company profitability, proxied by the return on capital employed. This relationship proves to be positive in most cases, with the strongest relationship being for air transport. Only a few sectors – water transport, refining, wood products, coal and peat extraction, food processing and quarrying having significant negative coefficients. The average effect, weighting sectoral effects by the output shares of these sectors in Europe, is positive and statistically significant. This suggests that a marginal increase in energy taxes would increase profitability on average.

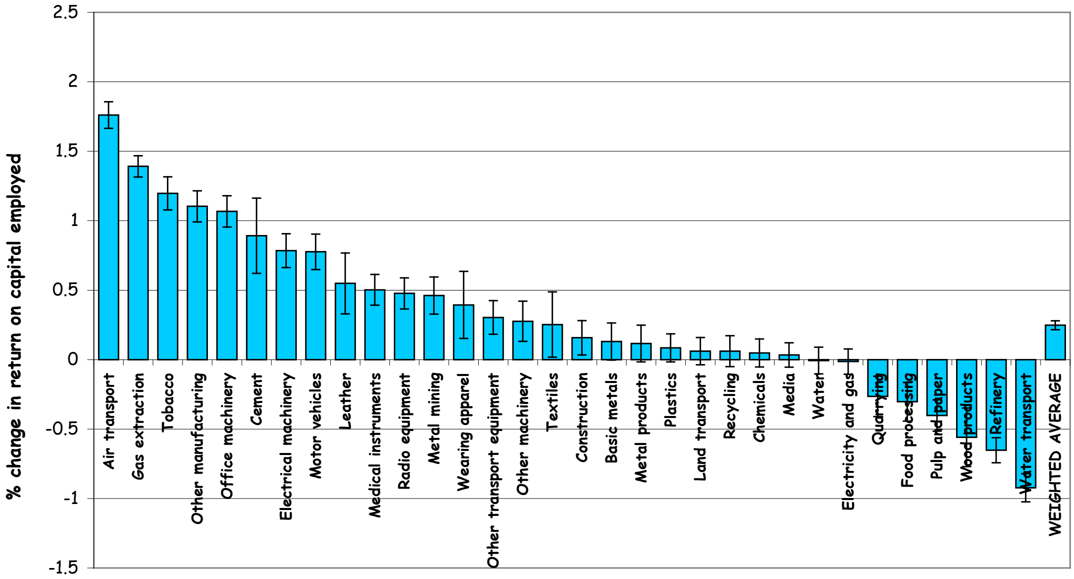

Figure 4: Average partial effect of 1% rise in energy taxes on firms' return on capital employed by sector

We considered whether the sectoral pattern of energy tax effects shown above might be driven by broader sectoral characteristics such as energy intensity or technology intensity. However, grouping sectors by these classifications did not reveal any obvious association with the tax effects. The impact of energy taxes on TFP, employment, investment and profitability vary by sector even amongst industries which have similar energy and technology use.

Other effects

Since we have estimated these models in differences, we only observe effects for factors that vary over time. All models allow for ETS participation effects, and the relevant coefficients are shown in Table 1 below. We find no significant association between ETS participation and employment or investment. However, both TFP growth and return on capital employed were lower in ETS participant firms, *ceteris paribus*. For a firm with a TFP growth rate of 2%, participation in the ETS would be associated with 0.12% lower TFP growth.

Table 1: ETS participation effects

Dependent variable	ETS effect	Robust standard error
TFP growth	-0.0616***	0.0196
ln(employment)	0.0173	0.0142
ln(investment)	0.00161	0.0249
ln(Return on capital employed)	-0.0673***	0.0185

Lower productivity and profitability among ETS firms is consistent with the view that the scheme increased firms' costs without inducing significant Porter Hypothesis effects. With the dataset we are using here, it is not possible to tell whether a different design or level of stringency for the ETS would have changed this conclusion.

Finally, we can report a range of secondary results. In the TFP model, sectoral import intensity, national education level and labour costs were not significant (we had expected the first two factors to have a positive effect on TFP and the third to have a negative effect). Labour cost was, as expected, negative and highly significant in the employment model. Returning to the TFP model, the output gap and electricity prices both showed highly significant negative effects, which was in line with our expectations.

5. Conclusions

In this paper, we study the impact of energy taxes and the EU ETS on a large number of firms in Europe between 1996 and 2007. To the best of our knowledge, we are the first to do so. We estimate the effect on the change in total factor productivity (a proxy for technological progress), on employment, on investment, and on the returns to capital (a proxy for accounting profits). The following results emerge. First, as one would expect, results vary dramatically between sectors, not just in the size of the estimated effects but also in their signs. Second, total factor productivity accelerates with higher carbon taxes. Although the effect is insignificant in large parts of the economy, and negative in some sectors, the positive impact in a number of sectors dominates. This finding supports the Porter Hypothesis. Regulation spurs innovation. Third, energy taxes reduce employment. There is a significant impact on employment in almost all sectors. The most important effect is a large shift in labour between sectors, but the overall effect is negative. While energy taxes create jobs, more jobs are destroyed. Fourth, energy taxes increase investment. The impact is again significant in most sectors, and the most notable effect is a shift in investment between sectors. The aggregate effect is positive, however. This suggests that businesses respond to energy taxes by substituting labour for capital. This is in sharp contrast to the findings by Koetse et al. (2008). Fifth, energy taxes increase the returns to capital. Again, differences between sectors are pronounced, but the average effect is positive. This finding reinforces the results for investment.

We obtain different results for the EU ETS. The effect on productivity and profits are negative, while the effect on labour and investment are insignificant. These results are indicative only, as our data only cover the experimental phase of the ETS and we were unable to define a permit price. Future research, using data from the second phase of the ETS, should reinvestigate this.

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Tables

Table 2: Variable definitions

Dependent variables		**Independent variables**	
Total Factor Productivity (lnTFP)	Olley-Pakes method. Log TFP in first differences	Tax rate (lntax_rate)	Log of energy taxes by sector and country, first differences. Includes taxes on petrol, diesel, gas, electricity etc.
Employment (lnL)	Log number of employees in a firm in year t, in first differences.	Lagged Tax rate (lntax_rate t-1)	Log of energy taxes, 1 period lag. First differences.
Return on Capital Employed	Return on capital employment in year t, in first differences	Import Intensity	Imports/ (Production – Exports + Imports)
Investment	Log change in tangible fixed assets minus depreciation, in first differences	Education	Tertiary education attainment for age group 25-64, as a percentage of the population of that age group in each country.
		Output Gap	Deviations of actual GDP from potential GDP as a percentage of potential GDP
		Electricity price (ln elec price)	Electricity prices per country (€ per kWH)
		Labour Cost	Total Labour Costs as a percentage of Output, per country

		ETS	Emissions Trading Scheme dummy variable, 1 if sector covered by ETS, 0 otherwise

Table 3: Variable means

	TFP	**Employment**	**Return On Capital Employed**	**Investment**
Independent Variables	227942 obs.	649809 obs.	506682 obs.	427483 obs.
Tax rate	0.004	0.003	0.004	0.004
Lagged Tax rate	0.004	0.003	0.004	0.004
Labour Cost	0.589	0.623		
Education	19.742			
Output Gap	-0.093			
Electricity price	0.070			
Import Intensity	0.277			

Annex A: Regression results

Table 4: Total factor productivity regression results, OLS panel regression in first differences; dependent variable: ln(TFP_{it})

Variables and statistics	Coef.	Robust standard error
Ltax_rate	0.935***	0.109
Ltax_rate-1	0.257***	0.0539
import_intensity	0.0268	0.0228
education	-0.0552	0.0331
output_gap	-0.166***	0.0568
Lelectricityprice	-0.129***	0.0382
labourcost	-1.77	2.9
ETS	-0.0616***	0.0196
NACExTax11	-1.04***	0.00638
NACExTax13	-0.371***	0.104
NACExTax14	-1***	0.104
NACExTax15	-1.01***	0.0808
NACExTax16	-2.95***	0.0588
NACExTax17	-1.04***	0.121
NACExTax18	-1.09***	0.12
NACExTax19	-1.49***	0.127
NACExTax20	-0.956***	0.118
NACExTax21	-0.79***	0.0732
NACExTax22	-0.63***	0.0751
NACExTax23	-0.823***	0.106
NACExTax24	-0.956***	0.108
NACExTax25	-0.945***	0.109
NACExTax26	-0.97***	0.108
NACExTax27	-0.924***	0.11
NACExTax28	-0.926***	0.111
NACExTax29	-0.963***	0.107
NACExTax30	-0.795***	0.112
NACExTax31	-0.631***	0.115
NACExTax32	-0.782***	0.111
NACExTax33	-0.875***	0.116
NACExTax34	-0.804***	0.0696
NACExTax35	-0.688***	0.071

Variables and statistics	Coef.	Robust standard error
NACExTax36	-0.974***	0.0966
NACExTax37	-1.72***	0.09
NACExTax40	-0.655***	0.0765
NACExTax14	-0.443***	0.0117
NACExTax15	0.0366	0.266
NACExTax16	0.753***	0.258
NACExTax17	-0.554***	0.0529
NACExTax18	-0.597***	0.0528
NACExTax19	-0.391***	0.0374
NACExTax20	-0.391***	0.0383
NACExTax21	0.0464	0.235
NACExTax22	0.0475	0.236
NACExTax23	-0.378***	0.0417
NACExTax24	-0.363***	0.0317
NACExTax25	-0.34***	0.0257
NACExTax26	-0.413***	0.0495
NACExTax27	-0.351***	0.0241
NACExTax28	-0.355***	0.0236
NACExTax29	-0.407***	0.0268
NACExTax30	0.482*	0.266
NACExTax31	0.121	0.262
NACExTax32	0.185	0.261
NACExTax33	0.131	0.26
NACExTax34	0.0835	0.273
NACExTax35	-0.191	0.275
NACExTax36	-0.211***	0.0747
NACExTax37	-0.802***	0.0677
NACExTax40	-0.00815	0.0479
D1998	0.378***	0.0983
D1999	0.363***	0.103
D2000	0.359***	0.117
D2001	0.168***	0.0498
D2003	-0.0209*	0.0103
D2004	0.178***	0.0634
D2005	-0.0453*	0.0232
Constant	-0.0438**	0.016

Variables and statistics	**Coef.**	**Robust standard error**
Sample	65,787 firms	
Observations	227,942	
Min. periods	1	
Avg. periods	3.5	
Max. periods	7	
R^2 within	0.0156	
R^2 between	0.0004	
R^2 overall	0.0077	
*Note: All variables are in first differences apart from the constant, and variables with an L prefix are in log terms. *, ** and *** denote significant at the 10%, 5% and 1% level respectively. t-statistics are heteroscedasticity-robust and allow for clustering at sector level.*		

Table 5: Employment regression results, OLS panel regression in first differences, dependent variable: ln(employment$_{it}$)

Variables and statistics	Coef.	Robust standard error
Ltax_rate	0.299***	0.0234
Ltax_rate-1	-0.062***	0.0113
labourcost	-2.29***	0.296
ETS	0.0173	0.0142
NACExTax11	-0.294***	0.00741
NACExTax13	-0.172***	0.013
NACExTax14	-0.0279	0.0178
NACExTax15	-0.328***	0.0242
NACExTax16	0.434***	0.0242
NACExTax17	0.0702**	0.0333
NACExTax18	0.0421	0.0368
NACExTax19	-0.162***	0.0127
NACExTax20	-0.224***	0.014
NACExTax21	-0.297***	0.0223
NACExTax22	-0.35***	0.0236
NACExTax23	-0.329***	0.021
NACExTax24	-0.222***	0.00984
NACExTax25	-0.168***	0.00964
NACExTax26	-0.0538*	0.0301
NACExTax27	-0.199***	0.00909
NACExTax28	-0.211***	0.00932
NACExTax29	-0.171***	0.0112
NACExTax30	-0.504***	0.0206
NACExTax31	-0.648***	0.0221
NACExTax32	-0.671***	0.0198
NACExTax33	-0.429***	0.0205
NACExTax34	-0.616***	0.0255
NACExTax35	-0.379***	0.0265
NACExTax36	-0.29***	0.0246
NACExTax37	-0.315***	0.0228
NACExTax40	-0.358***	0.0218
NACExTax41	-0.355***	0.0239
NACExTax45	-0.583***	0.0308
NACExTax60	-0.271***	0.0287
NACExTax61	-0.659***	0.029

Variables and statistics	Coef.	Robust standard error
NACExTax62	-0.861***	0.0299
NACExTax11	0.501***	0.00686
NACExTax13	0.455***	0.0167
NACExTax14	0.246***	0.0158
NACExTax15	-0.172***	0.0237
NACExTax16	-1.1***	0.0231
NACExTax17	0.439***	0.0382
NACExTax18	0.5***	0.0395
NACExTax19	0.106***	0.0166
NACExTax20	0.364***	0.0301
NACExTax21	-0.0845***	0.0229
NACExTax22	0.0489***	0.0148
NACExTax23	0.0806***	0.00946
NACExTax24	0.163***	0.00866
NACExTax25	0.189***	0.00898
NACExTax26	0.287***	0.0274
NACExTax27	0.216***	0.0132
NACExTax28	0.23***	0.0129
NACExTax29	0.275***	0.0139
NACExTax30	-0.18***	0.0276
NACExTax31	-0.0673**	0.0297
NACExTax32	0.0927***	0.027
NACExTax33	0.0369	0.0272
NACExTax34	-0.0669**	0.0284
NACExTax35	-0.112***	0.0293
NACExTax36	0.113***	0.0245
NACExTax37	0.222***	0.0175
NACExTax40	0.0121	0.0126
NACExTax41	0.139***	0.0101
NACExTax45	-0.00434	0.0342
NACExTax60	0.299***	0.0304
NACExTax61	-0.0668**	0.031
NACExTax62	-0.868***	0.0319
D1998	0.101	0.0128
D1999	0.0445	0.0129
D2000	0.147	0.0115

Variables and statistics	**Coef.**	**Robust standard error**
D2001	0.144	0.0122
D2002	0.0656	0.00897
D2003	0.0386	0.0113
D2004	-0.014	0.0131
Constant	-0.0115	0.00956
Sample	164,570 firms	
Observations	649,809	
Min. periods	1	
Avg. periods	3.9	
Max. periods	8	
R^2 within	0.0160	
R^2 between	0.0073	
R^2 overall	0.0048	

*Note: All variables are in first differences apart from the constant, and variables with an L prefix are in log terms. *, ** and *** denote significant at the 10%, 5% and 1% level respectively. t-statistics are heteroscedasticity-robust and allow for clustering at sector level.*

Table 6: Return on capital employed, OLS panel regression in first differences, dependent variable: ln($ROCE_{it}$)

Variables and statistics	Coef.	Robust standard error
Ltax_rate	-0.155***	0.0427
Ltax_rate-1	-0.298***	0.0486
ETS	-0.0673***	0.0185
NACExTax11	0.375***	0.026
NACExTax13	-1.37***	0.0308
NACExTax14	-0.224***	0.0673
NACExTax15	0.512***	0.0981
NACExTax16	0.766***	0.0849
NACExTax17	-0.289***	0.105
NACExTax18	-0.298**	0.112
NACExTax19	0.2	0.127
NACExTax20	-0.337**	0.136
NACExTax21	0.157***	0.0419
NACExTax22	0.342***	0.0305
NACExTax23	-0.162***	0.057
NACExTax24	-0.0174	0.0634
NACExTax25	-0.0315	0.0598
NACExTax26	-0.0686	0.13
NACExTax27	-0.0535	0.0882
NACExTax28	-0.0356	0.0843
NACExTax29	0.129*	0.0737
NACExTax30	0.416***	0.0599
NACExTax31	0.715***	0.0754
NACExTax32	0.396***	0.062
NACExTax33	0.295***	0.0598
NACExTax34	0.611***	0.0592
NACExTax35	0.404***	0.054
NACExTax36	0.98***	0.0477
NACExTax37	0.649***	0.08
NACExTax40	0.267***	0.0534
NACExTax41	0.147***	0.0534
NACExTax45	-0.000523	0.0556
NACExTax60	0.514***	0.0528
NACExTax61	0.0725	0.058
NACExTax62	1.2***	0.047

Variables and statistics	Coef.	Robust standard error
NACExTax11	1.47***	0.0314
NACExTax13	2.29***	0.113
NACExTax14	0.412***	0.111
NACExTax15	-0.362***	0.0748
NACExTax16	0.884***	0.0519
NACExTax17	0.995***	0.2
NACExTax18	1.14***	0.204
NACExTax19	0.801***	0.166
NACExTax20	0.23	0.147
NACExTax21	-0.106	0.0825
NACExTax22	0.144***	0.0505
NACExTax23	-0.0366	0.0271
NACExTax24	0.518***	0.0446
NACExTax25	0.569***	0.0483
NACExTax26	1.41***	0.229
NACExTax27	0.637***	0.0758
NACExTax28	0.605***	0.0785
NACExTax29	0.6***	0.106
NACExTax30	1.1***	0.0695
NACExTax31	0.523***	0.0703
NACExTax32	0.533***	0.0662
NACExTax33	0.66***	0.0672
NACExTax34	0.619***	0.0923
NACExTax35	0.352***	0.0872
NACExTax36	0.577***	0.0775
NACExTax37	-0.135***	0.0415
NACExTax40	0.171***	0.0354
NACExTax41	0.299***	0.0474
NACExTax45	0.611***	0.0894
NACExTax60	-0.000539	0.0508
NACExTax61	-0.542***	0.0525
NACExTax62	1.02***	0.0528
D1999	-0.404***	0.0918
D2000	-0.21***	0.0505
D2001	-0.213***	0.0296
D2002	-0.251***	0.0355

Variables and statistics	Coef.	Robust standard error
D2003	-0.292***	0.0411
D2004	-0.23***	0.0463
D2005	-0.236***	0.0465
Constant	0.15***	0.0432
Sample	162,771 firms	
Observations	506,682	
Min. periods	1	
Avg. periods	3.1	
Max. periods	8	
R^2 within	0.0082	
R^2 between	0.0027	
R^2 overall	0.0064	

*Note: All variables are in first differences apart from the constant, and variables with an L prefix are in log terms. *, ** and *** denote significant at the 10%, 5% and 1% level respectively. t-statistics are heteroscedasticity-robust and allow for clustering at sector level.*

Table 7: Investment, OLS panel regression in first differences, dependent variable: ln(investment$_{it}$)

Variables and statistics	Coef.	Robust standard error
Ltax_rate	-1.68***	0.0303
Ltax_rate-1	1.92***	0.0554
ETS	0.00161	0.0249
NACExTax11	1.93***	0.0257
NACExTax13	-0.225***	0.0469
NACExTax14	1.65***	0.0535
NACExTax15	1.73***	0.0296
NACExTax16	1.45***	0.0498
NACExTax17	1.68***	0.103
NACExTax18	1.13***	0.115
NACExTax19	1.27***	0.0325
NACExTax20	1.9***	0.0954
NACExTax21	1.67***	0.0385
NACExTax22	1.73***	0.0305
NACExTax23	2.37***	0.0364
NACExTax24	1.93***	0.048
NACExTax25	1.38***	0.0404
NACExTax26	0.847***	0.129
NACExTax27	2.43***	0.0586
NACExTax28	1.87***	0.0544
NACExTax29	1.85***	0.0622
NACExTax30	1.31***	0.0383
NACExTax31	1.49***	0.0376
NACExTax32	1.14***	0.0398
NACExTax33	1.31***	0.041
NACExTax34	2***	0.0346
NACExTax35	1.94***	0.0374
NACExTax36	1.49***	0.0911
NACExTax37	0.307***	0.0725
NACExTax40	1.95***	0.0301
NACExTax41	1.75***	0.0311
NACExTax45	1.26***	0.0627
NACExTax60	1.45***	0.0493
NACExTax61	1.41***	0.0498
NACExTax62	2.62***	0.0446

Variables and statistics	Coef.	Robust standard error
NACExTax11	-1.78***	0.039
NACExTax13	-0.141***	0.0462
NACExTax14	-1.73***	0.0353
NACExTax15	-2.05***	0.037
NACExTax16	-5.31***	0.0466
NACExTax17	-1.93***	0.105
NACExTax18	-1.69***	0.105
NACExTax19	-2.63***	0.0615
NACExTax20	-1.93***	0.0713
NACExTax21	-1.68***	0.044
NACExTax22	-1.94***	0.0431
NACExTax23	-1.85***	0.0669
NACExTax24	-1.97***	0.0595
NACExTax25	-1.96***	0.0615
NACExTax26	-1.65***	0.0461
NACExTax27	-1.78***	0.065
NACExTax28	-1.88***	0.0622
NACExTax29	-1.73***	0.0165
NACExTax30	-1.34***	0.0467
NACExTax31	-1.8***	0.0457
NACExTax32	-1.81***	0.0481
NACExTax33	-1.61***	0.0498
NACExTax34	-2.11***	0.0368
NACExTax35	-1.77***	0.037
NACExTax36	-1.85***	0.0966
NACExTax37	-2.18***	0.0861
NACExTax40	-1.88***	0.0554
NACExTax41	-1.96***	0.0556
NACExTax45	-2.03***	0.0796
NACExTax60	-1.52***	0.0488
NACExTax61	-0.877***	0.0507
NACExTax62	-0.802***	0.0533
D1999	-0.0204	0.0395
D2000	-0.0842**	0.0412
D2001	-0.196***	0.0368
D2002	-0.113**	0.0468

Variables and statistics	Coef.	Robust standard error
D2003	-0.151***	0.0354
D2004	-0.074*	0.037
D2005	-0.148***	0.0367
Constant	0.166***	0.0371
Sample	138,776 firms	
Observations	427,483	
Min. periods	1	
Avg. periods	3.1	
Max. periods	8	
R^2 within	0.0017	
R^2 between	0.0002	
R^2 overall	0.0012	

*Note: All variables are in first differences apart from the constant, and variables with an L prefix are in log terms. *, ** and *** denote significant at the 10%, 5% and 1% level respectively. t-statistics are heteroscedasticity-robust and allow for clustering at sector level.*

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