The Structure of Energy Prices of the French Manufacturing Sector Policy Drivers and Effects*

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Abstract

The paper evaluates the influence of energy prices on job creation and workforce composition French establishments in the manufacturing sector. A clear understanding of how energy prices influence the labour market is crucial to understand the potential impacts of pollution and carbon taxes on job creation and workforce composition.

We use detailed microdata on energy consumption and expenditure and workforce composition for a large panel of French manufacturing establishments (1997-2010). Our findings suggest a negative effect of energy prices on total employment, which is mainly driven by an negative effect on the demand for employees in routine (cognitive and manual) occupations. Our instrumental variable approach exploits exogenous variation in electricity prices due to changes in the regulatory framework as a consequence of the introduction of the CSPE electricity tax in 2003 and of the process of liberalization of electricity and natural gas markets in early 2000s.

Keywords: energy prices, workforce composition, energy taxes

JEL: Q41, Q48, J21

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* We thank the Centre d'accès sécurisé aux donnéees (CASD) du Genes (Group des écoles nationales d'économie et statistique) for the great work in providing high-quality confidential data and financial support from OFCE-SciencesPo. The access to the data was carried through the CASD dedicated to researchers authorized by the French Comité du secret statistique. Usual disclaimers apply.

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1 Introduction

The impact of environmental regulation on labour creation and workforce composition is an hot topic in the policy arena for its potentially large social costs and benefits. While economic benefits for the society from reduced environmental externalities are trivially associated with more stringent environmental regulation, the impact of environmental policies on production and job creation/destruction is less straightforward. In times of economic crisis and persistent unemployment, the job creation potential of environmental regulation as well as their possible negative impact on competitiveness are at the centre of the political discussion on the Green Economy (EEA, 2014).

The academic literature has contributed substantially to assessment of possible trade-offs between environmental goals and economic returns. As discussed in Palmer et al. (1995) and Jaffe and Palmer (1997), according to the neoclassical view environmental regulation introduces an additional constraints to the maximization problem of a profit-maximizing firm, thus resulting in lower production. However, by altering relative prices of the polluting input with respect to other inputs, according to the neoclassical view environmental regulation will induce innovation directed at reducing the demand for the more expensive polluting input. According to Porter and van der Linde (1995) however, well designed environmental regulation in presence of non-maximizing firms may induce innovation whose economic benefits exceed the costs of compliance with the policy, leading to a positive impact on the competitiveness of the firm.

No matter the overall impact of environmental regulation on production activities, the fact that environmental regulation alters relative prices of inputs is expected to generate an impact on the input mix. The polluting (more expensive) input will be substituted (also thanks to induced innovation) with other substitute inputs. However, inputs that were complement of the polluting inputs are also likely to be negatively influenced by environmental regulation. This mechanism operates both at the micro (establishment or firm) level and at the more aggregate level. First, establishments will adjust to account for the new vector of input prices by substituting the polluting inputs with other inputs. At the industry level, for a given mix of inputs in the establishments of the industry, a compositional effect will result into a faster growth in output in establishments and firms with a lower share of polluting inputs as they will be more competitive. At the macro-economic level, a structural change is likely to induce a shift in production and consumption from polluting-intensive sectors to less polluting sectors. Finally, in case environmental regulation generates some revenue for the public budget (e.g. pollution taxes), this additional tax revenue may be used to reduce taxes on other non-polluting inputs, thus reinforcing the change in relative prices.

While the sectoral and macro-level overall impacts of environmental regulation have been extensively documented and investigated by the economic literature, evidence on micro-level adjustments are less common. One of the few recent contribution on the issue is the paper by Martin et al (2014) that evaluates the impact of the Climate Change Levy (CCL) on a panel of UK manufacturing plants. Their results suggest a positive but insignificant impact of being subject to the CCL on the growth in total employment, also when accounting for the endogeneity of the tax, while a negative effect on energy intensity (energy share in gross output and energy share in variable costs) is found.

Other contributions look at the impact of the EU-ETS on firms' competitiveness, finding mixed results. Wagner et al. (2014) evaluate the impact of the EU-ETS on the performance of French manufacturing plants, finding a negative impact on employment, while no significant effect was found on employment by Petrick and Wagner (2014) and Anger and Oberndorfer (2008) for German firms. Abrell et al. (2011), on the other hand, evaluated the impact of the EU-ETS on a panel of European firms in different countries, finding no effect on profits and value added and a negative small and significant effect on employment.

Besides net job creation/destruction generated by more expensive polluting inputs, environmental policies are likely to affect different workers differently. The extent to which environmental regulation drives the demand of workers endowed with particular skills is investigated by Vona et al. (2015). After providing a taxonomy of 'green skills', the authors provide evidence that these skills are in high demand in more regulated areas in the US. These 'green skills' mostly consist into engineering-technical skills, scientific skills and operation management skills.

The objective of our paper is to shed light on the relationship between the cost of polluting inputs (here energy prices) as a proxy of environmental regulation and labour demand, aggregate and by skill group of workers, for a large panel of French manufacturing firms. In the general framework on the impact of environmental regulation on labour, we look at micro-level effects with no consideration (for the moment) on compositional changes of sector, structural change and general equilibrium effects.

The case of France is particularly interesting for various reasons. France relies on nuclear power to produce a large share of its electricity (77 percent in 2013 according to the IEA). Electricity generation from nuclear reactors is managed by the publicly-owned utility company EDF. The market for electricity was quite substantially regulated until recent years with the specific aim of securing a cheap and reliable supply of electricity to households and industrial customers. For all consumption bands, electricity prices for the French industrial sector are much smaller than in Italy (between about 40% and about 50% cheaper) and in Germany (between about 30% and 40% cheaper) (see Figure 1). This systematic lower energy prices may have induced a specialization of the French manufacturing sector in electricity-intensive products, making it more exposed to changes in energy prices than the manufacturing sector of other countries.

[Figure 1 about here]

In the period we are considering the French energy market, especially for electricity and natural gas, experienced substantial changes due to the combination of increasing liberalization of the electricity and gas market, setting of ambitious environmental targets and of the introduction of a specific tax on electricity (IEA, 2004; 2009). This lead to substantial (mostly exogenous) changes in energy prices and, more specifically, electricity prices for different industrial customers that is particularly helpful source of variation to be exploited to identify the impact of energy prices on job creation and workforce composition of French manufacturing establishments.

The paper is organized as follows. Section 2 describes the regulatory framework. Section 3 provides a selection of stylized facts on energy prices and consumption and on the workforce composition of the French manufacturing sector. Section 4 evaluates the impact of energy prices on labour demand and workforce composition for French manufacturing firms. Section 5 concludes.

2 Regulatory framework: market liberalization and the CSPE

The period we are considering is characterized by substantial regulatory changes in France that influenced the energy market, especially for what concerns electricity and natural gas. To illustrate, we report the regulation index build by the OECD for the electricity and gas sector in Figure 2 and Figure 3, respectively.

[Figure 2 and Figure 3]

The electricity sector was 'fully regulated' (score of 6) in France up to 1998 after which various reforms increasingly liberalized the French electricity market. According to the IEA (IEA, 2004; 2009), the most important reforms in this respect consisted in the creation of an independent transmission system operator, in allowing non-discriminatory third party access to the network and in the transformatioin of EDF from a EPIC (*ètablissement public industriel et* commercial) into a limited company (*société anonyme*) in 2004. These reforms, despite the continuing dominant position exerted by the (mostly) publicly-owned EDF, allowed the entry of new players in the market and induced changes in the electricity tariff system. A similar process of reforms also changed substantially the French market for natural gas. According to the IEA (IEA, 2004; 2009) the main reforms that influenced the market for natural gas were the transformation of GDF into a limited company (as EDF, in 2004) and the unbundling and opening to third party access to underground storage of natural gas. These reforms had substantial impacts on the supply side, leading to changes in the market structure and in tariffs offered to customers.

In addition to that, the French government introduced in 2003 (Loi 2003-8, 3 January 2003) the "*Contribution au Service Public de l'Électricité*" (contribution to public service electricity, CSPE henceforth) as a tax on electricity consumption. The tax is levied on all final consumers of electricity and it is aimed at refunding to EDF the costs due to the provision of public services. More specifically, the revenue is primarily (but not exclusively) used for: i) covering the obligatory purchase by EDF of electricity from renewable energy and co-generation; ii) subsidizing electricity production and distribution in regions (i.e. islands) not connected to the mainland network; iii) covering the contribution for special electricity prices granted for 'products for primary needs' and poor citizens. The tax per kWh was of 0.0033 euro in 2003, then raised to 0.0045 euro in 2004, 0.0075 euro and 0.009 euro in 2011, 0.0105 euro in 2012, 0.0135 euro in 2013, 0.0165 euro in 2014 and 0.0195 euro in 2015. Big industrial consumers of electricity are partly exempted from the contribution. First, a plafond at the establishment level is set on the total annual tax: the plafond was set to 500,000 euro in 2003 and grew up to 569,418 euro in 2013. This means that the actual tax on each kilowatt for big industrial plants is substantially smaller than the ones for smaller electricity consumers. An additional plafond is provided at the company level: the part of tax paid that exceeds the 0.5 percent of total company's value added is reimbursed in the following year for those companies that consume more than 7 GWh per year. Finally, consumption of self-produced electricity is exempted up to 240 GWh per year.

The impact of the CSPE tax on actual gross electricity prices is ambiguous. As we will show in the next section, big purchasers of electricity, despite receiving potentially large exemptions[1], also generally benefit for much smaller electricity prices than smaller purchasers (see next section). This results in a greater relative weight of the CSPE tax on total electricity prices than for smaller purchasers. The CSPE tax, thanks to its plafond-based scheme, does not create thresholds in the distribution of the tax, thus avoiding potential distortions due to strategic behaviours by consumers.

3 Some stylized facts about energy (consumption and prices) and workforce composition of French manufacturing establishments

Before moving to our main analysis, it is worth providing some descriptive evidence on energy consumption and prices and workforce composition for French industrial establishments. This is important to understand which are the sources of variation of energy prices across establishments and how the composition of the workforce differs across establishments with different energy prices. We combine two main sources of information about French manufacturing establishments for the period 1997-2010. The first one is the EACEI (*Enquête sur les consommations d'énergie dans l'industrie*) survey. EACEI collects detailed information on energy consumption and expenditure for a representative sample of industrial establishments with at least 10 employees.[2] The second source are microdata from the DADS (*Déclaration Annuelle des Données Sociales*). This database includes information on the population of French establishments in all sectors with information on number of employees and compensation by sex, type of contract and occupation. This latter dimension is particularly interesting as it can be linked to the distinction of workers according to their skills, in line with the approach proposed Vona et al. (2015). Employees are classified according to the classification of the French statistical office "*Professions et Catégories Socioprofessionnelles*" (PCS). For the period 1997-2004 we only have information on 1-digit PCS occupations while for 2005-2010 information at the 2-digit PCS was available. Table 1 provides a description of the occupations and the grouping of 1-digit PCS we use in our analysis.[3] A first group of occupations include managerial (non-routine) occupations. Workers in this group of occupations mostly deal with the management of establishments. A second group includes technical occupations that require high skills, such as engineering and scientific skills. These two groups of non-routine occupations may also be joined together as both require high degree of abstract thinking to be applied to problem-solving tasks. We then group together occupations that use routine cognitive skills, mostly constituted to clerical occupations and other white-collar occupations. Finally, the group of routine-manual occupation mostly includes manual blue collar occupations that use routine manual skills.

[Table 1 about here]

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[1] To illustrate: an establishment consuming 150 GWh per year in 2013 would have paid a total tax of 2.025 million euro. However, thanks to the plafond set at 569,418 euro, the actual tax rate per MWh for this establishment was 0.00379 euro per MWh instead of 0.0135 euro per MWh paid by establishment below the plafond threshold. The average discount on per-MWh consumed is thus about 72 percent.

[2] In the first part of our period sectors 10-12 (Manufacture of food products, beverages and tobacco products, NACE Rev 2) were not included in the sample. We thus exclude establishments in these sectors also in the second part of our panel. In some years other non-manufacturing industrial sectors were included (e.g. 38.3 'Material recovery'). We also exclude these additional non-manufacturing sectors.

[3] We follow as close as possible the taxonomy of occupations proposed by Acemoglu and Autor (2011).

3.1 Energy mix and prices in France

Figure 4 reports the aggregate average energy mix for French manufacturing establishments while Figure 5 and Figure 6 report, respectively, the share of energy use and natural gas use over total energy consumption by 2-digit sector. In all cases, we report both 'weighted' (by energy use and sampling weights) and 'not weighted' (weighted by sampling weights only) energy mixes: the former accounts for the fact that few establishments consume a large share of total energy, while the latter does not weight for total energy consumption (see Davis at al., 2013, for a discussion on the role of weighting in evaluating energy-related measures). In the 'weighted' energy mix we observe that the three energy sources contribute more or less equally to total energy consumption in the beginning of the period, with a continuous increase in 'other sources' (oil, coal and steam) especially from 2003 onwards. In the 'unweighted' figure we observe that the share of electricity is predominant (around 60%) and slightly increasing in time, while the share of 'other sources' is very small. The large differences in energy mix between the 'weighted' and 'unweighted' versions depends on the fact that 'other sources' are predominant in some specific sectors (e.g. NACE 24 "Manufacture of basic metals") that are characterized by few big establishments with very big energy intensity of production and that use a large share of 'other sources'. As our focus in the rest of the paper is on the labour component of establishments, it is interesting to note how changes in electricity (and natural gas) prices are more pervasive than changes in the prices of other fuels as for the majority of establishments electricity (and natural gas) represents the main fuel. According to Figure 5 and Figure 6 we observe a substantial heterogeneity of energy mix in different sectors, especially so when we look at 'weighted' figures. This is interesting as it results into heterogeneous exposure of different sectors to prices shocks of specific energy sources.

[Figure 4, Figure 5 and Figure 6 about here]

Figure 7 summarizes the trends of nominal energy prices for different energy sources: total energy use, electricity, natural gas and other sources (coal, oil, steam). Similarly to Davis et al. (2013), our measure of energy prices is simply computed as the ratio between total energy expenditure and total energy consumption and does not reflect explicitly differences in price schedules across establishments.[4]

Electricity is the most expensive energy source. However, the gap in price per kWh between electricity and other energy sources shrank between 1997 and 2010: one kWh of electricity was about four time as expensive than an kWh of natural gas in 1997 and less than two time as expensive in 2010. The price of other energy sources (coal, oil, steam) is in between the one of natural gas and the one of electricity and below average energy price. The price of electricity was declining until 2003, after which an increase is observed. For what concerns natural gas and other sources, the price was rather stable until 2004 after which a sharp increase is observed. Figure 8 shows the trends in energy prices (total and by source) and their distribution across different quartiles. It is evident as different energy sources are characterized by different degrees of heterogeneity in prices. The most spread appears to be electricity, with average prices in the fourth quartile of establishments being about 40 percent larger than average prices in the first

[4] In what follows, energy prices are always weighted by sampling weights only and not also by energy consumption.

quartile.[5] The difference between the fourth and first quartile is much smaller (but slightly increasing) for natural gas and other sources.

[Figure 7 and Figure 8 about here]

Linked to the previous point, it is worth further investigating what could be behind the dispersion in energy prices across establishments. This is particularly relevant for our purposes as this source of heterogeneity will be our main source of variation in our empirical analysis on the relationship between energy prices and labour demand. As a first step, we split energy prices by band of energy consumption (Table 2) as defined by Eurostat with the aim of evaluating the extent to which difference exists in prices paid by large or small industrial customers of energy. The trend of average prices by band is shown in Figure 9, Figure 10 and Figure 11 for total energy, electricity and gas respectively. On average, the discount of being an establishment in the band that consumes more energy with respect to the one with the lowest energy consumption was about 64 percent in 1997 that shrunk substantially to a minimum of about 47 percent in 2009. This reduction in the premium for large consumers of energy is mostly driven by the reduction in the premium for large consumers of electricity: the discount for establishments in the IG band with respect to the ones in the IA-IB-IC band was about 55 percent in 1997 to about 37 percent in 2010. This continuous reduction in the range of average electricity prices across different consumption bands was particularly fast from year 2005. The importance of electricity consumption as a driver of prices depends on both regulatory and technological features of the electricity production system and market, as stressed by Davis et al. (2013). Finally, natural gas shows a generally smaller premium for large consumers, which is also rather stable in time.

[Table 2, Figure 9, Figure 10 and Figure 11 about here]

If most of the heterogeneity in energy prices across establishments was explained by establishment size in terms of employees, that would not prove to be a relevant source of variation as large and small sized establishments are likely to be affected differently by other factors besides energy prices. To evaluate the overlap between size in terms of number of employees and in terms of energy consumption we show average size (number of employees) by year and band (electricity and natural gas) of energy use for our representative sample of French manufacturing establishments. (Table 3). For what concerns electricity, we observe a monotonic increase in establishment size when moving from low-consumption establishments to high consumption establishments for all years. However, when we look at simple the cross-sectional relationship between log of employees and log of electricity consumption, we estimate a correlation of 0.51, far from being a perfect match between employment and energy consumption. For what concerns natural gas, the relationship between size and consumption of natural gas is even weaker, with a correlation of about 0.39 percent.

[Table 3 about here]

[5] Davis et al. (2013) provide a comprehensive assessment of the dispersion of electricity prices across manufacturing establishments for the US. A large degree of dispersion is documented due to a variety of factors, ranging from large consumption/price elasticity to technology and regulation related factors.

3.2 Drivers of energy prices

We now dig deeper in the evaluation of the drivers of energy prices by providing some descriptive evidence on the conditional cross-sectional correlations between energy prices, energy consumption and establishment size. As we already observed that differences in energy use is related to substantial differences in energy prices and that energy consumption and establishment size are positively correlated, we here provide some descriptive evidence on conditional correlations between energy prices, energy consumption and establishment size conditional on other observable characteristics. We estimate the following equation for each year of our period (1997-2010):

$$\log(Ener\_price_i) = \gamma Size_i + \theta Energy\_consumption_i + \delta_s + \xi_r + \varepsilon_i \qquad (1)$$

where $Size_i$ is either the log of employees or class size dummies, $Energy\_consumption_i$ is either the log of energy consumption or band dummies, δ_s are sector (s) dummies and ξ_r are region (r) dummies. In the equation for electricity prices in which we use continuous variables we also add a variable that measures (the log of) maximum subscribed electricity. Results for total energy prices and electricity prices are reported in Table 6, Table 7, Table 4 and Table 5.

[Table 4, Table 5, Table 6 and Table 7 about here]

Results in Table 4 show as the elasticity of energy prices to energy consumption is negative and decreasing in time, from about -0.185 in 1997 to about -0.126 in 2010. This estimated elasticity is quite substantial especially when we also consider the very wide range of variation of energy consumption across different establishments. Once controlling for energy consumption, the elasticity of energy prices to establishment size is very small in magnitude and not stable in sign: it is negative and significant in 1997, 1999, 2002, 2003 and 2004, not significant in 1998 and 2001 and positive and significant in 2000 and from 2005 to 2010. When looking at electricity prices (Table 5), we observe a substantially larger elasticity with respect to energy consumption than when considering total energy, in line with the descriptive evidence discussed in section 3.1. However, the decrease in elasticity between energy consumption and prices was larger for electricity than for total energy, from -0.264 in 1997 to -0.140 in 2010. This decrease is particularly rapid from 2005 onwards, possible reflecting changes in the regulation of the electricity market in response to EU-wide directives and changes in taxes on electricity occurred starting from 2003 and reinforced from 2005. It is important to recall that we are also conditioning on the log of subscribed electricity capacity, that is a very strong predictor of electricity prices. In this respect, we observe a positive and very strong relationship between prices and capacity. This relationship, however, collapses in magnitude starting from 2005 onwards. This big change also suggests a big change in the price schedule for electricity occurred from 2005 onwards. Finally, also for electricity the conditional elasticity of prices and establishment size in terms of number of employees is always small in magnitude and unstable in sign. It is generally negative before 2005 (with the only exception of 2000) and positive from 2006 onwards.

To highlight possible non-linearities and quantify more easily differences across establishments in energy prices we use energy consumption and size dummies instead of continuous variables (Table 6 and Table 7 for total energy and electricity, respectively). While the relationship between energy prices and establishment size and energy consumption remain always monotonic, a more flexible approach suggests that the relationship between these variable is far from being linear.

3.3 Effect of the CSPE and liberalization on electricity prices

One of the changes that occurred in the first half of the 2000s decade was the introduction of the CSPE tax (see section 2). In this section we aim at evaluating the impact of the CSPE tax on average gross electricity prices paid by French manufacturing establishments. Even though we cannot claim a causal relationship due to the way the tax was designed, we can still provide some hints on the impact of the tax on electricity prices. As a first step we directly estimate average gross electricity prices (in log) as a function of a variable that measures the share of actual CSPE contribution (thus also considering the plafond discussed in section 2) over total expenditure in electricity according to the following equation:

$$\log(Electr\_price_{it}) = \alpha_i + \tau_t + \beta \frac{CSPE_{it}}{Electr\_pric} + \mathrm{X'}_{it}\gamma + \varepsilon_{it} \qquad (2)$$

Results are reported in Table 8. We begin with a very simple specification (including only establishment fixed effects and year dummies, column 1) and we then add a series of different measures of electricity consumption with different degrees of flexibility to account for the fact that the plafond of the CSPE contribution depends on the amount of electricity that is actually bought and for the fact that the relative weight of the CSPE over electricity price may also be affected by . $CSPE_{it}$ is by construction equal to zero prior to 2003. We observe from column 1 that the increase of 10 percent in the average relative weight of the tax increases energy prices by less than 2 percent. This is already a quite remarkable result: in case of a full pass-through of the tax into higher prices the estimated β should have been equal to one, while it is substantially smaller than that. This fact suggests as EDF, the main producer of electricity in France, adjusted its price schedule (of net and gross prices) as a consequence of the introduction of the CSPE. When we add our set of variables of electricity consumption assuming a constant relationship with prices (column 2, 3, and 4 for linear, squared and dummies of electricity consumption, respectively) the estimated β is greater in magnitude and still significant. As expected, this means that conditional on the average discount granted to greater consumers of electricity, the impact of the tax on prices is greater than in the unconditional case. Finally, β shrinks substantially when we allow changes in time in the link between consumption and prices by interacting electricity consumption with year dummies. β finally turns out to be not significant when we also allow for time-varying flexible (squared or dummies) relationships between electricity consumption and prices. All in all, these results suggest that the CSPE tax did not affect prices directly possibly induced changes in the price schedule offered to industrial customers.

[Table 8 about here]

In a second step we estimate a sort of difference-in-differences regression: we interact a 'post 2003' dummy (or dummies) with two different measures of electricity consumption (initial level - in log - and initial band dummies) to evaluate how the CSPE tax as well as other reforms to the electricity market occurred from 2003 onwards influenced different categories of consumers of electricity:

$$\log(Electr\_price_{it}) = \beta Electr\_cons_{i0} \times Post2003_t + \gamma_s Trend_t + \eta_s Trend_t \times Post2003_t + \theta_r Trend_t + \phi_r Trend_t \times Post2003_t + \alpha_i + \tau_t + \varepsilon_{it} \quad (3)$$

In all regressions we also allow for different linear trends (pre and post 2003) for different regions (r) and sectors (s). Results are reported in Table 9. In the first column we report results in which we use as set of dummies for the initial electricity consumption band as a measure of electricity consumption. Evidence shows that electricity prices grew systematically more in 'higher' bands than in 'lower' bands. More specifically, while for band ID the increase in price post-2003 with respect to band IA-IB-IC was 6.3 log points, the increase for band IG was 24 log points. In columns 2 and 3 we employ continuous measures of electricity consumption: on average, prices grew by 0.387 percent for 10 percent greater electricity consumption (column 2) and that increase was more than proportional in terms of energy consumption (both linear and quadratic terms are positive). Finally, in column 4 we evaluate the time profile of the increase for larger consumers of electricity. The increase was not significant in 2003 but it increased quite substantially starting from to 2004, up to a 0.6 percent increase in electricity prices for a 10 percent difference in the initial level of electricity consumption.[6]

[Table 9 about here]

All these results confirm what we observed in Figure 10: after the tax was introduced and reforms were put in place, the average gross electricity prices of bigger consumers of electricity grew more than the one of smaller consumers.

3.4 Workforce composition

As a last piece of descriptive analysis we look at how the composition of the workforce evolved in our period of analysis for establishments lying at different position in the distribution of energy prices. In Figure 12 we report the aggregate average share of employees in different macro-occupations (partialled out by 3-digit industry dummies and establishment size – in log of employees)[7] for establishments in different quartiles of the distribution of energy prices.

[Figure 12 about here]

On average, we observe an increase in the share of employees in non-routine technical occupations, from about 9 percent in 1997 to about 16 percent in 2010. Differences across quartiles of energy prices have increased in the period under investigation, with establishments with greater energy prices having a relatively larger share of non-routine 'technical' employment which also experienced a systematically faster growth when compared to establishments with smaller energy prices. Evidence is less stable for

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[6] To check whether this trend was present even before 2003, we do a sort of 'placebo test' by looking at possible departure from previous trends in years 2001 and 2002 (see Table 18 in Appendix 2). Results suggest that the increase did not start before 2003.

[7] By controlling for size and sector we partly shut down compositional effects. The figure, in fact, should be interpreted as workforce composition for a given industry structure and establishment size.

managerial occupations: the share of employees in these occupations was generally greater in establishments with higher energy prices, but differences seemed to shrink in time. For what concerns routine cognitive occupations, while the aggregate trend was stable up to 2008 and growing in 2009-2010, no clear difference is visible between establishments with low, medium or high energy prices. Finally, the share of manual workers decreased sharply and the difference between establishments with low energy price (and high share of manual workers) and establishments with high energy prices (and low share of manual workers) widened.

4 Impact of energy prices on employment

We now proceed with the discussion of our empirical strategy and results about the role played by energy prices in within-establishment driving labour demand and workforce composition for French manufacturing establishments.

4.1 Empirical strategy

Our empirical analysis aims at investigating the employment effects of energy prices for a panel of French manufacturing establishments. We estimate the following equation:

$$\log(Empl_{it}) = \beta \log(Ener\_price_{it}) + \mathrm{X'}_{\mathrm{it}}\gamma + \epsilon_{it} \tag{4}$$

in which $\log(Empl_{it})$ represents the logarithm of total employment of establishment *i* in year *t*, $\log(Ener\_price_{it})$ is the logarithm of average energy price (euro per kilowatt) of establishment *i* in year *t*, $\mathrm{X'}_{\mathrm{it}}$ is a set of control variables and ϵ_{it} is the error term. We assume the error term to be composed by a unobservable fixed effect that is time invariant and establishment-specific (η_i) and by a idiosyncratic component (θ_{it}). The establishment fixed effects (η_i) accounts for time-invariant unobserved heterogeneity across establishments. In our base specification $\mathrm{X'}_{\mathrm{it}}$ includes year-industry (3-digit NACE) dummies and year-region (NUTS2) dummies. The former may account, for example, for changes in energy prices for fuels that are used more intensively in specific sectors that are likely to influence both energy prices and employment of establishments in these sectors or for aggregate demand or supply shocks that influence both energy prices and labour demand. The latter account for unobservable region-specific shocks, also coming from either supply (e.g. changes in wages specific to the region) or demand.

In a second specification we condition employment demand on a proxy of establishment-level production.[8] Conditioning on output allows to account, at least partly, for the likely negative impact exerted by energy prices on overall production.

If the assumption of correlation between θ_{it} and our regressors is satisfied, $\hat{\beta}$ represents the cross elasticity of employment demand with respect to energy prices. This parameter

[8] In absence of establishment-specific production or turnover, we use company-level turnover (in logarithm) attribute to the establishment according to its employment share over total company employment. Company-level employment is retrieved from income-statement information for the population of French firm in FARE-FICUS.

is a very useful number as it is directly interpretable as the potential impact of a energy tax (or a pollution tax) on job creation and workforce composition.

In addition to estimating the relationship between energy prices and total employment, our main contribution consists providing evidence on the extent to which energy prices influence the demand of different categories of employees.

As our panel of establishment is unbalanced, we only retain those establishments that are included in the EACEI survey at least three times in the period 1997-2010. Differences between establishments included in the panel and the ones that remain outside the panel are discussed in Appendix 1.

4.2 Endogeneity issues

Endogeneity is a concern in our framework for at least two reasons. First, if establishments are hit by a unobserved negative demand shock (beyond regional- and sectoral-level shocks that are already partialled out with region and industry year dummies), they will reduced the demand for employment. At the same time, however, also (and even more so) the demand for energy will be reduced. In presence of contracts for energy supply (especially so for electricity and gas) that were signed before the demand shock was observed, a lower than expected demand for energy will result in observed average energy prices that are greater than expected at *t-1*. As the unobservable (omitted) shock is positively correlated with energy prices and negatively correlated with labour demand, we expect a downward bias in $\hat{\beta}$ if we fail to account for the endogeneity of energy prices.

A second reason of concern is related to the way different establishments perceive exogenous changes in source-specific energy prices. If we use year-specific energy mix to weight ‘exogenous’ energy prices, that would also incorporate changes in energy mix driven by exogenous changes in relative source-specific energy prices. This change is likely jointly determined with possible changes in the demand for labour input, thus contributing to biasing the estimated $\hat{\beta}$.

A way to deal with this endogeneity issue is to identify an instrumental variable that is correlated to the exogenous variation in energy prices and unrelated to establishment-specific demand and supply shocks. As we already discussed, the CSPE tax introduced in 2003 and other reforms in the electricity market provoked a substantial change in the electricity price schedule across different bands of electricity consumption starting from 2003 onwards. Band-specific electricity prices are clearly unrelated to establishment-specific demand shock while they are expected to be positively correlated with establishment-specific electricity prices. As also prices for natural gas prices are characterized by substantial differences in prices (and trends) across consumption bands, though less than electricity, we adopt a similar approach for natural gas prices. Other sources of fuel, due to their specific features (e.g. oil and coal are easier to be stocked), tend to respond more to 'global' prices rather than to other contingencies (e.g. seasonality, peak-hours, congestion of the distribution network, etc.). For these fuels we use average prices for French manufacturing firms for each year.

We combine the prices of different fuels into a single IV by weighting each price (band-specific for gas and electricity, using the ‘initial’ time-invariant band for each establishment, and 'national' for oil, steam and coal) by the energy mix we observe in the first year the establishment enters the EACEI survey. In fact, as discussed above, if we used year-specific establishment-specific energy mix we would also consider changes in energy mix occurred in response to changes in the price of different fuels.

4.3 Results

Baseline results are reported in Table 10. In the first panel we report results for total employment. In the first column we report the results for the fixed effect model, in which we observe a significant and negative impact of energy prices on the demand of employment, with a cross-price point elasticity of -0.125. When we turn to our preferred specification (second column) in which we account for the endogeneity of energy prices, the estimated point elasticity is -0.266, significantly larger (slightly more than double) than in the specification of the first column. As expected, the $\hat{\beta}$ estimated in fixed effect model is downward biased. The instrument is also very strong, as highlighted by high value of the F test on the excluded IV from the first stage (see Table 11). This means that a 10 percent increase in energy prices would reduce labour demand by about 2.66 percent.

[Table 10 and Table 11 about here]

When we move to the specification in which we condition the effect of energy prices on a proxy of establishment output, our estimates suggest much smaller (though still negative and significant) cross elasticity of labour with respect to energy prices, while labour demand is positively related to output. Again, the fixed effect estimate of $\hat{\beta}$ (third column) is downward biased with respect to the specification in which we account for the endogeneity of energy prices (fourth column). This latter result means that conditional on the same output, a 10 percent increase in energy price results in a reduction in labour demand of about 1.65 percent. Looking at the workforce composition, results suggest that the reaction of the demand for labour in non-routine occupations to changes in prices is negative but much smaller in absolute terms than for total labour when we do not condition on output, while nor substitution or complementarity exists when conditioning on output. When we split non-routine occupations into 'technical' and 'managerial' occupations, results suggest that complementarity exists between energy and labour demand in managerial occupations (that also show very little responses to output) while a smaller than average substitution still exists for technical occupations. Routine cognitive occupations (i.e. white collars) show results that are in line with the aggregate evidence while for routine manual occupations a generally lower than average degree of sensitiveness to energy prices is estimated.

We then move to apply our approach to the sub-sample of establishments that operate in energy intensive industries.[9] This is particularly relevant as energy represents a much greater component of total costs than for establishments in other sectors. Results are reported in Table 12 (first stage regressions are reported in Table 13). For what concerns total employment, the absolute value of estimated cross-elasticity is systematically and statistically greater for establishments in energy-intensive sectors

[9] Energy-intensive 3-digit (NACE rev 2) industries have been selected as the ones for which the average energy intensity (total energy consumption per employee) over the considered period was above median. Energy intensive establishments operate in the following 3-digit (NACE rev 2) industries: 141, 142, 143, 151, 152, 161, 162, 171, 172, 201, 202, 203, 204, 205, 206, 221, 222, 231, 232, 233, 234, 235, 236, 237, 239, 241, 242, 243, 244, 245.

than for the aggregate sample, with an unconditional cross-elasticity of about -0.317 and a conditional cross-elasticity of about -0.219. Results for employees in different occupations are in line with aggregate results in terms of direction, significance and magnitude of the effects.

[Table 12 and Table 13 about here]

5 Conclusions

Our paper provides evidence on the link between energy prices and job creation and workforce composition on a panel of French manufacturing establishments. After discussing the features of French manufacturing establishments in terms of energy use and energy prices we build an empirical framework that is suited to deal with potential endogeneity of energy prices and estimate their impact on jobs. Our instrumental variable approach exploits substantial exogenous changes in the regulatory framework in French energy markets occurred in the period we are considering.

Results suggest a generally negative relationship between energy prices and job creation. This relationship is particularly large for manual (blue collar) occupations while a positive relationship exists with managerial occupations. All in all, results suggest that higher energy prices generate a substantial change in the composition of the workforce, favouring non-routine occupations (managerial and technical) at the expenses of manual occupations. This result is particularly useful to inform policy maker on the likely impact of environmental policies that result in greater energy prices on the labour market.

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Tables and figures

Figure 1 – Discount on industrial electricity prices of France by energy consumption band in 2010 (including non-recoverable taxes and levies, own elaboration on Eurostat data)

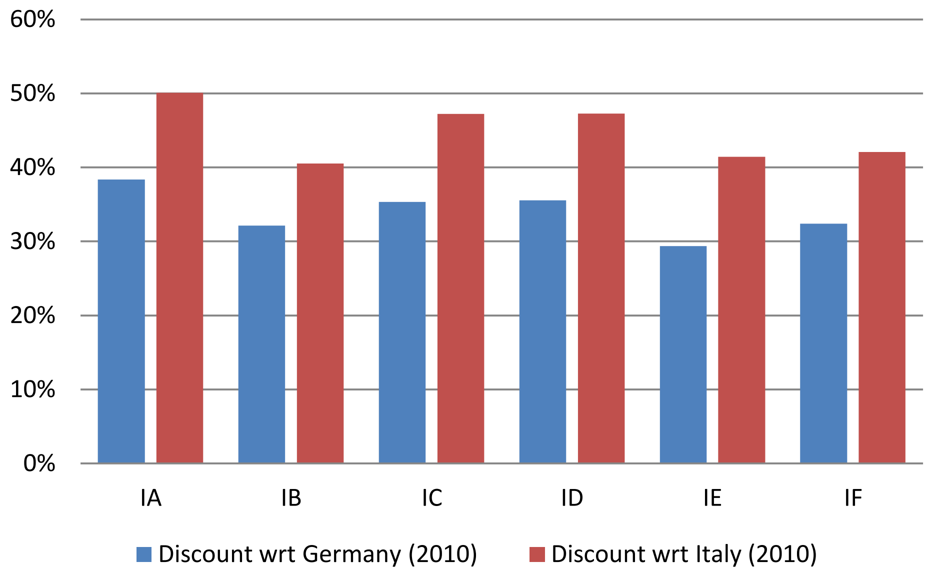


Figure 2 – Regulation in the electricity sector (Sector regulation index by OECD)

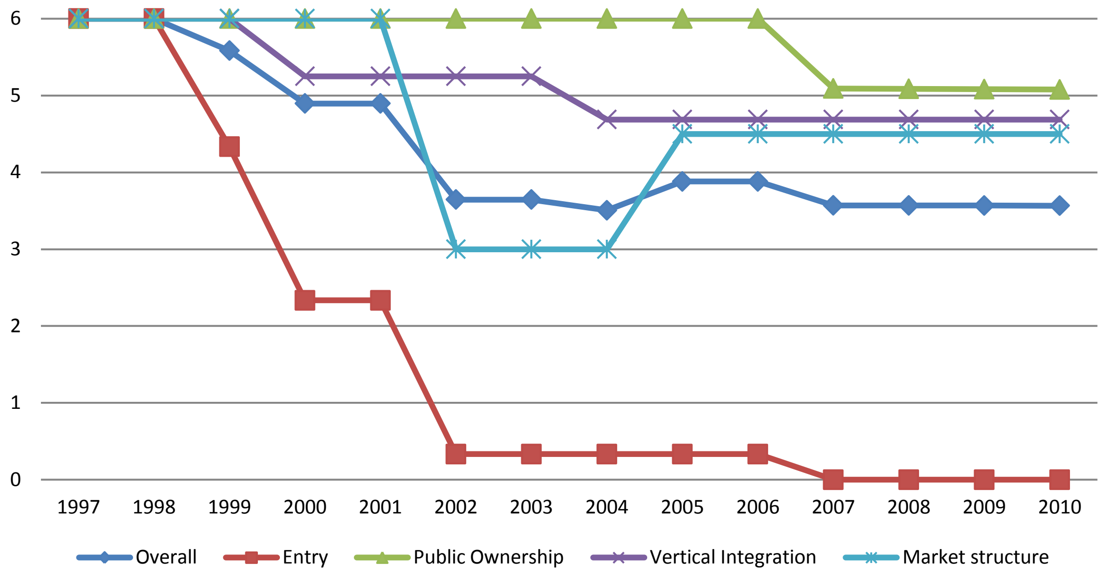


Figure 3 – Regulation in the gas sector (Sector regulation index by OECD)

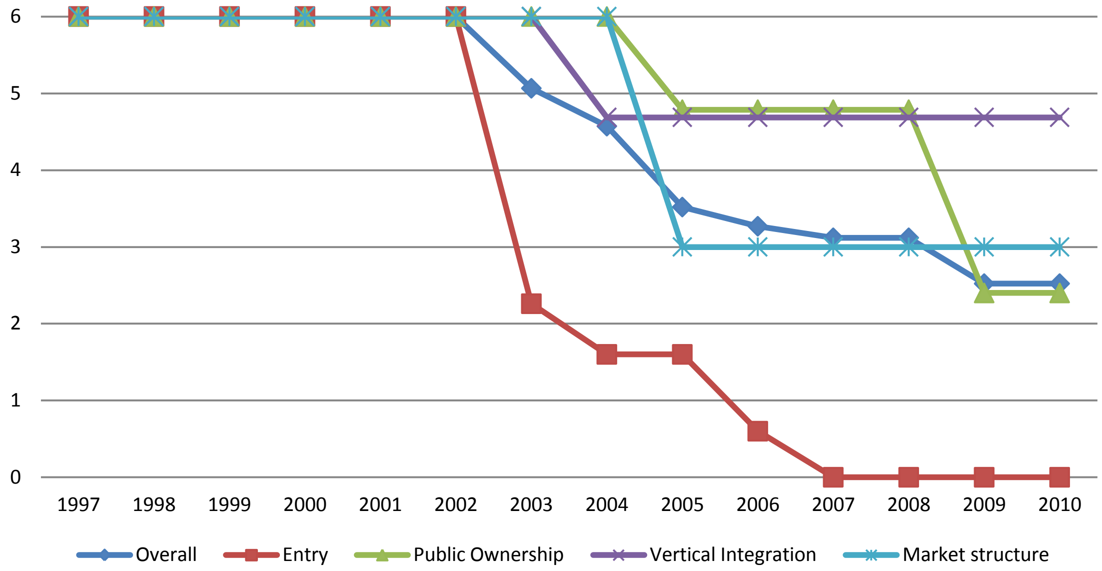
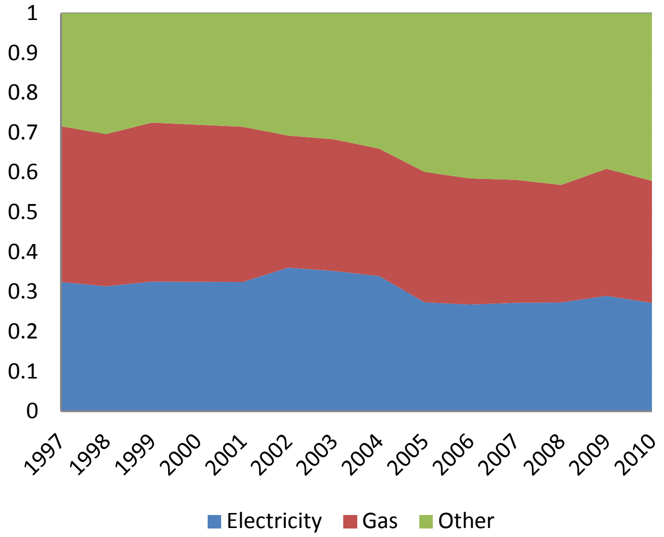


Table 1 - Classification of employees by occupation in DADS (*Professions et Catégories Socioprofessionnelless*, PCS)

PCS code (2-digit)	PCS code (1-digit)	Description (in French)	Group
21	20	Chefs d'entreprises artisanales	Non-routine 'managerial'
22	20	Chefs d'entreprises industrielles ou commerciales de moins de 10 salariés	
23	20	Chefs d'entreprises industrielles ou commerciales de 10 salariés et plus	
31	30	Professionnels de la santé et avocats	Non-routine 'technical'
33	30	Cadres de la Fonction Publique	
34	30	Professeurs, professions scientifiques	
35	30	Professions de l'information, des arts et des spectacles	
37	30	Cadres administratifs et commerciaux d'entreprises	
38	30	Ingénieurs et cadres techniques d'entreprises	
42	40	Instituteurs et assimilés	Routine cognitive
43	40	Professions intermédiaires de la santé et du travail social	
44	40	Clergé, religieux	
45	40	Professions intermédiaires administratives de la Fonction Publique	
46	40	Professions intermédiaires administratives et commerciales des entreprises	
47	40	Techniciens	
48	40	Contremaîtres, agents de maîtrise	
52	50	Employés civils et agents de service de la Fonction Publique	
53	50	Agents de surveillance	
54	50	Employés administratifs d'entreprises	
55	50	Employés de commerce	
56	50	Personnels des services directs aux particuliers	
62	60	Ouvriers qualifiés de type industriel	Routine manual
63	60	Ouvriers qualifiés de type artisanal	
64	60	Chauffeurs	
65	60	Ouvriers qualifiés de la manutention, du magasinage et du transport	
67	60	Ouvriers non qualifiés de type industriel	
68	60	Ouvriers non qualifiés de type artisanal	
69	60	Ouvriers agricoles	

Figure 4 – Energy mix of French establishments

Weighted by energy use



Not weighted by energy use

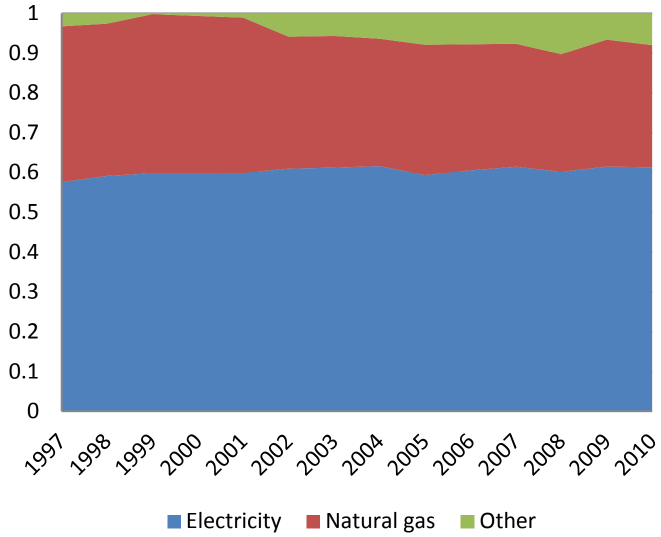
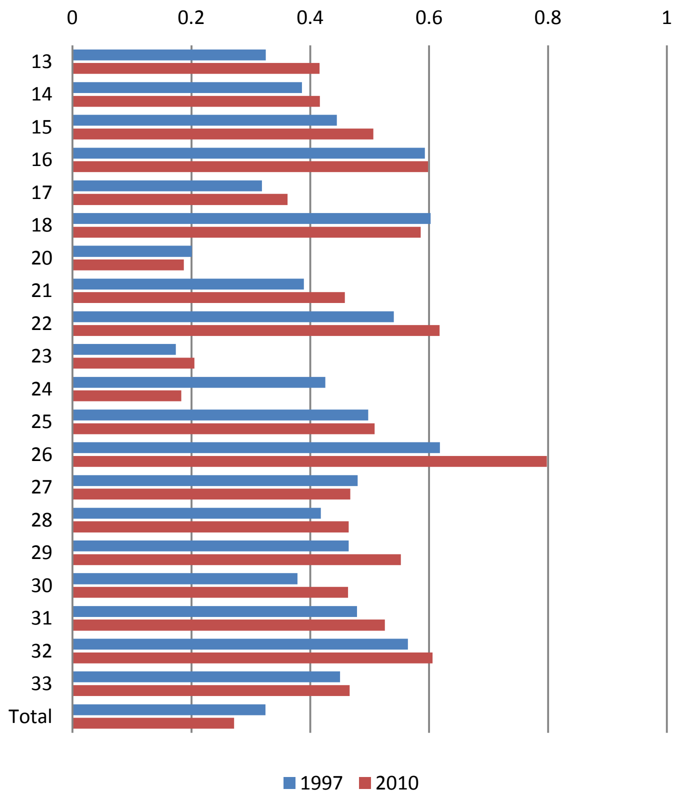


Figure 5 – Share of electricity consumption over total energy use of French establishments (by industry, NACE rev 2)

Weighted by energy use



Not weighted by energy use

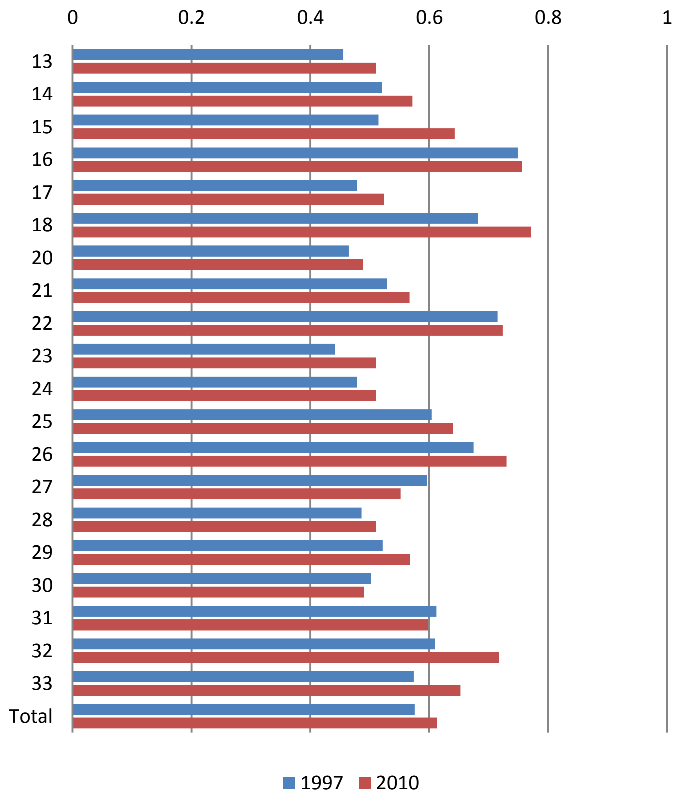


Figure 6 – Share of natural gas consumption over total energy use of French establishments (by industry, NACE rev 2)

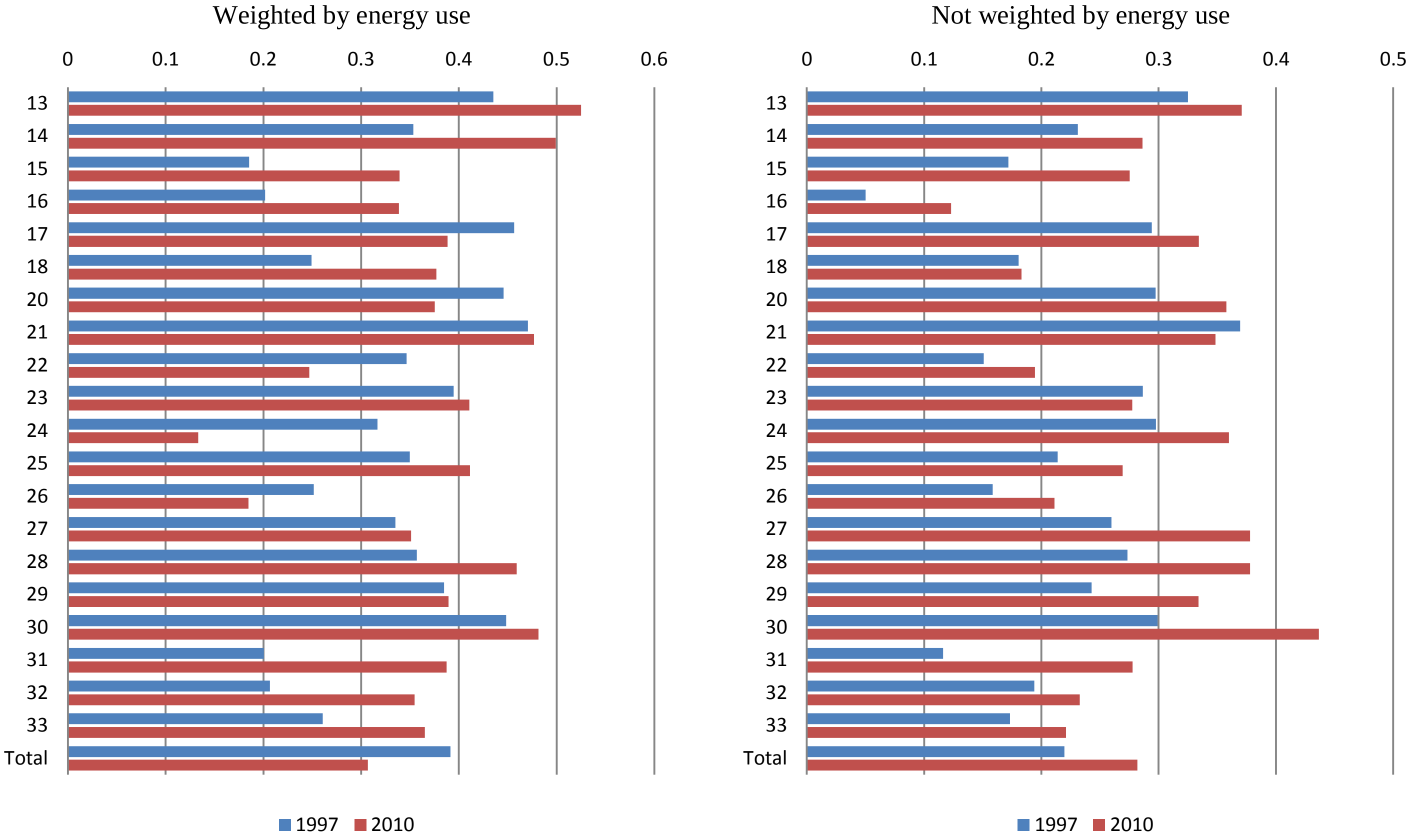


Figure 7 – Energy prices (€/kw)

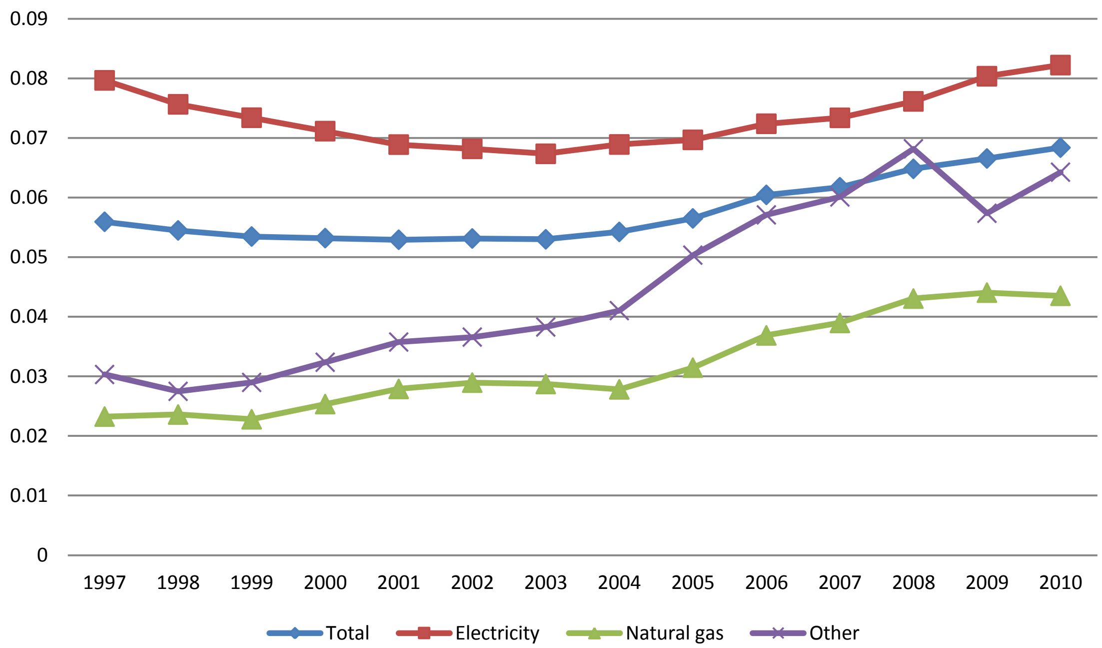


Figure 8 – Energy prices by energy sources (€/kw)

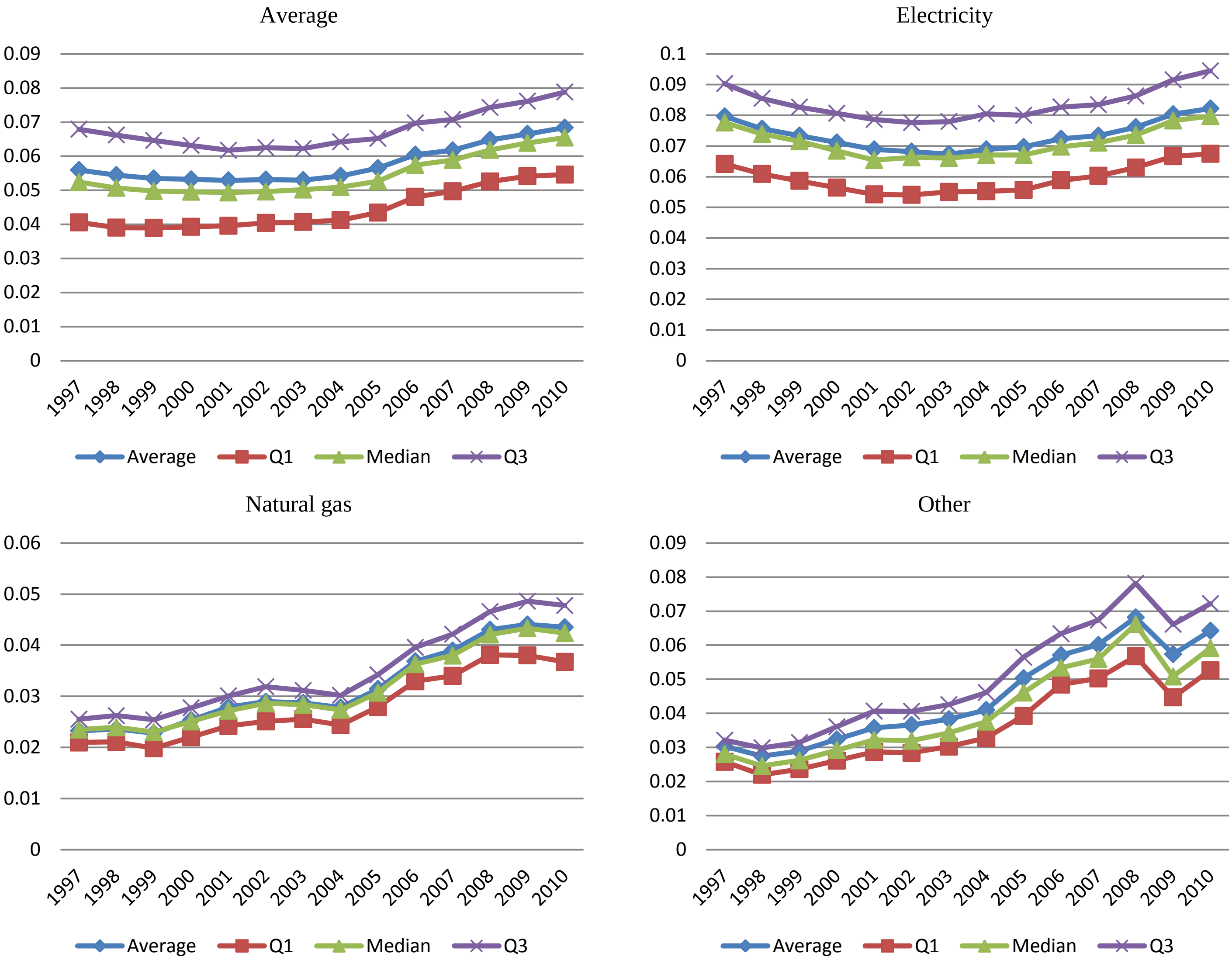


Table 2 – Definition of energy consumption bands (source: Eurostat)

Branche name	Range of annual energy consumption
IA-IB-IC	0-2,000 MWh / year
ID	2,001-20,000 MWh / year
IE	20,001-70,000 MWh / year
IF	70,001-150,000 MWh / year
IG	150,000+ MWh / year

Figure 9 - Trends in energy prices by band of energy consumption

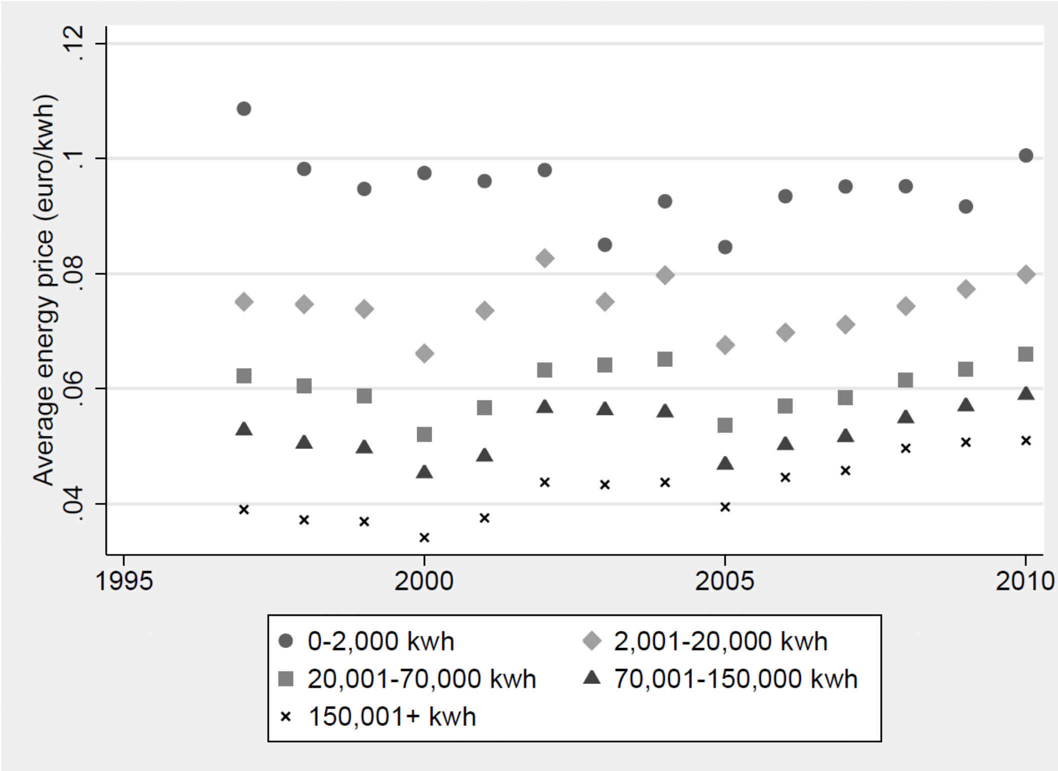


Figure 10 - Trends in electricity prices by band of electricity consumption

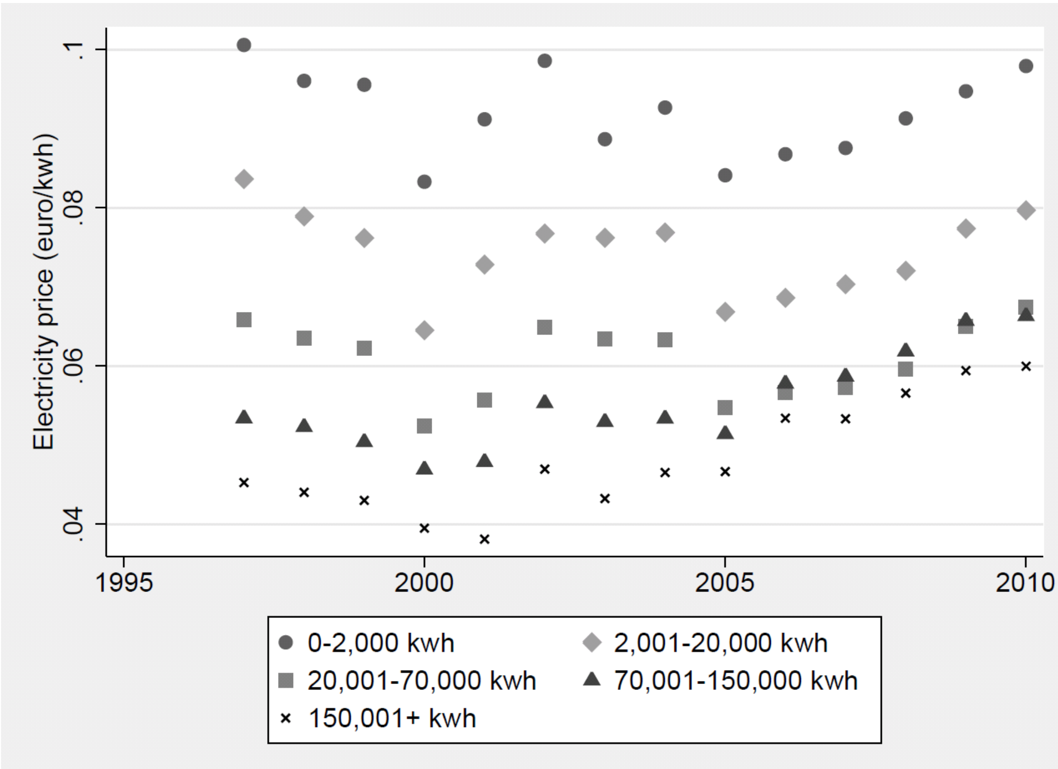


Figure 11 - Trends in gas prices by band of electricity consumption

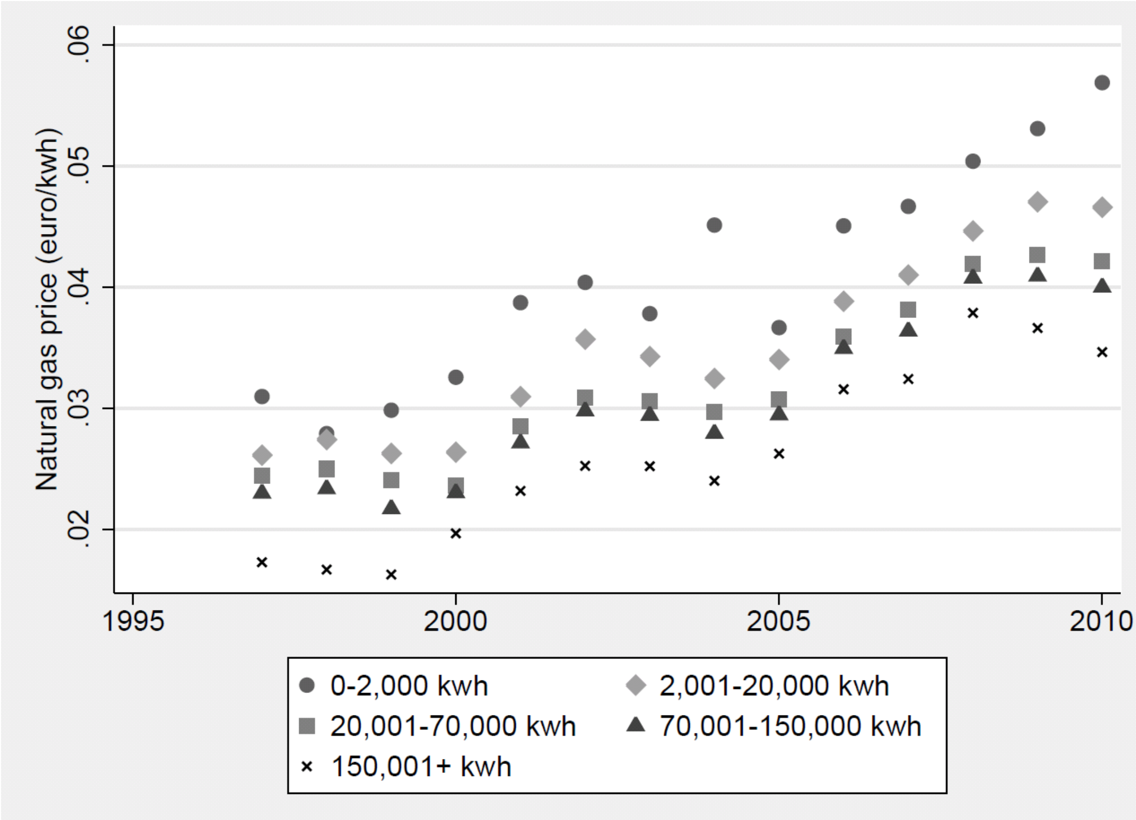


Table 3 - Average size (number of employees) by band of electricity and natural gas energy consumption

	IA-IB-IC	ID	IE	IF	IG	Total
			Electricity			
1997	59.8	102	203	372.29	617.9	186
1998	54.33	98	198	359.16	579.56	178
1999	56.8	99	197	360.95	578.21	180
2000	97.65	158	245	368.13	587.51	268
2001	65.13	111	200	330.46	589.8	199
2002	64.97	115	207	328.3	552.52	236
2003	47.13	98	193	319.33	534.75	223
2004	63.98	108	193	311.6	512.14	215
2005	45.44	100	203	348.27	560.22	192
2006	48.25	94	192	314.04	548.51	167
2007	47	92	193	312.15	557.86	164
2008	46.8	94	197	317.43	546.78	173
2009	43.69	93	198	315.32	551.2	170
2010	41.1	90	188	305.81	528.27	165
Total	50.5	100.57	199.65	330.45	556.86	189.1
			Natural gas			
1997	119	117.49	146.63	225.86	384	186
1998	113	105.05	150.87	213.48	363	178
1999	117	101.88	153.36	213.24	366	180
2000	194	161.62	221.98	273.11	412	268
2001	127	120.36	168.27	234.19	376	199
2002	147	132.4	192.65	253.63	387	236
2003	131	118.15	173.7	233.52	379	223
2004	132	122.88	171.99	228.31	360	215
2005	114	93.24	165.84	236.76	369	192
2006	103	89	153	205.1	348	167
2007	99	89	152	214.02	351	164
2008	106	87	156	207.3	352	173
2009	102	85	156	197.14	356	170
2010	104	79	141	185.64	347	165
Total	118.04	99.43	161.43	219.89	366.93	189.1

Table 4 - Drivers of establishment-specific energy prices (continuous variables)

	1997	1998	1999	2000	2001	2002	2003
log(energy cons)	-0.185***	-0.195***	-0.186***	-0.170***	-0.171***	-0.162***	-0.153***
	(0.00351)	(0.00343)	(0.00329)	(0.00265)	(0.00289)	(0.00448)	(0.00312)
log(empl)	-0.0133***	-0.00405	-0.0110**	0.0463***	-0.00162	-0.0546***	-0.0334***
	(0.00456)	(0.00423)	(0.00505)	(0.00452)	(0.00357)	(0.00589)	(0.00428)
R squared	0.496	0.520	0.514	0.678	0.535	0.564	0.586
N	11363	11634	11475	5319	9941	6694	6508
	2004	2005	2006	2007	2008	2009	2010
log(energy cons)	-0.159***	-0.146***	-0.134***	-0.132***	-0.124***	-0.121***	-0.126***
	(0.00373)	(0.00372)	(0.00291)	(0.00252)	(0.00291)	(0.00326)	(0.00279)
log(empl)	-0.0339***	0.0577***	0.0560***	0.0551***	0.0570***	0.0506***	0.0510***
	(0.00485)	(0.00653)	(0.00487)	(0.00434)	(0.00458)	(0.00586)	(0.00437)
R squared	0.566	0.520	0.535	0.541	0.519	0.477	0.481
N	7214	6878	9502	9832	8216	8349	8657

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Other control variables: 2-digit industry dummies, department dummies

Table 5 - Drivers of establishment-specific electricity prices (continuous variables)

	1997	1998	1999	2000	2001	2002	2003
log(electr cons)	-0.264***	-0.259***	-0.257***	-0.219***	-0.221***	-0.259***	-0.219***
	(0.00801)	(0.00870)	(0.00765)	(0.0108)	(0.00742)	(0.0135)	(0.00906)
log(empl)	-0.0267***	-0.0191***	-0.0238***	0.00875***	-0.0276***	-0.0435***	-0.0422***
	(0.00370)	(0.00331)	(0.00334)	(0.00318)	(0.00324)	(0.00446)	(0.00386)
log(capacity electr)	0.203***	0.194***	0.195***	0.116***	0.127***	0.179***	0.143***
	(0.00943)	(0.0105)	(0.00901)	(0.0133)	(0.00904)	(0.0163)	(0.0112)
R squared	0.529	0.545	0.534	0.657	0.514	0.598	0.599
N	11351	11630	11466	5308	9935	6689	6511
	2004	2005	2006	2007	2008	2009	2010
log(electr cons)	-0.221***	-0.136***	-0.150***	-0.159***	-0.164***	-0.136***	-0.140***
	(0.0101)	(0.00735)	(0.00713)	(0.00628)	(0.00796)	(0.00765)	(0.00718)
log(empl)	-0.0344***	0.00809	0.0128***	0.0207***	0.0193***	0.00690	0.0166***
	(0.00514)	(0.00517)	(0.00398)	(0.00361)	(0.00456)	(0.00454)	(0.00421)
log(capacity electr)	0.145***	0.0387***	0.0707***	0.0771***	0.0877***	0.0657***	0.0667***
	(0.0135)	(0.00774)	(0.00919)	(0.00800)	(0.00950)	(0.00955)	(0.00888)
R squared	0.567	0.527	0.500	0.530	0.514	0.437	0.395
N	7212	6030	8368	9122	7716	7765	7909

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Other control variables: 2-digit industry dummies, department dummies

Table 6 - Drivers of establishment-specific energy prices

	1997	1998	1999	2000	2001	2002	2003
Band IA-IB-IC	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
Band ID	-0.347***	-0.252***	-0.221***	-0.438***	-0.277***	-0.437***	-0.174**
	(0.0495)	(0.0511)	(0.0542)	(0.129)	(0.0629)	(0.0998)	(0.0689)
Band IE	-0.547***	-0.472***	-0.443***	-0.703***	-0.533***	-0.732***	-0.365***
	(0.0486)	(0.0503)	(0.0538)	(0.129)	(0.0624)	(0.0982)	(0.0684)
Band IF	-0.705***	-0.644***	-0.604***	-0.839***	-0.667***	-0.867***	-0.488***
	(0.0486)	(0.0506)	(0.0540)	(0.129)	(0.0626)	(0.0982)	(0.0686)
Band IG	-0.952***	-0.897***	-0.840***	-1.055***	-0.882***	-1.098***	-0.693***
	(0.0492)	(0.0511)	(0.0545)	(0.129)	(0.0628)	(0.0982)	(0.0685)
0-49 employees	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
50-99 employees	-0.0924***	-0.0797***	-0.0842***	-0.0155	-0.0471***	-0.0781***	-0.0603***
	(0.00958)	(0.00992)	(0.00910)	(0.0143)	(0.00810)	(0.0129)	(0.0110)
100-249 employees	-0.156***	-0.153***	-0.158***	0.0216*	-0.0991***	-0.181***	-0.167***
	(0.00938)	(0.00943)	(0.00914)	(0.0115)	(0.00734)	(0.0119)	(0.00998)
250-499 employees	-0.142***	-0.128***	-0.128***	0.0434***	-0.0859***	-0.224***	-0.200***
	(0.0136)	(0.0145)	(0.0141)	(0.0135)	(0.0110)	(0.0139)	(0.0134)
500+ employees	-0.205***	-0.197***	-0.189***	-0.0274*	-0.152***	-0.340***	-0.316***
	(0.0180)	(0.0186)	(0.0178)	(0.0160)	(0.0144)	(0.0169)	(0.0150)
R squared	0.442	0.454	0.450	0.533	0.452	0.494	0.503
N	11962	12115	12097	5681	10596	6876	6673
	2004	2005	2006	2007	2008	2009	2010
Band IA-IB-IC	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
Band ID	-0.162*	-0.231***	-0.287***	-0.291***	-0.258***	-0.152***	-0.205***
	(0.0981)	(0.0335)	(0.0334)	(0.0300)	(0.0283)	(0.0404)	(0.0343)
Band IE	-0.403***	-0.453***	-0.490***	-0.485***	-0.445***	-0.339***	-0.370***
	(0.0975)	(0.0342)	(0.0338)	(0.0300)	(0.0283)	(0.0403)	(0.0342)
Band IF	-0.556***	-0.596***	-0.621***	-0.616***	-0.563***	-0.449***	-0.484***
	(0.0974)	(0.0351)	(0.0347)	(0.0304)	(0.0287)	(0.0410)	(0.0347)
Band IG	-0.743***	-0.782***	-0.754***	-0.752***	-0.677***	-0.573***	-0.639***
	(0.0973)	(0.0354)	(0.0345)	(0.0308)	(0.0289)	(0.0409)	(0.0351)
0-49 employees	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
50-99 employees	-0.0719***	0.0259*	0.0217**	0.0137	0.0165*	0.000776	-0.00575
	(0.0109)	(0.0149)	(0.00869)	(0.00850)	(0.00858)	(0.00862)	(0.00897)
100-249 employees	-0.177***	0.0565***	0.0408***	0.0394***	0.0311***	0.0210**	0.0230**
	(0.0101)	(0.0123)	(0.00878)	(0.00773)	(0.00880)	(0.00858)	(0.00896)
250-499 employees	-0.199***	0.0876***	0.0684***	0.0660***	0.0570***	0.0480***	0.0499***
	(0.0127)	(0.0151)	(0.0123)	(0.0109)	(0.0112)	(0.0118)	(0.0119)
500+ employees	-0.282***	0.0478***	0.0677***	0.0693***	0.0697***	0.0770***	0.0697***
	(0.0151)	(0.0179)	(0.0156)	(0.0141)	(0.0144)	(0.0154)	(0.0153)
R squared	0.499	0.446	0.457	0.459	0.434	0.402	0.402
N	7390	6913	9558	9957	8299	8526	8888

Dependent variable: logarithm of average energy prices. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Other control variables: 2-digit industry dummies, department dummies

Table 7 - Drivers of establishment-specific electricity prices

	1997	1998	1999	2000	2001	2002	2003
Band IA-IB-IC	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
Band ID	-0.164***	-0.177***	-0.194***	-0.249***	-0.193***	-0.242***	-0.160***
	(0.0109)	(0.0106)	(0.0108)	(0.0149)	(0.0128)	(0.0263)	(0.0235)
Band IE	-0.345***	-0.343***	-0.348***	-0.427***	-0.393***	-0.411***	-0.306***
	(0.0125)	(0.0125)	(0.0132)	(0.0155)	(0.0135)	(0.0273)	(0.0243)
Band IF	-0.465***	-0.441***	-0.451***	-0.531***	-0.516***	-0.543***	-0.447***
	(0.0223)	(0.0158)	(0.0149)	(0.0159)	(0.0156)	(0.0331)	(0.0256)
Band IG	-0.585***	-0.567***	-0.579***	-0.698***	-0.706***	-0.664***	-0.581***
	(0.0158)	(0.0149)	(0.0153)	(0.0167)	(0.0166)	(0.0308)	(0.0254)
0-49 employees	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
50-99 employees	-0.0930***	-0.0962***	-0.0930***	-0.0136	-0.0774***	-0.0855***	-0.0795***
	(0.00831)	(0.00731)	(0.00714)	(0.0102)	(0.00714)	(0.0107)	(0.00865)
100-249 employees	-0.175***	-0.171***	-0.166***	-0.0156*	-0.141***	-0.194***	-0.169***
	(0.00671)	(0.00658)	(0.00637)	(0.00811)	(0.00598)	(0.00999)	(0.00778)
250-499 employees	-0.173***	-0.176***	-0.172***	-0.00626	-0.137***	-0.245***	-0.178***
	(0.00955)	(0.00954)	(0.00907)	(0.00940)	(0.00817)	(0.0114)	(0.0106)
500+ employees	-0.186***	-0.193***	-0.182***	-0.0193*	-0.149***	-0.299***	-0.265***
	(0.0147)	(0.0129)	(0.0122)	(0.0113)	(0.0118)	(0.0153)	(0.0116)
R squared	0.404	0.407	0.402	0.549	0.425	0.497	0.534
N	11950	12110	12088	5671	10590	6871	6676
	2004	2005	2006	2007	2008	2009	2010
Band IA-IB-IC	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
Band ID	-0.173***	-0.197***	-0.215***	-0.196***	-0.214***	-0.171***	-0.179***
	(0.0239)	(0.0114)	(0.00889)	(0.00868)	(0.01000)	(0.00894)	(0.0101)
Band IE	-0.333***	-0.363***	-0.375***	-0.368***	-0.378***	-0.305***	-0.311***
	(0.0242)	(0.0127)	(0.0100)	(0.00994)	(0.0111)	(0.0101)	(0.0110)
Band IF	-0.442***	-0.425***	-0.352***	-0.338***	-0.340***	-0.282***	-0.320***
	(0.0260)	(0.0160)	(0.0139)	(0.0115)	(0.0130)	(0.0120)	(0.0128)
Band IG	-0.523***	-0.521***	-0.435***	-0.443***	-0.441***	-0.387***	-0.427***
	(0.0268)	(0.0156)	(0.0138)	(0.0126)	(0.0138)	(0.0133)	(0.0142)
0-49 employees	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
50-99 employees	-0.0915***	-0.0244**	-0.0164**	-0.0170**	-0.00925	-0.0277***	-0.0256***
	(0.00952)	(0.0105)	(0.00789)	(0.00763)	(0.00848)	(0.00714)	(0.00864)
100-249 employees	-0.180***	-0.0465***	-0.0380***	-0.0470***	-0.0306***	-0.0494***	-0.0350***
	(0.00818)	(0.00915)	(0.00763)	(0.00718)	(0.00821)	(0.00734)	(0.00808)
250-499 employees	-0.214***	-0.0387***	-0.0402***	-0.0397***	-0.0290***	-0.0603***	-0.0410***
	(0.0100)	(0.0112)	(0.0108)	(0.00980)	(0.0105)	(0.00972)	(0.0106)
500+ employees	-0.254***	-0.0438***	-0.0311**	-0.0230*	-0.00234	-0.0319**	0.00416
	(0.0134)	(0.0145)	(0.0151)	(0.0129)	(0.0140)	(0.0131)	(0.0138)
R squared	0.487	0.408	0.409	0.418	0.427	0.357	0.320
N	7389	6882	9552	9968	8307	8529	8887

Dependent variable: logarithm of average electricity prices. Robust standard errors in parenthesis. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Other control variables: 2-digit industry dummies, department dummies

Table 8 - Impact of CSPE tax on electricity prices

Dep var: log(electr price)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CSPE tax share of gross electricity price	0.172***	0.241***	0.247***	0.239***	0.112***	0.0217	-0.0271
	(0.00880)	(0.00810)	(0.00828)	(0.00797)	(0.0112)	(0.0197)	(0.0173)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
log(electr cons)	No	Yes	Yes	No	Yes	Yes	No
log(electr cons) squared	No	No	Yes	No	No	Yes	No
Band electr cons	No	No	No	Yes	No	No	Yes
log(electr cons) x year dummies	No	No	No	No	Yes	Yes	No
log(electr cons) squared x year dummies	No	No	No	No	No	Yes	No
Band electr cons x year dummies	No	No	No	No	No	No	Yes
N	125470	125470	125470	125470	125470	125470	125470

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01.

Table 9 - Impact of CSPE scheme on electricity prices

Dep: log(price electr)	(1)	(2)	(3)	(4)
Band ID x post 2003	0.0630***			
	(0.0128)			
Band IE x post 2003	0.107***			
	(0.0129)			
Band IFx post 2003	0.162***			
	(0.0134)			
Band IG x post 2003	0.240***			
	(0.0134)			
Initial log(electr cons) x post 2003		0.0387***	0.0199***	
		(0.00152)	(0.00832)	
Initial log(electr cons) squared x post 2003			0.00172**	
			(0.000691)	
Initial log(electr cons) x D2003				0.00346
				(0.00202)
Initial log(electr cons) x D2004				0.0144***
				(0.00207)
Initial log(electr cons) x D2005				0.0347***
				(0.00257)
Initial log(electr cons) x D2006				0.0519***
				(0.00233)
Initial log(electr cons) x D2007				0.0485***
				(0.00237)
Initial log(electr cons) x D2008				0.0547***
				(0.00252)
Initial log(electr cons) x D2009				0.0594***
				(0.00255)
Initial log(electr cons) x D2010				0.0555***
				(0.00271)
N	103718	103714	103714	103714

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Other control variables: year dummies, industry-specific linear trends (split pre- and post-2003), region-specific linear trends (split pre- and post-2003)

Figure 12 - Trends in the composition of employment by quartile of energy price (partialled out by 3-digit industry dummies and establishment size - log of employees)

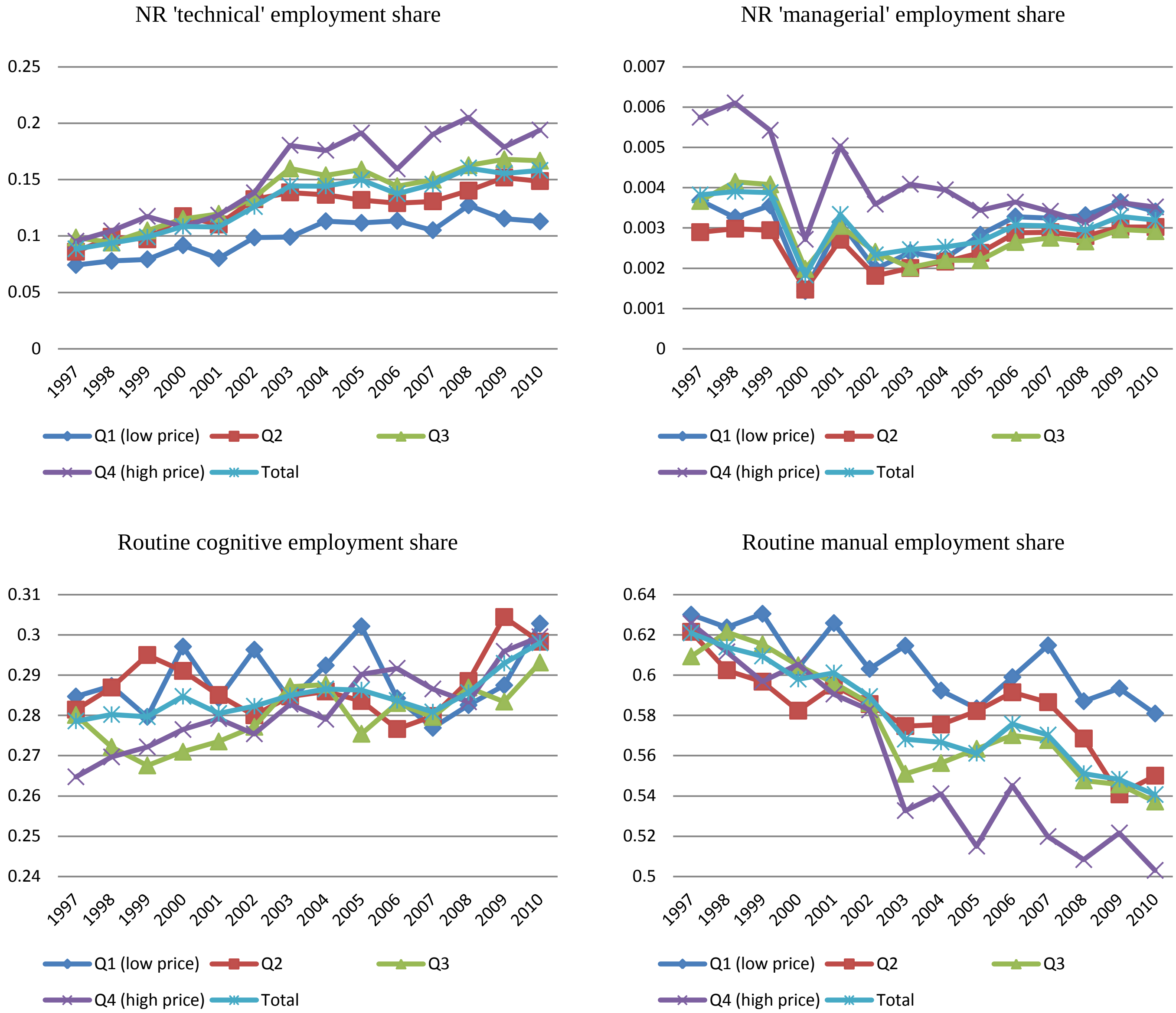


Table 10 - Baseline estimates

	OLS	IV	OLS	IV
		Total employment		
log(energy price)	-0.125***	-0.266***	-0.0796***	-0.165***
	(0.0123)	(0.0287)	(0.0111)	(0.0250)
log(output)			0.383***	0.380***
			(0.0140)	(0.0118)
		Employment in non-routine occupations		
log(energy price)	-0.0756***	-0.0568**	-0.0423***	0.0153
	(0.0131)	(0.0287)	(0.0125)	(0.0273)
log(output)			0.288***	0.290***
			(0.0127)	(0.00967)
		Employment in non-routine 'technical' occupations		
log(energy price)	-0.0925***	-0.152***	-0.0582***	-0.0793***
	(0.0134)	(0.0297)	(0.0128)	(0.0283)
log(output)			0.298***	0.297***
			(0.0131)	(0.00993)
		Employment in non-routine 'managerial' occupations		
log(energy price)	0.0407***	0.180***	0.0424***	0.185***
	(0.00906)	(0.0203)	(0.00906)	(0.0205)
log(output)			0.0166***	0.0216***
			(0.00606)	(0.00429)
		Employment in routine cognitive occupations		
log(energy price)	-0.109***	-0.257***	-0.0708***	-0.176***
	(0.0128)	(0.0279)	(0.0121)	(0.0258)
log(output)			0.332***	0.328***
			(0.0133)	(0.0106)
		Employment in routine manual occupations		
log(energy price)	-0.131***	-0.241***	-0.0848***	-0.141***
	(0.0144)	(0.0321)	(0.0133)	(0.0290)
log(output)			0.390***	0.388***
			(0.0146)	(0.0122)
F first stage		6448.9		6406.8
N	80092	80088	79887	79883

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Year-industry dummies (3-digit) and year-region dummies included.

Table 11 – First stage of baseline estimates

	log(energy prices)	log(energy prices)
IV	18.70***	18.61***
	(0.233)	(0.232)
log(output)		-0.0291***
		(0.00251)
N	80088	79883

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Year-industry dummies (3-digit) and year-region dummies included.

Table 12 - Results for energy intensive sectors

	OLS	IV	OLS	IV
		Total employment		
log(energy price)	-0.153***	-0.317***	-0.104***	-0.219***
	(0.0152)	(0.0336)	(0.0136)	(0.0298)
log(output)			0.363***	0.359***
			(0.0201)	(0.0176)
		Employment in non-routine occupations		
log(energy price)	-0.0712***	-0.0470	-0.0369**	0.0202
	(0.0172)	(0.0347)	(0.0165)	(0.0336)
log(output)			0.263***	0.265***
			(0.0168)	(0.0137)
		Employment in non-routine 'technical' occupations		
log(energy price)	-0.0900***	-0.147***	-0.0543***	-0.0776**
	(0.0178)	(0.0362)	(0.0171)	(0.0351)
log(output)			0.275***	0.274***
			(0.0175)	(0.0142)
		Employment in non-routine 'managerial' occupations		
log(energy price)	-0.0900***	0.157***	-0.0543***	0.159***
	(0.0178)	(0.0253)	(0.0171)	(0.0255)
log(output)			0.275***	0.0134**
			(0.0175)	(0.00572)
		Employment in routine cognitive occupations		
log(energy price)	-0.130***	-0.293***	-0.0909***	-0.218***
	(0.0165)	(0.0332)	(0.0156)	(0.0314)
log(output)			0.302***	0.297***
			(0.0181)	(0.0152)
		Employment in routine manual occupations		
log(energy price)	-0.169***	-0.330***	-0.119***	-0.233***
	(0.0178)	(0.0363)	(0.0167)	(0.0333)
log(output)			0.371***	0.366***
			(0.0213)	(0.0183)
F first stage		3906.9		3866.2
N	41537	41533	41424	41420

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Year-industry dummies (3-digit) and year-region dummies included.

Table 13 – First stage of estimates for energy-intensive sectors

	First stage	First stage
IV	19.29***	19.14***
	(0.309)	(0.308)
log(output)		-0.0322***
		(0.00385)
N	41533	41420

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Year-industry dummies (3-digit) and year-region dummies included.

Appendix 1 - Differences between establishments included and excluded from the sample used in the estimates for employment

Table 14 - Number of establishments in the EACEI survey included and excluded from baseline estimates

	Out	In	Total
1997	6828	5134	11962
1998	6525	5591	12116
1999	6171	5927	12098
2000	1962	3733	5695
2001	4893	5717	10610
2002	2394	4485	6879
2003	2211	4471	6682
2004	2177	5216	7393
2005	1502	5515	7017
2006	2091	7549	9640
2007	2350	7670	10020
2008	1627	6721	8348
2009	2506	6063	8569
2010	2928	5988	8916
Total	46165	79780	125945

Table 15 - Share of energy consumption and employees in establishments included in baseline estimates over total employment in EACEI survey

	Share of total energy	Share of total employees
1997	0.598	0.517
1998	0.598	0.548
1999	0.658	0.596
2000	0.741	0.756
2001	0.733	0.680
2002	0.553	0.698
2003	0.608	0.723
2004	0.624	0.751
2005	0.682	0.808
2006	0.681	0.813
2007	0.651	0.813
2008	0.625	0.811
2009	0.635	0.766
2010	0.592	0.752
Total	0.642	0.726

Table 16 - Number of establishments in the EACEI survey included and excluded from baseline estimates (by establishment size and band of total energy consumption)

	Out	In	Total
By establishment size			
0-49	27,282	17,838	45,120
50-99	8,999	18,909	27,908
100-249	6,773	27,211	33,984
250-499	1,976	10,310	12,286
500+	1,135	5,512	6,647
By total energy consumption band			
IA-IB-IC	950	271	1,221
ID	11,102	9,036	20,138
IE	13,864	19,055	32,919
IF	8,156	14,763	22,919
IG	12,093	36,655	48,748
Total	46,165	79,780	125,945

Table 17 - Differences in size, energy consumption and energy intensity between establishments included and excluded from baseline estimates

	log(empl)	log(ener cons)	log(ener cons/empl)	log(ener cons/empl)
Dummy 'included in estimates'	0.722***	0.705***	-0.0144	0.0867***
	(0.0123)	(0.0203)	(0.0173)	(0.0193)
log(empl)				-0.140***
				(0.0112)
N	121983	125783	121829	121829

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Year dummies and sector dummies (3-digit) included in all regressions.

Appendix 2 - Placebo test for the estimate of the impact of CSPE on electricity prices

Table 18 - Impact of CSPE scheme on electricity prices (placebo effect 2001-2002)

Dep: log(price electr)	(1)	(2)	(3)	(4)
Band ID x D2001	-0.0325*			
	(0.0179)			
Band ID x D2002	-0.0616**			
	(0.0258)			
Band ID x post 2003	0.0484***			
	(0.0130)			
Band IE x D2001	-0.0453**			
	(0.0179)			
Band IE x D2002	-0.0855***			
	(0.0259)			
Band IE x post 2003	0.0865***			
	(0.0132)			
Band IF x D2001	-0.0393*			
	(0.0209)			
Band IF x D2002	-0.106***			
	(0.0279)			
Band IF x post 2003	0.138***			
	(0.0138)			
Band IG x D2001	-0.111***			
	(0.0183)			
Band IG x D2002	-0.154***			
	(0.0267)			
Band IG x post 2003	0.192***			
	(0.0137)			
Initial log(electr cons) x D2001		-0.0124***	-0.00328	-0.0113***
		(0.00235)	(0.0122)	(0.00236)
Initial log(electr cons) x D2002		-0.0222***	-0.0390***	-0.0213***
		(0.00265)	(0.0150)	(0.00264)
Initial log(electr cons) x post 2003		0.0324***	0.0167*	
		(0.00164)	(0.00876)	
Initial log(electr cons) squared x D2001			-0.000889	
			(0.00101)	
Initial log(electr cons) squared x D2002			0.00149	
			(0.00118)	
Initial log(electr cons) squared x post 2003			0.00144**	
			(0.000730)	
Initial log(electr cons) x D2003				-0.00232
				(0.00215)
Initial log(electr cons) x D2004				0.00873***
				(0.00222)
Initial log(electr cons) x D2005				0.0290***
				(0.00265)
Initial log(electr cons) x D2006				0.0460***
				(0.00239)
Initial log(electr cons) x D2007				0.0425***
				(0.00239)
Initial log(electr cons) x D2008				0.0486***
				(0.00251)
Initial log(electr cons) x D2009				0.0532***
				(0.00264)
Initial log(electr cons) x D2010				0.0491***
				(0.00275)
N	103718	103714	103714	103714

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Other control variables: year dummies, industry-specific linear trends (split pre- and post-2003), region-specific linear trends (split pre- and post-2003)