The Impact of Energy Prices on Environmental and Socio-Economic Performance : Evidence from French Manufacturing plants

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Outline of the presentation

Energy prices and climate policy

- The **EU** committed to **ambitious climate policy targets** in the medium-long run
  - **2020 Climate and Energy Package** ⇒ 20% cut in GHG (wrt 1990), 20% of EU energy from renewables, 20% improvement in energy efficiency
  - **2030 Energy Strategy** (commitment of EU for **CoP21** in **Paris**, 2015) ⇒ 40% cut in GHG (wrt 1990), 27% of EU energy from renewables, 27% improvement in energy efficiency (wrt BAU)
- All in all the **impact** of climate policy is to **raise** the overall **price** of **fossil fuels** (e.g. Aldy and Pizer, 2015)
  - Induce **shift** towards (more expensive ?) **renewable** energy ⇒ **increase** in average **energy prices**
  - Energy prices will incorporate the cost of **carbon pricing policies** to comply with the Paris agreement
  - Induce **energy saving technical change** and changes in the **input mix**

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Climate policy vs EU competitiveness ?

- **Unilateral** climate **policies** may **reduce** the **competitiveness** of EU-based industries that rely on energy
  - **Social** and **economic damage** ⇒ **job** losses in EU manufacturing sectors and negative impact on **income** and **GDP**
  - **Environmental damage** ⇒ **carbon leakage** (i.e. emissions are just displaced abroad) ⇒ if energy efficiency (and carbon intensity of energy mix) is worse abroad, carbon leakage would **even** result in **greater global GHG** emissions
- This **risk** is **acknowledged** by the **Commission** ⇒ e.g exemption from auctioning in Phase III of EU-ETS (2013-2020) for selected leakage-exposed industries

Our contribution

1. Our paper contributes to the growing **micro-level** literature on **evaluation of environmental policies** considering energy prices rather than EU-ETS, tax discontinuities or the CAA (Walker, 2013 ; Greenstone et al. 2012 ; Martin et al., 2014 ; Petrick and Wagner, 2014 ; Flues and Lutz, 2015)
2. We propose a simple **shift-share IV strategy** to account for endogeneity in the effect of energy prices on plant performance
3. In practice :
   - We first assess the effects of recent **policy changes** on energy prices $\Rightarrow$ **bottom line** : difficult to evaluate new policies one-by-one, counter-intuitive impacts
   - We then evaluate the impact of **energy prices** on several measures of **plant performance** : energy demand, energy efficiency, CO2 emission, employment and productivity

Description of data

Unbalanced panel of **plants** for **1997-2010**

- **EACEI** (Enquête Annuelle sur le Consommations d'Energie dans l'Industrie)
  - **Survey** on **consumption** and **expenditure** for **energy** products (by **source** : electricity, oil, coal, gas, steam, other)
  - **Unit** of analysis ⇒ **plant** (SIRET)
  - **Stratified sample** of medium-small **manufacturing** plants (10-250 employees) and population of big manufacturing plants (250+ employees)
- **DADS** (Déclaration Annuelle des Données Sociales)
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  - **Balance sheets** for the **population** of French **companies**
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Definition of Energy prices

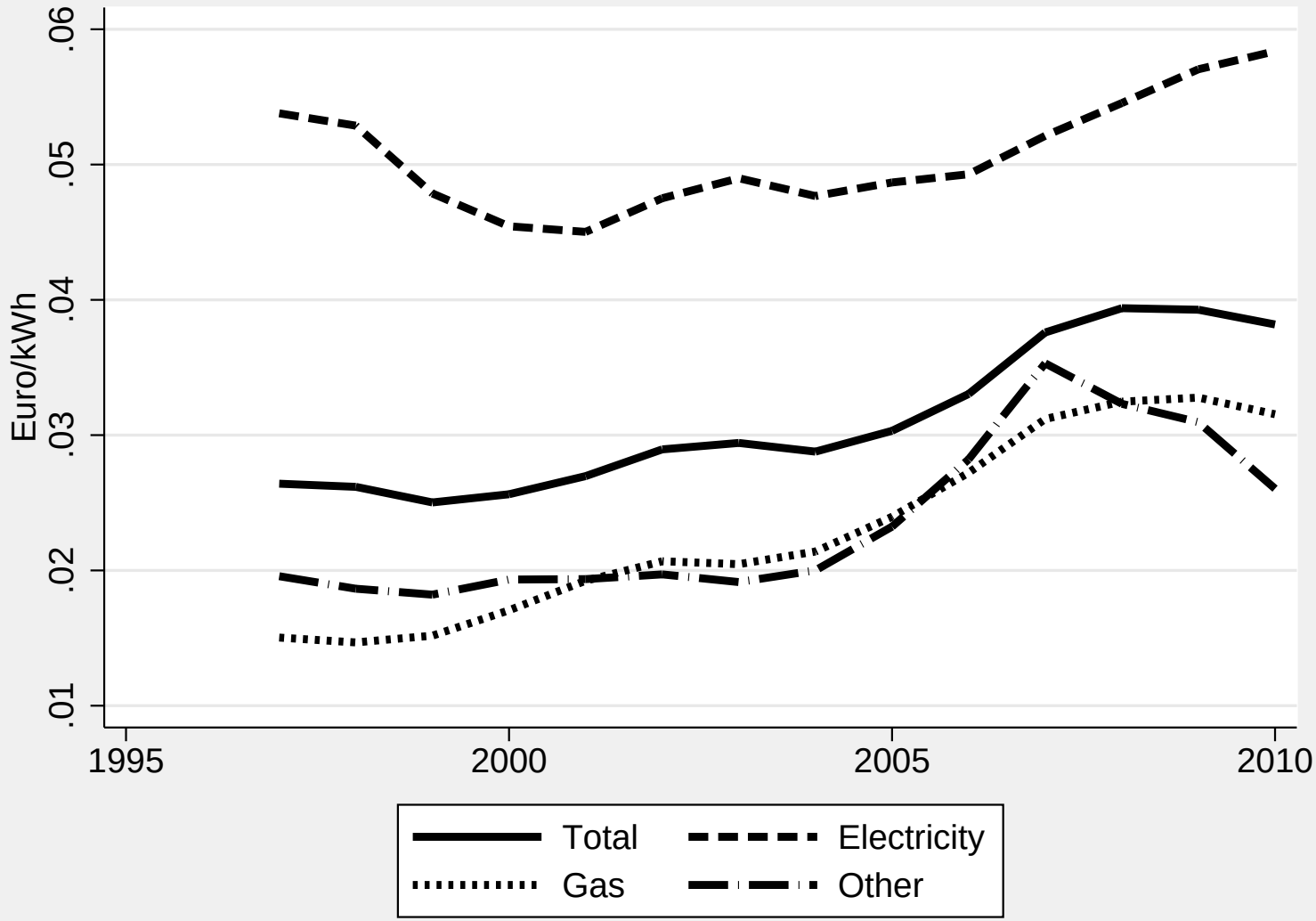
- As in Davis et al (2013, REStat), we cannot measure **marginal electricity prices** (e.g. price in peak or off-peak hours)
- **No** specific **information** on the detailed **structure** of energy **tariff** schedule
- What we call **energy price** is, actually, the average **unit value price**, that is : the **ratio** between total **expenditure** on energy and total **energy consumption** (in kWh) of plant i in year t
- This ratio can be conveniently written as :

$$p_{it}^{e} = \sum_{j=1}^{N} \phi_{it}^{j} p_{it}^{j},$$

where ϕ_{it}^{j} is the share of energy consumption of source j (i.e. gas, electr, coal, oil, etc) on total energy consumption, while p_{it}^{j} is the price of energy source j paid by plant j at time t.

Growing energy prices

FIGURE – Energy price trends (€/kWh)



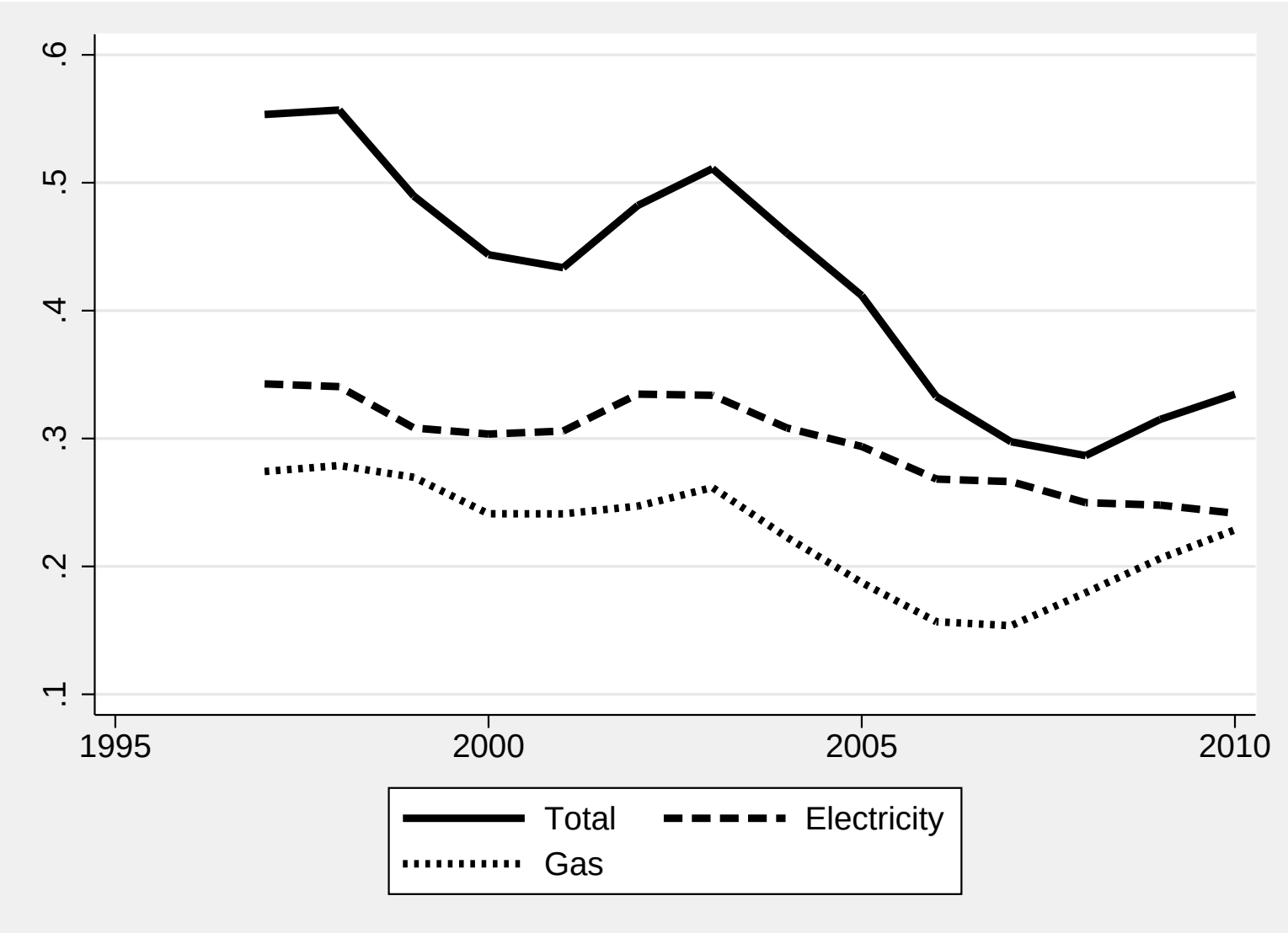
Heterogeneity in energy prices and mixes by selected sectors

Sector		Energy expend / wages	Average energy price per kwh	Average electr price per kwh	Average gas price per kwh	Average electr share	Average gas share
13	Textiles	0.323	0.048	0.068	0.03	0.497	0.347
		(0.524)	(0.018)	(0.018)	(0.010)	(0.317)	(0.351)
14	Wearing apparel	0.081	0.061	0.081	0.033	0.531	0.24
		(0.173)	(0.021)	(0.018)	(0.012)	(0.307)	(0.311)
17	Paper and paper products	0.284	0.049	0.066	0.03	0.509	0.321
		(0.507)	(0.019)	(0.019)	(0.011)	(0.276)	(0.313)
18	Coke and refined petroleum products	0.197	0.061	0.071	0.034	0.728	0.195
		(0.390)	(0.017)	(0.017)	(0.011)	(0.248)	(0.239)
20	Chemicals and chemical products	0.378	0.047	0.064	0.03	0.475	0.335
		(0.884)	(0.019)	(0.019)	(0.011)	(0.292)	(0.324)
22	Rubber and plastic products	0.238	0.055	0.064	0.033	0.721	0.177
		(0.391)	(0.016)	(0.017)	(0.011)	(0.286)	(0.263)
24	Basic metals	0.381	0.046	0.062	0.029	0.5	0.342
		(0.619)	(0.017)	(0.017)	(0.009)	(0.258)	(0.294)
25	Fabricated metal products	0.207	0.059	0.074	0.034	0.628	0.237
		(0.451)	(0.017)	(0.018)	(0.011)	(0.272)	(0.279)
27	Electrical equipment	0.135	0.056	0.071	0.033	0.605	0.289
		(0.358)	(0.017)	(0.018)	(0.010)	(0.270)	(0.285)
29	Motor vehicles, trailers and semi-trailers	0.164	0.054	0.072	0.033	0.543	0.297
		(0.368)	(0.016)	(0.020)	(0.010)	(0.261)	(0.292)
31	Furniture	0.205	0.062	0.077	0.034	0.634	0.191
		(0.359)	(0.018)	(0.017)	(0.010)	(0.297)	(0.290)
	Total	0.217	0.057	0.072	0.033	0.601	0.251
		(0.482)	(0.019)	(0.019)	(0.011)	(0.293)	(0.297)

Standard deviation in parenthesis. Own elaboration on EACEI and DADS data. Information refers to the period 1997-2010 and is weighted by sampling weights across plants.

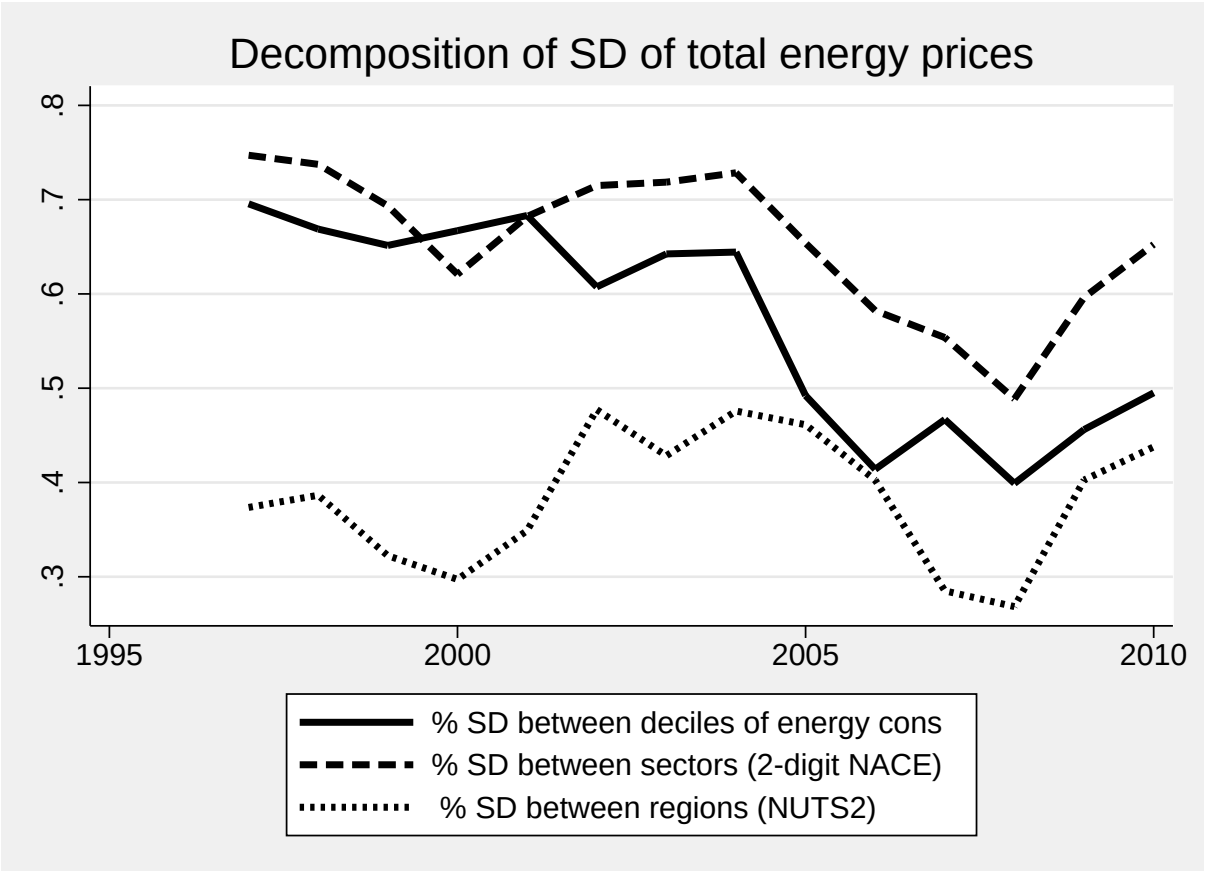
Heterogeneity in energy prices

FIGURE – SD of log energy prices



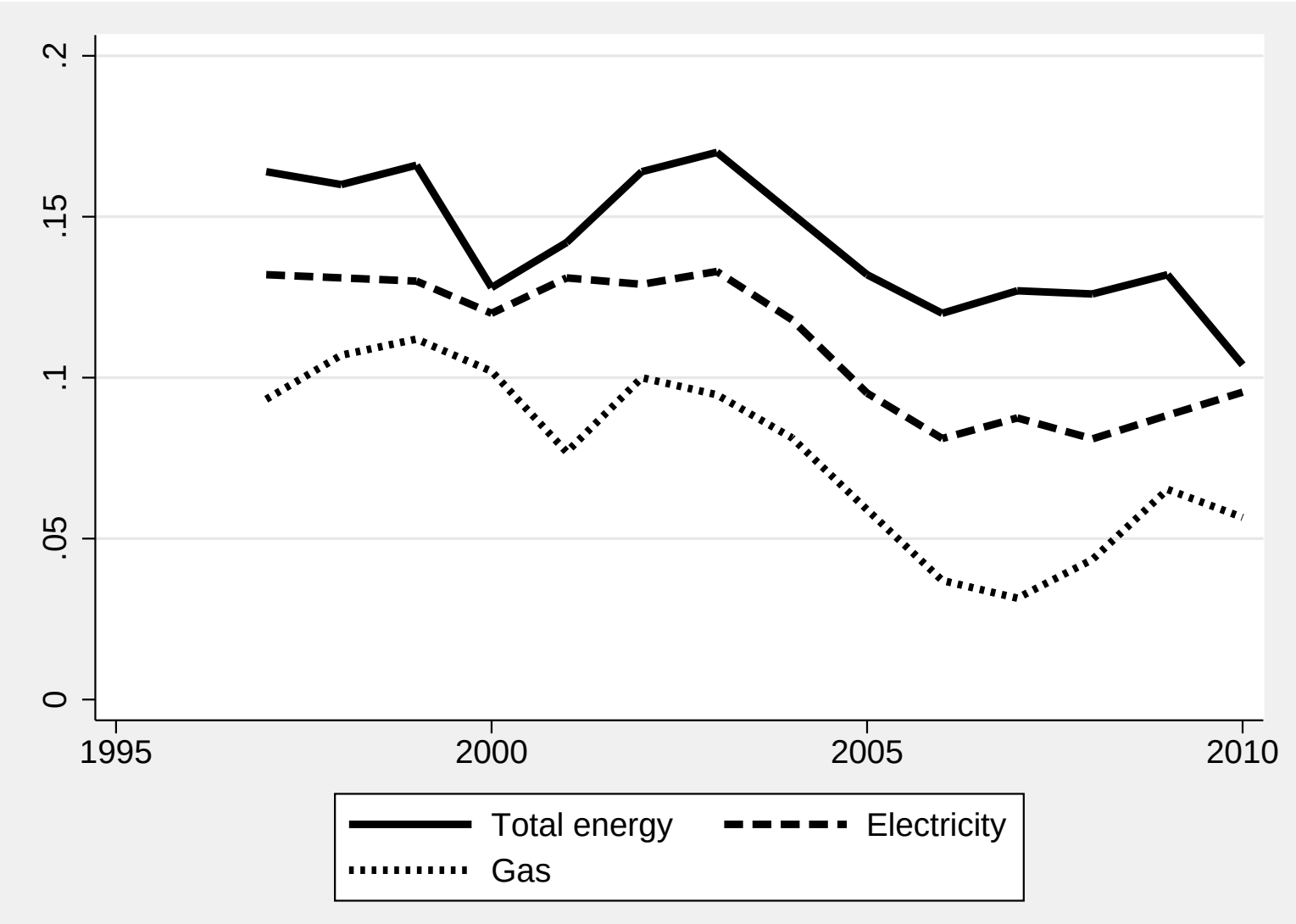
Reduction in quantity-discounts (Davis et al. 2014)

FIGURE – Share of explained SD - Total energy prices



Quantity-discounts cross-sectional estimates

FIGURE – Cross-sectional elasticity of energy prices wrt to energy consumption (region and industry dummies included, weighted by energy purchase)



The French case

1. **Large share** of electricity is generated by **nuclear** power plants
   - **Messmer Plan** (after the oil crisis of 1973)
   - Now about **80-90 percent of electricity** is produced with nuclear power
   - **Baseload** source that cannot deal with **peaks** ⇒ France both **exports** and **imports** electricity
2. **Electricity and gas markets** dominated by **one player** (EDF and GDF, respectively)
   - **State-owned** companies (and well-managed)
   - Guarantee for **low prices**
   - Explicit aim of **reducing** geographical **heterogeneity** in **prices**
3. **Ambitious**, **Unilateral** policy plan (**the Energy Transition Law**) :
   - **Carbon price floor** of 30€/tCO2 (ETS price around 6€/tCO2).
   - **Carbon tax** : 22 €/tCO2 in 2016, 56€/tCO2 in 2020, 100€/tCO2 in 2030.
   - Expected effect on energy prices between 10% and 20%

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Regulatory changes in France over the 2000s

- Introduction of a **tax** on **electricity** (**CSPE**) to support **renewables** and **low-carbon** technologies in **2002**
- Following **EU directives** and **deregulations** (from early 2000s) :
  - Creation of an **independent transmission** system **operator** for **electricity**
  - **Opening** the **grid** to **non-discriminatory** third party access (**electricity**)
  - **Unbundling** and **opening** to third party access to underground **storage** of **natural gas**
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The CSPE tax

- The **CSPE** (Contribution au Service Public de l'Électricité) is a tax on electricity aimed at **financing** the '**public-service**' component of the supply of electricity
- Set up in **2002** with a rate of **3€/MWh** (3.3 in 2003, 4.5 from 2004, 9 in 2011, 10.5 in 2012, 13.5 in 2013, 16.5 in 2014, 19.5 in 2015 and 22.5 in 2016)
- **Tax revenue** is use to :
  - Cover the **obligatory purchase** by EDF of electricity produced with **co-generation** and **renewable** energy
  - Contribute to the **stabilization** of **prices** across different **regions** (especially islands and DOM/TOM)
  - Provide **discounts** for **poor** households on electricity purchase

Exemptions from CSPE

- **Big consumers** of electricity are (**partly**) **exempted** from the tax ⇒ because of the risk to reduce the **international competitiveness** of energy-intensive manufacturing sectors
  - From 2003 onwards, **ceiling** of 500,000€/year of overall **tax cost** for each plant (beyond that amount each additional kWh is not taxed) ⇒ the ceiling grew in time (to accommodate the increase in the tax rate) ⇒ about 1/5 of total electricity consumption is exempted
  - Up to 240GWh of **self-production** is exempted from the tax
  - Ceiling set to 0.5 percent of **company-level value added** for companies that consume more than 7GWh/year

- **Average tax per kWh** for **very big plants** is close to **zero**
- However, we do not observe **a clear discontinuity** in the effects of the tax on energy prices and factor demand.
- **EDF** is **quasi-monopolist** ⇒ changes in **net** electricity **prices** (i.e. reduction in quantity-discounts) offset or more than offset the **tax exemptions**.

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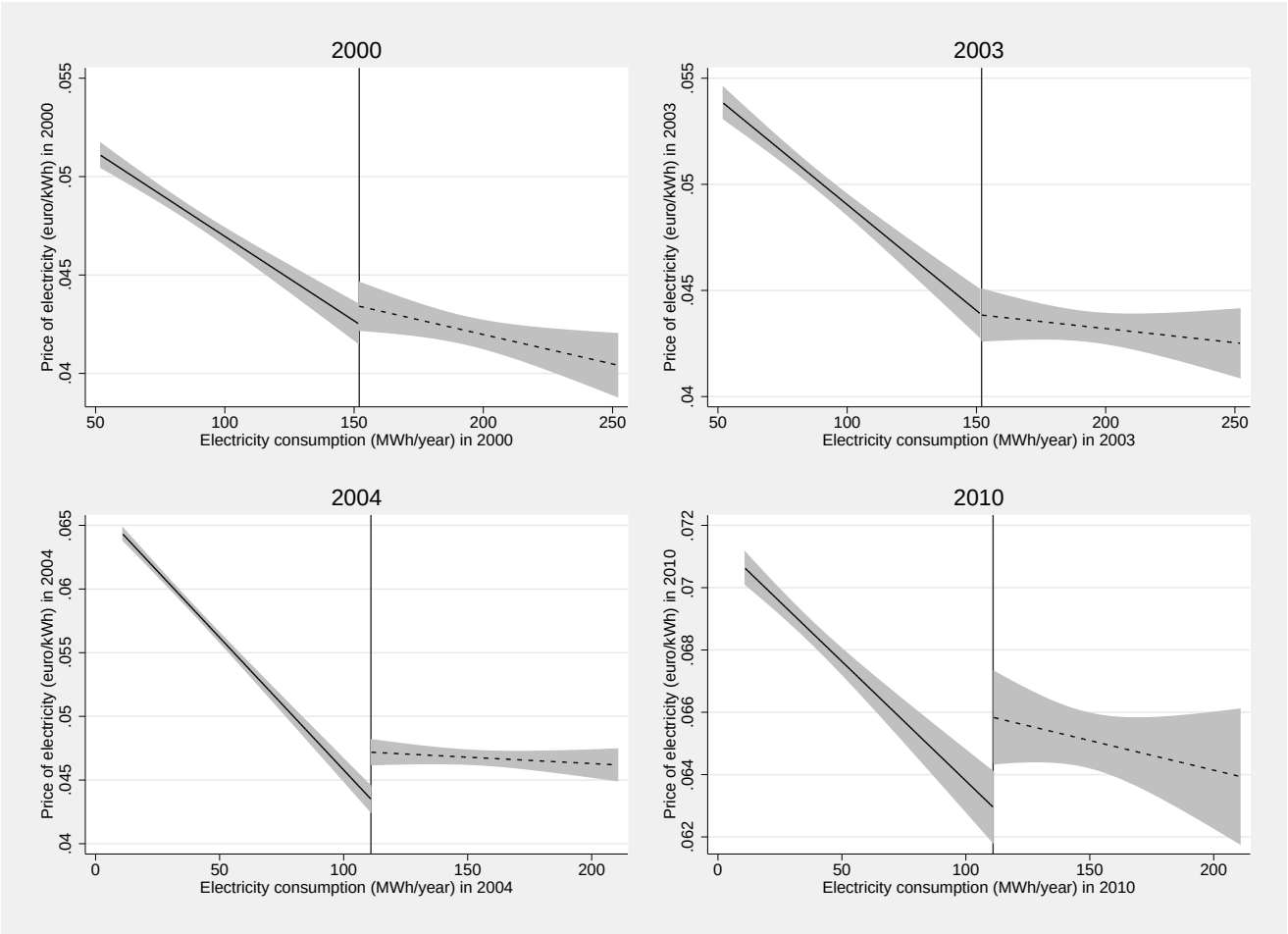
Did the ceiling create a discontinuity in tax-inclusive electricity prices ?

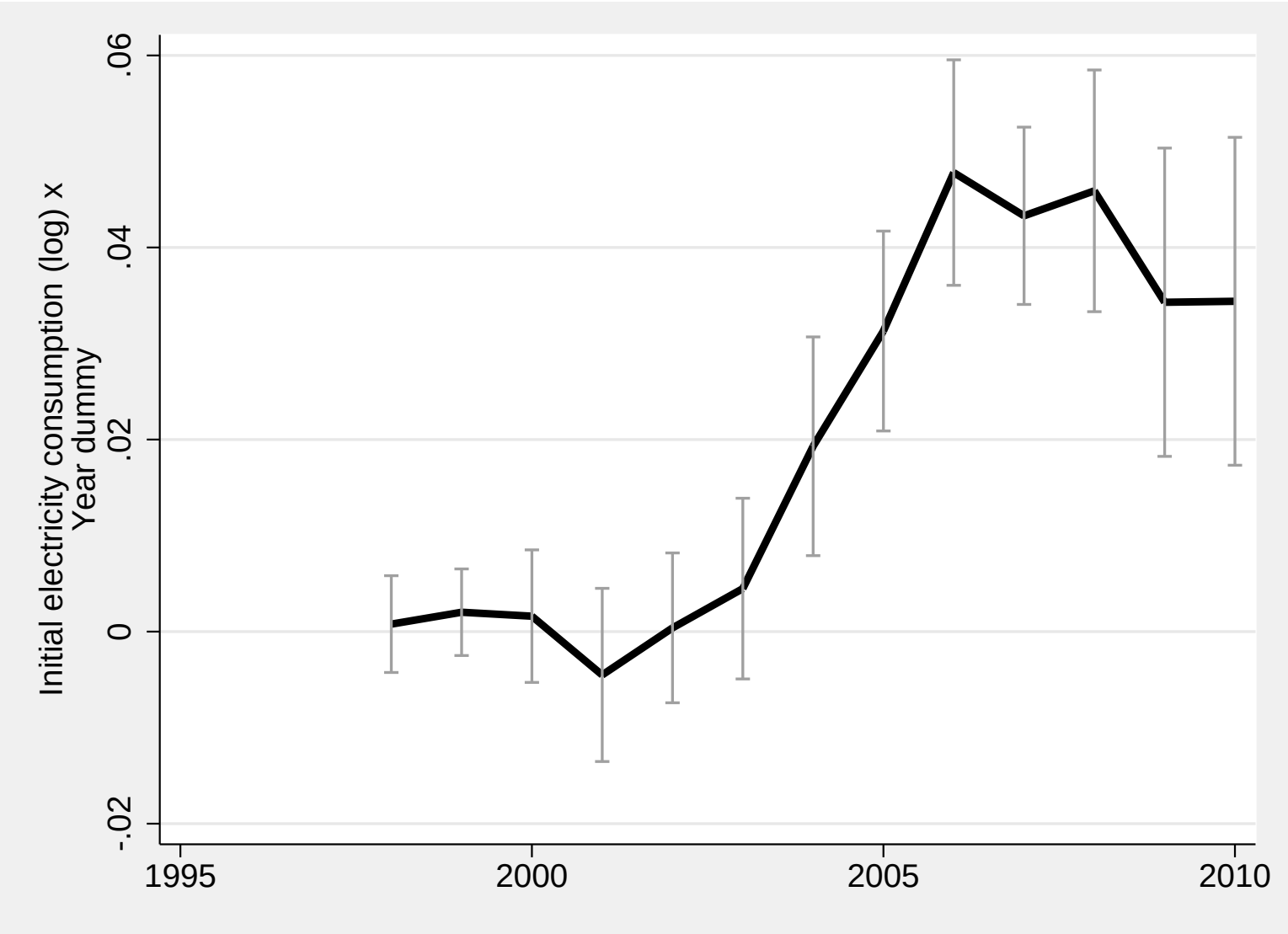


Does the CSPE changed the structure of electricity prices within the plant ?

- After **2003-2004** there has been a **reduction** in **quantity-discounts**, i.e. **elasticity** of prices to quantity
- **Hypothesis** ⇒ Do the changes in **regulation** and taxes **reduced** the **price discounts** for **big consumers** of electricity wrt small ones ?
- To **evaluate** and **quantify** this effect we estimate the following equation :

$$log(p_{it}^{el}) = \beta^t log(E_{i0}^{el}) + \gamma_t^{sect} + \eta_t^{reg} + \alpha_i + \varepsilon_{it}$$

FIGURE – Reductions in quantity discount on electricity price with respect to 1997



All policies together

Plant-specific measures of **policy change** :

- Plant-specific exposure to **Product Market Reforms** (PMR) for electricity and gas ;
- Dummy for plants subjected to the **EU-ETS** ;
- Average (plant-specific) **CSPE** per MWh of electricity.

Dep var : log(energy price)	(1)	(2)	(3)	(4)
PMR (1 : fully regulated ; 0 : unregulated)	0.122***			0.118***
	(0.0103)			(0.0103)
Firm-specific CSPE (euro/MWh)		-0.018***		-0.009***
		(0.0029)		(0.0029)
ETS x D(2001-2004)			0.0898***	0.0741***
			(0.0125)	(0.0124)
ETS x D(2005-2007)			0.173***	0.151***
			(0.0175)	(0.0179)
ETS x D(2008-2010)			0.209***	0.190***
			(0.0189)	(0.0193)
N	115639	115639	115639	115639

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years.

Summary

- **Counter-intuitive** effect of the **CSPE** ⇒ No discontinuity near the threshold, but instead change in the structure of electricity price since 2003
- **Expected** effect of **PMR** ⇒ deregulation decreases prices
- **Substantial changes** in the structure of energy prices ⇒ **reductions in quantity-discounts** likely affect energy intensive companies
- Overall, **energy prices** are the best **sufficient statistics** to evaluate effects of future climate policies

Estimating equation

- To evaluate the **effect** of **plant-specific energy prices** on **performance** (both **socio-economic** and **environmental**), we **estimate** the following equation :

$$log(y_{it}) = \beta log(p^e_{it}) + X'_{it}\gamma + \alpha_i + \varepsilon_{it}$$

- y_{it} is the outcome variable, that is : energy consumption, CO2 emissions, employment, wages, productivity
- β is the estimated **elasticity** of the outcome variable to energy prices
- X'_{it} is a series a **control** variables :
  - **Industry**-year dummies (NACE 2-digit rev 2)
  - **Region**-year dummies (NUTS2)
  - Year dummies specific for **ETS** plants (to account for the EU-ETS in a flexible way)
  - Initial **Size class**-year dummies (to account for faster conditional employment growth of smaller firms)
  - Year-specific dummy for exposure to peak electricity consumption
- α_i is the plant **fixed effect**

Identification of the effect

Three (unobservable) **omitted variables** correlated with y_{it} and p^e_{it} :

1. Plants hit by negative (resp. positive) **demand shock** d_{it} will reduce (resp. increase) the demand for inputs (L, E) $\Rightarrow$ increases (resp. decreases) energy prices
2. Endogenous **energy-saving technical change** a^E_{it} reduces simultaneously energy demand and quantity-discounts $\Rightarrow$ reinforces increase in p^e_{it}
3. **Technical change** facilitating the **substitution between L and E**, ϵ_{it} $\Rightarrow$ increases the demand of L, reinforces increase in p^e_{it}

Adapting the well-known formula of the OVB (Angrist and Pischke, 2009), we obtain :

$$\hat{\beta}_y = \frac{Cov(y_{it}, p_{it})}{Var(p_{it})} = \beta_y + \underbrace{\gamma_{y,d}\delta_{p,d}}_{-} + \underbrace{\gamma_{y,a^E}\delta_{p,a^E}}_{-} + \underbrace{\gamma_{y,\varepsilon}\delta_{p,\varepsilon}}_{+\text{ L, - E}},$$

- Clearly $\hat{\beta}_E > \beta_E$ for **energy** and **environmental outcomes**
- For **economic outcomes** not clear, but **conditional on survival** the positive bias should dominate over the negative one : $\hat{\beta}_L < \beta_L$.

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Instrumental variable

- We build a shift-share **IV** that **only** keeps **exogenous variations** in energy **prices** and **accounts** for **all sources** of **endogeneity**

$$p_{it}^{IV} = \sum_{j=1}^{N} \sum_{k=2000}^{2010} \phi_{i,k-3}^{j} p_t^j,$$

where j is the energy source (gas, etc), ϕ^j the presample initial share of source j and p_t^j the nation-level price of source j.

- We **shut down** possible **technological responses** of plants to changing energy prices in terms of **energy mix** by weighting exogenous prices with a **time-invariant** plant-specific energy mix.
- The **3-years lags** in computing the initial energy mix mitigates concerns that rational managers **forecast** the evolution of future energy prices in the coming years.

In-sample evidence of technical change : correlation between prices and the energy mix

TABLE – Correlation between energy prices and energy mix

	Electr share	log(electr share/ non-electr share)
Electr price / Tot energy price	-0.310***	
	(0.00410)	
log(Electr price)	-0.0383***	
	(0.00365)	
log(Electr price / Non-electr price)		-0.812***
		(0.0229)
N	96629	96629

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Establishments for which the energy mix is constituted by only electricity or only non-electricity are excluded. Sample : establishments that were observed at least twice over the period 1997-2010.

Testing for pre-trends

We test the validity of the exclusion restriction, i.e. the possibility that plants with different initial energy mix already had different trends.

TABLE – Pretrend in employment and initial energy mix

Dep var : log(empl)	(1)	(2)
Initial electricity share x D1998	0.0200	0.00151
	(0.0147)	(0.0155)
Initial electricity share x D1999	0.0219	-0.00515
	(0.0215)	(0.0228)
Initial electricity share x D2000	0.0798***	0.0277
	(0.0225)	(0.0237)
Initial electricity share x D2001	0.0780**	0.0329
	(0.0317)	(0.0335)
Initial gas share x D1998	0.0120	0.00742
	(0.0143)	(0.0148)
Initial gas share x D1999	-0.000556	-0.00402
	(0.0199)	(0.0203)
Initial gas share x D2000	0.00478	-0.00901
	(0.0222)	(0.0223)
Initial gas share x D2001	0.00289	0.000620
	(0.0309)	(0.0310)
N	43070	43070
F test : joint significance of electr share	4.078	0.817
p-value	0.00264	0.514
F test : joint significance of gas share	0.279	0.265
p-value	0.892	0.901
F test : joint significance of electr and shares	3.180	1.008
p-value	0.00133	0.427

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Year dummies included. Usual additional controls included in column (2). Sample : plant in EACEI 1997 that were observed in DADS in all years for the period 1997-2001

Table – Baseline results

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.218***	-0.644***	-1.735***	-1.149***
	(0.0308)	(0.0780)	(0.0553)	(0.117)
F excl IV first stage		1393.9		1151.0
N	61153	61153	54437	54437
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0742***	-0.263***	-0.00267	-0.0445**
	(0.0152)	(0.0593)	(0.00399)	(0.0174)
F excl IV first stage		1393.9		1423.2
N	61153	61153	59076	59076

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV). Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant.

Table – Energy intensive sectors

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.213***	-0.660***	-1.719***	-1.143***
	(0.0443)	(0.0958)	(0.0806)	(0.142)
F excl IV first stage		865.8		735.6
N	32622	32622	28941	28941
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0757***	-0.339***	-0.00206	-0.0508**
	(0.0184)	(0.0680)	(0.00520)	(0.0211)
F excl IV first stage		865.8		926.4
N	32622	32622	31606	31606

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV). Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant.

Table – Non energy intensive sectors

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.217***	-0.529***	-1.750***	-1.158***
	(0.0393)	(0.132)	(0.0634)	(0.206)
F excl IV first stage		540.4		430.0
N	28531	28531	25496	25496
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0691***	-0.0957	-0.00386	-0.0289
	(0.0258)	(0.113)	(0.00622)	(0.0304)
F excl IV first stage		540.4		505.5
N	28531	28531	27470	27470

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV). Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant.

Table – Trade intensive sectors

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.247***	-0.790***	-1.649***	-1.146***
	(0.0540)	(0.124)	(0.0913)	(0.174)
F excl IV first stage		573.0		491.2
N	24461	24461	22189	22189
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0844***	-0.308***	-0.00467	-0.0420
	(0.0247)	(0.100)	(0.00626)	(0.0295)
F excl IV first stage		573.0		559.8
N	24461	24461	23604	23604

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV). Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant.

Table – Non trade intensive sectors

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.202***	-0.538***	-1.796***	-1.122***
	(0.0371)	(0.104)	(0.0649)	(0.166)
F excl IV first stage		724.1		578.7
N	36692	36692	32248	32248
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0613***	-0163**	-0.000307	-0.0521**
	(0.0194)	(0.0770)	(0.00518)	(0.0223)
F excl IV first stage		724.1		764.8
N	36692	36692	35472	35472

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV). Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant.

Simulated policy effect

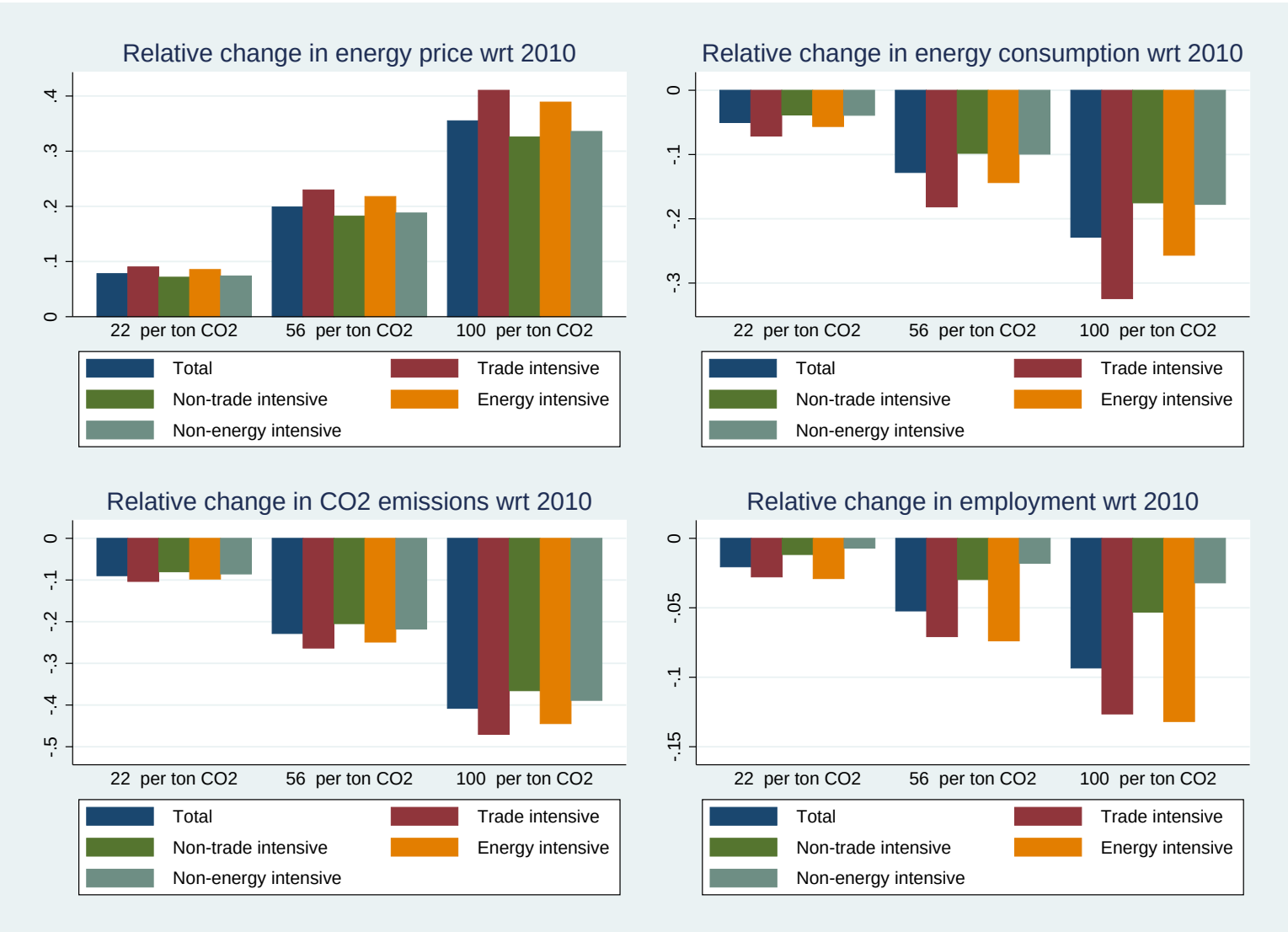
- In July 2015, within the **Energy Transition Law** the french senate approved a **carbon tax** with a specific time profile
- **Carbon tax** : 22 €/tCO2 in 2016, 56€/tCO2 in 2020, 100€/tCO2 in 2030 (for comparison : Swedish tax 400€/tCO2)
- After the last year in our sample (i.e. 2010), the **CSPE** increased substantially : from **4.5€/MWh** in 2004 to **22.5** in 2016

Our empirical framework is amenable to **policy simulations** that, exploiting differences in the **energy mix**, can capture the **multiplicity** of environmental policies and the **effect** of **source-specific policies**.

- Under the implicit assumption of log-linear policy effects, these simulated effects provide useful benchmark to calibrate CGE and IA models.

Scenario 1 : carbon tax but no CSPE

FIGURE – Scenario only carbon tax



Scenario 2 : carbon tax and CSPE at 22.5 €/MWh

FIGURE – Scenario carbon tax and CSPE

Firm-level analysis

- We **aggregate** up energy-related and labour-related information at the **firm** level for those **firms** with **all plants** included in the **EACEI** survey (i.e. all single-plant firms, and multi-plant firms with all plants included in the survey)
- We use **firm-level** data to retrieve information on **balance sheets** and income statements (FICUS-FARE)
- **Additional** measures $\Rightarrow$ **labour productivity** and **TFP**

Table – Firm-level performance

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.221***	-0.528***	-1.838***	-1.049***
	(0.0434)	(0.113)	(0.0700)	(0.178)
F excl IV first stage		829.9		619.2
N	30600	30600	26738	26738
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0915***	-0.262***	0.00655	-0.0447
	(0.0143)	(0.0447)	(0.0172)	(0.0580)
F excl IV first stage		813.4		804.1
N	30355	30355	30045	30045
	log(VA / empl)		log(TFP)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0154	-0.106	-0.0302	-0.122
	(0.0224)	(0.0845)	(0.0206)	(0.0793)
F excl IV first stage		806.9		795.4
N	29862	29862	29438	29438

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant. Sample : firms for which all plants are included in EACEI and that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV).

Is there a within-firm input's reallocation in response to change in energy prices ?

- We run regressions only on **multi-plant firms** (with all plants included in EACEI)
- We **condition** on **firm-year fixed effects** (γ_{ft}) $\Rightarrow$ $log(p^e_{i\in f,t})$ is the difference of prices between plant i and its company f.
- Dependent variable $\Rightarrow$ **share** of **labour** and energy in **plant** i with respect to the total in firm f.

$$y_{i\in f,t} = \beta log(p^e_{i\in f,t}) + \gamma_{ft} + \alpha_i + \varepsilon_{it}$$

TABLE – Within-firm relocation

	plant share of firm energy consumption		plant share of firm employment	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.374***	-0.337***	-0.0718***	-0.106**
	(0.0343)	(0.0622)	(0.0214)	(0.0420)
F excl IV first stage		140.5		137.0
N	5217	5217	5144	5144

Fixed effect model. Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : firm-year dummies. Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant. Sample : plants in multi-plant firms for which all plants are observed in EACEI ; plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV)

Summary

1. Our analysis of the **drivers** of energy price changes highlights potential problems of (supposedly cleaner) **single policy** evaluation in presence of **multiple policies**
2. Our policy analysis **confirms** previous results on the **effects** of environmental policies :

   Improve environmental performance and energy efficiency at the **cost** of a modest negative effect on employment and competitiveness
3. We highlight **heterogeneous responses** by sector especially for **employment**, much stronger impacts in **trade-exposed** and **energy-intensive** sectors

   In the scenario with both **carbon taxes** at 56€/tCO2 and **renewable energy subsidies**, an **induced 38% increase** in **energy prices** will **reduce employment** by approximately **12% in trade exposed sectors** and by **14% in energy-intensive sectors**

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THANK YOU FOR YOUR ATTENTION

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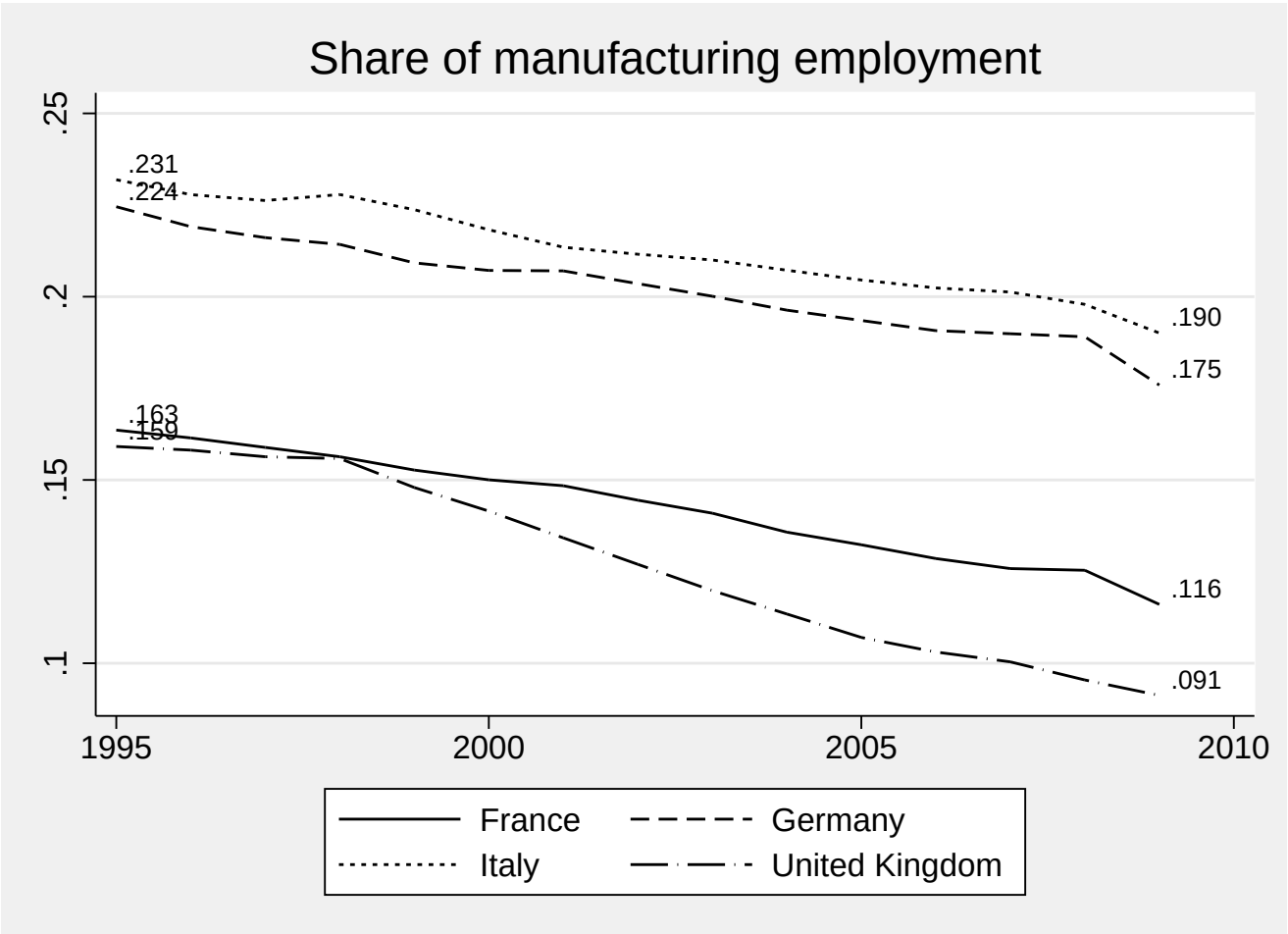
ADDITIONAL RESULTS

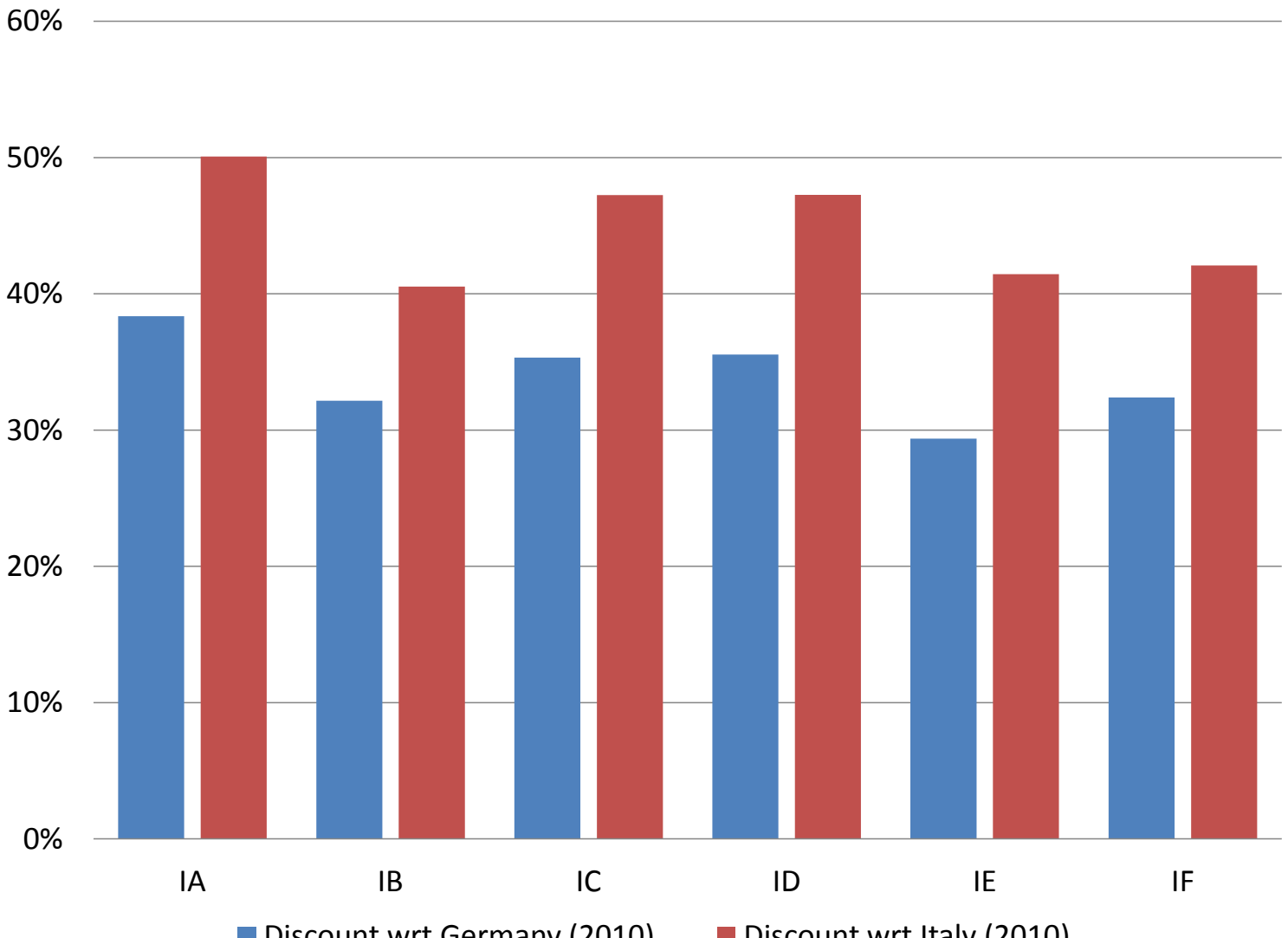
Climate policy vs EU competitiveness ?

FIGURE – Share of employees in manufacturing sectors (source : WIOD)



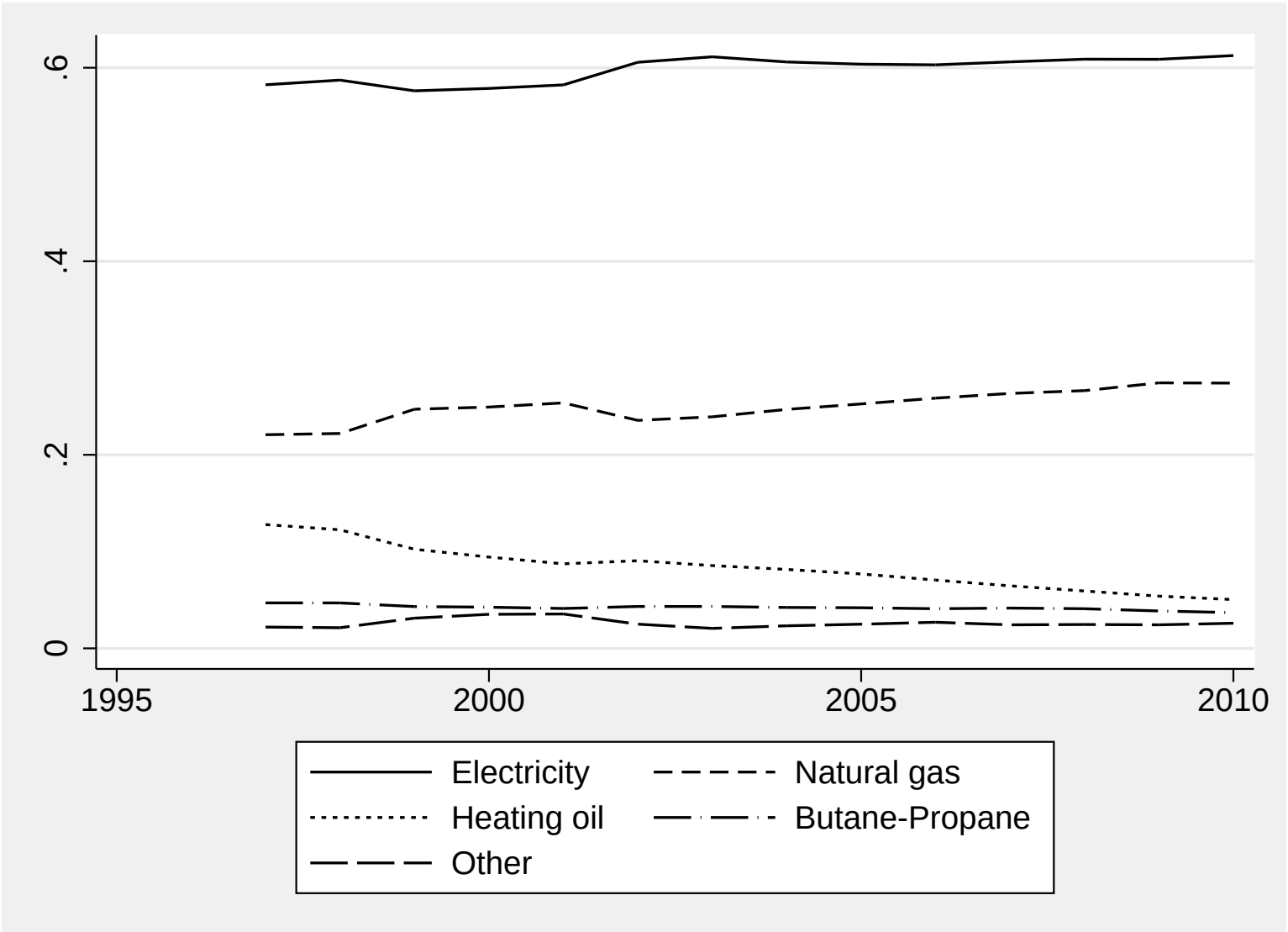
Energy Prices : France vs. Italy and Germany

FIGURE – Discount in electricity price in France with respect to Italy and Germany by consumption band - IA : small consumers ; IF : big consumers



Stable energy mix

FIGURE – Energy mix of French plants



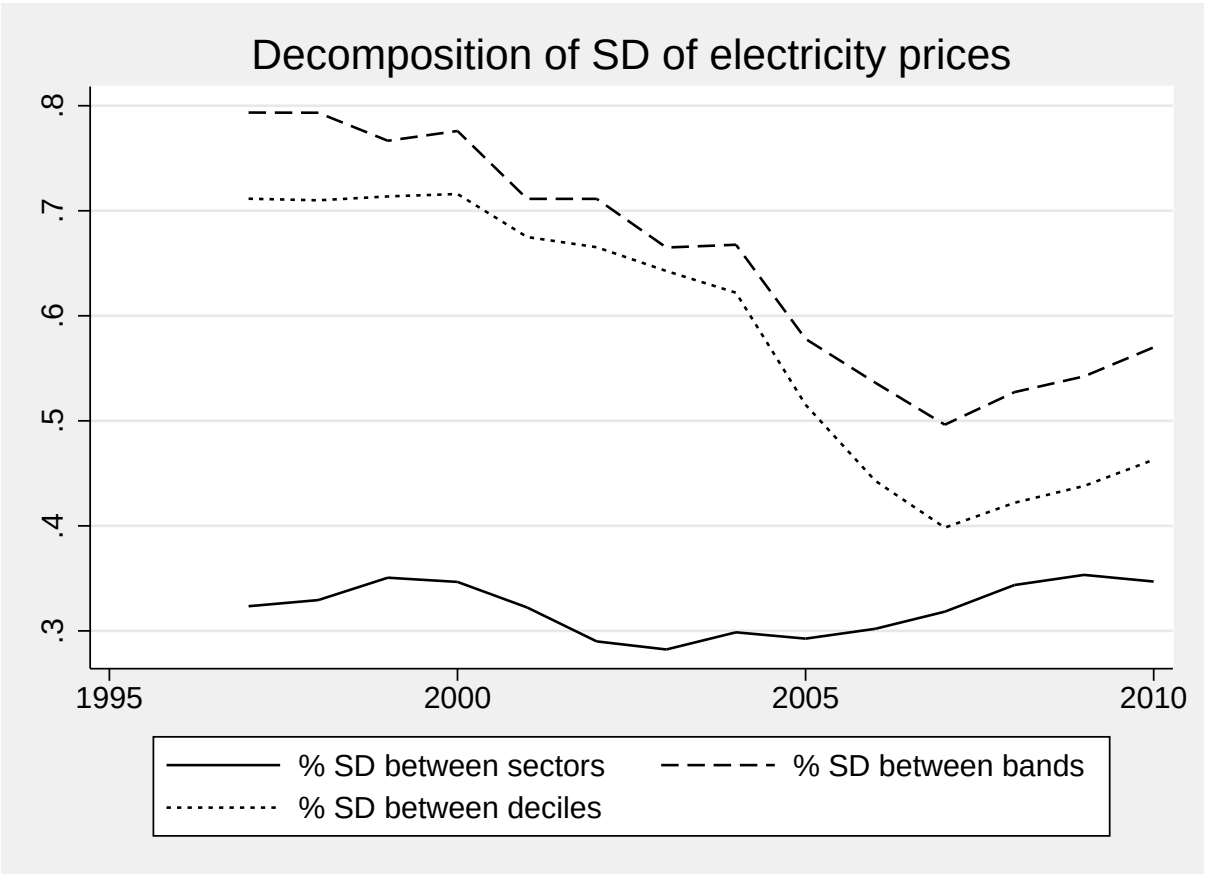
Detailed sector-level information

Sector		Energy expend / wages	Average energy price per kwh	Average electr price per kwh	Average gas price per kwh	Average electr share	Average gas share
13	Textiles	0.323	0.048	0.068	0.03	0.497	0.347
		(0.524)	(0.018)	(0.018)	(0.010)	(0.317)	(0.351)
14	Wearing apparel	0.081	0.061	0.081	0.033	0.531	0.24
		(0.173)	(0.021)	(0.018)	(0.012)	(0.307)	(0.311)
15	Leather and related products	0.086	0.059	0.078	0.035	0.557	0.196
		(0.174)	(0.018)	(0.018)	(0.011)	(0.264)	(0.278)
16	Wood and of products of wood and cork	0.338	0.064	0.074	0.034	0.736	0.073
		(0.619)	(0.019)	(0.019)	(0.012)	(0.258)	(0.191)
17	Paper and paper products	0.284	0.049	0.066	0.03	0.509	0.321
		(0.507)	(0.019)	(0.019)	(0.011)	(0.276)	(0.313)
18	Coke and refined petroleum products	0.197	0.061	0.071	0.034	0.728	0.195
		(0.390)	(0.017)	(0.017)	(0.011)	(0.248)	(0.239)
20	Chemicals and chemical products	0.378	0.047	0.064	0.03	0.475	0.335
		(0.884)	(0.019)	(0.019)	(0.011)	(0.292)	(0.324)
21	Basic pharmaceutical products	0.144	0.046	0.058	0.029	0.555	0.37
		(0.277)	(0.014)	(0.013)	(0.009)	(0.227)	(0.256)
22	Rubber and plastic products	0.238	0.055	0.064	0.033	0.721	0.177
		(0.391)	(0.016)	(0.017)	(0.011)	(0.286)	(0.263)
23	Other non-metallic mineral products	0.367	0.049	0.067	0.028	0.471	0.294
		(0.590)	(0.021)	(0.018)	(0.010)	(0.320)	(0.356)
24	Basic metals	0.381	0.046	0.062	0.029	0.5	0.342
		(0.619)	(0.017)	(0.017)	(0.009)	(0.258)	(0.294)
25	Fabricated metal products	0.207	0.059	0.074	0.034	0.628	0.237
		(0.451)	(0.017)	(0.018)	(0.011)	(0.272)	(0.279)
26	Computer, electronic and optical products	0.127	0.061	0.072	0.034	0.727	0.194
		(0.683)	(0.019)	(0.020)	(0.011)	(0.272)	(0.254)
27	Electrical equipment	0.135	0.056	0.071	0.033	0.605	0.289
		(0.358)	(0.017)	(0.018)	(0.010)	(0.270)	(0.285)
28	Machinery and equipment n.e.c.	0.144	0.058	0.077	0.035	0.524	0.317
		(0.310)	(0.018)	(0.019)	(0.011)	(0.266)	(0.304)
29	Motor vehicles, trailers and semi-trailers	0.164	0.054	0.072	0.033	0.543	0.297
		(0.368)	(0.016)	(0.020)	(0.010)	(0.261)	(0.292)
30	Other transport equipment	0.101	0.054	0.072	0.033	0.523	0.345
		(0.315)	(0.017)	(0.019)	(0.010)	(0.258)	(0.290)
31	Furniture	0.205	0.062	0.077	0.034	0.634	0.191
		(0.359)	(0.018)	(0.017)	(0.010)	(0.297)	(0.290)
32	Other manufacturing	0.112	0.062	0.077	0.035	0.655	0.227
		(0.187)	(0.019)	(0.019)	(0.012)	(0.287)	(0.280)
33	Repair and installation	0.156	0.068	0.086	0.037	0.606	0.213
		(0.399)	(0.019)	(0.019)	(0.011)	(0.312)	(0.293)
	Total	0.217	0.057	0.072	0.033	0.601	0.251
		(0.482)	(0.019)	(0.019)	(0.011)	(0.293)	(0.297)

Standard deviation in parenthesis. Own elaboration on EACEI and DADS data. Information refers to the period 1997-2010 and is weighted by sampling weights across plants.

Reduction in quantity-discounts electricity (Davis et al. 2014)

FIGURE – Share of explained SD - Electricity prices



Product Market Regulation and EU-ETS

PMR

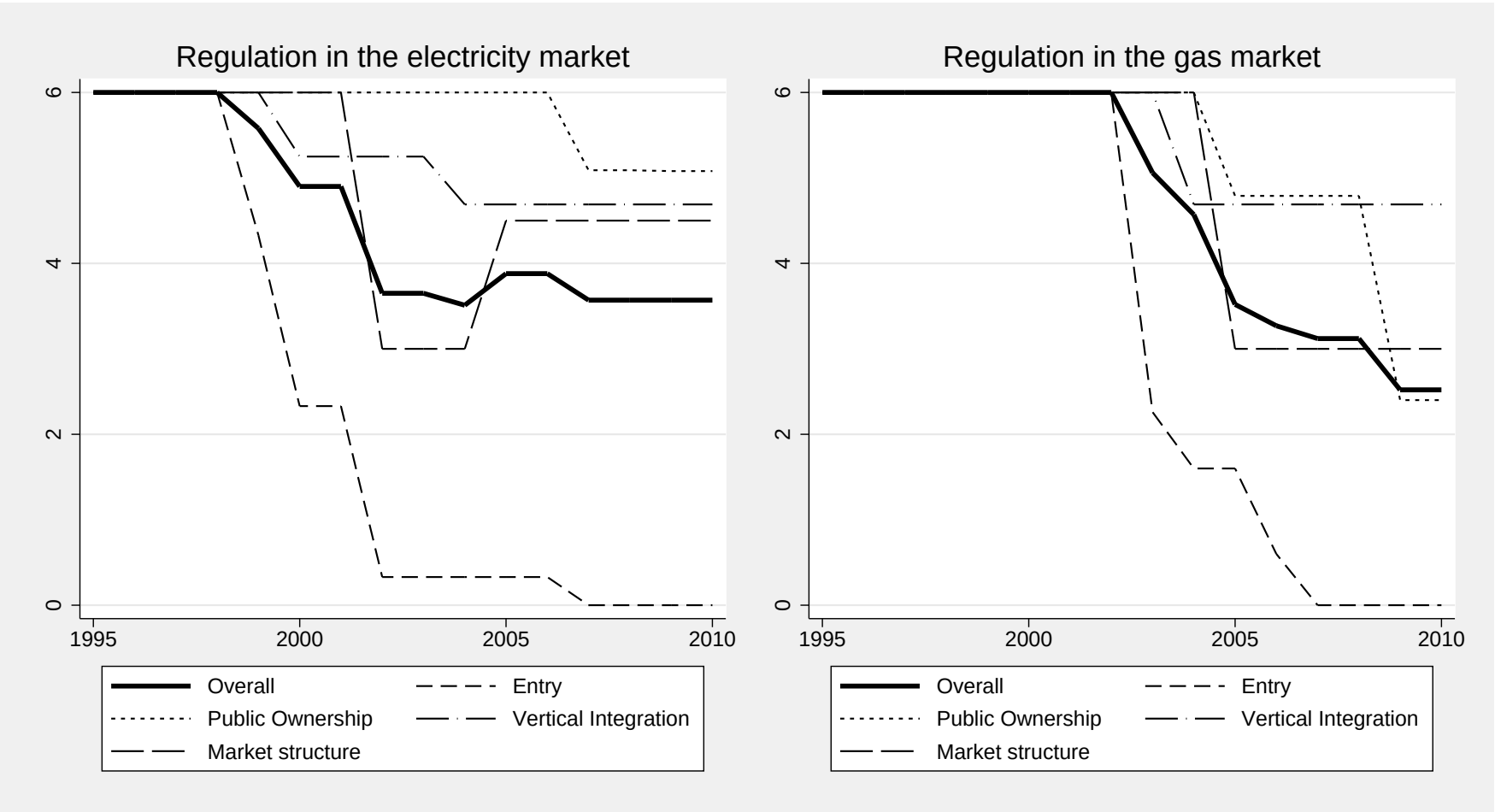
- **Decreases** in **PMR** are expected to **reduce** energy **prices** for plants buying a larger share of energy in the regulated markets
- Lower price will induce a **change in the energy mix** towards gas and electricity

ETS

- Impact of **EU-ETS** on overall **electricity** prices ⇒ **not easy** to quantify in our framework
- The **price** of dirty fuels, like coal, **inclusive** of **price of allowances** for EU-ETS plants, is higher than for non-ETS plants ⇒ **move** from 'optimal' **fuel mix** to **less carbon intensive** fuel mix (more expensive)

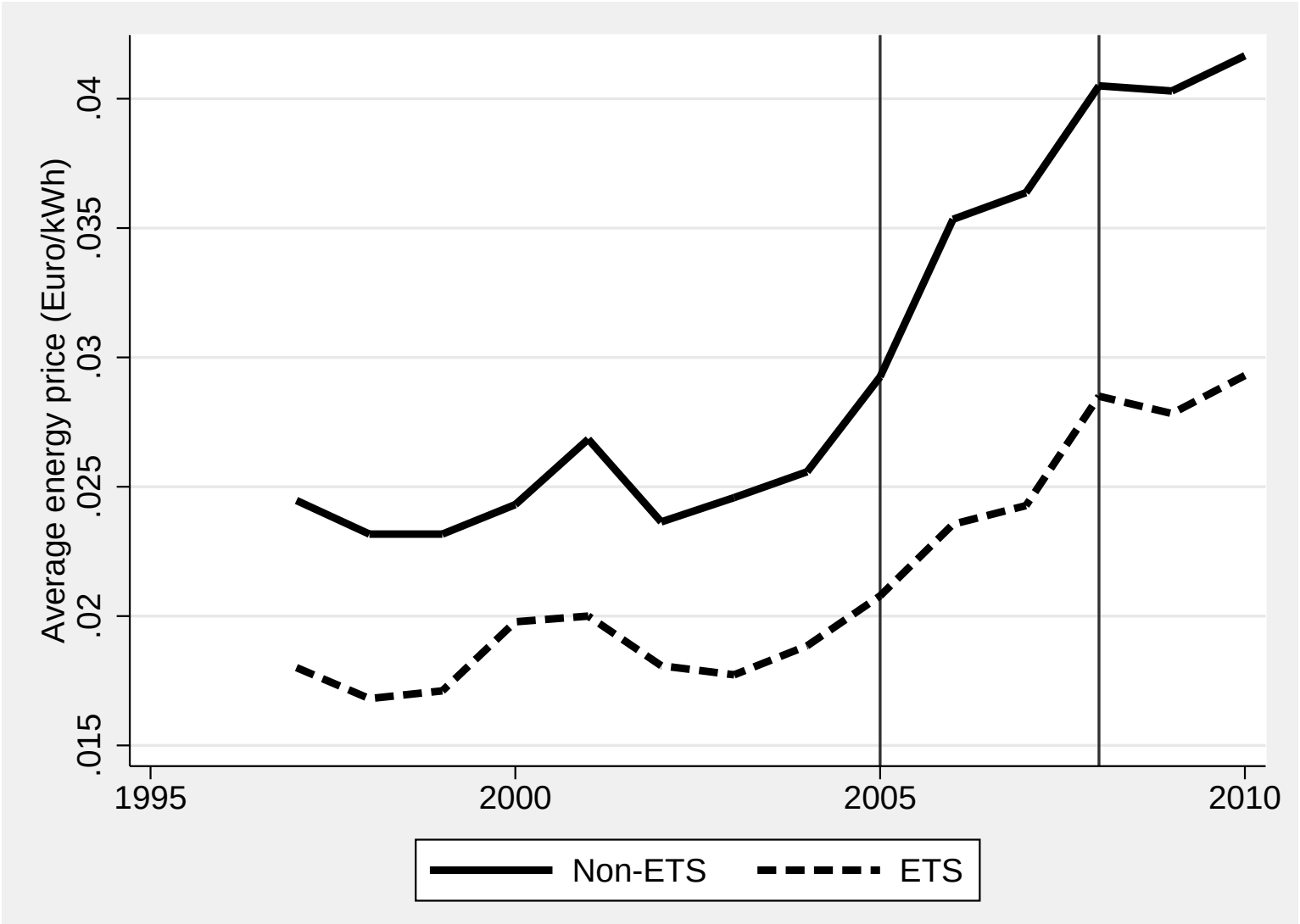
Market regulation in energy and gas

FIGURE – Regulation index (6=fully regulated ; 0=unregulated - source : OECD)



Prices and ETS

FIGURE – Average energy prices for ETS and non-ETS plants (weighted by energy consumption)



Alternative IV

TABLE – Results using an alternative IV based on industry/decile of energy consumption energy mix

	log(energy cons)	log(CO2)	log(empl)	log(average wage per empl)
log(energy price)	-0.582***	-0.813***	-0.194**	-0.0320
	(0.0940)	(0.151)	(0.0753)	(0.0221)
F excl IV first stage	988.3	820.8	988.3	959.8
N	61153	54437	61153	59076

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI. Excluded IV : log of national energy prices (by source) weighted with average 1997-1999 energy mix of the sector/decile of energy consumption cell.

Conditional on firm's turnover

Table – Results conditional on firm's turnover

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.202***	-0.607***	-1.726***	-1.119***
	(0.0308)	(0.0782)	(0.0552)	(0.118)
log(turnover - firm)	0.190***	0.203***	0.165***	0.176***
	(0.0123)	(0.0110)	(0.0161)	(0.0136)
F excl IV first stage		1370.5		1132.5
N	60600	60600	53978	53978
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.0444***	-0.164***	-0.00259	-0.0458***
	(0.0143)	(0.0533)	(0.00397)	(0.0174)
log(turnover - firm)	0.340***	0.338***	0.00787	0.00694
	(0.0169)	(0.0150)	(0.00545)	(0.00507)
F excl IV first stage		1370.5		1409.6
N	60600	60600	58806	58806

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-ETS dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV). Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant.

Only ETS plants

Table – ETS plants

	log(energy cons)		log(CO2)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-1.000***	-0.823***	-1.935***	-1.355**
	(0.123)	(0.268)	(0.353)	(0.532)
F excl IV first stage		47.77		53.05
N	2450	2450	2421	2421
	log(empl)		log(average wage per empl)	
	FE	FE-IV	FE	FE-IV
log(energy price)	-0.00434	0.130	0.0234	-0.215***
	(0.0696)	(0.208)	(0.0215)	(0.0789)
F excl IV first stage		49.77		50.9
N	2450	2450	2418	2418

Robust standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables : year-sector (2-digit NACE rev 2), year-region (NUTS2) dummies, year-peak (>Q3) dummies, year-size (initial size classes) dummies. Sample : plants that are observed in EACEI for at least two years and observations three years or more after the first year in EACEI (used to build the initial energy mix for the IV). Excluded IV : log of national energy prices (by source) weighted with initial energy mix of the plant.