Selling under other skies when energy prices skyrocket: how do the companies adapt their export strategy when energy prices rise?

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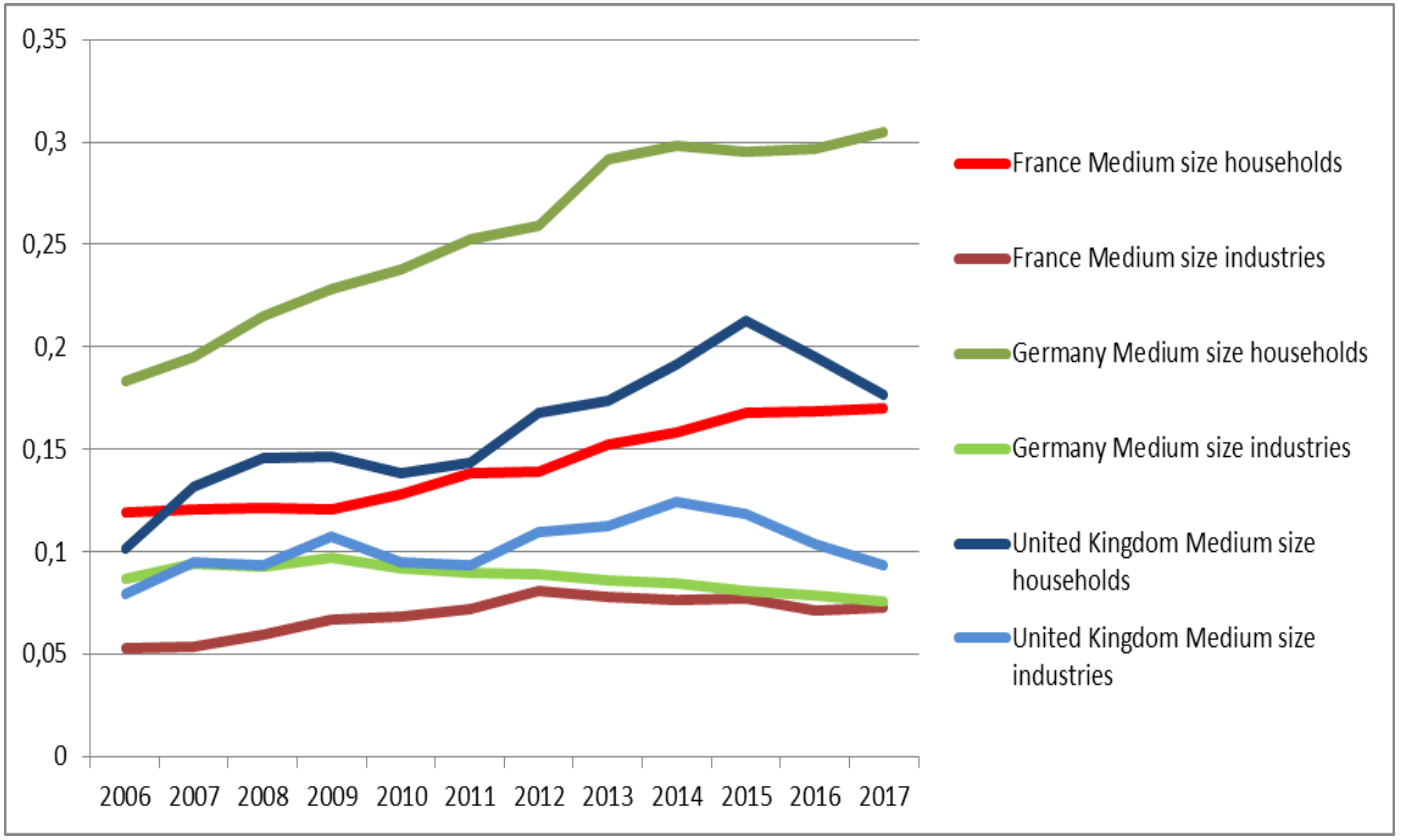
Energy cost and competitiveness

- Frequent concerns that higher energy prices may harm competitiveness
  - *“Energy Policy Is Fundamental to U.S. Competitiveness” (*Harvard Business Review, 2012)
  - *"The price of electrical energy for the industry is relatively low in France and represents an advantage that it is essential to preserve"* (Report Gallois to the French Prime Minister, 2012)
  - *“Energy prices, including electricity prices for industrial users, are a major driver of competitiveness in many industrial sectors”* (Competitiveness Working Group of European Round Table of Industrialists, 2018)
- Policies leading to increase the energy prices, such as carbon taxation, much debated or contested
  - Especially for energy-intensive sectors
- Recent jump in energy prices has brought the issue back to the forefront
- This paper investigates the impact of a change in energy prices on export patterns of manufacturing firms

Significant differences in energy cost

Electricity prices by type of user (including taxes and levies) 2006-2017 (EUR per kWh)



Source: Eurostat

The heterogeneity of export responses

- From the models *"à la Melitz"*, the literature in international economics demonstrated the crucial role of firms' heterogeneity
- Despite the apparent importance of energy for competitiveness and trade performances
  - relatively few theoretical and empirical papers and …
  - mainly based on data at the country or at the sectoral level

- Our objective is to explore the question: ***What are the firms' export responses to change in the energy cost?...*** **by using individual data**

Which are the determinants of export performance at firm level?

- Increasing literature on the microeconomics of trade and exporting
  - Models of heterogeneous firms *à la Melitz* (2003)
  - Both theoretically and empirically
- Several robust facts about **variation in export performance across firms** (Mayer and Ottaviano, 2007; Manova and Zhang, 2009)
  - Across a wide range of countries and industries, exporters **are larger, more productive, more skill- and capital-intensive** than non-exporting firms
- Better understanding of the **exporters' responses to different kinds of shocks**
  - Estimations of the elasticities of exports to tariffs, exchange rates and transportation cost based on individual data (Berman et al., 2012; Fontagné et al., 2018; Chaney, 2018)

Energy cost, a determinant of export performance?

- Sato and Dechezleprêtre (2015)
  - Based on aggregated trade data (sectoral level)
  - **+10% in the energy price difference** between two country-sectors => **imports by +0.2%**
- Chan et al. (2017)
  - Energy consumption at all the stages of production
  - **1% increase** in the exporter's electricity costs => **-0.07% in exports** for a sector of average electricity intensity
- Arezki et al. (2016)
  - Causal impact of the sudden increase in gas supply in USA
  - **Significant expansion in exports of energy-intensive goods**
- Aldy and Pizer (2015)
  - Analysis based **on historical electricity prices**
  - Higher energy prices (around $15 tax per ton CO_2) => **-5% in production** among key energy-intensive sectors

Contribution of the paper

- Based on a large panel of French firms from 2001 to 2015
  - Firm-level analysis allows taking into account firms' heterogeneity
- Estimation of the effect of energy cost **on exports and its margins**: extensive, intensive, price
- We highlight the **important differences** between large firms and SMEs and between energy intensive firms and non intensive firms
- We show that **trade adjustments (extensive, intensive, price) depend on the firms' characteristics** as well as on the export destinations

The database

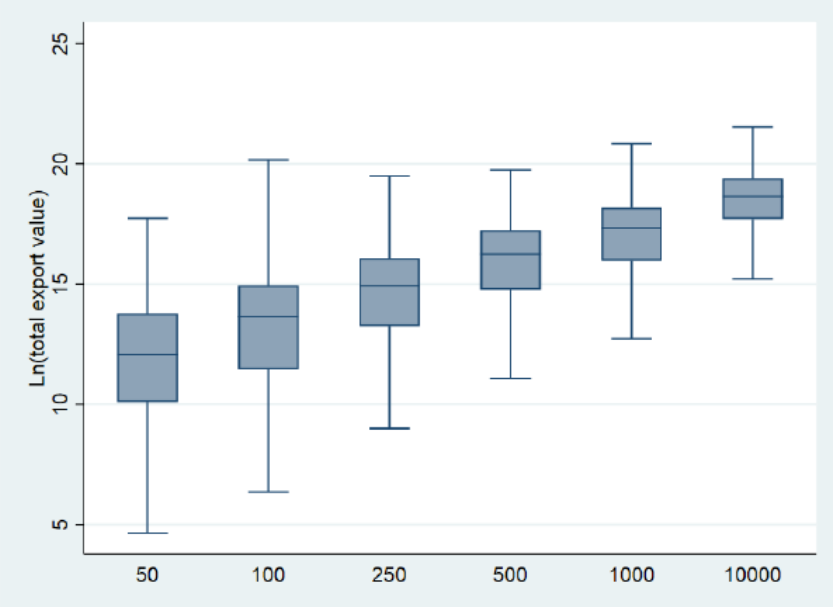
- 9,700 firms from 2001 to 2015 covering the whole manufacturing sector
- Merging (i) an energy use dataset, (ii) French custom dataset, and (iii) a fiscal dataset
- Plant-fuel-level consumption and expenditure data come from the EACEI (Insee)
- Firm-product-destination value and quantities provided by the French customs

Preliminary observations

Size category	Number of firms	Percent of sample	Cumulative
1 - 50	4,052	41.8	45.2
51 - 100	2,294	23.7	65.4
101 - 250	2,180	22.5	87.9
251 - 500	716	7.4	95.3
501 - 1,000	296	3.1	98.3
1,001 - 10,000	163	1.7	100.0

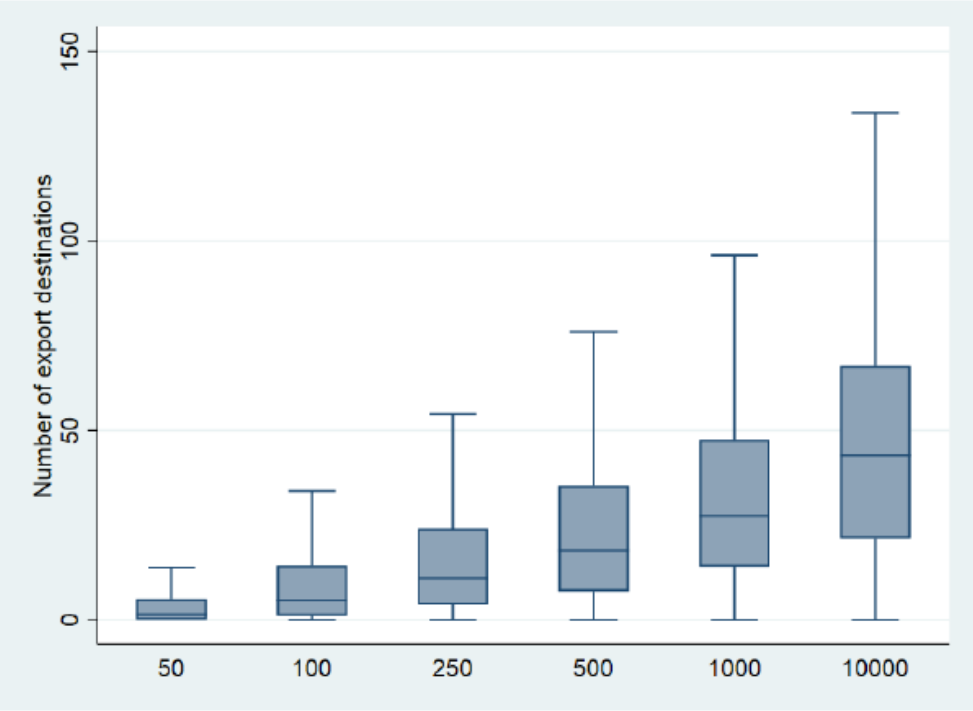
Number of firms by size category

Total export by size category
Distribution of the average value of 9,700 French firms during 2001-2015 (*category 100 contains firms having between 51 and 100 employees*)



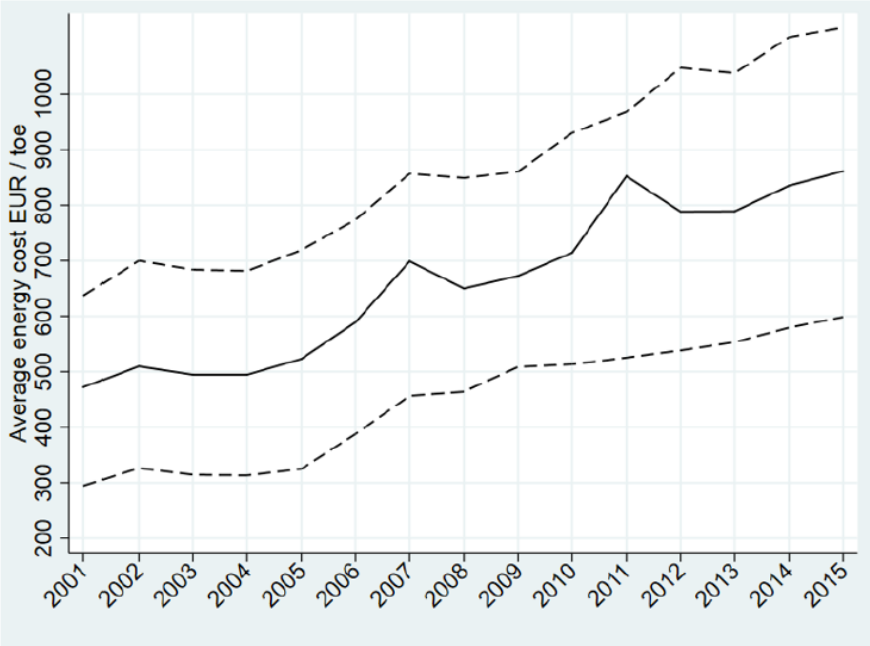
Preliminary observations

Number of export destinations by size category



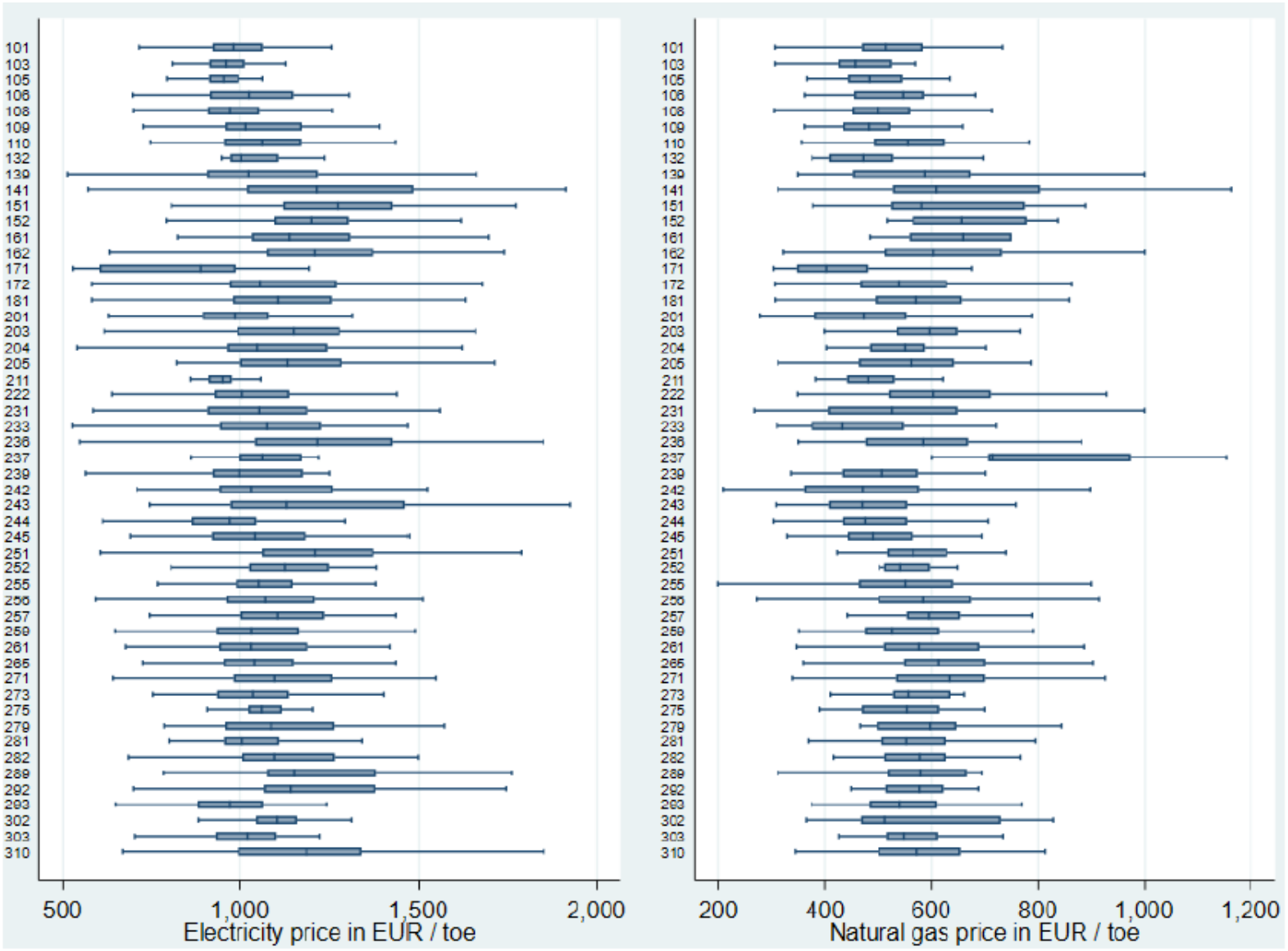
Energy cost

- Focus only **on 4 fuels** : electricity, gas, heating oil and butane/propane (other fuels are much less used)
- Significant evolution of the energy cost during the period 2001-2015



Dotted lines represents the 10th and the 90th percentiles. Source: Authors' calculation.

Between-firms variation in fuel prices within industries



Empirical strategy

- We estimate the short-run effect of the energy price on firms export behaviors using the following model:

$$Export_{ti}=\beta_0+\beta_1.Cost_{it-1}+\beta_2.X_{it-1}+\mu_i+\gamma_t+\varepsilon_{it}$$

- $Export_{ti}$ *:* outcome variable for firm *i* at time *t* (export value, export unit value, average export value per destination and number of export destinations)
- *Cost* : logged average energy cost measured by the ratio between expenditure in electricity, natural gas, heating oil, and butane propane in thousand euros and the quantity of these fuels in ton oil equivalent (in euros/toe)
- *X* : vector of firm-level controls (number of employees, EU ETS inclusion…)

Empirical strategy

$$Export_{ti} = \beta_0 + \beta_1 . Cost_{it-1} + \beta_2 . X_{it-1} + \mu_i + \gamma_t + \varepsilon_{it}$$

- We estimate this equation with a fixed-effect estimator
  - Control for time invariant and firm specific characteristics *:* this captures for instance differences across firms operating in industries that vary in terms of energy intensity
  - Year dummies: this captures for instance consumer demand and fuel price variations in France affecting all firms
- Robust standard errors clustered at the firm level

Empirical strategy

- In the equation, $Export_{it}$ and $Cost_{it}$ are chosen simultaneously
  - Firms can change the fuel prices they face by changing their fuel use as well as their output level or their technologies
  - OLS yields a biased estimate of the fuel prices even with a fixed-effects estimator
- To address this simultaneity bias, use of an exogenous variation in the fuel price as instrumental variable for the energy cost as in Sato et al. (2018) and Linn (2018):
  - Fixed-weight energy price index:

$$FEPI_{it} = \sum_{f} w_{if0}.\ln(p_{kft})$$

  - w_{if0} : share of fuel *f* in total energy of firm *i* at the pre-sample year *0*
  - p_{kft} : median price of fuel *f* for the 3-digit industry *k* in which the firm *i* operates at year *t*

Empirical strategy

- We use FEPI as an instrumental variable **in a control function estimator**
  - **M**ethod developed by Wooldridge (2015)
- First stage:

$$Cost_{it}=\delta_1.X_{it}+\delta_2.FEPI_{it}+\mu_i+\gamma_t+\upsilon_{it}$$

- The residuals of this first-stage estimation controls for the endogeneity of $Cost_{it-1}$
- Second stage:

$$Export_{ti}=\beta_0+\beta_1.Cost_{it-1}+\beta_2.X_{it-1}+\mu_i+\gamma_t+\delta.\widehat{\upsilon_{it-1}}+e_{it}$$

Energy cost on trade volume and export prices

	Ln(total export value)		Ln(export unit value)	
	OLS	CF	OLS	CF
Ln(average energy cost)	-0.056	-0.361***	-0.014	0.228**
	(0.036)	(0.125)	(0.024)	(0.109)
First stage residual		-0.321**		0.256**
		(0.129)		(0.113)
Firm FE	X	X	X	X
Year dummies	X	X	X	X
Observations	49,658	49,658	49,658	49,658
Number of firms	9,700	9,700	9,700	9,700
Kleinbergen Paap		817		817

- Kleibergen Paap LM = 817 & First-stage F = 1,905 $\Rightarrow$ **strong IV**

Energy cost on the extensive and intensive margins

	# of export destinations		Ln(average export value)	
	Poisson	CF	OLS	CF
Ln(average energy cost)	-0.018	-0.274***	-0.037	-0.185*
	(0.018)	(0.065)	(0.030)	(0.111)
First stage residual		-0.267***		-0.156
		(0.066)		(0.112)
Firm FE	X	X	X	X
Year dummies	X	X	X	X
Observations	54,393	54,393	49,658	49,658
Number of firms	9,700	9,700	9,700	9,700
Kleinbergen Paap	817		817	

- Kleibergen Paap LM $= 817$ & First-stage F $= 1{,}905 \Rightarrow$ **strong IV**

Exploring firms' heterogeneity

- Possible that firms react to energy price changes differently
  - Does the effect of energy price differ between Small and Medium Enterprises (SMEs) and bigger firms?
- We focus on 2 dimensions at the firm level: **size and energy intensity**
- We interact the energy cost with a **SME dummy** and an **energy intensity dummy** (both pre-sample)
  - SME equals 1 if the firm has **less than 250 employees**
  - Intensive (EI) equals 1 if the firm's energy intensity is higher than the 75^{th} percentile of the energy intensity distribution of the 3-digits industry in which it operates

Exploring firms' heterogeneity

Marginal effects	Ln(total export value)
Non intensive large	-0.456***
Intensive large	-0.666***
Non intensive SME	-0.214
Intensive SME	-0.424***

- **Marginal effects** for each kind of firms (IV regressions
- Biggest reductions in total export value for
  - Large EI firms,
  - Small and medium EI firms,
  - But also large non-EI firms
- But their export responses to energy price variation differ

Exploring firms' heterogeneity

Marginal effects	Ln(total export value)	Ln(export unit value)	# of export destinations	Ln(average export value)
Non intensive large	-0.456***	0.230**	-0.198***	-0.218
Intensive large	-0.666***	0.044	-0.311***	-0.334***
Non intensive SME	-0.214	0.329***	0.005	-0.109
Intensive SME	-0.424***	0.142	-0.108**	-0.225*

- For the EI firms:
  - No change in export prices
  - But decrease in the extensive margin and in the intensive margin
- For the non-EI firms
  - Increase in exports prices, but only the largest adjust their intensive and extensive margins

Conclusions

- Significant changes in export pattern due to energy prices variations
  - Increasing energy cost by 10% leads to a 3.6% decrease in total export value
  - The reduction does not occur only through the intensive margin (-1.9%) but also via the extensive margins (-2.7%)
  - Large firms that are energy intensive experience the largest decrease in exports
- Decisions about the price, quantity, presence … differ across the firms
- In the paper, results also on the heterogeneity between export markets

Thank you for your attention

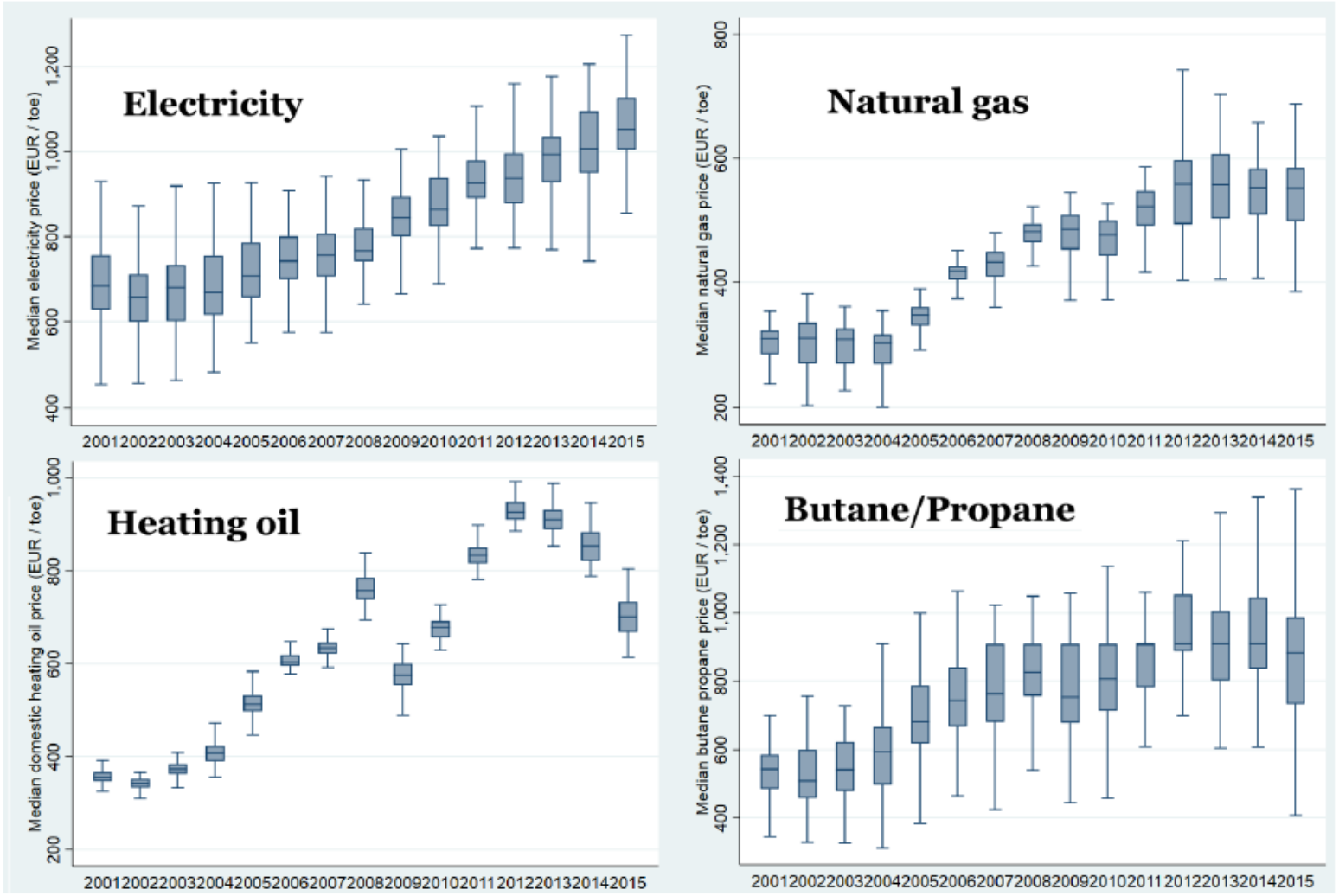
Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Ln(export value)	49,658	14.41	2.75	0	23.42
Ln(export unit value)	49,658	2.80	1.81	-6.19	11.96
Ln(average export value per destination)	49,658	12.11	1.93	0	19.77
Nr. exported products	60,808	10.99	19.19	0	415
Nr. export destinations	60,808	15.05	19.13	0	167
Nr. exported varieties	60,808	48.54	145.67	0	6,421
Ln(average energy cost)	60,808	-0.46	0.35	-5.96	7.14
FEPI	60,808	-0.47	0.29	-1.53	0.34
SME	60,808	0.83	0.38	0	1
Energy intensive	60,808	0.27	0.44	0	1
Ln(employees)	60,808	4.63	1.04	1.95	10.20

	Ln(average energy cost)
FEPI	0.702***
	(0.017)
Firm FE	X
Year dummies	X
F-stat	1,905
Observations	60,808
Number of firms	11,640

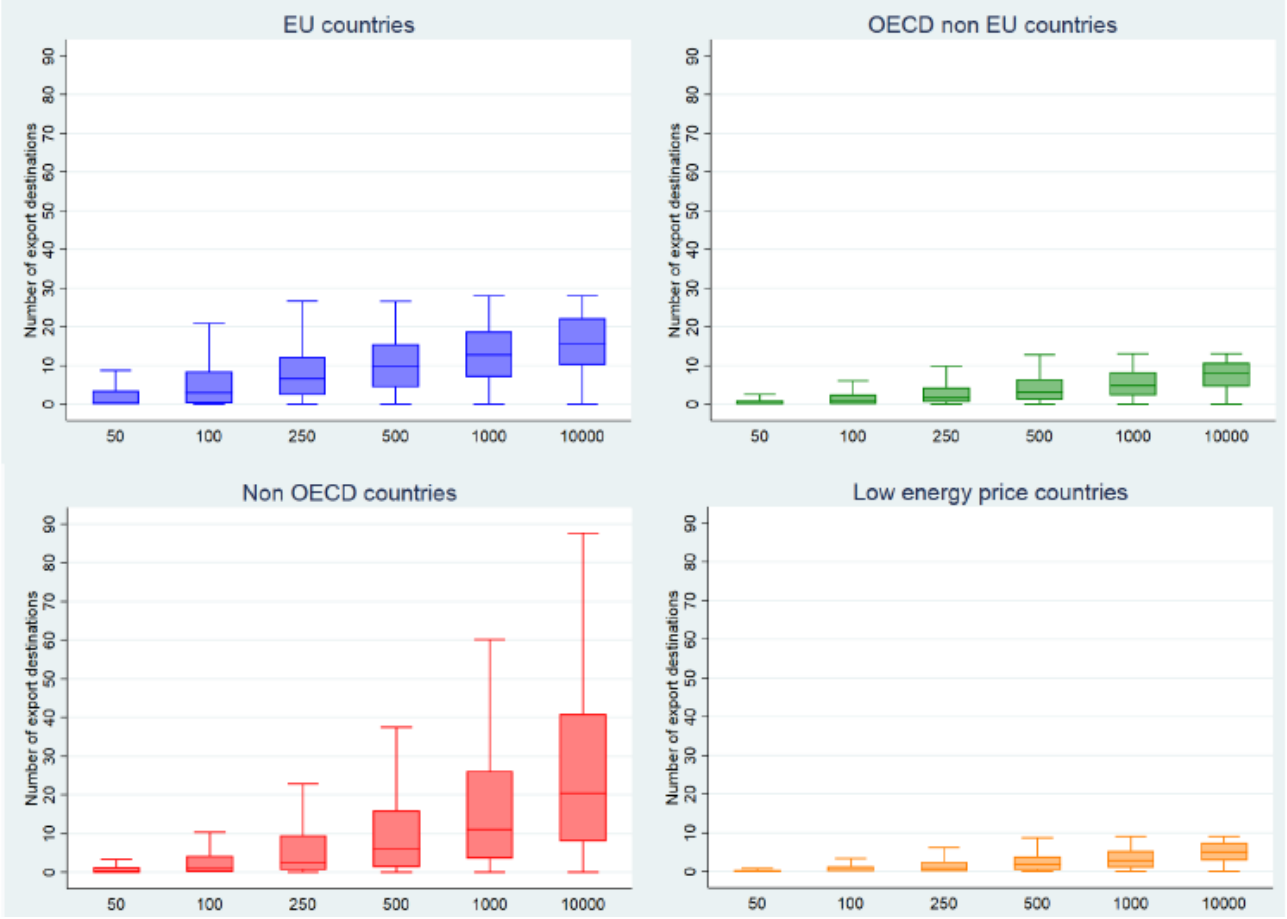
	Ln(energy cost)	Ln(energy cost) x SME	Ln(energy cost) x intensive
FEPI	0.728***	-0.169***	-0.093***
	(0.020)	(0.016)	(0.010)
FEPI x SME	-0.094***	0.885***	-0.026***
	(0.012)	(0.007)	(0.007)
FEPI x intensive	0.115***	0.094***	0.974***
	(0.011)	(0.010)	(0.009)
Firm FE	X	X	X
Year dummies	X	X	X
F-stat	1,800	1,232	700
Observations	60,808	60,808	60,808
Number of firms	11,640	11,640	11,640

Distribution of industry-level median of the energy cost



Exploring firms' heterogeneity and markets' heterogeneity

Number of export destinations by size category



Exploring firms' heterogeneity

- Countries in EU, OECD non EU and non OECD countries **have different trade cost** relative to France and various development level
- Low energy price countries = Energy Price Level < 25th percentile (500 USD per toe) includes Canada, China, Mexico, New Zealand, South Africa, Kazakhstan, Indonesia, Taiwan, and the USA

Exploring markets' heterogeneity

- Separate IV regressions (each cell is a regression)

	Ln(export value)	Ln(export unit value)	Nr. export destinations	Ln(average export value per destination)
EU	-0.545***	0.092	-0.077*	-0.378***
OECD non EU	0.141	0.391***	-0.108*	0.155
Non OECD	-0.550***	0.225**	-0.209***	-0.347**
Low energy price	-0.613**	0.472***	-0.189***	-0.534**

- Biggest reductions in export in
  - Low energy price countries
  - Non OECD countries and EU