The impact of the 2021 energy crisis on large industrial firms

Matteo Alpino [1] Luca Citino [1] Annalisa Frigo [1]

[1] Bank of Italy

26 April 2023

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Three contributions:

1. **Document key descriptive facts about energy costs**
2. **Estimate short-run price elasticity of electricity and gas demand**
3. **Effect of crisis on own price setting**

We exploit **Invind** survey information on **2021** for **Industry $\geq$50 employees**

- Energy section in the context of the annual Invind survey
- **941** respondents $\approx$ **50%** of whole sample Attrition
- We drop refineries & coke (NACE 19) and energy generation (NACE 35)

Survey questions

Rising energy prices

At the beginning of 2021, did your firm own any instruments that protected it, wholly or partly, from energy price increases over the second half of the year?	E11

1 No
2 Yes, fixed-price contracts
3 Yes, financial derivatives
4 Yes, other instrument

	In the first half of the 2021		In the second half of the 2021	
Please indicate, even approximately, the purchased quantity and the respective cost of the following products:	Purchased quantity	Total cost (thousands of euros)	Purchased quantity	Total cost (thousands of euros)
Electricity	E9A MWh	E7A €	E9B MWh	E7B €
Natural gas	E10A Scm	E8A €	E10B Scm	E8B €

- Data cleaning and validation with Eurostat price and ETS quantity data Validation

Descriptive facts

Retail prices of energy are heterogeneous

- Almost exclusively negotiated on the free market
- Retail price includes several components
  - fees for transport and distribution
  - taxes and levies (lower for large consumers)
  - quantity of energy (MWh)
  - power capacity (MW)
- Some of these components are fixed costs i.e. not a function of quantity purchased

$\rightarrow$ **average price declines with quantity**

- Two main types of contracts for the energy component:
  - **Fixed price** for typically 12 to 24 months **(rolling basis)**
  - **Floating price**, indexed to wholesale price

Firm-level energy prices increased but less than wholesale

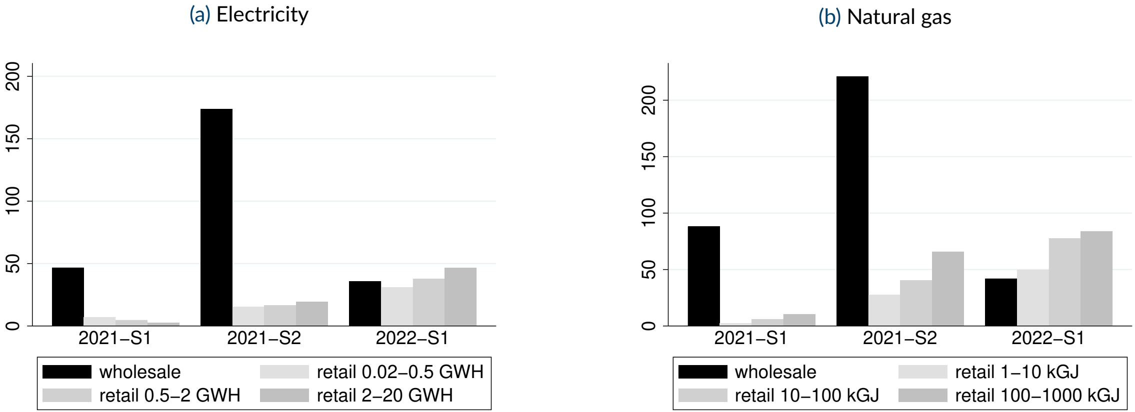


Figure: Price change relative to previous semester (%).

Source: Eurostat and Gestore Mercati Energetici.

Substantial heterogeneity in changes of the retail price

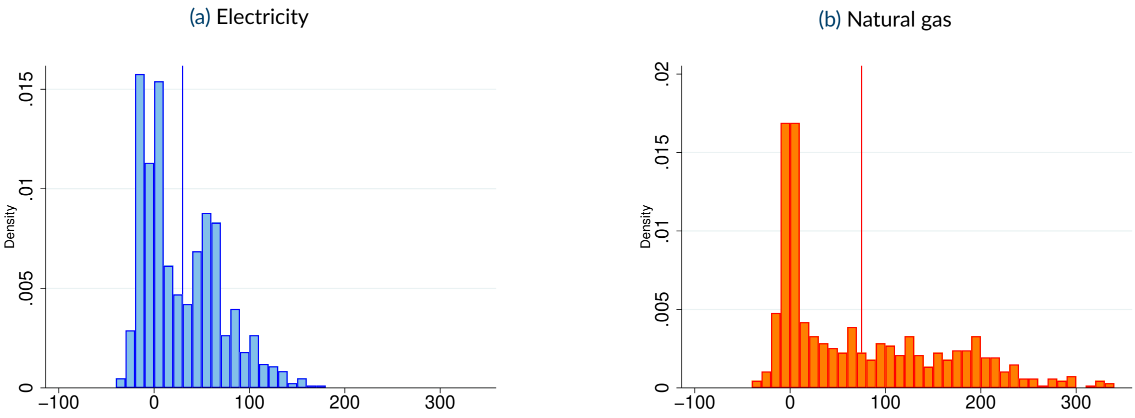
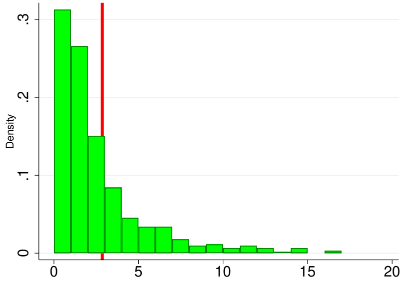


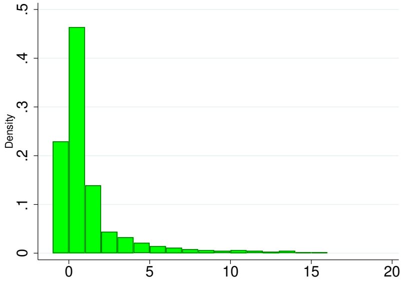
Figure: Price changes in the second semester 2021 relative to previous semester (%).
Source: Invind.

Incidence of energy costs before the crisis was low for most firms and it didn't increase much

(a) Energy cost / turnover (%) - 1 sem. 2021



(b) % change sem. 2 vs sem. 1



- Heterogeneity both **across** and **within** sectors Heterogeneity
- Qualitatively similar when using total cost as denominator Energy cost over total cost

Elasticity of the demand of energy to its own price

Credible estimation requires an instrumental variable

- Regressing $\Delta \log Q$ on $\Delta \log P$ by OLS leads to simultaneity
- As price is a decreasing function of demanded quantity, OLS might capture reverse causality
- Need a price shifter **Z** that is unrelated to demand-side unobservables

$\rightarrow$ **Z** $=$ dummy for whether pre-crisis (i.e. *"At the beginning of 2021"*) the firm was at least **partially insured** (e.g. with fixed price contracts) against energy price swings occurred in Q3-Q4 2021

the ideal quasi-experiment

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the ideal quasi-experiment

A1: Independence

Two possible violations of A1:

1. Firms with $Z = 1$ were expecting a large price surge that firms with $Z = 0$ did not expect and for this reason they purchased insurance
   - But at the beginning of 2021 markets were **not** expecting the crisis
2. Firms with different levels of Z are difficult to compare because Z also captures differences in the time-constant propensity to insure (e.g. due to risk aversion)
   - Indeed $Z = 1$ are larger and more likely to be ETS, *energivore* and self-generating electricity Table
   - Solution: absorb firm fixed effects and control for differential trends

A2: exclusion restriction

Fixed-price contracts affect gas quantities only through gas prices

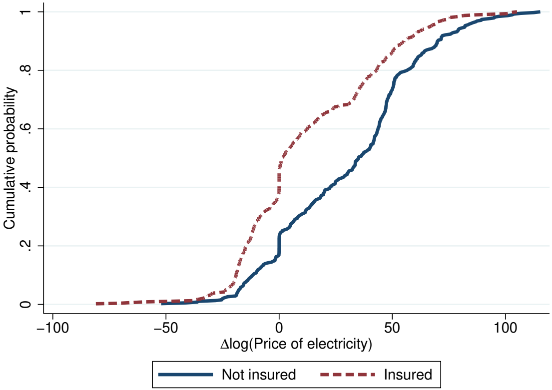
- We have one instrument that moves two prices: electricity and gas
- Then exclusion restriction may be violated if Q_{gas} responds to P_{elec}, also affected by the instrument. Consider the *long* equation:

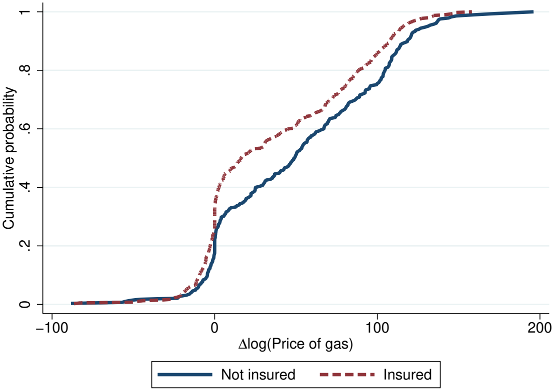
$$\Delta \log Q_{gas} = \alpha + \beta \Delta \log P_{gas} + \gamma \Delta \log P_{elec} + u \tag{1}$$

- In this specific case, no violation if $\gamma = 0$
  - $\gamma = 0$ true if electricity and gas are not substitutes nor complements
  - Reasonable to assume no substitutability in the short-run
  - The two could be complements, but this could lead to overestimation

A3 and A4: relevance of first stage and monotonicity check

$$F_z(p) = Pr(\Delta logP_i(Z) \leq p) \text{ for } Z = 0, 1$$





Empirical specification

First stage:

$$\Delta \log(P_i^s) = \rho_0 + \rho_1 Z_i + \gamma X_i + u_i \tag{2}$$

Second stage:

$$\Delta \log(Q_i^s) = \alpha_s + \beta_s \Delta \log(P_i^s) + \gamma X_i + \epsilon_i^s \tag{3}$$

where

- $s = \{\text{electricity, gas}\}$ and i is firm
- $\Delta \log(Q_i^s)$ is the log change in quantities between the 1st and the 2nd semester of 2021
- $\Delta \log(P_i^s)$ is the log change in prices between the 1st and the 2nd semester of 2021
- X_i includes fixed effects (class size, sector, macroregion) and covariates (ETS, *energivore*, own energy production, 2020 sales, emission accounting)

Price-elasticities of energy demand

	Whole sample	Gas intensive (EU ETS)	Electricity intensive
Electricity	**- 0.03**	**0.0**	**- 0.1**
	[-0.21,0.16]	[-0.97,...]	[-0.36,0.18]
Natural gas	**- 0.18**	**- 0.71**	**- 0.24**
	[-0.71,0.33]	[-2.05,-0.01]	[-1.11,0.29]

Table: IV with no controls. Anderson Rubin confidence bands in parenthesis.

- K-P F statistics around 80 for electricity and 13 for natural gas

OLS vs IV IPW Lee (2009) bounds

Price-elasticities of energy demand

	Whole sample	Gas intensive (EU ETS)	Electricity intensive
Electricity	**0.01**	**0.2**	**- 0.02**
	[-0.16,0.20]	[-0.94,...]	[-0.31,0.30]
Natural gas	**- 0.01**	**- 0.85**	**0.01**
	[-0.42,0.41]	[...,-0.15]	[...,...]

Table: IV Including FEs and firm-level controls. Anderson Rubin confidence bands in parenthesis.

- K-P F statistics around 80 for electricity and 13 for natural gas

OLS vs IV IPW Lee (2009) bounds

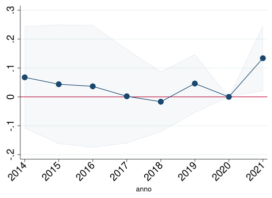
Additional evidence from administrative data

Event-study on ETS data

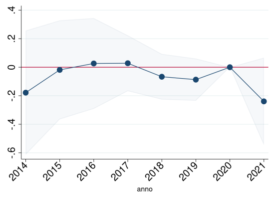
- annual-frequency data on fossil fuel consumption by ETS plants
- μ_i firm fixed effects; γ_t year fixed effects; Z_i as before, from Invind

$$\log(consumption_{it}) = \mu_i + \gamma_t + \sum_k \lambda_k \cdot Z_i \cdot \mathbf{1}(\text{year} = k) + \varepsilon_{i,t}. \tag{4}$$

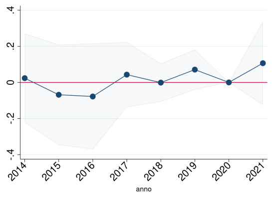
(a) natural gas



(b) substitutes



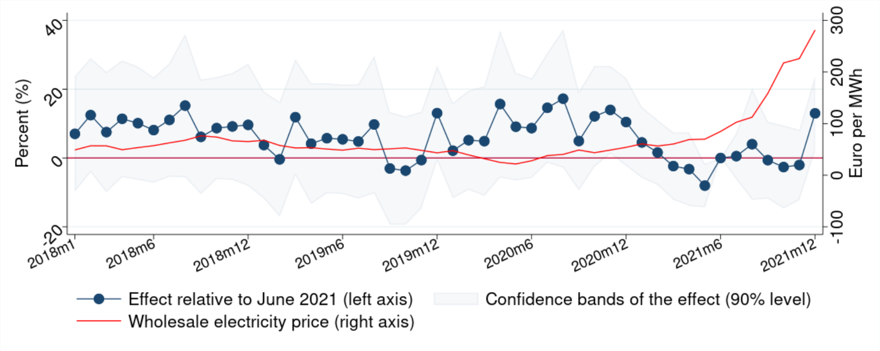
(c) gas+substitutes



Event-study on ETS data

- monthly-frequency data on electricity consumption by *energivore* firms
- μ_i firm fixed effects; γ_t month-year fixed effects; Z_i as before, from Invind

$$\log(electricity_{it}) = \mu_i + \gamma_t + \sum_k (\lambda_k \cdot Z_i \cdot \mathbf{1}(\text{monthly date} = k)) + \varepsilon_{i,t}. \quad (5)$$



Effect on price setting

Consequences on price setting behaviour - Invind data

$$
\begin{aligned}
\pi_{it} = & \mu_i + \gamma_t && (6)\\
& + \sum_k \alpha_k \cdot Z_i \cdot \mathbf{1}(\text{year} = k) && (7)\\
& + \sum_k \beta_k \cdot W_i \cdot \mathbf{1}(\text{year} = k) && (8)\\
& + \sum_k \gamma_k \cdot Z_i \cdot W_i \cdot \mathbf{1}(\text{year} = k) + \varepsilon_{i,t}. && (9)
\end{aligned}
$$

- i indexes firm and t year
- π_{it} is the annual change in own price
- μ_i firm fixed effects and γ_t year fixed effects
- Z_i same as before
- W_i is a dummy for energy-intensity (different proxies)

All firms increase prices, but energy-intensive more, unless insured

	(1)	(2)	(3)	(4)
2021	6.60***	5.58***	5.85***	6.52***
	(0.86)	(0.84)	(0.78)	(1.23)
2021 × Z_i	-0.08	-0.00	0.39	0.55
	(1.09)	(1.15)	(1.04)	(1.53)
2021 × *Energivora* status		4.15*		
		(2.50)		
2021 × Z_i x *Energivora* status		-1.00		
		(2.89)		
2021 × ETS			11.35*	
			(6.51)	
2021 × Z_i x ETS			-8.27	
			(7.08)	
2021 × Energy intensive (cost)				1.48
				(2.91)
2021 × Z_i x Energy intensive (cost)				-3.35
				(3.22)

Conclusions

Key take-aways from Invind 2021

- **Heterogeneity**: Energy costs remain a low share of turnover for most firms, but wide variation
- **Response**: Despite big price changes in 2021, elasticities at the **lower end** of literature estimates
- **Own price setting**: energy-intensive firms adjust more, unless insured

What about 2022?

What about 2022?

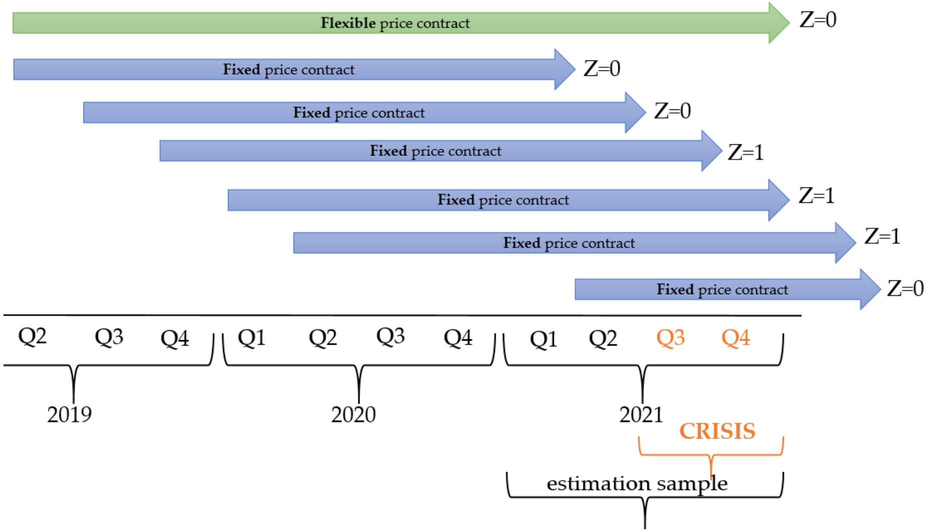
- Prices still on the rise, fixed contracts expiring
- We know from the literature that elasticity gets larger if:
  - time horizon is longer
  - shock is not perceived as temporary
- Aggregate data suggests a drop in industrial energy consumption in the second half of 2022
- Large role of public policies (e.g. tax credit) in 2022

→ new section in the **current INVIND**: new data is coming in as we speak...

Thank you for your attention.

matteo.alpino@bancaditalia.it

How the instrument is constructed: example



	Insured	Not insured	Diff.	
	mean	mean	b	t
Sales 2020 (milion euro)	209.06	105.40	-103.66*	(-2.26)
Tot. investments (milion euro)	12.59	6.16	-6.42*	(-2.02)
Tot. costs (milion euro)	197.09	104.59	-92.51	(-1.85)
Share tot. costs on sales 2020	0.64	0.65	0.00	(0.19)
Utilization of prod. capacity (%)	78.42	78.36	-0.07	(-0.06)
Labour force	487.74	306.36	-181.38*	(-2.19)
Exp. utilization of prod. capacity 2022	81.17	81.17	0.00	(0.00)
Public limited company (0/1)	0.69	0.66	-0.03	(-0.94)
Limited liability company (0/1)	0.28	0.32	0.04	(1.29)
Share of energy costs on sales (%)	2.66	3.14	0.48	(1.33)
Self-generating electricity (0/1)	0.56	0.36	-0.21***	(-6.32)
Self-generated electricity (%)	17.17	8.86	-8.32***	(-5.55)
Status “Energivora” (0/1)	0.30	0.22	-0.07*	(-2.49)
Emission accounting (0/1)	0.40	0.28	-0.12***	(-3.74)
Subject to ETS in 2021 (0/1)	0.09	0.06	-0.04*	(-2.05)
Observations	500	407	907	

back

	Insured	Not insured	Diff.	
	mean	mean	b	t
Food and beverages	0.14	0.10	-0.05*	(-2.25)
Textiles & apparel	0.10	0.09	-0.00	(-0.13)
Chem., pharma., rubber	0.18	0.13	-0.06*	(-2.46)
Non-metallic minerals	0.06	0.04	-0.02	(-1.18)
Wood, paper, furniture	0.09	0.11	0.02	(1.14)
Water & waste	0.03	0.05	0.02	(1.80)
50-99 addetti	0.26	0.33	0.07*	(2.14)
100-199 addetti	0.26	0.27	0.01	(0.50)
200-499 addetti	0.27	0.24	-0.03	(-0.94)
500-999 addetti	0.12	0.09	-0.02	(-1.21)
1000 e oltre addetti	0.09	0.06	-0.03	(-1.59)
Nord-Ovest	0.31	0.28	-0.04	(-1.28)
Nord-Est	0.26	0.21	-0.04	(-1.50)
Centro	0.25	0.27	0.02	(0.61)
Sud e Isole	0.18	0.24	0.06*	(2.31)
Observations	500	407	907	

back

Our elasticities are at the lower end of the literature estimates

- Our **point estimates are close to zero** and at the lower end of the literature estimates
- Our confidence intervals safely rule out elasticities larger than
  - -0.2 for electricity
  - -0.4 for natural gas
- These intervals include the elasticities obtained by a meta-analysis of the literature (Labandeira et al. 2017 Energy Policy)
  - Electricity: -0.15
  - Natural gas: -0.25

Frame Title

	(1)	(2)	(3)	(4)
	Whole sample	non-ETS	ETS	ETS + controls
Δ log P electricity	-0.0286	-0.0224	-0.00480	0.0465
	[-0.216,0.159]	[-0.200,0.155]	[-0.909,0.899]	[-0.609,0.702]
Observations	848	785	63	63
K-P F stat	76.14	75.86	7.935	5.567

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Frame Title

	(1)	(2)	(3)	(4)
	whole sample	non-energivore	energivore	energivore + controls
Δ log P electricity	-0.0286	-0.0252	-0.0985	-0.0189
	[-0.216,0.159]	[-0.261,0.211]	[-0.354,0.157]	[-0.311,0.273]
Observations	848	620	228	224
K-P F stat	76.14	53.48	33.63	26.00

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Frame Title

	(1)	(2)	(3)	(4)
	whole sample	non-energivore	energivore	energivore + controls
Δ log P gas	-0.183	-0.0656	-0.238	-0.0201
	[-0.627,0.261]	[-0.631,0.500]	[-0.712,0.235]	[-0.600,0.560]
Observations	682	486	196	189
K-P F stat	13.13	9.175	7.666	3.930

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Policy interventions in 2021

D.L. n. 130 on 27 September 2021, for the last quarter of 2021 and
Budget law in December 2021, for the first quarter of 2022:

- eliminate general system charges in the electricity sector for small businesses (with low-voltage up to 16.5kW, $\approx$ 6 million SMEs);
- cancel the charges on gas bills for all users;
- drop VAT on the use of natural gas to 5% on supplies for both civil and industrial uses;
- other advantages for households (e.g. possibility to pay bills in multiple instalments)

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Ideal quasi-experiment and our instrument

- Fixed price contracts lasts typically 12 to 24 months and expire on a **rolling basis**
- Whether the contract expires in June ’21, January ’22 or any point in between is random
- The ideal **Z**= date of contract expiration

- Our binary **Z** conflates two sources of variation:
  - timing of contract expiration (as above)
  - fixed vs. floating contracts (less ideal)
- However, we control for time-invariant firm-level characteristics that should absorb differences in risk aversion

back

The instrument

- Survey question:

  "At the beginning of 2021, did your company have (even if partial) ***hedging tools against the rising energy prices*** *that occurred around the end of the year?"*

  1. No;
  2. Yes, through fixed price contracts;
  3. Yes, through derivatives;
  4. Yes, other tools.

- **Z**=0 if the answer is "No" and 1 otherwise
- Only one question, not specific by energy source

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Anecdotes – from Ben Moll's list on German manufacturers

- **Fuel substitution:** *Berchtesgadener Land dairy* and *Wieland-Glas* substitute gas with heating oil.
- **Electrification of production:** *Wurth* converts ovens to make screws from gas to electricity
- **Import-substitutes:** *BASF* produces ammonia from its plants in USA.

Many of these required either import substitution or new capital, except if heating

back

Literature

Virtually no evidence on the impacts of the gas crisis

- Time series analysis Runhau et al. (2022) find 11% decline in industry gas demand in GER.

Our contribution: micro data with information on *actual* retail prices

- Case studies on single industries: Stiewe et al. (2022)

Our contribution: Look at many industries, although firm size $\geq$50

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Data validation: Eurostat reference prices by consumption class

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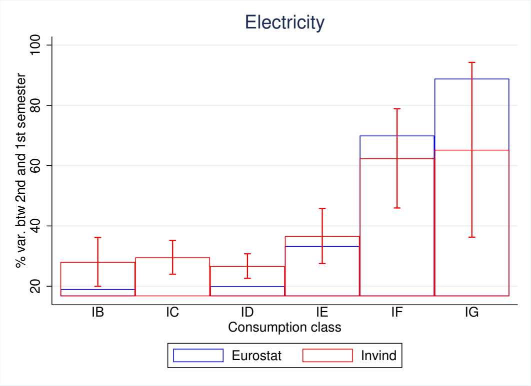
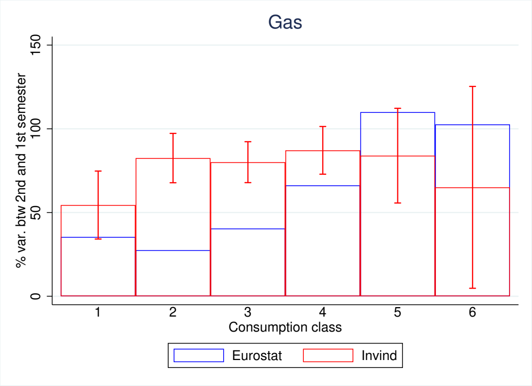
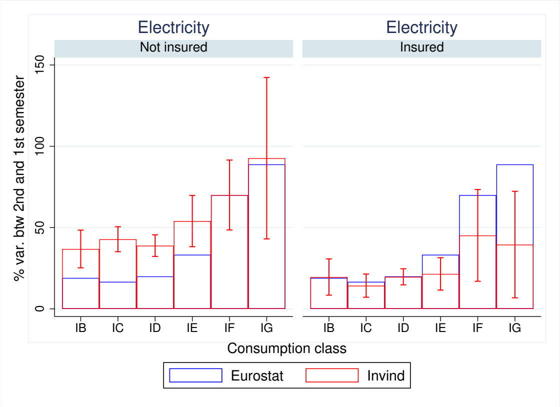
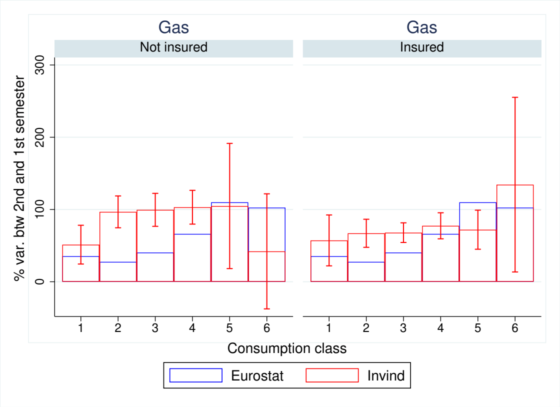




Data validation: Eurostat reference prices by insurance status Back





Data validation: Eurostat reference prices by consumption class

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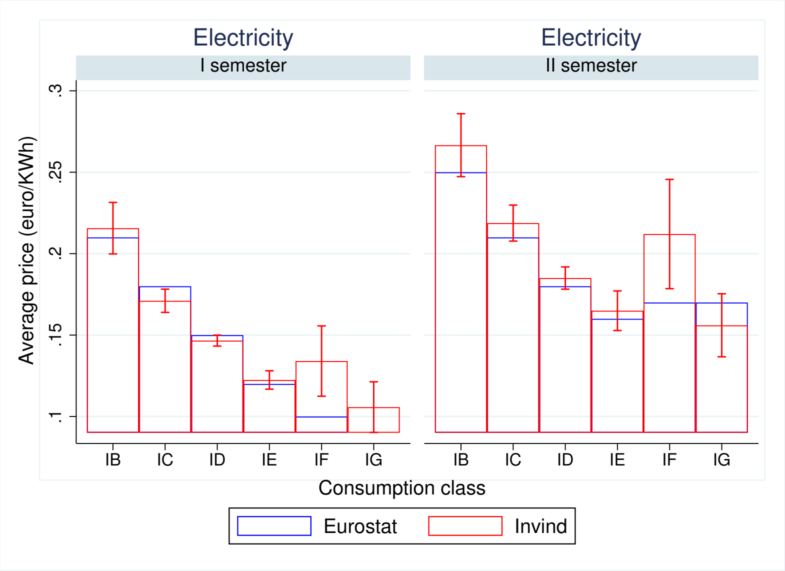

Data validation: Eurostat reference prices by consumption class

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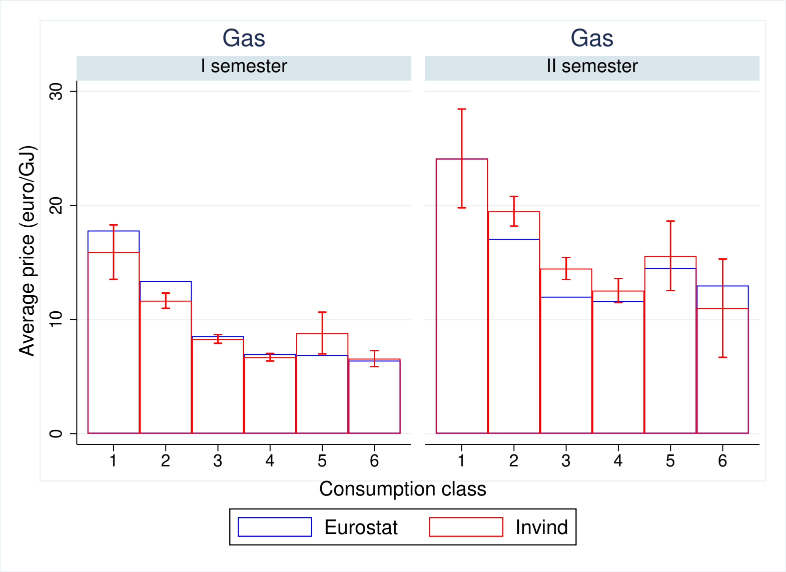

Data validation: gas consumption of firms subject to ETS

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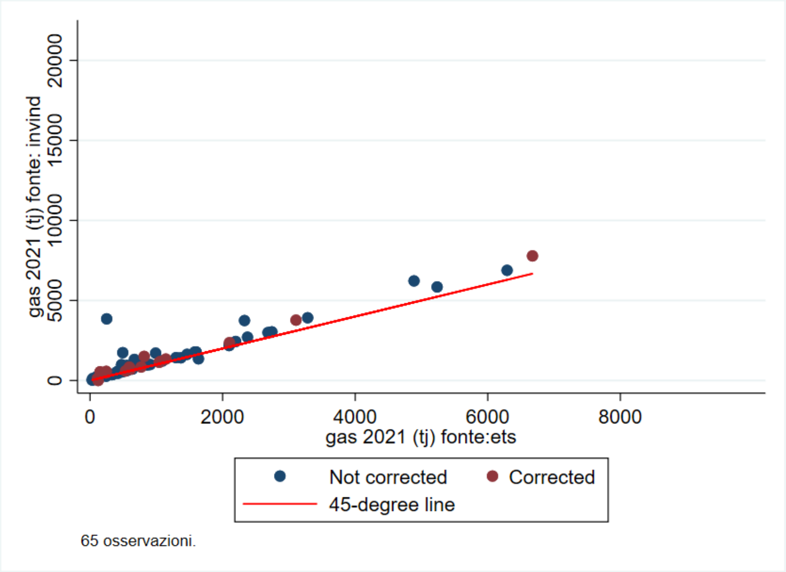
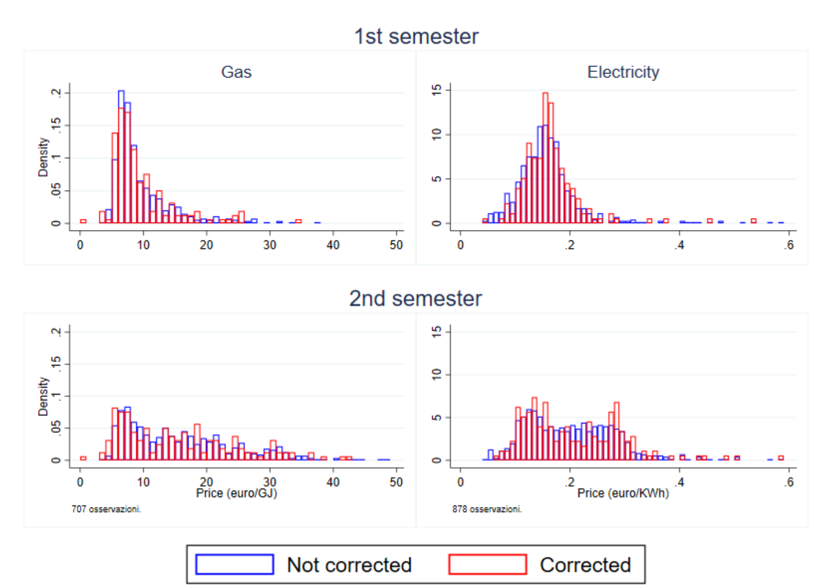


Data validation: comparison of corrected observations Back



What is LATE in this setting?

Binary instrument and continuous endogenous price (Angrist et al. Restud 2000)

- Weighted average of complier elasticities
- Higher weights to price ranges where IV induces largest shifts formula
- Check CDFs to see how powerful IV is and where variation is coming from

back

Angrist Graddy Imbens (ReStud 2000)

$$\beta^*(x) = \int_0^\infty E\left[\frac{\partial q_t^d}{\partial p}(p) \,\middle|\, p_t^e(1) \geqq p \geqq p_t^e(0), x_t = x\right] \cdot \omega(p|x)dp,$$

where the weights

$$\omega(p|x) = \frac{\Pr(p_t^e(0) < p < p_t^e(1) | x_t = x)}{\int_0^\infty \Pr(p_t^e(0) < r < p_t^e(1) | x_t = x)dr},$$

are nonnegative and integrate to one.

- More powerful IV bracket more prices p along the distribution: LATE $\rightarrow$ ATE

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Pass-through on consumer prices: a benchmark

To what extent the input price surge of energy can propagate and pass-through consumers?

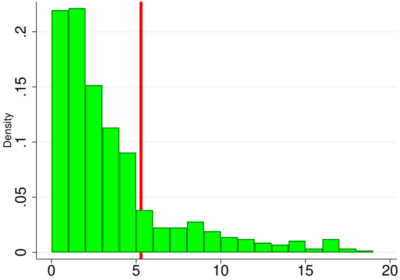
Accetturo et al. (2022)[1] use Input-Output tables to assess the impact of the surge of energy commodities and imported intermediate input prices on **producer price dynamics**.

- the implied price variation on the private sector is 4.2% in the period Dec. 2020-Dec. 2021;
- $\approx$ 50% of the effects are due to the increase in energy prices;
- the largest effects are in manufacturing;

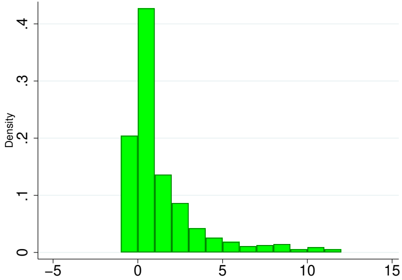
[1] Source: "*Direct and Indirect effects of input price shocks in 2021*", A. Accetturo, A. Linarello and P. Zoi (Bank of Italy), February 2022.

Incidence of energy costs before the crisis is low for most firms and it didn't increase much

(a) Energy cost / total cost (%) - 1 sem. 2021



(b) % change sem. 2 vs sem. 1



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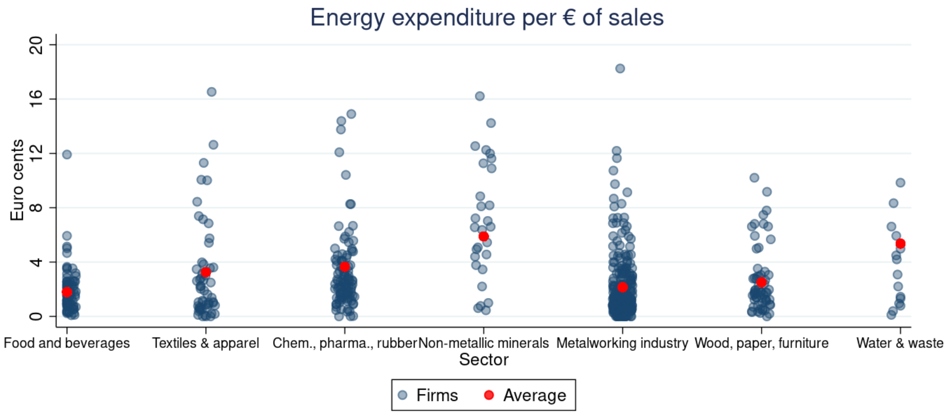
Incidence of energy costs: sectoral heterogeneity



- Sector dummies explain 10% of the variation
- ETS dummy and *energivora* dummy explains respectively 7% and 14%

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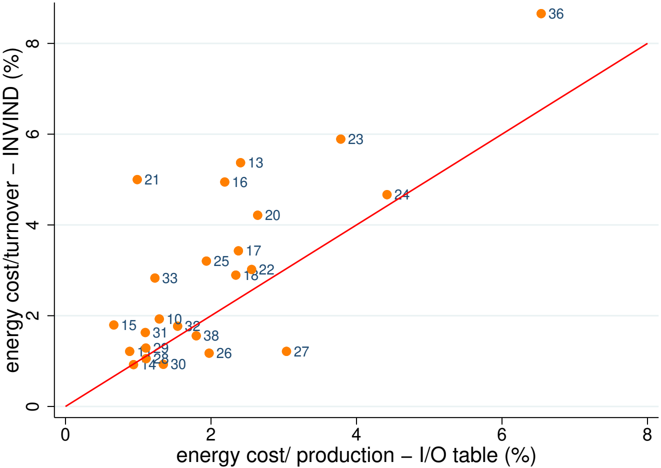
Incidence of energy cost from Invind consistent with I/O tables



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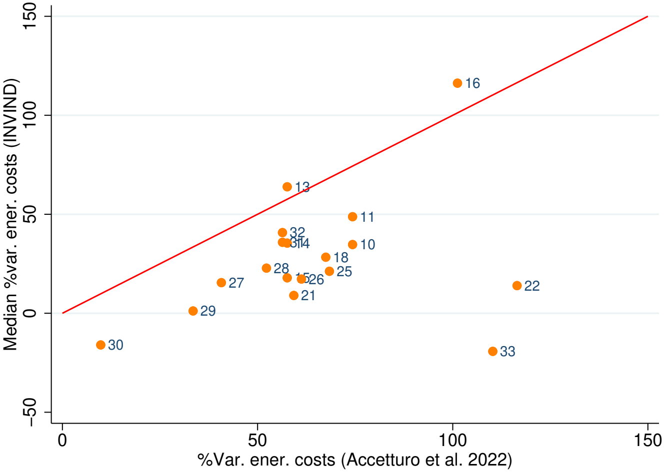
Change in energy cost from Invind consistent with Accetturo et al.



Self power-generation: associated firm characteristics

	Yes/No	Share	Yes/No	Share	Yes/No	Share
Nord-Ovest	-0.0951**	-2.512	-0.118**	-2.896	-0.136***	-3.393
	(0.05)	(2.11)	(0.05)	(2.51)	(0.05)	(2.63)
Nord-Est	-0.0689	-0.767	-0.0812	-1.534	-0.107**	-2.679
	(0.05)	(2.10)	(0.05)	(2.38)	(0.05)	(2.42)
Centro	-0.109**	-0.862	-0.130***	-1.733	-0.133***	-1.626
	(0.04)	(2.33)	(0.05)	(2.38)	(0.05)	(2.51)
Occupazione media annua	0.0000570**	0.00145*	0.0000656**	0.000323	0.0000695**	0.000153
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Alimentari	0.0789	-1.690	0.0842	-0.807	0.132	-0.00708
	(0.08)	(4.06)	(0.08)	(3.98)	(0.08)	(4.12)
Tessili	0.0335	-2.769	0.0293	-2.245	0.0732	-1.558
	(0.08)	(3.99)	(0.09)	(3.79)	(0.09)	(3.82)
Coke	0.000701	0.172	0.0330	1.352	0.0770	2.133
	(0.07)	(4.31)	(0.08)	(3.96)	(0.08)	(4.06)
Minerali non metaliferi	0.00925	-7.705*	-0.00179	-9.833**	0.0800	-8.523*
	(0.10)	(4.21)	(0.10)	(4.11)	(0.11)	(4.41)
Metalmeccanica	-0.0642	-7.741**	-0.0343	-5.777*	0.0203	-4.567
	(0.06)	(3.54)	(0.07)	(3.17)	(0.07)	(3.29)
Estrattive-energetico	-0.133	-6.024	-0.105	-3.935	-0.0603	-3.150
	(0.09)	(5.51)	(0.10)	(5.93)	(0.10)	(5.98)
Sales (milion euro)			0.000000543	-0.000721	-0.00000414	-0.00112
			(0.00)	(0.00)	(0.00)	(0.00)
Total investments			-0.000000328	-0.00000751	-0.000000340	-0.00000917
			(0.00)	(0.00)	(0.00)	(0.00)
Costo per l'acquisto di beni e di servizi			-4.40e-08	9.30e-09	-4.29e-08	0.000000483
			(0.00)	(0.00)	(0.00)	(0.00)
Public limited company (0/1)			-0.170	2.616	-0.190	2.312
			(0.11)	(3.53)	(0.12)	(3.75)
Limited liability company (0/1)			-0.262**	1.037	-0.275**	0.759
			(0.11)	(3.73)	(0.12)	(3.99)
Emission accounting (0/1)			0.182***	5.308***	0.187***	5.210**
			(0.05)	(2.03)	(0.05)	(2.09)
Energy-intensive (0/1)			-0.0690	-3.041	-0.0723	-2.901
			(0.05)	(1.88)	(0.05)	(1.93)
Subject to ETS in 2019 (0/1)			0.123*	20.71***	0.136*	21.51***
			(0.07)	(6.41)	(0.08)	(6.51)
Mol					0.00105	0.0631
					(0.00)	(0.09)
leverage					-0.000724	-0.0227
					(0.00)	(0.02)
Sector FE	✓	✓	✓	✓	✓	✓
Observations	1293	1293	1113	1113	1045	1045

Invind survey questionnaire

1. All'inizio del 2021 la vostra impresa possedeva **strumenti che l'hanno tutelata**, anche parzialmente, **dai rincari dei prezzi energetici** osservati nella seconda parte dell'anno?
   1.1 No;
   1.2 Sì, tramite contratti a prezzo fisso;
   1.3 Sì, tramite derivati;
   1.4 Sì, tramite altri strumenti.

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Invind: parte monografica su energia

5. Mantenete una **contabilità delle Vostre emissioni annuali di gas ad effetto serra** dirette (le cosiddette “scope 1”) o indirette (“scope 2”), per esempio in termini di tonnellate di CO2 equivalente? Sì/No.

   Dove le emissioni di gas serra possono essere suddivise nei seguenti gruppi: a) emissioni di gas ad effetto serra dirette (“Scope 1”) generate da sorgenti di gas serra, o da unità fisiche o processi che rilasciano gas serra in atmosfera, di proprietà o controllate dall’azienda; b) emissioni di gas ad effetto serra indirette (“Scope 2”) dovute al consumo di elettricità, calore o vapore acquistati dall’azienda.

The instrument

- Survey question:

  "At the beginning of 2021, did your company have (even if partial) ***hedging tools against the rising energy prices*** *that occurred around the end of the year?"*

  1. No;
  2. Yes, through fixed price contracts;
  3. Yes, through derivatives;
  4. Yes, other tools.

  Hedging by sector OtherChar

- Z=0 if the answer is "No" and 1 otherwise
- Only one question, not specific by energy source

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Fiscal and welfare losses of subsidies – gas prices fixed

- Consider the introduction of a subsidy to gas consumption $S = -dp$. The fiscal cost is proportional to the demand elasticity ϵ and the subsidization rate $s = S/p$

$$\text{Fiscal cost} = S(q + dq) = spq\,(1 + \epsilon s) \tag{10}$$

- The welfare loss is the standard Harberger triangle and is a fraction of the fiscal cost. We are giving consumers something which is costlier than WTP.

$$\text{Welfare loss} = \frac{1}{2}\frac{\epsilon s}{1 + \epsilon s} \cdot \text{Fiscal cost} \tag{11}$$

- Say $s = 0.5$ and $\epsilon = -0.2$, then welfare loss $\approx 5\%$ of fiscal cost
- If elasticity is $\epsilon = -1$, welfare loss $\approx 17\%$ of fiscal cost
- Italy gave 8.5 € bil. in tax credits for firms. Welfare loss could be btw 0.4 € and 1.4 € bil.

Fiscal and welfare losses of subsidies – terms of trade effects

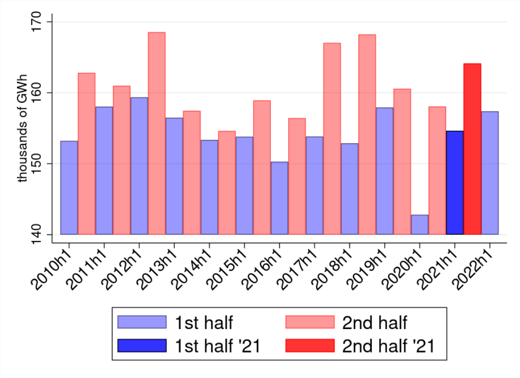
- Europe as a whole can avoid rationing if and only if it is willing to pay a higher price. Why?
- Because elasticity of demand is low elsewhere in the world too! Someone else in the world must be induced to consume less gas. Since elasticity is **low**, a **big** price increase is needed.
- Assume demand elasticity ϵ = world supply elasticity σ = 0.2, the share of subsidized gas consumption $\alpha = 0.5$ and the subsidization rate is 50%

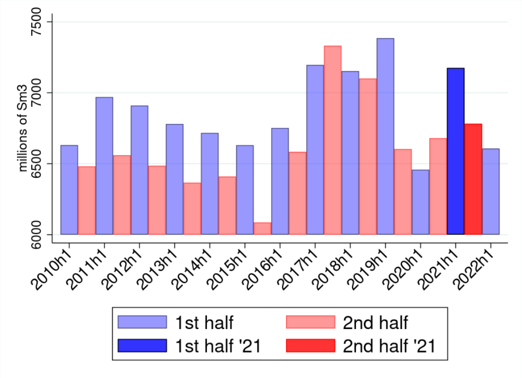
$$\frac{\text{Terms of trade loss}}{pQ} = \frac{\epsilon}{\sigma} s\alpha(1 + \epsilon s\alpha) \tag{12}$$

- Then the welfare loss would be equal to 25% of the gas import bill, even with a low elasticity.

- Ganapati et al. 2020 AEJ highlight three steps by which an energy shock transmits to prices
  - Energy prices $\rightarrow$ marginal costs
  - Marginal costs $\rightarrow$ prices (through markups)

In 2021 industrial energy consumption was in line with historical standards

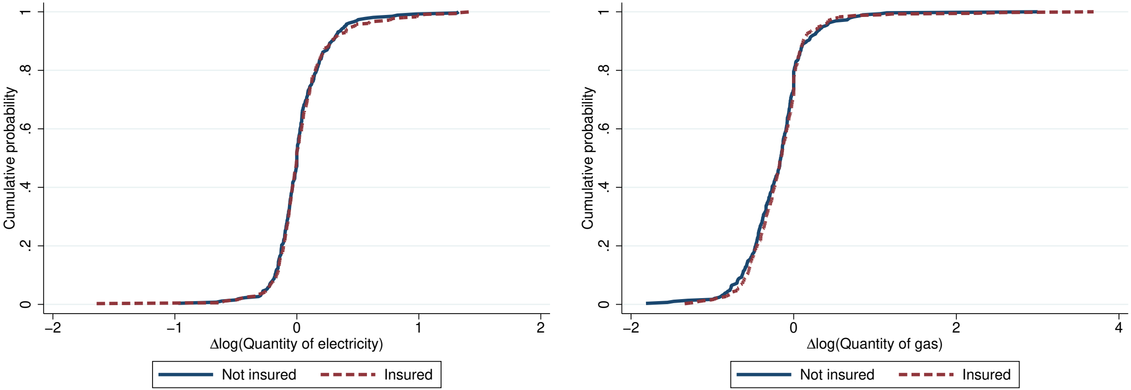




- Gas consumption is dropping in 2022, but that's a story for another day

Reduced forms

$$F_z(q) = Pr(\Delta log Q_i(Z) \leq q) \text{ for } Z = 0, 1$$



The estimate for electricity is robust to alternative specifications

	(1) Baseline	(2) Class size FE	(3) Sector FE	(4) Macroregions FE	(5) Controls	(6) All
Panel (a) : Demand equation						
Δ log P electricity	-0.0286	-0.0237	0.0118	-0.0389	-0.0186	0.00997
	[-0.216,0.159]	[-0.210,0.163]	[-0.172,0.195]	[-0.223,0.145]	[-0.196,0.159]	[-0.169,0.189]
Panel (b) : First stage estimates						
Protected from price increase (0/1)	-18.70***	-18.73***	-18.70***	-18.81***	-20.17***	-19.72***
	[-22.90,-14.49]	[-22.98,-14.48]	[-22.92,-14.47]	[-23.05,-14.57]	[-24.41,-15.94]	[-23.99,-15.46]
Observations	848	848	848	848	816	816
K-P F stat	76.14	74.94	75.36	75.81	87.47	82.37
AR confidence set	[-.213866, .164186]	[-.208103, .168218]	[-.16235, .208286]	[-.22071, .150424]	[-.187153, .164218]	[-.159609, .201189]

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimate for gas is robust to alternative specifications

	(1) Baseline	(2) Class size FE	(3) Sector FE	(4) Macroregions FE	(5) Controls	(6) All
Panel (a) : Demand equation						
$\Delta \log P$ gas	-0.183	-0.179	-0.00607	-0.185	-0.0905	-0.00589
	[-0.627,0.261]	[-0.606,0.248]	[-0.445,0.433]	[-0.621,0.250]	[-0.515,0.334]	[-0.426,0.414]
Panel (b) : First stage estimates						
Protected from price increase (0/1)	-14.02***	-14.37***	-13.56***	-14.18***	-13.56***	-14.18***
	[-21.62,-6.425]	[-22.06,-6.676]	[-21.14,-5.974]	[-21.73,-6.633]	[-23.23,-7.561]	[-22.74,-7.073]
Observations	682	682	682	682	315	315
K-P F stat	13.13	13.45	12.32	13.60	14.89	13.96
AR confidence set	[-.712454, .327942]	[-.688024, .312232]	[-.47612, .570405]	[-.704239, .298562]	[-.544907, .432417]	[-.438845, .545927]

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

OLS vs IV: electricity

	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
Δ log P electricity	-0.154***	-0.0286	-0.146***	0.0152
	[-0.206,-0.101]	[-0.216,0.159]	[-0.198,-0.0945]	[-0.166,0.196]
Observations	848	848	848	848
Controls	NO	NO	YES	YES
K-P F stat		76.14		73.84
AR confidence set		[-.213866, .164186]		[-.156729, .208986]

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back

OLS vs IV: natural gas

Table: Price-elasticity of gas demand: OLS vs. IV estimates

	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
Δ log P gas	-0.150***	-0.183	-0.112***	-0.00645
	[-0.208,-0.0928]	[-0.627,0.261]	[-0.168,-0.0561]	[-0.431,0.418]
Observations	682	682	682	682
K-P F stat		13.13		12.58
AR confidence set		[-.712454, .327942]		[-.46118, .551239]

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Full sample	Insurance sample			Electricity sample			Gas sample		
	mean	mean	Δ	t-stat	mean	Δ	t-stat	mean	Δ	t-stat
Sales in 2020	0.13	0.13	-0.01	(-0.36)	0.16	-0.06*	(-2.07)	0.19	-0.10**	(-2.98)
Costs for interm. goods in 2020	5.28	5.36	-0.44	(-0.30)	6.69	-2.61	(-1.63)	7.35	-3.28	(-1.74)
Labour force in 2020	349.18	347.41	9.48	(0.19)	406.38	-105.91*	(-2.00)	460.06	-175.96**	(-2.81)
Hours worked in 2020	0.52	0.51	0.03	(0.36)	0.59	-0.14*	(-2.06)	0.67	-0.24**	(-3.10)
Hirings in 2020	0.32	0.32	0.03	(0.53)	0.36	-0.08	(-1.41)	0.36	-0.06	(-0.97)
Separations in 2020	0.34	0.34	0.00	(0.05)	0.38	-0.07	(-1.33)	0.38	-0.06	(-1.08)
Status (energy intensive)	0.22	0.23	-0.03	(-1.44)	0.27	-0.09***	(-4.35)	0.29	-0.10***	(-4.93)
Subject to ETS in 2021	0.06	0.06	-0.01	(-0.39)	0.07	-0.03*	(-2.41)	0.10	-0.06***	(-4.66)
Food and beverages	0.13	0.14	-0.02	(-1.17)	0.13	0.01	(0.66)	0.12	0.02	(1.14)
Textiles & apparel	0.09	0.09	0.01	(0.35)	0.09	0.01	(0.41)	0.09	0.00	(0.33)
Chem., pharma., rubber	0.13	0.14	-0.03	(-1.34)	0.16	-0.05**	(-3.11)	0.16	-0.04*	(-2.50)
Non-metallic minerals	0.04	0.04	-0.01	(-1.16)	0.05	-0.01	(-0.95)	0.05	-0.01	(-0.74)
Metalworking industry	0.44	0.43	0.05	(1.75)	0.44	-0.00	(-0.12)	0.45	-0.01	(-0.27)
Wood, paper, furniture	0.11	0.10	0.01	(0.35)	0.09	0.02	(1.57)	0.11	-0.00	(-0.20)
Water & waste	0.05	0.05	-0.00	(-0.27)	0.04	0.02*	(2.39)	0.03	0.04***	(3.87)
50-99 employees	0.34	0.34	-0.01	(-0.38)	0.29	0.09***	(4.12)	0.26	0.13***	(6.12)
100-199 employees	0.28	0.28	0.03	(0.99)	0.27	0.03	(1.36)	0.26	0.04	(1.74)
200-499 employees	0.23	0.23	-0.01	(-0.32)	0.26	-0.05*	(-2.45)	0.27	-0.06**	(-2.79)
500-999 employees	0.08	0.08	-0.02	(-0.99)	0.10	-0.05***	(-3.71)	0.12	-0.07***	(-4.61)
1000 and more employees	0.06	0.06	0.01	(0.43)	0.08	-0.02	(-1.93)	0.10	-0.05***	(-3.80)
North-West	0.30	0.28	0.15***	(5.18)	0.30	0.01	(0.55)	0.33	-0.05*	(-2.09)
North-Est	0.23	0.21	0.09***	(3.45)	0.24	-0.01	(-0.61)	0.28	-0.08***	(-3.86)
Center	0.22	0.24	-0.11***	(-4.96)	0.26	-0.07***	(-3.40)	0.24	-0.03	(-1.48)
South and Islands	0.25	0.27	-0.14***	(-6.35)	0.21	0.07***	(3.32)	0.15	0.16***	(8.22)
Observations	1844	1500			848			682		

Differential attrition by insurance status

$$\mathbf{1}(\text{Not in sample}_i) = \theta_0 + \theta_1 \text{Insured}_i + \theta_2 \text{Not insured}_i + \varepsilon_i \quad (13)$$

	(1)	(2)	(3)	(4)
	Electricity sample		Gas sample	
Insured	-0.637***	-0.630***	-0.542***	-0.550***
	[-0.672,-0.602]	[-0.667,-0.592]	[-0.578,-0.505]	[-0.589,-0.511]
Not Insured	-0.497***	-0.522***	-0.372***	-0.427***
	[-0.532,-0.461]	[-0.560,-0.483]	[-0.406,-0.337]	[-0.465,-0.389]
$H_0 : \theta_1 - \theta_2 = 0$, p-value	0.00	0.00	0.00	0.00
Observations	1844	1844	1844	1844
Controls	NO	YES	NO	YES

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Inverse probability weighting

	(1) Electricity	(2) Electricity	(3) Electricity	(4) Gas	(5) Gas	(6) Gas
$\Delta \log P$ electricity	-0.0286	-0.0234	0.0113			
	[-0.216,0.159]	[-0.210,0.163]	[-0.163,0.186]			
$\Delta \log P$ gas				-0.183	-0.265	-0.0526
				[-0.627,0.261]	[-0.614,0.0842]	[-0.350,0.244]
Observations	848	848	848	682	682	682
Inverse probability weighting	NO	YES	YES	NO	YES	YES
Controls	NO	NO	YES	NO	NO	YES
K-P F stat	76.14	71.41	80.68	13.13	14.79	16.38
AR confidence set	[-.213866, .164186]	[-.200178, .175871]	[-.154457, .19821]	[-.712454, .327942]	[-.723673, .094766]	[-.358549, .301348]

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- Estimate by logit the probability of being included in the sample as a function of observables
- Weight our baseline IV equation by those probabilities
- IPW results similar to baseline results

back

Lee (2009) bounds - electricity

		ΔQ experienced by the MU are...	
		the lowest	the highest
ΔP experienced by the MU are...	the lowest	$\frac{7.8}{-9} = -0.86$	$\frac{-8.7}{-9} = +0.96$
	the highest	$\frac{7.8}{-31.5} = -0.24$	$\frac{-8.7}{-31.5} = +0.28$

Note: figures at the numerator refer to the reduced form estimates, those at the denominator at the first-stage estimates.

back

Lee (2009) bounds - natural gas

		ΔQ experienced by the MU are...	
		the lowest	the highest
ΔP experienced by the MU are...	the lowest	$\frac{20}{7} = +2.8$	$\frac{-14}{7} = -2$
	the highest	$\frac{20}{-42} = -0.5$	$\frac{-14}{-42} = +0.3$

Note: figures at the numerator refer to the reduced form estimates, those at the denominator at the first-stage estimates.

back

Gas elasticity is much higher for ETS firms

	(1) Whole sample	(2) non-ETS	(3) ETS	(4) ETS + controls
Δ log P gas	-0.183	0.0586	-0.789**	-0.718*
	[-0.627,0.261]	[-0.415,0.533]	[-1.547,-0.0314]	[-1.496,0.0599]
Observations	682	616	66	65
K-P F stat	13.13	10.67	10.43	4.374

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- non-energy ETS plants ($\approx$ 700) account for $\approx$ 60% of total industrial consumption

Estimated elasticities are at the lower end of literature estimates

	(1) Electricity (OLS)	(2) Gas (OLS)	(3) Electricity (IV)	(4) Gas (IV)
Panel (a) : Demand equation				
Δ log P electricity	-0.154***		-0.0286	
	[-0.206,-0.101]		[-0.216,0.159]	
Δ log P gas		-0.150***		-0.183
		[-0.208,-0.0928]		[-0.627,0.261]
Panel (b) : First stage				
Fixed price contracts dummy			-18.698***	-14.023***
			[-22.904,-14.492]	[-21.621,-6.425]
Observations	848	682	848	682
K-P F stat			76.14	13.13

95% confidence intervals in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- Results rule out large LATE-elasticities, especially for electricity what is LATE?