Energy cost pass-through and the rise of inflation: Evidence from French manufacturing firms[1]

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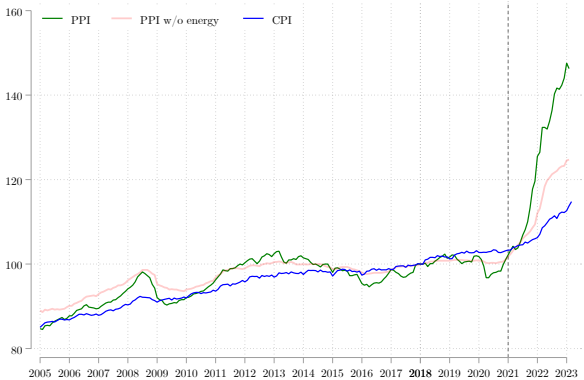
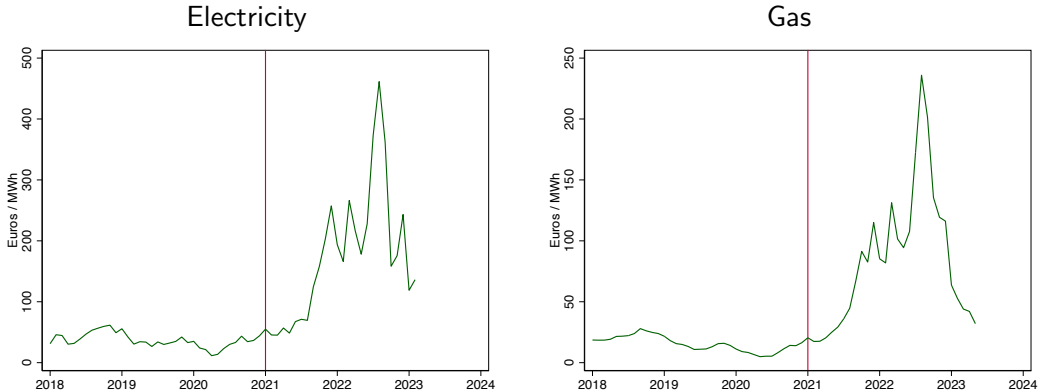
2021-2022 inflation in France



Source: INSEE

- Average year-on-year change:
- CPI
  - → 1.2% in 2005-2020
  - → 3.05% in 2021-2022
- PPI (w/o energy)
  - → 0.8% in 2005-2020
  - → 8.4% in 2021-2022

External factors: Energy prices



Source: i) Electricity: Epex Spot SE Price, ii) Gas: ICE, Dutch TTF Natural Gas spot price

External factors: Energy prices

- Energy price shocks:
  - → generate supply chain effects (through firms' input costs)...
  - → ... which are unevenly distributed across sectors and firms (heterogeneous exposures)

- Contribution to the dynamics of inflation depends on the extent and speed of the pass-through of input cost shocks to producer prices

- **This paper**:
  1. Exploits heterogeneity in firms' exposure to energy price shocks...
  2. ... to estimate their transmission to output prices...
  3. ... and quantify their impact on PPI inflation

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What we do / what we find

1. Use monthly micro-price matched with energy exposure data for French firms
   - → High dispersion in exposure to energy price shocks
   - → Driven by heterogeneity in energy mix and energy intensity

2. Estimate the pass-through of energy cost shocks to producer prices
   - → Fast and almost full pass-through
   - → Full pass-through of **positive** cost shocks after 2021

3. Quantify the impact of energy as a driver of inflation
   - → Energy cost pass-through **explains about 10%** of PPI growth over 2021-2022
   - → **Distributional** impact: firms are impacted, much more than industries

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Related literature

- **Surge in inflation in 2021-2022.** (e.g. Cavallo Kryvstov (2021), Bunn et al. (2022), di Giovanni et al. (2022), Amiti et al. (2022), Cavallo et al. (2023), Guerrieri et al (2023))

  → We use micro price data that we can match with energy costs.

- **Cost pass-through into producer prices.** (e.g. Nakamura Zerom (2010), Martin (2011), Goldberg Hellerstein (2013), Ganapati et al. (2020), Dedola et al. (2021), Arquié Thie (2023))

  → We use fined-grained data on energy use + focus on the role of cost PT in 2021-2022.

- **Asymmetric pass-through.** (Peltzmann (2000), Tappata (2009), Fung (2014), Benzarti et al. (2020))

  → We document and explore the origin of asymmetric pass-through.

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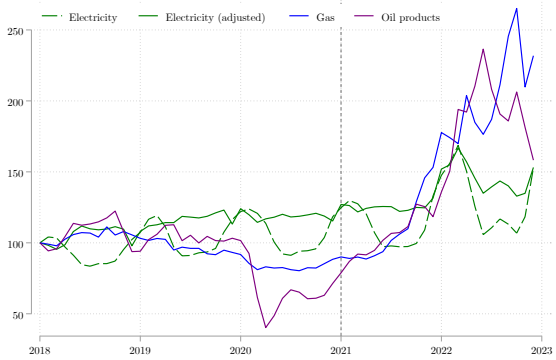
Energy crisis: Institutional background

- 2021-2022 the French government has introduced a "tariff shield" ("bouclier tarifaire") on electricity and gas prices
- Limits the growth of prices to 4% in 2022 and 15% in 2023
- Importantly, the policy is restricted to regulated sales prices, which exclusively concern households (and small firms for electricity prices)
- Direct impact of the energy crisis on households has been limited
- Indirect effect through firms' input costs may be much higher

Average evolution of energy prices



Source: INSEE, Price indices of energy sold to businesses

- Average year-on-year change
- Electricity
  - → 6.1% in 2005-2020
  - → 8.7% in 2021-2022
- Gas
  - → -8% in 2005-2020
  - → 56% in 2021-2022
- Oil
  - → 2.6% in 2005-2020
  - → 6.9% in 2021-2022

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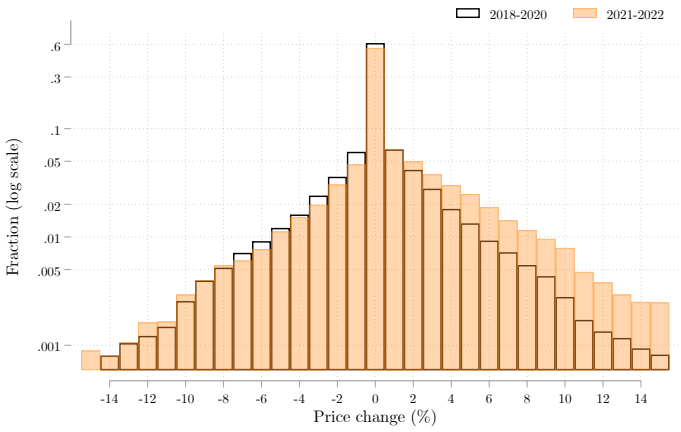
Micro-price data: OPISE

- Monthly survey of manufacturing prices (Insee)
- Survey
  - → Firms are selected from a survey of manufacturing firms, via a cut-off method
    - Top firms within a product market (CPF4), until 40% of sales covered
    - Minimum and maximum number of firms
    - CPF4-sample renewed once every 5 years on average
  - → Firms are asked to report the evolution of the price charged on their main product / partner
- Our sample
  - → Manufacturing except energy, mining, and tobacco; January 2018 – December 2022
  - → 2,352 firms and 10,242 products
  - → We work with **firm×product**-level series grouped in 4-D product markets

Monthly price changes



- Avg. size:
  → from .11% to .94%
- Small increase in the frequency of price adjustments in 2022 (+6 p.p)

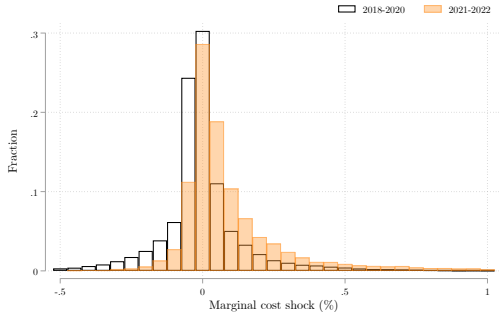
Energy cost shocks: EACEI

- Annual survey of industrial energy use (Insee)
- Real and nominal energy consumption, by energy type (electricity, gas and oil), over 2014-2017
- Data reveals wide heterogeneity in:
  - Energy mix $\{w^e_{f0}\}$: the share of each energy in real energy consumption → By sector →
    - → **Firms face different energy price changes** Δp^E_{ft}
  - Exposure to energy S^E_{f0}: the ratio of energy bill to variable costs (balance-sheet) →
    - → **Conditional on** Δp^E_{ft}**, firms face different cost shocks**

Energy cost shocks are larger after 2021

- Marginal cost shock: $\underbrace{\Delta p^E_{ft}}_{\text{Energy price change}} \times \underbrace{S^E_{f0}}_{\text{Exposure}} = \left(\sum_e w^e_{f0} \Delta p^e_t \right) \times S^E_{f0}$
- Δp^E_{ft} is a weighted average
- Δp^e_t is the change in price index of energy e (→)

- Avg. size from .02% to .15%



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Passing cost shocks to prices

- We estimate

$$\Delta p_{fkt} = \sum_{j=0}^{L} \alpha_j \Delta p^E_{ft-j} \times S^E_{f0} + \beta X_{fkt} + FE_{st} + \epsilon_{fkt}$$

  → f, k, t: firm, product, and time.
  → FE_{st}: 2D-industry×period: identification in the cross-section

- Two main empirical challenges: (1) timing and zeros; and (2) common factors (X_{fkt})
- Timing. We estimate on:
  1. A monthly balanced panel (Cavallo et al., 2021)
  2. Cumulated cost shocks since last price adjustment (Burstein and Gopinath, 2014)
  3. A quarterly balanced panel

Estimated cost pass-through

	Monthly		Quarterly	
	(1)	(2)	(3)	(4)
$\Delta p^E_{ft} \times S^E_{f0}$	0.507***		1.128***	1.158***
	(0.088)		(0.180)	(0.142)
$\Delta p^E_{ft-1} \times S^E_{f0}$	0.231***		0.325	
	(0.091)		(0.196)	
$\Delta p^E_{ft-2} \times S^E_{f0}$	0.259***		0.173	
	(0.087)		(0.194)	
$\Delta p^E_{ft-3} \times S^E_{f0}$	0.202**		-0.0314	
	(0.087)		(0.214)	
$\Delta p^E_{ft-4} \times S^E_{f0}$	-0.003			
	(0.083)			
$\Delta p^E_{ft-\tau} \times S^E_{f0}$		0.896***		
		(0.101)		
Long-run PT	1.229	0.896	1.594	1.158
S.E.	(0.204)	(0.101)	(0.393)	(0.142)
Obs.	181,605	104,720	51,453	64,721

Common factors

- Identification exploits heterogeneity in exposure to energy price shocks
- But firms also expected to adjust to price adjustments from their competitors or input suppliers
- Δp_{kt}^{H} controls for changes in competitors' prices.
  - → Average price adjustment in the market
- Δp_{ft}^{V} controls for exposure to (non-energy) input price shocks
  - → $\Delta p_{ft}^{V} = [\sum_{s'} w_{f0}^{s'} \Delta p_{s't}] \times S_{f0}^{I}$

	(1)	(2)
$\Delta p_{ft}^{E} \times S_{f0}^{E}$	1.158***	0.862***
	(0.142)	(0.131)
Δp_{kt}^{H}		0.648***
		(0.023)
Δp_{ft}^{V}		0.583***
		(0.123)
Obs.	64,721	64,721

Discussion

- Consistent with recent estimates of pass-through of energy shocks in France (Arquié Thie 2023, Fontagné et al. 2023)
- Higher than estimates in Ganapati et al (2020) based on earlier data for the US (.7)
- Robust to the structure of energy contracts here
- Heterogeneity
  - → Large firms pass a larger share of their cost shocks
  - → No significant heterogeneity across sectors (lack statistical power)

Asymmetric pass-through in 2021-2022

$Z =$	(1)	(2) $\mathbb{1}_{2021-2022}$
Δ_t^+	1.014***	0.324**
	(0.154)	(0.141)
$\Delta_t^+ \times Z$		0.873***
		(0.236)
Δ_t^-	0.196	0.209
	(0.228)	(0.228)
Δp_{kt}^H	0.648***	0.647***
	(0.023)	(0.023)
Δp_{ft}^V	0.594***	0.609***
	(0.123)	(0.123)
Avg. Z		.42
Obs.	64,721	64,721

- PT rate in 2021-2022: $\hat{\alpha} = 119.7\%$
- Largely driven by the pass-through rate of positive shocks increasing in 2021-22
- Asymmetry is consistent with survey evidence from Eurostat and earlier empirical evidence (Peltzman, 2000; Benzarti et al, 2020)

Asymmetry in theory

- Collusion easier to sustain when costs increase (Fung, 2014)
  - → Collusion dummy from (Connor, 2020)
- Higher transmission when inflation is high / shocks are large (Taylor, 2000; Harding et al., 2023; Karadi and Reiff, 2019; Cavallo et al., 2023)
  - → High-inflation quarters + Large shocks
- Imperfect information and salience (Westphal, 2023)
  - → buyers may pay more attention to shocks in high inflation episodes
  - → (Korenok et al., 2023; Weber et al., 2023)
  - → High Google Trend Index for "energy prices"

Asymmetry in practice

	(1)	(2) $\mathbf{1}_{\text{2021-2022}}$	(3) $\mathbf{1}_{\text{Collusion}}$	(4) $\mathbf{1}_{\Delta PPI \geq 1\%}$	(5) $\mathbf{1}_{\text{Large shock}}$	(6) $\mathbf{1}_{\text{Salience}}$
Δ_t^+	1.014***	0.324**	0.863***	0.563***	0.776***	0.713***
	(0.154)	(0.141)	(0.224)	(0.152)	(0.278)	(0.164)
$\Delta_t^+ \times Z$		0.873***	0.258	0.590***	0.310	1.123***
		(0.236)	(0.306)	(0.226)	(0.391)	(0.395)
Δ_t^-	0.196	0.209	0.197	0.211	0.204	0.198
	(0.228)	(0.228)	(0.228)	(0.229)	(0.228)	(0.229)
Δp_{kt}^H	0.649***	0.647***	0.648***	0.645***	0.649***	0.647***
	(0.023)	(0.023)	(0.023)	(0.027)	(0.023)	(0.023)
Δp_{ft}^V	0.594***	0.609***	0.594***	0.604***	0.590***	0.605***
	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)
Avg. Z		.42	.41	.34	.035	.15
Obs.	64,721	64,721	64,721	64,721	64,721	64,721

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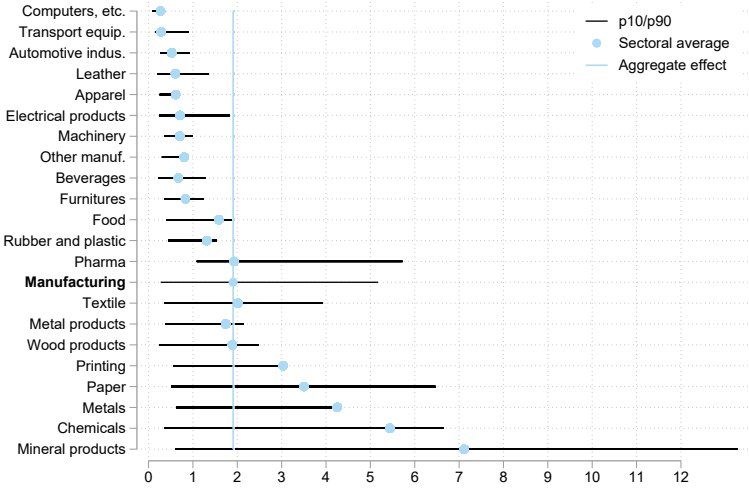
Aggregate implications

- Back-of-the-envelope calculation of energy cost shocks effect on PPI in 2021-2022
- Asymmetric pass-through rate: 119.7%
- Micro-level predicted price changes: $\Delta\hat{p}_{fk} = \hat{\alpha} \times \Delta\hat{p}_f^E \times S_f^E$

  → For firms not covered by energy survey: average marginal cost shock in 2-D industry
- Sector-level implications: $\Delta\hat{p}_s^D = \sum_{fk \in s} w_{fk}^s \times \Delta\hat{p}_{fk}$
- Amplification through input-output linkages: $\Delta\hat{\mathbf{p}}_s^{D+I} = (\mathbf{I} - \mathbf{A})^{-1}\Delta\hat{\mathbf{p}}_s^D$

  → $\mathbf{A}$: IO table × transmission of input price shocks (59%)

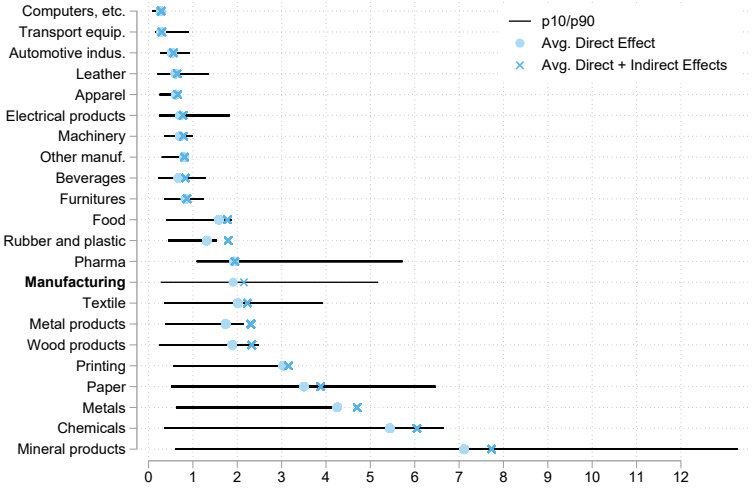
Aggregate impact of energy cost shocks



→ 70% of variance **within** sectors

→ 9% of PPI growth (+1.6pp)

Amplification through IO linkages



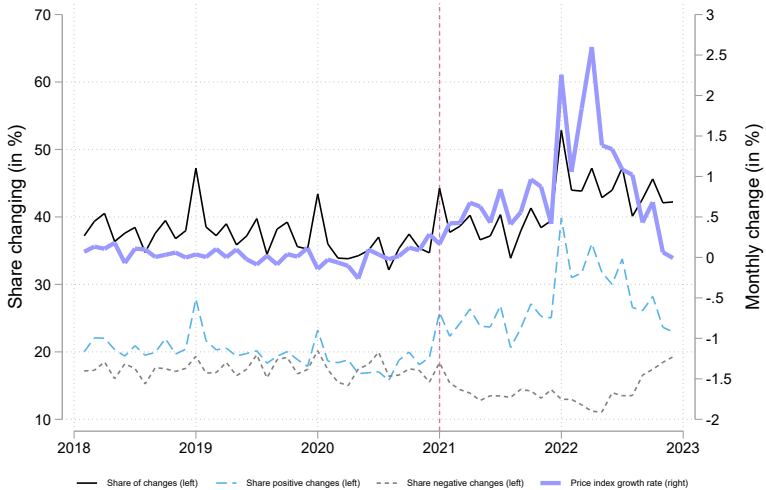
→ 11% of PPI growth

Wrap-up

- We estimate energy cost pass-through to French producer prices
- **Full** pass-through of **upward** cost shocks in 2021-2022
- 30% in 2018-2020 and 20% of **downward** shocks
- Direct transmission of energy shocks explains around a tenth of the observed PPI inflation in 2021-2022
- Importance of **distributional effects**, within and across sectors

Appendix

Frequency of positive price changes increases



- Avg. frequency change:
  - → from 37.2 to 41.5%
  - → from 19.8 to 27.8%
  - → from 17.4 to 13.6%
- Consistent with Goldberg and Hellerstein (2009) on US PPI data

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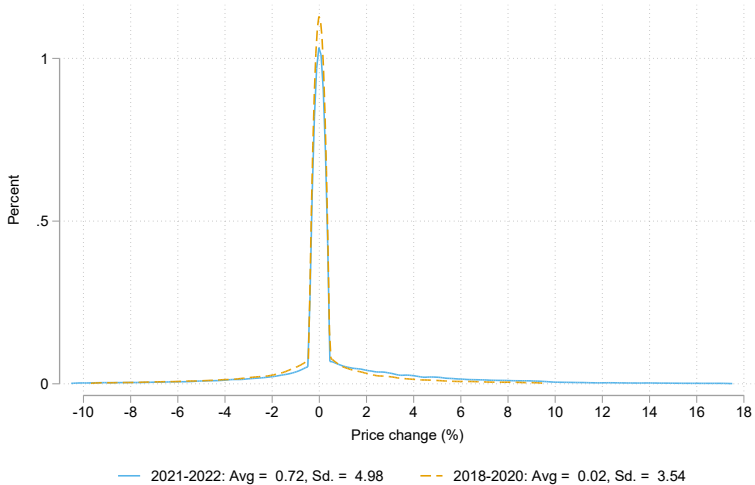
Distribution of monthly output price changes



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Distribution of cost shocks and output price changes

	5 pctl	Mean	Median	95 pctl	St.dev.
Monthly					
$\Delta p_{ft}^{E} \times S_{f}^{E}$	-.15	.03	.01	.26	.21
Δp_{fkt}	-3.62	.31	0	5.42	4.2
Quarterly					
$\Delta p_{ft}^{E} \times S_{f}^{E}$	-.16	.07	.03	.41	.31
Δp_{fkt}	-4.8	1	0	9.11	5.63

Notes: This table reports statistics on the changes in output prices and cost shocks in our two estimation samples: monthly and quarterly data. $\Delta p_{ft}^{E} \times S_{f}^{E}$ is the firm-level direct change in marginal costs from energy prices. Δp_{fkt} is the output price change. In %. N = 199,742 and 64,721, respectively.

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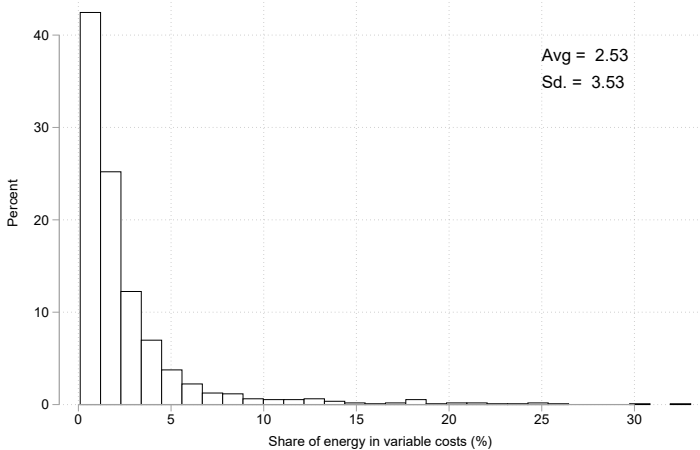
Exposure to energy costs S^E_{f0} is small and heterogeneous



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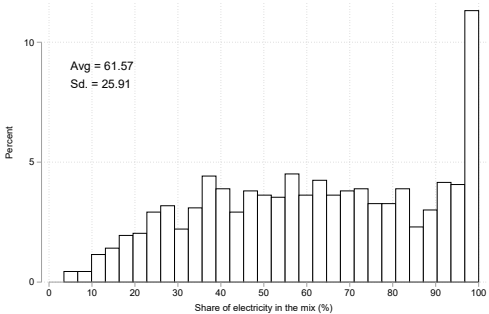
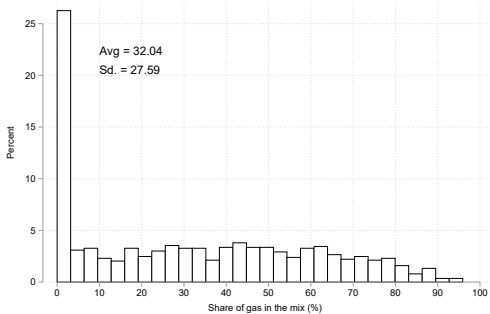
Energy mix

Electricity



Gas



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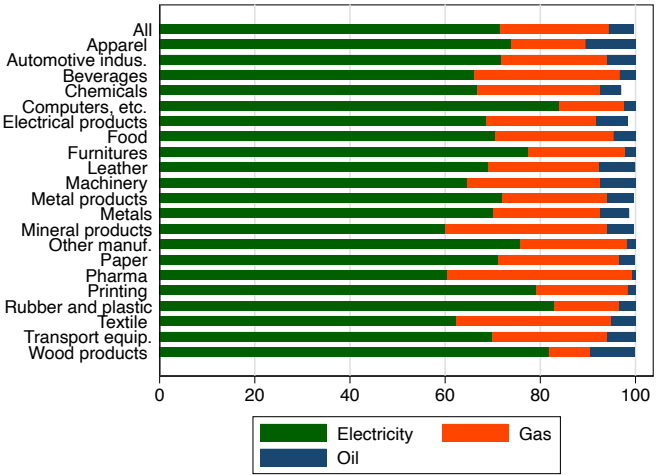
Energy mix w_f^e, by sector



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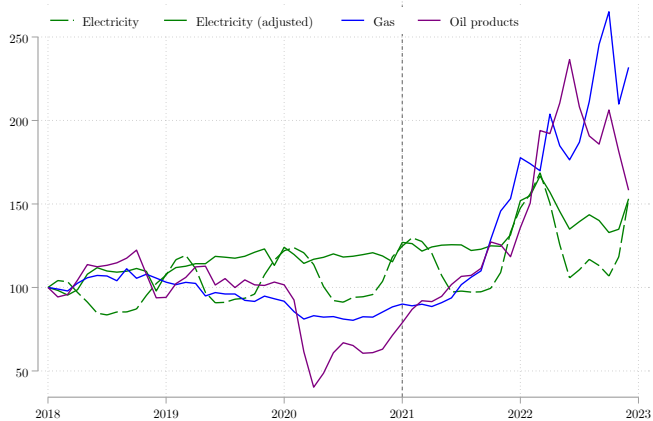
Energy price indices



Notes: Electricity: 010534766 ("Électricité vendue aux entreprises ayant souscrit un contrat pour capacité $>$ 36kVA"), Gas: 010534775 ("Commerce du gaz par conduites aux entreprises consommatrices finales"). Oil products: 010535610 ("Produits de la cokéfaction et du raffinage "). Normalized to 100 in January 2018. Back

Pass-through by type of energy

	(1)	(2)	(3)
$\Delta p_{ft}^{E} \times S_{f0}^{E}$	0.891^{***}		
	(0.139)		
$\Delta p_{ft}^{elec} \times S_{f0}^{elec}$		0.404^{**}	0.428^{**}
		(0.206)	(0.207)
$\Delta p_{ft}^{gas} \times S_{f0}^{gas}$		0.991^{***}	1.381^{***}
		(0.249)	(0.260)
$\Delta p_{ft}^{oil} \times S_{f0}^{oil}$		1.526^{***}	2.097^{***}
		(0.259)	(0.343)
Δp_{kt}^{H}	0.648^{***}	0.647^{***}	
	(0.023)	(0.023)	
Δp_{ft}^{V}	0.585^{***}	0.589^{***}	
	(0.123)	(0.123)	
Obs.	64,721	64,721	64,721

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Extensive margin

				Marginal Effects (pp) on a Price	
		Coefficient	Z-stat	Decrease	Increase
Energy	Δ Cost	0.35	3.24	-0.11	0.12
	Δ Cost $\times$ Share	5.23	2.82	-1.57	1.84

Notes: The first column reports the estimated coefficient, the second column shows the associated Z-statistic. The last two columns report the marginal effect of a 1 p.p. negative and positive cost shock on the probability to adjust price, setting the other covariates at their sample mean. All models control for period and 2-digit product fixed effects and changes in competitors prices, 2-digit industry-level labor costs, and 2-digit industry output.

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Pass-through and energy contracts

- Merge the estimation sample with data on energy contracts
- Remove firms with either electricity or gas contracts indexed on wholesale prices

	(1)	(2)	(3)
$\Delta p^E_{ft} \times S^E_{f0}$	0.891***	1.250***	0.935***
	(0.139)	(0.178)	(0.206)
Δp^H_{kt}	0.648***	0.662***	0.617***
	(0.023)	(0.031)	(0.036)
Δp^V_{ft}	0.585***	0.777***	0.901***
	(0.123)	(0.212)	(0.228)
Obs.	64,721	27,394	22,479

Notes: Column (1) is the baseline regression. Column (2) replicates the baseline on the sample matched with the survey on energy contracts. Column (3) removes firms which electricity or gas contract is indexed on wholesale prices.

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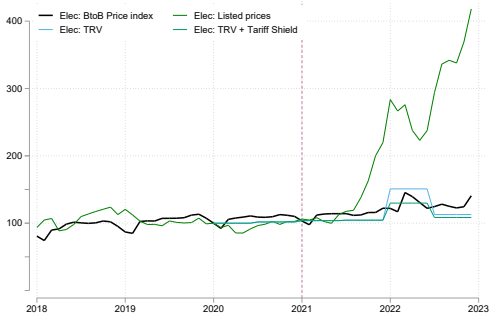
Firms' energy contracts: Survey evidence

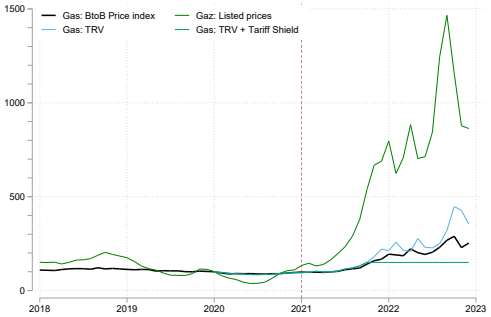
- Nov 2022: INSEE survey on energy contracts
- Matched with our data (1/3 of our sample)
- Most fixed-price contracts renewed in 2022 or 2023
- More

	Electricity (%)	Gas (%)
Contract type		
Regulated prices	8.5	0
Indexed on regulated prices	6.8	0
Fixed price	47.3	45.4
Indexed on wholesale prices	10.9	14.8
Other	21.4	13.1
No response	5.1	26.7
Contract renewal (Fixed price contract)		
Before end of 2022	53.8	34.8
2023-S1	6.7	8.6
2023-S2	24.1	28.3
2024	8.7	15.0
2025+	6.7	10.7

Note: Regulated prices are restricted to firms with less than 10 employees. In our data, all firms that declare benefitting from a contract with regulated prices have more than 10 employees.

Price dynamics, across contracts





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Distributional effect of energy in 2021-2022

Table: Distribution of predicted price changes attributable to energy cost shocks

	Percentile						
	10	25	50	75	90	95	99
Direct	.3	.61	1.2	2.1	5.4	7.2	17.6
Direct + IO	.71	1.2	2.5	4	7.4	9.8	13.1
Observed	0	5.5	14.8	29.8	48.8	65	115.2

Notes: This table reports the percentiles of the predicted and observed price changes (in %) for firms in our sample between 2021Q1 and 2022Q4. Predicted price changes are based on the asymmetric pass-through rate of 119.7%.

- R^2 of predicted vs actual change: 25%

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Sample size

	Share of...			
	PPI (%)	Production (%)	Imports (%)	Exports (%)
Sample	54	22.65	22.73	25.15
Energy	22.75	9.47	10.48	11.18
Superstar	10.51	4.61	4.8	5.52