Consumer Price Stickiness in the Euro Area During an Inflation Surge

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Motivation

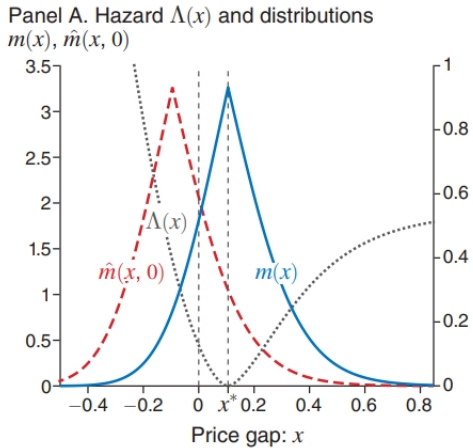
- Price rigidity is key for monetary policy transmission
  - Frequency at which firms revise their prices
  - Selection effects (menu cost vs Calvo) (Alvarez et al. 2022)

- In a low and stable inflation environment, price rigidity models have similar predictions (Alvarez et al. 2017)
  - Constant frequency of price changes over time
  - Small role for selection effects in response to macro shocks

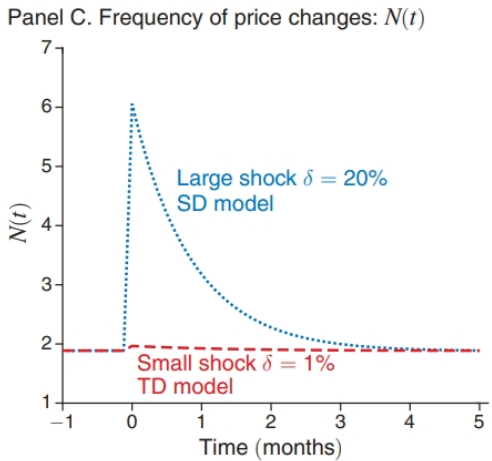
- Does it differ in the presence of large cost shocks?
  - Available empirical literature on consumer price rigidity for the euro area covers low and stable inflation periods (Dhyne et al. 2006, Gautier et al. 2024)

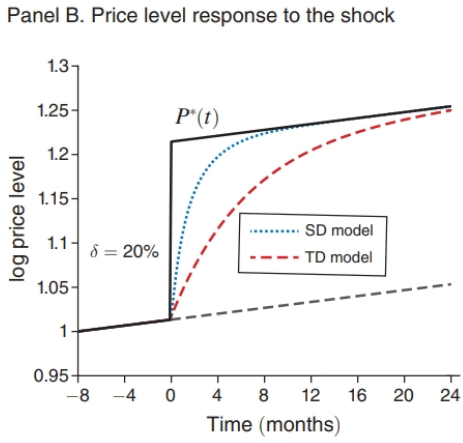
"Large shocks travel fast" (Cavallo et al. 2024)

- Sticky prices generate profit losses that depend on the price gap
- Hazard rate relates price gap to the proba. of price changes (policy function)



"Large shocks travel fast" (Cavallo et al. 2024)





Do large shocks travel that fast in the euro area?

This paper: New facts on price stickiness during an inflation surge

- Extend national CPI micro data sets in 9 EA countries until the end of 2024, covering the full inflation cycle
- Document how the inflation surge affects price rigidity moments
- Provide evidence of state dependence in the euro area
- Make available euro area moments of price stickiness during a large inflation shock
- Some macro implications using counterfactual exercises from a simple macro model with endogenous frequency of price changes

Preview of our findings: Three new facts on price stickiness

- Fact 1: The frequency of price changes almost doubled, then normalised unevenly
  - +4 pp in 2022 on average, peak at +8 pp in Jan 2023 (relative to 2010-2019)
  - Stronger and more transitory increase for food than services
  - Some country differences but smaller than product heterogeneity
  - Back to "normal" levels at the end of 2024
- Fact 2: The distribution of price changes shifted in composition, not in scale
  - More price increases (80% of price changes in 2022 vs 66% in normal times)
  - But little variation in the average size of price increases and decreases (taken separately)
- Fact 3: State-dependent pricing became more prevalent
  - Stronger reaction of the frequency of price changes for products with larger energy cost shares
  - V-shaped hazard rates
  - Extensive margin contributed more to inflation variation in 2022-2023
- Using a simple calibrated model with endogenous frequency, the quarterly inflation rate would have been 1 pp lower in 2022 with no response to the inflation surge

190 million price quotes for 9 countries in the Euro Area (2010-2024)

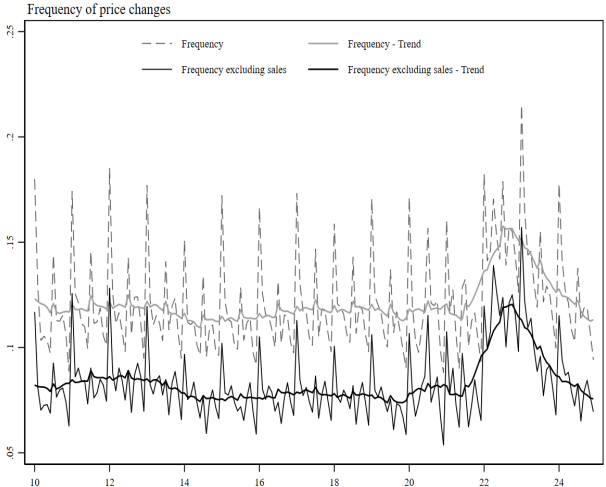
- National micro price data sets from Gautier et al. (2024) updated until end of 2024
  - A common sample of 166 (COICOP5) products covering all broad sectors except energy (57% of EA HICP) Product coverage
  - 9 countries (DE, FR, IT, ES, AT, GR, EE, LT, LV) covering 83% of EA HICP country weights + inflation heterogeneity across countries during the period 2022-2023 Figure
  - Sales flag vs sales filter + excluding price changes due to product substitution

- Four recent measurement challenges
  - Covid and price collection
  - Fiscal measures implemented during the inflation surge (VAT changes)
  - Introduction of scanner data Scanner
  - Online price data in Germany Online data

Country	Code	Period	% of products[a]		% of EA HICP[b]	Number of obs.[c]	
			(total)	EA (common sample)		total (millions)	by month (thousands)
Austria	AT	2000M01-2024M12	95.3	57.8	3.4	9.5	31.8
Estonia	EE	2019M01-2024M12	69.6	54.2	0.2	1.4	19.9
France	FR	1994M07-2024M12	83.0	57.2	20.1	45.2	124.5
Germany	DE	2005M01-2024M12	89.7	58.6	28.0	79.2	335.5
Greece	GR	2002M01-2024M12	66.1	53.2	2.2	10.2	36.9
Italy	IT	2011M01-2024M12	63.1	56.5	16.9	33.9	203.0
Latvia	LV	2017M01-2024M12	92.4	57.2	0.3	2.0	20.5
Lithuania	LT	2010M01-2023M03	82.8	58.2	0.5	8.4	53.6
Spain	SP	2008M02-2024M12	57.1	54.2	11.3	2.9	14.1
Total				57.0	83.0	192.6	527.7

Notes: **(a):** % of products covered by the national micro price dataset, expressed in terms of euro area product weights at the COICOP-5 level (2017-2024 average). For the euro area, we report the coverage of the common product sample. **(b):** Country weights in euro area HICP (2017-2024 average). **(c):** Total number of monthly observations (in millions/thousands).

The frequency of price changes almost doubled, then normalised unevenly



The frequency of price changes almost doubled, then normalised unevenly

Quantitative estimation of year fixed effects (relative to 2019) Year % products

$$f_{jt} = \alpha_j + \sum_{y=2020}^{2024} \beta_j^y + \gamma_j X_{jt} + \epsilon_{jt}, \tag{1}$$

Average β^y	Frequency			Frac.
in pp.	All	Increases	Decreases	Increases
2020	0.46	0.14	0.33	-2.97
2021	0.57	0.66	-0.09	3.22
2022	4.30	4.63	-0.33	13.38
2023	2.45	2.30	0.15	6.34
2024	0.81	0.67	0.14	1.05

Higher Frequency of Price Changes - Product Heterogeneity

Time series

Average β^y	Frequency			Frac.
in pp.	All	Increases	Decreases	Increases
Food				
2022	6.99	8.03	-1.04	19.27
2023	3.46	3.20	0.26	6.32
2024	-0.35	-0.22	-0.13	-1.08
NEIG				
2022	3.04	3.38	-0.33	17.71
2023	1.54	1.55	-0.01	8.80
2024	0.33	0.27	0.06	0.31
Services				
2022	3.53	3.38	0.15	5.80
2023	2.52	2.31	0.21	4.33
2024	1.98	1.60	0.38	3.10

Higher Frequency of Price Changes - Product Heterogeneity

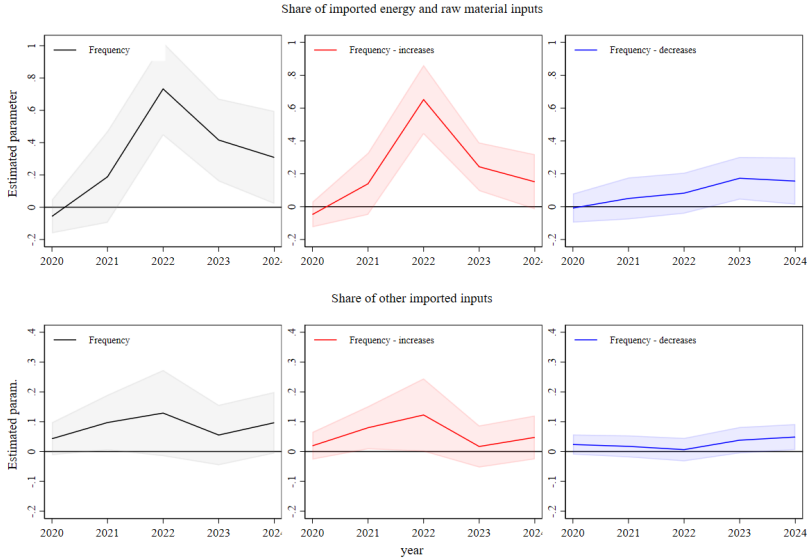
Link product-level changes in frequency over the period 2020-2024 to the product cost structure (using EA input output matrix matched with COICOP products)

$$\beta^{y}_{j,c} = a + b_1 Labour_j + b_2 Energy_j + b_3 Import_j + b_4 Reg^{y}_{j,c} + u_{s,c} + v_{j,c}, \tag{2}$$

- $\beta^{y}_{j,c}$ estimated year fixed-effects for product j in country c
- $Labour_j$: the share of labour costs in total costs
- $Energy_j$: the share of imported energy and raw material inputs
- $Import_j$: the share of other imported inputs
- $Reg^{y}_{j,c}$: a dummy variable for regulated prices in year y.
- Interacted dummies broad sectors $*$ countries are included

Higher Frequency of Price Changes - Product Heterogeneity

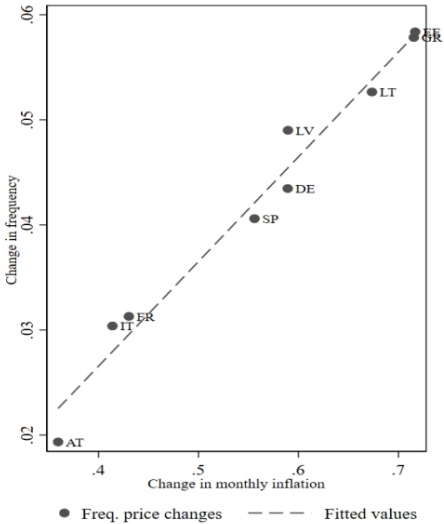
Other

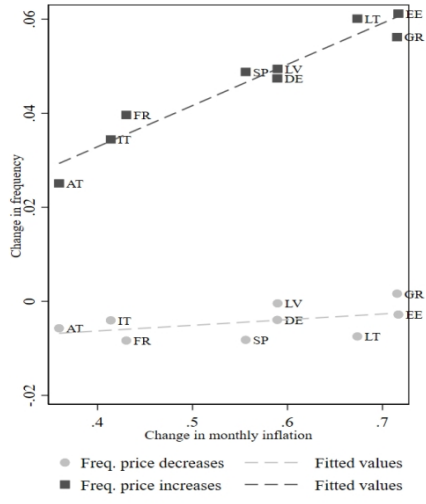


Higher Frequency of Price Changes - Country Heterogeneity

More

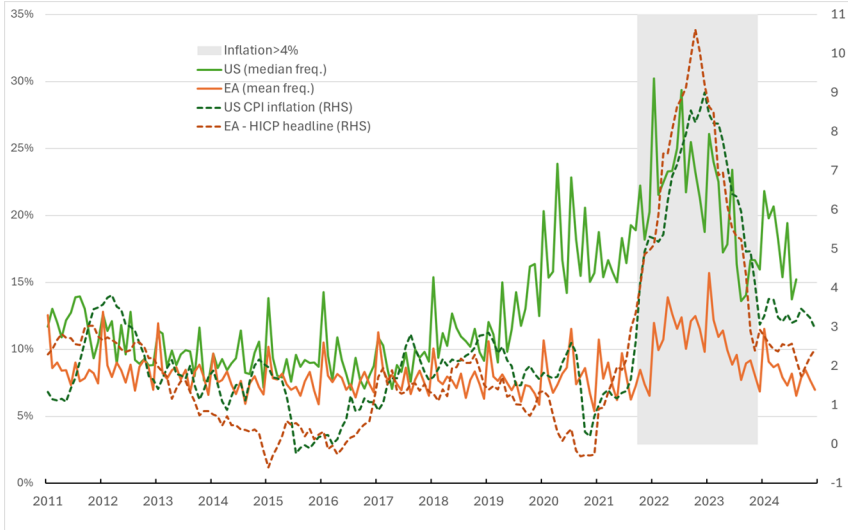
Link changes in aggregate country-specific frequency to annualized inflation rates (2022)





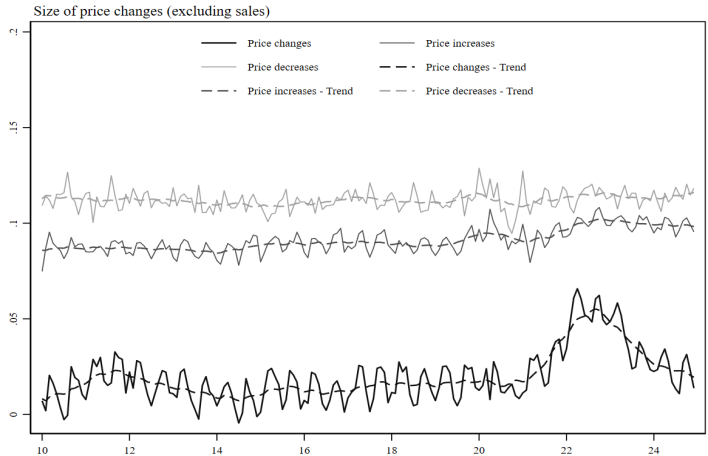
Higher Frequency of Price Changes - US vs. EA

Figure: Cross-sectoral frequency of price changes in 2020-2024 and product-level cost structure



The distribution of price changes shifted in composition, not in scale

More



The distribution of price changes shifted in composition, not in scale

Quantitative estimation of year effects (relative to 2010-2019)

$$dp_{jt} = \alpha_j + \sum_{y=2020}^{2024} \beta_j^y + \gamma_j X_{jt} + \epsilon_{jt}, \tag{3}$$

Average β^y in pp.	All	Size Increases	Size Decreases	Frac. Increases
2020	-0.16	0.41	0.03	-2.97
2021	0.98	0.27	0.25	3.22
2022	3.72	1.10	0.41	13.38
2023	2.10	1.14	0.43	6.34
2024	0.70	0.95	0.29	1.05

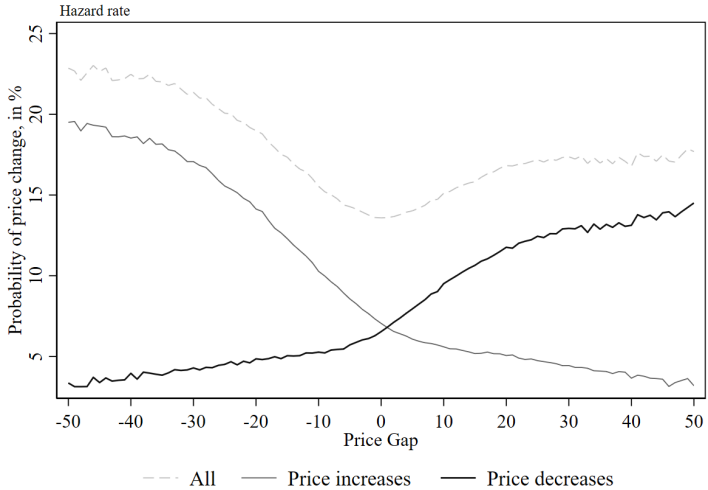
State-dependent pricing became more prevalent

- In state-dependent models:
  - Profit losses are a function of the price gap (=distance between the firm's current price and the profit-maximizing price)
  - The probability of price changes increases with price gaps (vs Calvo - flat hazards)

- How to measure the price gap? (Gagnon et al., 2012 or Karadi et al., 2023)
  - p_{jot} log price of COICOP-5 product j sold in the outlet o at time t
  - "Unadjusted" gap: $x^*_{jot} = p_{jot} - p_{jt}$ (p_{jt} the average reset price of the same product j)
  - We adjust for systematic average price gap by controlling for outlet and time fixed effects to define x_{jot}

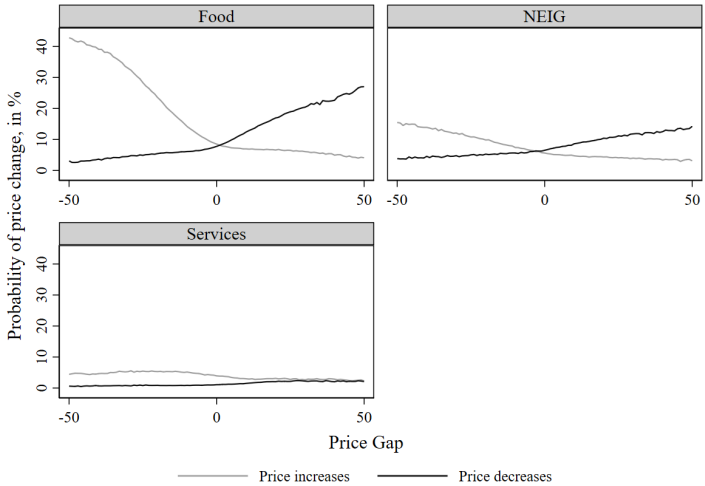
- Estimation on the period of low inflation (measure of the retailer policy function at the "steady state")

State-dependent pricing became more prevalent



Hazard Rates by Sector

Country



Intensive vs Extensive Margins of Price Adjustments

- What is the main margin of adjustment in price setting?
  - Calvo model: size drives the inflation dynamics
  - State dependent model: frequency drives the inflation dynamics
- Define counterfactual inflation rates

$$\pi_{jt}^{\bar{f}} = f_{j.} \times dp_{jt} \tag{4}$$

$$\pi_{jt}^{\bar{dp}} = f_{jt} \times dp_{j.} \tag{5}$$

- Estimate the following regression

$$\pi_{jt} = a + b_{Ext}^{H} \pi_{jt}^{\bar{dp}} 1_H + b_{Ext}^{L} \pi_{jt}^{\bar{dp}} 1_L + b_{Int}^{H} \pi_{jt}^{\bar{f}} 1_H + b_{Int}^{L} \pi_{jt}^{\bar{f}} 1_L + \epsilon_{jt}, \tag{6}$$

- High inflation period defined as after 2020 + regressions using year dummies in interaction

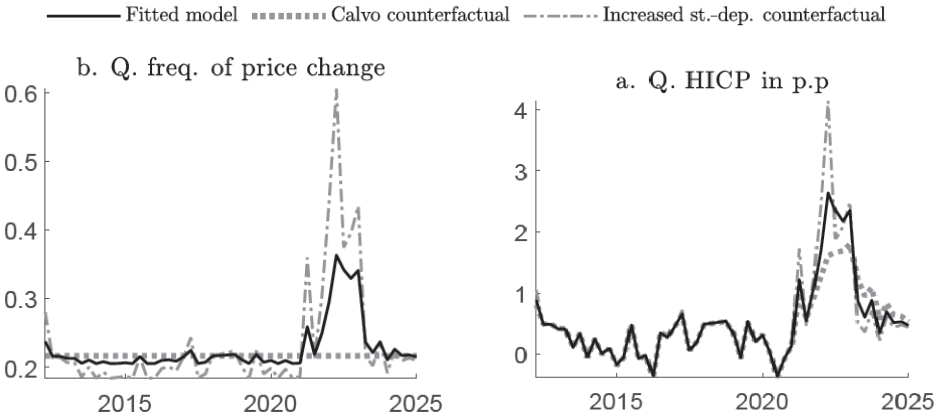
Intensive vs Extensive Margins of Price Adjustments

		All sectors		Food	NEIG	Services
Extensive margin	2010-2020	0.540***				
	2021-2024	1.006***				
	2010-2019		0.581***	0.807***	0.318***	0.754***
	2020		0.290***	0.051	0.219**	0.298
	2021		0.801***	1.202***	0.575***	0.810***
	2022		1.105***	2.178***	0.751***	1.211***
	2023		0.962***	1.554***	0.635***	1.167***
	2024		0.926***	1.065***	0.571***	1.120***
Intensive margin	2010-2020	0.801***				
	2021-2024	0.928***				
	2010-2019		0.808***	0.899***	0.719***	0.783***
	2020		0.716***	0.714***	0.662***	0.762***
	2021		0.794***	0.823***	0.733***	0.797***
	2022		1.082***	1.158***	1.008***	0.908***
	2023		0.959***	1.087***	0.871***	0.845***
	2024		0.809***	0.845***	0.720***	0.916***
	Constant	-0.123***	-0.120***	-0.060	-0.085***	0.025
	Observations	195,620	195,620	69,594	80,323	45,703
	R-squared	0.754	0.763	0.828	0.740	0.740

Macroeconomic Calibration

- Calibrate a simple GE NK model assuming endogenous frequency of price adjustment (Gasteiger and Grimaud, 2023)
- One parameter γ driving the sensitivity of the frequency to the difference btw the present value of resetting prices and the present value of keeping the same price
  Two polar cases: Calvo $\gamma \to 0$ vs. a pure menu cost $\gamma \to \infty$
- We estimate the model on our EA data (fitting the frequency of price changes) ($\hat{\gamma} = 9.5$)
- We then run some counterfactual exercises (Calvo and very large value of γ)

Macroeconomic Calibration



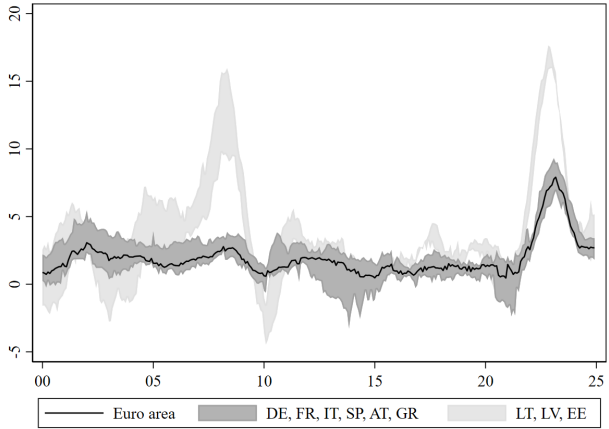
Conclusion

- More frequent price changes during the inflation surge 2022-2023
  - +4 pp in 2022
  - Somewhat more persistent effects for services
  - Evidence in favor of state-dependence
    - Stronger reaction for products more exposed to the cost shock
    - V-shape hazard rates (with some heterogeneity across products)
    - A stronger role for the extensive margin
- Inflation would have been lower in 2022 without state-dependence (but also higher for longer afterwards)
- Average size of price changes were also larger reflecting a larger share of price increases
- Implications for macro-models and monetary policy transmission:
  - Both state-dependence and product heterogeneity in price rigidity are key to reproduce the dynamics of inflation in presence of large shocks
  - This project provides product-specific moments of price stickiness to calibrate models embedding state-dependence and production network (Ghassibe and Nakov 2025)

Appendix

Inflation (HICP excl. energy) in the euro area

Back



Sample Coverage

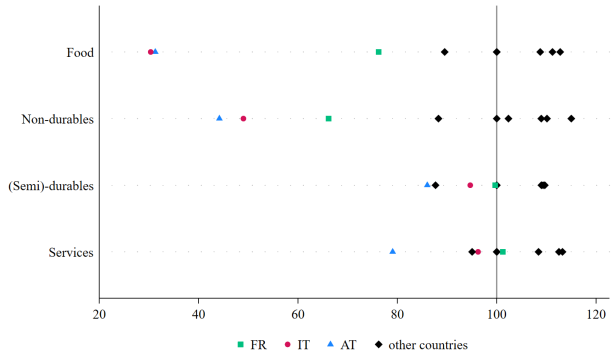
Back

Special aggregate	HICP total share in % (EA 2017-2024)	Share not covered in %	Share covered in %	No. of COICOP-5s covered
Food	19.9	2.5	17.4	59
Processed food	15.3	2.5	12.8	49
Unprocessed food	4.6	0.0	4.6	10
NEIG	26.4	7.9	18.4	66
Energy	10.0	10.0	0.0	0
Services	43.8	20.4	23.4	41
Total	**100.0**	**40.8**	**59.2**	**166**

Scanner data

Back

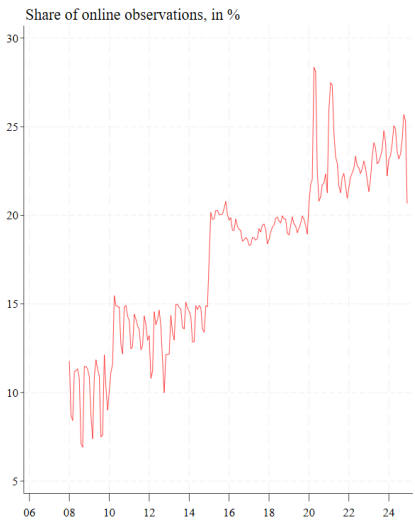
Figure: Share of number of observations by broad category, 2019=100



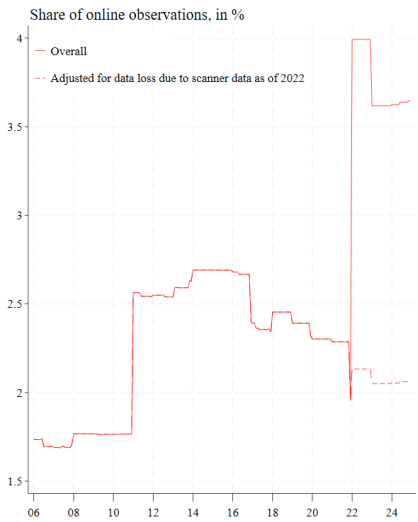
Notes: The graph shows the average number of observations per product category and country between 2020 and 2023 relative to the number of observations in 2019. Note that for Austria, the number of observations for food items declines significantly for the period 2022-2023 because of the introduction of scanner data.

Offline and online price setting for non-energy industrial goods (NEIG)

Germany Back

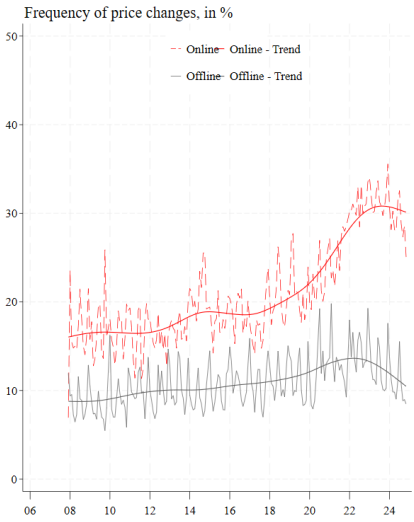


Austria

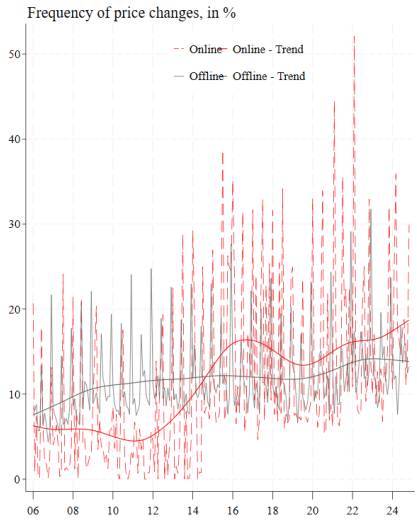


Offline and online price setting for non-energy industrial goods (NEIG)

Germany Back



Austria



What we know so far

Gautier et al. (2024) - EA in a context of low and stable inflation (2010-2019)

- Prices change infrequently (in the "core" sectors)
  - About 8.5% of price changes in a given month
  - Excluding sales and for comparable products, same degree of price stickiness in the US as in the EA
- Idiosyncratic shocks matter for frequency and size/dispersion of price changes
  - Large price changes (about 10%)
  - Two thirds of price increases among price changes
- Limited cyclical variation in frequency of price changes in 2005-19
  - Inflation fluctuations due to average size of price changes (share of increases)
- Calvo or Menu-Cost models with large idiosyncratic shocks could match these facts

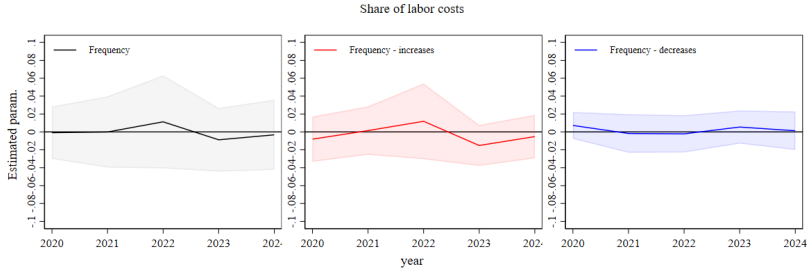
Frequency or price changes by year

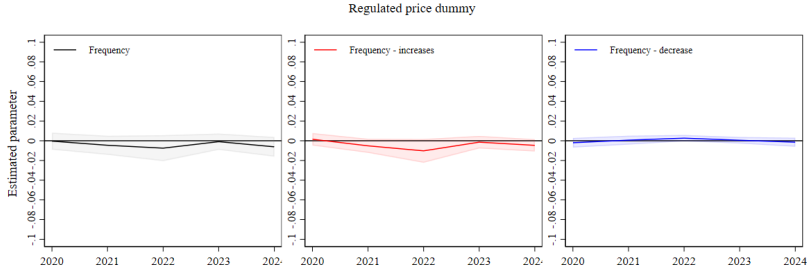
Back

Period	Including sales				Excluding sales			
	All	Up	Down	% Up	All	Up	Down	% Up
2010-2019	12.0	6.6	5.4	63.0	8.2	5.0	3.2	67.2
2020	11.9	6.4	5.5	60.9	8.0	4.8	3.2	65.7
2021	11.8	6.7	5.0	65.6	8.0	5.1	2.9	71.2
2022	15.7	10.8	4.9	74.8	12.0	9.4	2.6	81.7
2023	14.2	8.6	5.5	69.3	10.2	7.1	3.1	74.7
2024	13.3	7.2	6.0	61.9	8.6	5.3	3.3	66.4

Higher Frequency of Price Changes - Product Heterogeneity

Back





Higher Frequency of Price Changes - Country Heterogeneity

Back Time series

Average β^y		Frequency		Frac.
in pp. (2022)	All	Increases	Decreases	Increases
Austria	3.17	2.99	0.18	7.59
Estonia	6.13	6.31	-0.18	13.13
France	3.06	3.94	-0.88	16.05
Germany	5.20	5.31	-0.11	13.64
Greece	5.88	5.57	0.32	19.26
Italy	4.11	4.07	0.05	8.92
Latvia	5.08	5.25	-0.27	13.80
Lithuania	6.40	6.62	-0.23	11.73
Spain	4.21	4.85	-0.64	13.52

Share of products for which freq/size is significantly higher/lower than in 2019

Back freq. Back size

Period	Frequency of price changes			Size of price changes			
	All	Increases	Decreases	All	Increases	Decreases	% inc.
% of products significantly higher than in 2010-2019							
2020	13.8	13.1	12.6	4.7	14.1	8.3	3.1
2021	23.6	25.2	9.6	19.1	15.9	8.6	21.6
2022	68.4	73.1	9.1	65.4	40.0	14.7	59.2
2023	58.8	62.1	20.9	46.8	41.2	14.8	31.2
2024	37.9	35.7	22.1	19.8	33.4	15.5	11.9
% of products significantly lower than in 2010-2019							
2020	13.5	12.1	14.5	6.6	9.8	10.3	11.2
2021	11.3	9.6	18.5	4.0	8.9	10.0	5.1
2022	2.6	0.3	18.7	0.2	5.0	8.8	1.2
2023	1.5	0.3	12.7	0.6	5.4	8.4	4.3
2024	12.7	10.6	11.8	7.2	3.8	8.3	12.2

Frequency of price changes by sector

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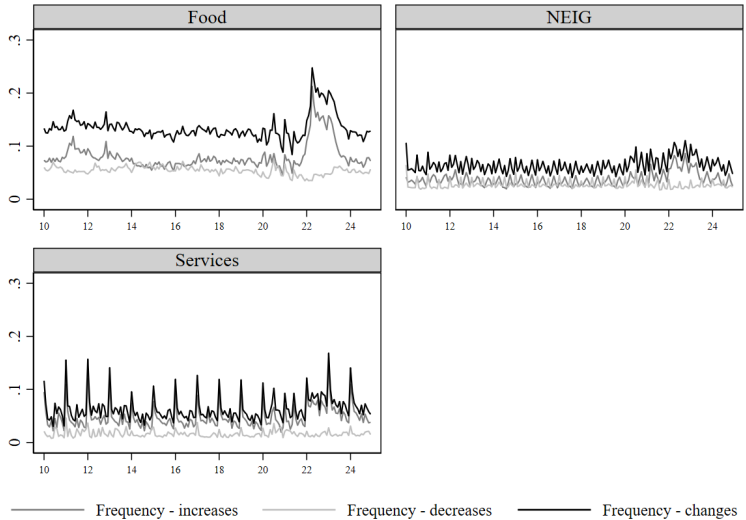

Frequency of price increases and decreases by country

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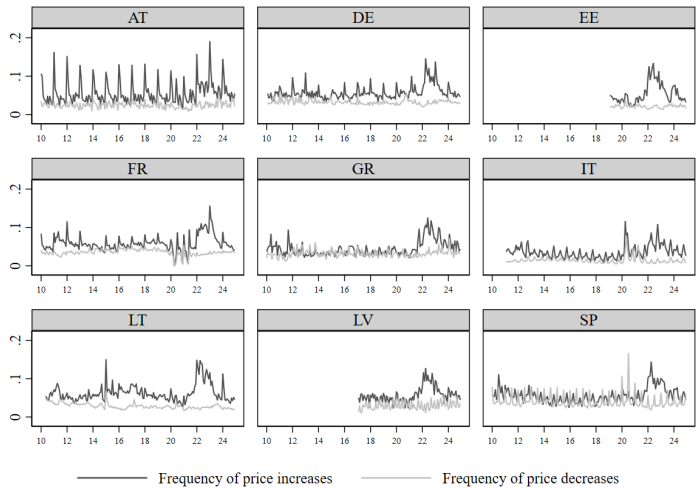

Larger Size of Price Changes in the EA

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Quantitative estimation of year effects (relative to 2019) Year % products

$$dp_{jt} = \alpha_j + \sum_{y=2020}^{2024} \beta_j^y + \gamma_j X_{jt} + \epsilon_{jt}, \tag{7}$$

Average β^y in pp.	All	Size Increases	Decreases	Frac. Increases
2020	-0.16	0.41	0.03	-2.97
2021	0.98	0.27	0.25	3.22
2022	3.72	1.10	0.41	13.38
2023	2.10	1.14	0.43	6.34
2024	0.70	0.95	0.29	1.05

Larger Size of Price Changes - Product Heterogeneity

Regressions

Average β^y in pp.	All	Size Increases	Size Decreases	Frac. Increases
Food				
2022	4.62	1.23	1.37	19.27
2023	1.69	1.12	0.84	6.32
2024	-0.08	0.77	0.68	-1.08
NEIG				
2022	4.87	0.84	-0.12	17.71
2023	2.62	0.76	-0.16	8.80
2024	0.27	0.92	0.07	0.31
Services				
2022	2.15	1.23	0.17	5.80
2023	1.94	1.45	0.65	4.33
2024	1.57	1.10	0.17	3.10

Size or price changes by year

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Period	Including sales				Excluding sales			
	All	Up	Down	% Up	All	Up	Down	% Up
2010-2019	1.9	12.3	15.7	63.0	1.5	8.8	11.3	67.2
2020	2.0	13.3	16.4	60.9	1.6	9.3	11.2	65.7
2021	3.6	13.2	16.5	65.6	2.7	9.3	11.5	71.2
2022	6.6	12.7	16.3	74.8	5.5	10.2	11.9	81.7
2023	4.7	13.3	16.0	69.3	3.9	10.2	11.6	74.7
2024	2.4	14.6	17.0	61.9	1.8	10.2	12.1	66.4

Size of price changes - product heterogeneity

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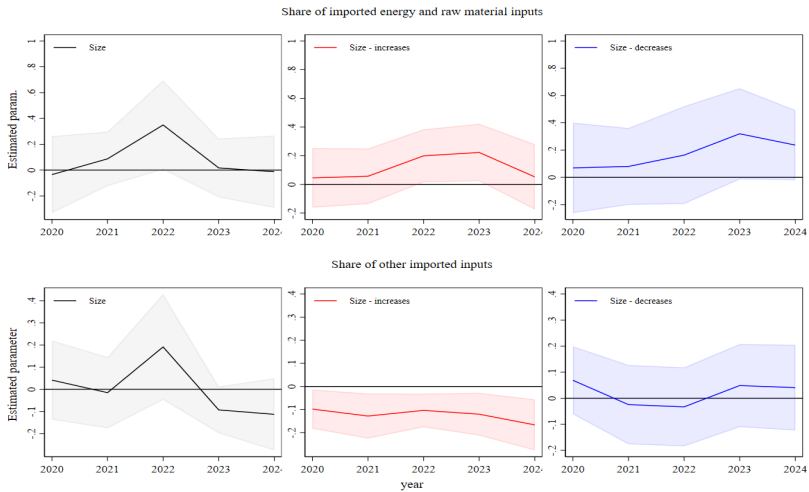
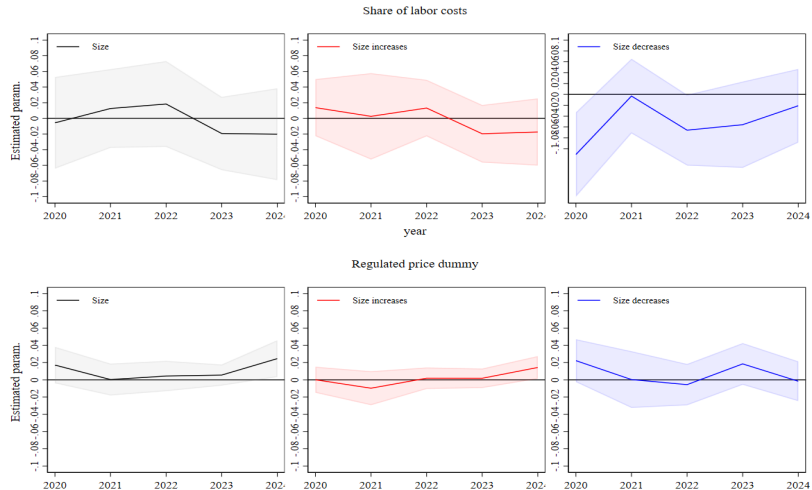
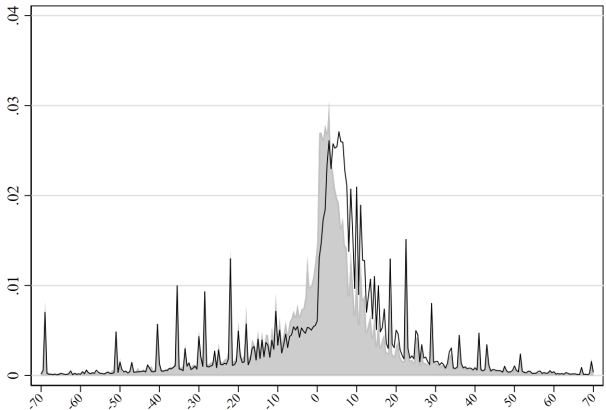


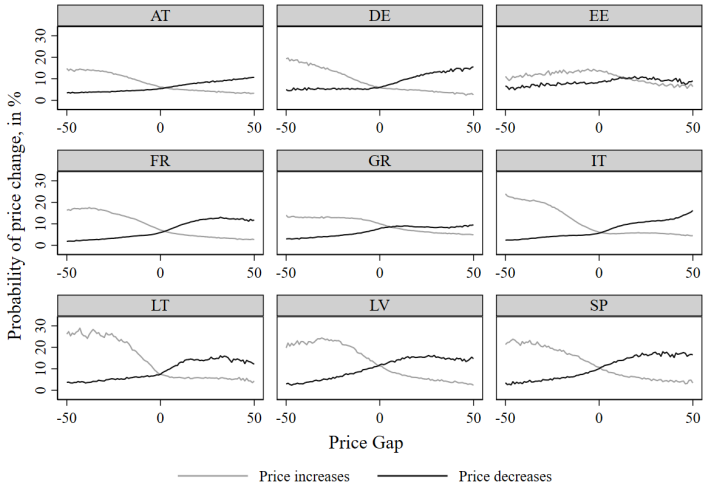
Size of price changes - product heterogeneity



Distribution of Price Changes

Figure: Distribution of price changes in the euro area before and after 2022



Hazard Rates - Country Heterogeneity

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