# How do supply shocks to inflation generalize? Evidence from the pandemic era in Europe

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# Post-pandemic surge in inflation in the Euro Area

- $\cdot\,$  Monetary and fiscal support during the pandemic  $\rightarrow$  boom in spending after re-opening
- $\cdot$  Supply chain pressures (constraints to production and shipping) and energy shock



CPI growth: Eurostat, overall CPI growth, Euro Area time series, monthly frequency.

# Supply chain pressures mounting in 2021



Share of firms answering the question "What main factors are currently limiting your production?" with "Shortage of labor", "Shortage of material/equipment", "Financial constraints". Data at industry-country data from The Joint Harmonised EU Programme of Business and Consumer. This survey covers 27 EU countries.

Material and equipment shortages increasingly cited as production constraints in 2021
Labor shortages steadily becoming more apparent

# Post-pandemic surge in inflation *expectations* in the Euro Area



Households expectations is the share of households expecting inflation to increase "a lot" minus share of households expecting inflation to decrease "a lot" over 12 months; monthly data; Euro area. Firm expectations are the same as household, except over 3 months ahead; monthly ahead.

- · Increasing share of households/firms expect prices to go up substantially
- $\cdot\,$  Firm expectations move before household expectations
- $\cdot\,$  Distribution becomes fat-tailed as in other episodes

# Manufacturing vs service inflation



# Inflation becoming more broad-based with time



# Our "narrative" of mechanisms at work

- - → Channel at work for all households — Channel reinforced by firms' pricing power



- · Alessandria et al. (2022) and Kalemli-Ozcan et al. (2022) model aggregate effects of supply chain shocks during COVID-19 pandemic
- Growing body of research on supply-side factors and inflation (e.g., Amiti et al., 2022; Ball et al., 2022; Bernanke and Blanchard, 2023; Binici et al., 2022; Celasun et al., 2022; Comin et al., 2023; Finck and Tillmann, 2022; Franzoni et al. (2023); Isaacson and Rubinton, 2022)

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# Our "narrative" of mechanisms at work



- Experience channel is consistent with adaptive expectations (Cagan, 1956), diagnostic expectations (Bordalo et al., 2018), and adaptive learning models (Evans and Honkapohja, 2001; Eusepi and Preston, 2011; Malmendier and Nagel, 2016; D'Acunto et al., 2021)
- · Agents adjust inflation expectations in response to news about supply shocks (Carroll, 2003; Pfajfar and Santoro, 2010; Dräger and Lamla, 2017; Larsen et al., 2021; Mazumder, 2021)

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# Our "narrative" of mechanisms at work



- · If households perceive shock as widespread ("common shock"), lower incentive to search for better deals elsewhere (Benabou and Gertner, 1993; Gaballo and Paciello, 2022).
- Higher price variability associated with higher inflation depreciates value of information about future prices contained in current ones, lowering search incentives (Tommasi, 1994)

# Findings

Supply-side inflation impulses can generalize, via interaction of market power and household expectations, into broad-based inflation

#### $\cdot$ Initially, inflation via "cost-push" channel

- Supply-chain pressures caused an increase in inflation through a cost-push channel (product level evidence for CPI)
- Largely driven by import dependence on China during lockdown periods
- Market power intensified the cost-push channel as firms sustained, or even increased, their markups in sectors witnessing high demand (firm-level evidence)

#### $\cdot$ Persistent inflation in spite of easing supply-chain pressures

- Supply-chain pressures lead to an increase in households inflation expectations
- $\rightarrow\,$  Relatively higher price growth for products less affected by supply chain pressures
  - High-market power firms further increased markups in response to heightened HH inflation expectations (generalization through household *adaptive* expectations) (product-country and firm-level evidence)

 $\rightarrow\,$  Spillover of inflation into products less affected by supply pressures

- Pass-through of supply chain constraints into household expectations

#### Pass-through of supply chain constraints into prices

Pass-through of supply constraints into CPI growth

$$\begin{aligned} CPI \ Growth_{pct+1} &= \sum_{f \in \text{Constraint}} \beta_{1f} \ f_{pct} + \sum_{f \in \text{Constraint}} \sum_{\tau=20,21,22} \beta_{2f\tau} \ f_{pct} \times Year_{\tau} \\ &+ \nu_{ct} + \mu_{pc} + \epsilon_{pct}, \end{aligned}$$

- · p is a product, c is a country, t is a date (quarter)
- · CPI Growth<sub>pct+1</sub> defined as  $(CPI_{pct+1}-CPI_{pct-3})/CPI_{pct-3}$ , where t is a quarter
- $\cdot\,$  Firm constraints (transformed at pc level) are supply chain, labor, financial, other
  - 1) Contribution to inflation from other country's industries (input-output tables)
  - 2) Inverse COICOP-CPA matrix to build product-country supply chain constraints
- $\cdot\,$  Sample runs from 2019:Q1 to 2022:Q4 (2019 base year)
- $\cdot\,$  Fixed effects at the country-quarter and product-country level
- $\cdot\,$  Controlling for energy use of a pc pair as of 2019 interacted with the Energy CPI

# Supply constraints positively associated with CPI growth

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CP1 Growth	CPI Growth
$Material_{pct} \times Covid_t$	$0.087^{***}$ (0.023)	$0.086^{***}$ (0.022)				
$Material_{pct} \times 2020$			$0.126^{***}$	$0.126^{***}$	$0.127^{***}$	$0.095^{**}$
			(0.025)	(0.027)	(0.028)	(0.034)
$Material_{pct} \times 2021$			$0.076^{**}$	$0.074^{**}$	$0.074^{**}$	$0.064^{**}$
			(0.027)	(0.027)	(0.026)	(0.027)
$Material_{pct} \times 2022$			$0.074^{**}$	$0.071^{**}$	0.070 * *	$0.060^{**}$
			(0.027)	(0.027)	(0.026)	(0.027)
Energy Use <sub>pc</sub> × Energy Inflation <sub>ct</sub>		$1.448^{***}$		$1.454^{***}$	$1.471^{***}$	$1.515^{***}$
		(0.481)		(0.482)	(0.481)	(0.478)
Controls						
Other constraints					$\checkmark$	$\checkmark$
Other constraints interacted						$\checkmark$
Country-time FE	$\checkmark$	$\checkmark$	✓	✓	✓	✓
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	9,187	9,187	9,187	9,187	9,187	9,187
R-squared	0.537	0.545	0.537	0.546	0.546	0.550

CPI Growth: Quarterly frequency for each product, directly obtained from Eurostat (no trasformation needed). Annual growth defined as CPI Growth  $p_{t+1}$  defined as  $(CPI_{pt+1}-CPI_{pt-3})/CPI_{pt-3}$ , where t is a quarter. Constraints transformed from industry-level to product-level using inverse  $p(\tau) = p(\tau)$ . Energy Inflation is the country-time-level CPI index for energy. Energy Use is a product-country pair's energy input before the COVID-19 pandemic, measured in 2019 and scaled by the country's total energy use.

- · 1 SD higher supply chain constraints post Covid  $\rightarrow$  1.3pp higher CPI growth
- · 1 SD higher energy dependence post Covid  $\rightarrow 0.8$  pp higher CPI growth  $\rightarrow 0.8$  p hig

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth
$\text{Material}_{pct} \times \text{Covid}_t$	$0.087^{***}$ (0.023)	0.086*** (0.022)				
$Material_{pct} \times 2020$			0.126***	0.126***	0.127***	0.095**
$Material_{pct} \times 2021$			(0.025) 0.076**	(0.027) $0.074^{**}$	(0.028) 0.074**	(0.034) $0.064^{**}$
$Material_{pct} \times 2022$			(0.027) $0.074^{**}$	(0.027) $0.071^{**}$	(0.026) 0.070**	(0.027) $0.060^{**}$
Energy Use <sub>pc</sub> × Energy Inflation <sub>ct</sub>		1.448***	(0.027)	(0.027) $1.454^{***}$	(0.026) $1.471^{***}$	(0.027) 1.515***
		(0.481)		(0.482)	(0.481)	(0.478)
<u>Controls</u> Other constraints Other constraints interacted					$\checkmark$	$\checkmark$
Country-time FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations R-squared	$9,187 \\ 0.537$	$9,187 \\ 0.545$	$9,187 \\ 0.537$	$9,187 \\ 0.546$	$9,187 \\ 0.546$	$9,187 \\ 0.550$

## Supply constraints positively associated with CPI growth

CPI Growth: Quarterly frequency for each product, directly obtained from Eurostat (no trasformation needed). Annual growth defined as CPI Growth<sub>pt+1</sub> defined as  $(CPI_{pt+1}-CPI_{pt-3})/CPI_{pt-3}$ , where t is a quarter. Constraints transformed from industry-level to product-level using inverse of CPA-COICOP matrix. Energy Inflation is the country-time-level CPI index for energy. Energy Use is a product-country pair's energy input before the COVID-19 pandemic, measured in 2019 and scaled by the country's total energy use.

- $\cdot~1$  SD higher supply chain constraints post Covid  $\rightarrow$  1.3pp higher CPI growth
- · 1 SD higher energy dependence post Covid  $\rightarrow 0.8$ pp higher CPI growth  $\rightarrow 0.8$   $\rightarrow 0.8$

# Inflation if supply frictions had stayed at pre-Covid level



#### Moving closer to a supply-side mechanism

Instrument: Reliance on input goods from China during lockdown

 $ChinaDependence_{pc,2019} \times Lockdown_t$ 

- Cross-sectional variation: Share of inputs to produce product p in country c that are imported from China in 2019 (input-output tables).
- **Time-series variation**: Stringency of lockdowns in the top 5 exporting provinces in China (Oxford Covid-19 Government Response Tracker (OxCGRT))
  - Top-5 exporting provinces: Guangdong, Jiangsu, Shandong, Shanghai, and Zhejiang.
  - Provinces account for 67% of total Chinese exports.

# IV estimation

	CPI Growth $pct$	$Material_{pct}$
$Material_{pct}$	0.081***	
	(0.017)	
China Dependence <sub>pc</sub> × Lockdown Stringency <sub>t</sub>		$6.973^{***}$
		(0.339)
F-Test		423.17
Product-country FE	$\checkmark$	$\checkmark$
Country-time FE	$\checkmark$	$\checkmark$
Observations	9,187	9,187
R-squared		0.782

CPI Growth is the one-quarter ahead annual CPI growth at the product-country-time level. Constraints transformed from industry-level to product-level using inverse of CPA-COICOP matrix. The constraints Material, Labor, Financial, and Other are all included in this estimation. Also included the interaction of Energy Inflation and Energy Use. We exclude the product Energy from the regression.

· Dependence on Chinese imports predicts material frictions of EU firms during lockdown

#### Pass-through of supply chain constraints into expectations

# Supply chain constraints $\rightarrow$ high inflation expectations

#### ECB Consumer Expect. Survey (DE/ES/IT/FR/BE/NL; HH panel '20-)

- 1) "Looking ahead to 12 months from now, what do you think will happen to prices?"
- 2) "Please think further ahead to < survey month year +2 >. What do you think will happen to prices in general in the country you currently live in over the 12-month period < between survey month year +2 and survey month year +3 >?"
  - (i) prices will increase a lot, (ii) prices will decrease a lot, (iii) prices will increase a little, (iv) prices will decrease a little, or (v) prices will be exactly the same (that is 0% change).

## Short- and long-term expectations increase



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Supply chain constraints  $\rightarrow$  high inflation expectations

$$\hat{\pi}_{ht}^{e} = \sum_{f \in \text{Constraint}} \beta_f f_{ct} + X_{ht} + \mu_c + \epsilon_{ht}$$

 $\hat{\pi}_{ht}^{e}$  is a dummy equal to one if the household expects prices to increase a lot over the next year

 $\cdot\,$  Transform supply constraints from industry-country to country level using share of consumption that each industry contributes to the final household consumption

Short-Term Expectations	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$
Material <sub>ct</sub>	$0.951^{***}$	$0.593^{***}$	$0.296^{***}$	$0.261^{***}$	$0.281^{***}$	$0.110^{**}$
	(0.037)	(0.034)	(0.041)	(0.041)	(0.059)	(0.050)
Food Inflation $_{ct}$		$1.715^{***}$	$1.359^{***}$	$0.949^{***}$	$1.032^{***}$	
		(0.050)	(0.050)	(0.067)	(0.088)	
Energy Inflation <sub><math>ct</math></sub>			$0.192^{***}$	$0.175^{***}$	$0.158^{***}$	
			(0.011)	(0.011)	(0.013)	
Core Inflation <sub><math>ct</math></sub>				$1.468^{***}$	$1.731^{***}$	
				(0.201)	(0.207)	
Perceived (realized) $Inflation_{ht}$						$1.178^{***}$
						(0.030)
Observations	126,080	126,080	126,080	126,080	126,080	126,080
R-squared	0.512	0.526	0.530	0.530	0.531	0.539
Household fixed effects	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	~
Other Frictions					$\checkmark$	$\checkmark$

→  $\uparrow$  share of firms reporting material frictions from 10th to 90th percentile during COVID-19 → 4pp higher probability for a household to believe prices will increase a lot in the following year =

Supply chain constraints  $\rightarrow$  high inflation expectations

$$\hat{\pi}_{ht}^{e} = \sum_{f \in \text{Constraint}} \beta_f f_{ct} + X_{ht} + \mu_c + \epsilon_{ht}$$

 $\hat{\pi}_{bt}^{e}$  is a dummy equal to one if the household expects prices to increase a lot from y+2 to y+3

· Transform supply constraints from industry-country to country level using share of consumption that each industry contributes to the final household consumption

Long-Term Expectations	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$	$\hat{\pi}^e$
$Material_{ct}$	$0.242^{***}$	$0.157^{***}$	0.097***	0.082***	$0.110^{***}$	0.100***
	(0.019)	(0.020)	(0.023)	(0.024)	(0.038)	(0.034)
Food Inflation <sub><math>ct</math></sub>		$0.410^{***}$	$0.338^{***}$	$0.160^{***}$	$0.212^{***}$	
		(0.037)	(0.040)	(0.061)	(0.071)	
Energy Inflation <sub><math>ct</math></sub>			$0.039^{***}$	$0.031^{***}$	$0.025^{***}$	
			(0.009)	(0.009)	(0.010)	
Core Inflation <sub><math>ct</math></sub>				$0.636^{***}$	$0.747^{***}$	
				(0.162)	(0.173)	
Perceived (realized) Inflation $ht$						$0.518^{***}$
						(0.023)
Observations	126,080	126,080	126,080	126,080	126,080	126,080
R-squared	0.498	0.499	0.499	0.500	0.500	0.504
Household fixed effects	$\checkmark$	~	$\checkmark$	√	$\checkmark$	~
Other Frictions					$\checkmark$	$\checkmark$

Similar magnitude for longer horizon  $\rightarrow$ 

- $\cdot$  Extend analysis adding interactions with Accurate (HH-level dummy for accurate past inflation expectations)
  - Two measures of accuracy:
    - (i) within household correlation between realized inflation and answer to "How much higher (lower) do you think prices in general are now compared with 12 months ago in the country you currently live in?" above the sample median
    - (ii) abs. difference between realized inflation and HH estimate of realized inflation < 2pp
- Korenok, Munro and Cheng (2023): *Attentiveness* of households to inflation increases once inflation exceeds a certain threshold (measured through Google Search trends)
- $\cdot$  Consider Google Searches (country-quarter level index for searches for supply chain issues) using keywords such as "delivery delay" in the native language

	$\hat{\pi}^e_{ht}$			
$Material_{ct}$	$-0.461^{***}$			
	(0.052)			
$Material_{ct} \times Accurate_h$	$1.547^{***}$	$1.209^{***}$		
	(0.048)	(0.047)		
Food Inflation $_{ct}$	$1.020^{***}$			
	(0.084)			
Energy Inflation <sub><math>ct</math></sub>	$0.139^{***}$			
	(0.013)			
Core Inflation $_{ct}$	$2.027^{***}$			
	(0.202)			
Perceived (realized) Inflation <sub><math>ht</math></sub>		$0.849^{***}$		
		(0.028)		
Observations	122,096	122,096		
R-squared	0.534	0.554		
Household FE	$\checkmark$	$\checkmark$		
Country-time FE		$\checkmark$		

The dependent variable is equal to one if household h believes prices will increase a lot over the next 12 month. Material, Labor, Financial, and Other measure the share of firms that indicate that their production is constrained by the respective constraint (all included). All constraints are transformed from the industry-country-time level to the country-time level using the share of consumption that each industry contributes to the final household consumption. Accurate is a dummy equal to one for households with an above median within household correlation between realized inflation over the last 12 months and the household's inflation estimate for the last 12 months. Food Inflation, Energy Inflation, and Core Inflation are the country-time-level CPI indices for food, energy, and core, respectively. Perceived (realized) Inflation is household h's perception about the inflation over the last 12 months.

		$\hat{\pi}^{e}_{ht}$	
Material <sub>ct</sub>	0.067	-0.260**	
	(0.081)	(0.110)	
$Material_{ct} \times Accurate_h$		$0.694^{***}$	$0.503^{***}$
		(0.152)	(0.120)
$Material_{ct} \times Accurate_h \times Search_{ct}$		1.408***	1.308***
		(0.275)	(0.220)
Search <sub>ct</sub>	$-0.254^{***}$	-0.230***	
	(0.033)	(0.035)	
$Material_{ct} \times Search_{ct}$	0.882***	0.099	
	(0.138)	(0.177)	
$Accurate_h \times Search_{ct}$		-0.089	$-0.172^{***}$
		(0.057)	(0.042)
Food Inflation <sub>ct</sub>	$1.205^{***}$	$1.156^{***}$	
	(0.097)	(0.093)	
Energy Inflation <sub><math>ct</math></sub>	$0.095^{***}$	$0.090^{***}$	
	(0.018)	(0.017)	
Core Inflation <sub><math>ct</math></sub>	$2.476^{***}$	$2.695^{***}$	
	(0.282)	(0.268)	
Perceived (realized) $Inflation_{ht}$			$0.841^{***}$
			(0.026)
Observations	106,144	102,551	103,088
R-squared	0.536	0.539	0.556
Household FE	~	~	~
Country-time FE			$\checkmark$

Search is a country-time-level variable measuring the intensity of Google searches for "delays in shipping" (in the respective country's language).

		$\hat{\pi}^{e}_{ht}$	
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$Material_{ct} \times Accurate_h$		$0.694^{***}$	$0.503^{***}$
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$Material_{ct} \times Accurate_h \times Search_{ct}$		$1.408^{***}$	$1.308^{***}$
		(0.275)	(0.220)
$Search_{ct}$	$-0.254^{***}$	$-0.230^{***}$	
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Perceived (realized) Inflation <sub><math>ht</math></sub>			$0.841^{***}$
			(0.026)
Observations	106,144	102,551	103,088
R-squared	0.536	0.539	0.556
Household FE	√	~	$\checkmark$
Country-time FE			$\checkmark$

Search is a country-time-level variable measuring the intensity of Google searches for "delays in shipping" (in the respective country's language).

From localized inflation to the generalization of inflation

- $\cdot$  **Documented so far:** Supply-side shock pass-through to
  - (i) prices
  - (ii) household inflation expectations
  - $\Rightarrow$  Localized inflation mainly concentrated in Manufacturing goods
- Next step: Why is inflation also prevalent in Services?
  - (i) inflation expectations affect elasticity of demand
  - (ii) this influences firms' pricing strategy
  - (iii) interaction of firm pricing power and HH inflation expectations
  - $\Rightarrow\,$  Generalized inflation affects also services

#### Generalization of inflation

## Generalization of inflation



Difference in manufacturing - service inflation in high vs low inflation expectation countries

## Generalization of inflation

$$\begin{split} CPI \ Growth_{pct+1} &= \beta_1 Service_{pc} \times High \ Infl \ Exp_c \\ &+ \sum_{\tau=20,21,22} \beta_{2\tau} Service_{pc} \times Year_{\tau} \\ &+ \sum_{\tau=20,21,22} \beta_{3\tau} Service_{pc} \times High \ Infl \ Exp_c \times Year_{\tau} \\ &+ Controls + \nu_{ct} + \theta_{pc} + \epsilon_{cpt} \end{split}$$

- $\cdot p$  is a product, c is a country, t is a date (quarter)
- · CPI Growth<sub>pct+1</sub> defined as  $(CPI_{pct+1}-CPI_{pct-3})/CPI_{pct-3}$ , where t is a quarter
- $\cdot \ \operatorname{Service}_{pc}$  is contribution of service sectors to consumption of product p
- · High Infl  $Exp_c$ : indicator equal to one if increase in share of households with high expectations between 2021:Q1 and 2022:Q2 is above median
- $\cdot\,$  Fixed effects at the country-quarter and product-country level

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# Inflation generalizes to products unaffected by supply shortages

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-0.246	-0.728	0.460	-0.581	-0.669
	(0.669)	(1.203)	(0.928)	(0.821)	(1.127)
$\text{Service}_{pc} \times 2021$	$-2.219^{***}$	$-3.156^{***}$	-1.389	$-1.528^{**}$	$-2.657^{**}$
	(0.675)	(1.173)	(1.149)	(0.747)	(1.082)
$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-5.406^{***}$	$-4.885^{***}$	$-4.615^{***}$	$-4.788^{***}$
	(0.903)	(1.310)	(1.852)	(1.209)	(1.404)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	0.550	-1.634	-0.221	-2.399
	(0.787)	(1.006)	(1.532)	(0.789)	(2.039)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	1.503	-1.921	-0.568	-0.079
	(0.734)	(1.242)	(1.358)	(0.842)	(1.659)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2022$	$2.675^{**}$	$4.445^{**}$	0.029	$2.111^{*}$	$3.336^{*}$
	(1.073)	(1.788)	(1.995)	(1.245)	(2.012)
Energy Use <sub>pc</sub> × Energy Inflation <sub>ct</sub>	$1.467^{***}$	$1.077^{***}$	$1.437^{***}$	$1.213^{***}$	$2.580^{***}$
	(0.268)	(0.385)	(0.343)	(0.282)	(0.879)
Sample	Full	High Market	Low Market	High Collective	Low Collective
	Sample	Power	Power	Bargaining	Bargaining
Controls	$\checkmark$	$\checkmark$	✓	✓	✓
$\text{Service}_{pc} \times \text{Energy Inflation}_{ct} \times \text{Year Controls}$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	$\checkmark$	$\checkmark$	✓	✓	✓
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	8,099	3,645	3,430	5,062	3,037
R-squared	0.580	0.604	0.630	0.513	0.630

 $\rightarrow$   $\uparrow$  One SD material friction  $\rightarrow$  0.94pp higher inflation for Low Material Growth markets in 2022

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$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-5.406^{***}$	$-4.885^{***}$	$-4.615^{***}$	$-4.788^{***}$
	(0.903)	(1.310)	(1.852)	(1.209)	(1.404)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	0.550	-1.634	-0.221	-2.399
	(0.787)	(1.006)	(1.532)	(0.789)	(2.039)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	1.503	-1.921	-0.568	-0.079
	(0.734)	(1.242)	(1.358)	(0.842)	(1.659)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2022$	$2.675^{**}$	$4.445^{**}$	0.029	$2.111^{*}$	$3.336^{*}$
	(1.073)	(1.788)	(1.995)	(1.245)	(2.012)
Energy Use <sub>pc</sub> $\times$ Energy Inflation <sub>ct</sub>	$1.467^{***}$	$1.077^{***}$	$1.437^{***}$	$1.213^{***}$	$2.580^{***}$
	(0.268)	(0.385)	(0.343)	(0.282)	(0.879)
Sample	Full	High Market	Low Market	High Collective	Low Collective
	Sample	Power	Power	Bargaining	Bargaining
Controls	$\checkmark$	$\checkmark$	✓	✓	✓
$Service_{pc} \times Energy Inflation_{ct} \times Year Controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	$\checkmark$	$\checkmark$	✓	✓	$\checkmark$
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	8,099	3,645	3,430	5,062	3,037
R-squared	0.580	0.604	0.630	0.513	0.630

 $\rightarrow$   $\uparrow$  One SD material friction  $\rightarrow$  0.94pp higher inflation for Low Material Growth markets in 2022

# Inflation generalizes to products unaffected by supply shortages

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-0.246	-0.728	0.460	-0.581	-0.669
	(0.669)	(1.203)	(0.928)	(0.821)	(1.127)
$\text{Service}_{pc} \times 2021$	$-2.219^{***}$	$-3.156^{***}$	-1.389	$-1.528^{**}$	$-2.657^{**}$
	(0.675)	(1.173)	(1.149)	(0.747)	(1.082)
$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-5.406^{***}$	$-4.885^{***}$	$-4.615^{***}$	$-4.788^{***}$
	(0.903)	(1.310)	(1.852)	(1.209)	(1.404)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	0.550	-1.634	-0.221	-2.399
	(0.787)	(1.006)	(1.532)	(0.789)	(2.039)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	1.503	-1.921	-0.568	-0.079
	(0.734)	(1.242)	(1.358)	(0.842)	(1.659)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2022$	$2.675^{**}$	$4.445^{**}$	0.029	$2.111^{*}$	$3.336^{*}$
	(1.073)	(1.788)	(1.995)	(1.245)	(2.012)
Energy Use <sub>pc</sub> × Energy Inflation <sub>ct</sub>	$1.467^{***}$	$1.077^{***}$	$1.437^{***}$	$1.213^{***}$	$2.580^{***}$
	(0.268)	(0.385)	(0.343)	(0.282)	(0.879)
Sample	Full	High Market	Low Market	High Collective	Low Collective
	Sample	Power	Power	Bargaining	Bargaining
Controls	$\checkmark$	$\checkmark$	✓	$\checkmark$	√
$\text{Service}_{pc} \times \text{Energy Inflation}_{ct} \times \text{Year Controls}$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	✓
Observations	8,099	3,645	3,430	5,062	3,037
R-squared	0.580	0.604	0.630	0.513	0.630

 $\rightarrow$   $\uparrow$  One SD material friction  $\rightarrow$  0.94pp higher inflation for Low Material Growth markets in 2022

# Generalization of inflation: driven by supply chain relations?

- $\cdot\,$  Focus on material constraint of upstream products
- $\cdot\,$  Material Supply  $_{pct}$ : weighted share of supply frictions of one-level upstream suppliers

$$=\sum_{\overline{j},\overline{c}}\left[COICOP \; Share_{pc\overline{j}} \times Consumption \; Share_{c\overline{j}\overline{c}} \times \left(\sum_{\underline{j},\underline{c}} Supply \; Share_{\overline{j}\overline{c}\underline{j}\underline{c}} \times Constraint_{\underline{j}\underline{c}t}\right)\right]$$

- p is a product, c is a country, t is a date (quarter),  $\overline{j}$  ( $\overline{c}$ ) is the customer industry (country) selling to final consumption,  $\underline{j}$  ( $\underline{c}$ ) is the supplier industry (country)
- · COICOP Share  $p_{c\bar{i}}$ : weights for CPA categories that are related to a COICOP category
- · Consumption Share  $c_{i\bar{c}}$ : weights for CPA categories contributing to final consumption
- · Use different lags of upstream frictions (contemporaneous, one/two quarter lag)

	CPI Growth				
$\text{Service}_{pc} \times 2020$	-0.246	-0.330	-0.529	-0.031	-0.2929
	(0.669)	(0.774)	(0.733)	(0.815)	(0.778)
$\text{Service}_{pc} \times 2021$	$-2.219^{***}$	-0.996	$-1.254^{*}$	-1.250*	-1.309*
	(0.675)	(0.676)	(0.662)	(0.709)	(0.694)
$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-4.361^{***}$	$-4.630^{***}$	$-4.568^{***}$	$-4.705^{***}$
	(0.903)	(1.097)	(1.100)	(1.231)	(1.248)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	-1.307*	-1.290	-1.932*	-1.494
P	(0.787)	(0.783)	(0.784)	(1.037)	(0.981)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	-0.139	-0.108	0.312	0.303
	(0.734)	(0.721)	(0.720)	(0.840)	(0.821)
Service <sub>pc</sub> × High Infl $\text{Exp}_c \times 2022$	$2.675^{**}$	$2.624^{**}$	$2.657^{**}$	$2.994^{*}$	3.004*
	(1.073)	(1.075)	(1.076)	(1.569)	(1.583)
Material Supply <sub>pcx</sub> $\times$ 2020		-0.001	-0.055	0.066	0.016
		(0.070)	(0.058)	0.100	(0.093)
Material Supply <sub>pcx</sub> $\times$ 2021		$0.127^{***}$	$0.140^{***}$	0.0522	$0.132^{**}$
		(0.025)	(0.027)	(0.066)	(0.058)
Material Supply <sub>pcx</sub> $\times$ 2022		0.030	0.011	-0.0422	0.003
		(0.036)	(0.035)	(0.0875)	(0.071)
Material Supply Timing		x = t	x = t - 1	x = t	x = t - 1
Material Supply <sub><i>pcx</i></sub> × High Infl $Exp_c$ × Year Control				√	√
$Service_{pc} \times Energy Inflation_{ct} \times Year Controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Other Constraints	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	√	√	√	√	√
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	8,099	8,099	8,099	8,099	8,099
R-squared	0.580	0.583	0.582	0.582	0.582

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-0.246	-0.330	-0.529	-0.031	-0.2929
	(0.669)	(0.774)	(0.733)	(0.815)	(0.778)
$\text{Service}_{pc} \times 2021$	$-2.219^{***}$	-0.996	-1.254*	-1.250*	-1.309*
	(0.675)	(0.676)	(0.662)	(0.709)	(0.694)
$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-4.361^{***}$	$-4.630^{***}$	-4.568 * * *	$-4.705^{***}$
	(0.903)	(1.097)	(1.100)	(1.231)	(1.248)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	-1.307*	-1.290	-1.932*	-1.494
	(0.787)	(0.783)	(0.784)	(1.037)	(0.981)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	-0.139	-0.108	0.312	0.303
	(0.734)	(0.721)	(0.720)	(0.840)	(0.821)
Service <sub>pc</sub> × High Infl $\text{Exp}_c \times 2022$	$2.675^{**}$	$2.624^{**}$	2.657 * *	$2.994^{*}$	3.004*
	(1.073)	(1.075)	(1.076)	(1.569)	(1.583)
Material Supply <sub>pcx</sub> $\times$ 2020		-0.001	-0.055	0.066	0.016
		(0.070)	(0.058)	0.100	(0.093)
Material Supply <sub>pcx</sub> $\times$ 2021		$0.127^{***}$	$0.140^{***}$	0.0522	$0.132^{**}$
		(0.025)	(0.027)	(0.066)	(0.058)
Material Supply <sub>pcx</sub> $\times$ 2022		0.030	0.011	-0.0422	0.003
*		(0.036)	(0.035)	(0.0875)	(0.071)
Material Supply Timing		x = t	x = t - 1	x = t	x = t - 1
Material Supply <sub><i>ncx</i></sub> × High Infl $Exp_c$ × Year Control				✓	~
Service <sub>pc</sub> × Energy Inflation <sub>ct</sub> × Year Controls	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Other Constraints	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	√	√	√	√	✓
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	8,099	8,099	8,099	8,099	8,099
R-squared	0.580	0.583	0.582	0.582	0.582

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-0.246	-0.330	-0.529	-0.031	-0.2929
	(0.669)	(0.774)	(0.733)	(0.815)	(0.778)
$\text{Service}_{pc} \times 2021$	$-2.219^{***}$	-0.996	-1.254*	-1.250*	-1.309*
	(0.675)	(0.676)	(0.662)	(0.709)	(0.694)
$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-4.361^{***}$	$-4.630^{***}$	-4.568 * * *	$-4.705^{***}$
	(0.903)	(1.097)	(1.100)	(1.231)	(1.248)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	-1.307*	-1.290	-1.932*	-1.494
	(0.787)	(0.783)	(0.784)	(1.037)	(0.981)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	-0.139	-0.108	0.312	0.303
	(0.734)	(0.721)	(0.720)	(0.840)	(0.821)
Service <sub>pc</sub> × High Infl $\text{Exp}_c \times 2022$	$2.675^{**}$	$2.624^{**}$	$2.657^{**}$	$2.994^{*}$	3.004*
	(1.073)	(1.075)	(1.076)	(1.569)	(1.583)
Material Supply <sub>pcx</sub> $\times$ 2020		-0.001	-0.055	0.066	0.016
		(0.070)	(0.058)	0.100	(0.093)
Material Supply <sub>pcx</sub> $\times$ 2021		$0.127^{***}$	$0.140^{***}$	0.0522	$0.132^{**}$
		(0.025)	(0.027)	(0.066)	(0.058)
Material Supply <sub>pcx</sub> $\times$ 2022		0.030	0.011	-0.0422	0.003
*		(0.036)	(0.035)	(0.0875)	(0.071)
Material Supply Timing		x = t	x = t - 1	x = t	x = t - 1
Material Supply <sub><i>pcx</i></sub> × High Infl $Exp_c$ × Year Control				$\checkmark$	$\checkmark$
$Service_{pc} \times Energy Inflation_{ct} \times Year Controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Other Constraints	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	✓	√	√	✓	✓
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	8,099	8,099	8,099	8,099	8,099
R-squared	0.580	0.583	0.582	0.582	0.582

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-0.246	-0.330	-0.529	-0.031	-0.2929
	(0.669)	(0.774)	(0.733)	(0.815)	(0.778)
$\text{Service}_{pc} \times 2021$	$-2.219^{***}$	-0.996	-1.254*	-1.250*	-1.309*
	(0.675)	(0.676)	(0.662)	(0.709)	(0.694)
$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-4.361^{***}$	$-4.630^{***}$	-4.568 * * *	$-4.705^{***}$
	(0.903)	(1.097)	(1.100)	(1.231)	(1.248)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	-1.307*	-1.290	-1.932*	-1.494
	(0.787)	(0.783)	(0.784)	(1.037)	(0.981)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	-0.139	-0.108	0.312	0.303
	(0.734)	(0.721)	(0.720)	(0.840)	(0.821)
$Service_{pc} \times High Infl Exp_c \times 2022$	$2.675^{**}$	2.624 * *	$2.657^{**}$	$2.994^{*}$	$3.004^{*}$
	(1.073)	(1.075)	(1.076)	(1.569)	(1.583)
Material Supply <sub>pcx</sub> $\times$ 2020		-0.001	-0.055	0.066	0.016
		(0.070)	(0.058)	0.100	(0.093)
Material Supply <sub>pcx</sub> $\times$ 2021		$0.127^{***}$	$0.140^{***}$	0.0522	$0.132^{**}$
		(0.025)	(0.027)	(0.066)	(0.058)
Material Supply <sub>pcx</sub> $\times$ 2022		0.030	0.011	-0.0422	0.003
		(0.036)	(0.035)	(0.0875)	(0.071)
Material Supply Timing		x = t	x = t - 1	x = t	x = t - 1
Material Supply <sub><i>pcx</i></sub> × High Infl $Exp_c \times Year$ Control				$\checkmark$	$\checkmark$
$Service_{pc} \times Energy Inflation_{ct} \times Year Controls$	$\checkmark$	$\checkmark$	$\checkmark$	√	$\checkmark$
Other Constraints	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	√	√	√	✓	✓
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	8,099	8,099	8,099	8,099	8,099
R-squared	0.580	0.583	0.582	0.582	0.582

	CPI Growth	CPI Growth	CPI Growth	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-0.246	-0.330	-0.529	-0.031	-0.2929
	(0.669)	(0.774)	(0.733)	(0.815)	(0.778)
$\text{Service}_{pc} \times 2021$	$-2.219^{***}$	-0.996	$-1.254^{*}$	-1.250*	-1.309*
	(0.675)	(0.676)	(0.662)	(0.709)	(0.694)
$\text{Service}_{pc} \times 2022$	$-4.709^{***}$	$-4.361^{***}$	$-4.630^{***}$	$-4.568^{***}$	-4.705 ***
	(0.903)	(1.097)	(1.100)	(1.231)	(1.248)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.256	-1.307*	-1.290	-1.932*	-1.494
	(0.787)	(0.783)	(0.784)	(1.037)	(0.981)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	0.106	-0.139	-0.108	0.312	0.303
	(0.734)	(0.721)	(0.720)	(0.840)	(0.821)
Service <sub>pc</sub> × High Infl $\text{Exp}_c \times 2022$	$2.675^{**}$	$2.624^{**}$	$2.657^{**}$	$2.994^{*}$	3.004*
	(1.073)	(1.075)	(1.076)	(1.569)	(1.583)
Material Supply <sub>pcx</sub> $\times$ 2020		-0.001	-0.055	0.066	0.016
		(0.070)	(0.058)	0.100	(0.093)
Material Supply <sub>pcx</sub> $\times$ 2021		$0.127^{***}$	$0.140^{***}$	0.0522	$0.132^{**}$
		(0.025)	(0.027)	(0.066)	(0.058)
Material Supply <sub>pcx</sub> $\times$ 2022		0.030	0.011	-0.0422	0.003
		(0.036)	(0.035)	(0.0875)	(0.071)
Material Supply Timing		x = t	x = t - 1	x = t	x = t - 1
Material Supply <sub><i>pcx</i></sub> × High Infl $Exp_c$ × Year Control				√	✓
$Service_{pc} \times Energy Inflation_{ct} \times Year Controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	√
Other Constraints	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Country-time FE	√	√	√	√	√
Product-country FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Observations	8,099	8,099	8,099	8,099	8,099
R-squared	0.580	0.583	0.582	0.582	0.582

- $\cdot\,$  Two additional tests to rule out generalization is driven by demand
- 1) Control for product (1-digit COICOP) country time fixed effects to rule out product specific demand changes in a given country and quarter
- 2) Control for lockdown stringency in 2021 as a measure of accumulated demand for service sector products ( $Service_{pc} \times LockdownIntensity_c \times Year_t$ )

	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-1.627*	-1.212*
	(0.835)	(0.691)
$\text{Service}_{pc} \times 2021$	-3.230***	-2.379***
	(0.783)	(0.805)
$\text{Service}_{pc} \times 2022$	$-3.874^{***}$	-4.933***
	(0.884)	(0.990)
$\text{Service}_{pc} \times \text{High Infl } \text{Exp}_c \times 2020$	-1.627*	-1.212*
	(0.835)	(0.691)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	-0.286	0.131
	(0.976)	(0.732)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2022$	$2.806^{**}$	$2.755^{**}$
	(1.241)	(1.083)
Energy Use <sub>pc</sub> × Energy Inflation <sub>ct</sub>	$1.298^{***}$	$1.480^{**}$
	(0.252)	(0.505)
Control	Product-country-time	Lockdown intensity
Controls	$\checkmark$	$\checkmark$
$\text{Service}_{pc} \times \text{Energy Inflation}_{ct} \times \text{Year Controls}$	$\checkmark$	$\checkmark$
Country-time FE	$\checkmark$	√
Product-country FE	$\checkmark$	$\checkmark$
Observations	7,262	8,051
R-squared	0.776	0.579

	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-1.627*	-1.212*
	(0.835)	(0.691)
$\text{Service}_{pc} \times 2021$	-3.230***	-2.379 * * *
	(0.783)	(0.805)
$\text{Service}_{pc} \times 2022$	$-3.874^{***}$	-4.933***
	(0.884)	(0.990)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.627*	-1.212*
	(0.835)	(0.691)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	-0.286	0.131
	(0.976)	(0.732)
$\text{Service}_{pc} \times \text{High Infl } \text{Exp}_c \times 2022$	$2.806^{**}$	$2.755^{**}$
	(1.241)	(1.083)
Energy Use <sub>pc</sub> × Energy Inflation <sub>ct</sub>	$1.298^{***}$	$1.480^{**}$
	(0.252)	(0.505)
Control	Product-country-time	Lockdown intensity
Controls	$\checkmark$	$\checkmark$
$\text{Service}_{pc} \times \text{Energy Inflation}_{ct} \times \text{Year Controls}$	$\checkmark$	√
Country-time FE	$\checkmark$	$\checkmark$
Product-country FE	$\checkmark$	✓
Observations	7,262	8,051
R-squared	0.776	0.579

	CPI Growth	CPI Growth
$\text{Service}_{pc} \times 2020$	-1.627*	-1.212*
F	(0.835)	(0.691)
$\text{Service}_{pc} \times 2021$	-3.230***	-2.379 * * *
	(0.783)	(0.805)
$\text{Service}_{pc} \times 2022$	$-3.874^{***}$	-4.933***
	(0.884)	(0.990)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2020$	-1.627*	-1.212*
	(0.835)	(0.691)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2021$	-0.286	0.131
	(0.976)	(0.732)
$\text{Service}_{pc} \times \text{High Infl} \operatorname{Exp}_{c} \times 2022$	$2.806^{**}$	$2.755^{**}$
	(1.241)	(1.083)
Energy Use <sub>pc</sub> × Energy Inflation <sub>ct</sub>	$1.298^{***}$	$1.480^{**}$
	(0.252)	(0.505)
Control	Product-country-time	Lockdown intensity
Controls	$\checkmark$	$\checkmark$
Service <sub>pc</sub> × Energy Inflation <sub>ct</sub> × Year Controls	$\checkmark$	√
Country-time FE	$\checkmark$	$\checkmark$
Product-country FE	$\checkmark$	√
Observations	7,262	8,051
R-squared	0.776	0.579

#### Firm markups and pricing behavior

# Firm markup analysis

Firm level analysis based on triple-interaction specification at firm-quarter level:

$$\begin{split} Markup_{it+1} &= \beta_1 Markup_i^{2018} \times Constraint_{jct} \times Post_t + \beta_2 Markup_i^{2018} \times Post_t \\ &+ \beta_3 Markup_i^{2018} \times Constraint_{jct} + \beta_4 Markup_i^{2018} + \eta_{jct} + \epsilon_{it} \end{split}$$

- $\cdot \,$  where i is a firm, t is a quarter, c is a country, and j
- · Markups from Compustat Global (data 19Q1-22Q4) following De Loecker et al. (2020)
- $\cdot \ Markup^{2018}$  is the firm-level markup measured at the end of 2018
- ·  $Constraint_{jct}$  is the supply chain constraint at the industry-country-quarter level for manufacturing firms or labor constraint for service firms

	Markup	Markup	Markup	Markup	Markup
Sample	Manuf	Service	Full	Manuf	Service
$Material_{ict} \times Markup_i^{2018}$	-0.003**			-0.003***	
ju Pi	(0.001)			(0.001)	
$Markup_i^{2018} \times 2020$	-0.111***	-0.077	-0.083***	-0.126***	-0.074
	(0.037)	(0.067)	(0.030)	(0.037)	(0.115)
$Markup_i^{2018} \times 2021$	-0.142**	-0.072	-0.089*	-0.170**	-0.136
	(0.062)	(0.118)	(0.045)	(0.076)	(0.163)
$Markup_i^{2018} \times 2022$	-0.192**	-0.071	-0.158***	-0.327***	-0.246
	(0.092)	(0.108)	(0.049)	(0.108)	(0.160)
$Material_{ict} \times Markup_i \times 2020$	0.001			0.001	
<b>,</b>	(0.001)			(0.001)	
$Material_{ict} \times Markup_i^{2018} \times 2021$	0.004**			0.004***	
	(0.002)			(0.001)	
$Material_{ict} \times Markup_i \times 2022$	0.003*			0.005***	
	(0.002)			(0.001)	
High Infl $Exp_c \times Markup_i^{2018}$			$0.157^{***}$	0.129**	0.159
			(0.051)	(0.056)	(0.116)
High Infl Exp <sub>c</sub> × Markup <sup>2018</sup> <sub>i</sub> × 2020			0.023	0.056	0.013
			(0.057)	(0.076)	(0.111)
High Infl Exp <sub>c</sub> × Markup <sup>2018</sup> <sub>i</sub> × 2021			0.070	0.074	0.135
			(0.057)	(0.073)	(0.138)
High Infl Exp <sub>c</sub> × Markup <sup>2018</sup> × 2022			$0.126^{**}$	$0.176^{**}$	0.218*
			(0.058)	(0.081)	(0.128)
Markup <sup>2018</sup>	$0.902^{***}$	$0.895^{***}$	$0.789^{***}$	$0.855^{***}$	$0.796^{***}$
	(0.033)	(0.081)	(0.034)	(0.029)	(0.138)
Industry-country-time FE	~	~	~	~	~
$Labor_{jct} \times Markup_i^{2018} \times Year controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	✓
Observations	12,420	6,462	18,882	12,420	6,462
R-squared	0.797	0.616	0.764	0.800	0.621

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	Markup	Markup	Markup	Markup	Markup				
Sample	Manuf	Service	Full	Manuf	Service				
$Material_{ict} \times Markup_i^{2018}$	-0.003**			-0.003***					
	(0.001)			(0.001)					
$Markup_i^{2018} \times 2020$	-0.111***	-0.077	-0.083***	-0.126***	-0.074				
	(0.037)	(0.067)	(0.030)	(0.037)	(0.115)				
$Markup_i^{2018} \times 2021$	$-0.142^{**}$	-0.072	-0.089*	-0.170**	-0.136				
	(0.062)	(0.118)	(0.045)	(0.076)	(0.163)				
$Markup_i^{2018} \times 2022$	$-0.192^{**}$	-0.071	$-0.158^{***}$	$-0.327^{***}$	-0.246				
	(0.092)	(0.108)	(0.049)	(0.108)	(0.160)				
$Material_{jct} \times Markup_i \times 2020$	0.001			0.001					
	(0.001)			(0.001)					
$Material_{jct} \times Markup_i^{2018} \times 2021$	$0.004^{**}$			$0.004^{***}$					
	(0.002)			(0.001)					
$Material_{jct} \times Markup_i \times 2022$	$0.003^{*}$			$0.005^{***}$					
	(0.002)			(0.001)					
High Infl $Exp_c \times Markup_i^{2018}$			$0.157^{***}$	$0.129^{**}$	0.159				
			(0.051)	(0.056)	(0.116)				
High Infl Exp <sub>c</sub> × Markup <sup>2018</sup> <sub>i</sub> × 2020			0.023	0.056	0.013				
			(0.057)	(0.076)	(0.111)				
High Infl $\text{Exp}_c \times \text{Markup}_i^{2018} \times 2021$			0.070	0.074	0.135				
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			(0.058)	(0.081)	(0.128)				
Markup <sup>2018</sup>	$0.902^{***}$	$0.895^{***}$	$0.789^{***}$	$0.855^{***}$	$0.796^{***}$				
	(0.033)	(0.081)	(0.034)	(0.029)	(0.138)				
Industry-country-time FE	√	$\checkmark$	$\checkmark$	~	√				
$Labor_{jct} \times Markup_i^{2018} \times Year controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	✓				
Observations	12,420	6,462	18,882	12,420	6,462				
R-squared	0.797	0.616	0.764	0.800	0.621				
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	Markup	Markup	Markup	Markup	Markup
Sample	Manuf	Service	Full	Manuf	Service
$Material_{ict} \times Markup_i^{2018}$	-0.003**			-0.003***	
	(0.001)			(0.001)	
$Markup_i^{2018} \times 2020$	-0.111***	-0.077	-0.083***	-0.126***	-0.074
	(0.037)	(0.067)	(0.030)	(0.037)	(0.115)
$Markup_i^{2018} \times 2021$	$-0.142^{**}$	-0.072	-0.089*	-0.170**	-0.136
	(0.062)	(0.118)	(0.045)	(0.076)	(0.163)
$Markup_i^{2018} \times 2022$	$-0.192^{**}$	-0.071	$-0.158^{***}$	$-0.327^{***}$	-0.246
	(0.092)	(0.108)	(0.049)	(0.108)	(0.160)
$Material_{jct} \times Markup_i \times 2020$	0.001			0.001	
	(0.001)			(0.001)	
$Material_{jct} \times Markup_i^{2018} \times 2021$	$0.004^{**}$			$0.004^{***}$	
	(0.002)			(0.001)	
$Material_{jct} \times Markup_i \times 2022$	$0.003^{*}$			$0.005^{***}$	
	(0.002)			(0.001)	
High Infl $Exp_c \times Markup_i^{2018}$			$0.157^{***}$	$0.129^{**}$	0.159
			(0.051)	(0.056)	(0.116)
High Infl Exp <sub>c</sub> × Markup <sup>2018</sup> × 2020			0.023	0.056	0.013
			(0.057)	(0.076)	(0.111)
High Infl $\text{Exp}_c \times \text{Markup}_i^{2018} \times 2021$			0.070	0.074	0.135
2010			(0.057)	(0.073)	(0.138)
High Infl Exp <sub>c</sub> × Markup <sup>2018</sup> <sub>i</sub> × 2022			$0.126^{**}$	$0.176^{**}$	0.218*
0010			(0.058)	(0.081)	(0.128)
Markup <sup>2018</sup>	$0.902^{***}$	$0.895^{***}$	$0.789^{***}$	$0.855^{***}$	$0.796^{***}$
	(0.033)	(0.081)	(0.034)	(0.029)	(0.138)
Industry-country-time FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	~
$Labor_{jct} \times Markup_i^{2018} \times Year controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	√
Observations	12,420	6,462	18,882	12,420	6,462
R-squared	0.797	0.616	0.764	0.800	0.621
					- <u> </u>

	Markup	Markup	Markup	Markup	Markup							
Sample	Manuf	Service	Full	Manuf	Service							
$Material_{ict} \times Markup_i^{2018}$	-0.003**			-0.003***								
	(0.001)			(0.001)								
$Markup_i^{2018} \times 2020$	-0.111***	-0.077	-0.083***	-0.126***	-0.074							
	(0.037)	(0.067)	(0.030)	(0.037)	(0.115)							
$Markup_i^{2018} \times 2021$	-0.142**	-0.072	-0.089*	-0.170**	-0.136							
	(0.062)	(0.118)	(0.045)	(0.076)	(0.163)							
$Markup_i^{2018} \times 2022$	$-0.192^{**}$	-0.071	-0.158 * * *	-0.327***	-0.246							
	(0.092)	(0.108)	(0.049)	(0.108)	(0.160)							
$Material_{jct} \times Markup_i \times 2020$	0.001			0.001								
-	(0.001)			(0.001)								
$Material_{jct} \times Markup_i^{2018} \times 2021$	$0.004^{**}$			0.004***								
	(0.002)			(0.001)								
$Material_{jct} \times Markup_i \times 2022$	$0.003^{*}$			0.005***								
	(0.002)			(0.001)								
High Infl $Exp_c \times Markup_i^{2018}$			$0.157^{***}$	$0.129^{**}$	0.159							
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			(0.057)	(0.073)	(0.138)							
High Infl $\text{Exp}_c \times \text{Markup}_i^{2018} \times 2022$			$0.126^{**}$	$0.176^{**}$	0.218*							
			(0.058)	(0.081)	(0.128)							
Markup <sup>2018</sup>	$0.902^{***}$	$0.895^{***}$	$0.789^{***}$	$0.855^{***}$	$0.796^{***}$							
	(0.033)	(0.081)	(0.034)	(0.029)	(0.138)							
Industry-country-time FE	√	$\checkmark$	$\checkmark$	$\checkmark$	√							
$Labor_{jct} \times Markup_i^{2018} \times Year controls$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	✓							
Observations	$12,\!420$	6,462	18,882	12,420	6,462							
R-squared	0.797	0.616	0.764	0.800	0.621							
						-			비가 가득가 가득가 드는 것이 같아.		말 이 이름이 이름이 나름다. 나는 것 ??	말 이 이름이 이름이 나름다. 나는 나가지?

	Markup	Markup	Markup	Markup	Markup								
Sample	Manuf	Service	Full	Manuf	Service								
$Material_{ict} \times Markup_i^{2018}$	-0.003**			-0.003***									
,	(0.001)			(0.001)									
$Markup_i^{2018} \times 2020$	-0.111***	-0.077	$-0.083^{***}$	-0.126***	-0.074								
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$Markup_i^{2018} \times 2021$	$-0.142^{**}$	-0.072	-0.089*	-0.170**	-0.136								
	(0.062)	(0.118)	(0.045)	(0.076)	(0.163)								
$Markup_i^{2018} \times 2022$	$-0.192^{**}$	-0.071	-0.158 * * *	$-0.327^{***}$	-0.246								
	(0.092)	(0.108)	(0.049)	(0.108)	(0.160)								
$Material_{jct} \times Markup_i \times 2020$	0.001			0.001									
	(0.001)			(0.001)									
$Material_{jct} \times Markup_i^{2018} \times 2021$	$0.004^{**}$			$0.004^{***}$									
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$Material_{jct} \times Markup_i \times 2022$	$0.003^{*}$			$0.005^{***}$									
	(0.002)			(0.001)									
High Infl $Exp_c \times Markup_i^{2018}$			$0.157^{***}$	$0.129^{**}$	0.159								
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High Infl $\text{Exp}_c \times \text{Markup}_i^{2018} \times 2021$			0.070	0.074	0.135								
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High Infl $\text{Exp}_c \times \text{Markup}_i^{2018} \times 2022$			$0.126^{**}$	$0.176^{**}$	0.218*								
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	(0.033)	(0.081)	(0.034)	(0.029)	(0.138)								
Industry-country-time FE	√	$\checkmark$	$\checkmark$	~	~								
$Labor_{jct} \times Markup_i^{2018} \times Year controls$	~	~	~	$\checkmark$	✓								
Observations	12,420	6,462	18,882	12,420	6,462								
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# Price heterogeneity

- High inflation expectations (beliefs that supply-side shocks are widespread) lower perceived value of search (small benefit of looking for better deals)
- · High price variability associated with higher inflation depreciates value of information current relative prices convey about future ones, lowering value of search (Tommasi, 1994)
- $\rightarrow\,$  Consumers are less informed about prices,  $\uparrow$  reservation price:  $\downarrow$  elasticity of demand  $\rightarrow\,$  Firms can charge higher markups
  - $\cdot\,$  Explore price variation in prices of subcategories of consumer spending in our analysis
  - $\cdot\,$  Example: The st. dev. of price growth for different food items in the consumer basket

# Price heterogeneity

- Measure growth in variation of prices of consumer spending subcategories for each broader product in the early stage of the pandemic (2020:Q2-2021:Q2)
- $\cdot$  Check whether firms in industries with higher growth in price variability are better able to raise markups in response to higher HH inflation expectations in 2022

	Markup	Markup	Markup	Markup
Sample	Full	Full	Manufacturing	Service
High Infl $\text{Exp}_c \times Markup_i^{2018}$	$0.006^{**}$	$0.006^{*}$	$0.007^{**}$ (0.004)	0.002 (0.004)
High Infl $\operatorname{Exp}_c \times Markup_i^{2018} \times \operatorname{Growth} \operatorname{SD}(\operatorname{Prices})_{jc}$	(0.000)	$3.664^{***}$ (1.299)	(2.333)	(1.556)
Observations	4,371	3,591	2,231	1,360
R-squared	0.732	0.729	0.768	0.596
Industry-country-time FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$

The dependent variable is a firm's markup. High Infl Exp is a dummy equal to one if the share of households in a country-quarter that believe consumer prices will increase more rapidly over the next 12 months has increased above the median level in a country between 2021:Q1 and 2022:Q1. Markup2018 measures a firm's markup in the fiscal year 2018. SD(Price Growth) is the standard deviation in the prices within each consumer product category (i.e., 2-digit COICOP) in 2020:Q2 to 2021:Q2 at the industry-country level.

# Price heterogeneity

- Measure growth in variation of prices of consumer spending subcategories for each broader product in the early stage of the pandemic (2020:Q2-2021:Q2)
- · Check whether firms in industries with higher growth in price variability are better able to raise markups in response to higher HH inflation expectations in 2022

	Markup	Markup	Markup	Markup
Sample	Full	Full	Manufacturing	Service
High Infl $\mathrm{Exp}_c \times Markup_i^{2018}$	$0.006^{**}$ (0.003)	$0.006^{*}$ (0.003)	$0.007^{**}$ (0.004)	$0.002 \\ (0.004)$
High Infl $\operatorname{Exp}_c \times Markup_i^{2018} \times \operatorname{Growth} \operatorname{SD}(\operatorname{Prices})_{jc}$		$3.664^{***}$ (1.299)	$5.299^{**}$ $(2.333)$	$3.420^{**}$ $(1.556)$
Observations	4,371	$3,\!591$	2,231	1,360
R-squared	0.732	0.729	0.768	0.596
Industry-country-time FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$

The dependent variable is a firm's markup. High Infl Exp is a dummy equal to one if the share of households in a country-quarter that believe consumer prices will increase more rapidly over the next 12 months has increased above the median level in a country between 2021:Q1 and 2022:Q1. Markup2018 measures a firm's markup in the fiscal year 2018. SD(Price Growth) is the standard deviation in the prices within each consumer product category (i.e., 2-digit COICOP) in 2020:Q2 to 2021:Q2 at the industry-country level.

# Conclusion

- $\cdot\,$  We document the complex interactions between supply-chain pressures, firm market power, and household expectations in the 2021-22 inflation in the euro area
  - Supply-chain pressures caused an increase in inflation through a cost-push channel and unanchored household inflation expectations
  - Once inflation expectations are elevated in their country, firms with market power able to increase markups irrespective of actual material frictions
- · Supply-side inflation impulses can generalize and spiral upwards, via an interaction of market power and household adaptive expectations, into broad-based inflation
- · Firms pricing power plays two distinct roles:
  - Surge: cost-push (manufacturing)
  - Generalization: household inflation expectations x markup (+ services)
  - Generalization: household inflation expectations **x** markup **x** high dispersion growth

# CPA-COICOP Matrix

		01.1	02.2	04.5	09.3	
	CPA x COICOP	Food	Tobacco	Electricity, gas and other fuels	Other recreational items and equipment, gardens and pets	Total
01	Products of agriculture, hunting and related services	2383080	61651	-	913837	3358568
02	Products of forestry, logging and related services	-	-	521557	43503	565060
03	Fish and fishing products	123244	-	-	-	123244
05-07	Coal a.lignite; crude petroleum a.natural gas; metal ores	-	-	35791	-	35791
08-09	Other mining a. quarrying prod.; mining support services	-	-	-	15400	48336
10	Food products	13300811	-	-	641128	15105243
	Total	15807135	3425510	7055310	3715785	177798703

Example of an consumption allocation table. Source: Statistics Austria.