

Inflation heterogeneity across households

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Research question

Magnitude and persistence of inflation heterogeneity between households in Europe?

- 1 Does inflation heterogeneity originate from different prices paid or different product choices?
- 2 What household characteristics determine the differences in inflation between households? Role of income?
- 3 Does heterogeneity in standard inflation statistics (COGI) imply similar heterogeneity in changes in cost of living (COLI)? Role of preference heterogeneity?

Related literature

- Inflation heterogeneity across households
 - ▶ CPI micro data + household budget survey:
 - ★ USA: e.g. Michael (1979), Hobijn et al. (2009), ...
 - ★ Europe: e.g. Colavecchio et al. (2011), Fessler & Fritzer (2013), ...
 - ▶ Household panel data:
 - ★ USA: Kaplan & Schulhofer-Wohl (2017)
 - ★ Switzerland: Braun & Lein (2020)
- Inflation differences between income groups (Jaravel 2019, Ampudia et al. 2024)
- Cost of living
 - ▶ Constant tastes (Sato 1976, Vartia 1976)
 - ▶ Time-varying tastes (Redding & Weinstein 2020, Martin 2021)

Households differ in ...

- 1 Local economic conditions (Coibion et al. 2015, Handbury 2021)
- 2 Demographic characteristics, such as age and income (Dube et al. 2018)
- 3 Idiosyncratic preferences and behavior:

(3a) Product preference

(consumption basket)

- Jaravel (2019): high-income HHs benefit more from increase in product variety
- Jaravel & O'Connell (2020a): drop in purchasing power during lockdown due to reduction in product variety
- Cravino et al. (2020): prices of goods consumed by high-income HHs are less volatile

(3b) Shopping behaviour

- Nevo & Wong (2019): HHs varied time allocation in Great Recession
- Jaravel & O'Connell (2020b): change in shopping behaviour not primary driver of UK inflation during lockdown (but fewer promotions)
- Coibion et al. (2021): increase in expenditure inequality due to change in inventory holding behavior of HHs
- Argente & Lee (2021): high-income HHs had lower inflation following Great Recession by changing shopping behaviour and substituting product qualities

This paper

Source of inflation heterogeneity in “supermarket” consumption

- 1 Prices account for less than half of inflation heterogeneity. Not household-, but region-specific.
- 2 Demographic factors capture only small part of household heterogeneity. Most inflation differences idiosyncratic to household (i.e. its preferences and behavior). Key household-specific driver is product (brand) choice (within category).
- 3 Changes in cost of living more heterogeneous than in HICP due to time-variation in tastes.

Outline

- ① Approach and Data
- ② Heterogeneity: decomposition and drivers
- ③ Substitution

Aggregate and granular data sources: coverage vs. detail

HICP subindices + household budget surveys (from NSAs)

- Broad coverage (entire HICP)
- Balanced sample of entire euro area
- Aggregates only (income groups, product categories)
- Infrequent HBS updates
- No income-specific price indices

Household panel (from PRISMA = GfK/Kantar)

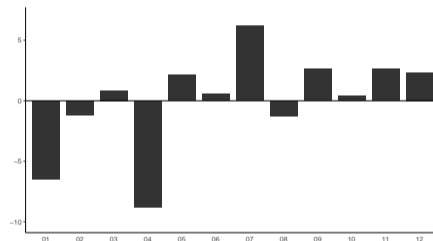
- Transaction data, barcode-level
- ... linked to specific household
- “Supermarket” items only (“fast moving consumer goods”)
- Unbalanced sample (households and countries)

Expenditure share difference between income groups

(share of high- minus share of low-income households, by product category, p.p.)

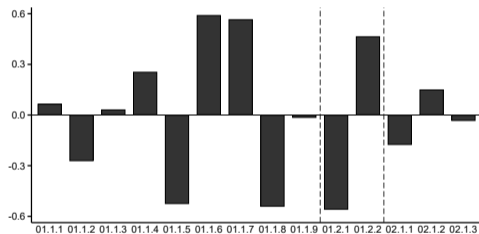
HICP/HBS

Higher share for high-income households



Higher share for low-income households

Household panel (food and beverages)



(HBS euro area, average of 1999, 2004, 2010, 2015 waves; household panel for six largest EA countries 2005/2012–2018)

Source: Ampudia et al. (2024)

GfK/Kantar household panel

Fast-moving consumer goods (FMCG), “low” inflation period

- Transaction: value, unit, quantity
- Product: barcode, private label flag
- Retailer: chain, store type
- Household (quarterly): size, age and (net) income class, 5-digit zip

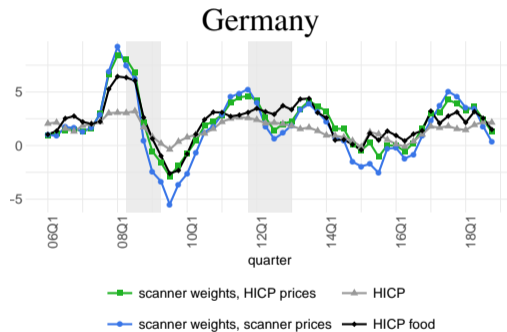
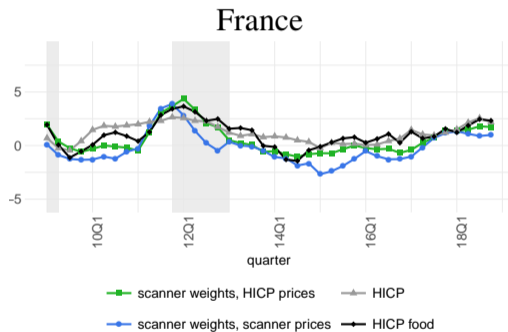
	France	Germany
sample period	2008-2018	2005-2018
# of households ('000)	46	147
# of purchases (mn)	149	334
# of barcodes ('000)	575	612

Empirical approach

- “Supermarket goods” (COICOPs 1.1, 1.2, 2.1.1, 2.1.3, 5.6, 9.3, 12.1)
- Inflation rate
 - ▶ Household-level
 - ▶ Quarterly
 - ▶ Based on repurchased items (i.e. common good index)
- Cross-check with group (e.g., income) indices

Household panel vs. HICP

Aggregate inflation rates (q/q-4)



Actual and counterfactual inflation

(Household-level inflation with transaction prices)

Quarterly year-on-year ($q/q - 4$) household-level Laspeyres inflation index

$$\pi_{hq}^h = \frac{\sum_{i \in I(hq)} P_{ih,q} x_{ih,q-4}}{\sum_{i \in I(hq)} P_{ih,q-4} x_{ih,q-4}}$$

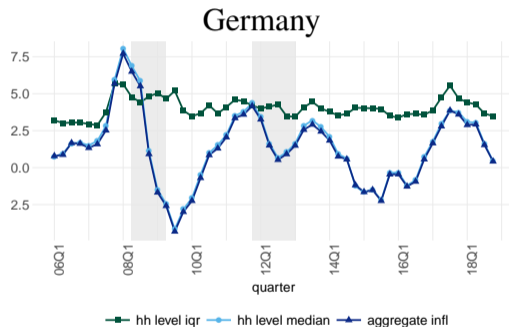
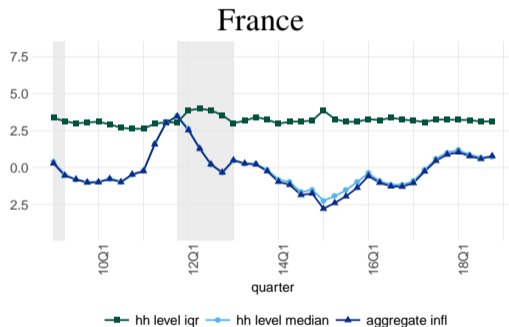
(Household-level inflation with barcode-average prices)

Quarterly year-on-year ($q/q - 4$) household-level Laspeyres inflation index based on regional barcode-average prices within a three-digit postal region

$$\pi_{hq}^{br3} = \frac{\sum_{i \in I(hq)} \bar{p}_{ihq}^{r3} x_{ih,q-4}}{\sum_{i \in I(hq)} \bar{p}_{ih,q-4}^{r3} x_{ih,q-4}}$$

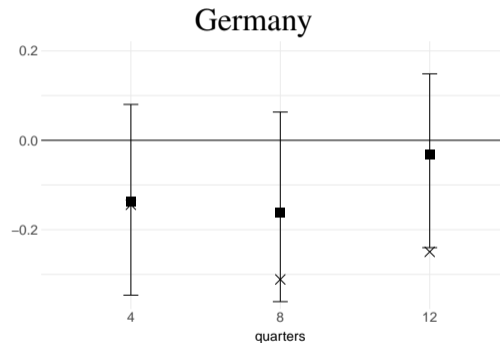
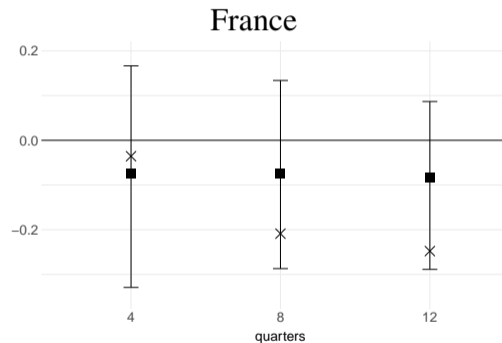
Dispersion of household-level inflation rates over time

Median (q/q-4) HH-level inflation (blue) and its interquartile range (green)



Persistence at household level

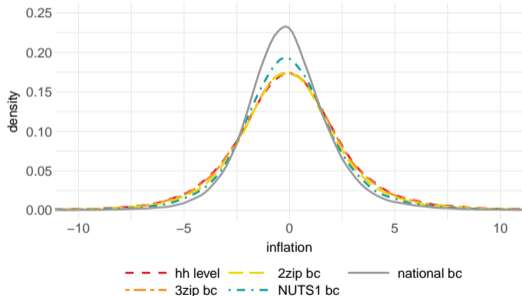
Autocorrelation of household-level inflation (quarters)



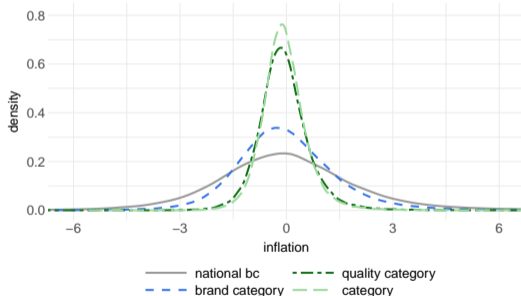
Inflation difference between households

Distribution of household-level inflation rates
(France, Laspeyres, in %)

Effect of household-specific prices



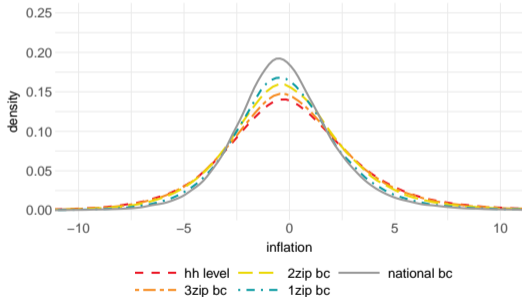
Effect of household-specific baskets



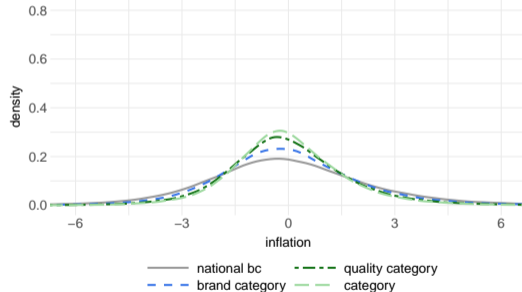
Inflation difference between households

Distribution of household-level inflation rates
(Germany, Laspeyres, in %)

Effect of household-specific prices



Effect of household-specific baskets



Relative importance of prices, variety and baskets

price aggregate	household- level π_{hq}^h	3-digit zip π_{hq}^{br3}	2-digit zip π_{hq}^{br2}	national barcode π_{hq}^{bn}	brand- cat. π_{hq}^{bc}	quality- cat. π_{hq}^{qc}	product cat. π_{hq}^c
<i>(a) interquartile range</i>							
France	3.18	3.14	3.03	2.43	1.76	0.85	0.74
Germany	3.94	3.86	3.64	3.01	2.57	2.20	2.03
USA	7.33	n.a.	n.a.	3.99	n.a.	n.a.	1.96
<i>(b) variance ratio vs. π_{hq}^h</i>							
France	1	0.97	0.90	0.58	0.27	0.06	0.04
Germany	1	0.93	0.82	0.54	0.39	0.27	0.23
USA	1	n.a.	n.a.	0.38	n.a.	n.a.	0.14

What explains inflation heterogeneity?

$$\pi_{h,q}^h = \alpha_{r2(h),q} + \beta X_{h,q} + \gamma Y_{h,q} + \lambda Z_{r3(h),q} + \varepsilon_{h,q}$$

- 1 Demographics and household situation $X_{h,q}$: age, age², size, size², income, income²; baby, birth year of head
- 2 Shopping behaviour and product preferences $Y_{h,q}$
 - ▶ Number of shopping days, number of stores visited
 - ▶ Expenditure share of store types
 - ▶ Brand loyalty, private label share, ...
 - ▶ Expenditure shares of food, alcohol, personal care, ...
 - ▶ Total reported expenditure per capita
- 3 Regional averages $Z_{r3(h),q}$ (and regional cycles $\alpha_{r2(h),q}$), population density, ...

R^2 decomposition by demographic and regional variable groups

(Laspeyres inflation, Shorrocks-Shapley decomposition, %)

	explanatory characteristic	France	Germany
Household characteristics	Expenditure	60	58
	Income	18	1
	Age	14	30
	Situation (e.g., size)	6	11
Region	Age, size, income	2	1
R^2		< 0.01	< 0.01

R^2 decomposition by (all) variable groups (incl. behavioral)

(Laspeyres inflation, Shorrocks-Shapley decomposition, %)

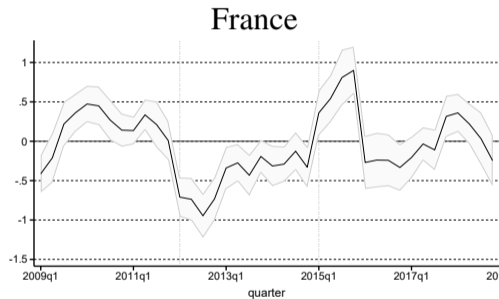
	explanatory characteristic	France	Germany
Shopping behavior	Channels	32	20
	Intensity	15	14
	Chain loyalty	1	< 1
Product preferences	Variety choice	30	10
	Basket	7	28
Household characteristics	Expenditure	9	16
	Income	2	< 1
	Age	1	9
	Situation (e.g., size)	2	3
Region	Age, size, income	< 1	< 1
R^2		0.05	0.02

What dampened the FMCG inflation of a household?

- Low (!) exp. share on private label
- Low exp. share in discounters and specialty stores
- Many shopping trips (days), stores per day
- Small brand concentration, high brand loyalty
- Low exp. share on food and beverages
- More overall spending per capita
- Income at regional level, not household level
- Age, size remain significant (i.e. capture systematic behavior/preference difference not captured by other variables)

Inflation differential between income groups

Contrasts of predictive margins between top and bottom income class with 95% CIs (% p.a.)

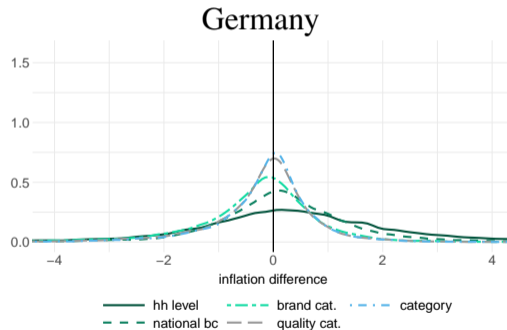
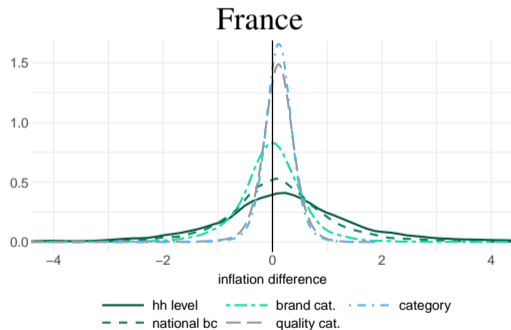


France: >3000 euro vs. <1200 euro head of household income

Germany: >3750 euro vs. <1250 euro head of household income

Household substitution in “wrong” direction?

Difference between Laspeyres and Paasche indices
(quarterly, distribution across households)



R^2 decomposition of Laspeyres-Paasche differential

(Laspeyres minus Paasche, Shorrocks-Shapley decomposition, %)

	explanatory characteristic	France	Germany
Shopping behavior	Channels	12	7
	Intensity	31	38
	Chain loyalty	1	10
Product preferences	Variety choice	30	14
	Basket	6	8
Household characteristics	Expenditure	2	2
	Income	3	1
	Age	8	5
	Situation (e.g., size)	5	14
Region	Age, size, income	2	1
R^2		0.01	0.01

Homothetic CES households

Utility function

$$U_{hq} = \left[\sum_{i \in I(hq)} (\varphi_{ih,q} x_{ih,q})^{\frac{\sigma_h - 1}{\sigma_h}} \right]^{\frac{\sigma_h}{\sigma_h - 1}}$$

(taste $\varphi_{ih,q}$, item i , household h , quarter q)

Household optimization implies unit expenditure function

$$P_{hq}(p, \varphi) = \left[\sum_{i \in I(hq)} \left(\frac{p_{ih,q}}{\varphi_{ih,q}} \right)^{1 - \sigma_h} \right]^{\frac{1}{1 - \sigma_h}}$$

(elasticity of substitution across varieties $\sigma_h =$ household-specific constant)

COGI and COLI inflation indices

Quarterly year-on-year ($q/q - 4$) inflation indices (for each household h)

(Fixed baskets: Laspeyres and Paasche)

$$\pi_q^{Lasp} = \frac{\sum_{i \in I(q)} P_{i,q} x_{i,q-4}}{\sum_{i \in I(q)} P_{i,q-4} x_{i,q-4}}$$

$$\pi_q^{Paas} = \frac{\sum_{i \in I(q)} P_{i,q} x_{i,q}}{\sum_{i \in I(q)} P_{i,q-4} x_{i,q}}$$

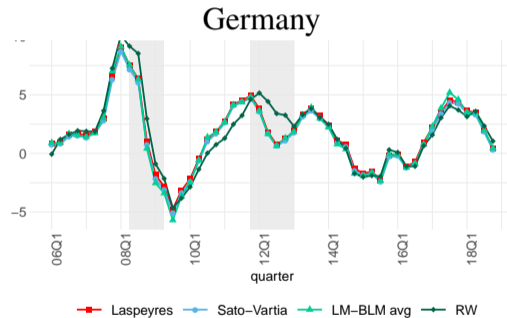
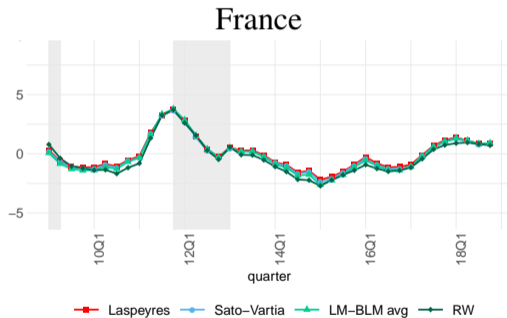
(Substitution: Sato-Vartia and Redding-Weinstein)

$$\pi_q = \prod_{i \in I(q)} \left(\frac{P_{i,q}}{P_{i,q-4}} \frac{\Phi_{i,q-4}}{\Phi_{i,q}} \right)^{\omega_{i,q}} \quad \omega_{i,q} = \frac{s_{i,q} - s_{i,q-4}}{\ln(s_{i,q}) - \ln(s_{i,q-4})} / \left(\sum_{l \in I(q)} \frac{s_{l,q} - s_{l,q-4}}{\ln(s_{l,q}) - \ln(s_{l,q-4})} \right)$$

$$s_{i,q} = \frac{P_{i,q} x_{i,q}}{\sum_{l \in I(q)} P_{l,q} x_{l,q}} = \left(\frac{P_{i,q}}{\Phi_{i,q}} \right)^{1-\sigma} / \left[\sum_{l \in I(q)} \left(\frac{P_{l,q}}{\Phi_{l,q}} \right)^{1-\sigma} \right]$$

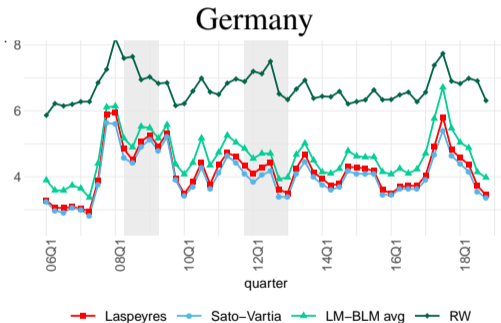
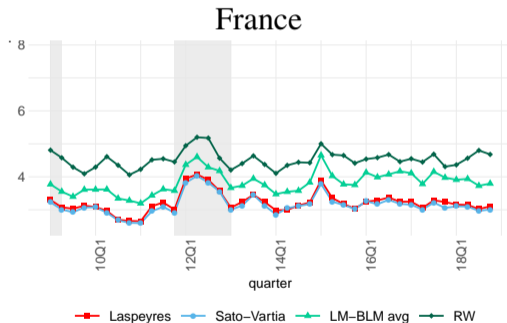
COLI index median close to Laspeyres index

(time-invariant tastes, median across households, within food and beverages)



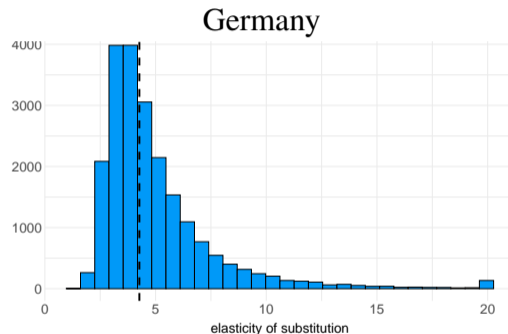
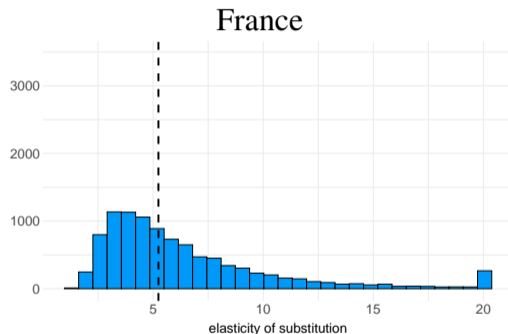
Changing tastes may increase estimated inflation heterogeneity

Interquartile range of inflation indices without (L, SV) and with time variation in tastes (RW, LM), range across households



Heterogeneity in elasticity of substitution

(within food and beverages; estimation following Broda and Weinstein 2006)



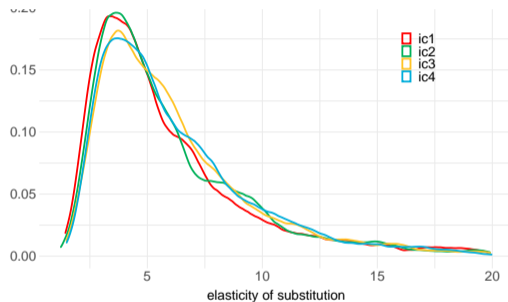
median France: 6.0 (based on \varnothing 4400 households per quarter)

median Germany: 4.6 (based on \varnothing 10600 households per quarter)

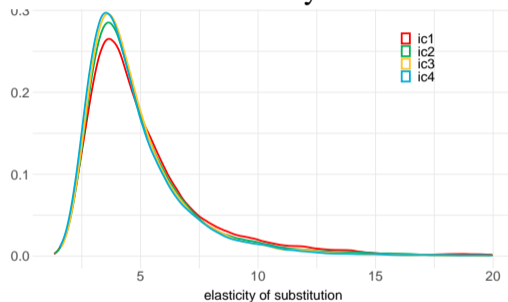
Elasticity of substitution by income

(within food and beverages)

France



Germany



In Germany, low income households substitute slightly more. Little difference in France.

Summary

Household inflation heterogeneity large compared to aggregate inflation, but not persistent.

- 1 Prices account for less than half of inflation heterogeneity. Not household-, but region-specific. Key household-specific driver is the household's product (brand) choice.
- 2 Demographic factors capture only small part of household heterogeneity. Most inflation heterogeneity idiosyncratic to the household (i.e. its behavior). Income *group* differences somewhat more persistent than for individual households, but also small and time-varying.
- 3 Changes in cost of living more heterogeneous than in HICP due to time-variation in tastes.

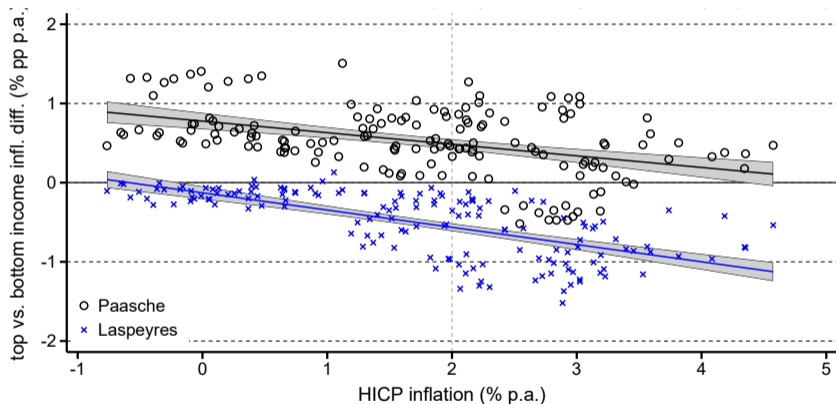
Implications

- Inflation experience of households is extremely heterogeneous. Mostly unrelated to household demographics.
- Heterogeneity in inflation statistic might understate heterogeneity in changes of cost of living.
- In low inflation periods the household idiosyncratic component of inflation dominates time variation in aggregate inflation.

Might explain very dispersed inflation perceptions and expectations of households.

Laspeyres and Paasche FMCG inflation differentials

Top vs. bottom income group FMCG inflation differential, vs. HICP inflation



(High-income minus low-income; difference of six-country six-country-weighted averages;
COICOPs 01.1, 01.2, 02.1; 2005/2012–2018; y-o-y, p.p. p.a.)

Source: Ampudia et al. (2024)