Pass-Through in Levels and the Unequal Incidence of Commodity Shocks

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August 2025

Disclaimer

This presentation contains my own analyses calculated (or derived) based in part on data from Nielsen Consumer LLC and marketing databases provided through the NielsenIQ Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the NielsenIQ data are those of the author and do not reflect the views of NielsenIQ. NielsenIQ is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

A Within-Category Source of Fluctuations in Inflation Inequality

- Inflation differs across households due to composition of expenditures.
- Large literature: Inflation heterogeneity due to spending shares across categories.
  - E.g., low-income households devote larger budget share to necessities like food, energy.
    E.g., Hobijn and Lagakos (2005), Orchard (2022), Jaravel (2024).
- This paper: New source of fluctuations in inflation inequality *within* product categories.

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- This paper: New source of fluctuations in inflation inequality *within* product categories.

1. Complete pass-through in levels of input cost increases to prices.
2. Same absolute price increase $\Rightarrow$ higher inflation for low-priced varieties in category.
3. Low-income households buy lower-price varieties, and thus face higher inflation.

A Within-Category Source of Fluctuations in Inflation Inequality

- Channel parsimoniously accounts for cycles in “cheapflation” and inflation inequality.
  - Explains 70% of variation in food-at-home inflation inequality over 18 year period.
  - Explains cheapflation & inflation inequality during Great Recession and 2021–2023.
    Li (2019), Argente and Lee (2021); Cavallo and Kryvtsov (2024), Chen et al. (2024).
  - Little need for other channels (price-gouging at low end, elevated demand from stimulus).
- Official statistics understate gaps in inflation across income groups by 70–90%.
  - Even the most granular BLS data aggregate inflation across varieties within category.
  - Miss systematic differences in inflation across varieties due to pass-through in levels.
- Evidence that channel applies to other consumption categories beyond food at home.

Selected Related Literature

- **Inflation inequality**:
  - *Using differences in spending across categories*: Michael (1979), Hagemann (1982), Garner et al. (1996), Hobijn and Lagakos (2005), Hobijn et al. (2009), Klick and Stockburger (2021, 2024), Orchard (2022), Hochmuth et al. (2022), Pallotti et al. (2023), Cavallo (2024), Jaravel (2024), Lan et al. (2024), Olivi et al. (2024), Lokshin et al. (2025).
    - Del Canto et al. (2025): "[...] there is no a priori reason to think inflation rates of finer product categories should be differentially responsive to short-run shocks. We therefore limit attention to the 25 CPI groups."
  - *Scanner data, secular trend*: Kaplan and Schulhofer-Wohl (2017), Jaravel (2019).
  - *Scanner data, specific episodes*: *Great Recession*: Argente and Lee (2021), Li (2019). *Post-Pandemic*: Weber et al. (2023), Cavallo and Kryvtsov (2024), Chen et al. (2024).
- **Pass-through**:
  - E.g., Bulow and Pfleiderer (1983), Campa and Goldberg (2005), Nakamura and Zerom (2010), Weyl and Fabinger (2013), Burstein and Gopinath (2014), Mrázová and Neary (2017), Amiti et al. (2019), Butters et al. (2022), Minton and Wheaton (2022).
  - See companion paper, *"Complete Pass-Through in Levels."*

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Coffee: A case study

- Roasted coffee products as a laboratory to explore price dynamics.
- Primary input, green coffee beans, traded on global commodity markets, with large fluctuations over 2006–2023.

1. Complete pass-through in levels of input cost increases to prices.
2. Same absolute price increase $\Rightarrow$ higher inflation for low-priced varieties in category.
3. Low-income households buy lower-price varieties, and thus face higher inflation.

Coffee: Data on retail prices

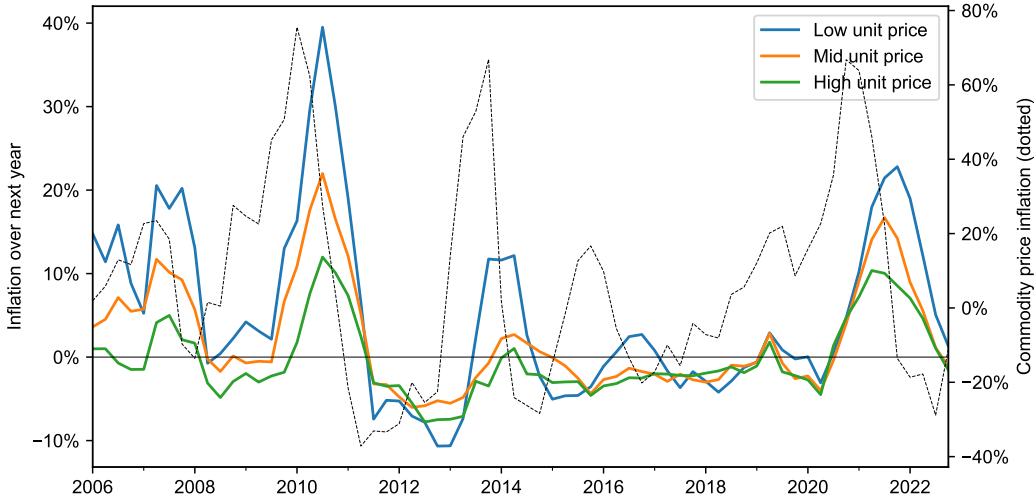
- NielsenIQ Retail Scanner data on sales and quantities at >30k participating stores.
- For UPC i at retail chain r in quarter t: sales λ_{irt}, quantity-weighted avg. unit price p_{irt}.
- Measure inflation and price change over the next year (to avoid seasonality effects):

$$\pi_{irt} = p_{irt+4}/p_{irt} - 1, \qquad \Delta p_{irt} = p_{irt+4} - p_{irt}.$$

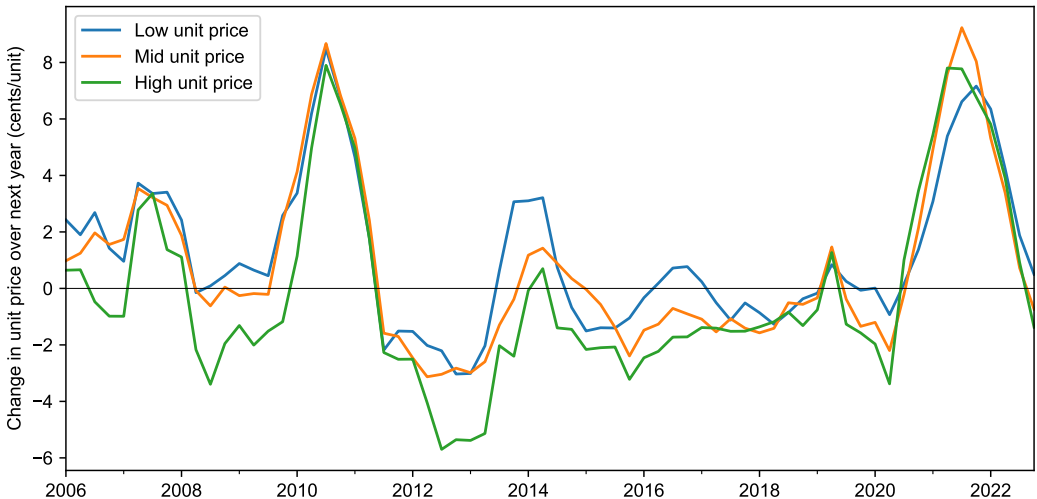
- In each quarter, sort products by avg unit price and group into N "unit price groups.":

$$\pi_{gt} = \sum_{ir \in g} \frac{\lambda_{irt}}{\sum_{js \in g} \lambda_{jst}} \pi_{irt}, \qquad \Delta p_{gt} = \sum_{ir \in g} \frac{\lambda_{irt}/p_{irt}}{\sum_{js \in g} \lambda_{jst}/p_{jst}} \Delta p_{irt}.$$

Low-priced products exhibit greater sensitivity of inflation to costs



Differences disappear when measuring price changes in levels



Canonical approach to measure pass-through of commodity cost changes

- Specification à la Campa and Goldberg (2005), Nakamura and Zerom (2010), etc.
- Price change in quarter t due to commodity cost changes in last K quarters:

$$\Delta p_{irt} = a_{ir} + \sum_{k=0}^{K} b_k \Delta c_{t-k} + \sum_{k=1}^{4} d_k q_t + \varepsilon_{irt}.$$

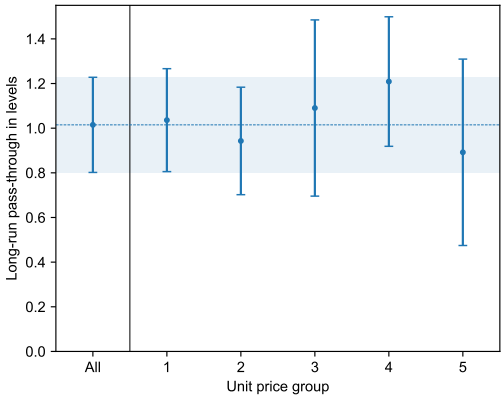
  - Absorb product-retailer trends a_{ir} and seasonal effects with quarter-of-year dummies q_t.
  - Horizon of $K = 6$ quarters, following Nakamura and Zerom (2010).
  - Long-run pass-through in levels given by $\sum_{k=1}^{K} b_k$.

- Long-run pass-through in logs $\sum_{k=1}^{K} \beta_k$ from analogous specification,

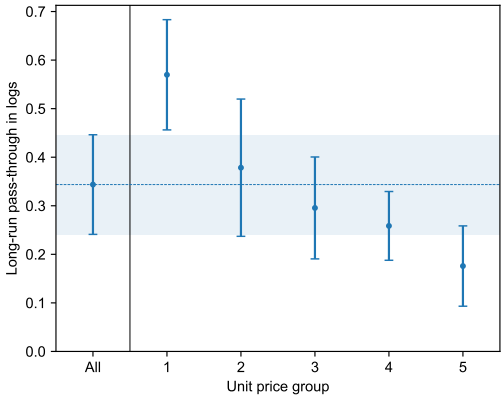
$$\Delta \log p_{irt} = \alpha_{ir} + \sum_{k=0}^{K} \beta_k \Delta \log c_{t-k} + \sum_{k=1}^{4} \delta_k q_t + \varepsilon_{irt}.$$

Complete pass-through in levels $\rightarrow$ heterogeneous log pass-through

- Pass-through in levels is 1.01 (se: 0.11) and uniform across unit price groups.
- Pass-through in logs is incomplete (0.34; se: 0.05) and decreasing with unit price.



(a) Pass-through in levels.



(b) Pass-through in logs.

Robustness

Unit price group	*Panel A. Pass-through in levels*					
	Baseline	IV: Exchange rates	IV: Weather shocks	Product-quarter FEs	$K = 4$	$K = 8$
1	0.13	0.10	0.25	0.22	0.23	−0.38
2	−0.44	−0.42	−0.17	−0.64	−0.40	0.18
3	0.33	0.52	0.24	−0.02	−0.15	0.06
4	1.06	0.85	−0.32	1.42	1.13	1.30
5	−0.51	−0.36	−0.30	−0.36	−0.52	−0.18
Unit price group	*Panel B. Pass-through in logs*					
	Baseline	IV: Exchange rates	IV: Weather shocks	Product-quarter FEs	$K = 4$	$K = 8$
1	2.90**	2.21**	1.70*	2.81**	2.57**	2.30**
2	0.39	0.35	0.13	0.25	0.14	1.05
3	−0.64	−0.35	−0.53	−0.88	−0.88	−0.76
4	−1.34	−1.14	−2.04**	−1.02	−0.76	−0.89
5	−2.50**	−2.33**	−2.05**	−2.28**	−2.22**	−2.32**

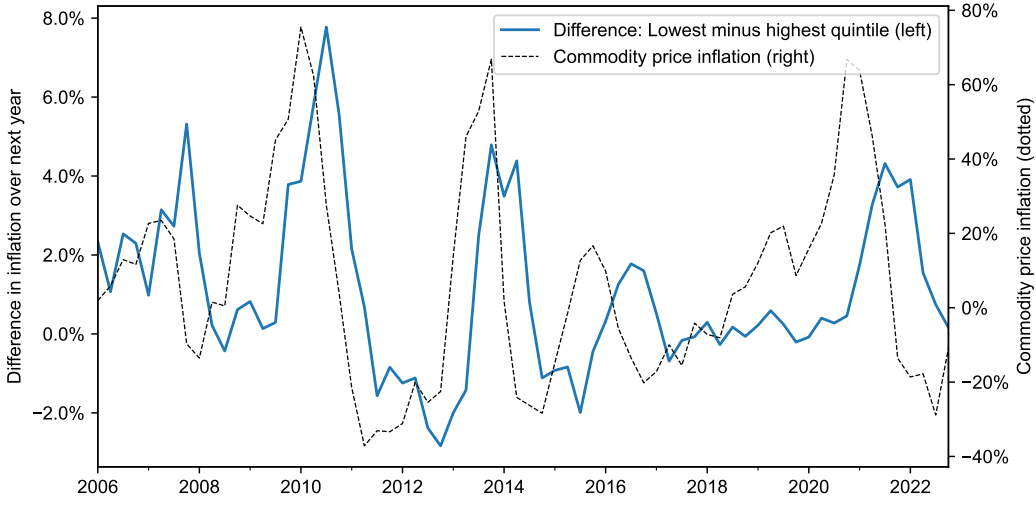
- Difference in pass-through relative to all products: $(\rho_i - \rho_{\text{all}})/(\text{SE}_i^2 + \text{SE}_{\text{all}}^2)^{1/2}$.
- Result: Uniform pass-through in levels, higher log pass-through for low-price varieties.

From cheapflation to inflation inequality

- Construct inflation by income quintile using NielsenIQ Homescan panelist data.
- Low-income buy cheaper varieties $\Rightarrow$ more sensitive to inflation.

Panel A. Prices paid		*Panel B. Inflation sensitivity*		
	Log unit price (1)		*Coffee inflation for income group* (OLS)	(IV)
Income quintile 2	0.036**	Coffee inflation × Income quintile 2	−0.039**	−0.055**
	(0.000)		(0.002)	(0.018)
Income quintile 3	0.093**	Coffee inflation × Income quintile 3	−0.096**	−0.119**
	(0.001)		(0.004)	(0.030)
Income quintile 4	0.157**	Coffee inflation × Income quintile 4	−0.155**	−0.201**
	(0.005)		(0.008)	(0.050)
Income quintile 5	0.236**	Coffee inflation × Income quintile 5	−0.270**	−0.322**
	(0.006)		(0.017)	(0.024)
Time FEs	Yes	Time FEs	Yes	Yes
N	360	*N*	340	340
R^2	0.99	R^2	1.00	0.99
Within R^2	0.93	Within R^2	0.80	0.19

Fluctuations in within-category inflation inequality



- BLS has one ELI for “roasted and instant coffee.” Misses all variation within coffee!

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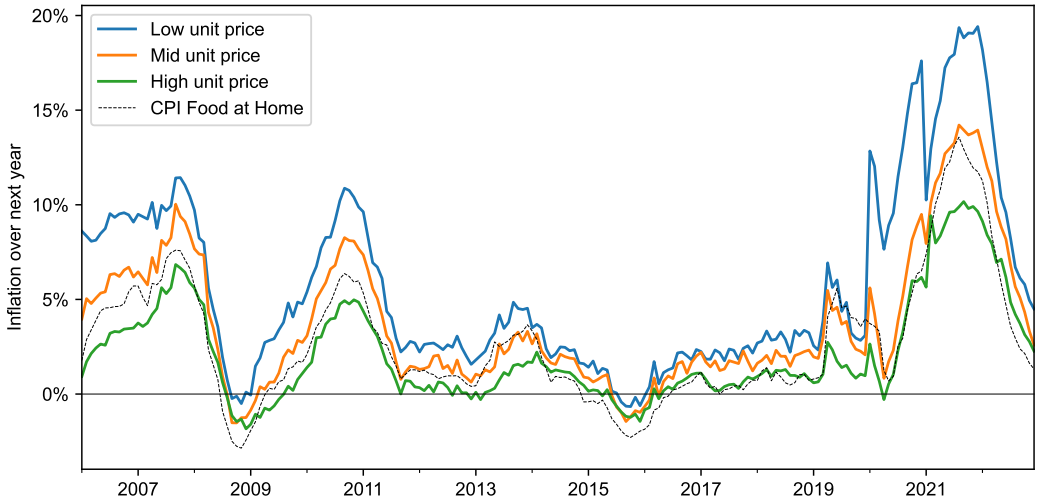
Mechanism emerges across entire food-at-home basket

- The same patterns from coffee appear across food-at-home categories.

1. Complete pass-through in levels of input cost increases to prices.
2. Same absolute price increase $\Rightarrow$ higher inflation for low-priced varieties in category.
3. Low-income households buy lower-price varieties, and thus face higher inflation.

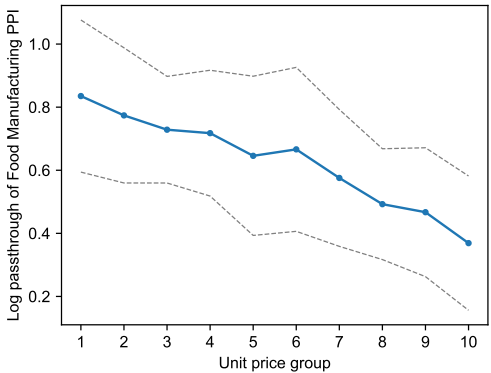
Cycles in food-at-home cheapflation

- Inflation for lower-priced varieties more sensitive to aggregate inflation rate.

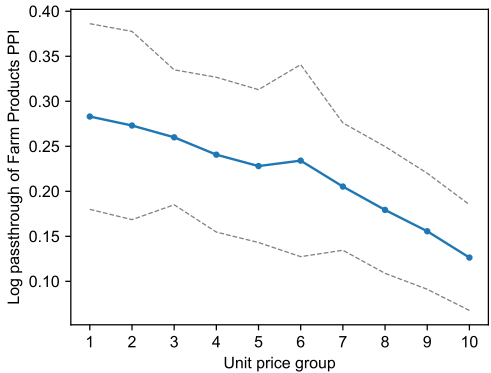


Driven by differential log pass-through of upstream costs

$$\Delta \log p_{it} = \alpha_i + \sum_{k=0}^{K} \beta_k \Delta \log \text{PPI}_{t-k} + \sum_{k=1}^{4} \delta_k q_k + \varepsilon_{it}.$$



(a) Food Manufacturing PPI.



(b) Farm Products PPI.

Testing for pass-through in levels

- How do we know declining log pass-through is due to complete pass-through in levels?
- Suppose each module consists of varieties indexed by i, with unit prices

$$p_i = m + b_i w.$$

$\Rightarrow$ Complete pass-through in levels of changes in material price m.

  - Assumption 1: A unit of each variety contains the same quantity of material input.
  - Assumption 2: Demand system generates additive markup priced relative to labor w. E.g., under generalized logit

$$q_i = \frac{\exp(\delta_i - b_i p_i / w)}{\int_j \exp(\delta_j - b_i p_j / w)\, dj}.$$

Testing for pass-through in levels

- Suppose each module consists of varieties indexed by i, with unit prices

$$p_i = m + b_i w.$$

- Then, to a first order, the gap between module inflation rates for groups L and H is

$$\pi^L - \pi^H = \underbrace{\left(\frac{p}{p^L} - \frac{p}{p^H}\right)}_{\text{Price gap}} \times \underbrace{\left(\pi^{\text{all}} - \pi^w\right)}_{\text{Excess inflation}},$$

  - p is the average module unit price, and p^L, p^H are the avg unit prices paid by L and H.
  - $\pi^{\text{all}} - \pi^w$ is the difference between the module inflation rate and wage inflation.

- Empirical specification: Indexing modules m and quarters t, we predict $\beta \approx 1$:

$$\text{Cheapflation}_{mt} = \beta \left(\text{PriceGap}_{mt} \times \text{ExcessModuleInflation}_{mt}\right) + \varepsilon_{mt}.$$

Testing for pass-through in levels

- We find $\beta \approx 1$.

	Inflation of lowest-price decile − highest-price decile					
	(1)	(2)	(3)	(4)	(5)	(6)
Excess module inflation × Price gap	1.183**		1.188**		1.194**	
	(0.027)		(0.025)		(0.019)	
Module inflation × Price gap		1.186**		1.188**		1.194**
		(0.025)		(0.025)		(0.019)
Wage inflation × Price gap		-1.657**		-1.047**		-1.540**
		(0.335)		(0.299)		(0.453)
Post-2020			-0.067**	-0.073**		
			(0.018)	(0.024)		
Time FEs					Yes	Yes
Product Module FEs					Yes	Yes
N	42137	42137	42137	42137	42137	42137
R^2	0.92	0.92	0.92	0.92	0.93	0.93

Testing for pass-through in levels

- We find $\beta \approx 1$. Predictions also hold if we split module vs. wage inflation.

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	(1)	(2)	(3)	(4)	(5)	(6)
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Testing for pass-through in levels

- We find $\beta \approx 1$. Predictions also hold if we split module vs. wage inflation.
- No excess cheapflation from 2021–2023. Little add'l time variation in cheapflation.

	Inflation of lowest-price decile − highest-price decile					
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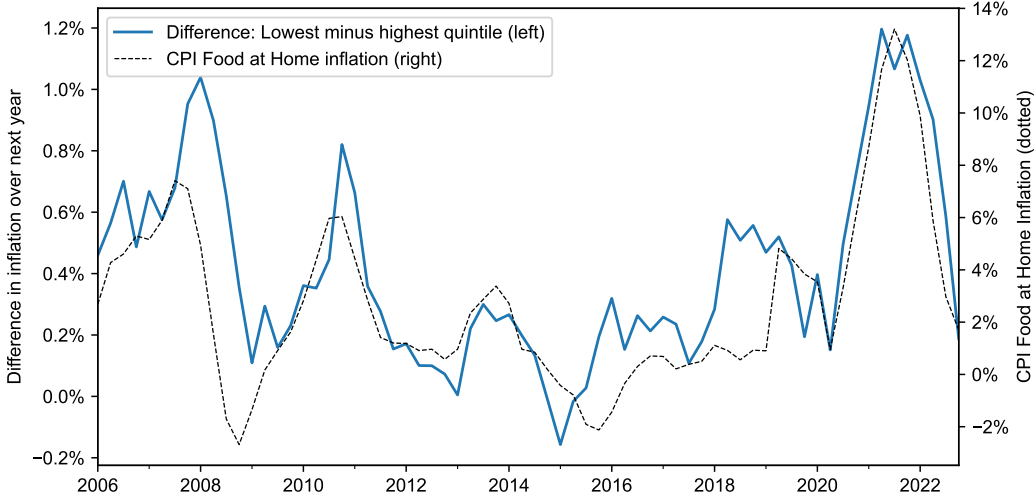
From cheapflation to inflation inequality

- Low-income buy cheaper varieties across food-at-home. (Handbury 2021; Sangani 2022).
- $\Rightarrow$ Low-income inflation rates more sensitive to category-level inflation.

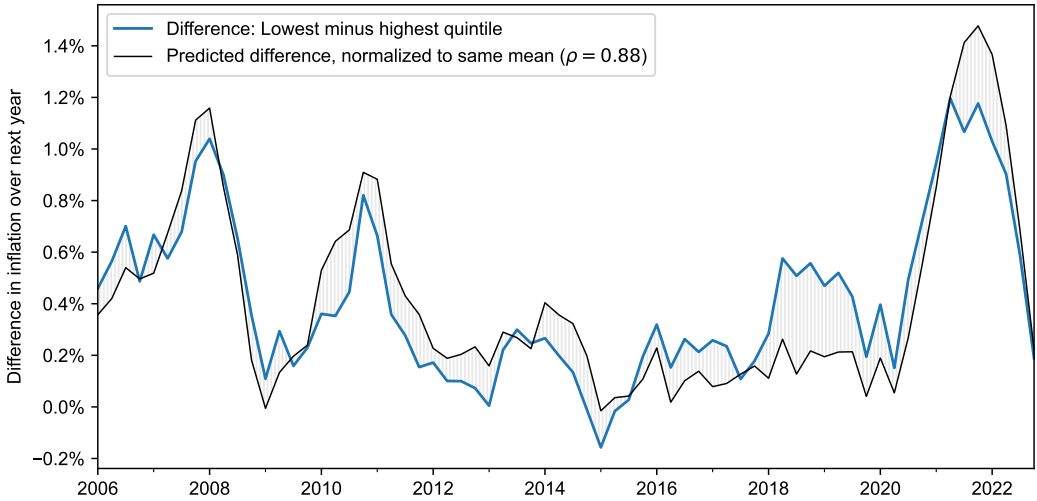
Panel A. Prices paid		*Panel B. Inflation sensitivity*	
	Log unit price (1)		*Module inflation for income group* (2)
Income quintile 2	0.012**	Avg. module inflation × Income quintile 2	0.000
	(0.003)		(0.003)
Income quintile 3	0.027**	Avg. module inflation × Income quintile 3	−0.008*
	(0.004)		(0.004)
Income quintile 4	0.049**	Avg. module inflation × Income quintile 4	−0.025**
	(0.006)		(0.006)
Income quintile 5	0.082**	Avg. module inflation × Income quintile 5	−0.052**
	(0.008)		(0.010)
Module-Time FEs	Yes	Module-Time FEs	Yes
N	213971	N	201667
R^2	1.00	R^2	0.99
Within R^2	0.19	Within R^2	0.08

Cycles in inflation inequality over entire food-at-home bundle



Cycles in inflation inequality over entire food-at-home bundle

- Predicted gap = diff within-module infl (pass-through in levels) + diff spending shares.



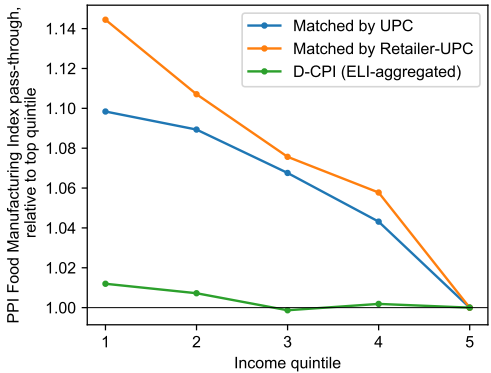
Explaining variation in inflation inequality over time

	Variance of inflation gap (pp^2)	*Excess inflation inequality relative to full sample average* (percentage points)	
	All Years	2008–2011	2021–2023
Actual	0.100	0.122	0.323
After accounting for pass-through in levels	0.043	0.002	0.117
After accounting for pass-through in levels and module expenditure shares	0.030	−0.041	−0.043

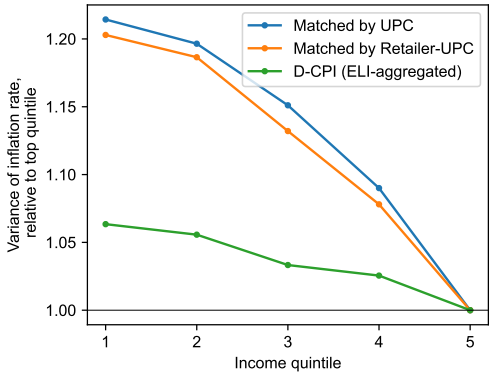
- Predicted gap explains 70% of variation in inflation inequality over time.
- Accounts for excess inflation inequality during Great Recession (’08–11) and Post-Pandemic Inflation (’21–23).

BLS data does not capture higher volatility, sensitivity of low-income inflation

- Food-at-home inflation for low-income more sensitive to upstream costs, more volatile.
- Inflation measures built on BLS ELI data (e.g., D-CPI) do not capture these effects.



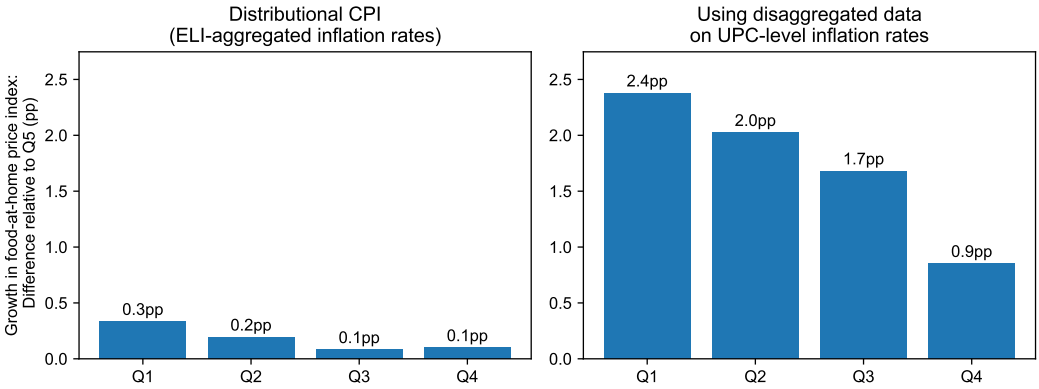
(a) Log pass-through of Food Manufacturing PPI.



(b) Variance of annual inflation rates.

BLS data misses 86% of differential food-at-home inflation over 2021–2023

- Differences in food-at-home price growth by income quintile, 2020Q4 to 2023Q4.
- Average growth was 21pp over this period $\Rightarrow \approx$10% higher for low-income.



Official price indices understate gaps by 70–90%

- "BLS data" column uses most disaggregated official price indices available.
- Aggregation within BLS indices understates differences across income groups.

	Difference: 1st vs. 5th income quintile		
Measure	Scanner data	BLS data	Understatement in BLS data
Pass-through of Food Manufacturing PPI, 2006–2020	9.8%	1.2%	88%
Pass-through of Farm Products PPI, 2006–2020	5.8%	1.6%	72%
Variance of food-at-home inflation rates, 2006–2020	21.4%	6.3%	70%
Growth in food-at-home price index, 2006Q4–2020Q4	5.9pp	−0.1pp	101%
Growth in food-at-home price index, 2020Q4–2023Q4	2.4pp	0.3pp	86%

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Beyond Food at Home?

- Highly disaggregated purchase data for food-at-home / fast-moving consumer goods.
- Does pass-through in levels affect inflation inequality in other categories? Should if:
  - Firms have other input costs besides labor,
  - Firms exhibit complete pass-through in levels of these input costs to prices,
  - Consumers purchase differently-priced varieties.
- In paper: Two complementary strategies.
  1. Evidence from across U.S. cities. $\Rightarrow$ Cycles in cheapflation and inflation inequality across cities for other consumption categories.
  2. Evidence from vehicle purchases. $\Rightarrow$ Similar cycles in cheapflation, inflation inequality.

Beyond Laspeyres? Accounting for substitution and nonhomotheticity

- Change in true price index may differ from Laspeyres index two reasons.
  1. Substitution: Households may substitute to products with smaller price increases.
  2. Nonhomotheticity: Households' spending shares may change with real income.
- How does accounting for substitution and nonhomotheticity shape differential inflation?
  1. Törnqvist price index accounts for changes in spending shares.
  2. Nonhomothetic adjustment from Jaravel and Lashkari (2024).
- On net, differences across income groups largely unchanged.
  1. Substitution dampens volatility of inflation, $\approx$ proportionately across income distribution.
  2. Nonhomotheticity amplifies volatility: when food prices rise, households trade down to low-price goods that inflate the fastest.

Conclusion

- A new source of fluctuations in cheapflation and inflation inequality.
- Pass-through in levels of cost changes + diff varieties bought by income groups.
- Largely invisible in official statistics due to aggregation.
- Note: Mechanism applies to any units with different expenditures across varieties.
  - Cities with higher-priced varieties will have muted response to national cost shocks.
  - Countries that import high-price varieties will have less volatile import price inflation.
- For other macro implications re: industry dynamics, aggregation CPI volatility, see *"Complete Pass-Through in Levels."*

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Testing for pass-through in levels: Robustness with 5 groups

	Inflation of lowest-price quintile − highest-price quintile					
	(1)	(2)	(3)	(4)	(5)	(6)
Excess module inflation × Price gap	1.176**		1.181**		1.188**	
	(0.027)		(0.025)		(0.019)	
Module inflation × Price gap		1.178**		1.181**		1.188**
		(0.025)		(0.025)		(0.019)
Wage inflation × Price gap		-1.561**		-0.926**		-1.261**
		(0.299)		(0.243)		(0.336)
Post-2020			-0.048**	-0.056**		
			(0.011)	(0.014)		
Price gap	0.004	0.023*	0.012	0.001	0.051**	0.054**
	(0.010)	(0.011)	(0.007)	(0.006)	(0.007)	(0.013)
Time FEs					Yes	Yes
Product Module FEs					Yes	Yes
N	42405	42405	42405	42405	42405	42405
R^2	0.92	0.92	0.93	0.93	0.94	0.94

Evidence on cheapflation from Cost of Living Index (COLI) data

- Cost of Living Index (COLI) price data from 300 cities over 1990–2010.
  - Covers grocery items, apparel, other nondurables (e.g., aspirin, newspaper subscription, can of tennis balls), and services (e.g., haircut, movie ticket, pizza at restaurant).
  - Products chosen to be as standardized as possible across cities.
  - $\Rightarrow$ Prices not necessarily representative of product mix across cities.

- Test for cheapflation using prices of same product i across cities c:

$$\text{Inflation}_{ict} = \beta \left(\text{AvgProductInflation}_{it} \times \text{RelativePrice}_{ict}\right) + \alpha_{it} + \delta_{ic} + \kappa_{ct} + \varepsilon_{ict},$$

  - $\text{RelativePrice}_{ict} = \log p_{ict} - \log \bar{p}_{it}$ is relative price of product i in city c in quarter t.
  - Absorb product-quarter, product-city, and city-quarter FEs $\alpha_{it}, \delta_{ic}, \kappa_{ct}$.
  - Lower-priced products more sensitive to inflation ("cheapflation") implies $\beta < 0$.

Evidence on cheapflation from Cost of Living Index (COLI) data

	Product Inflation in City					
	All	Grocery	Apparel	Other Goods	Services	Housing & Utilities
	(1)	(2)	(3)	(4)	(5)	(6)
Avg. Product Infl. × Relative Price	−1.565**	−1.496**	−2.440**	−1.343**	−5.181**	−0.586*
	(0.250)	(0.329)	(0.522)	(0.366)	(1.996)	(0.274)
Product-Quarter FEs	Yes	Yes	Yes	Yes	Yes	Yes
Product-City FEs	Yes	Yes	Yes	Yes	Yes	Yes
City-Quarter FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	1 164 952	516 770	55 111	183 189	262 382	147 500
R^2	0.35	0.38	0.55	0.55	0.27	0.55

- Cheapflation extends beyond grocery to apparel, other nondurables, and services.

Evidence on inflation inequality from BLS metro area data

- BLS collects price quotes and reports price indices for 32 metropolitan areas.
- Differences in price indices across cities reflect:
  - Differences in product mix and product-level inflation. $\Leftarrow$ Our mechanism.
  - Differences in expenditure shares across categories.
- Test for lower sensitivity to inflation in low-income cities:

$$\text{Inflation}_{mt} = \beta \left(\text{USInflation}_t \times \text{LogIncome}_{mt}\right) + \gamma \text{LogIncome}_{mt} + \alpha_m + \delta_t + \varepsilon_{mt},$$

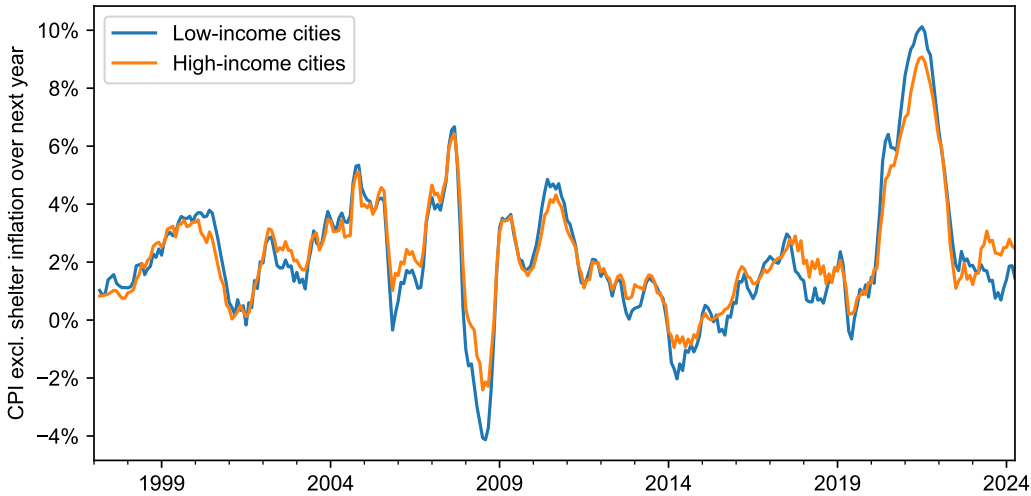
  - USInflation_t is inflation in a U.S. city average (nationwide average).
  - LogIncome_{mt} is log MSA income from BEA.
  - Low-income more sensitive to inflation implies $\beta < 0$.
  - Test within categories to ensure not driven by category expenditure shares.

Inflation inequality across U.S. metros

	Inflation in Metropolitan Area					
Series	CPI	CPI Ex. Shelter	All Food	Food Away from Home	Goods Ex. Food	Services Ex. Shelter
BLS Code	SA0	SA0L2	SAF1	SEFV	SACL1	SASL2RS
	(1)	(2)	(3)	(4)	(5)	(6)
U.S. Avg. Inflation × Log Income	−0.970**	−0.452**	−0.258**	−0.589**	−0.227**	−0.271*
	(0.085)	(0.066)	(0.084)	(0.242)	(0.041)	(0.161)
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Metropolitan Area FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	3540	3534	3528	3515	3534	3534
R^2	0.85	0.89	0.75	0.42	0.92	0.57

- Higher sensitivity of inflation in lower-income cities.
- Beyond food-at-home, appears in food away from home, other goods, and services.

Inflation of CPI excluding shelter in high- and low-income cities



Differences in expenditure weights across categories explains only half

- BLS publishes expenditure weights across categories for metro areas.
- Construct MSA inflation rates w/ area weights $\times$ national category inflation.
- $\Rightarrow$ Sensitivity of actual MSA inflation rates varies 2x more with income, suggesting differences in within-category product mix and product-level inflation matter.

	Inflation in Metropolitan Area			
	CPI Data		Constructed with Area Weights	
	CPI	CPI Ex. Shelter	CPI	CPI Ex. Shelter
	(1)	(2)	(3)	(4)
U.S. Avg. Inflation $\times$ Log Income	-0.970^{**}	-0.452^{**}	-0.208^{**}	-0.224^{**}
	(0.085)	(0.066)	(0.035)	(0.030)
Time FEs	Yes	Yes	Yes	Yes
Metropolitan Area FEs	Yes	Yes	Yes	Yes
N	3540	3534	7452	7452
R^2	0.85	0.89	0.99	0.99

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