Pass-Through and the Unequal Incidence of Commodity Shocks

Kunal Sangani

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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.

Puzzle: Incomplete Long-Run Pass-Through

- Incomplete pass-through of commodity price changes.
  E.g., Peltzman (2000), Kim and Cotterill (2008), Nakamura and Zerom (2010), Hong and Li (2017).
  - When marginal costs increase 10%, prices increase $<$10%.
  - Incomplete at long horizons, even after accounting for input cost share.
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  - Find complete pass-through in levels. When costs rise \$1/unit, prices rise \$1/unit.
  - Explains overall level of “log pass-through” $+$ cross-sectional heterogeneity.

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  - Find complete pass-through in levels. When costs rise $1/unit, prices rise $1/unit.
  - Explains overall level of "log pass-through" $+$ cross-sectional heterogeneity.
  - Does not appear to be due to (1) perfect competition, (2) demand curvature.

Puzzle: Incomplete Long-Run Pass-Through

- Application: New, within-category, *cyclical* component of inflation inequality.
    - When commodity costs rise, absolute price changes similar across products.
    - But appears as larger inflation (in %) for low-price / low-margin products.
    - Inflation inequality since low-income households buy low-margin products. (Sangani 2023).
    - Within-category: not captured by e.g. Distributional CPIs (Jaravel 2024).
    - Estimated price growth of bottom decile food-at-home products 11pp higher ($>$2x) than top decile from 2020–2023.

Selected Related Literature

- **Pass-through and incidence**:
  - Bulow and Pfleiderer (1983), Weyl and Fabinger (2013), Mrázová and Neary (2017).
- **Empirical studies of commodity pass-through**:
  - Peltzman (2000), Hong and Li (2017), **Butters et al. (2022)**, Minton and Wheaton (2022).
  - *Retail Gasoline*: (*Pass-through asymmetry*) Karrenbrock (1991), Borenstein et al. (1997), Lewis (2011) (*Cycles*) Wang (2009), Noel (2009, 2015), Lewis and Noel (2011), Atkinson et al. (2014), Byrne and de Roos (2017, 2019).
  - *Coffee*: Bettendorf and Verboven (2000), Leibtag et al. (2007), **Nakamura and Zerom (2010)**, Bonnet et al. (2013); *Cheese*: Kim and Cotterill (2008); *Spirits*: Conlon and Rao (2020).
- **Pricing heuristics**:
  - *Full-cost pricing / fairness*: Hall and Hitch (1939), Heflebower (1955), Kaplan et al. (1958), Okun (1981), Kahneman et al. (1986), Blinder et al. (1998), Rotemberg (2005).

- Outside this project: (1) Asymmetry in speed of adjustment, (2) firm-specific idiosyncratic shocks (e.g., exchange rate shocks), (3) highly differentiated goods.

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Long-run desired passthrough: Framework

- Consider industry where production in Leontief in commodity x and variable input ℓ:

$$y = \min\{x, \ell\}.$$

  Per-unit costs of x and ℓ are c and w respectively.

- Standard constant-markup pricing rule predicts pass-through in levels of μ:

$$p = \mu(c + w), \qquad \Rightarrow \qquad \Delta p = \mu \cdot \Delta c.$$

- Later in talk: Perfect competition ($\mu = 1$), variable markup models.
  - In paper: Relaxing Leontief production, relaxing constant returns, $cov(\Delta c, \Delta w) \neq 0$.

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- Additive margin pricing rule predicts complete pass-through in levels:

$$p = (c + w) + \alpha, \qquad \Rightarrow \qquad \Delta p = \Delta c.$$

Long-run desired pass-through: Measurement

- Canonical approach (e.g., Campa and Goldberg 2005, Nakamura and Zerom 2010).

- Market m price change in t due to commodity cost changes in last K periods:

$$\Delta p_{m,t} = a_m + \sum_{k=0}^{K} b_k \Delta c_{m,t-k} + \varepsilon_{m,t}.$$

  Long-run pass-through is $\sum_{k=0}^{K} b_k$.

- Details:
  - Ensure p is unit root, ensure Δp and Δc are non-unit root.
  - Check for one way Granger causality from Δc to Δp.
  - Use $K = 8$ weeks for gasoline, $K = 12$ months for all food products.
  - Robustness: Estimate long-run pass-through using VAR.

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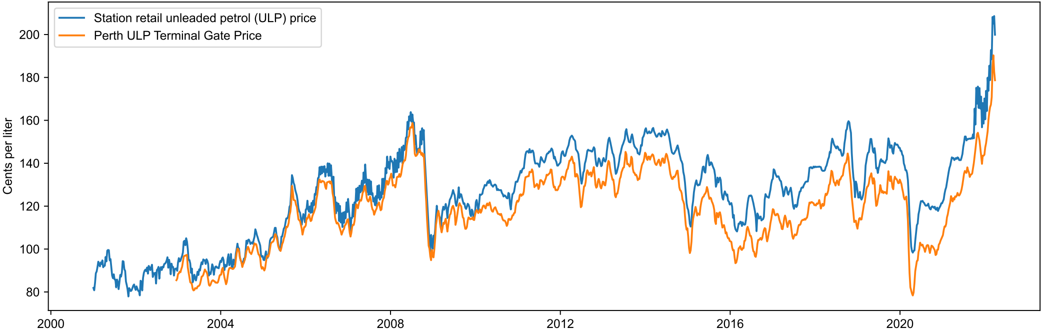
Station-level panel dataset of gas prices in Perth, Australia

- 2.3M price observations (2001-present) for 875 stations in Perth metropolitan area.
- Perth Terminal Gate Price (spot price sold to retailers) available daily.

Figure: Price for BP at 549 Abernethy Rd, Kewdale, Perth, Australia and Perth Terminal Gas Price.



Pass-through of terminal gas price to station gas prices: Unleaded

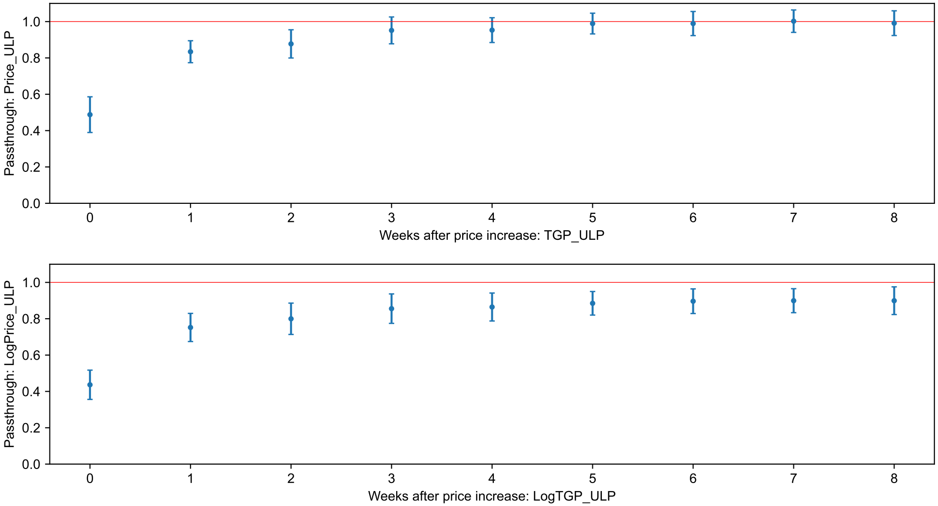


Figure: Passthrough in levels (top) and in logs (bottom). SEs two-way clustered by postcode × year.

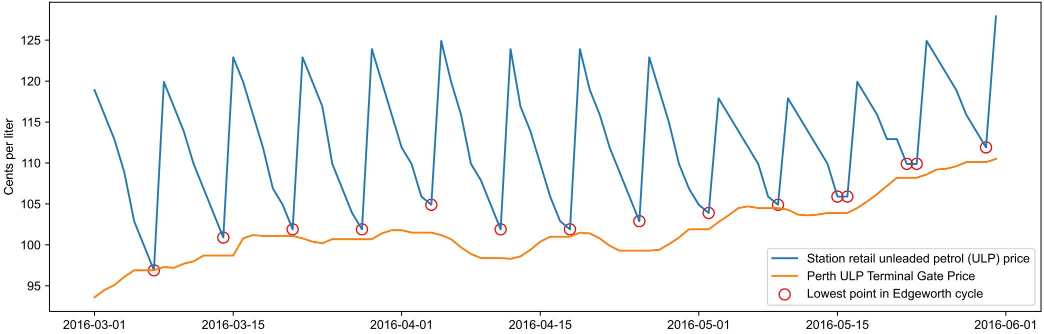
Summary of retail gasoline pass-through estimates

Description	Pass-through (8 weeks) Logs		Levels	
Australia, station-level, 2001–2022				
Terminal to retail, Unleaded	0.899	(0.039)	**0.991**	(0.035)
Terminal to retail, Premium Unleaded	0.887	(0.037)	**0.985**	(0.032)
Canada, city-level, 2007–2022				
Crude to wholesale	0.553	(0.074)	**0.927**	(0.063)
Wholesale to retail (excl. taxes)	0.859	(0.023)	**1.008**	(0.023)
South Korea, station-level, 2008–2022				
Refinery to retail, Unleaded	0.948	(0.014)	**1.007**	(0.008)

- **Cannot reject complete pass-through in levels.** (Reject in logs for all.)
- Robustness: Känzig (2021) OPEC announcement IV for wholesale oil price.

Log pass-through incomplete, even adjusting for cost share

Figure: Price for BP at 549 Abernethy Rd, Kewdale, Perth, with lowest points in price cycle.



- "Log pass-through" estimates: 0.899 (unleaded), 0.887 (premium unleaded).
- Cost shares using days at lowest end of price cycle: 0.98 (ULP), 0.96 (PULP).
- $\Rightarrow$ Even accounting for cost share, log pass-through appears incomplete.

Exploiting variation in margins

- Low markups, hard to differentiate pass-through in levels of 1 from 1.02–1.05.

- Test: Pass-through in levels should be higher for stations with 5% vs. 2% markup.

$$\Delta p_{i,t} = \alpha + \beta_1 \Delta c_{i,t} + \delta \text{AvgMarkup}_{i,t} + \beta_2 \left(\Delta c_{i,t} \times \text{AvgMarkup}_{i,t}\right) + \varepsilon_{i,t},$$

  - where $\Delta p_{i,t}$, $\Delta c_{i,t}$ are change in station retail price and wholesale cost over 16 weeks.
  - Measures of $\text{AvgMarkup}_{i,t}$ exploit variation across stations / over time.

    1. $\text{AvgMarkup}_i =$ average markup (price / terminal cost) of station i over all periods.
    2. $\text{AvgMarkup}_t =$ average markup of all stations in year t.
    3. IV1: Instrument for AvgMarkup_i with amplitude of price cycle by station.
    4. IV2: Instrument for AvgMarkup_t with level of pricing coordination.

- Prediction: If constant multiplicative markup, $\beta_2 > 0$.

Exploiting variation in margins

ΔPrice_{it}	(1) (OLS)	(2) (OLS)	(3) (IV1)	(4) (OLS)	(5) (IV2)
ΔCost_t	0.950**	0.989**	0.952**	0.985**	0.973**
	(0.021)	(0.037)	(0.044)	(0.043)	(0.048)
$\Delta\text{Cost}_t \times$ Avg. Station Markup$_i$ (Net %)		-0.005	-0.000		
		(0.003)	(0.005)		
$\Delta\text{Cost}_t \times$ Avg. Year Markup$_t$ (Net %)				-0.004	-0.003
				(0.004)	(0.005)
N	312215	312215	312215	312215	312215
R^2	0.89	0.89	0.89	0.89	0.89

- Stations with higher margins do not have higher pass-through in levels ($\beta_2 \approx 0$).
- Robustness: Split stations by relative price compared to neighborhood / postcode.

Pass-through in levels explains heterogeneity in "log pass-through"

$\Delta\log(\text{Price})_{it}$	(1) (OLS)	(2) (OLS)	(3) (IV1)	(4) (OLS)	(5) (IV2)
$\Delta\log(\text{Cost})_t$	0.870**	0.998**	0.968**	0.985**	0.977**
	(0.031)	(0.035)	(0.041)	(0.035)	(0.040)
$\Delta\log(\text{Cost})_t \times$ Avg. Station Markup$_i$ (Net %)		-0.015**	-0.011**		
		(0.003)	(0.004)		
$\Delta\log(\text{Cost})_t \times$ Avg. Year Markup$_t$ (Net %)				-0.012**	-0.011**
				(0.003)	(0.004)
N	312215	312215	312215	312215	312215
R^2	0.88	0.89	0.89	0.89	0.89

- As a result, stations with high margins appear to have "incomplete" pass-through.
- Intercept: Pass-through is complete as Net Markup$_{i,t} \to 0$.

Retail Gasoline: Taking Stock

1. Pass-through complete in levels.
2. Pass-through incomplete in logs, even accounting for cost share of gasoline.
3. No apparent heterogeneity in pass-through in levels.
4. Differences in margins rationalizes cross-sectional heterogeneity in log pass-through.

- In paper:
  - Similar results for U.S., South Korea.
  - Similar results using Känzig (2021) OPEC announcement IV for upstream prices.

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Test for six food commodities

- Commodity prices (IMF), BLS average retail price data, 1980–Present.
- Carefully match units (e.g., lbs flour per bushel wheat, oz. roasted coffee per beans).

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		Pass-through (12 mos.)			
Commodity (IMF)	Final Good (BLS)	Logs		Levels	
Arabica coffee price, per lb.	Coffee, 100%, ground roast	0.466	(0.051)	**0.946**	**(0.099)**
Sugar, No. 16, per lb.	Sugar, white, per lb.	0.370	(0.035)	0.691	(0.072)
Beef, global price, per lb.	Ground beef, 100% beef	0.410	(0.068)	**0.899**	**(0.126)**
Rice, Thailand, per metric ton	Rice, white, long grain, uncooked	0.307	(0.049)	**0.882**	**(0.169)**
Wheat, global price, per metric ton	Flour, white, all purpose	0.240	(0.048)	**0.819**	**(0.152)**
Frozen orange juice solids, per lb.	Orange juice, frozen concentrate	0.327	(0.040)	**1.006**	**(0.114)**

- **Cannot reject complete pass-through in levels for 5 of 6.** (Reject in logs for all.)

Example: Pass-through of coffee commodity costs to BLS retail price

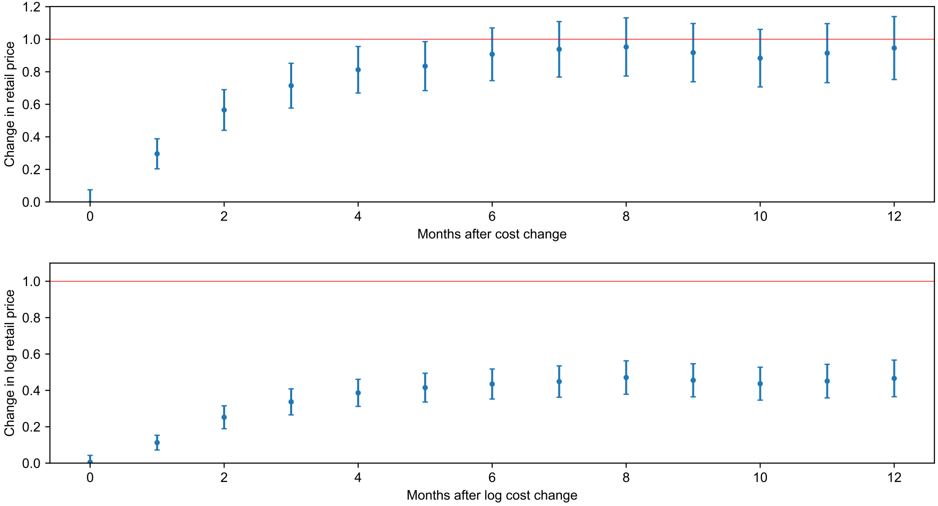
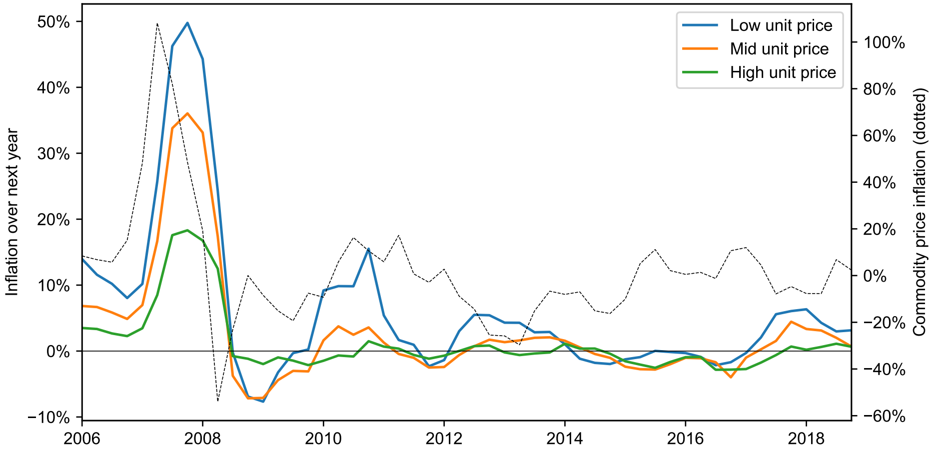


Figure: Passthrough in levels (top) and in logs (bottom)

Pass-through in levels implies variation in “log pass-through”

Figure: Inflation of Rice products in Nielsen data, split by tercile of unit price.



Prediction: Highest-price items exhibit lowest "log pass-through"

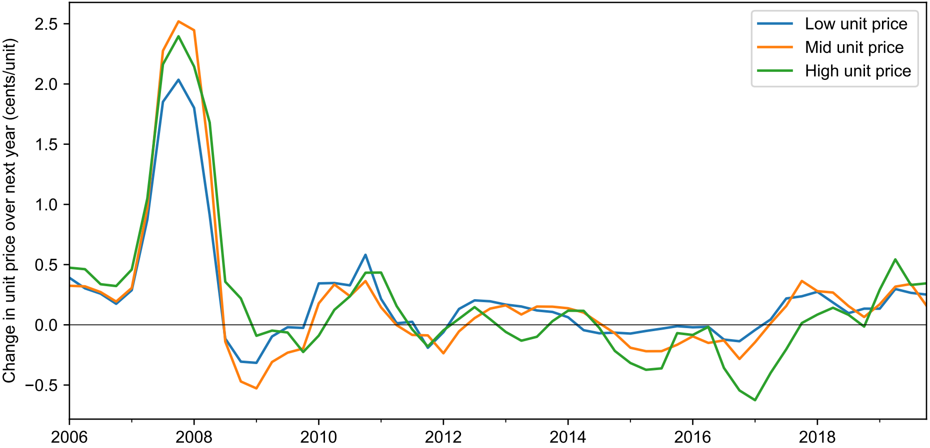
$$\text{Inflation}_{i,t} = \alpha_i + \sum_{k=1,2,3} \beta_k (1\{\text{Unit Price Group } k\} \times \text{CommodityInflation}_t) + \varepsilon_{i,t}.$$

Retail product inflation	Rice (1)	Flour (2)	Coffee (3)
Commodity Inflation	0.239**	0.061**	0.123**
	(0.027)	(0.008)	(0.012)
Commodity Inflation × Unit Price Group 2	−0.060**	−0.017	−0.045**
	(0.018)	(0.011)	(0.009)
Commodity Inflation × Unit Price Group 3	−0.154**	−0.035**	−0.084**
	(0.029)	(0.007)	(0.016)
UPC FEs	Yes	Yes	Yes
N (millions)	20.6	9.8	101.3
R^2	0.09	0.02	0.10

Note: SEs clustered by brand. ** indicates significance at 5%.

Differences in pass-through disappear in absolute (level) terms

Figure: Change in unit price of Rice products in Nielsen data, split by tercile of unit price.



Differences in pass-through disappear in absolute (level) terms

Change in retail price (levels)	Rice (1)	Flour (2)	Coffee (3)
Δ Commodity Cost	0.057**	0.044**	0.086**
	(0.009)	(0.007)	(0.009)
Δ Commodity Cost × Unit Price Group 2	0.017**	0.004	0.010
	(0.006)	(0.012)	(0.010)
Δ Commodity Cost × Unit Price Group 3	0.002	−0.007	−0.004
	(0.012)	(0.009)	(0.022)
UPC FEs	Yes	Yes	Yes
N (millions)	20.6	9.8	101.3
R^2	0.06	0.02	0.07

Note: SEs clustered by brand. ** indicates significance at 5%.

- No systematic difference in pass-through in levels across unit price groups.

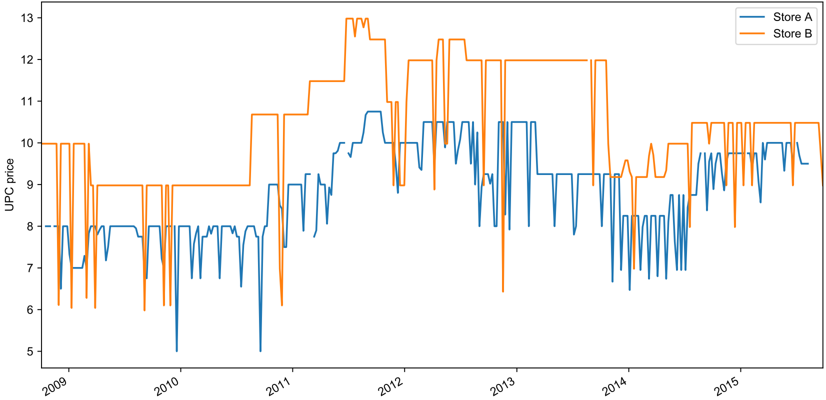
Robustness

- Concern: Log pass-through differences due to non-commodity input costs?
  - Exploit variation in margins across retailers selling the same UPC.
  - Same result: log pass-through declines with margin, pass-through in levels flat.
- Concern: Are these product categories (coffee, rice, flour) special?
  - Variation in margins exercise across all food-at-home products in NielsenIQ data.
  - Log pass-through declines with margin for $\approx$90% of categories.
  - Pass-through in levels flat with margin for $\approx$60% of categories.

Exploiting variation in margins across retailers

- Consider two retailers selling the same UPC, with low and high markup.
- Test: When cost of UPC rises, retailer with high markup should increase more in levels.

Figure: Prices of identical coffee UPC in two stores in same 3-digit ZIP code in Philadelphia, PA.



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Perfect Competition? At Odds with Evidence of Inelastic Demand

- Perfect competition ($\mu = 1$) produces complete pass-through in levels.
- But other features inconsistent...
  1. Downward-sloping demand curves.
     - Demand elasticities for food products (est. using Hausman IV) $\approx$3–6.
     - Demand elasticities for retail gasoline $\approx$6–19 (Wang 2009).
  2. Markups over cost.
     - Retail markups $\approx$30% (Sangani 2023). Other studies find markups $\geq$40% (e.g., Nakamura and Zerom 2010, Park 2013).
     - Price cycles in retail gasoline suggest $p > mc$.
  3. Price dispersion for identical goods in narrow markets.
     - E.g., Kaplan and Menzio (2016).

Curvature of Demand Curves? Knife-Edge Inconsistent with Data

- For complete pass-through in levels, need super-elasticity of demand exactly $= 1$.
- Homothetic demand systems (e.g., Kimball) have super-elasticity $= 0$ for agg. shocks.
  - Logit demand has super-elasticity ≈ 1.

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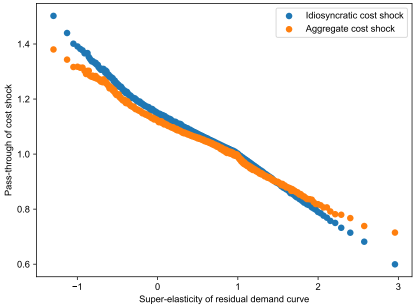

Figure: Nakamura and Zerom (2010) demand system.

- Logit demand has super-elasticity ≈ 1.
- But... calibrated random coefficient models have wide range of super-elasticities & pass-throughs.

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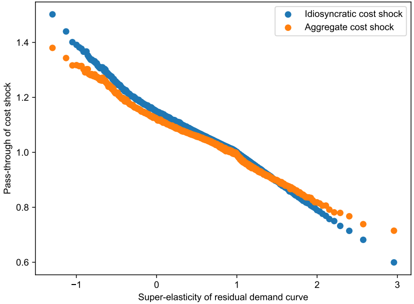

Figure: Nakamura and Zerom (2010) demand system.

- Logit demand has super-elasticity ≈ 1.
- But... calibrated random coefficient models have wide range of super-elasticities & pass-throughs.
- Directly estimate super-elasticities in the data (Burya and Mishra 2023 approach).
- Point estimates ≤ 1 for 90% products.

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Cyclical inflation inequality within narrow categories (e.g. coffee)

- Same Δp across products $\rightarrow$ higher % inflation for low-price products.

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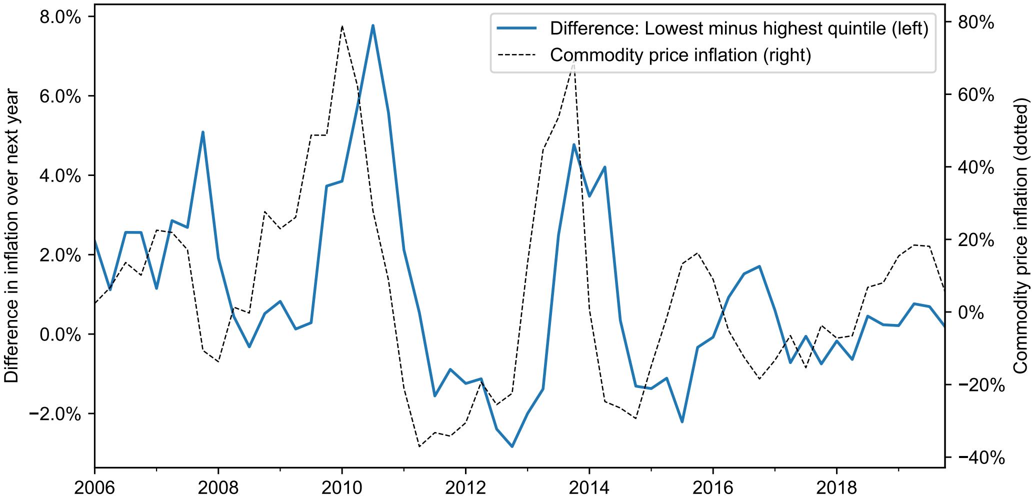
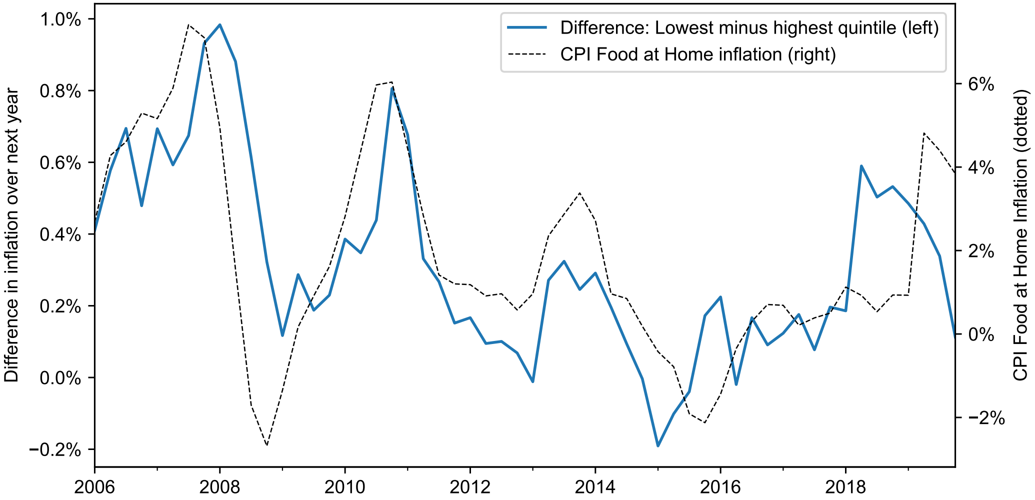
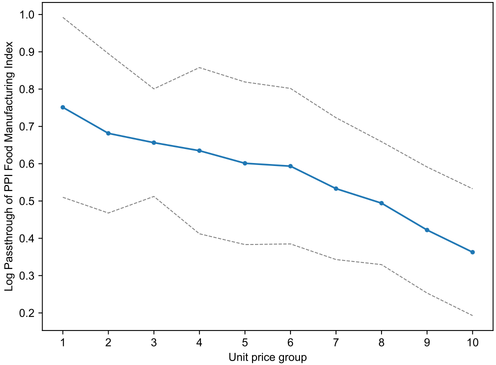


Cyclical inflation inequality over entire food-at-home bundle

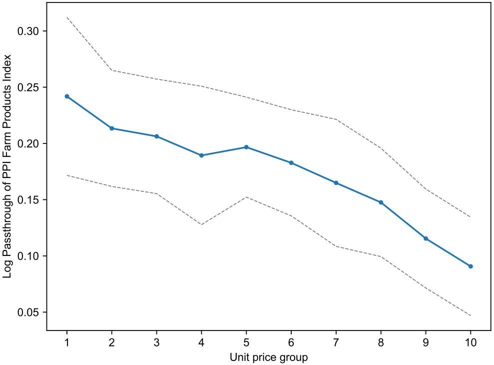


In logs, low-margin products more sensitive to upstream costs

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

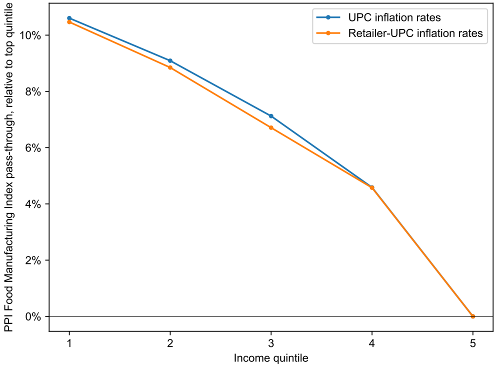


(b) Log pass-through of Farm Products PPI.



Food-at-home inflation across income groups

- Inflation for low-income groups more sensitive to upstream costs, more volatile.



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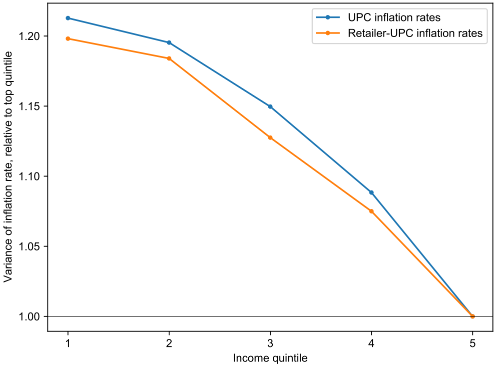


(b) Variance of annual inflation rates.

Attention to inflation of low-end products in 2021

Jack Monroe @BootstrapCook

Woke up this morning to the radio talking about the cost of living rising a further 5%. It infuriates me the index that they use for this calculation, which grossly underestimates the real cost of inflation as it happens to people with the least. Allow me to briefly explain.

7:30 AM · Jan 19, 2022

37.1K Retweets **9,873** Quote Tweets **82.7K** Likes

Jack Monroe @BootstrapCook · Jan 19, 2022
Replying to @BootstrapCook
This time last year, the cheapest pasta in my local supermarket (one of the Big Four), was 29p for 500g. Today it's 70p. That's a 141% price increase as it hits the poorest and most vulnerable households.

171 3,532 16.5K

Jack Monroe @BootstrapCook · Jan 19, 2022
This time last year, the cheapest rice at the same supermarket was 45p for a kilogram bag. Today it's £1 for 500g. That's a 344% price increase as it hits the poorest and most vulnerable households.

119 2,785 13.5K

Jack Monroe @BootstrapCook · Jan 19, 2022
Baked beans: were 22p, now 32p. A 45% price increase year on year.

46 1,164 9,532

Office for National Statistics

Article

Tracking the price of the lowest-cost grocery items, UK, experimental analysis: April 2021 to September 2022

How the prices of the lowest-cost products for 30 everyday items have changed since April 2021.

Contact: Emily Hopson cpi@ons.gov.uk +44 1633 455 592

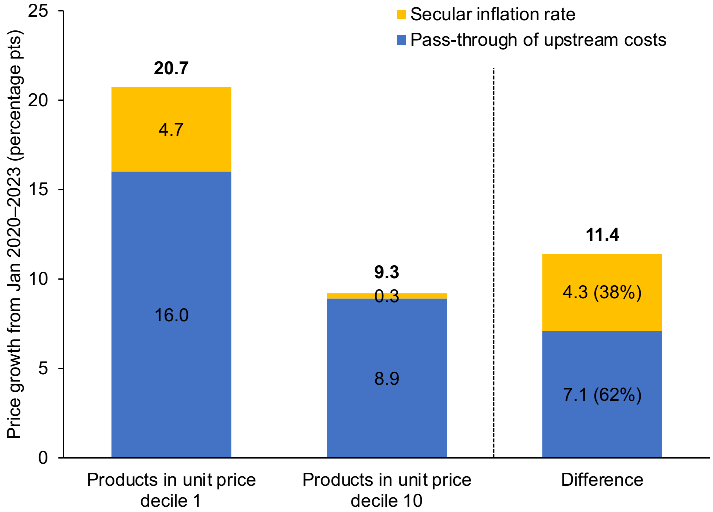
Release date: 25 October 2022

Next release: To be announced

- Discussion: “supermarkets are recouping their margins on value/budget products.”

Predictions for food-at-home inflation, 2020–2023

- 20pp price growth for low-price products.
- 11pp higher than high-price products.
- 60% due to pass-through *vs.* secular inflation diffs.



Conclusion

- Empirical evidence: Pass-through of commodity costs tends to be complete in *levels*.
- Taking pass-through in levels as benchmark helps us understand pricing dynamics:
  - Long-term incomplete pass-through.
  - Cross-sectional heterogeneity in pass-through.
  - Cyclical inflation inequality caused by $\uparrow$ commodity prices.
  - Cyclicality of downstream industry margins w.r.t. upstream commodity costs (see paper).
- Puzzle: price dynamics resemble perfect competition, even though price levels do not.
  - Demand curvature does not appear to rationalize empirical patterns.

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Negative correlation between commodity costs and margins

	Gross margins from SIC industry		Correlation Costs = Materials		Correlation Materials + Labor	
Commodity price	Description	SIC	Levels	First diff.	Levels	First diff.
Sugar	Candy and other confectionery products	2064	-0.58**	-0.37**	-0.49**	-0.16
Beef	Sausages and other prepared meats	2013	-0.82**	-0.39**	-0.82**	-0.28**
Wheat	Flour and other grain mill products	2041	-0.80**	-0.55**	-0.73**	-0.45**
Wheat	Prepared flour mixes and doughs	2045	-0.80**	-0.57**	-0.79**	-0.47**
Wheat	Bread, cake, and related products	2051	-0.84**	-0.64**	-0.76**	-0.50**
Rice	Rice milling	2044	-0.70**	-0.17	-0.62**	-0.08
Coffee	Roasted coffee	2095	-0.79**	-0.58**	-0.74**	-0.54**
Cocoa beans	Chocolate and cocoa products	2066	-0.36**	-0.07	-0.34**	-0.03
Milk	Cheese; natural and processed	2022	-0.66**	-0.61**	-0.56**	-0.48**
Milk	Dry, condensed, evaporated products	2023	-0.52**	-0.58**	-0.53**	-0.51**
Aluminum	Aluminum sheet, plate, and foil	3353	-0.73**	-0.41**	-0.72**	-0.29*
Aluminum	Aluminum die-castings	3363	-0.63**	-0.57**	-0.64**	-0.23
Orange Juice	Frozen fruits and vegetables	2037	-0.63**	-0.18	-0.67**	-0.14

- *Note:* Industry gross margins 1958–2018 from NBER-CES manufacturing database (from Annual Census of Manufacturers). Commodity prices from UNCTADSTAT (1960–2017), except milk, aluminum, and OJ (IMF Commodities database, 1980–2018), deflated using CPI excl. food and energy.

First differences eliminates unit root in commodity price series

$$\text{Levels}: \quad c_t = \beta c_{t-1} + \varepsilon_t,$$
$$\text{First Differences}: \quad \Delta c_t = \gamma \Delta c_{t-1} + v_t.$$

	Levels		First differences	
	Coefficient (β)	SE	Coefficient (γ)	SE
Canada Crude*	0.982	(0.009)	-0.090	(0.097)
Canada Wholesale*	0.987	(0.010)	0.139	(0.048)
Australia Terminal Unleaded	0.996	(0.007)	0.449	(0.058)
Australia Terminal Premium Unleaded	0.995	(0.006)	0.442	(0.058)
Australia Terminal Diesel	0.999	(0.007)	0.302	(0.142)
Beef Farm Price	0.993	(0.007)	0.280	(0.041)
Pork Farm Price	0.930	(0.018)	0.170	(0.039)
Skim Milk*	0.949	(0.036)	-0.030	(0.100)
Butterfat*	0.904	(0.045)	0.152	(0.072)
Coffee	0.983	(0.010)	0.229	(0.052)
Sugar	0.975	(0.018)	0.199	(0.083)
Beef	0.997	(0.008)	0.238	(0.042)
Rice	0.987	(0.010)	0.347	(0.078)
Flour	0.984	(0.011)	0.213	(0.047)
Orange	0.967	(0.013)	0.238	(0.045)

Unless otherwise noted, regressions use Newey-West standard errors with four lags. * Driscoll-Kraay standard errors.

First differences eliminates unit root in commodity price series

Table: Augmented Dickey-Fuller tests for unit root (H_0: Series is a random walk).

	Levels	First differences
Canada Crude*	0.721	0.000
Canada Wholesale*	0.961	0.000
Australia Terminal Unleaded	0.731	0.000
Australia Terminal Premium Unleaded	0.665	0.000
Australia Terminal Diesel	0.919	0.000
Beef Farm Price	0.555	0.000
Pork Farm Price	0.000	0.000
Skim Milk*	0.498	0.000
Butterfat*	0.149	0.000
Coffee	0.322	0.000
Sugar	0.242	0.000
Beef	0.939	0.000
Rice	0.165	0.000
Flour	0.343	0.000
Orange	0.028	0.000

p-values are from Augmented Dickey-Fuller test for unit root. * Maximum p-value for ADF test across all markets.

Granger causality tests for one-directional impact

	Granger causality test *p*-value	
	1 to 2	2 to 1
Canada, city-level, 2007–2022		
Crude to wholesale	0.003	0.908
Crude to retail (excl. taxes)	0.053	0.999
Wholesale to retail (excl. taxes)	0.000	1.000
Australia, station-level, 2001–2022		
Terminal ULP to Station Price ULP	0.000	0.001
Terminal PULP to Station Price PULP	0.000	0.001
Terminal Diesel to Station Price Diesel	0.000	0.120
USDA ERS		
Beef Farm to Wholesale	0.000	0.205
Beef Farm to Retail	0.000	0.126
Beef Farm to Fresh Retail	0.044	0.567
Beef Wholesale to Retail	0.000	0.003
Beef Wholesale to Fresh Retail	0.000	0.441
Pork Farm to Wholesale	0.000	0.007
Pork Farm to Retail	0.000	0.069
Pork Wholesale to Retail	0.063	0.785
U.S. CPI commodities		
Coffee Commodity (IMF) to Retail (CPI)**	0.000	0.334
Sugar Commodity (IMF) to Retail (CPI)**	0.003	0.652
Beef Commodity (IMF) to Retail (CPI)**	0.688	0.956
Rice Commodity (IMF) to Retail (CPI)**	0.353	0.877
Flour Commodity (IMF) to Retail (CPI)**	0.700	0.931
Orange Commodity (IMF) to Retail (CPI)**	0.053	0.979

** Uses four lags instead of twelve.

Comparing cost shares and log pass-through with higher order terms

- Suppose perfect competition and the presence of other variable unit costs w:

$$p = c + w.$$

  Denote the commodity cost share $\chi = c/(c+w)$.

- Given $d\log c$, we can calculate the change in log prices to second order:

$$\Delta \log p \approx \chi(d\log c) + \chi(1-\chi)(d\log c)^2 + h.o.t.$$

- Therefore the log pass-through estimate is:

$$\hat{\rho} = \mathbb{E}\left[\frac{\Delta \log p}{d\log c}\right] \approx \mathbb{E}[\chi] + \mathbb{E}\left[\chi(1-\chi)(d\log c)\right].$$

- If cost changes symmetric ($\mathbb{E}[d\log c] = 0$), uncorrelated w/ $\chi(1-\chi)$, then $\hat{\rho} \to \mathbb{E}[\chi]$.
  With upward drift ($\mathbb{E}[d\log c] > 0$), $\hat{\rho}$ biased upward.

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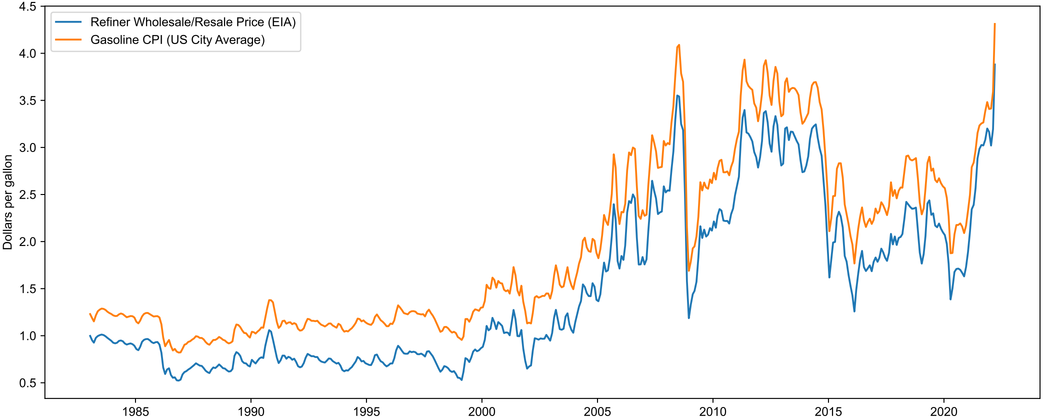
Motivation: U.S. Gasoline Prices

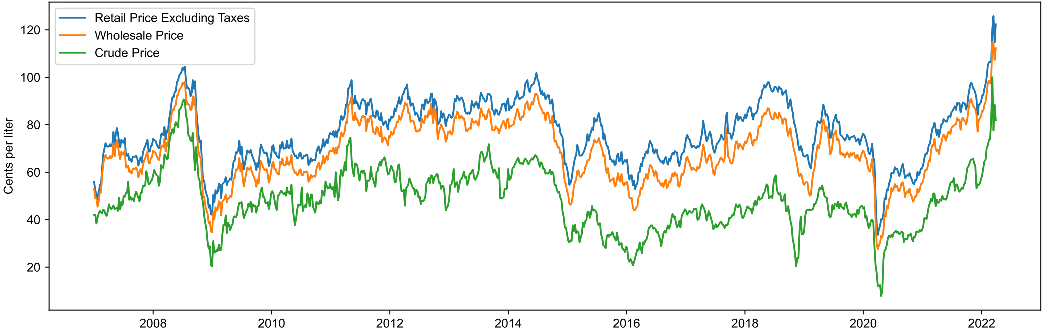
Figure: Refiner wholesale/resale prices (Energy Information Administration) and retail prices (CPI).



Panel dataset of gas prices by city in Canada

- Weekly price data (2007-present) for 71 cities in 10 provinces from Kalibrate Solutions.

Figure: Example: Retail gas (excl. taxes), wholesale gas, and crude prices in the City of Toronto.



Example: Pass-through of crude prices to wholesale gas prices

Table: Pass-through to wholesale gas price. (Standard errors two-way clustered by province & year.)

	Logs				Levels			
Variable	Effect		Cumulative		Effect		Cumulative	
Δ Crude oil price (t)	0.248	(0.042)	0.248	(0.042)	0.379	(0.050)	0.379	(0.050)
Δ Crude oil price $(t-1)$	0.189	(0.033)	0.437	(0.054)	0.330	(0.062)	0.709	(0.091)
Δ Crude oil price $(t-2)$	0.043	(0.020)	0.479	(0.067)	0.042	(0.034)	0.751	(0.098)
Δ Crude oil price $(t-3)$	-0.004	(0.022)	0.475	(0.064)	0.032	(0.028)	0.783	(0.101)
Δ Crude oil price $(t-4)$	0.013	(0.032)	0.489	(0.067)	0.052	(0.033)	0.834	(0.082)
Δ Crude oil price $(t-5)$	0.006	(0.014)	0.495	(0.063)	0.027	(0.026)	0.862	(0.068)
Δ Crude oil price $(t-6)$	0.016	(0.012)	0.510	(0.068)	0.014	(0.020)	0.876	(0.063)
Δ Crude oil price $(t-7)$	0.032	(0.026)	0.542	(0.071)	0.063	(0.036)	0.939	(0.067)
Δ Crude oil price $(t-8)$	0.010	(0.015)	**0.553**	(0.074)	-0.012	(0.027)	**0.927**	(0.063)

- Pass-through incomplete in logs. Cannot reject complete pass-through in levels.
- Show cumulative effects graphically in following slides.

Pass-through of crude prices to wholesale gas prices in Canada

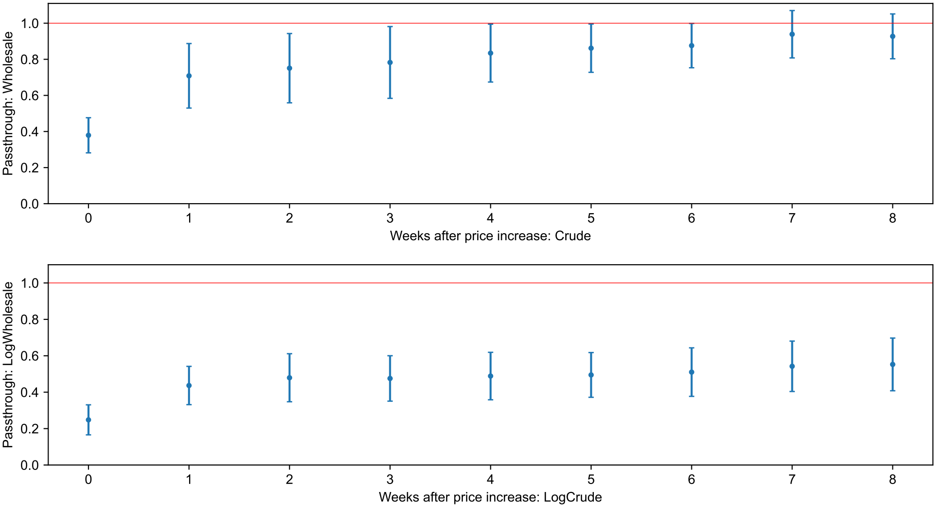


Figure: Passthrough in levels (top) and in logs (bottom)

Pass-through of wholesale prices to retail gas prices (excl. tax) in Canada

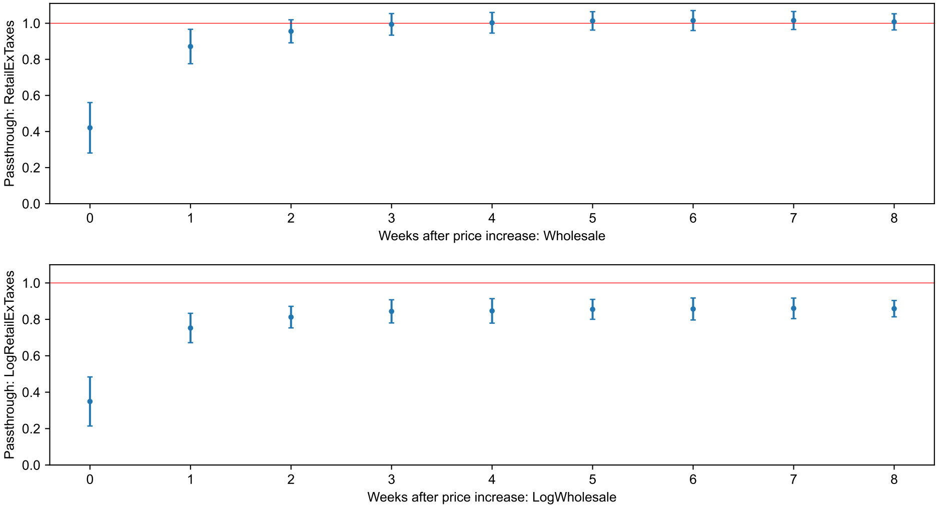


Figure: Passthrough in levels (top) and in logs (bottom)

Pass-through of terminal gas price to station gas prices: Premium Unleaded

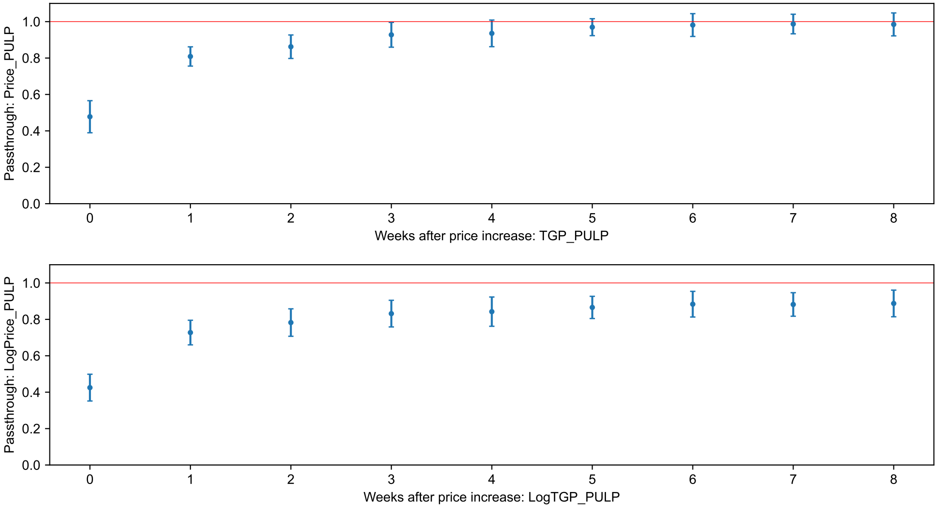


Figure: Passthrough in levels (top) and in logs (bottom). SEs two-way clustered by postcode $\times$ year.

Robustness: Instrumenting with OPEC announcement shocks

- Instrument for upstream oil price with 8 lags of OPEC announcement shocks from Känzig (2021). (F-stat in all regressions > 10.)

Description	Pass-through estimate (8 weeks)			
	Logs		Levels	
	Baseline	IV	Baseline	IV
Canada, city-level, 2007–2022				
Crude to wholesale	0.553	0.713	0.927	1.086
Wholesale to retail (excl. taxes)	0.859	0.848	1.008	0.994
Australia, station-level, 2001–2022				
Terminal to retail, Unleaded	0.899	0.805	0.991	0.888
Terminal to retail, Premium Unleaded	0.887	0.812	0.985	0.901

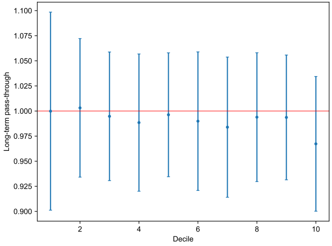
Test: Do stations with higher μ have higher pass-through in levels?

- Retail gas markets may be close to competitive, so hard to distinguish $\mu > 1$.
- Test if stations with higher markup have higher pass-through in levels.
- Define relative price: station i's price compared to average neighborhood price ($N_t(i)$):

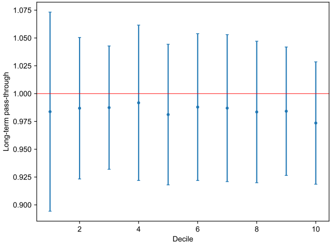
$$\text{RelativePrice}_i = \frac{1}{T}\sum_t \left(\text{Price}_{it} - \frac{1}{|N_t(i)|}\sum_{j\in N_t(i)} \text{Price}_{jt} \right).$$

- Assuming unobserved costs (e.g., transport, rent) are the same within neighborhood, stations with higher relative price have higher markups.
- Compare pass-through in levels over deciles of RelativePrice_i.

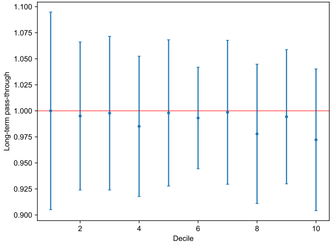
Result: Pass-through in levels unchanged across deciles of relative price



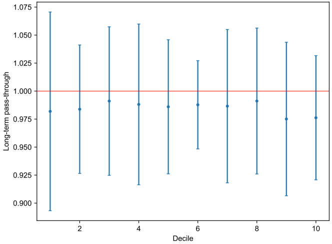
(a) ULP within postcode



(b) PULP within postcode



(c) ULP within neighborhood



(d) PULP within neighborhood

Misspecification in “log pass-through”: Positive squared $\Delta\log(c)$ term

$\Delta\log(\text{Price})_{it}$	Unleaded petrol (ULP) (1)	(2)	Premium (PULP) (3)	(4)
$\Delta\log(\text{Cost})_t$	0.870^{**}	0.889^{**}	0.865^{**}	0.881^{**}
	(0.031)	(0.024)	(0.032)	(0.025)
$(\Delta\log(\text{Cost})_t)^2$		0.155^{**}		0.147
		(0.068)		(0.097)
N	312215	312215	259437	259437
R^2	0.88	0.89	0.87	0.87

- Since cost share varies with commodity cost, misspecification in log regression.

Rejecting perfect competition: Price dispersion (price range)

- Perfectly elastic demand under perfect competition cannot admit price dispersion.
- Data shows price dispersion even within 228 narrowly defined neighborhoods in Perth.

Table: Highest minus lowest price across Perth gas stations.

Daily price range (cents per liter)	All	Within: Brand	Within: Neighborhood
Mean	40.0	10.9	4.1
Q1	30.6	4.4	0.6
Median	40.1	8.2	2.0
Q3	47.5	14.0	5.2

Price Dispersion and Non-Infinite Elasticities

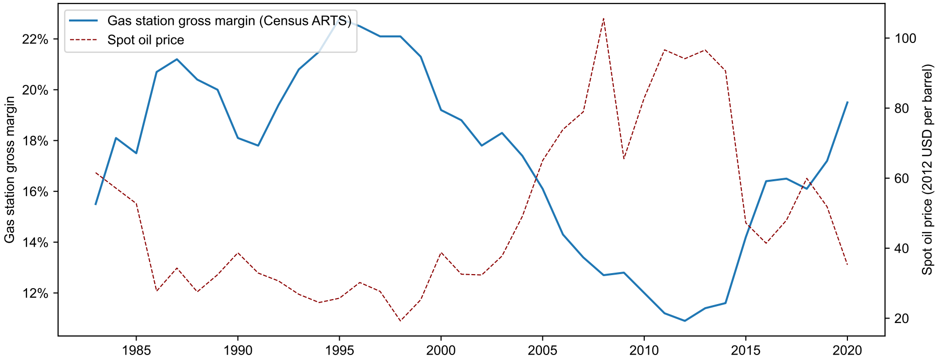
- Wang (2009) shows station-level demand elasticity ranges from 6–19. However, median Lerner index of 5.1% below what these elasticities would imply.
- Data shows price dispersion even within 228 narrowly defined neighborhoods in Perth.

Table: Unleaded price dispersion across Perth gas stations.

Stdev. daily prices		Within	
(cents per liter)	All	Brand	Neighborhood
Mean	4.74	3.43	2.35
Q1	3.59	1.22	0.42
Median	4.31	2.40	1.26
Q3	5.36	4.43	3.00

Evidence on margin adjustment: Census Annual Retail Trade Survey

- Census ARTS collects survey data on gross margins for gas stations from 1983–2020.
    - Gross margins defined as total sales minus total costs of goods sold, as % of sales.
- Correlation inconsistent with fixed markup pricing ($\rho = -0.93$).



Evidence on margin adjustment: California Price Breakdown

- California Gas Commission weekly estimates of gas price breakdown and margins.
  - Pass-through of wholesale oil cost changes to “retail margin” (includes distribution and marketing costs).
  - Pass-through of crude cost to “refinery margin” (includes processing costs).
- Unable to reject zero margin adjustment in all cases.

Description	Pass-through (8 weeks)			
	Baseline		IV (Känzig 2021)	
Crude costs to branded refinery margin	0.051	(0.142)	0.004	(0.237)
Branded wholesale costs to branded retail margin	0.047	(0.045)	-0.208	(0.111)
Crude costs to unbranded refinery margin	-0.048	(0.176)	-0.005	(0.328)
Unbranded wholesale costs to unbranded retail margin	0.013	(0.048)	-0.281	(0.158)

Pass-through of crude prices to refinery margin

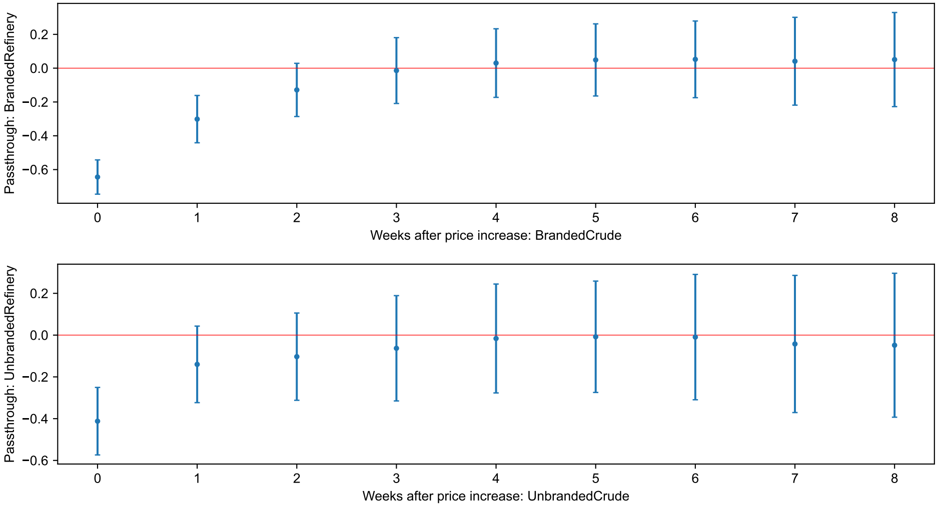


Figure: Branded (top) and unbranded (bottom) estimates. Newey-West standard errors.

Pass-through of wholesale prices to retail margin

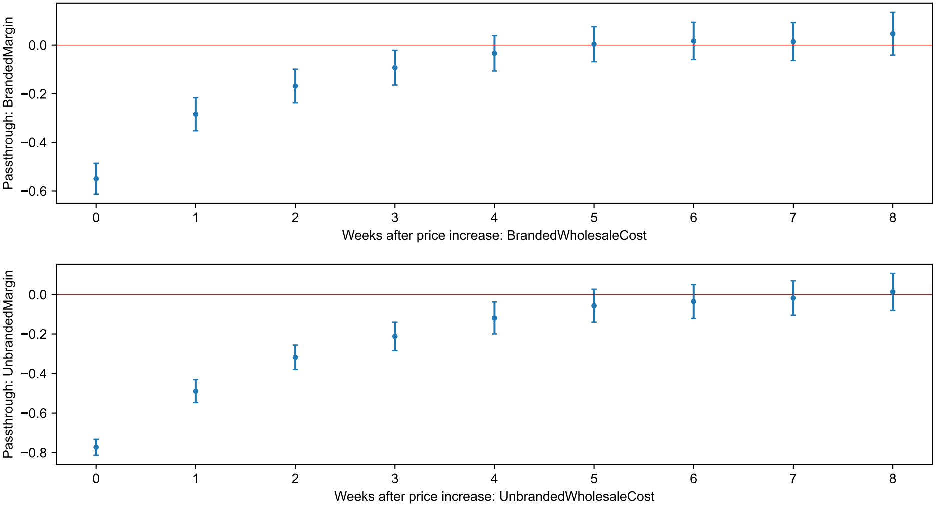


Figure: Branded (top) and unbranded (bottom) estimates. Newey-West standard errors.

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Evidence from Coffee Commodity Prices: Nakamura & Zerom (2010)

- Complete pass-through in levels disguised as incomplete pass-through in logs.

Figure: Nakamura & Zerom (2010): Pass-through of coffee costs to wholesale/ retail prices.

	Log specification		Levels specification	
Variable	Retail	Wholesale	Retail	Wholesale
Δ Commodity cost (t)	0.063 (0.013)	0.115 (0.018)	0.142 (0.040)	0.218 (0.061)
Δ Commodity cost ($t-1$)	0.104 (0.008)	0.169 (0.013)	0.446 (0.024)	0.520 (0.043)
Δ Commodity cost ($t-2$)	0.013 (0.007)	−0.010 (0.010)	0.016 (0.019)	0.029 (0.028)
Δ Commodity cost ($t-3$)	0.031 (0.006)	−0.016 (0.009)	0.080 (0.018)	0.004 (0.026)
Δ Commodity cost ($t-4$)	0.048 (0.007)	0.007 (0.013)	0.144 (0.018)	0.023 (0.030)
Δ Commodity cost ($t-5$)	0.007 (0.006)	0.025 (0.011)	0.070 (0.017)	0.067 (0.031)
Δ Commodity cost ($t-6$)	−0.015 (0.008)	−0.026 (0.012)	0.017 (0.021)	−0.009 (0.029)
Constant	0.033 (0.003)	−0.004 (0.003)	0.007 (0.0004)	0.001 (0.0005)
Long-run pass-through	0.252 (0.007)	0.262 (0.018)	0.916 (0.023)	0.852 (0.052)
Number of observations	40,129	2867	40,129	2867
R-squared	0.079	0.141	0.088	0.134

Notes: The retail price variable is the change in the UPC-level retail price per ounce in a particular US market over a quarter. The wholesale price variable is the change in the wholesale price per ounce (including trade deals) of a particular UPC in a particular US market over a quarter. The standard errors are clustered by unique product and market to allow for arbitrary serial correlation in the error term for a given product. The data cover the period 2000–2005.

Complete pass-through in levels is not mechanical

Table: Placebo: Long-run pass-through of other goods' commodity costs to CPI.

	Pass-through of commodity cost in...					
	Coffee	Sugar	Beef	Rice	Wheat	Orange
Coffee	**0.946**	1.583	0.014	**2.167**	2.122	-1.097
	(0.099)	(0.815)	(0.326)	(0.909)	(2.055)	(0.261)
Sugar	0.025	0.691	0.053	-0.005	0.181	-0.010
	(0.004)	(0.072)	(0.019)	(0.075)	(0.107)	(0.014)
Beef	0.158	**2.551**	**0.899**	-1.221	**2.482**	0.111
	(0.042)	(1.009)	(0.126)	(0.691)	(0.866)	(0.130)
Rice	-0.009	0.159	0.003	**0.882**	**1.075**	0.041
	(0.010)	(0.156)	(0.043)	(0.169)	(0.230)	(0.032)
Flour	0.011	0.097	0.007	0.390	**0.819**	-0.026
	(0.007)	(0.110)	(0.024)	(0.108)	(0.152)	(0.022)
Orange	-0.040	0.605	0.244	**1.486**	3.130	**1.006**
	(0.033)	(0.412)	(0.105)	(0.450)	(0.736)	(0.114)

- **Bold**: Cannot reject $= 1$, but significantly different from zero.
- Most off-diagonal cells are rejected, even though commodity costs highly correlated.

Correlation of food commodity prices

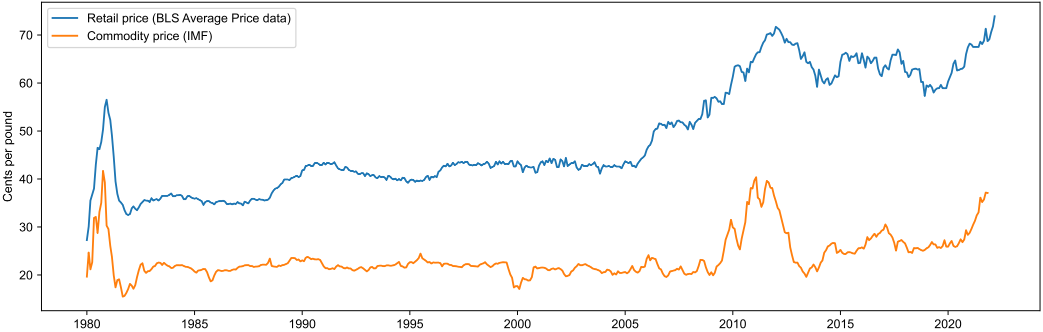
Table: Correlation between commodity prices series.

	Coffee	Sugar	Beef	Rice	Wheat	Orange
Coffee	1.00					
Sugar	0.60	1.00				
Beef	0.50	0.61	1.00			
Rice	0.50	0.49	0.55	1.00		
Flour	0.53	0.43	0.52	0.73	1.00	
Orange	0.33	0.31	0.34	0.20	0.29	1.00

- Food commodity price series significantly positively correlated.

Example: Pass-through of sugar commodity costs to CPI

Figure: Sugar No. 16 commodity costs (IMF) and retail sugar price (U.S. CPI).



Example: Pass-through of sugar commodity costs to CPI

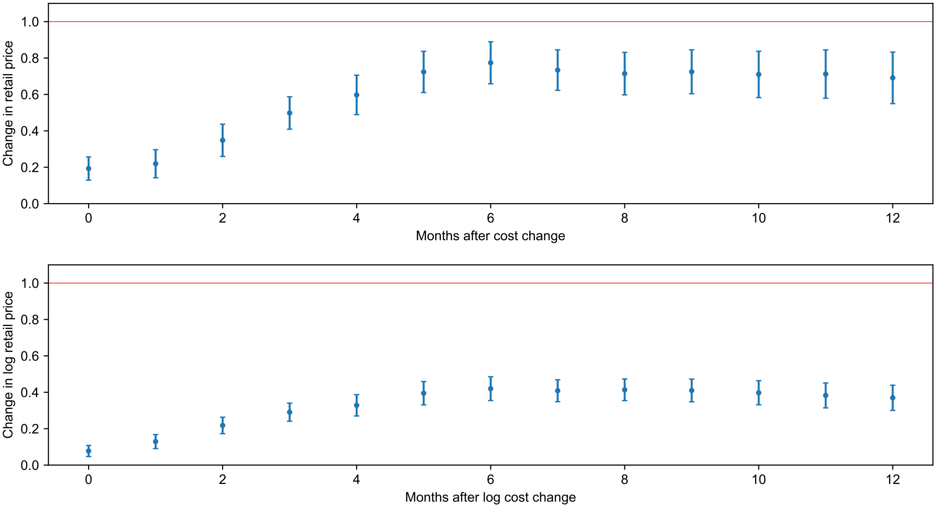
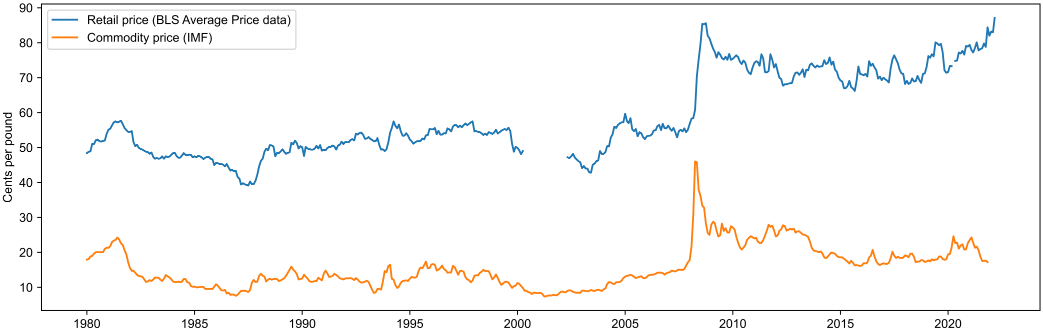


Figure: Passthrough in levels (top) and in logs (bottom)

Example: Pass-through of rice commodity costs to CPI

Figure: Rice (Thailand) commodity costs (IMF) and retail rice price (U.S. CPI).



Example: Pass-through of rice commodity costs to CPI

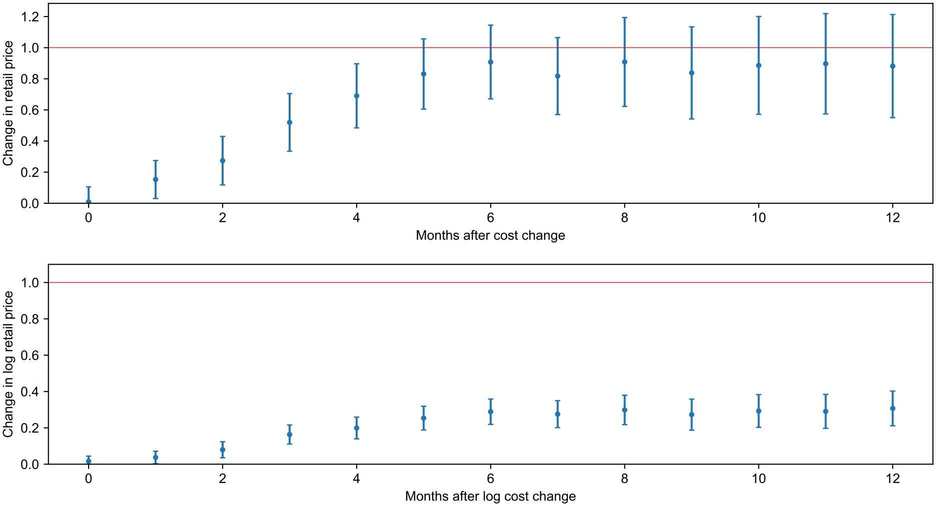
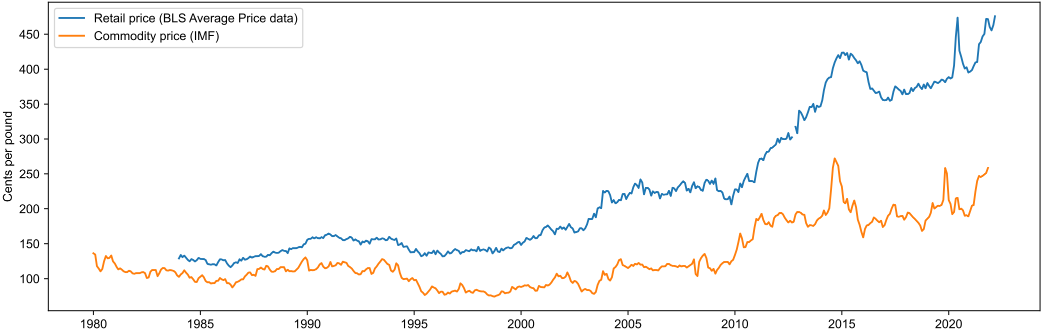


Figure: Passthrough in levels (top) and in logs (bottom)

Example: Pass-through of beef commodity costs to CPI

Figure: Beef commodity costs (IMF) and retail ground beef price (U.S. CPI).



Example: Pass-through of beef commodity costs to CPI

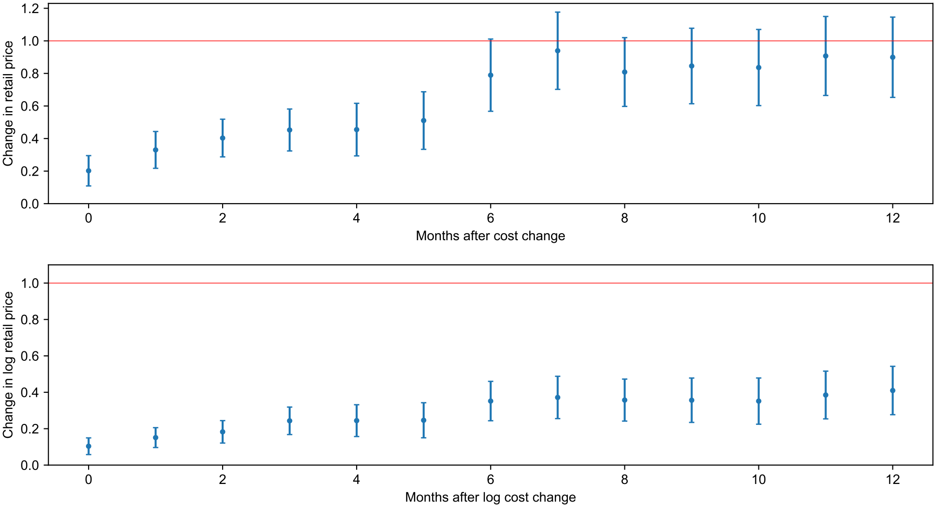
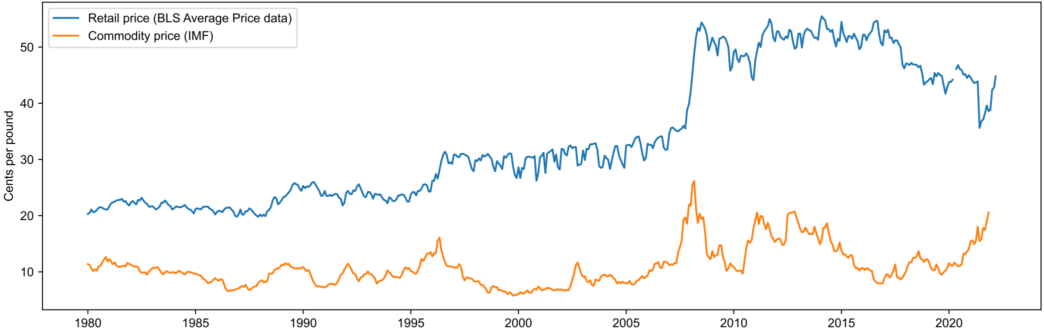


Figure: Passthrough in levels (top) and in logs (bottom)

Example: Pass-through of wheat commodity costs to CPI (flour)

Figure: Wheat commodity costs (IMF) and retail flour price (U.S. CPI).



Example: Pass-through of wheat commodity costs to CPI (flour)

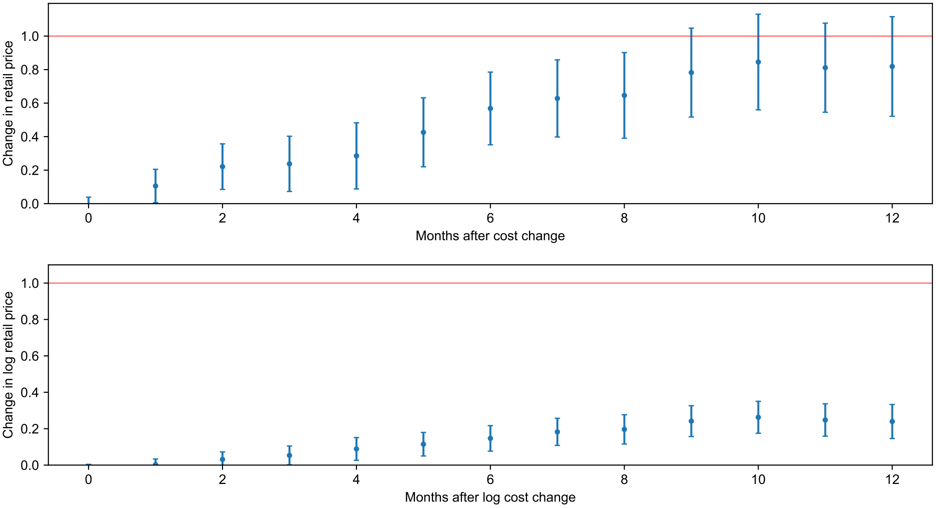
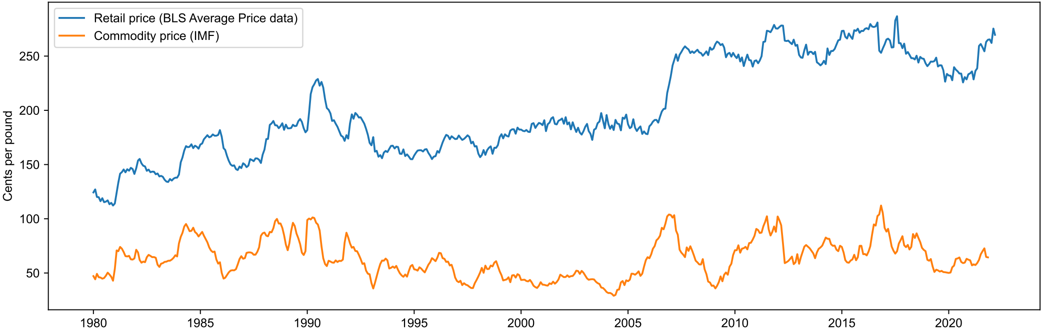


Figure: Passthrough in levels (top) and in logs (bottom)

Example: Pass-through of orange commodity costs to CPI

Figure: Frozen orange commodity costs (IMF) and retail frozen OJ concentrate (U.S. CPI).



Example: Pass-through of orange commodity costs to CPI

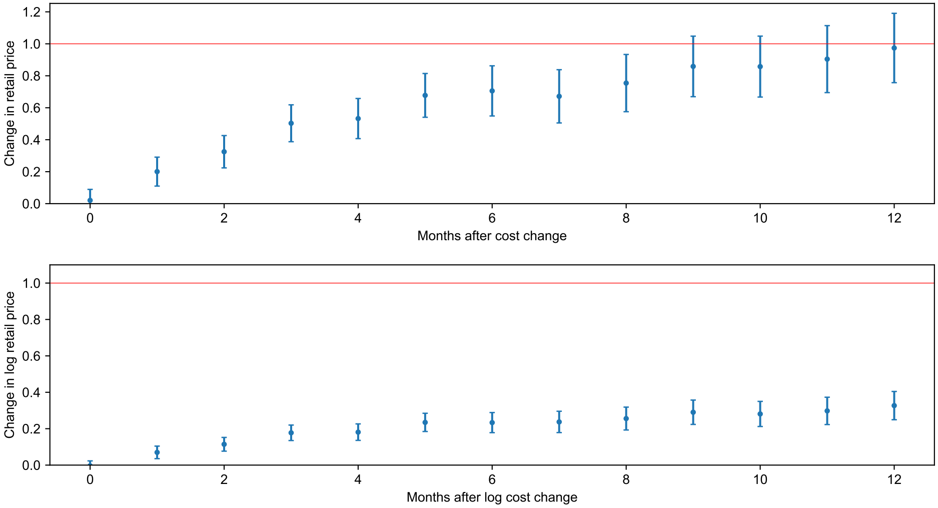


Figure: Passthrough in levels (top) and in logs (bottom)

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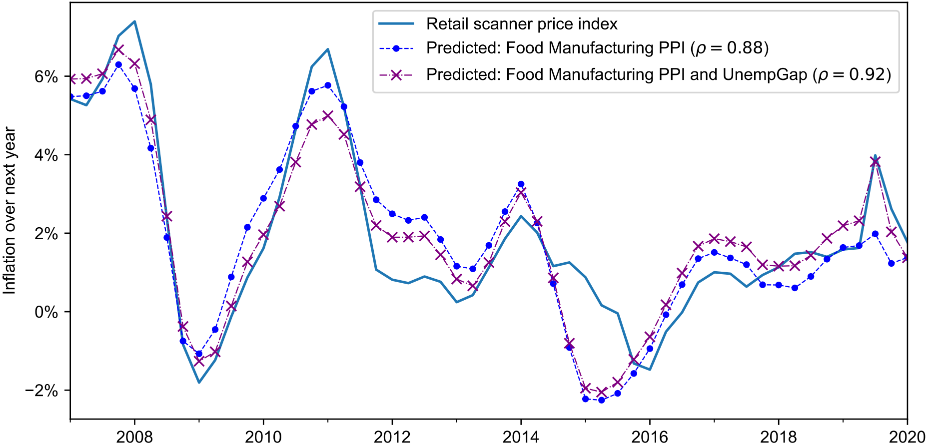
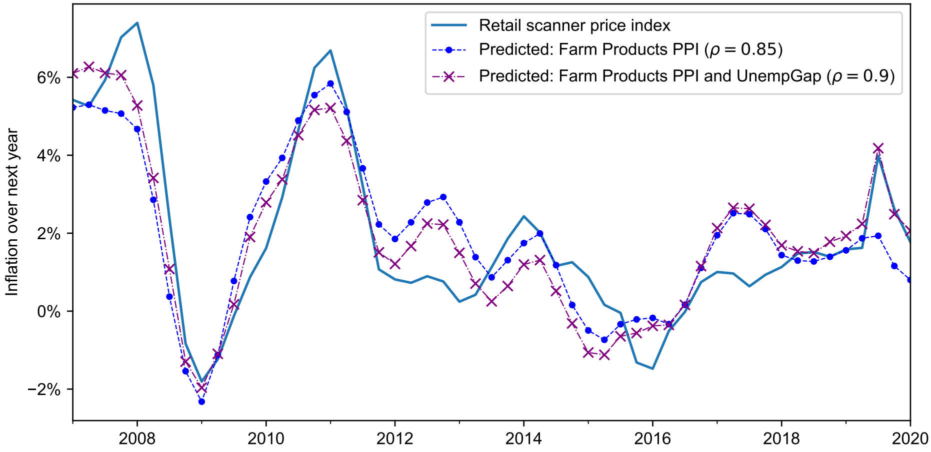
Backup: Upstream PPI explains food-at-home inflation well

Figure: Predicted Retail Scanner index inflation using Food Manufacturing PPI and unemp. gap.



Backup: Upstream PPI explains food-at-home inflation well

Figure: Predicted Retail Scanner index inflation using Farm Products PPI and unemp. gap.



Backup: Match rate of consumer expenditures to retail scanner infl. data

Table: Percent of expenditures matched to retail scanner and inflation data, by income group.

Income quintile	Matched to UPC		Matched to retailer-UPC	
	Total	With infl.	Total	With infl.
1	60.2	52.7	22.5	18.5
2	59.9	52.6	23.1	19.0
3	60.2	53.5	24.0	20.1
4	60.7	54.5	25.7	21.7
5	59.7	52.6	27.2	22.7

Backup: R^2 upstream PPI changes on inflation by income

Table: R^2 from long-term log pass-through regression.

	Food Manufacturing PPI		Farm Products PPI	
Index	UPC	Retailer-UPC	UPC	Retailer-UPC
Food-at-home CPI	0.59	0.59	0.42	0.42
Retail scanner index	0.58	0.62	0.50	0.51
All income groups	0.42	0.45	0.31	0.27
1st quintile	0.43	0.43	0.30	0.21
2	0.43	0.44	0.30	0.25
3	0.43	0.44	0.30	0.27
4	0.42	0.45	0.30	0.27
5th quintile	0.43	0.44	0.30	0.30

Backup: R^2 upstream PPI changes on inflation by unit price group

Table: R^2 from long-term log pass-through regression.

	Food Manufacturing PPI		Farm Products PPI	
Index	UPC	Retailer-UPC	UPC	Retailer-UPC
Food-at-home CPI	0.59	0.59	0.42	0.42
Retail scanner index	0.58	0.62	0.50	0.51
1st decile	0.61	0.58	0.55	0.42
2	0.41	0.49	0.34	0.34
3	0.34	0.64	0.27	0.51
4	0.41	0.54	0.33	0.46
5	0.46	0.50	0.42	0.49
6	0.42	0.55	0.40	0.42
7	0.47	0.52	0.47	0.39
8	0.40	0.52	0.23	0.43
9	0.38	0.46	0.38	0.43
10th decile	0.39	0.34	0.33	0.31

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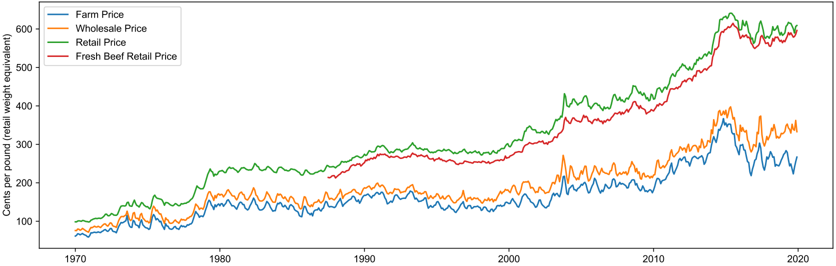
Farm, wholesale, and retail prices for beef and pork from USDA



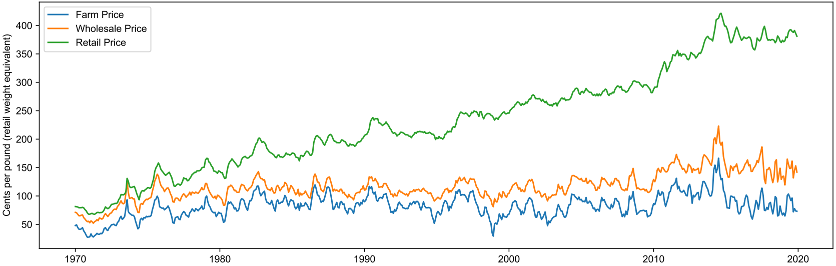


Figure: Beef (top) and pork (bottom) prices over time.

Test for pork and beef using monthly USDA data, 1970–2019

Description	Pass-through (12 mos.) Logs		Levels	
Beef				
Farm price to retail price	0.653	(0.048)	**1.058**	(0.115)
Farm price to wholesale price	0.852	(0.031)	**0.970**	(0.089)
Farm price to fresh beef retail price	0.547	(0.038)	**0.911**	(0.106)
Wholesale price to retail price	0.760	(0.037)	**1.013**	(0.100)
Pork				
Farm price to retail price	0.381	(0.058)	**0.955**	(0.099)
Farm price to wholesale price	0.550	(0.057)	0.804	(0.063)
Wholesale price to retail price	0.628	(0.071)	**0.992**	(0.087)

- **Cannot reject complete pass-through in levels** for most parts of supply chain. (Reject in logs for all.)

Pass-through of farm and wholesale price to retail prices: Beef

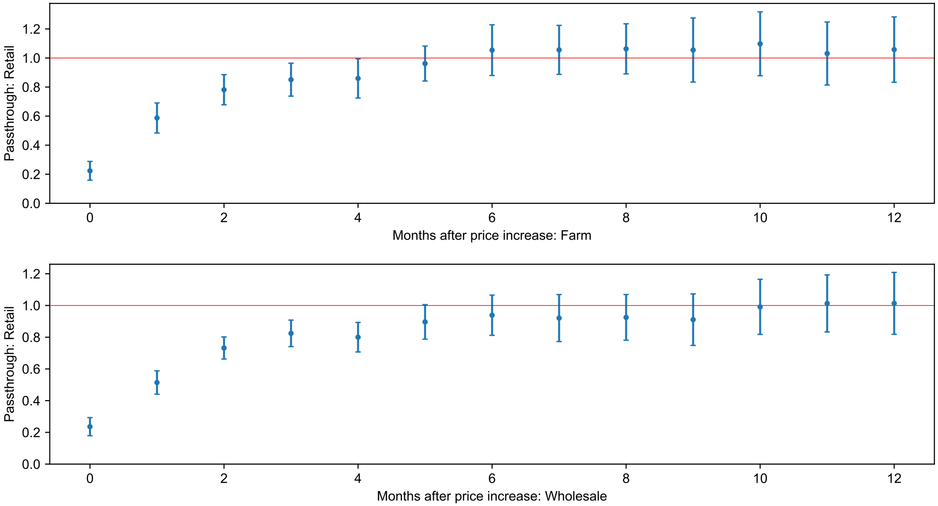


Figure: Passthrough of farm (top) and wholesale (bottom) prices. Newey-West standard errors.

Pass-through of farm and wholesale price to retail prices: Pork

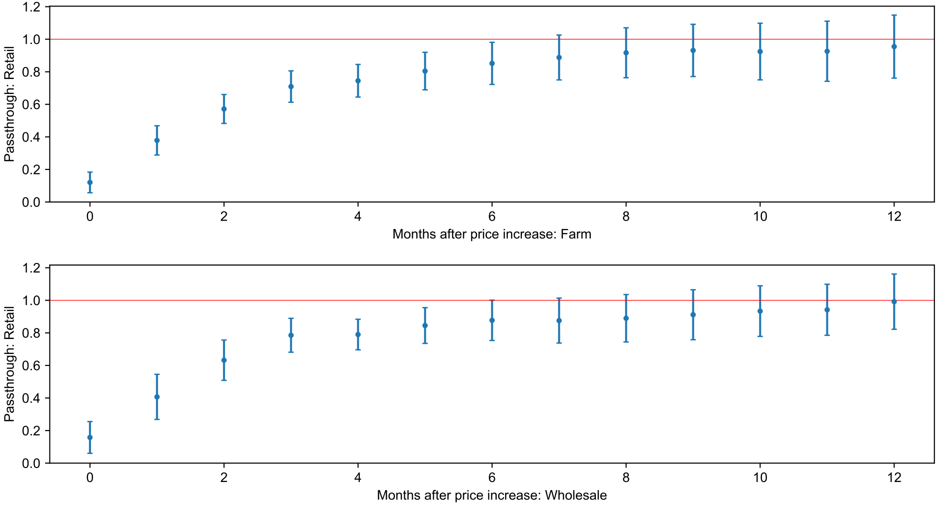
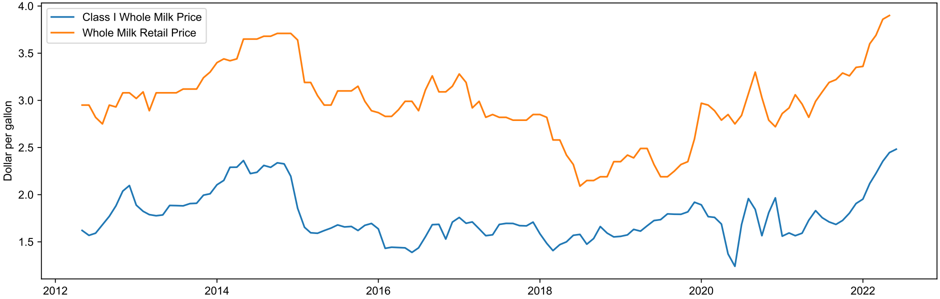


Figure: Passthrough of farm (top) and wholesale (bottom) prices. Newey-West standard errors.

Panel dataset of milk prices across 25 U.S. cities, 2012–2022

- Skim milk and butterfat prices across 10 Federal Milk Marketing Orders (FMMOs).
- Retail milk prices from monthly survey of food store outlets by USDA.

Figure: Class I Whole Milk price and retail whole milk price in Dallas, TX.



Pass-through of milk commodity prices

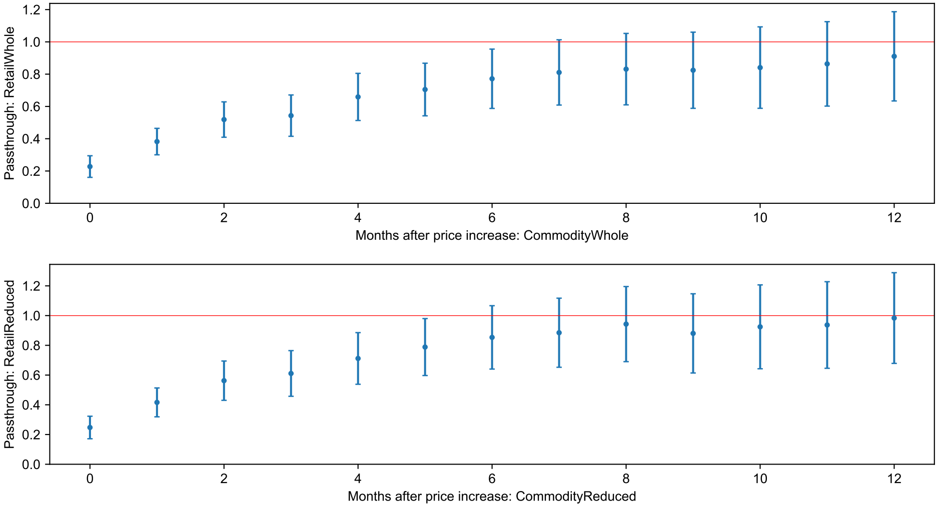
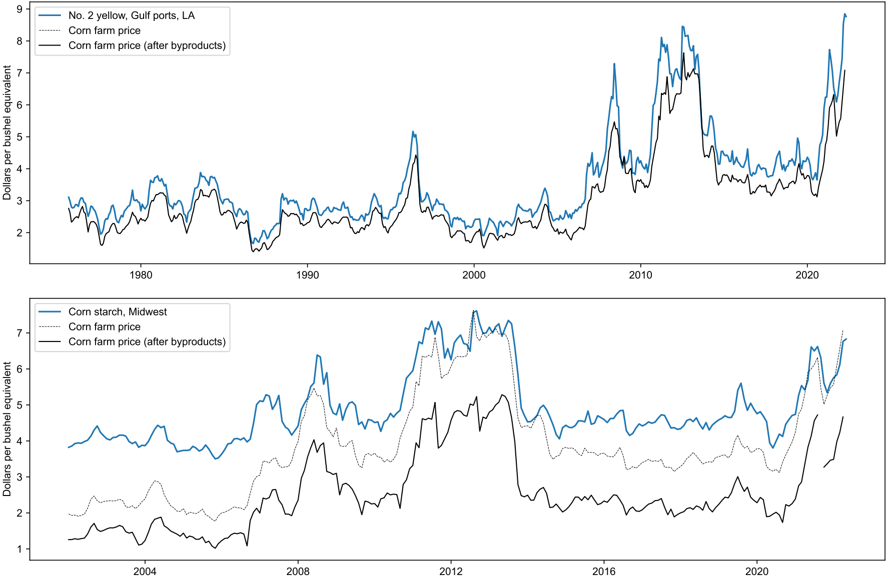


Figure: Passthrough in whole milk (3.5%) (top) and reduced fat (2%) (bottom). Driscoll-Kraay SEs.

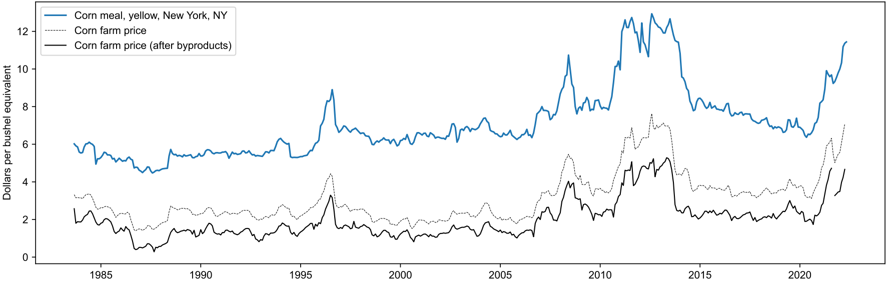
Corn commodities and related products

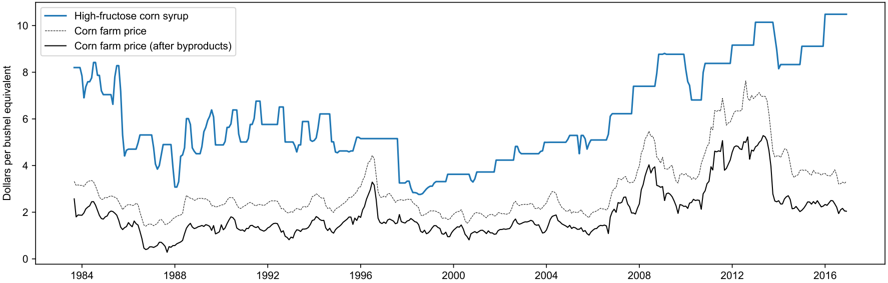
Commodity	Average cost of corn (farm price) as % of price
Corn markets:	
No. 2 yellow, Minneapolis, MN	101
No. 2 yellow, Omaha, NE	100
No. 2 yellow, Central IL	99
No. 2 yellow, Toledo, OH	96
No. 2 yellow, Kansas City, MO	95
No. 2 yellow, Chicago, IL	94
No. 2 yellow, St Louis, MO	93
No. 2 yellow, Memphis, TN	91
No. 2 yellow, Gulf ports, LA	85
Corn products:	
Corn starch, Midwest	50
Corn meal, Chicago	33
High-fructose corn syrup	31
Corn syrup, Midwest	31
Corn meal, New York	27
Dextrose, Midwest	23

Corn products prices vs. corn commodity cost

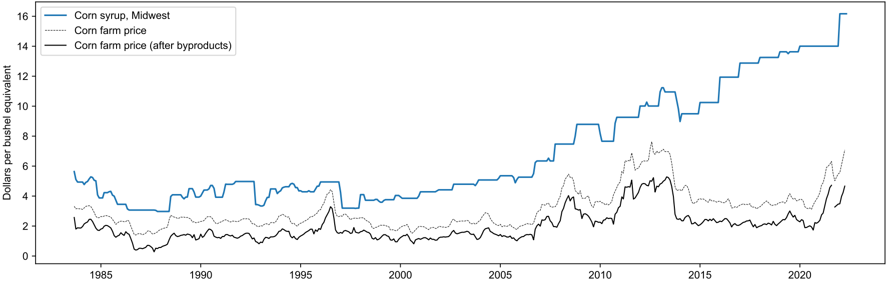


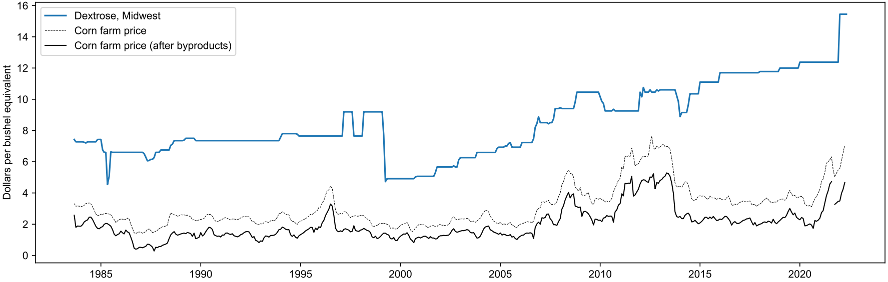
Corn products prices vs. corn commodity cost



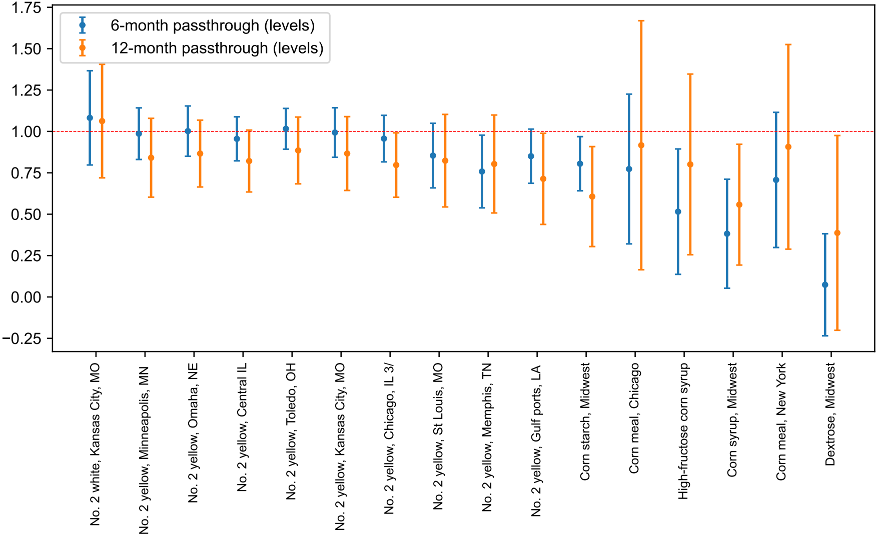


Corn products prices vs. corn commodity cost

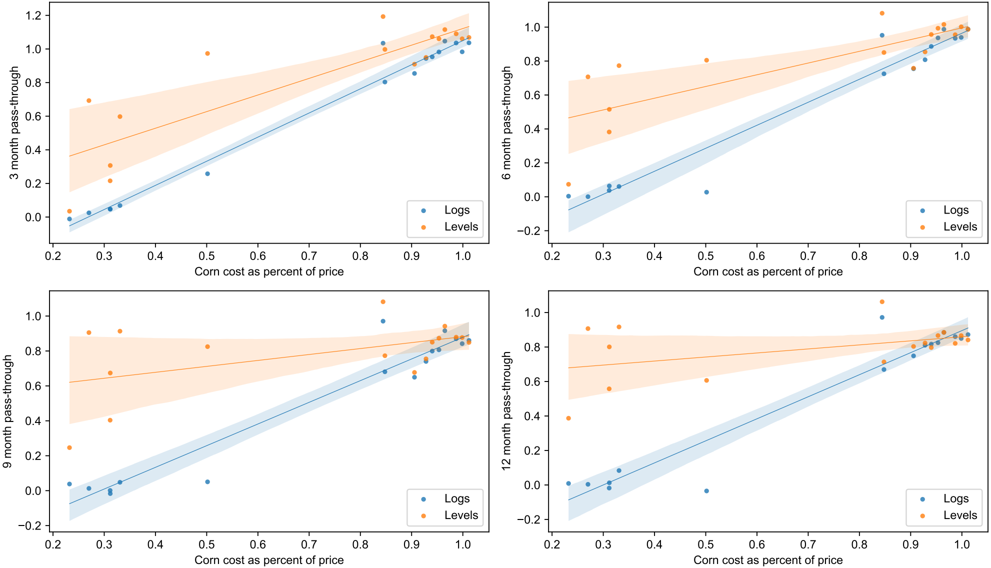




Pass-through of corn farm price increases in levels



Pass-through of downstream products initially low, converges to complete



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Free entry condition in a simple industry model

- Industry with const. marginal cost c_t, price p_t, entry and overhead costs f_e, f_o.

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left[(p_{t+k} - c_{t+k}) y_{t+k} - f_o \right] = f_e.$$

- Simple case: Unit mass of consumers buy 1 unit each period; firms symmetric. Then:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left[(p_{t+k} - c_{t+k}) \frac{1}{N_{t+k}} - f_o \right] = f_e,$$

  where N_t is the number of firms in the market at time t.

- Since this holds at all t, we must have

$$(p_t - c_t)/N_t = \text{const} = f_o + (1-\beta) f_e.$$

Free entry condition: Dixit-Stiglitz resolution

$$(p_t - c_t)/N_t = \text{const} = f_o + (1-\beta)f_e.$$

- Suppose Dixit-Stiglitz with constant elasticity σ.

$$p_t = \frac{\sigma}{\sigma - 1}c_t, \qquad N_t = \frac{1}{(\sigma-1)(f_o + (1-\beta)f_e)}c_t.$$

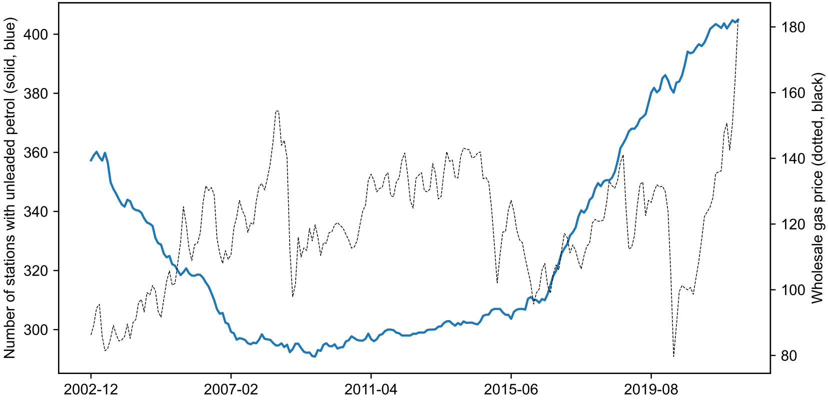
Implications: (1) Multiplicative markup, (2) entry positively related to commodity cost c.

- However, under constant unit margin,

$$p_t - c_t = \text{const}, \qquad N_t \not\propto c_t.$$

Entry does not increase in commodity cycles: Perth gas stations

Figure: Number of Perth gas stations (blue) and wholesale gas price (orange).

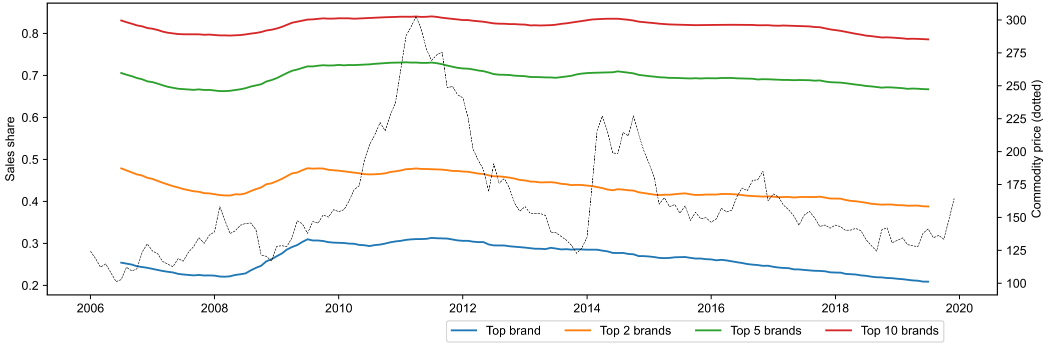


- No visual relationship, correlation of 1-month changes is 0.07.

Entry does not increase in commodity cycles: Coffee

- If entry rises when commodity prices are high, market share of incumbents should fall.

Figure: Market shares of incumbent coffee brands vs. commodity costs (IMF).



Entry does not increase in commodity cycles: Flour, Rice

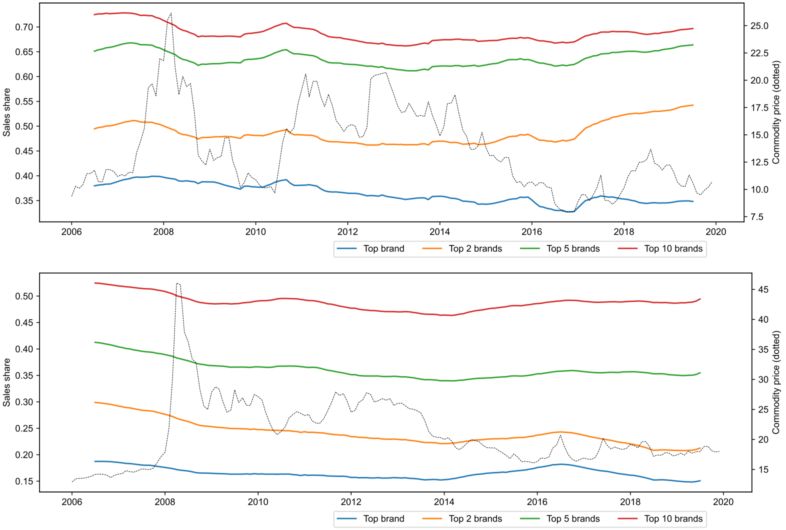


Figure: Flour (top) and Rice (bottom)

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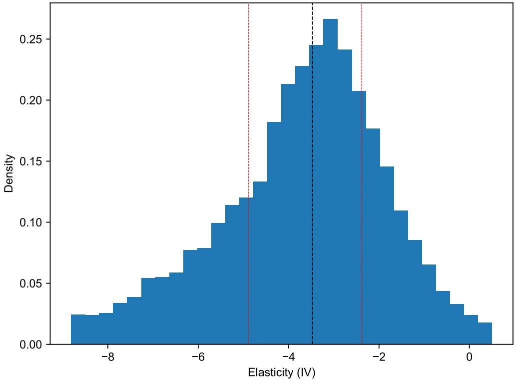
Backup: Finite demand elasticities

- Estimate demand elasticity for top 50 coffee UPCs at each store in Nielsen data:

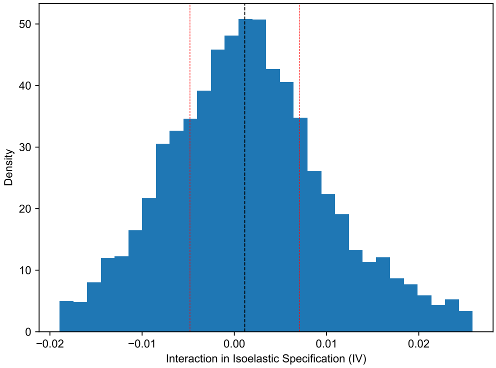
$$\log q_{it} = \beta \log p_{it} + \phi \log \bar{p}_t + \gamma(\log p_{it} \times \text{CommodityPrice}_t) + \alpha_{\text{Year}} + \delta_{\text{Week-of-year}} + \varepsilon_{it},$$

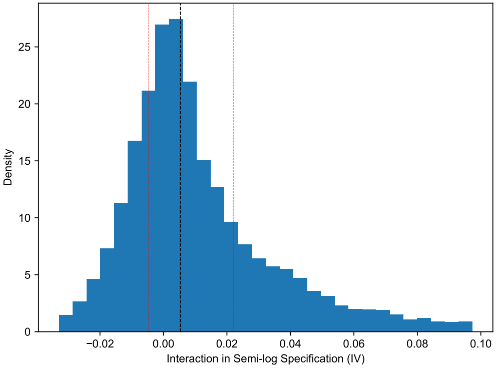
- Hausman IV: price in retailer's other stores excl. DMA (DellaVigna & Gentzkow 2019).
- Median demand elasticity for coffee UPCs is 3.47 (Q1 = 2.39, Q2 = 4.88).



No evidence that semi-log demand curve better fits the data

- Interaction in isoelastic specification is centered around zero.
- Interaction coefficient in semi-log specification more often positive.





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Pass-through quotes

- "P&G, of Cincinatti, said Friday that it raised the list price of Folgers ground coffee by 28 cents per 11.5-ounce equivalent [...] to \$2.56 from \$2.28."
- "In futures trading Friday, arabica coffee beans for March delivery closed down 1.30 cents at \$1.3445 a pound on the New York Board of Trade. A Folgers spokeswoman said the last time the company changed retail coffee prices, in December, the contract was trading around 96 cents a pound."
- $\$0.28 \times (16/11.5 \text{ ounces}) = \$0.38$ per pound. *Wall Street Journal*.

Pass-through quotes

- “A weighted average price increase of approximately 8 percent across the company’s instant consumable, multi-pack, packaged candy and grocery lines is effective today. These changes will help offset part of the significant increases in Hershey’s input costs, including raw materials, packaging, fuel, utilities and transportation, which the company expects to incur in the future.” Source.
- “Kruger Products L.P. (“KPLP”), a company in which KP Tissue Inc. (TSX:KPT) holds a limited partnership interest, announced that it will increase the price of its consumer branded tissue products sold in Canada effective Sunday, October 14, 2018. The increase is required to offset unprecedented and sustained cost increases on input materials and freight with pulp costs being up over 23% since our last pricing announcement in July 2017.” Source. Article.
- “Mars Chocolate North America, the maker of M&M’s and Snickers, said on Wednesday that it will raise its prices by an average of 7 percent “to offset rising costs,” its first increase in three years.” Source.
- “Michael Bronner, president of California-based Dr. Bronner’s, said the natural-products company is increasing the price of soaps it sells to Whole Foods, Target Corp., Costco Corp., Walmart Inc. and other retailers by 3%. Prices for the

Kahneman et al. (1986) surveys on occasions for price changes

- **Price increases to offset cost increases are perceived as fair.**
  - "Suppose that, due to a transportation mixup, there is a local shortage of lettuce and the wholesale price has increased. A local grocer has bought the usual quantity of ltetuce at a price that is 30 cents per head higher than normal. The grocer raises the price of lettuce to customers by 30 cents per head."
    Acceptable 79%, Unfair 21%.
  - "A landlord owns and rents out a single small house to a tenant who is living on a fixed income. A higher rent would mean the tenant would have to move. Other small rental houses are available. The landlord's costs have increased substantially over the past year and the landlord raises rent to cover the cost increases when the tenant's lease is due for renewal."

    Acceptable 75%, Unfair 25%.
- **With inventories, fairness considerations delay pass-through.**
  - "A grocery store has several months supply of peanut butter in stock which it has on the shelves and in the storeroom. The owner hears that the wholesale price of peanut butter has increased and immediately raises the price on the current stock of peanut butter."

    Acceptable 21%, Unfair 79%.
- **Price increases in response to demand shocks deemed unfair.**
  - "A severe shortage of Red Delicious apples has developed in a community and none of the grocery stores or produce markets have any of this type of apple on their shelves. Other varieties of apples are plentiful in all of the other stores. One grocer receives a single shipment of Red Delicious apples at the regular wholesale cost and raises the retail price of these Red Delicious apples by 25% over the regular price."

    Acceptable 37%, Unfair 63%.

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