Pass-Through in Levels and the Incidence of Commodity Shocks

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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.

Pass-Through in Logs and Levels

- Incomplete long-run pass-through of commodity cost changes.
  E.g., Peltzman (2000), Kim and Cotterill (2008), Nakamura and Zerom (2010), Hong and Li (2017).
  - When costs increase 10%, firms raise prices $<$10%.
  - Incomplete even after accounting for commodity cost share and at long horizons.
  - Prevailing explanation: curvature of demand (more concave than CES).

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  - When costs increase 10%, firms raise prices $<$10%.
  - Incomplete even after accounting for commodity cost share and at long horizons.
  - Prevailing explanation: curvature of demand (more concave than CES).
- Today: Measure commodity pass-through on a dollars-and-cents basis.
- Result: Firms in selected industries exhibit complete pass-through in levels.
  - Faced with \$1/unit increase in cost, firms tend to increase prices \$1/unit.
  - Do not increase prices by \$1 $\times$ markup, so "incomplete" in logs.

Outline of Empirical Evidence

- In workhorse macro models, pass-through in levels should equal the markup, $\mu > 1$.
  (E.g., Dixit and Stiglitz 1977, Melitz 2003.)
- Even in richer demand systems with variable markups, pass-through in levels of *aggregate* cost shocks equals $\mu > 1$ if demand is homothetic.
  (E.g., Kimball 1995; Atkeson and Burstein 2008; HSA from Matsuyama and Ushchev 2022.)

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  (E.g., Kimball 1995; Atkeson and Burstein 2008; HSA from Matsuyama and Ushchev 2022.)
- Evidence from microdata on retail gasoline and several food products.
  - Complete pass-through in levels of commodity shocks in nearly all markets.
  - Pass-through in logs is incomplete, even accounting for cost share.
  - Pass-through in levels rationalizes cross-sectional variation in “log pass-through.”

Explaining Pass-Through in Levels

- Standard discrete choice model with quasilinear preferences.
  - Constant elasticity of substitution (CES), logit, Hotelling models are special cases.
- Key parameter η determines intensive margin elasticity of demand w.r.t. price.
  - Many standard macro models assume $\eta = 1$ (e.g., CES demand).
- Result: Pass-through in levels of aggregate cost shocks whenever $\eta = 0$.
- Identifies class of models where pass-through in levels holds.

Implications

- Implication 1: Dynamics of industry profits, margins, and entry.
  - When $\eta = 1$, operating margins and entry are highly volatile.
  - Instead, data consistent with $\eta = 0$.
- Implication 2: 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-margin products.
  - Not captured by price indices that use only expenditure shares across categories (e.g. Jaravel 2024 Distributional CPIs).
  - Absent this channel, inflation inequality from 2020–2023 would have been 1/3 as large.

Selected Related Literature

- **Theoretical and empirical determinants of pass-through**:
  - E.g., Bulow and Pfleiderer (1983); Nakamura and Zerom (2010); Weyl and Fabinger (2013); Hong and Li (2017); Minton and Wheaton (2022); Mongey and Waugh (2023); (*Exchange rate*) Campa and Goldberg (2005); Burstein et al. (2006); Burstein and Gopinath (2014); Fitzgerald and Haller (2014); Amiti et al. (2019).
  - Abstract from (1) asymmetry in speed of adjustment (Borenstein et al. 1997; Peltzman 2000; Benzarti et al. 2020) and (2) firm-specific shocks (e.g., Amiti et al. 2019).
    - Recently, Alvarez et al. (2024) find pass-through in levels of idiosyncratic shocks.
- **Studies that measure pass-through in levels (not exhaustive)**:
  - *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).
  - *Food*: (*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), (*Cigarettes, Beer, Milk*) Butters et al. (2022).

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Pass-Through in Levels: Example

- Leontief production in commodity ($1/unit) and other variable costs ($1/unit).

Cost per unit	Baseline
Commodity	$1
Other components of marginal cost	$1
Total marginal cost	$2
Price	$4

Pass-Through in Levels: Example

- Leontief production in commodity (\$1/unit) and other variable costs (\$1/unit).

Cost per unit	Baseline	
Commodity	\$1	+\$0.20
Other components of marginal cost	\$1	
Total marginal cost	\$2	+\$0.20
Price	\$4	

Pass-Through in Levels: Example

- Leontief production in commodity ($1/unit) and other variable costs ($1/unit).

Cost per unit	Baseline		New
Commodity	$1	+$0.20	$1.20
Other components of marginal cost	$1		$1.00
Total marginal cost	$2	+$0.20	$2.20
Price	$4	?	?

Pass-Through in Levels: Example

- Leontief production in commodity ($1/unit) and other variable costs ($1/unit).

Cost per unit	Baseline		New	*% Change*
Commodity	$1	+$0.20	$1.20	*+20%*
Other components of marginal cost	$1		$1.00	
Total marginal cost	$2	+$0.20	$2.20	*+10%*
Price	$4	?	?	

Pass-Through in Levels: Example

- Leontief production in commodity ($1/unit) and other variable costs ($1/unit).

Cost per unit	Baseline		New	*% Change*
Commodity	$1	+$0.20	$1.20	*+20%*
Other components of marginal cost	$1		$1.00	
Total marginal cost	$2	+$0.20	$2.20	*+10%*
Price	$4	+$0.40	$4.40	*+10%*

- Complete pass-through in logs: $p = \mu(c + w) \;\; \Rightarrow \;\; \Delta p = \mu \cdot \Delta c$.

Pass-Through in Levels: Example

- Leontief production in commodity ($1/unit) and other variable costs ($1/unit).

Cost per unit	Baseline		New	*% Change*
Commodity	$1	+$0.20	$1.20	*+20%*
Other components of marginal cost	$1		$1.00	
Total marginal cost	$2	+$0.20	$2.20	*+10%*
Price	$4	+$0.20	$4.20	*+5%*

- Complete pass-through in logs: $p = \mu(c + w) \Rightarrow \Delta p = \mu \cdot \Delta c$.
- Complete pass-through in levels $\rightarrow \Delta p = \Delta c$. Appears incomplete in logs.

Canonical approach to measure pass-through of cost changes

- Specification à la Campa and Goldberg (2005), Nakamura and Zerom (2010), etc.
- Price change at time t in market m 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 others.
  - Robustness: Estimate long-run pass-through using VAR.

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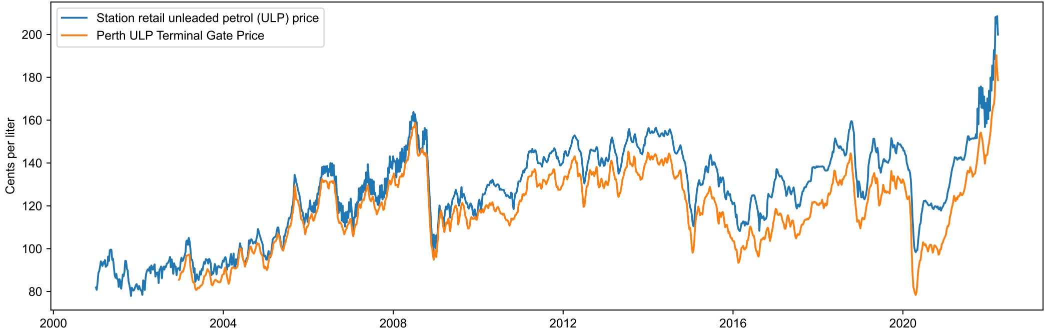
Station-level panel dataset of gas prices in Perth, Australia

- 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

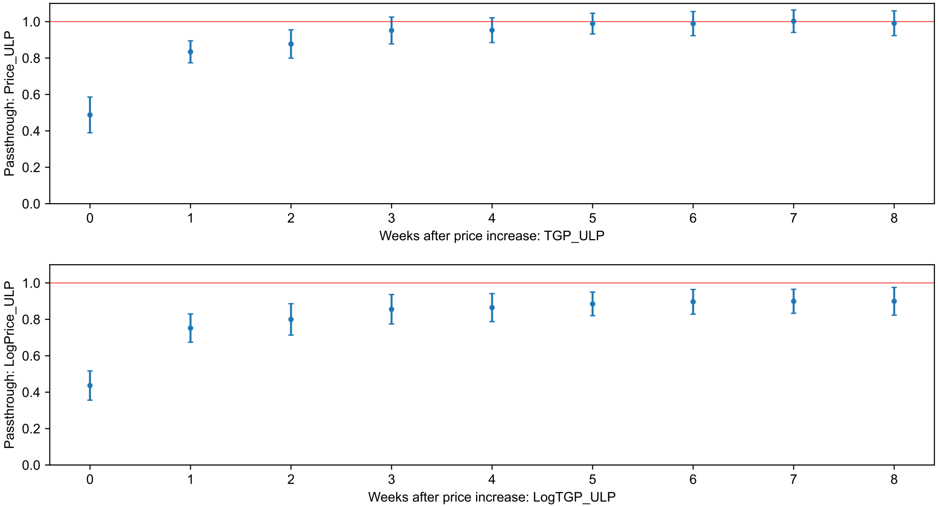


Figure: Passthrough in levels (top) and in logs (bottom). SEs two-way clustered by postcode × year.

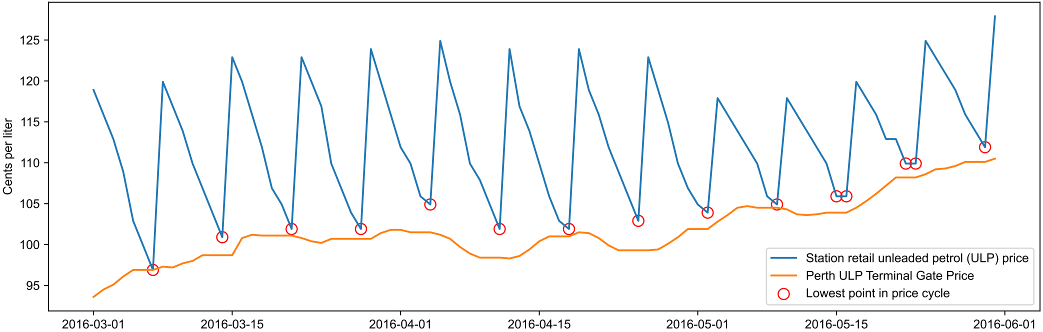
Summary of retail gasoline pass-through estimates

Description	Pass-through (8 weeks) Logs		Levels	
Australia, station-level, 2001–2022				
Terminal to retail, Unleaded	0.899	(0.043)	**0.991**	(0.038)
Terminal to retail, Premium Unleaded	0.887	(0.041)	**0.985**	(0.036)
Canada, city-level, 2007–2022				
Crude to wholesale	0.553	(0.098)	**0.927**	(0.100)
Wholesale to retail (excl. taxes)	0.859	(0.016)	**1.008**	(0.022)
South Korea, station-level, 2008–2022				
Refinery to retail, Unleaded	0.926	(0.044)	**0.997**	(0.052)
United States, national, 1990–2022				
NY Harbor spot price to retail	0.570	(0.051)	**0.954**	(0.053)

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

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 markups

- 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.

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

  - where $\Delta p_{i,t}$, $\Delta c_{i,t}$ are change in station retail price and wholesale cost over 16 weeks.

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

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  - where $\Delta p_{i,t}$, $\Delta c_{i,t}$ are change in station retail price and wholesale cost over 16 weeks.
  - Exploit cross-sectional / time series variation in AvgMarkup_{it}, with IVs to isolate markups.

    1. AvgMarkup_i = average markup (price / terminal cost) of station i over all periods.
    2. AvgMarkup_t = average markup of all stations in quarter 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^{**}				
	(0.021)				
$\Delta \text{Cost}_t \times$ Avg. Station Markup$_i$ (Net %)					
$\Delta \text{Cost}_t \times$ Avg. Quarter Markup$_t$ (Net %)					
N	312215				
R^2	0.89				

Exploiting variation in margins

ΔPrice$_{it}$	(1) (OLS)	(2) (OLS)	(3) (IV1)	(4) (OLS)	(5) (IV2)
ΔCost$_t$	0.950**	0.989**			
	(0.021)	(0.037)			
ΔCost$_t$ $\times$ Avg. Station Markup$_i$ (Net %)		-0.005			
		(0.003)			
ΔCost$_t$ $\times$ Avg. Quarter Markup$_t$ (Net %)					
N	312215	312215			
R^2	0.89	0.89			

- Stations with higher markups do not have higher pass-through in levels ($\beta_2 \approx 0$).

Exploiting variation in margins

ΔPrice_{it}	(1) (OLS)	(2) (OLS)	(3) (IV1)	(4) (OLS)	(5) (IV2)
ΔCost_t	0.950^{**}	0.989^{**}		0.987^{**}	
	(0.021)	(0.037)		(0.034)	
$\Delta \text{Cost}_t \times$ Avg. Station Markup$_i$ (Net %)		-0.005			
		(0.003)			
$\Delta \text{Cost}_t \times$ Avg. Quarter Markup$_t$ (Net %)				-0.003	
				(0.003)	
N	312215	312215		312215	
R^2	0.89	0.89		0.89	

- Stations with higher markups do not have higher pass-through in levels ($\beta_2 \approx 0$).

Exploiting variation in margins

ΔPrice_{it}	(1) (OLS)	(2) (OLS)	(3) (IV1)	(4) (OLS)	(5) (IV2)
ΔCost_t	0.950**	0.989**	0.952**	0.987**	0.971**
	(0.021)	(0.037)	(0.044)	(0.034)	(0.043)
$\Delta \text{Cost}_t \times$ Avg. Station Markup_i (Net %)		-0.005	-0.000		
		(0.003)	(0.005)		
$\Delta \text{Cost}_t \times$ Avg. Quarter Markup_t (Net %)				-0.003	-0.002
				(0.003)	(0.004)
N	312215	312215	312215	312215	312215
R^2	0.89	0.89	0.89	0.89	0.89

- Stations with higher markups do not have higher pass-through in levels ($\beta_2 \approx 0$).

IV2: Instrument for Avg. Markup using strength of price cycles

- Byrne and de Roos (2019) show emergence of coordinated price cycles in Perth market starting in 2010 “unrelated to market primitives.”

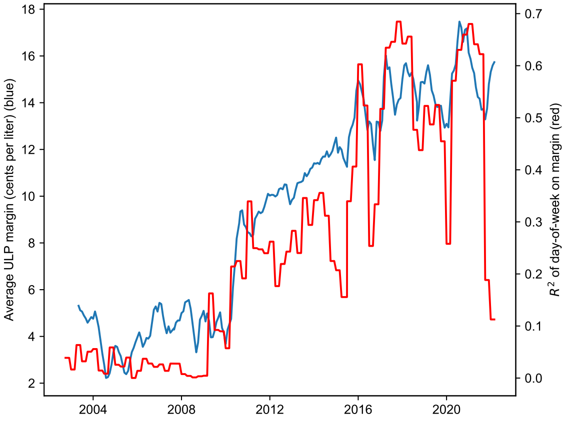

Figure: Margins (6mo. centered avg.) and R^2 of daily margins on day-of-week dummies.

Pass-through in levels explains extent & variation of “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^{**}				
	(0.031)				
$\Delta\log(\text{Cost})_t \times$ Avg. Station Markup$_i$ (Net %)					
$\Delta\log(\text{Cost})_t \times$ Avg. Quarter Markup$_t$ (Net %)					
N	312215				
R^2	0.88				

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

Pass-through in levels explains extent & variation of "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**			
	(0.031)	(0.035)			
$\Delta \log(\text{Cost})_t \times$ Avg. Station Markup$_i$ (Net %)		-0.015**			
		(0.003)			
$\Delta \log(\text{Cost})_t \times$ Avg. Quarter Markup$_t$ (Net %)					
N	312215	312215			
R^2	0.88	0.89			

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Pass-through in levels explains extent & variation of "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**	0.977**	0.967**
	(0.031)	(0.035)	(0.041)	(0.026)	(0.033)
$\Delta\log(\text{Cost})_t \times$ Avg. Station Markup$_i$ (Net %)		-0.015**	-0.011**		
		(0.003)	(0.004)		
$\Delta\log(\text{Cost})_t \times$ Avg. Quarter Markup$_t$ (Net %)				-0.010**	-0.010**
				(0.002)	(0.003)
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 rationalize cross-sectional heterogeneity in log pass-through.

- In paper: Similar results from other geographies (Canada, South Korea, U.S.).
- Similar results using Känzig (2021) OPEC announcement IV for upstream costs.

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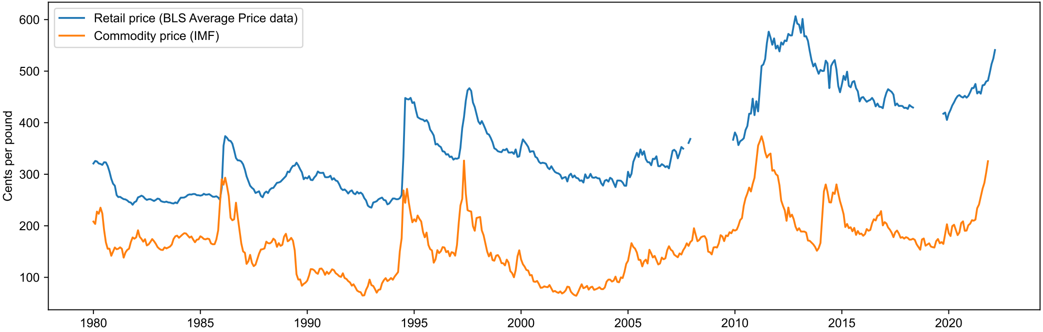
Test for six food commodities

Commodity (IMF)	Final Good (U.S. CPI)	Pass-through (12 mos.) 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)	**0.865**	**(0.160)**
Frozen orange juice solids, per lb.	Orange juice, frozen concentrate	0.327	(0.040)	**0.974**	**(0.111)**

- Monthly commodity prices from IMF, retail prices from U.S. CPI, 1990-Present.
- Match units (e.g., lbs flour per bushel of wheat, oz. roasted coffee per lbs bean).
- **Cannot reject complete pass-through in levels for 5 of 6.** (Reject in logs for all.)

Example: Pass-through of coffee commodity costs to CPI

Figure: Arabica coffee commodity costs (IMF) and retail ground coffee prices (U.S. CPI).



Example: Pass-through of coffee commodity costs to CPI

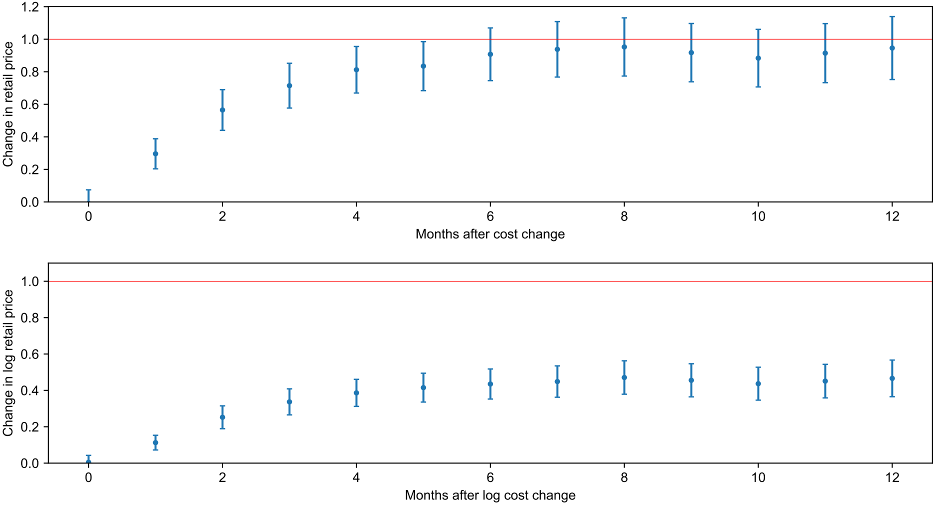
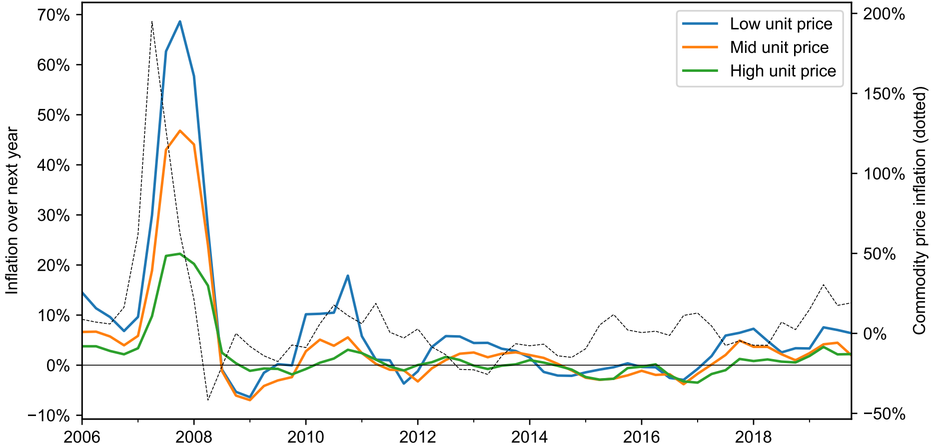


Figure: Passthrough in levels (top) and in logs (bottom)

Pass-through in levels implies variation in "log pass-through"

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



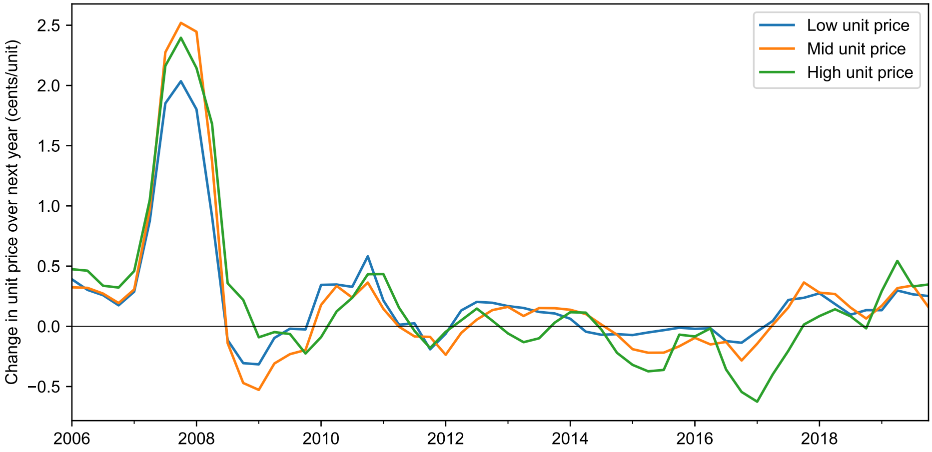
Prediction: Highest-price items exhibit lowest “log pass-through”

$$\Delta \log p_{it} = \alpha_i + \beta_1 \Delta \log c_t + \sum_{g=2}^{3} \beta_g \left(1\{G(i,t) = g\} \times \Delta \log c_t\right) + \varepsilon_{it}.$$

Panel A: In percentages			
	Retail price inflation		
	Rice	Flour	Coffee
Commodity Inflation × Mid Unit Price	−0.075**	−0.007	−0.064**
	(0.014)	(0.009)	(0.015)
Commodity Inflation × High Unit Price	−0.150**	−0.045**	−0.091**
	(0.022)	(0.009)	(0.017)
UPC FEs	Yes	Yes	Yes
N (thousands)	399.4	101.4	1570.0
R^2	0.15	0.05	0.14

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

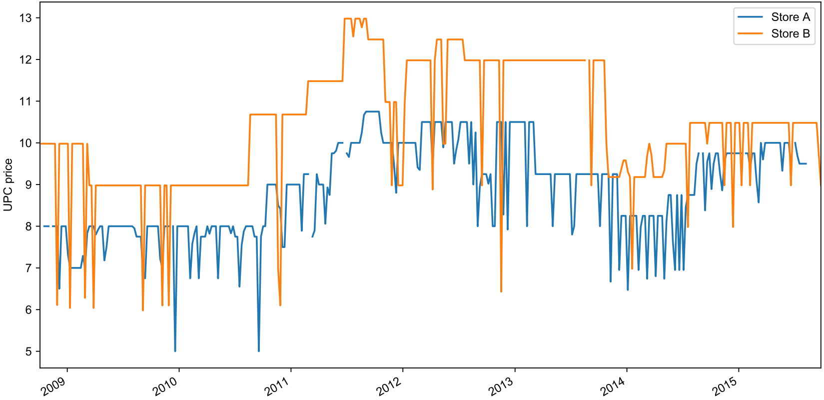
Panel B: In levels			
	Δ Retail price		
	Rice	Flour	Coffee
Δ Commodity Price $\times$ Mid Unit Price	0.059	0.027	-0.069
	(0.052)	(0.040)	(0.046)
Δ Commodity Price $\times$ High Unit Price	0.042	-0.067	-0.099*
	(0.100)	(0.044)	(0.058)
UPC FEs	Yes	Yes	Yes
N (thousands)	399.4	101.4	1570.0
R^2	0.07	0.05	0.14

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

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.



Exploiting variation in margins across retailers

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

$$\Delta p_{irt} = \beta\left(\mu_{irt} \times \overline{\Delta p_{it}}\right) + \delta\mu_{irt} + \alpha_{it} + \varepsilon_{irt}.$$

  where

  - Δp_{irt} is the change in price of UPC i at retailer r,
  - $\overline{\Delta p_{it}}$ is the average change in the price of UPC i across all retailers,
  - μ_{irt} is the markup charged by retailer r on UPC i.
    - Proxy for μ: Deviation in retailer's price relative to average. $\widehat{\mu}_{irt} = \log\left(p_{irt}/\bar{p}_{it}\right)$.

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

Exploiting variation in margins across retailers

	Δ UPC Price (Δp_{irt})		
	Rice	Flour	Coffee
	(1)	(2)	(3)
Avg Δ UPC Price $\times$ Markup$_{irt}$	-0.019	-0.200	-0.123
	(0.111)	(0.216)	(0.352)
UPC-Quarter FEs	Yes	Yes	Yes
N (thousands)	399.4	101.4	1570.0
R^2	0.51	0.50	0.55

Note: Driscoll-Kraay standard errors. * indicates significance at 10%, ** indicates at 5%.

- Instead, $\beta_2 \approx 0 \Rightarrow$ retailers with higher margins change UPC price by same amount.

Exploiting variation in margins across retailers

	Δ UPC Price (Δp_{irt})			Δ Log UPC Price ($\Delta \log p_{irt}$)		
	Rice	Flour	Coffee	Rice	Flour	Coffee
	(1)	(2)	(3)	(4)	(5)	(6)
Avg Δ UPC Price $\times$ Markup$_{irt}$	-0.019	-0.200	-0.123			
	(0.111)	(0.216)	(0.352)			
Avg Δ Log UPC Price $\times$ Markup$_{irt}$				-0.988**	-0.879**	-1.386**
				(0.104)	(0.250)	(0.213)
UPC-Quarter FEs	Yes	Yes	Yes	Yes	Yes	Yes
N (thousands)	399.4	101.4	1570.0	399.4	101.4	1570.0
R^2	0.51	0.50	0.55	0.64	0.60	0.58

Note: Driscoll-Kraay standard errors. * indicates significance at 10%, ** indicates at 5%.

- Instead, $\beta_2 \approx 0 \Rightarrow$ retailers with higher margins change UPC price by same amount.
- Makes “log pass-through” appear to decline with retailer markup.

Food Products: Taking Stock

1. Pass-through complete in levels for several food products.
2. Across products within a category, different non-commodity input costs $+$ markups explain cross-sectional variation in “log pass-through.”
3. Across retailers selling same product, markups explain variation in “log pass-through.”

Empirical Results: Concerns and Extensions

- **Concern:** Are these product categories (coffee, rice, flour) special?
    - Complex goods with differentiated inputs may be different.
    - Variation in margins across stores exercise for all product categories in NielsenIQ.
    - Vast majority exhibit same patterns (e.g., log pass-through falls with markup for 90%).
- **Concern:** Is this pass-through behavior specific to retailers?
    - Pass-through from commodity to retail picks up if *any* firm sets fixed markup along chain.
    - In paper: Also test pass-through from farm $\rightarrow$ wholesale $\rightarrow$ retail in beef, pork.
    - Find complete pass-through in levels at each step in chain.

Empirical Results: Concerns and Extensions

- Previous work shows "log pass-through" declines with firm size and product quality.
  (Size: Berman et al. 2012; Amiti et al. 2019; Gupta 2020; Quality: Chen and Juvenal 2016; Auer et al. 2018).
  - If markups increase with firm size / quality, pass-through in levels yields both results.
  - Caution: Evidence from idiosyncratic shocks, while our evidence is on aggregate shocks.

- Misspecification can lead to asymmetries and convexity.
  - We find little systematic evidence of asymmetry in *long-run* pass-through in our setting.
  - If firms set prices $p = c + a$, to a second order

$$\hat{\rho}^{\log} = \frac{\Delta \log p}{\Delta \log c} \approx \frac{c}{p}\left(1 + \frac{a}{p}\Delta \log c\right).$$

  - Misspecification can lead to (1) asymmetry ($\hat{\rho}^{\log}_{+} > \hat{\rho}^{\log}_{-}$), (2) convexity ($\hat{\rho}^{\log}_{\text{big}} > \hat{\rho}^{\log}_{\text{small}}$).

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A Standard Model of Industry Demand

- Discrete choice model of industry demand with quasilinear preferences.
- Nests CES, heterogeneous coefficient logit (e.g., BLP), Hotelling as special cases.
- Key parameter η determines intensive margin elasticity of consumption.
- Equilibrium exhibits complete pass-through in levels with restriction $\eta = 0$.

A Model of Industry Demand

- Mass M of consumers indexed by $i \in [0,1]$. Each consumer has income Y.
- Firms $j \in \{1,...,J\}$. Consumers choose exactly one firm to purchase from.
- Quasilinear preferences over q_{ij} and quantity of numeraire good $\hat{q}_i$,

$$U_i = \max_{j,q_{ij}}\{u_{ij}\}, \qquad \text{where} \qquad u_{ij} = \delta_{ij} q_{ij} + \hat{q}_i,$$

  subject to budget constraint, $p_j q_{ij} + \hat{q}_i \leq Y$.

- Tastes δ_{ij} drawn from arbitrary distribution without mass points.
- Impose $q_{ij} = (Y/p_j)^{\eta}$.
  - η determines intensive margin elasticity of consumption with respect to price.
  - Can microfound with preferences $u_{ij} = \frac{\eta}{\eta-1} q_{ij}^{\frac{\eta}{\eta-1}} + \hat{q}_i$.

Nested Models

- Unit demand ($\eta = 0$):
  - Heterogeneous coefficient logit demand (e.g., BLP 1995; Nevo 2001):
  $$\delta_{ij} = \xi_{ij} + \varepsilon_{ij},$$
  where ξ_{ij} are systematic tastes and ε_{ij} are i.i.d. Type 1 Extreme Value shocks.
  - Hotelling (1929) model of spatial differentiation (e.g., Salop 1979, Barro 2024):
  $$\delta_{ij} = |i - j|.$$
- Fixed budget ($\eta = 1$):
  - Constant elasticity of substitution (e.g., Dixit and Stiglitz 1977):
  $$\delta_{ij} = \beta_j \varepsilon_{ij},$$
  where β_j are taste shifters and ε_{ij} are i.i.d. Frechet shocks.

Firm Pricing

- Firm j produces with constant marginal cost c_j.
- Demand curve for firm j is

$$D_j(p) = \int_0^1 1\{u_{ij} \geq u_{ik}, \forall k \neq j\}\, q_{ij}\, M\, di.$$

- Firms choose p_j to maximize variable profits, taking tastes and other prices as given,

$$\max_{p_j} (p_j - c_j) D_j(p).$$

Pass-Through in Logs and Levels

Proposition (Pass-Through in Logs)

Suppose all marginal costs increase $d\log c_j = d\log c$. If $\eta = 1$, then pass-through in logs

$$d\log p_j = d\log p = d\log c,$$

is an equilibrium solution.

- Intuition: With $\eta = 1$, consumer choice depends on comparison of δ_{ij}/p_j across all j.
- If we multiply all p_j by same proportion, no change to consumer choices.
- No change to elasticity of demand $\Rightarrow$ no change to desired markup.

Pass-Through in Logs and Levels

Proposition (Pass-Through in Levels)

Suppose all marginal costs increase $dc_j = dc$. If $\eta = 0$, then pass-through in levels

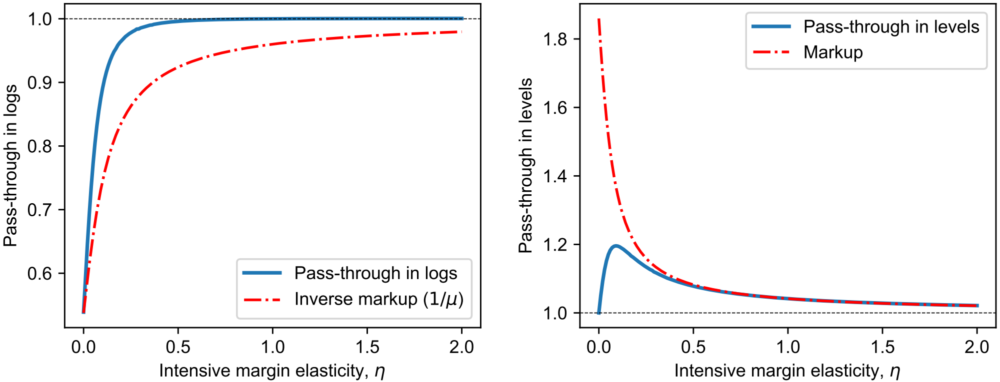
$$dp_j = dp = dc,$$

is an equilibrium solution.

- Intuition: With $\eta = 0$, consumer choice depends on comparison of $\delta_{ij} - p_j$ across all j.
- If we increase all p_j by dp, no change to consumer choices and desired margin.
- Any model with $\eta = 0$ generates pass-through in levels of aggregate cost shocks.

Simulation: Pass-Through in Logs and Levels by η

(a) Pass-through in logs. (b) Pass-through in levels.



- For $\eta = 0$, complete pass-through in levels and incomplete in logs.
- As $\eta \to 1$, pass-through in logs complete and in levels $= \mu$.

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Profits, Margins, and Entry in Monopolistic Competition

- Standard monopolistic competition setup:
  - Mass N of symmetric firms, constant returns production with marginal cost c.
  - Consumer tastes for each firm δ_{ij} drawn i.i.d. from common distribution G.
  - Firms pay fixed cost f_e to enter, pay overhead cost for period f_o.
  - Choose (symmetric) output price p to maximize profits.
  - Aggregate industry demand relatively inelastic, $Q = p^{-\theta}$, with $\theta < 1$.
    - Can choose relationship between M and p to ensure.
- Compare results when $\eta = 0$ ("unit demand") vs. $\eta = 1$ ("full budget").

Profits, Margins, and Entry in Monopolistic Competition

- Gross and operating profits:

$$\pi^{\text{gross}} = (p-c)\frac{Q}{N}, \qquad \text{and} \qquad \pi^{\text{op}} = \pi^{\text{gross}} - f_o.$$

  Let m denote corresponding margins as percent of sales ($m^{\text{gross}} = \pi^{\text{gross}} N/pQ$).

- Finally, close model with a condition that nests both free entry and fixed mass of firms:

$$N = N_0 \left(\pi^{\text{op}} - f_e\right)^{\zeta}.$$

  - $\zeta = 0$: Fixed mass of firms.
  - $\zeta \to \infty$: Free entry and zero profits.

Profits, Margins, and Entry: Fixed Budget ($\eta = 1$)

Proposition (“Fixed budget”: Response to increase in commodity costs)

If $\eta = 1$, in response to an increase in costs $dc > 0$,

		Gross margins dm^{gross}	Operating margins dm^{op}	Mass of firms $d \log N$
$\zeta = 0$	*(Fixed mass)*	0	> 0	0
$\zeta \in (0, \infty)$		0	> 0	> 0
$\zeta \to \infty$	*(Free entry)*	0	0	> 0

Gross margins do not move.

Operating profits rise, firms enter, or both!

- Intuition: $p = \mu\, c$, so per-unit profits $(\mu - 1)c$ increase with the commodity cost c.

Profits, Margins, and Entry: Unit Demand ($\eta = 0$)

Proposition ("Unit demand": Response to increase in commodity costs)

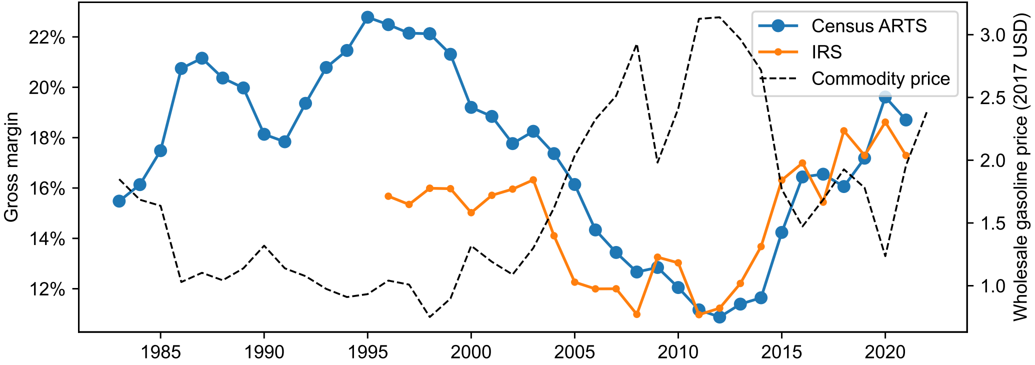
If $\eta = 0$, in response to an increase in costs $dc > 0$,

		Gross margins dm^{gross}	*Operating margins* dm^{op}	*Mass of firms* $d \log N$
$\zeta = 0$	*(Fixed mass)*	< 0	≤ 0	0
$\zeta \in (0, \infty)$		< 0	≤ 0	≤ 0
$\zeta \to \infty$	*(Free entry)*	< 0	0	≤ 0

Industry equilibrium primarily adjusts along gross margins.

Profits, Margins, and Entry in the Data: Retail Gasoline

- Gross margins *do move* with commodity costs in the data.
- Retail gas stations: corr. with wholesale gas price is -0.94 (Census) and -0.74 (IRS).



Profits, Margins, and Entry in the Data: Retail Gasoline

Table: Changes in gross margins, operating margins, and entry.

Dep var:	Δ *Gross Margin*		Δ *Operating Margin*		Δ *Log Num. Estabs*	
Source:	ARTS	IRS	ARTS	IRS	BDS	SUSB
	(1)	(2)	(3)	(4)	(5)	(6)
Δ log Wholesale Price	-4.337**	-4.124**	0.668	-0.150	-0.002	0.001
	(0.703)	(0.731)	(0.824)	(0.749)	(0.006)	(0.007)
N	39	26	15	26	39	24
R^2	0.53	0.49	0.05	0.00	0.00	0.00

- No increase in operating margins or entry.
- I.e., changes in prices must be maintaining constant per-unit profits!

Profits, Margins, and Entry in the Data: Food Products

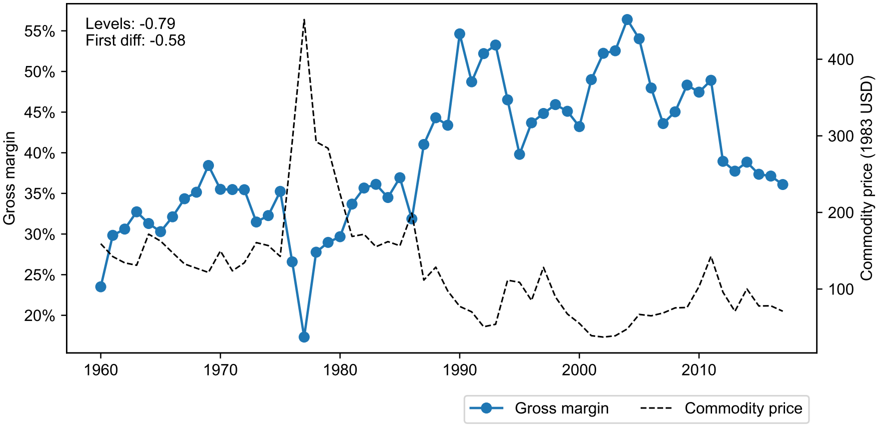


Figure: Roasted coffee manufacturing gross margins, with coffee commodity prices.

- In paper: Same for 14 manufacturing sectors matched to commodity inputs.
- No evidence of ↑ c leading to ↑ entry or operating margins.

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

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

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

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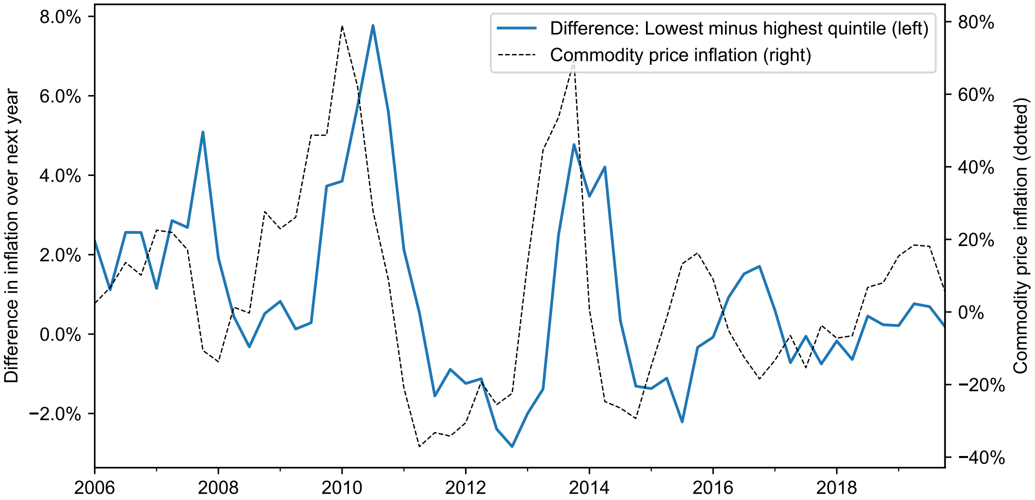
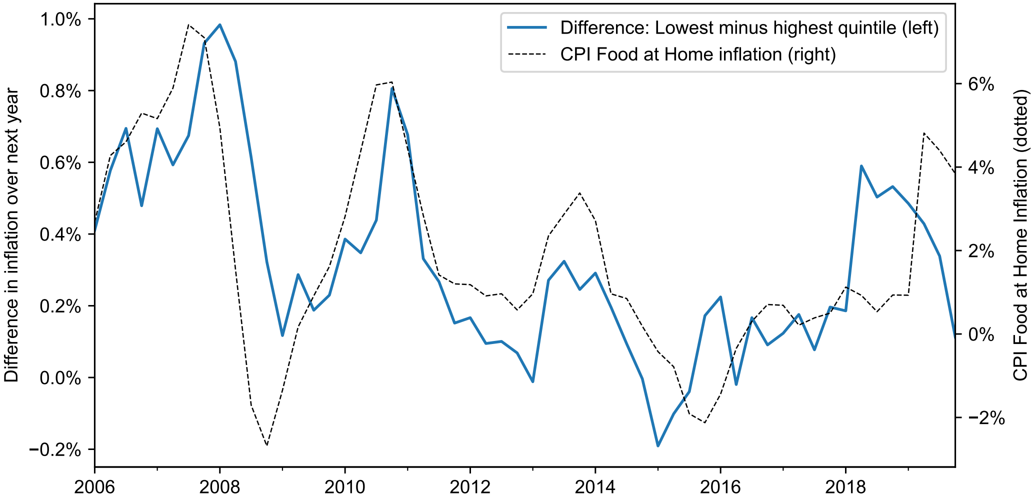
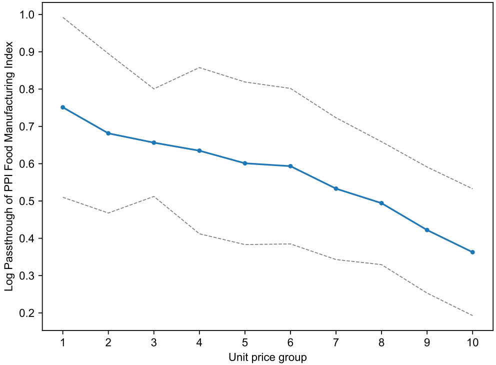


Cyclical inflation inequality over entire food-at-home bundle

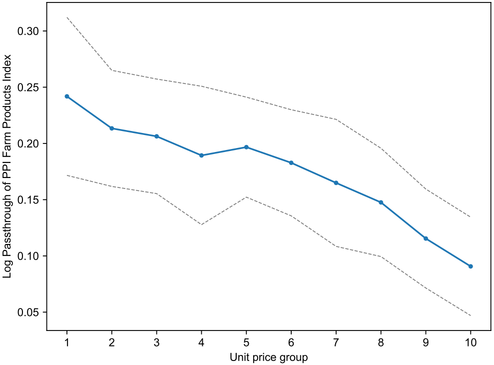


In logs, low-margin products more sensitive to upstream costs

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

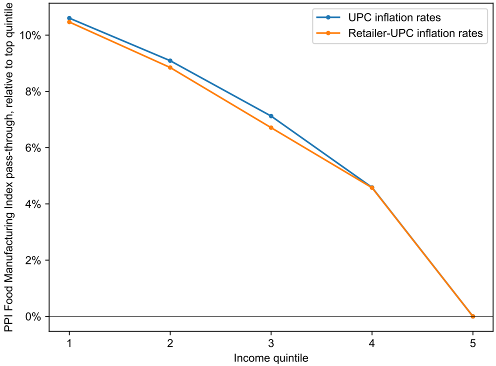


(b) Log pass-through of Farm Products PPI.

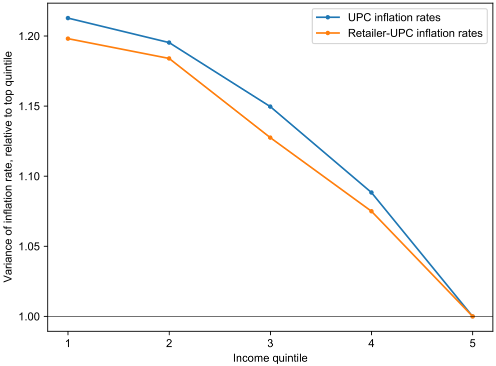


Food-at-home inflation across income groups

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



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



(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

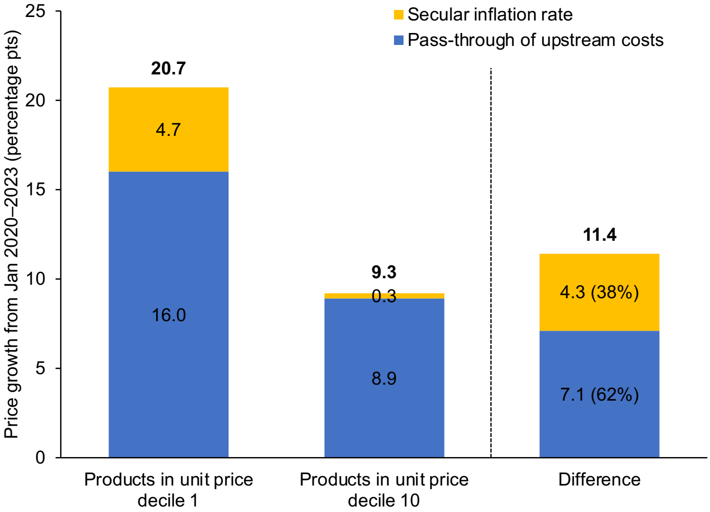
How the prices of the lowest-cost products for 30 everyday items have changed since April 2021.

Contact:	Release date:	Next release:
Emily Hopson cpi@ons.gov.uk +44 1633 455 592	25 October 2022	To be announced

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

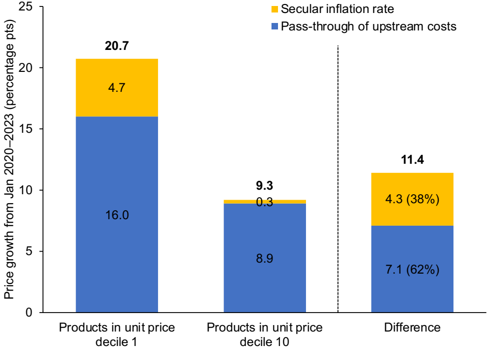
Predictions for food-at-home inflation, 2020–2023

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

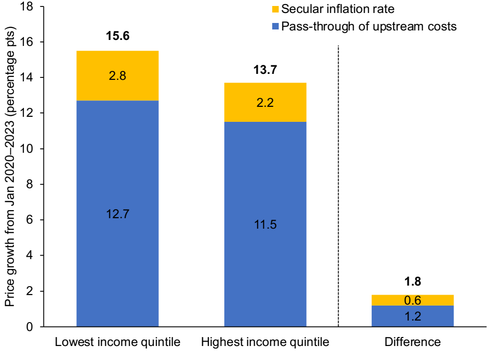


Estimated differences in 2020–2023 price growth

- Estimated 11pp higher price growth for low-price products within product categories.
- Translates to 2pp differential food-at-home price growth for low-income households.



(a) Least vs. most expensive products.



(b) Low vs. high income.

Conclusion

- Empirical evidence: Pass-through of commodity costs tends to be complete in *levels*.
- Class of demand systems with $\eta = 0$ can explain pass-through behavior.
- Helps us understand dynamics of prices and industry outcomes:
  - Incomplete log pass-through.
  - Dynamics of profits, margins, and entry.
  - Unequal incidence of commodity inflation across income distribution.

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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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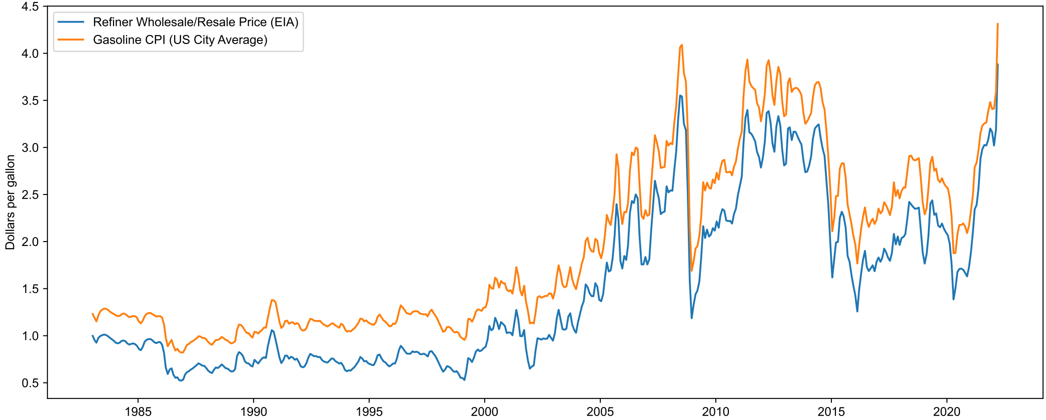
Motivation: U.S. Gasoline Prices

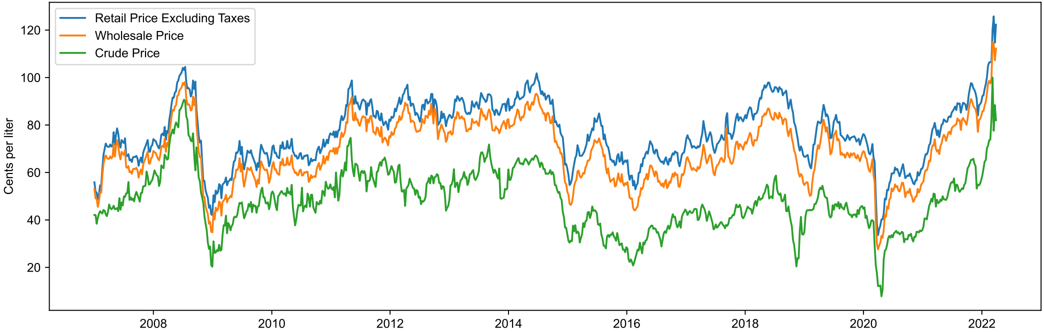
Figure: Refiner wholesale/resale prices (Energy Information Administration) and retail prices (CPI).



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

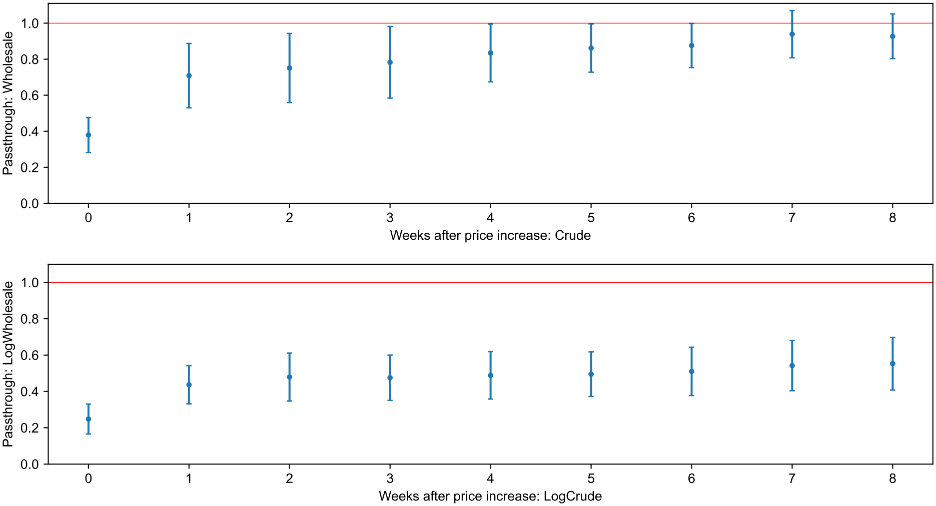


Figure: Passthrough in levels (top) and in logs (bottom)

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

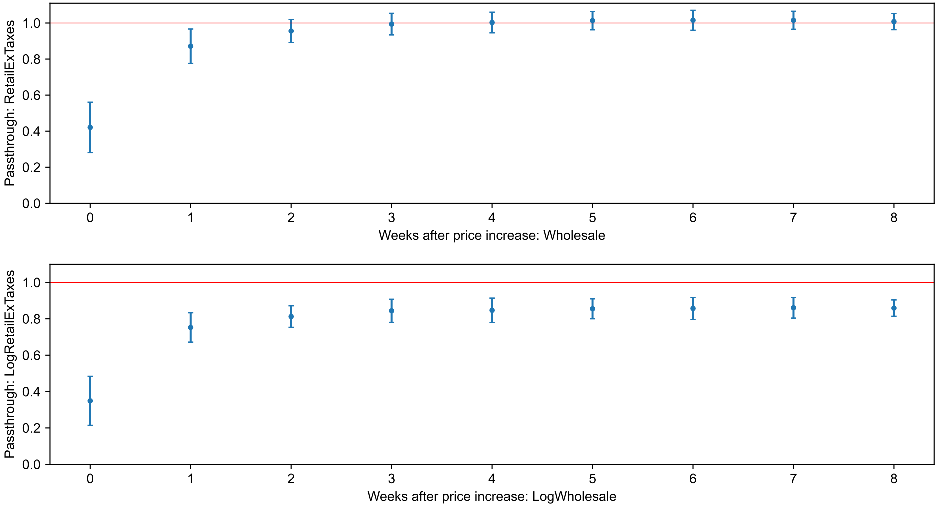
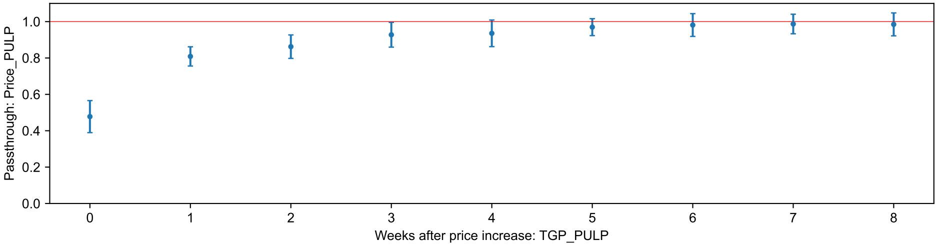


Figure: Passthrough in levels (top) and in logs (bottom)

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



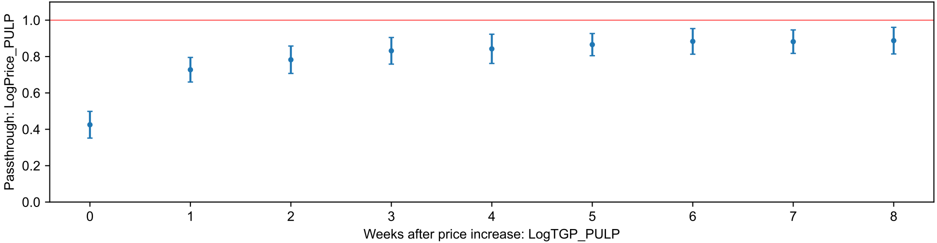


Figure: Passthrough in levels (top) and in logs (bottom). SEs two-way clustered by postcode $\times$ year.

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

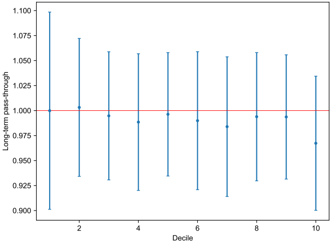
Test: Do stations with higher μ have higher pass-through in levels?

- 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 ($N_t(i)$):

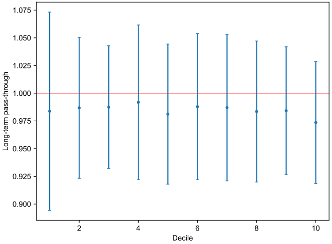
$$\text{RelativePrice}_i = \frac{1}{T}\sum_t \left(\text{Price}_{it} - \frac{1}{|N_t(i)|} \sum_{j \in N_t(i)} \text{Price}_{jt} \right).$$

- 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.

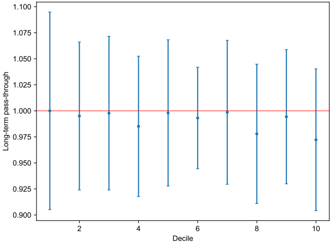
Result: Pass-through in levels unchanged across deciles of relative price



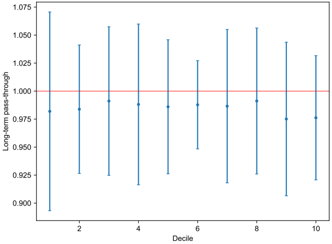
(a) ULP within postcode



(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		Within	
(cents per liter)	All	Brand	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

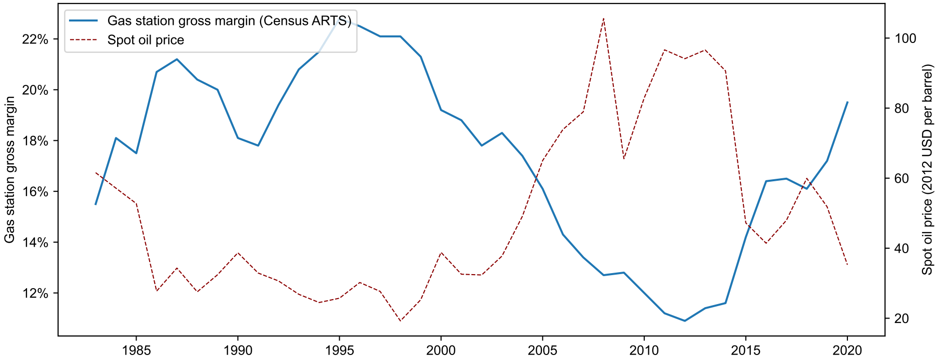
- Wang (2009) shows station-level demand elasticity ranges from 6–19. However, median Lerner index of 5.1% below what these elasticities would imply.
- Data shows price dispersion even within 228 narrowly defined neighborhoods in Perth.

Table: Unleaded price dispersion across Perth gas stations.

Stdev. daily prices (cents per liter)	All	Within: Brand	Within: 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

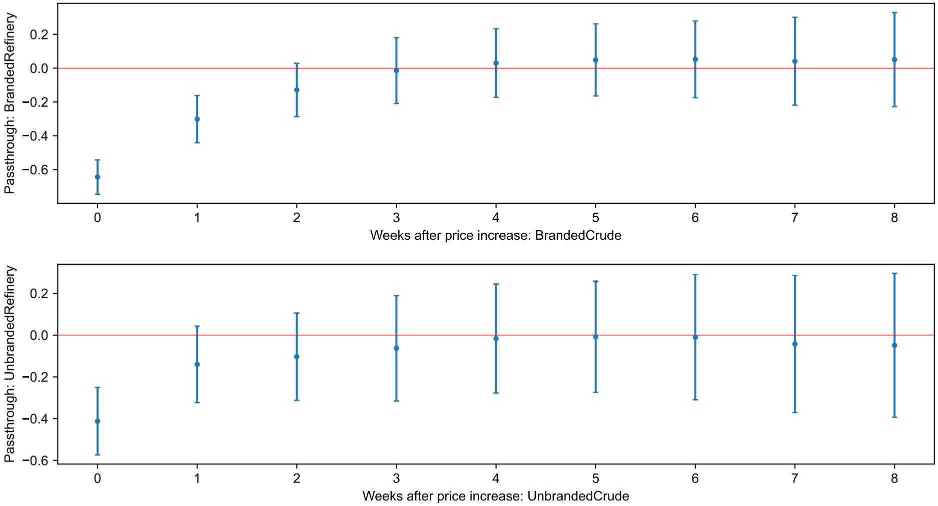


Figure: Branded (top) and unbranded (bottom) estimates. Newey-West standard errors.

Pass-through of wholesale prices to retail margin

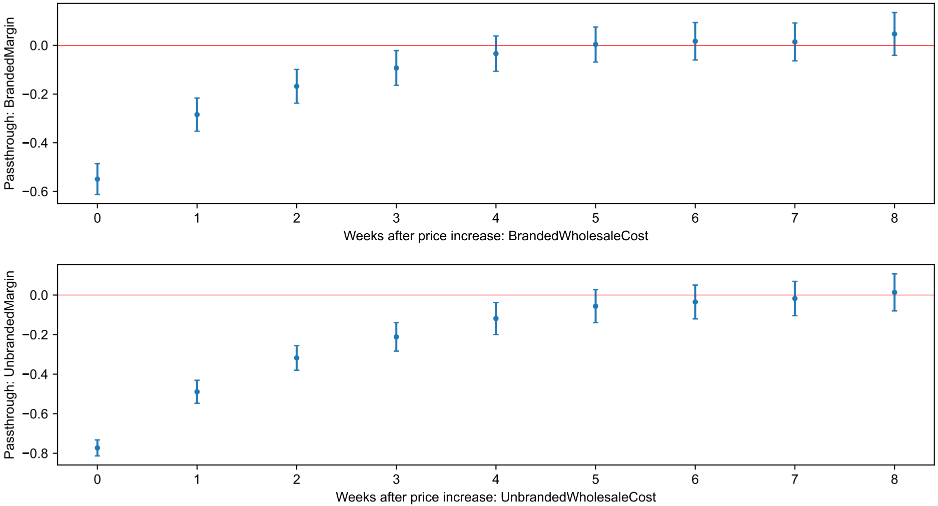


Figure: Branded (top) and unbranded (bottom) estimates. Newey-West standard errors.

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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

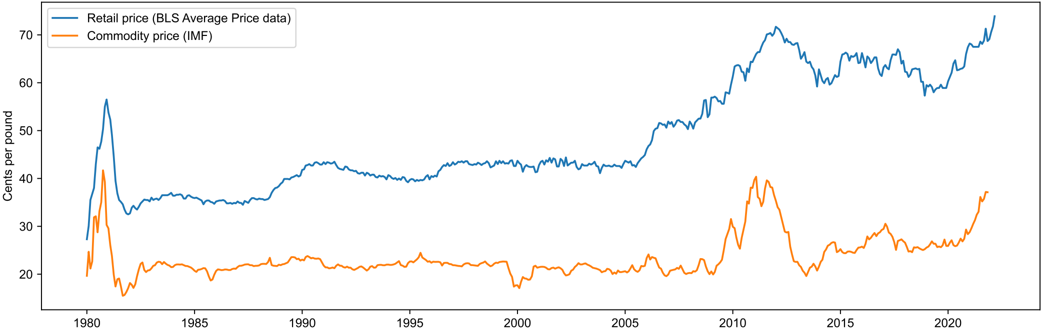
Table: Correlation between commodity prices series.

	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

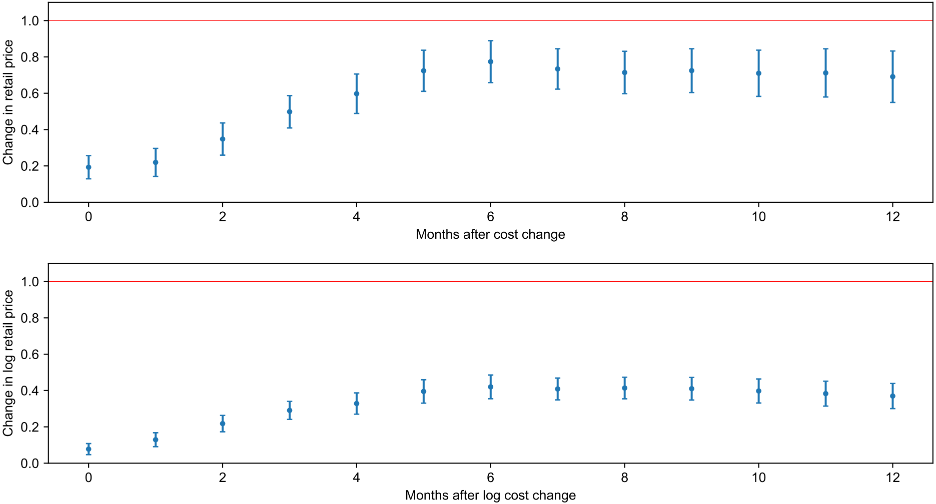
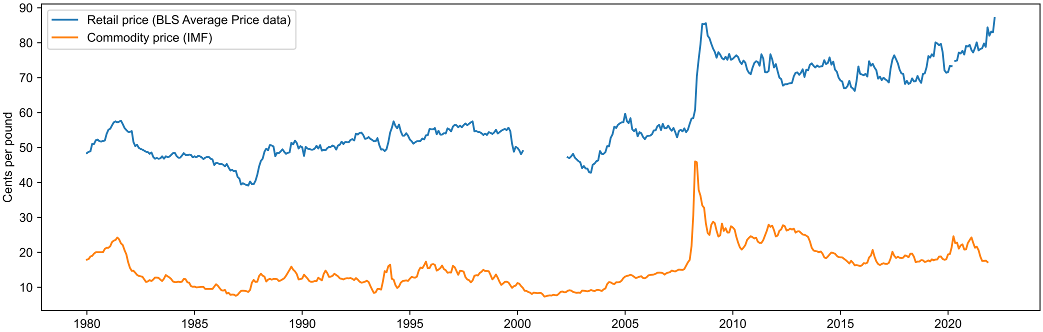


Figure: Passthrough in levels (top) and in logs (bottom)

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

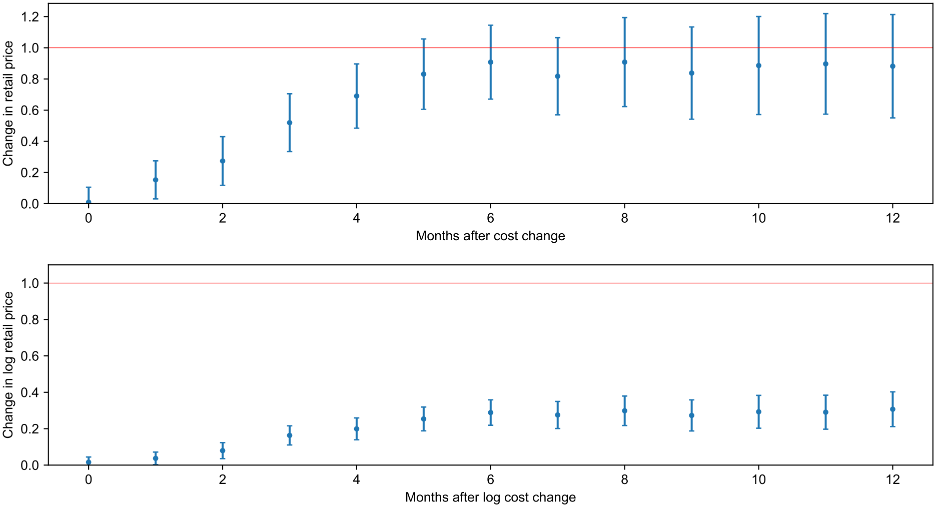
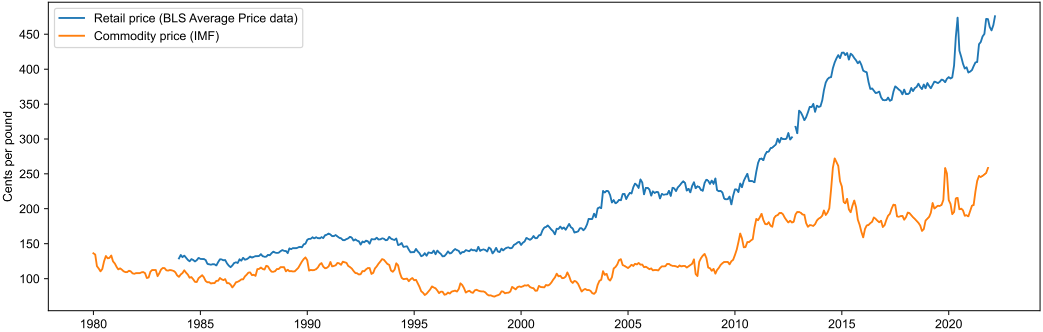


Figure: Passthrough in levels (top) and in logs (bottom)

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

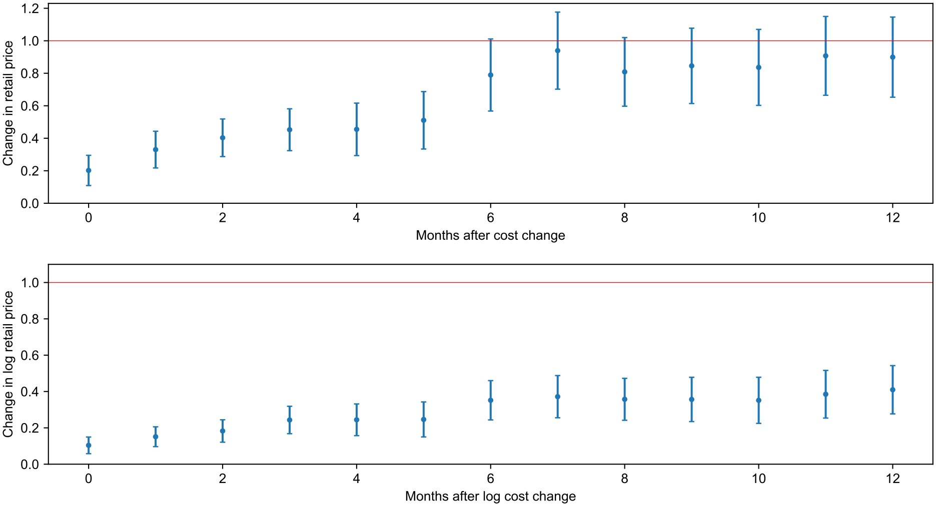
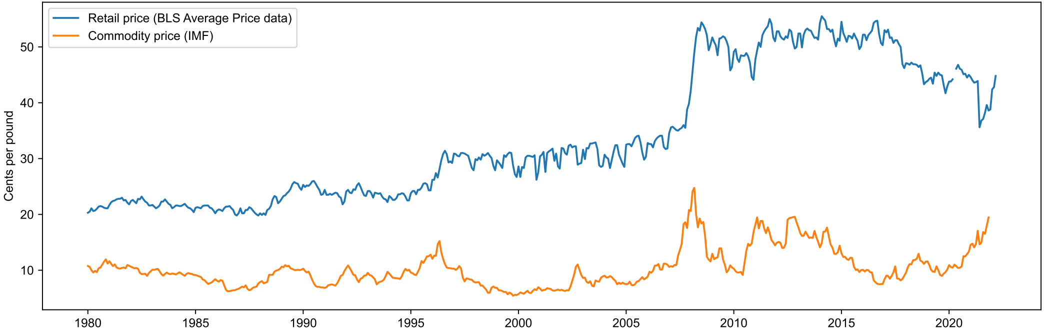


Figure: Passthrough in levels (top) and in logs (bottom)

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)

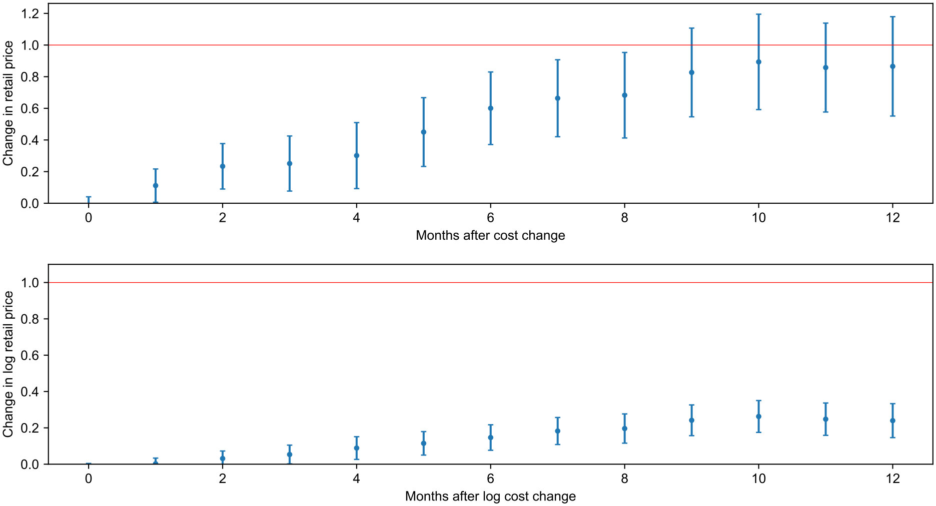
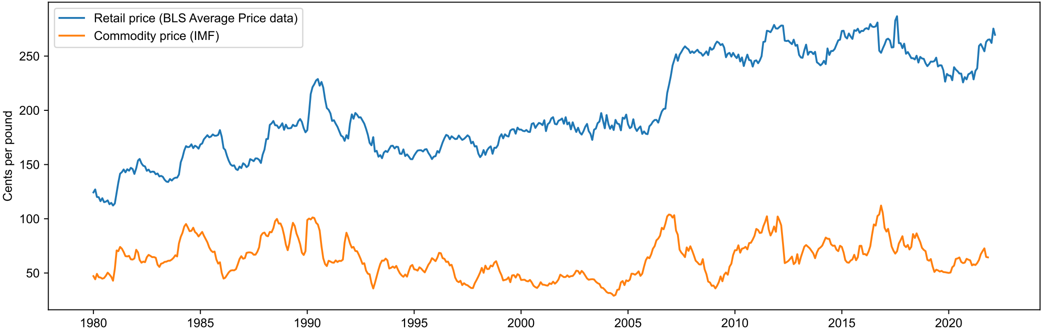


Figure: Passthrough in levels (top) and in logs (bottom)

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

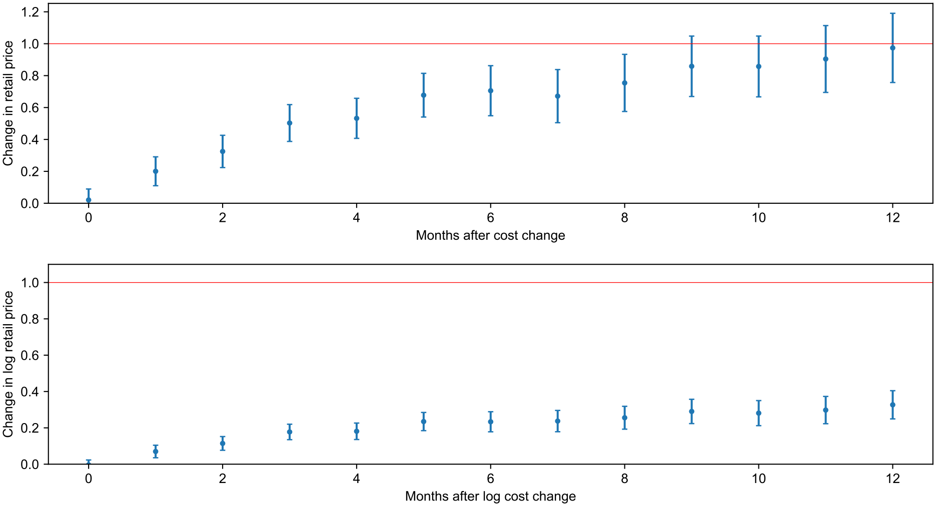


Figure: Passthrough in levels (top) and in logs (bottom)

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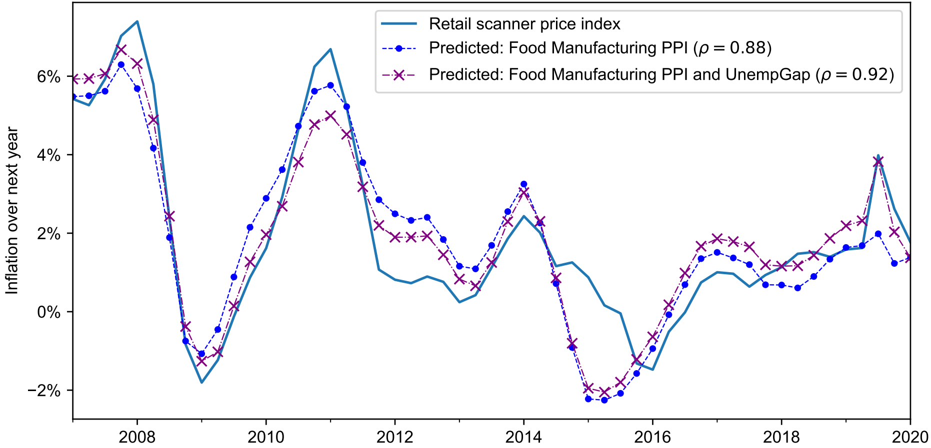
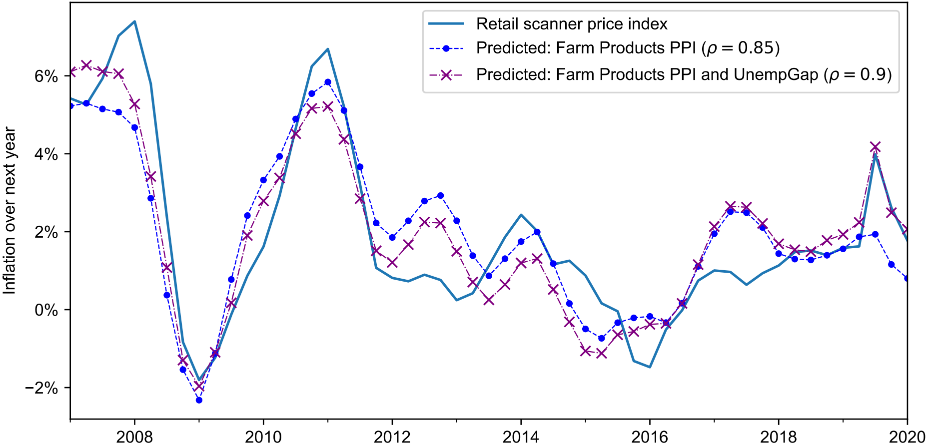
Backup: Upstream PPI explains food-at-home inflation well

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	Matched to UPC		Matched to retailer-UPC	
quintile	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

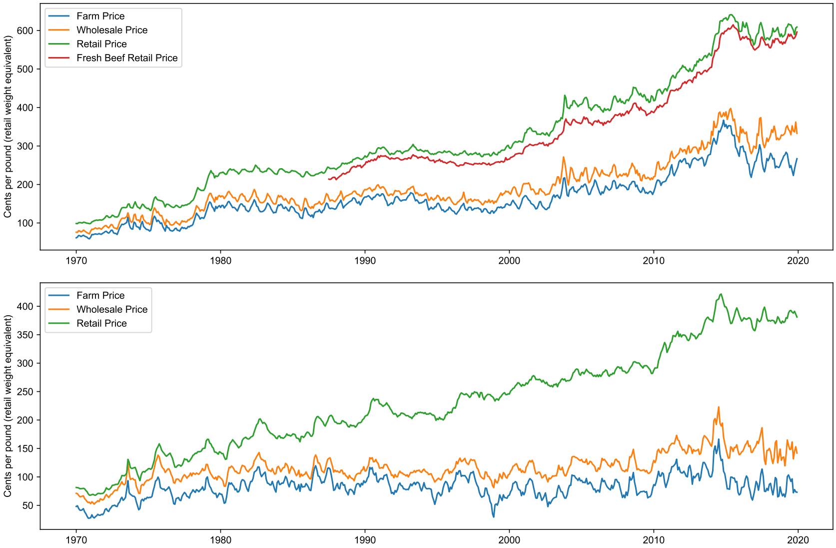


Figure: Beef (top) and pork (bottom) prices over time.

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

	Pass-through (12 mos.)			
Description	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

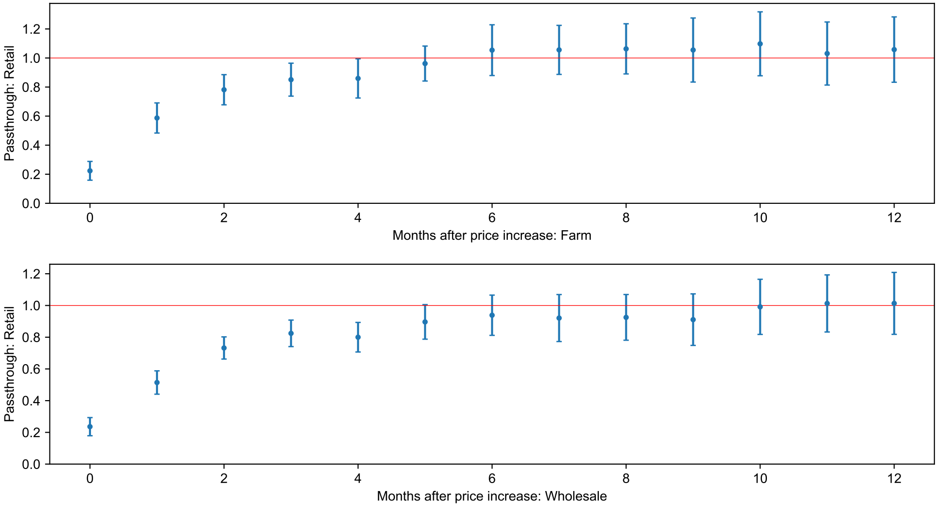


Figure: Passthrough of farm (top) and wholesale (bottom) prices. Newey-West standard errors.

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

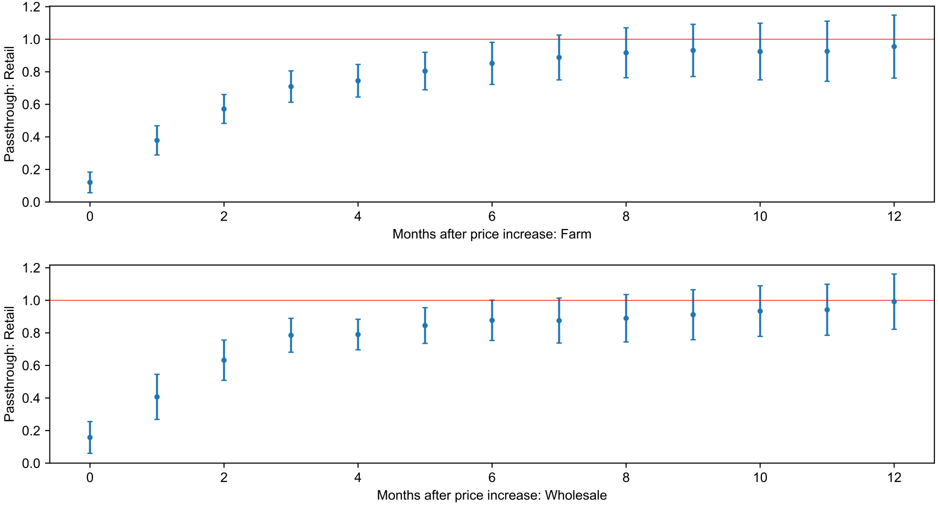
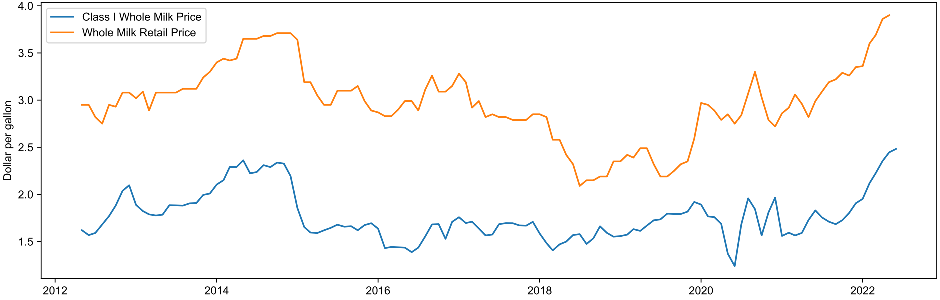


Figure: Passthrough of farm (top) and wholesale (bottom) prices. Newey-West standard errors.

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

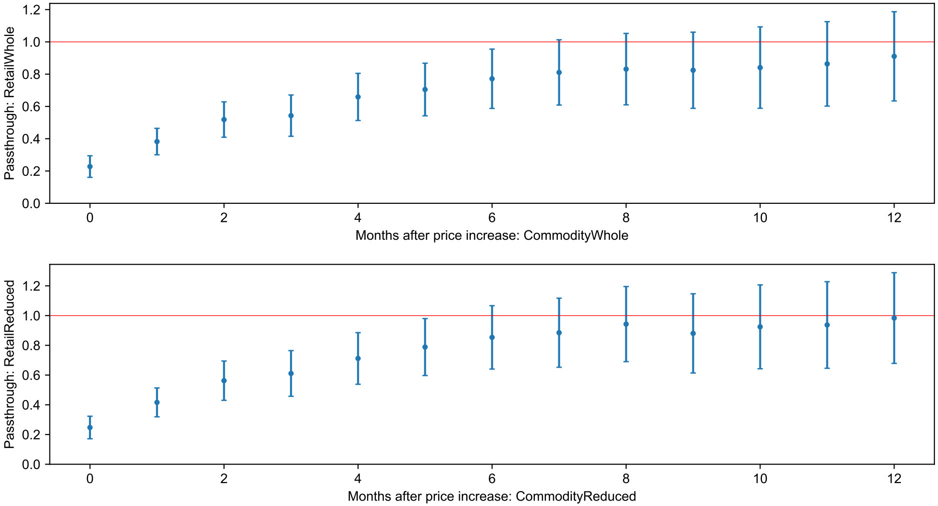
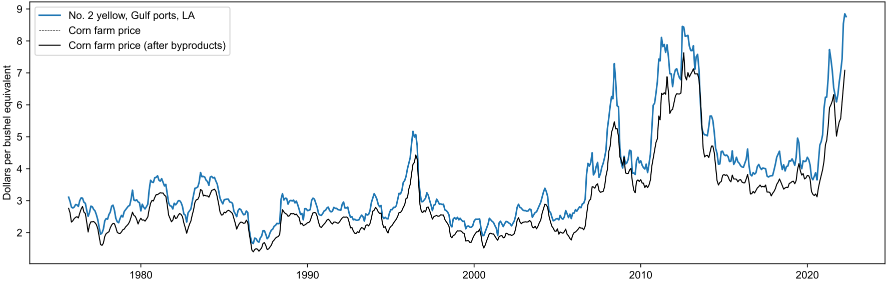


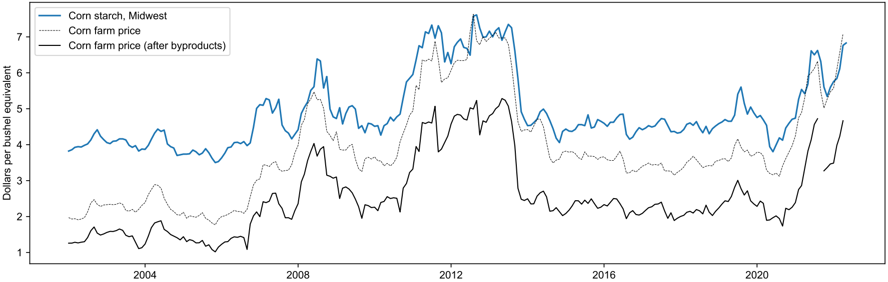
Figure: Passthrough in whole milk (3.5%) (top) and reduced fat (2%) (bottom). Driscoll-Kraay SEs.

Corn commodities and related products

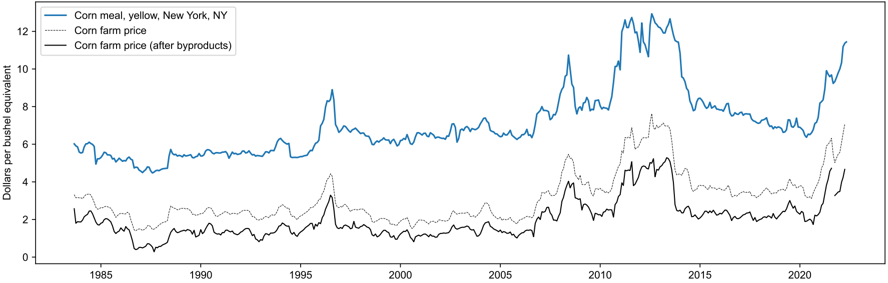
Commodity	Average cost of corn (farm price) as % of price
Corn markets:	
No. 2 yellow, Minneapolis, MN	101
No. 2 yellow, Omaha, NE	100
No. 2 yellow, Central IL	99
No. 2 yellow, Toledo, OH	96
No. 2 yellow, Kansas City, MO	95
No. 2 yellow, Chicago, IL	94
No. 2 yellow, St Louis, MO	93
No. 2 yellow, Memphis, 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

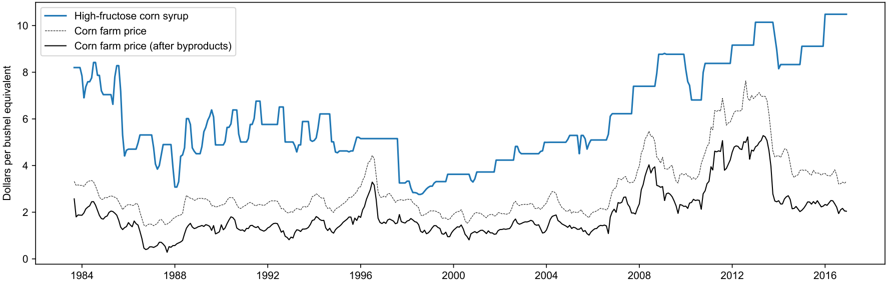
Corn products prices vs. corn commodity cost



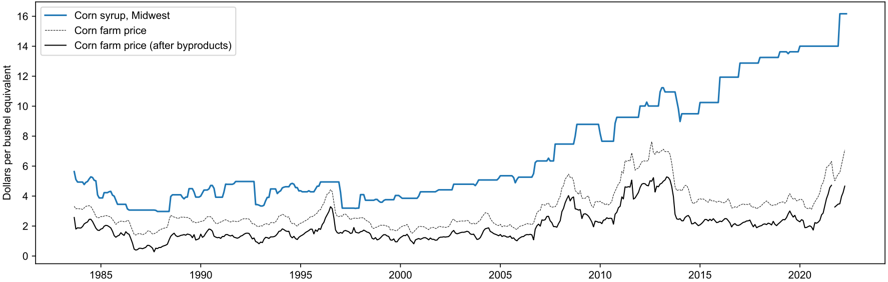


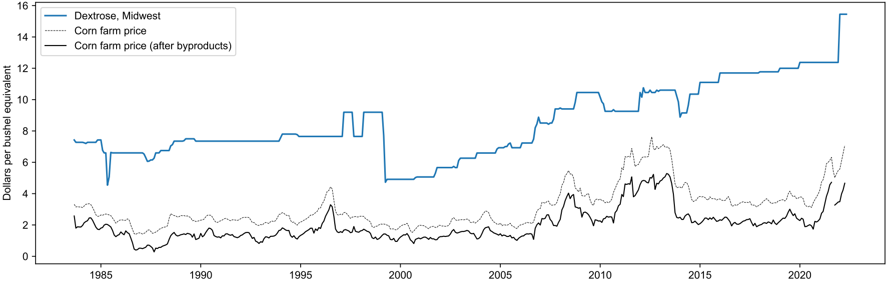
Corn products prices vs. corn commodity cost



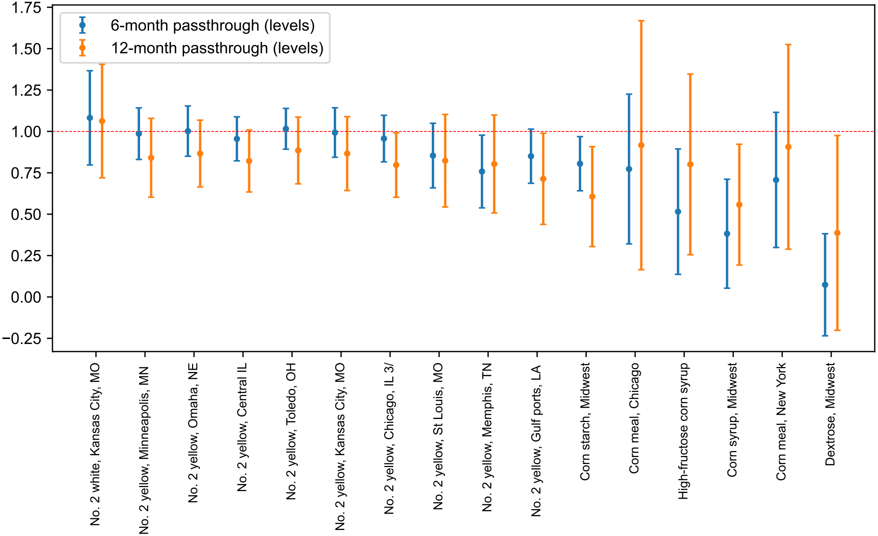


Corn products prices vs. corn commodity cost

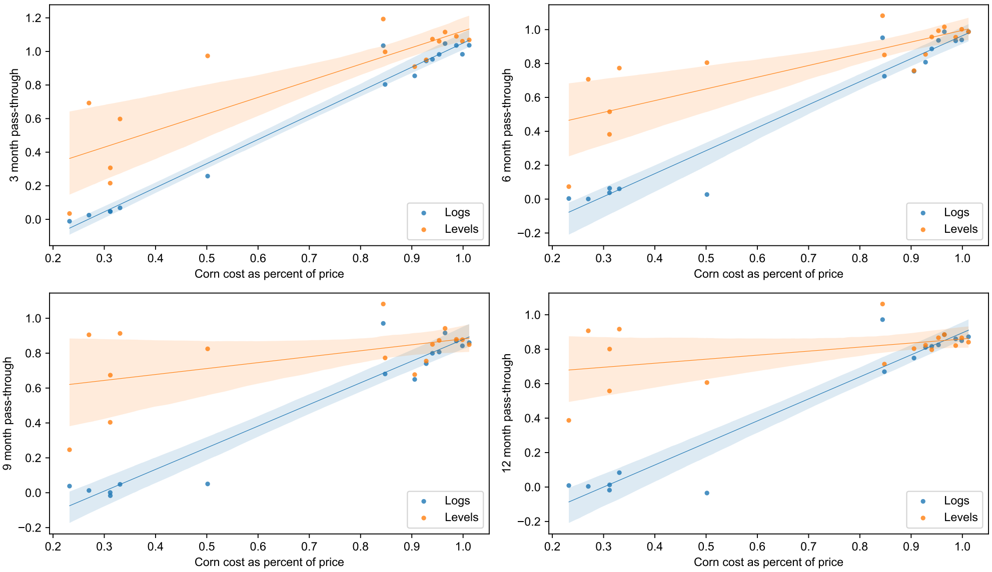




Pass-through of corn farm price increases in levels



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.

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

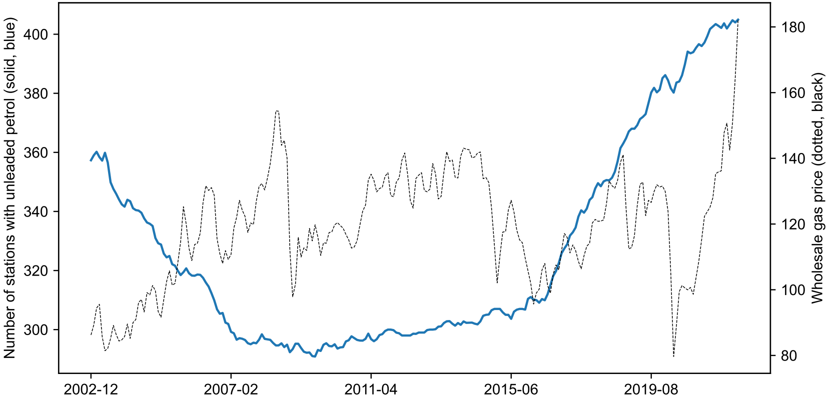
Implications: (1) Multiplicative markup, (2) entry positively related to commodity cost c.

- 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).

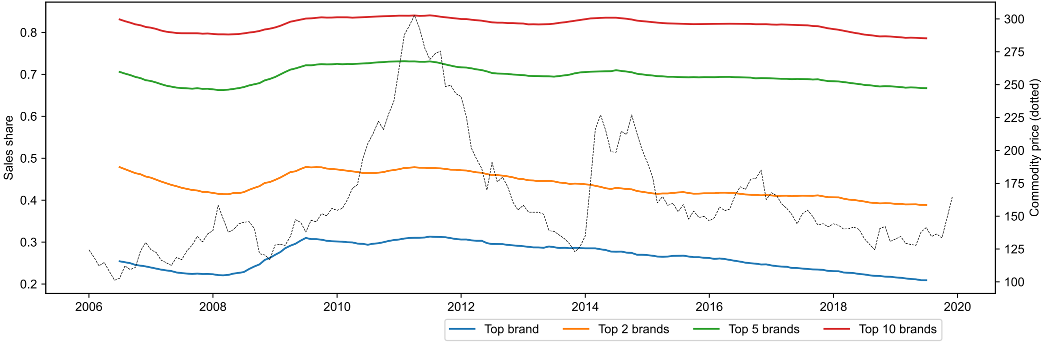


- No visual relationship, correlation of 1-month changes is 0.07.

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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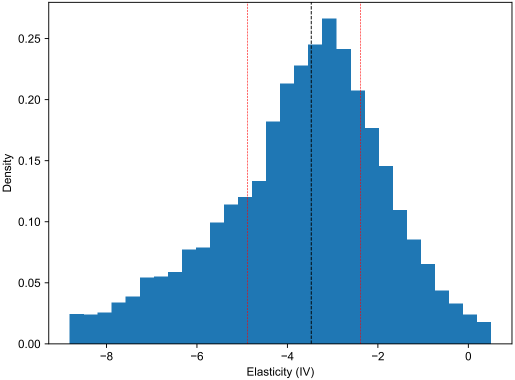
Backup: Finite demand elasticities

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

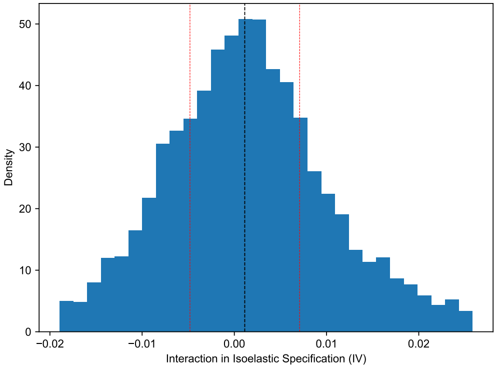
$$\log q_{it} = \beta \log p_{it} + \phi \log \bar{p}_t + \gamma(\log p_{it} \times \text{CommodityPrice}_t) + \alpha_{\text{Year}} + \delta_{\text{Week-of-year}} + \varepsilon_{it},$$

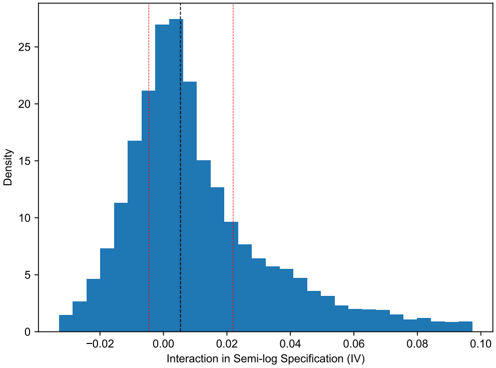
- Hausman IV: price in retailer's other stores excl. DMA (DellaVigna & Gentzkow 2019).
- Median demand elasticity for coffee UPCs is 3.47 (Q1 $=$ 2.39, Q2 $=$ 4.88).



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."

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Food inflation exp. of low-income households more sensitive to inflation rate

	Food 1-yr Inflation Expectations		
Data	NY Fed, 2013–2023		
Aggregation	Median	Indiv.	Indiv.
	(1)	(2)	(3)
Mid-Income	-0.371**	-1.657**	-
	(0.160)	(0.078)	-
High-Income	-0.799**	-2.361**	-
	(0.223)	(0.093)	-
Food-at-home infl. over past year	0.430**	0.462**	0.215**
	(0.034)	(0.061)	(0.078)
Mid-Income $\times$ Food-at-home infl.	-0.255**	-0.163**	-0.075**
	(0.038)	(0.024)	(0.037)
High-Income $\times$ Food-at-home infl.	-0.293**	-0.250**	-0.129**
	(0.041)	(0.026)	(0.043)
Respondent FEs	No	No	Yes
N	360	133780	133780

- Food infl. exp. of low-income higher, but also more sensitive to past food-at-home infl.

Overall inflation exp. of low-income more sensitive to food-at-home infl.

	1-yr Inflation Expectations				
Data	NY Fed, 2013–2023			Michigan Survey, 1978–2024	
Aggregation	Median	Indiv.	Indiv.	Mean	Median
	(1)	(2)	(3)	(4)	(5)
Mid-Income	-0.885**	-1.647**	-	-0.779**	-0.775**
	(0.216)	(0.289)	-	(0.092)	(0.071)
High-Income	-0.984**	-3.130**	-	-1.430**	-1.244**
	(0.263)	(0.380)	-	(0.136)	(0.091)
Food-at-home infl.	0.258**	0.243**	0.129*	0.139**	0.104**
	(0.040)	(0.071)	(0.074)	(0.026)	(0.023)
Mid-Income $\times$ Food-at-home infl.	-0.142**	-0.055	-0.042	-0.027	-0.023*
	(0.036)	(0.042)	(0.039)	(0.024)	(0.013)
High-Income $\times$ Food-at-home infl.	-0.148**	-0.150**	-0.079	-0.060*	-0.044**
	(0.043)	(0.064)	(0.063)	(0.031)	(0.019)
Controls	CPI less food & energy infl., gas infl., income interactions				
Respondent FEs	-	No	Yes	-	-
N	360	153051	153051	1599	1599

- Overall infl. exp. more sensitive to food-at-home infl (not true for broader CPI or gas).

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Effect on macro aggregates: Homogeneous varieties

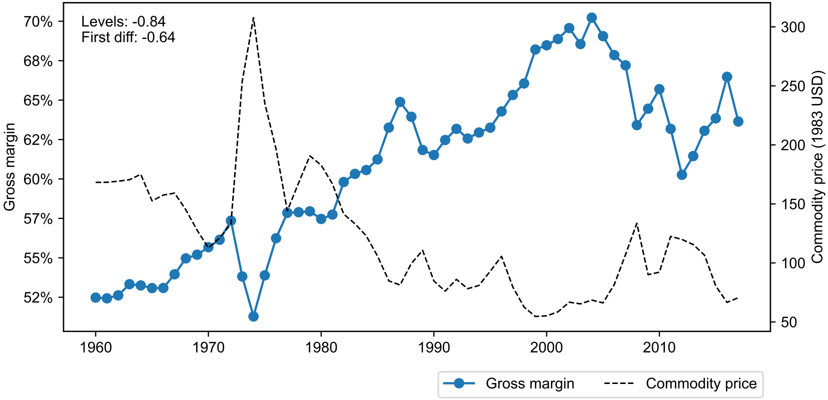
- Suppose $\beta_\theta = \beta$ and $\delta_\theta = \delta$ for all θ. Response of economic aggregates:

Variable		CES	Limit pricing
Gross margin	$d\log\bar{\mu}$	0	$-\frac{c_x X}{PY}$
Price level	$d\log P$	$\frac{\sigma}{\sigma-1}\frac{c_x X}{PY}$	$\frac{c_x X}{PY}$
Labor	$d\log L$	$-\frac{\sigma}{\sigma-1}\frac{c_x X}{PY}\frac{\varphi}{1+\gamma\varphi}$	$-\frac{c_x X}{PY}\frac{\varphi}{1+\gamma\varphi}$
Output	$d\log Y$	$-\frac{\sigma}{\sigma-1}\frac{c_x X}{PY}\frac{\varphi}{1+\gamma\varphi}$	$-\frac{c_x X}{PY}\frac{\varphi}{1+\gamma\varphi}$

- Implications: (1) Fall in gross margin. (2) Inflation, labor, output less sensitive to shock.

Prediction: Do gross margins fall when commodity costs rise?

- Upstream commodity: Wheat.
- Downstream industry: Bread, cake, and related products manufacturing.



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.

Effect on macro aggregates: Heterogeneous varieties

- Now allow β_θ and δ_θ to vary across varieties θ.
- Denote $V = Var_\lambda \left[\frac{\beta_\theta w}{p_\theta}\right] \geq 0$ and $C = Cov_\lambda \left[\frac{\delta_\theta \beta_\theta w}{p_\theta}, \frac{(1+\delta_\theta)\beta_\theta w}{p_\theta}\right]$ (likely ≥ 0).

Variable		CES	Limit pricing
Gross margin	$d\log\bar{\mu}$	$\frac{\sigma}{\sigma-1}\frac{\sigma}{\bar{\mu}}\left(\frac{c_x X}{wL}-1\right)V$	$-\frac{c_x X}{PY}+\frac{\sigma}{\bar{\mu}}\left(\left(\frac{c_x X}{wL}-1\right)V+C\right)$
Price level	$d\log P$	$\frac{\sigma}{\sigma-1}\frac{c_x X}{PY}$	$\frac{c_x X}{PY}$
Labor	$d\log L$	$-\frac{\sigma}{\sigma-1}\left(\frac{c_x X}{PY}-\gamma\sigma\frac{PY}{wL}V\right)\frac{\varphi}{1+\gamma\varphi}$	$-\left(\frac{c_x X}{PY}-\gamma\sigma\frac{PY}{wL}(V-C)\right)\frac{\varphi}{1+\gamma\varphi}$
Output	$d\log Y$	$-\frac{\sigma}{\sigma-1}\left(\frac{c_x X}{PY}+\frac{\sigma}{\varphi}\frac{PY}{wL}V\right)\frac{\varphi}{1+\gamma\varphi}$	$-\left(\frac{c_x X}{PY}+\frac{\sigma}{\varphi}\frac{PY}{wL}(V-C)\right)\frac{\varphi}{1+\gamma\varphi}$

- Implications: Reallocation toward high-margin firms $\rightarrow$ Y falls less than L.

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