More Amazon Effects :
Online Competition and Pricing Behaviors

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Motivation

- The Amazon Effect
  - September 2017: Janet Yellen suggest that increased competition with online retailers *may have reduced price margins and restrained the ability of firms to raise prices in response to rising demand* .
  - Potential explanation for why US inflation was still too low

- Some issues
  - hard to measure (no margins data)
  - one-time reduction in margins → temporary effect on inflation
  - can only explain *low* inflation → not so relevant by mid-2018

- Are there more persistent Amazon Effects ?

Motivation

- I study instead how online competition is affecting pricing behaviors in the retail sector

- I focus on two distinctive features of online retailers:
  - Algorithmic pricing → affects *price stickiness* over time
  - Uniform pricing → affects *price dispersion* across locations

- Changes in these pricing behaviors can have long-lasting implications for shock pass-through, inflation dynamics, and monetary policy
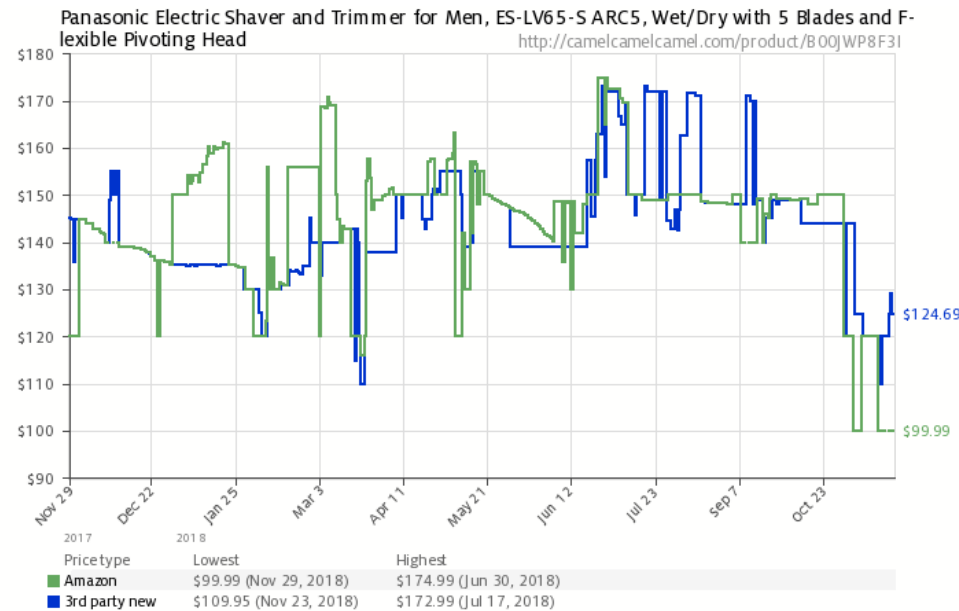
Data

1. Daily prices from the Billion Prices Project
   - From 2008 to 2017
   - All goods sold in CPI categories
   - ~50 largest US *multi-channel* retailers (online & offline)

2. Walmart — Amazon comparison → 50K goods with product-level indicator of online competition

3. Geographical prices for identical goods
   - ~ 10K products in 4 retailers: Amazon, Walmart, BestBuy, Safeway
   - Simultaneously-collected prices for 102 zip codes in March 2018

Agenda

- Price Flexibility
  - Over time
  - Cross-section → online competition
- Uniform Pricing
  - Cross-section → online competition
- Shock Pass-through
  - Over time
  - Cross-section → online competition

Price Flexibility in Online Retailers

- Amazon s prices appear to change very frequently

Panasonic Electric Shaver and Trimmer for Men, ES-LV65-S ARC5, Wet/Dry with 5 Blades and F-lexible Pivoting Head   http://camelcamelcamel.com/product/B00JWP8F3I

Price type	Lowest	Highest
■ Amazon	$99.99 (Nov 29, 2018)	$174.99 (Jun 30, 2018)
■ 3rd party new	$109.95 (Nov 23, 2018)	$172.99 (Jul 17, 2018)

Source: Screenshot from CamelCamelCamel.com taken on 11/29/2018

- Gorodnichenko et al (2017, 2018) show evidence that online-only retailers tend to have more flexible prices than previously found in CPI data
  - About 3.9 months implied duration for regular (non-sale) prices
  - Data from an online comparison website
- Is this affecting more traditional multi-channel retailers?

Increase in the frequency of US price changes

- I use BPP data to measure the aggregate frequency of price changes in the US from 2008 to 2017 (with CPI expenditure weights)

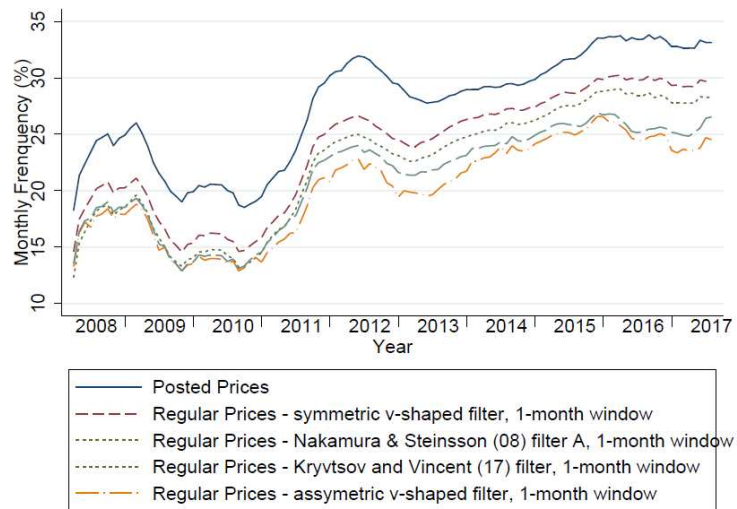Figure 1: Monthly Frequency of Price Changes, 2008 to 2017

(a) Posted and Regular Price Changes

- The median monthly frequency has risen from approximately 14% in 2008 to 34% today → implied duration of prices has fallen from 7 to 3.5 months
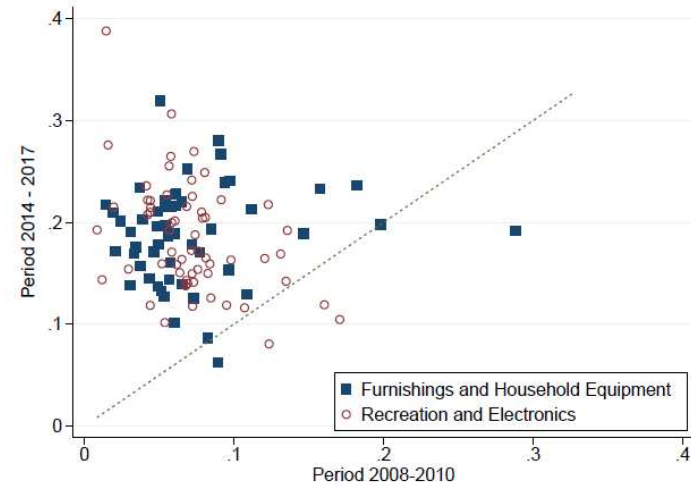
Increase in the frequency of US price changes

- Not driven by sale prices or retailer composition

A1: Monthly Frequency of Price Changeswith Different Sales Filters

A5: Average Monthly Frequency by Retailer and Sector

Increase in the frequency of US price changes

- Affects both regular price increases and decreases

Other pricing statistics are less affected

Table 1: Behavior of Regular Prices in Large U.S. Retailers

|	Period Averages		
	2008-2010	2011-2013	2014-2017
Frequency of Price Changes (%)	15.43	22.39	27.39
Implied Duration (months)	6.48	4.47	3.65
Frequency of Price Increases (%)	6.89	10.27	12.49
Frequency of Price Decreases (%)	8.94	12.12	14.96
Absolute Size of Price Changes (%)	17.45	16.24	15.02
Size of Price Increases (%)	18.3	17.09	15.42
Size of Price Decreases (%)	-16.79	-14.71	-14.02
Share of Price Changes under 1pc	6.59	5.23	8.01
Sales as Share of Price Changes (%)	4.02	3.98	3.29

Implied durations are falling in all sectors

Table 2: Implied Duration of Regular Price Changes by Sector

	Period Averages		
	2008-2010 (months)	2011-2013 (months)	2014-2017 (months)
Food and Non-Alcoholic Beverages	6.4	6.6	6.4
Clothing and Footwear	6.2	5.5	5.3
Furnishings and Household Goods	14.2	12.9	5.9
Health and Medical	12.1	13.6	8.5
Transportation Goods	3.6	2	1.8
Recreation and Electronics	13.1	10.1	5.5
Miscellaneous Goods	13.7	10.4	7.8
All Sectors	6.48	4.47	3.65

Is this driven by online competition?

- Data:
  - 50K Walmart products sold during 2016-2018
    - randomly selected within categories
  - Constructed an "online competition" indicator for each product→ is it easy to find on Amazon?
    - Search Walmart s product descriptions on Amazon s website.
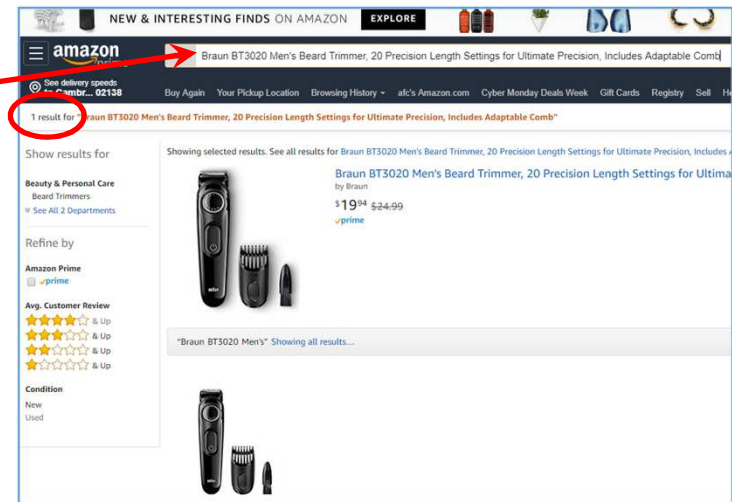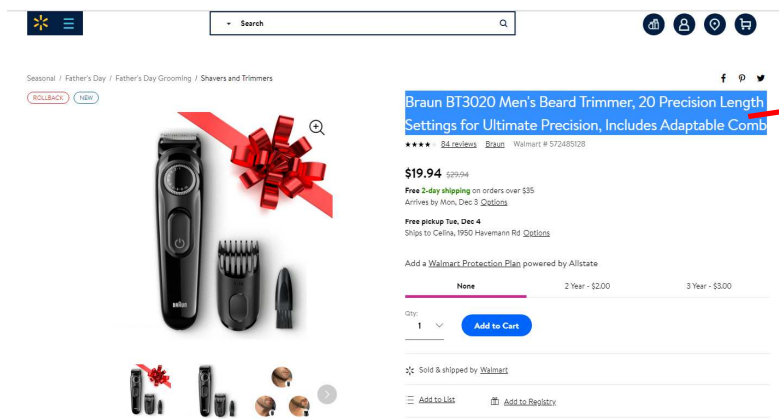
Is this really driven by online competition?

- Data:
  - 50K Walmart products sold during 2016-2018
    - randomly selected within categories
  - Constructed an "online competition" indicator for each product→ is it easy to find on Amazon?
    - Search Walmart's product descriptions on Amazon's website.
    - Binary outcome:
      - 0 if no matches found ("No results")
      - 1 if one or more matches found
    - Mimics the behavior of a consumer trying to compare prices
    - Amazon's algorithms are more likely to find matches for goods that are searched more often (algorithm learns from history/clicks)

Online competition reduces implied durations

Table 3: Implied Duration for Walmart's Products Found on Amazon

	All Sectors	Food & Beverages	Clothing & Footwear	Furnishings & Household	Health & Medical	Recreation & Electronics
Found on Amazon	-5.45	-3.63	-41.18	-1.55	-8.33	-5.71
	(0.46)	(0.75)	(4.78)	(0.76)	(6.38)	(0.59)
Constant	27.95	30.97	94.98	22.42	59.25	23.43
	(0.60)	(0.40)	(2.61)	(0.50)	(3.92)	(0.35)
Observations	49,867	15,766	2,719	11,152	973	16,541
Obs. on Amazon	17,498	4,554	831	4,858	420	6,040
R squared	0.10	0.00	0.03	0.00	0.00	0.01

Notes: The dependent variable is the implied duration for posted prices, measured in days, using prices collected from 2016–2018. The variable "Found on Amazon" is a dummy that identifies whether the product was found by a scraping robot that searched for the first 100 characters of the product description on Amazon's website. Fixed effects are computed using the product's COICOP 3-digit category (for example, COICOP 1.1.1 corresponding to "Bread and Cereals").

- Competition with Amazon reduces good-level implied durations by about 20%

So far

- The frequency of price changes has increased in the last 10 years
- It rises with online competition

- What are these prices/algorithms reacting to?
  - Idiosyncratic or aggregate shocks
  - Local or national shocks

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  - Cross-section → online competition
- **Uniform Pricing**
  - **Cross-section → online competition**
- Shock Pass-through
  - Over time
 - Cross-section → online competition

Geographical Price Differences Within Retailers

- The same technology that allows quick price changes (dynamic pricing) can be used to set different prices for different consumers (at the same time) → spatial price discrimination

Geographical Price Differences Within Retailers

- Online retailers also tend to have a **single-price** across locations
  - Only a few supermarkets ask for zipcodes before showing prices
  - Discriminate via shipping charges? Coupons? → limited
  - Seems linked to online transparency and customer anger
    - Eg. Amazon 2002 promises to   never test prices based on customer demographics
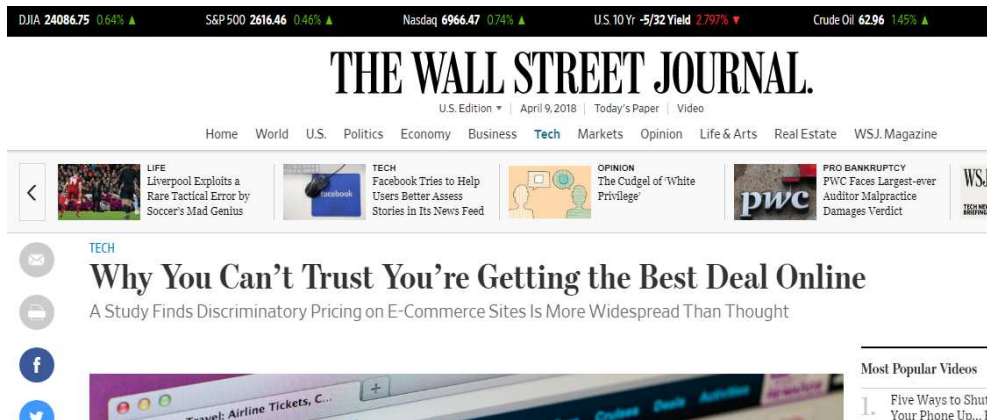
Employees at Best Buy stores repeatedly failed to honor discounted prices listed on BestBuy.com, putting the burden of proof on consumers. When questioned about the cheaper online prices, Best Buy employees flashed customers the intranet site, which often failed to display the discounted prices.
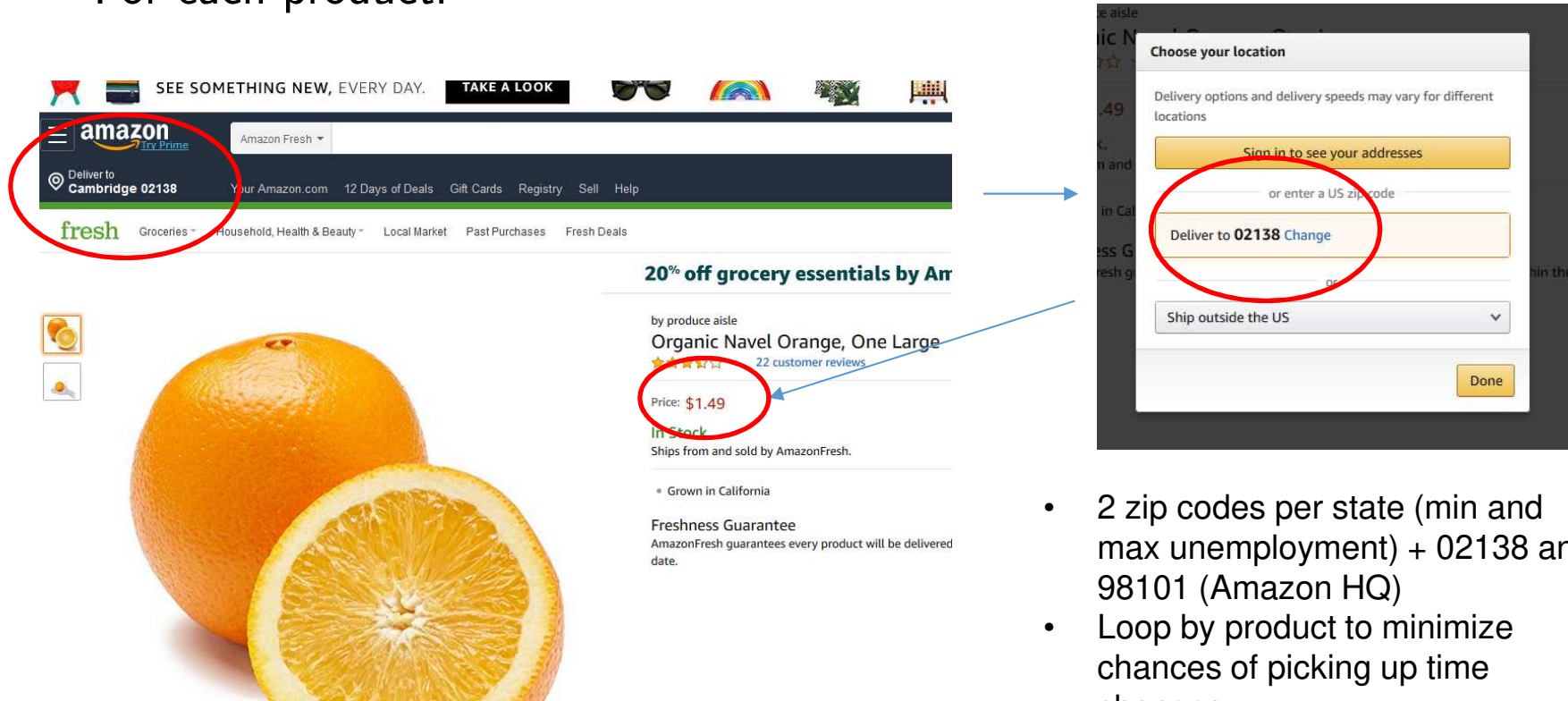
Source: Screenshot taken on 4/9/2018,
https://www.wired.com/2007/03/best-buy-pushes/

Geographical Price Differences Within Retailers

- Offline retailers have uniform pricing → DellaVigna & Gentzkow (2017) with US scanner data

- Is uniform pricing another Amazon Effect ?

Geographical Price Differences Within Retailers

- Data from 4 US retailers (Amazon & 3 traditional) in 102 zip codes.
- For each product:

- 2 zip codes per state (min and max unemployment) + 02138 and 98101 (Amazon HQ)
- Loop by product to minimize chances of picking up time changes

- Two measures of price dispersion using all bilateral price comparisons: share of identical & average price difference

Uniform Pricing

Table 4: Evidence of Uniform Pricing in Large US Retailers

	Share of Identical Prices		Average Price Difference	
	Other Retailers	Amazon	Other Retailers (%)	Amazon (%)
Panel A: All Sectors				
Mean	0.78	0.91	5.49	1.61
Standard Deviation	(0.30)	(0.19)	(9.44)	(4.44)
Number of Products	9469	823		
Average Zip Codes	22	80		
Panel B: Major Sectors				
Food & Beverages				
Mean	0.76	0.84	6.33	2.97
Standard Deviation	(0.31)	(0.24)	(9.84)	(5.26)
Number of Products	6588	344		
Average Zip Codes	15	65		
Recreation & Electronics				
Mean	0.99	0.99	0.006	0.003
Standard Deviation	(0.16)	(0.05)	(0.22)	(0.04)
Number of Products	1578	191		
Average Zip Codes	42	100		

- Amazon has more uniform pricing, but traditional retailers are close
- Differences are concentrated in   Food and Beverages

Online competition increases Uniform Pricing

Table 5: Uniform Pricing for Walmart's Grocery Products Found on Amazon

	Share of Identical		Average Price Difference	
Found on Amazon	0.058	0.055	-1.979	-1.891
	(0.008)	(0.008)	(0.306)	(0.309)
Zip Codes Sampled		0.002		-0.044
		(0.000)		(0.017)
UE Rate Difference		-0.006		0.386
		(0.002)		(0.071)
Constant	0.914	0.921	2.939	1.794
	(0.004)	(0.009)	(0.152)	(0.386)
Observations	3,982	3,949	3,778	3,746
Obs. on Amazon	934	929	908	903
R-squared	0.022	0.031	0.014	0.024

- Walmart s products that are found on Amazon have less price dispersion
- The impact of found on Amazon is equivalent to a 10% unemployment rate difference across locations

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  - Cross-section → online competition
- Pass-through
  - Cross-section → online competition
  - Over time

What are the inflation implications?

- High frequency of price changes + uniform pricing policies →
  more price sensitivity to aggregate national shocks?

- I start with Walmart and measure pass-through using a standard
  distributed-lag regression with quarterly data

$$\Delta p_{ic,t} = \sum_{k=0}^{1} \beta_k \Delta s_{ic,t-k} + \delta_{ic,t} \Delta X_{ic,t} + \epsilon_{ic,t}$$

Where s is either
- Gas prices
- Nominal exchange rates (trade-weighted broad index)

and X has includes sector & good fixed effects, and lagged dep.
variable

Impact on fuel and exchange-rate pass-through

Table 6: Short-Run Pass-through into Walmart's Prices (2016-2018)

		Found on Amazon	
	Full Sample	No	Yes
Gas Prices (1 quarter)	0.22	0.19	0.28
	(0.02)	(0.02)	(0.03)
N	191,690	122,800	68,890
r2	0.17	0.17	0.16
Exchange Rate (2 quarters)	0.32	0.26	0.44
	0.03	0.04	0.05
N	61,340	39,296	22,043
r2	0.17	0.18	0.16

Notes: All data are quarterly. The dependent variable is the log change in individual product prices, and the independent variables include the first lag of the dependent variable and lags of either the log change in gas prices or the trade-weighted nominal exchange rate broad index published by the Board of Governors of the Federal Reserve (TWEXB). The TWEXB is inverted so that an increase is a depreciation of the US dollar and the sign of the pass-through estimates are consistent with those reported in the exchange-rate pass-through literature. This table shows the results us-

Impact on fuel and exchange-rate pass-through

- Estimated *levels* of pass-through are sensitive to number of lags and other details in the regression

- The *increase* in levels when found on Amazon is robust to different estimation methods (OLS, fixed effects, difference and system GMM, both variables in the same regression)

- Does this happen in other retailers? Is it affecting aggregate pass-through over time?

Pass-through over time

I use 2 different methodologies:

1. Distributed lag regression with *changes* and price indexes →
   Burstein and Gopinath (2014)
   - Short-run (2 quarters) & long-run (2 years)

2. Relative *levels* price regression using identical products across
   countries → Gorodnichenko & Talavera (2017)

$$\ln\left(p_{i,t}^{us}/p_{i,t}^{z}\right) = \alpha^{us,z} + \beta\ln\left(e_{t}^{us,z}\right) + \epsilon_{i,t}^{us,z}$$

   - Limited to food and electronics (matched dataset)
   - Advantage: only tradables & implicitly control for shocks that
     impact prices in both locations and may be correlated with e

- Goal: show that pass-through has been increasing over time
  regardless of the method used

Increase in exchange rate sensitivity over time

Table 7: Price Sensitity to Exchange Rate Over Time

	Full Sample	By Period	
		2008-2012	2013-2017
Panel A: Online US Price Indexes **(All goods excluding fuel)**			
Short-Run (2 quarters)	0.16	0.12	0.25
	(0.05)	(0.07)	(0.06)
Long-Run (2 years)	0.31	0.04	0.44
	(0.09)	(0.37)	(0.12)
Panel B: Matched Relative Prices **(2 sectors, 7 countries)**			
Food & Beverages	0.38	0.23	0.45
	(0.01)	(0.05)	(0.02)
Electronics	0.83	0.79	0.91
	(0.03)	(0.14)	(0.07)

Unprecedented levels in retail prices → 44% is closer to "at-the-dock" results

Close to Gorodnichenko & Talavera (2017) results with data from a price comparison website in 2012

Conclusions

- Online competition is changing retail pricing behaviors:
  - More frequent price changes
  - More uniform pricing

- When combined, these changes appear to make prices more sensitive to aggregate national shocks
  - Retail prices are less insulated than typically assumed
  - Makes recent US inflation less puzzling (dollar appreciation, falling gas prices until jan 2019)

- Other Macro implications
  - Inflation measurement
  - Price stickiness and fairness
  - Price dispersion and welfare