Recent Trends in Price Setting and Implications for Monetary Policy Non-Neutrality

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Motivation and Scope

- Increasing share of e-commerce in retail trade reflected, with some lag, in the prices collected by the FSO to construct the CPI for Switzerland
- E-commerce may differ in terms of price-setting characteristics from other sectors
  - Literature: Gorodnichenko and Talavera (2017)
- What do developments such as these mean for monetary policy?
- In this paper we examine the consequences of recent changes/trends in price-adjustment patterns for monetary policy non-neutrality based on the micro prices underlying the Swiss CPI.

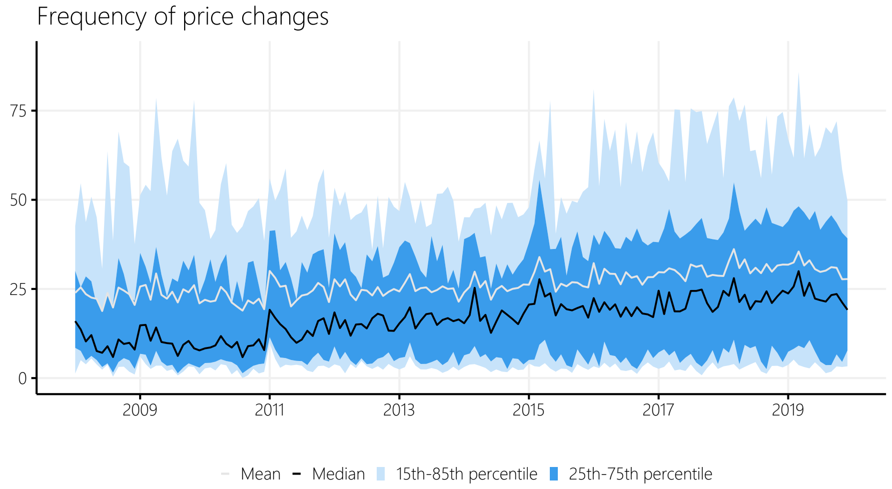
A first look at the data

Changes in price-setting characteristics from 2008 to 2020 (based on Swiss CPI micro prices):

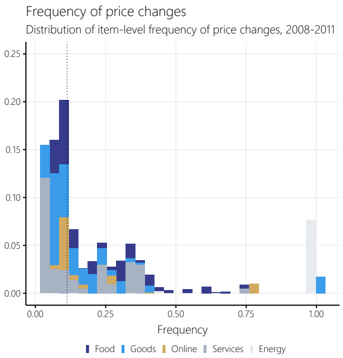
- Level and dispersion of price adjustment frequency have increased over time.
- Size of price changes (and other characteristics of the price data, except kurtosis) remained stable.
- Sectoral specific changes: Prices of product groups that were collected in-store at the beginning and online at the end of the observation period exhibit a strong increase in the frequency of price changes.

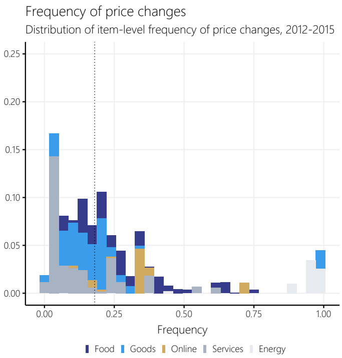
▸ Share positive ▸ Size ▸ IQR ▸ Kurtosis ▸ Table 5 sectors ▸ Distribution Frequency ▸ Distribution Size ▸ Distribution Kurtosis

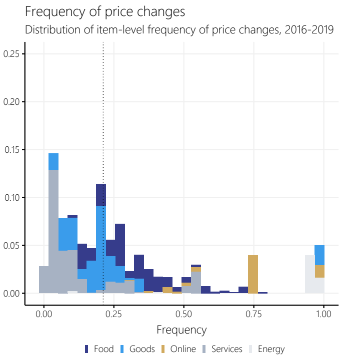
Evolution of frequency of price changes: 2008–2020



Cross-sector distribution of frequency of price changes







Approach

- Multi-sector NK model to capture the degree and the heterogeneity of price stickiness
  - Price stickiness causes monetary policy to affect real variables, at least temporarily
  - Heterogeneity in price stickiness across sectors amplifies monetary non-neutrality (cf. Nakamura and Steinsson, 2010; Gautier and LeBihan, 2020)
- Estimation of price-setting friction in multi-sector menu cost model using Simulated Method of Moments approach (Gautier and LeBihan, 2020)
- Evaluation of monetary policy non-neutrality over time
  - Impulse-response functions
  - Discussion of the sufficient statistic proposed by Alvarez et al. (2016)

Model

A multi-sector menu-cost model (Nakamura and Steinsson, 2010)

Set up a multi-sector menu-cost model to allow for heterogeneity in price-setting behaviour and idiosyncratic shock process across product groups.

- Standard household utility function (log utility)
- Production technology of firm i in sector k:

$$Y_{i,k,t} = A_{i,k,t} N_{i,k,t}$$

where the log of the idiosyncratic productivity process is given by:

$$\ln A_{i,k,t} = \rho_k \ln A_{i,k,t-1} + \varepsilon_{i,k,t}, \quad \sigma_{a,k} = E_t \varepsilon_{i,k,t}^2$$

- Firms face downward sloping demand curve:

$$Y_{i,k,t} = \left(\frac{P_{i,k,t}}{P_t} \right)^{-\theta} Y_t$$

Price-setting friction: *CalvoPlus*

- Monopolistic firm i sets price to maximize current and expected future profits subject to sticky price constraint

$$\Pi_{i,k,t} = \left(\frac{P_{i,k,t}}{P_t}\right) Y_{i,k,t} - \left(\frac{W_t}{P_t}\right) \frac{Y_{i,k,t}}{A_{i,k,t}}$$

- Random menu cost embeds both pure menu-cost based and Calvo-type price-setting frictions
  Menu cost process for firm i in sector k:

$$\mu_{i,k,t} = \begin{cases} 0, & \text{with probability } \lambda_k \\ \mu_k, & \text{with probability } 1-\lambda_k \end{cases}$$

  For $\mu_k \to \infty$ pricing frictions become purely Calvo.

Closing and Solving the Model

- The model is closed by assuming that the monetary authority targets a path for nominal output,

$$S_t = P_t Y_t$$

- Log nominal output follows a random walk with drift:

$$\ln S_t = \pi + \ln S_{t-1} + \eta_t.$$

  where η_t can be interpreted as an aggregate policy shock.
- The model is solved by numerical methods suggested by Krusell and Smith (1998) and implemented by Nakamura and Steinsson (2010).

Estimation

Estimation by Simulated Method of Moments Approach (Gautier and LeBihan, 2020)

- The Simulated Method of Moments approach of estimating the parameter vector $\hat{\theta}_{SMM}$ is to choose θ to minimize some distance measure between the model moments Ψ_{sim} and the data moments Ψ_{data} :

$$\hat{\theta}_{SMM} : \min_{\theta} \left(\Psi_{sim}(\theta) - \Psi_{data}\right)' W \left(\Psi_{sim}(\theta) - \Psi_{data}\right)$$

- For each product group k, three structural parameters are estimated:

$$\hat{\theta}_k = (\lambda_k, \mu_k, \sigma_{a,k})$$

- For each product group k, five price-setting moments are matched:

$$\Psi_k = \begin{bmatrix} freq_k \\ freq+_k \\ median_k \\ IQR_k \\ kurtosis_k \end{bmatrix}$$

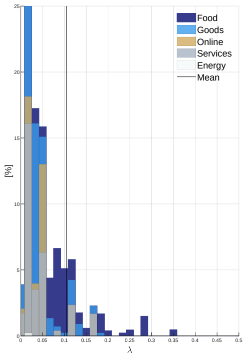
▸ Calibrated Parameters ▸ Data

Estimates of price-setting parameters

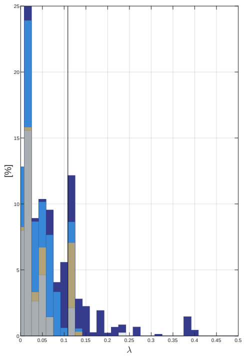
	Calvo λ	menu cost μ	av. menu cost $\bar{\mu}$	Volatility σ	Calvo Share $\frac{\lambda}{freq}$
One-Sector Model					
2008-2011	0.061	0.035	0.138	0.043	0.531
2012-2015	0.098	0.015	0.097	0.035	0.518
2016-2019	0.186	0.098	0.152	0.062	0.898
Five-Sector Model					
2008-2011	0.107	0.075	0.224	0.054	0.725
2012-2015	0.173	0.090	0.259	0.046	0.813
2016-2019	0.180	0.088	0.433	0.054	0.723
Multi-Sector Model					
2008-2011	0.099	0.089	0.242	0.060	0.518
2012-2015	0.102	0.090	0.222	0.052	0.469
2016-2019	0.126	0.072	0.314	0.071	0.557

Distribution of estimated λ parameters ("Calvo-ness")

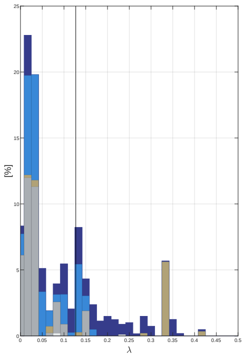
2008 – 2011



2012 – 2015



2016 – 2019



▸ Distribution Av. menu cost ▸ Distribution sigma

Evaluation

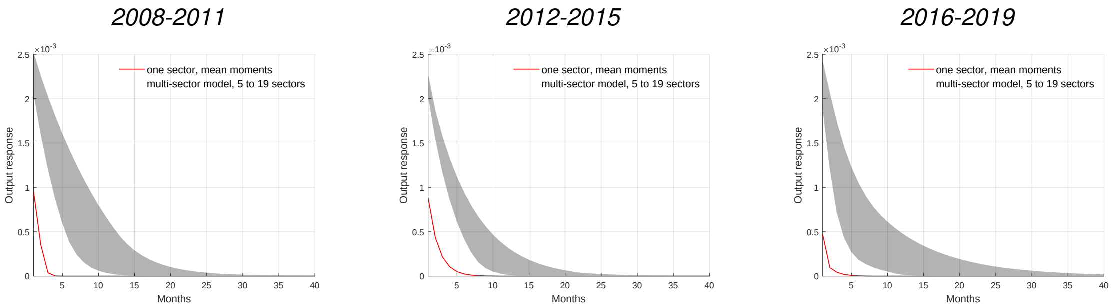
Evaluation of monetary policy non-neutrality

Two approaches to evaluate effect of shifts in price-setting moments on monetary non-neutrality

- *Impulse response function* of real output to monetary policy shock
- Alvarez et al. (2016) proposes a *sufficient statistic* approach to measure monetary policy non-neutrality
  - They show that ratio of kurtosis to frequency of price changes is a *sufficient statistic* for monetary policy non-neutrality in a wide class of models of price stickiness:

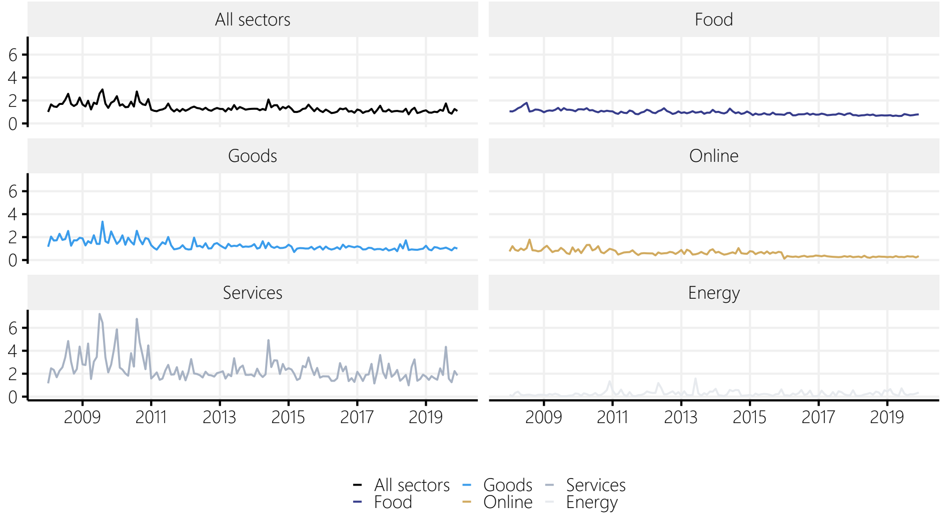
$$R = \sum_{k=1}^{K} \omega_k \frac{Kur_k}{Freq_k}$$

Impulse response function of real output to monetary shock



Impulse responses of real output to a one-standard deviation monetary policy shock

Alvarez et al. sufficient statistic based on observed sectoral moments



Conclusions

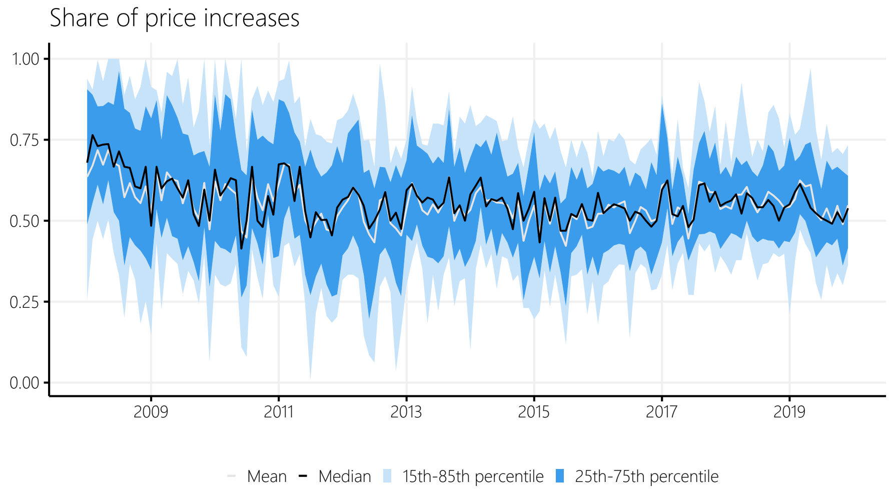
The main finding of this paper is that the observed changes in price-setting characteristics have not affected monetary policy non-neutrality in Switzerland.

- The effect of the increase in the frequency of price adjustment is largely compensated by the effect of the increase in the heterogeneity of price-adjustment patterns.
- This highlights the role of heterogeneity for the dynamics of aggregate prices and the potential of multi-sector models in analyzing monetary policy transmission.
- Other interesting findings:
    - Empirical evidence on the type of price stickiness prevalent in Swiss CPI micro prices (Calvo vs menu cost frictions)
    - Update of stylized facts on price-setting characteristics for Switzerland (frequency and size of price adjustments, etc.)

Appendix

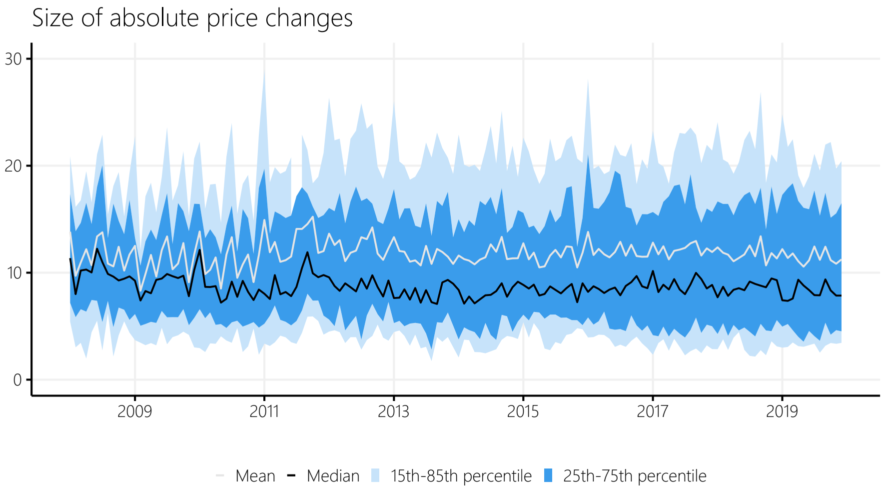
Evolution of the share of positive price changes: 2008–2020

▸ back



Evolution of absolute size of price changes: 2008–2020

back



Evolution of IQR of size of price changes: 2008–2020

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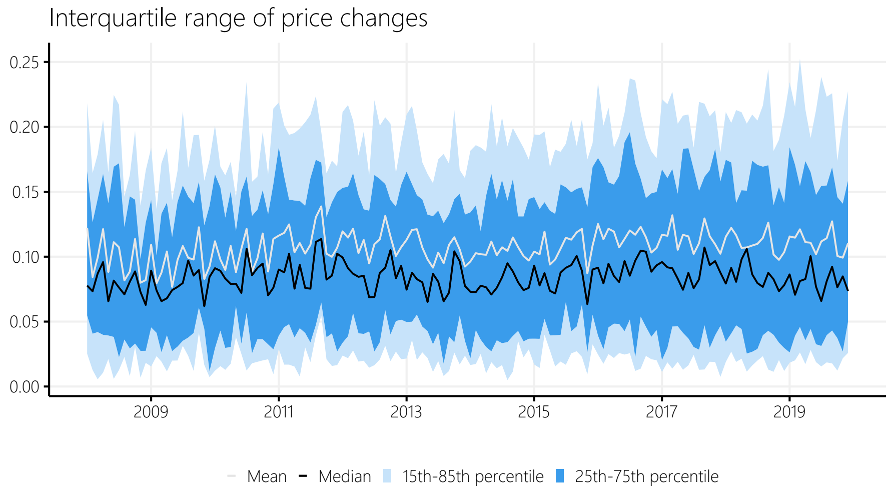

Evolution of the kurtosis of price changes: 2008–2020

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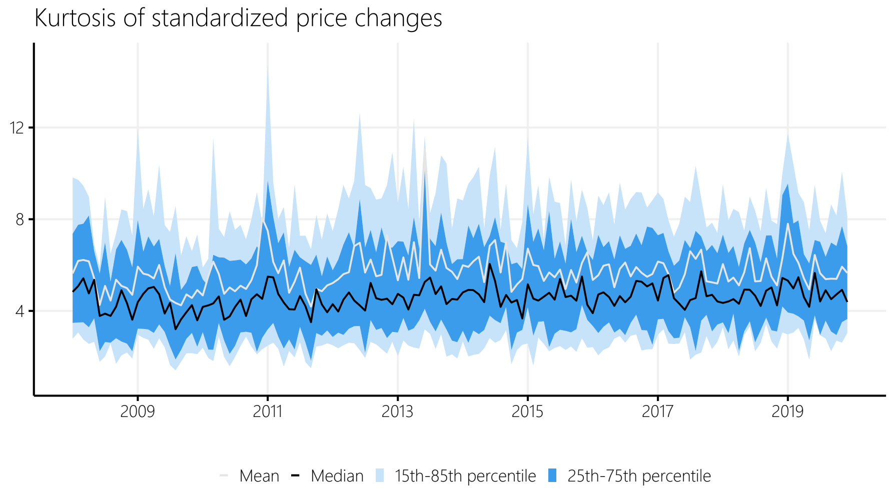

Average price-setting moments for 5 Sectors: 2008–2011, 2012–2015 and 2016–2019

back

	N	Freq. of changes	Share of increases	Size of price changes Median	IQR	Kurtosis	CPI Weight
2008–2011							
Food	66	0.13	0.53	0.10	0.11	6.35	12.69
Goods	72	0.10	0.54	0.14	0.19	5.76	18.28
Online	9	0.11	0.57	0.09	0.13	9.59	5.07
Services	32	0.10	0.72	0.08	0.07	6.29	16.89
Energy	4	0.97	0.52	0.03	0.05	2.70	4.53
2012–2015							
Food	66	0.23	0.52	0.08	0.07	7.15	12.23
Goods	71	0.15	0.49	0.15	0.21	5.63	17.48
Online	9	0.29	0.55	0.08	0.11	6.48	4.49
Services	33	0.07	0.65	0.08	0.10	5.33	17.95
Energy	4	0.93	0.44	0.03	0.04	2.66	4.03
2016–2019							
Food	79	0.28	0.52	0.07	0.07	7.44	13.27
Goods	84	0.20	0.51	0.15	0.22	6.35	16.32
Online	12	0.63	0.50	0.15	0.21	4.69	3.94
Services	43	0.06	0.65	0.08	0.10	5.60	17.96
Energy	5	0.95	0.53	0.02	0.04	2.61	3.20

Cross-sector distribution of abs. size of price changes

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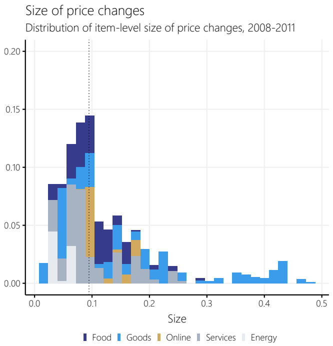

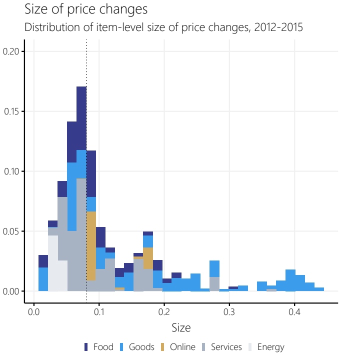

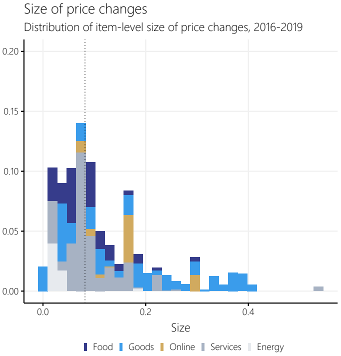

Cross-sector distribution of kurtosis of price changes

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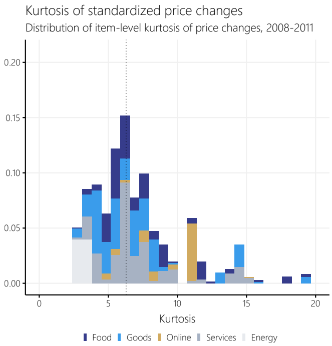

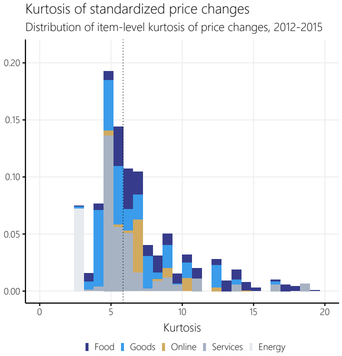

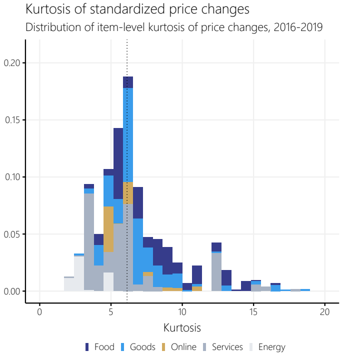

Calibration of other parameters

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Discount factor	β	$0.98^{1/12}$
Coefficient of relative risk aversion	γ	1
Elasticity of Demand	θ	4
Inverse Frisch elasticity of labor supply	ψ	0
Intermediate inputs share in production	s_m	0.0
Steady state labor supply	L	0.33
Steady state growth of nominal aggregate output	μ	0.01
Persistence parameter shock to growth of nom. aggregate demand	ρ_η	0.65
Std. deviation of shock to growth of nom. aggregate demand	σ_η	0.0028
Persistence parameter of idiosyncratic productivity process	ρ_k	0.7

Data

▸ back

- Calculate price-setting moments at product-group level k based on individual price quotes collected by FSO.
- In total $\sim 6,8$ millions price observations for the period Jan 2008 to Dec 2019
- The sample includes temporary sales but excludes administered prices and unit value indices.
- Monthly price-setting moments calculated for each product group; averages over three sample periods: Jan 2008 to Dec 2011, Jan 2012 to Dec 2015 and Jan 2016 to Dec 2019
- Moments calculated: freq, freq+, median size, IQR, kurtosis

Distribution of $\bar{\mu}$ estimates over time

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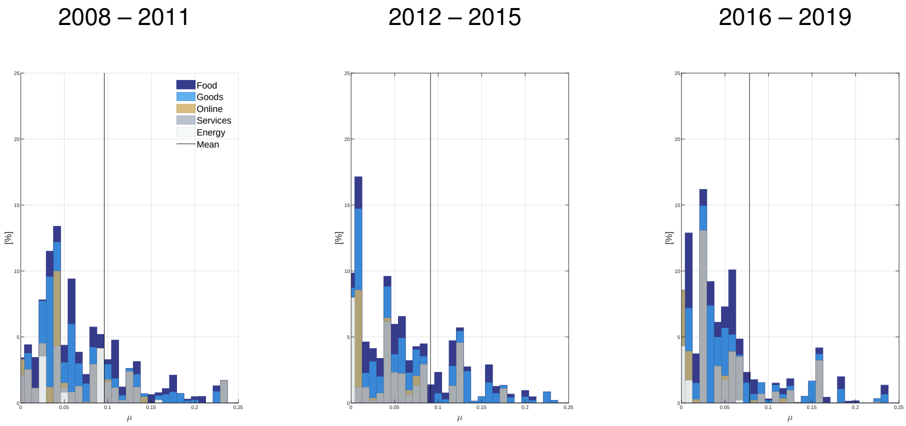

Distribution of σ estimates over time

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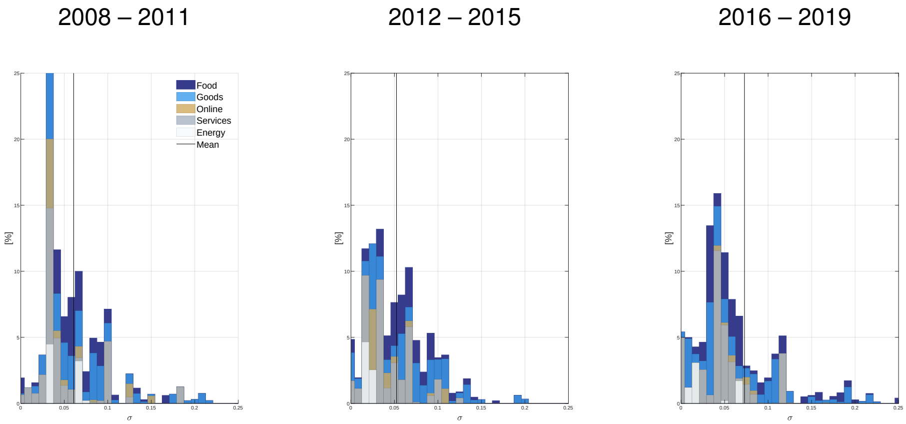

Data moments vs simulated model moments: kurtosis of price changes

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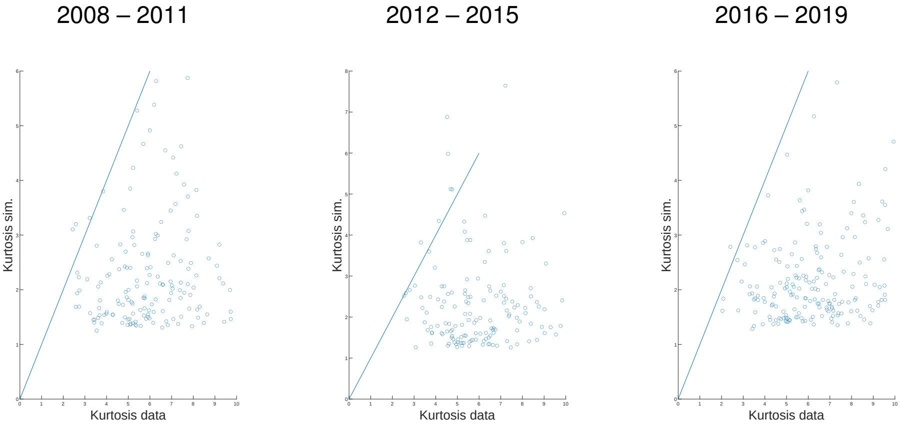

Data moments vs simulated model moments: share of price increases

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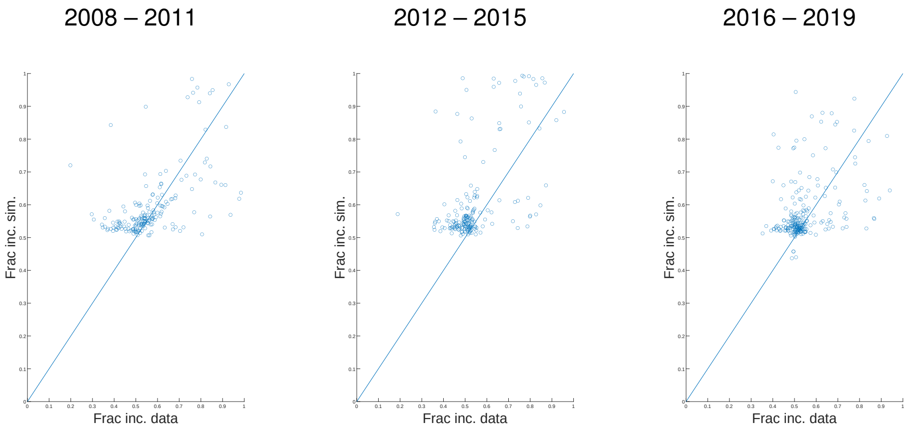

Data moments vs simulated model moments: abs. size of price changes

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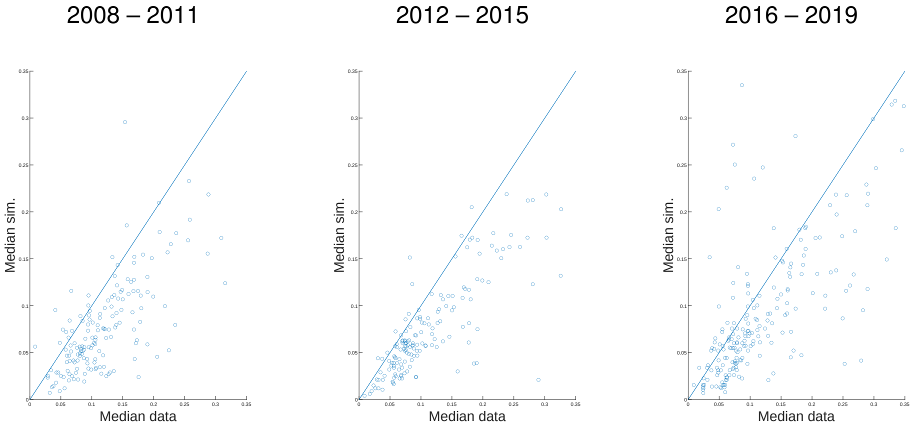

Data moments vs simulated model moments: IQR of price changes

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