Price rigidity with microeconomic data

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Financial Technologies and Central Banking
Mexico City, November 12-14, 2019

The opinions expressed here are those of the authors and do not reflect the views of CEMLA, University College London or the Central Bank of Uruguay.

Summary

- Understand price rigidity
- Characterize *sales* and explore its role in price flexibility
- Relate sales and retail price changes with unemployment and other macroeconomic variables
- Dataset: + 2.5 million observations
  1. +20,0000 retail product prices
  2. Weekly basis
  3. Macroeconomic data
  4. From 2014 to *now*

Structure

1. Motivation
2. Literature review
3. Data
4. PCA
5. Forthcoming

Why retail data?

- Price forecasting, e.g.: fruits and vegetables
- Study price flexibility $\rightarrow$ PM models and analysis
- Possibility to manage and process big databases with a panel structure

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- Correlation with local business cycle

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Why Uruguay?

- Small and open country
- Rich dataset to exploit

Literature review

Literature review

- **Nakamura and Steinsson (2006).** *Five facts about prices: a reevaluation of menu cost models.*
- **Nakamura and Steinsson (2013).** *Informational rigidities and the stickiness of temporary sales.*
- **Eichenbaum and Jaimovich (2011).** *Reference prices, costs and nominal rigidities.*
- **Coibion, Gorodichenko and Hee Hong (2013).** *The cyclicality of sales, regular and effective prices: business cycle and policy implications.*
  - **Gagnon, López-Salido, Sockin (2017).** *Comment.*
- **Glandon (2018).** *Sales and the (mis)measurement of price level fluctuations.*

Data description

Data

- Retail prices: **weekly** from August 2014 to *now* (October 2019)
  - Classification by *sectors*:

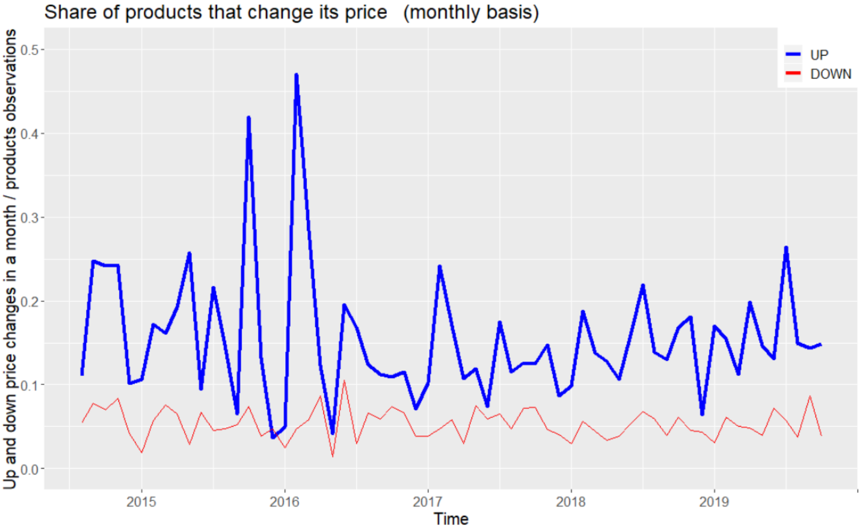
    1. Drinks
    2. Alcoholic drinks
    3. Food (sample)
    4. Fruit and vegetables
    5. Tobacco
    6. Personal care
    7. Other (stationery, pet food, toys, etc.)

  - Dummy variable for *sales* (1 on sale, 0 normal price).
  - Currency (Uruguayan pesos)
- Macrodata: **monthly** from May 2013 to September 2019
  - Cpi index
  - Employment rate
  - Unemployment rate

Data

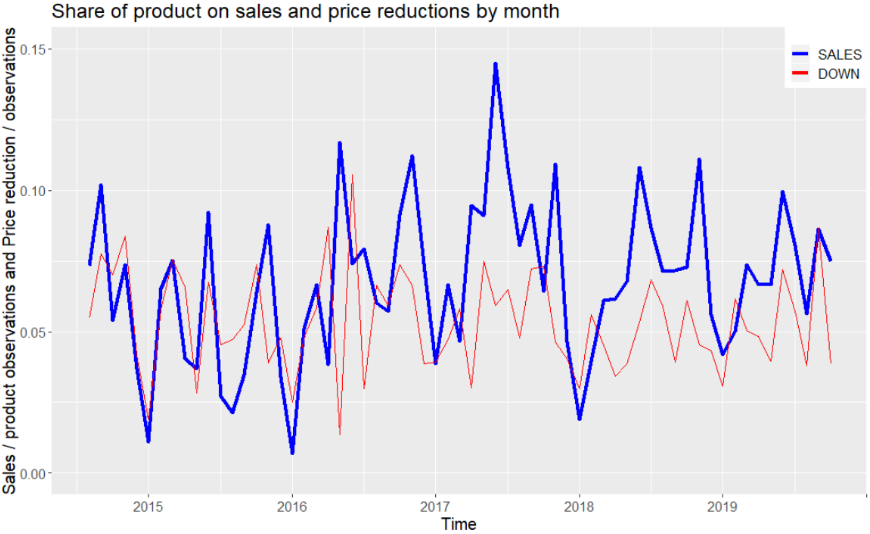
- Data cleaning for the PCA
  - Few constant prices were removed
  - Missing values were filled by assuming the last previous observation
  - Few multiple price cases, where a product reported multiple prices in the same week, we took the minimum price observed
- Softwares: **MATLAB + R**

How many products changed its price?



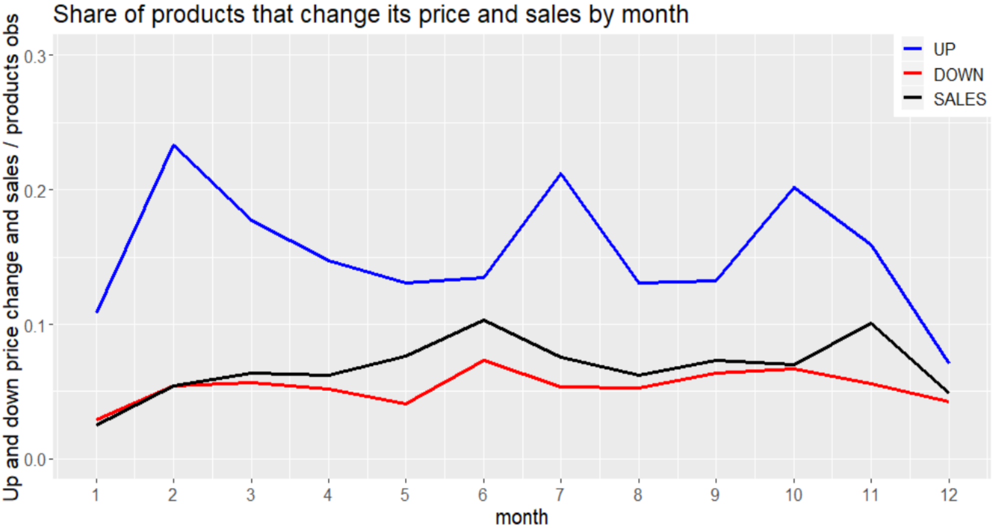
Source: Banco Central del Uruguay from supermarket data

Price reductions and sales



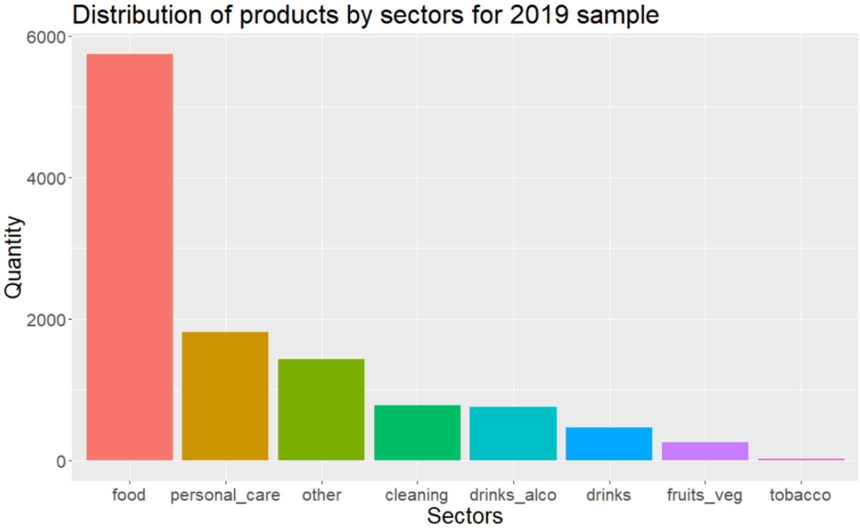
Source: Banco Central del Uruguay from supermarket data

Seasonality of price changes and sales



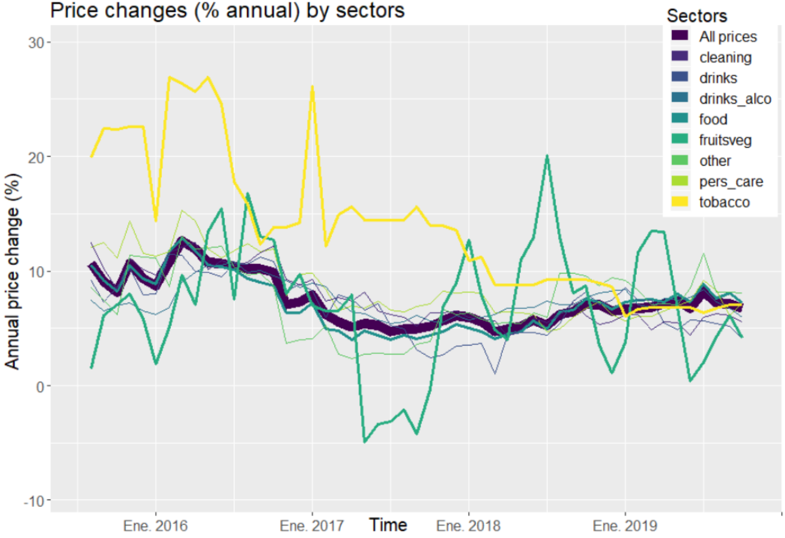
Source: Banco Central del Uruguay from supermarket data

Product sectors



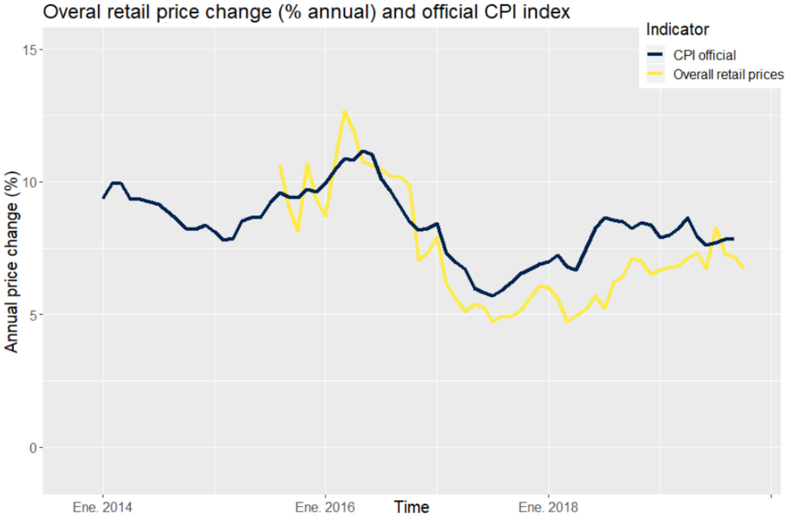
Source: Banco Central del Uruguay from supermarket data

Price variation: all sectors



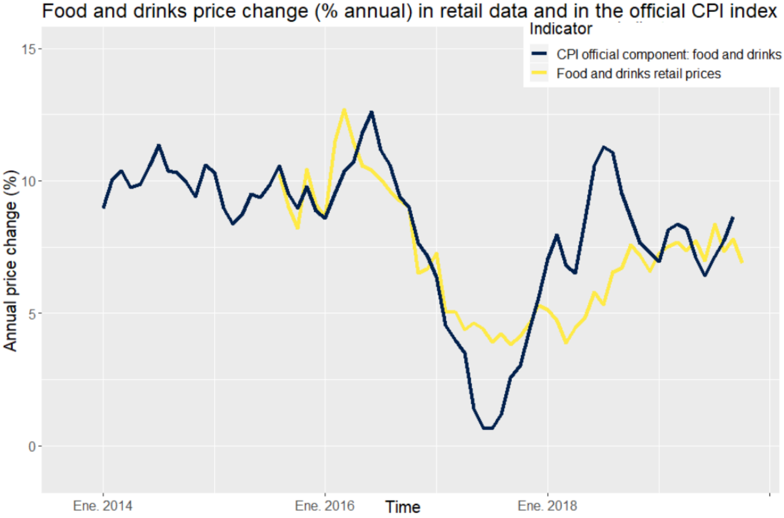
Source: Banco Central del Uruguay from supermarket data

Price variation: retail data vs. official CPI



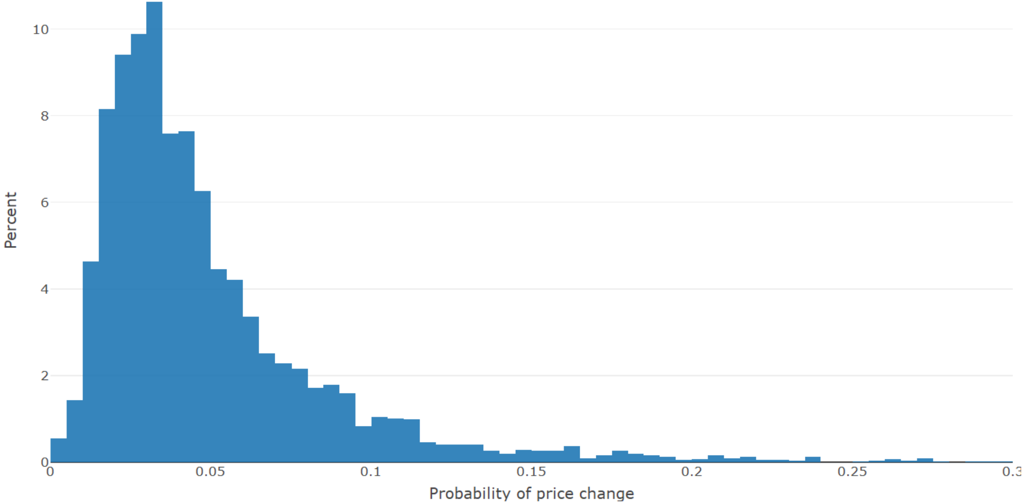
Source: Banco Central del Uruguay from supermarket data and National Institute of Statistics

Price variation: food and drinks



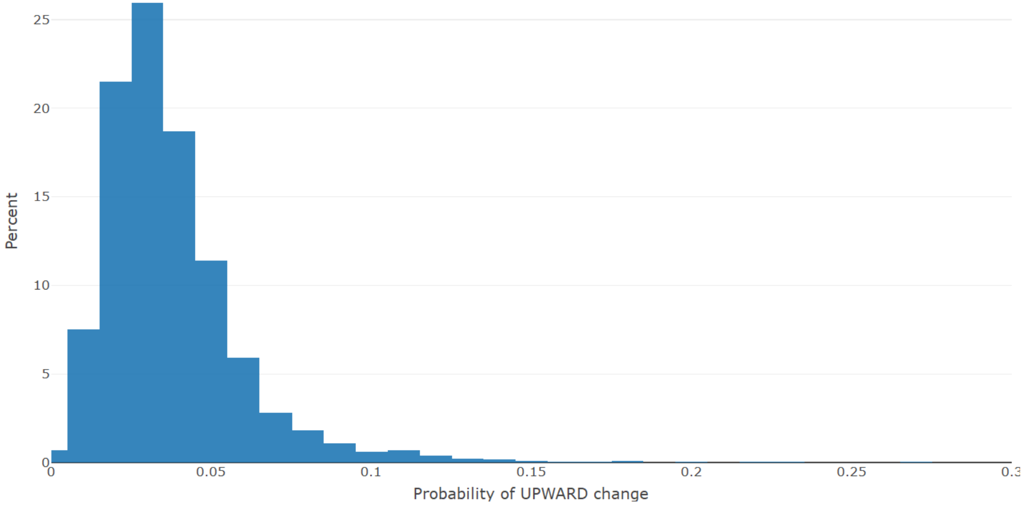
Source: Banco Central del Uruguay from supermarket data and National Institute of Statistics

Price change probability



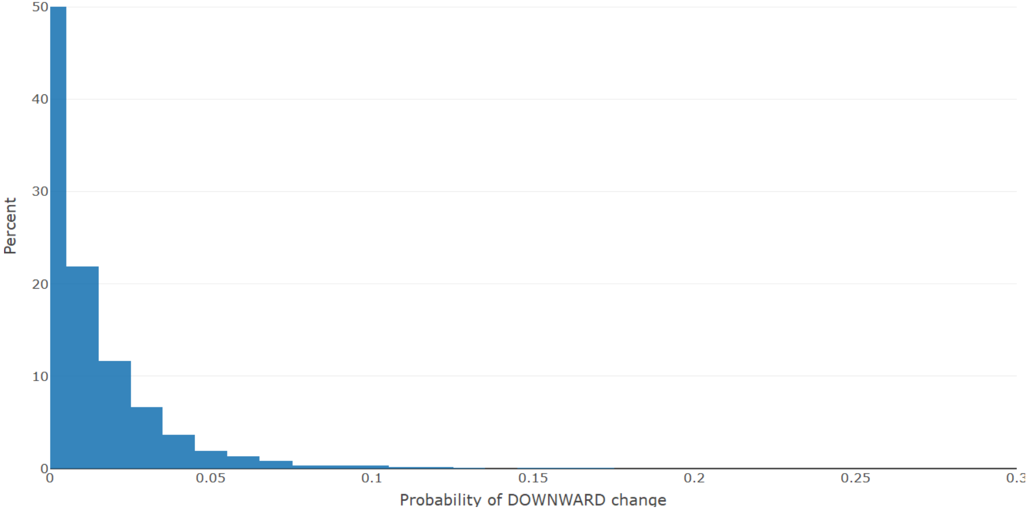
Source: Banco Central del Uruguay from supermarket data

Price change probability: **upward**



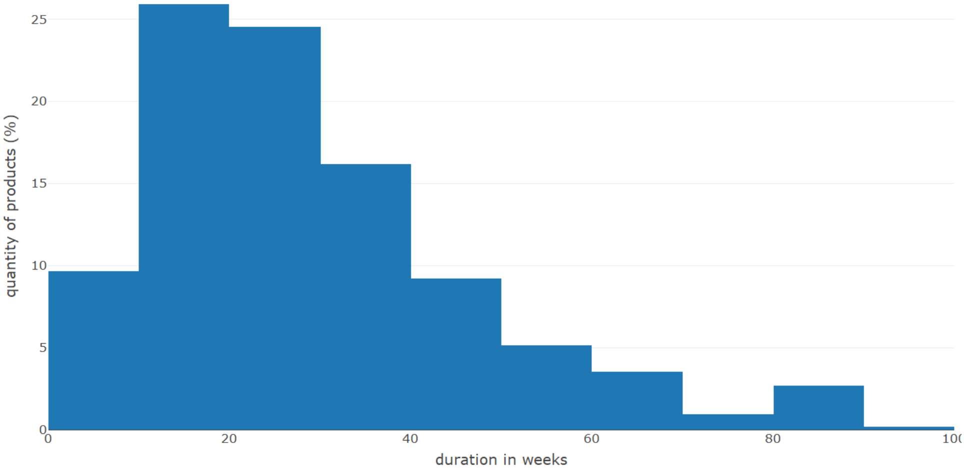
Source: Banco Central del Uruguay from supermarket data

Price change probability: **downward**



Source: Banco Central del Uruguay from supermarket data

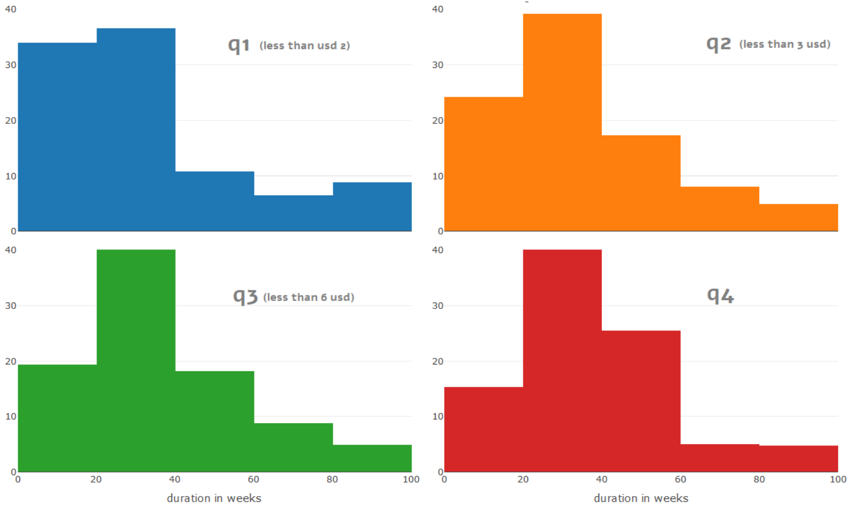
Duration



$$\text{Duration in weeks} = \frac{-1}{1 - log(prob(price\_change))}$$

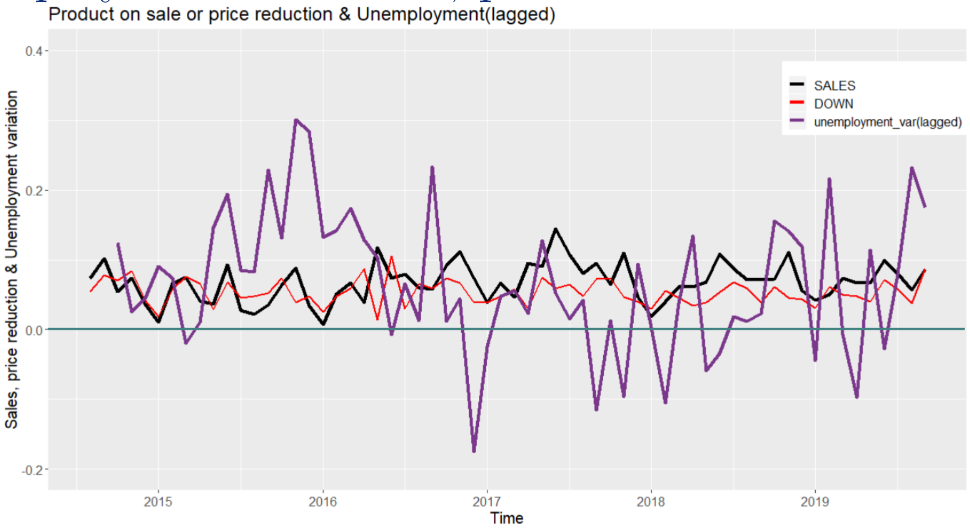
Source: Banco Central del Uruguay from supermarket data

Duration by quantiles



Source: Banco Central del Uruguay from supermarket data

Unemployment variation, price reduction and sales



Source: Banco Central del Uruguay from supermarket data and National Institute of Statistics

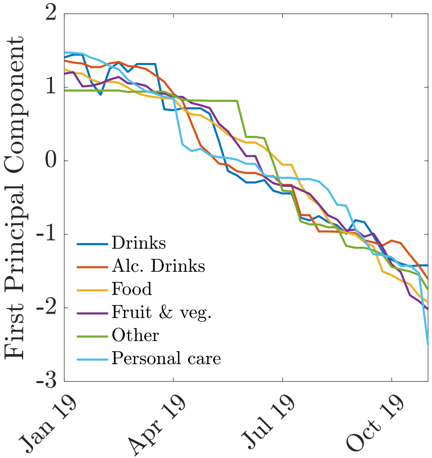
Principal Component Analysis

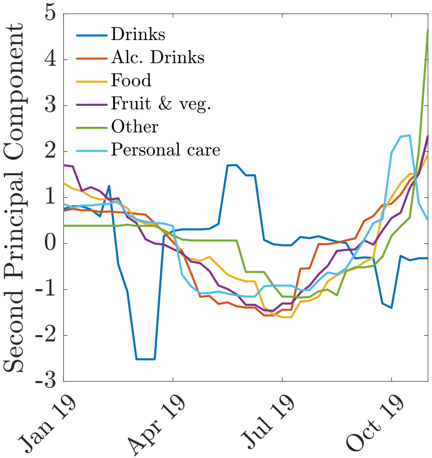
Data and PCs

- January - October 2019 (41 weeks)
- Sectors:

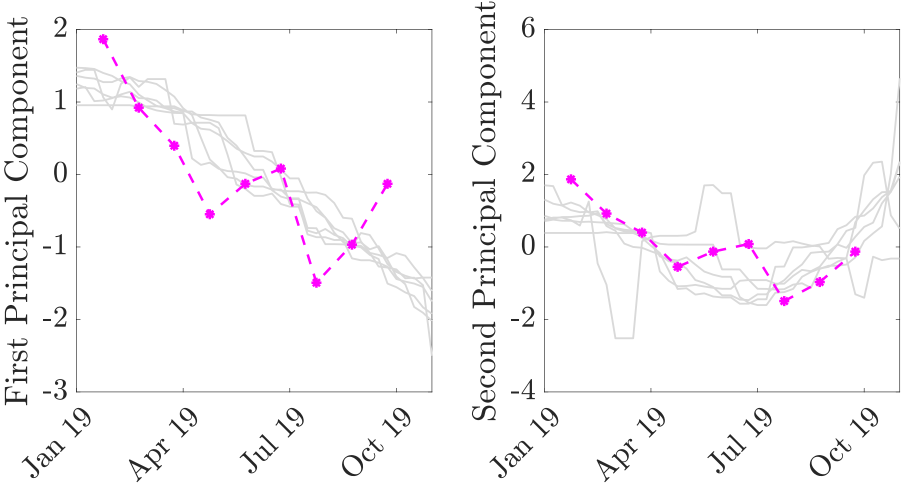
❑ Drinks	$N = 132; \lambda_1/N = 34.8\%; \lambda_2/N = 14.0\%$
❑ Alc. drinks	$N = 608; \lambda_1/N = 53.6\%; \lambda_2/N = 12.5\%$
❑ Food	$N = 896; \lambda_1/N = 49.4\%; \lambda_2/N = 10.7\%$
❑ Fruit	$N = 140; \lambda_1/N = 38.1\%; \lambda_2/N = 16.9\%$
❑ Other	$N = 317; \lambda_1/N = 61.0\%; \lambda_2/N = 12.8\%$
❑ Personal	$N = 1601; \lambda_1/N = 45.9\%; \lambda_2/N = 14.3\%$

1st and 2nd PCs





PCs and employment



Correlations

- Highest correlation and significance is achieved between employment and PCs in 2nd week of the following month (especially with 2nd PC)

	1st PC	2nd PC
Drinks	0.74*	0.17
Alc. drinks	0.69*	0.60*
Food	0.64*	0.92***
Fruit & veg.	0.67*	0.82**
Other	0.60*	0.79*
Personal care	0.75*	0.75**

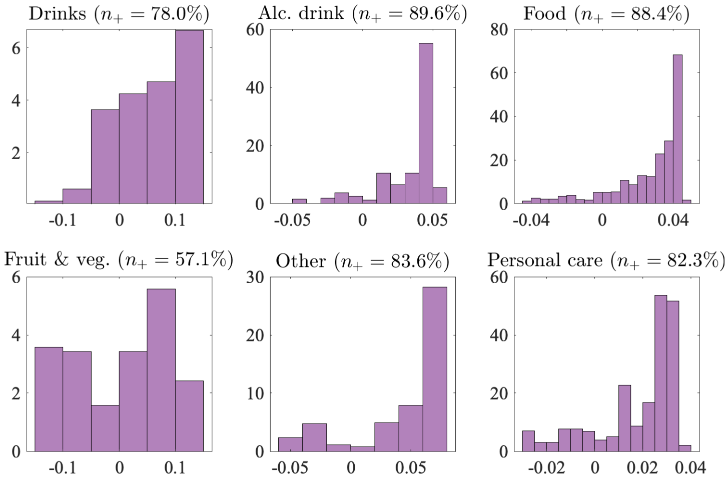
- Much lower correlation and significance in the case of unemployment

Granger causality

- Granger causality (at 5% significance level, 1 time lag) of PCs by employment

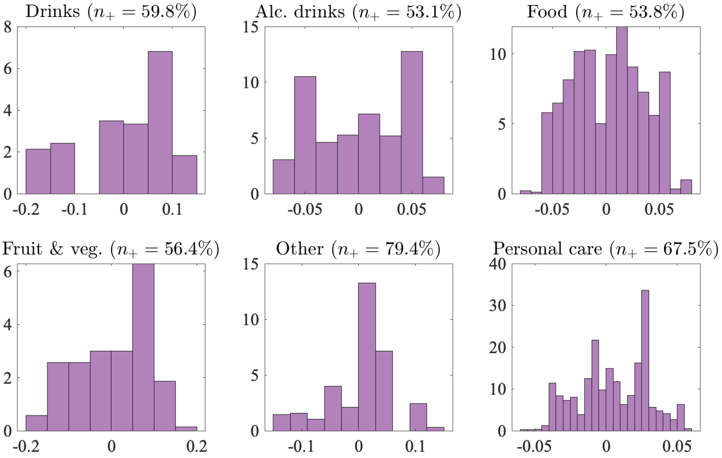
	1st PC	2nd PC
Drinks	$\times$	$\times$
Alc. drinks	$\checkmark$	$\times$
Food	$\checkmark$	$\checkmark$
Fruit & veg.	$\times$	$\times$
Other	$\times$	$\times$
Personal care	$\times$	$\times$

1st eigenvectors



In 4 out of 5 cases there is a clear interpretation of 1st PC as a source of positive correlation between products, driven by employment (“sector mode” / “employment mode”)

2nd eigenvectors



Roughly 50-50 splits in 4 out of 5 sectors: possible interpretation as a source of negative correlation between groups of products w.r.t. 1st PC (different responses w.r.t. changes in employment)

(Very preliminary) Conclusions

- All sectors share a **common correlation structure** as revealed by PCA
- 1st PC: **“employment mode”**
- 2nd PC: correlations with respect to employment mode, describing different product sensitivity
- Some **causality** (especially in the case of **food**)

Forthcoming

Forthcoming

- PCA with all the data
- More MACRO variables
- More MICRO variables
- Seasonality
- Price forecasting
  - **Now**casting
  - Martingale prediction market methodology

¡Gracias! / Thanks!

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