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"Food price inflation in the dairy sector: the role of retailers' strategies"

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High frequency data

- Data are from Symphony IRI Group
- 156 weeks (2009-2011)
- 400 points of sale (POS) described by
  - Chain name (blinded as “chain A”)
  - Retailer Formats (Hyper, Super, Superette)
  - We don’t know where the store is located (just in Italy), discounts are excluded
  - Sample is not representative
- 9 dairy product categories:
  - Butter, Mozzarella, Ricotta, Processed cheese, Yogurt
  - Cream and Milk (both refrigerated and UHT)

An Example:

Within the **Refrigerated milk** category:

for each

- Week (156)
- Point of sale (400)
- Group(14)

We observe

- **Value Volume and Unit sold with\without Temporary Price Reductions (TPR)**
- **Price in volume, value and Unit with\without TPR**

Brand Unit (BU)=
Producers x Brands x Packaging

Research Questions:

I. Do retailer strategies influence prices? How?

II. What is the influence of certain observed retailer's strategies on food prices?
   - Assortment strategy;
   - PL share;
   - PL shelf depth;
   - Promotion;
   - PL promotion intensity.

III. What is the magnitude of specific chain and format not observed strategies on prices variation?

Research Design:

I. For each of the dairy product available we compute drift-free indexes chain-format specific over weeks.

II. Use three-way ECM estimator to capture the unobservables due to chain time and format variation.

III. Identify the contribution of some observed retailer strategy on prices.

The observed retail strategies are:

-Promotion (overall and PL promotion);

-Assortment;

-PL presence and shelf depth .

What price index?

The use of high frequency scanner data on computing Price indexes has many advantages:

I. **Product price and quantities of all goods are available**
   -> Superlative weighted CPI

I. **Use actual consumer purchasing behavior**

   -> CPI accounts for all observable and unobservable marketing strategies influencing consumption

1. However, some complications arise:

Chain Drift Bias:

- Caused by some price dynamics known as “price and quantity bouncing” (Nakamura et al. 2011, Ivanic et al. 2011, Haan and van der Grent 2011)
- **“*Quantity bouncing arises from the fact that households tend to stock up during sale periods and consume from inventory at times when the goods are not on sale*”** (Haan and van der Grient, 2011)
- *Presence of chain drift bias has been found comparing price indexes calculated with all prices and only with “regular prices”, without sales (Nakamura et al.,2011)*
- *Highly disaggregated unit and time values will lead to **more volatile and unstable estimates** of price changes* (Ivancic et al. 2011).

Solutions to overcome the Chain Drift Bias:

I. Nakamura et al. (2011) analysis suggests that “averaging within chains will ameliorate the chain drift problem.” However “…the chain drift problem will not be solved solely by averaging data across stores within retail chains”.

II. **Ivanic et** al. (2011) show conventional superlative indexes, even calculated at the level of aggregation that empirically seems to minimize the drift bias, “show a troubling degree of volatility when high-frequency data are used”

They proposed the use of a drift-free multilateral index

→ **GEKS index.**

1.A) Index Calculation:

The GEKS index (Ivanic et al. 2011):

I. It is a multilateral index.

II. It satisfies the multilateral circularity property (same result can be obtained comparing entities among each others or with an external entity).

Assume we want to make comparison among **M** different entities:

P_{ij} = Fisher index between entities i and j ($j = 1 \dots M$)

P_{kj}= Fisher index between entities k and j

$$GEKS_{i,k} = \prod_{j=1}^{M} \left[\frac{P_{ij}}{P_{kj}}\right]^{1/M}$$

Geometric mean of the two Fisher indexes

1.B) Index Calculation:

GEKS index (Ivanic et al. 2011) can be used:

to compare T different time periods $j = 1 \ldots T$.

Considering as $t = 0$ the reference period to make comparison among $t = 1 \ldots T$ periods.

We use the GEKS price index simply substituting M with T :

$$GEKS_{o,t} = \prod_{t=0}^{T} \left[\frac{P_{0l}}{P_{tl}} \right]^{1/T}$$

1.C) Index Calculation:

Advantages of using the GEKS index:

I. Given the **circularity property** the **GEKS** index can be written as a period to period chain index $\prod_{t=1}^{t} GEKS_{t-1,t}$;

II. According to the **multi-period identity** test (Walsh,1901; Szulc,1983) the GEKS is free of drift chain bias;

III. Suitability to **flexible basket** approach on the index computation.

1.D) Index Calculation:

Product by product we calculate the weekly GEKS index at any combination of:

$i = 1 \dots 14$ Chain and $j = 1 \dots 3$ Format

As not every chain has the full format range we have a total of 33 chain-format combinations.

For each of the seven products we have a panel of:

33 chain-formats x 156 weeks (t) = 5,148 observations

To capture the initial difference among the 33 different combinations we scaled down the mean price in the first week for the GEKS price index.

$$\text{GEKS-P}_{i,j,t} = \text{GEKS}_{i,j,t} * \bar{P}_{i,j,1}$$

Where $\bar{P}_{i,j,1}$ = average price in the $i's$ Chain and the $j's$ format in the first week

Observed retailer Strategies:

- $PL\ share_{i,j,t}$ = Value PL sold / total value sold
- ✓ $PL\ shelf\ Depth_{i,j,t}$ = Num. market segment where PL is present/ total num. segments in the market
- ✓ $Assortment_{i,j,t}$ = Average number of Brand Units (BU)among stores for different i, j, t
- ✓ $Promotion_{i,j,t}$ = Share in value sold under promotion
- ✓ $PL\ Promotion_{i,j,t}$ = Share PL in value sold under promotion Value PL sold with promotion/ total PL sold.

Descriptive Statistics:

Mean values							
	Butter	Cheese	Milk	UHT	Mozzarelle	Cream	Yogurt
GEKS-Price	7.12	9.06	1.43	0.96	7.70	4.48	4.22
Assortment	15.27	12.58	15.85	26.47	23.54	13.15	86.67
Share PL	0.28	0.03	0.11	0.16	0.19	0.21	0.09
PL Shelf Depth	0.40	0.30	0.28	0.70	0.41	0.40	0.58
Promotion	0.22	0.32	0.05	0.32	0.31	0.20	0.26
PL Promotion	0.17	0.15	0.12	0.22	0.23	0.19	0.22

Model Specification and estimation:

For each of the seven products

we estimate the following model using a **three-way ECM** estimator:

$$GEKS - P_{ij,t} =$$

$$\beta_1 Assortment_{i,j,t} + \beta_2 PL\ share_{i,j,t} + \beta_3 PL\ shelf\ Depth_{i,j,t} + \beta_5 Promotion_{i,j,t} + \beta_6 PL\ Promotion_{i,j,t} + u_{i,j,t}$$

Where $u_{i,j,t} = \mu_i + \delta_j + \gamma_t + \varepsilon_{i,j,t}$

We repeat the estimation for a fixed effect and random effect model

Variable	Butter		Cheese		UHT		Milk	
	FE	RE	FE	RE	FE	RE	FE	RE
Constant		7.1759***		9.7064***		1.0224***		1.3174***
Assortment	0.0056**	0.0057**	0.0063	0.0079*	-0.0002	-0.0002	0.0073***	0.0075***
Share PL	-0.4587***	-0.4193***	-0.3252	-0.2020	-0.0392***	-0.0331**	-0.2690***	-0.2729***
PL Shelf Depth	0.9635***	0.9302***	0.5905***	0.5074***	0.0714***	0.0671***	0.1039***	0.1071***
Promotion	-1.9547***	-1.9555***	-3.0148***	-3.0106***	-0.3281***	-0.3281***	-0.1751***	-0.1885***
PL Promotion	0.1063***	0.0948***	0.2192***	0.2094***	0.0275***	0.0251***	0.0007	0.0019
R squared	0.6795		0.6856		0.6709		0.7503	
σ^2 Chain		0.2146		0.5531		0.00370		0.0057
σ^2 Time		0.1137		0.1049		0.00020		0.0007
σ^2 Format		0.1282		0.1375		0.00015		0.0019
σ^2	0.1967	0.1967	0.4627	0.4627	0.0035	0.0035	0.0031	0.0031

Variable	Mozzarella		Yogurt		Cream	
	FE	RE	FE	RE	FE	RE
Constant		7.9673***		4.7864***		4.8963***
Assortment	0.0084***	0.0296***	-0.0022***	-0.0023***	-0.0133***	-0.0101**
Share PL	-2.1910***	-2.1393***	-2.3033***	-2.2219***	-0.4655***	-0.4369**
PL Shelf Depth	0.5814***	0.4616***	0.2311***	0.2596***	0.1594***	0.1873***
Promotion	-2.9341***	-2.9099***	-1.5281***	-1.5096***	-1.5510***	-1.5544**
PL Promotion	0.5934***	0.5614***	0.2149***	0.2056***	0.2640***	0.2462***
R squared	0.5085		0.6574		0.5648	
σ^2 Chain		0.2325		0.0284		0.1269
σ^2 Time		0.0240		0.0015		0.0025
σ^2 Format		-0.0064		0.0025		0.0075
σ^2	0.3525	0.3525	0.0476	0.0476	0.1250	0.1250

Results

- Assortment strategy has a mixed effect among products (Overall positive effect on price index with the exception of yogurt and cream).

- A higher PL market share has a negative effect on the Price Index over all products categories.

- However, a higher variety of the PL products in the shelf (shelf depth) has a positive influence on the Price index.

  - Do categories with higher price attract more consumers after the PL entry?

  - Do higher PL variety bring an increase of PL prices?

Result 2:

- Higher rate of promotion activity, considering both NB and PL products, has a negative impact on Price indexes;

- However, a higher PL promotion share has a positive effect on prices.

  - **Does PL promotional share have lower impact on price Index reduction with respect to promotion on NB products?**

  - **Are promotions on PL smaller on value with respect to NB products?**

What is next?

- **Explore effect of retailer strategies on the inflation rate of the overall dairy industry** *(considering all products covered by our dataset)*

  → **This will imply the construction of an unique model with all products category included.**

- **Investigate the casual relationship between NB prices and PL share.**

  → **The literature is controversial. Giving the high level of disaggregation of our database, we can explore the research question controlling for more effects (sub group in a products, chains and formats, POS etc..)**

Selected references

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Thank you!

Comments…