

Measuring Price Setting Behaviors Using Scanner Data

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Background

- Temporary bargain sales are suggested to influence on inflation rates because of their relatively larger sales quantities or changes of pricing-frequencies.
- In principle, Japan's CPI does not include short-term temporary sales prices.
- To verify the influence of temporary sales prices on inflation rates, we compare the price indices *including* temporary sales prices ("quantity weighted average price index") and *excluding* temporary sales prices ("reference price index") by using scanner data.
- We also investigate the frequencies of reference price changes and temporary pricing.

Quantity weighted average price index vs. Reference price index

Scanner data

- We use National POS Index (NPI) data.
 - NPI contains daily sales information of supermarkets and general merchandise stores thorough Japan.
 - Each record has the number of units sold and its sales for a product i at a shop s on a date td .
 - A product i at a shop s might have plural different prices in one day because there are not only daily basis discount sales but also limited-time discount sales.
- Our data set
 - To eliminate the 'shop/product replacement effects' (i.e. prices seem to be changed not by the real price changes but by the sales quantity changes among shops/products), we narrow down the data to the shops/products in the table above.
 - We select a product for each item which was sold every month from January 2012 through December 2015, and shops which sold these products every month through the same 48 months.

Items	Number of Shops	Number of Prices					Products
		2012	2013	2014	2015	Total	
Ketchup	148	45,551	45,826	44,337	44,665	180,379	Kagome Tomato Ketchup, 500g
Yogurt	189	66,517	66,575	66,595	66,900	266,587	Meiji Bulgaria Yogurt LB81, 450g
Potato chips	173	54,902	54,760	54,522	53,948	218,132	Calbee Lightly Salted Potato Chips, 60g
Laundry detergent	155	37,303	35,900	32,002	29,711	134,916	Kao Biozet Attack Laundry Powder, 1kg

Quantity weighted average price index

- Average Price $P_{s,itm}^{(Q)} = \frac{\sum_{td \in tm} Q_{s,itm} P_{s,itm}}{Q_{s,itm}}$
- Price index $I_{i,tm}^{(Q)} = \frac{M}{\sum_{tm=1}^M P_{i,tm}^{(Q)}} P_{i,tm}^{(Q)} \times 100$, where $P_{i,tm}^{(Q)} = \frac{1}{n} \sum_{s=1}^n P_{s,itm}^{(Q)}$

Reference price index

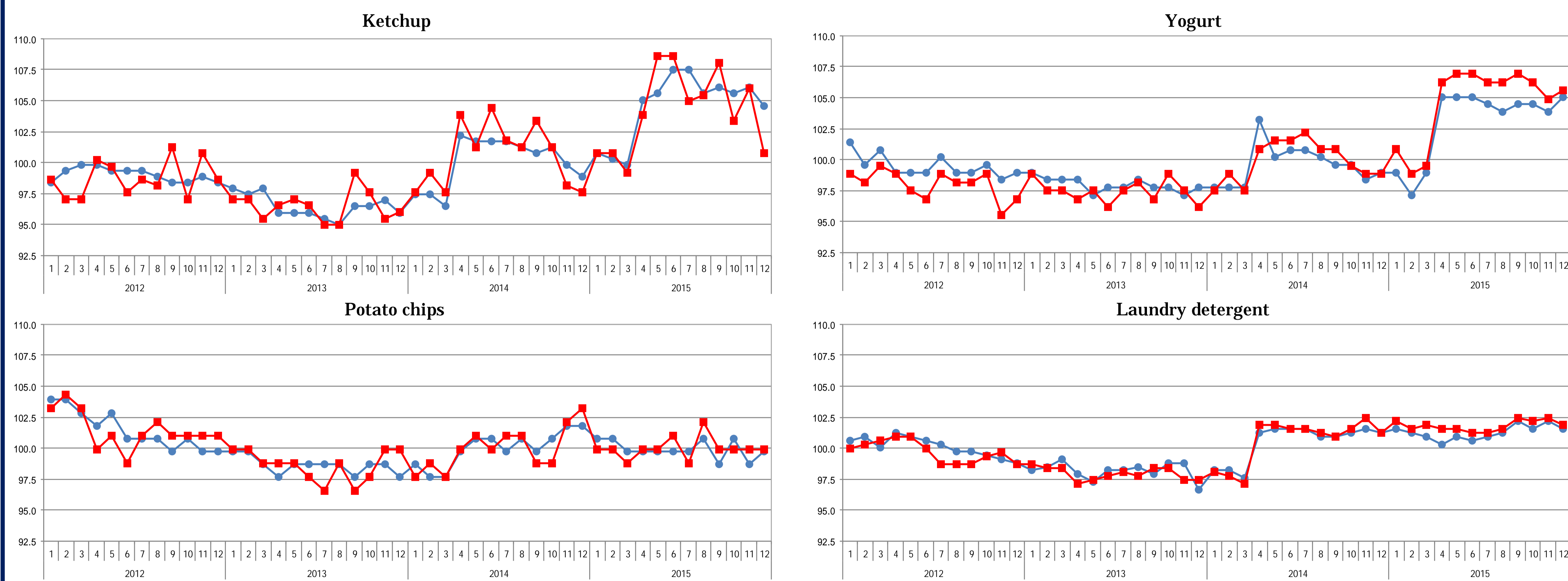
- Reference price $P_{s,itm}^{(R)} = \max_{td \in tm} (P_{s,itm})$
- Price index $I_{i,tm}^{(R)} = \frac{M}{\sum_{tm=1}^M P_{i,tm}^{(R)}} P_{i,tm}^{(R)} \times 100$, where $P_{i,tm}^{(R)} = \frac{1}{n} \sum_{s=1}^n P_{s,itm}^{(R)}$

($P_{s,itm} = (S_{td}^{s,i}) / (Q_{td}^{s,i})$, S = sales, Q = sold quantity, $M = 48$, n = number of shops, i : product, s : shop, td : day, tm : month)

Results

■ : Quantity weighted average price index ● : Reference price index

(2012 to 2015 = 100)



Frequency and Discount rate

Reference price changes

- Price change dummy $d_{s,itm} = 1$ when $|P_{s,itm}^{(R)} - P_{s,itm-1}^{(R)}| \geq 2$
- Monthly frequency (%) $F_i^{(R)} = \frac{\sum_s \sum_{tm \in ty} d_{s,itm}}{12n_i} \times 100$
(n = number of shops, i : product, s : shop, tm : month, ty : year)

Temporary pricing

- Assumption: *Temporary pricing is to set a discount rate on a "reference price".*
- Temporary pricing dummy $d_{s,itm}^{(P)} = 1$ when $\frac{P_{s,itm}}{P_{s,itm}^{(R)}} < 1$ and $|P_{s,itm} - P_{s,itm-1}| \geq 2$
- Real sales dummy $d_{s,itm}^{(Q)} = 1$ when $Q_{td}^{s,i} > 0$
- Daily frequency (%) $F_i^{(T)} = \frac{1}{n_i} \sum_s \left(\frac{\sum_{td \in ty} d_{s,itm}^{(P)}}{\sum_{td \in ty} d_{s,itm}^{(Q)}} \right) \times 100$
- Discount rate (%) $D_i = \frac{\sum_s \sum_{td \in ty} D_{s,itm}}{n_i N_i}$, where $D_{s,itm} = \left(\frac{P_{s,itm}}{P_{s,itm}^{(R)}} - 1 \right) \times 100$
 $N_i = \sum_s \sum_{td \in ty} d_{s,itm}^{(Q)}$
(n = number of shops, i : product, s : shop, td : date, tm : month, ty : year)

Results

Frequency of reference price changes

Items	(% per Month)				
	2012	2013	2014	2015	Total
Ketchup	4.3	3.3	6.4	10.8	6.2
Yogurt	5.6	4.8	6.9	9.2	6.6
Potato chips	4.3	5.4	6.6	7.2	5.9
Laundry detergent	7.6	6.1	6.3	5.6	6.4

Frequency of temporary pricing

Items	(% per Day)				
	2012	2013	2014	2015	Total
Ketchup	15.8	13.3	14.9	15.4	14.8
Yogurt	27.5	28.5	30.0	27.8	28.5
Potato chips	17.5	17.8	15.4	15.7	16.6
Laundry detergent	13.7	14.7	16.3	15.2	15.1

Discount rate of temporary pricing

Items	(%)				
	2012	2013	2014	2015	Total
Ketchup	-15.0	-15.6	-15.2	-16.0	-15.3
Yogurt	-13.4	-12.6	-11.0	-10.7	-11.9
Potato chips	-13.2	-13.9	-13.8	-12.9	-13.2
Laundry detergent	-9.3	-8.0	-7.0	-7.4	-8.3

Conclusion

- Frequency of reference price changes are close to the prior estimations (e.g. Kurachi, Hiraki and Nishioka (2016)). It suggests that our temporary pricing filter works well.
- The quantity weighted average price index ($I^{(Q)}$) moves up and down across the reference price index ($I^{(R)}$). $I^{(Q)}$'s larger volatilities are possibly caused by (1) temporary sales prices, or (2) our limited data set on specific products and shops.
- Discount rates and frequencies of temporary pricing are different for each item.