Dynamic and Individual Preference Change Analysis for Evaluating Frequent Shoppers Program

Kei Takahashi School of Statistical Thinking, Project Assistant Professor

▶Frequent Shoppers Program

frequent shopper program is a continuity incentive program offered by a retailer to reward customers and encourage repeat business using issuing coupon or crediting point. The reward is usually based on either purchase volume or number of store visits.

Reference: AMA

▶ Shop's problem

To whom to issue a coupon?
On which item to issue a coupon?
How much to discount?

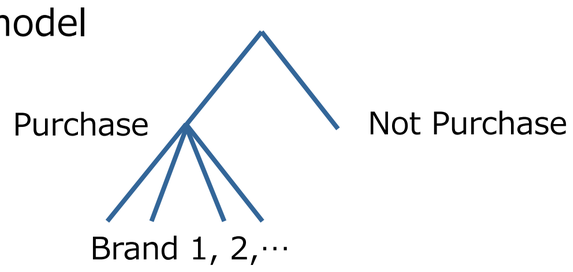
Developing dynamic and individual consumer choice model in category level using particle filter

Example

▶ Model and Its Estimation

Nested (Hierarchical) Logit Model

Upper level: Purchase incidence model
Lower level: Brand choice model



▶ Brand Choice Model

・Choice probability

$$P_t^h(j|c) = \frac{\exp V_{jt}^h}{\sum_{j'} \exp V_{j't}^h}$$

・Utility function

$$V_{jt}^h = \alpha_{1t}^h Y_{1jt}^h + \alpha_{2t}^h Y_{2jt}^h + \alpha_{3t}^h Y_{3jt}^h + \alpha_{4t}^h Y_{4jt}^h$$

Y_{1jt}^h :Volume of brand j for consumer h at t

$$Y_{2jt}^h = \begin{cases} R_{jt}^h - I_{jt}^h & R_{jt}^h > I_{jt}^h \\ 0 & R_{jt}^h \le I_{jt}^h \end{cases} \qquad R_{jt}^h = \omega^h R_{jn}^h + (1-\omega^h) I_{jn}^h$$

$$Y_{3jt}^h = \begin{cases} 0 & R_{jt}^h > I_{jt}^h \\ I_{jt}^h - R_{jt}^h & R_{j,t}^h \le I_{jt}^h \end{cases}$$

R_{jt}^h :Reference price

Y_{4jt}^h :Brand royalty

▶ Purchase Incidence Model

・Choice probability

$$P_t^h(c) = \frac{1}{1+\exp(-V_{ct}^h)}$$

・Utility function

$$V_{ct}^h = \beta_{1t}^h X_{1t}^h + \beta_{2t}^h X_{2t}^h + \beta_{3t}^h X_{3t}^h$$

$X_{1t}^h = \log\left(\sum_j \exp V_{jt}^h\right)$:Category Value

X_{2t}^h :Home stock

X_{3t}^h :Purchase interval

Estimation

・Time-varying parameter⇒ particle filter

$$\begin{bmatrix} \alpha_{1t}^h \\ \alpha_{2t}^h \\ \alpha_{3t}^h \\ \alpha_{4t}^h \\ \log\left(\frac{\beta_{1t}^h}{1-\beta_{1t}^h}\right) \\ \beta_{2t}^h \\ \beta_{3t}^h \end{bmatrix} = \boldsymbol{I} \begin{bmatrix} \alpha_{1(t-1)}^h \\ \alpha_{2(t-1)}^h \\ \alpha_{3(t-1)}^h \\ \alpha_{4(t-1)}^h \\ \log\left(\frac{\beta_{1(t-1)}^h}{1-\beta_{1(t-1)}^h}\right) \\ \beta_{2(t-1)}^h \\ \beta_{3(t-1)}^h \end{bmatrix} + \boldsymbol{I} \begin{bmatrix} e_{\alpha_{1t}^h} \\ e_{\alpha_{2t}^h} \\ e_{\alpha_{3t}^h} \\ e_{\alpha_{4t}^h} \\ e_{\beta_{1t}^h} \\ e_{\beta_{2t}^h} \\ e_{\beta_{3t}^h} \end{bmatrix}$$

$$e_{t,\alpha_{k,t}^h} \sim N(0, \tau^2_{\alpha_{k,t}^h}) \quad k = 1,\dots,4$$

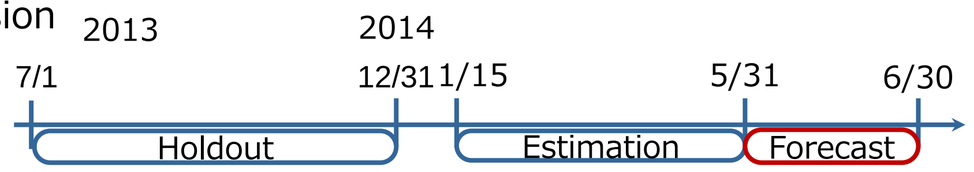
$$e_{t,\beta_{l,t}^h} \sim N(0, \tau^2_{\beta_{l,t}^h}) \quad l = 1,\dots,3$$

parameter at t | parameter at t-1 | error term

・Time constant parameter⇒ MLE via Nelder Meed Method
・Home Stock, Initial Value⇒ MLE from Holdout Data

▶ Using Data

▶ Scan Paneled Data with ID from Data Analyzing Competition 2014 in JASMAC and Zennisshoku Chain
▶ Target Category: Eggs
5 Brands (sum of these has over 90% share) + others
▶ Target Household
35 Households (over 40 times in estimation period)
▶ Data Division



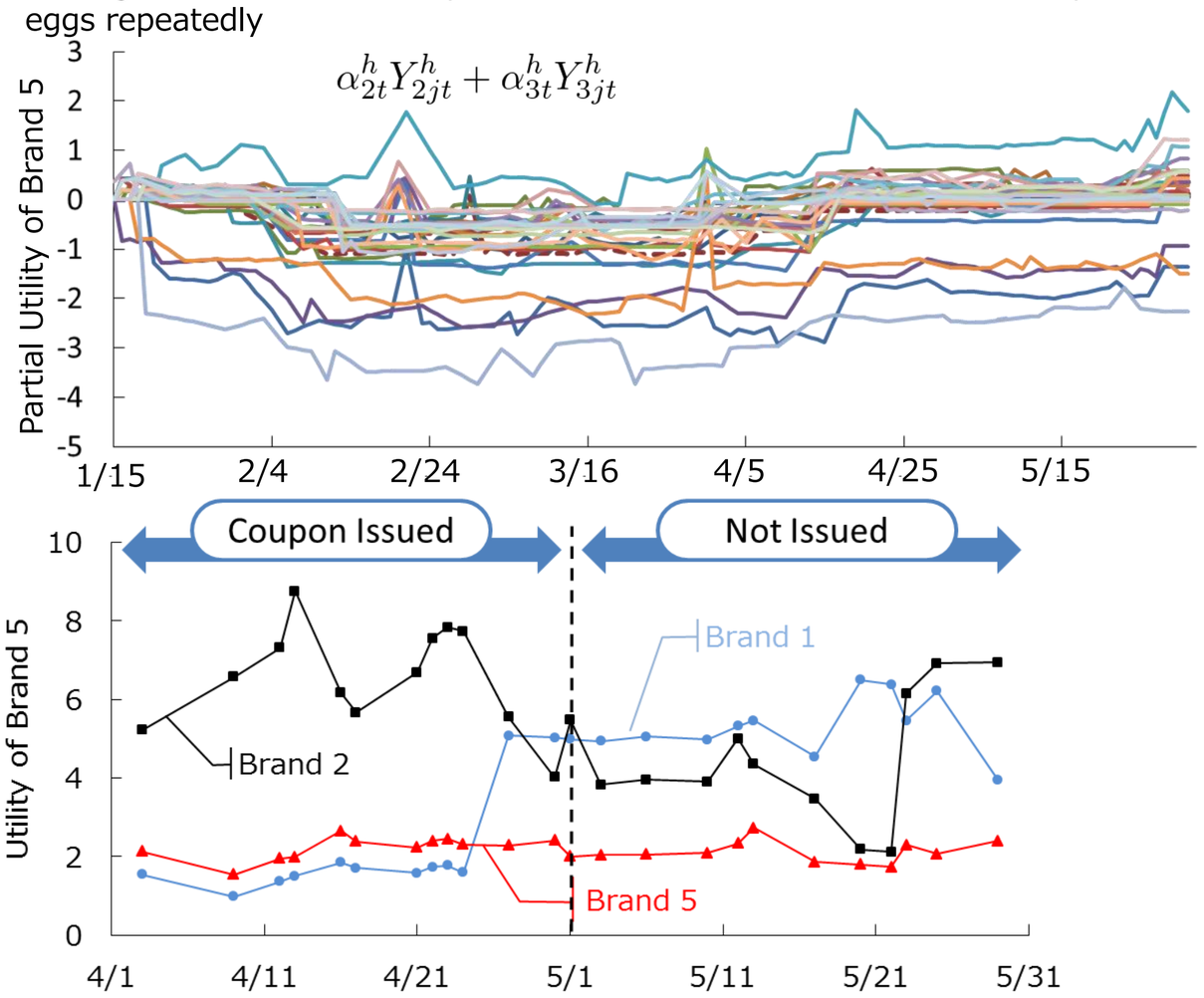
▶ Result and Improvement Plan

▶ Verification

	Hit Ratio	
	Purchase Incidence	Brand Choice
Proposed Model	**59%**	**66%**
Time Constant Model (Bell and Bucklin,1999)	46%	64%

▶ Analysis on actual issuing strategy

Issuing 20 % discount coupon on Brand 5 for all customers who purchase eggs repeatedly



▶ Improvement Plan

	Actual	Plan 1	Plan 2
Discount Rate	Common	Common	Consumer Specific
Numbers of Monthly Usage Times	2	2	
Target Brand	Brand 5	Consumer Specific (Brand of Maximal Royalty at start time)	

Expected Sales Actual : ¥21,456
Plan1 : ¥33,825 (+12,369)
Plan2 : ¥34,361 (+12,905)

References

[1]Bell, D. R. and Bucklin, R. E.: "The Role of Internal Reference Points in the Category Purchase Decision," *Journal of Consumer Research* **26**, 128-143 (1999)
[2]Briesch, R. A., Lakshman, K., Tridib, M. and Raj, S. P.: "A Comparative Analysis of Reference Price Models," *Marketing Science* **24**, 202-214 (1997)
[3]Sato, T. and Higuchi T.: "An Analysis of Purchase Incidence Behavior Using Dynamic Individual Model," *Japan Institute of Marketing Science* **16**, 49-73 (2009)