Consumers' Activities for Brand Selection and Their Matrices Structure in the Case of Jewelry/Accessory Purchasing

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***Abstract*- Consumers often buy higher ranked brand after they are bored using current brand goods. This may be analysed utilizing matrix. Suppose past purchasing data are set input and current purchasing data are set output, then transition matrix is identified using past and current data. If all brand selections are composed by the upper shifts, then the transition matrix becomes an upper triangular matrix.**

Utilizing jewelry/accessory purchasing history record of on-line shopping (especially we focus on pierced earrings, ring, bracelet/bangle) over three years, above structure is investigated and confirmed. Comparison with our previous research is also executed. Some interesting results are obtained.

Keywords- Brand Selection; Matrix Structure; Brand Position; Jewelry; Accessory

I. INTRODUCTION

It is often observed that consumers select upper class brand when they buy next time. Suppose that the former buying data and the current buying data are gathered. Also suppose that upper brand is located upper in the variable array. Then the transition matrix becomes upper triangular matrix under the supposition that the former buying variables are set input and the current buying variables are set output. If the top brand were selected from lower brand in jumping way, the corresponding part in upper triangular matrix would be 0. These are verified in numerical examples with simple models. There may be also the case that customers select lower brand to seek suitable price when they have chosen higher brand. Then it may compose items of lower triangular matrix.

If the transition matrix is identified, S-step forecasting can be executed. Unless planner for products does not notice its brand position whether it is higher or lower than other products, matrix structure makes it possible to identify those by calculating consumers' activities for brand selection. Thus, this proposed approach enables making effective marketing plan and/or establishing new brand.

Quantitative analysis concerning brand selection has been executed by Yamanaka [5], Takahashi et al. [4]. Yamanaka [5] examined purchasing process by Markov Transition Probability with the input of advertising expense. Takahashi et al. [4] made analysis by the Brand Selection Probability model using logistics distribution.

In this paper, matrix structure is analysed for the case brand selection is executed for upper class and for lower class, utilizing jewelry/accessory purchasing history record of on-line shopping over three years. Comparison with our previous research [7] is also executed. Some interesting results are obtained. Such research cannot be found as long as searched. Hereinafter, matrix structure is clarified for the selection of brand in Section 2. Block matrix structure is analysed when brands are handled in group in Section 3. Purchase history investigation of jewelry/accessory on-line shopping is examined and its numerical calculation is executed in Section 4. Application of this method is extended in Section 5, which is followed by the remarks of Section 6.

II. BRAND SELECTION AND ITS MATRIX STRUCTURE

A. Upper Shift of Brand Selection

It is often observed that consumers select upper class brand when they buy next time.

Now, suppose that x is the most upper class brand, y is the second upper brand, and z is the lowest brand. Consumer's behaviour of selecting brand would be $z \to y$, $y \to x, z \to x$ etc. $x \to z$ might be few.

Suppose that x is the current buying variable, and x_b is the previous buying variable. Shift to x is executed from x_b, y_b, or z_b.

Therefore, x is stated in the following equation.

$$x = a_{11}x_b + a_{12}y_b + a_{13}z_b$$

Similarly,

$$y = a_{22}y_b + a_{23}z_b$$

and

$$z = a_{33}z_b$$

These are re-written as follows.

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ 0 & a_{22} & a_{23} \\ 0 & 0 & a_{33} \end{pmatrix} \begin{pmatrix} x_b \\ y_b \\ z_b \end{pmatrix} \quad (1)$$

Set

$$\mathbf{X} = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

$$\mathbf{A} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ 0 & a_{22} & a_{23} \\ 0 & 0 & a_{33} \end{pmatrix}$$

$$\mathbf{X_b} = \begin{pmatrix} x_b \\ y_b \\ z_b \end{pmatrix}$$

then, $\mathbf{X}$ is represented as follows.

$$\mathbf{X} = \mathbf{A}\mathbf{X_b} \tag{2}$$

Here,

$$\mathbf{X} \in \mathbf{R}^3, \mathbf{A} \in \mathbf{R}^{3\times 3}, \mathbf{X_b} \in \mathbf{R}^3$$

$\mathbf{A}$ is an upper triangular matrix.

To examine this, generating following data, which are all consisted by upper brand shift data,

$$\mathbf{X^i} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \quad \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \quad \cdots \quad \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} \tag{3}$$

$$\mathbf{X_b^i} = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} \quad \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \quad \cdots \quad \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} \tag{4}$$

$i = 1 \quad 2 \quad \ldots \quad N$

parameter can be estimated using least square method.

Suppose

$$\mathbf{X}^i = \mathbf{A}\mathbf{X}_\mathbf{b}^i + \boldsymbol{\varepsilon}^i \tag{5}$$

and

$$J = \sum_{i=1}^{N} \boldsymbol{\varepsilon}^{iT} \boldsymbol{\varepsilon}^i \rightarrow Min \tag{6}$$

$\hat{\mathbf{A}}$ which is an estimated value of $\mathbf{A}$ is obtained as follows.

$$\hat{\mathbf{A}} = \left(\sum_{i=1}^{N} \mathbf{X}^i \mathbf{X}_\mathbf{b}^{iT} \right) \left(\sum_{i=1}^{N} \mathbf{X}_\mathbf{b}^i \mathbf{X}_\mathbf{b}^{iT} \right)^{-1} \tag{7}$$

In the data group of upper shift brand, an estimated value $\hat{\mathbf{A}}$ should be an upper triangular matrix.

If following data that have lower shift brand are added only a few in Equations (3) and (4),

$$\mathbf{X}^i = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

$$\mathbf{X}_\mathbf{b}^i = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$\hat{\mathbf{A}}$ would contain minute items in the lower part of triangle.

B. Sorting Brand Ranking by Re-Arranging Row

In a general data, variables may not be in order as x, y, z. In that case, large and small value lie scattered in $\hat{\mathbf{A}}$. But re-arranging this, we can set in order by shifting row. The large value parts are gathered in the upper triangular matrix, and the small value parts are gathered in the lower triangular matrix.

$$\hat{\mathbf{A}} \qquad\qquad \hat{\mathbf{A}}$$

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} \begin{pmatrix} \bigcirc & \bigcirc & \bigcirc \\ \varepsilon & \bigcirc & \bigcirc \\ \varepsilon & \varepsilon & \bigcirc \end{pmatrix} \quad \text{Shifting row} \quad \Leftarrow \quad \begin{pmatrix} z \\ x \\ y \end{pmatrix} \begin{pmatrix} \varepsilon & \varepsilon & \bigcirc \\ \bigcirc & \bigcirc & \bigcirc \\ \varepsilon & \bigcirc & \bigcirc \end{pmatrix} \tag{8}$$

C. In the Case That Brand Selection Shifts in Jump

It is often observed that some consumers select the most upper class brand from the most lower class brand and skip selecting the middle class brand.

We suppose v, w, x, y, z brands (suppose they are laid from upper position to lower position as $v > w > x > y > z$).

In the above case, selection shifts would be:

$$v \leftarrow z$$

$$v \leftarrow y$$

Suppose they do not shift to y, x, w from z, to x, w from y, and to w from x, then Matrix structure would be as follows.

$$\begin{pmatrix} v \\ w \\ x \\ y \\ z \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} \\ 0 & a_{22} & 0 & 0 & 0 \\ 0 & 0 & a_{33} & 0 & 0 \\ 0 & 0 & 0 & a_{44} & 0 \\ 0 & 0 & 0 & 0 & a_{55} \end{pmatrix} \begin{pmatrix} v_b \\ w_b \\ x_b \\ y_b \\ z_b \end{pmatrix} \tag{9}$$

III. BLOCK MATRIX STRUCTURE IN BRAND GROUPS

Next, we examine the case in brand groups. Matrices are composed by Block Matrix.

A. Brand Shift Group — in the Case of Two Groups

Suppose brand selection shifts from Corolla class to Mark Ⅱ class in car. In this case, it does not matter which company's car they choose. Thus, selection of cars is executed in a group and brand shift is considered to be done from group to group. Suppose brand groups at time n are as follows.

$\mathbf{X}$ consists of p varieties of goods, and $\mathbf{Y}$ consists of q varieties of goods.

$$\mathbf{X_n} = \begin{pmatrix} x_1^n \\ x_2^n \\ \vdots \\ x_p^n \end{pmatrix}$$

$$\mathbf{Y_n} = \begin{pmatrix} y_1^n \\ y_2^n \\ \vdots \\ y_q^n \end{pmatrix}$$

$$\begin{pmatrix} \mathbf{X_n} \\ \mathbf{Y_n} \end{pmatrix} = \begin{pmatrix} \mathbf{A_{11}}, & \mathbf{A_{12}} \\ \mathbf{0}, & \mathbf{A_{22}} \end{pmatrix} \begin{pmatrix} \mathbf{X_{n-1}} \\ \mathbf{Y_{n-1}} \end{pmatrix} \quad (10)$$

Here,

$$\mathbf{X_n} \in \mathbf{R}^p \ (n = 1,2,\cdots), \ \mathbf{Y_n} \in \mathbf{R}^q \ (n = 1,2,\cdots),$$
$$\mathbf{A_{11}} \in \mathbf{R}^{p\times p}, \ \mathbf{A_{12}} \in \mathbf{R}^{p\times q}, \ \mathbf{A_{22}} \in \mathbf{R}^{q\times q}$$

B. Brand Shift Group —in the Case of Three Groups

Suppose brand selection is executed in the same group or to the upper group, and also suppose that brand position is $x > y > z$ (x is upper position). Then the brand selection transition matrix would be expressed as:

$$\begin{pmatrix} \mathbf{X_n} \\ \mathbf{Y_n} \\ \mathbf{Z_n} \end{pmatrix} = \begin{pmatrix} \mathbf{A_{11}}, & \mathbf{A_{12}}, & \mathbf{A_{13}} \\ \mathbf{0}, & \mathbf{A_{22}}, & \mathbf{A_{23}} \\ \mathbf{0}, & \mathbf{0}, & \mathbf{A_{33}} \end{pmatrix} \begin{pmatrix} \mathbf{X_{n-1}} \\ \mathbf{Y_{n-1}} \\ \mathbf{Z_{n-1}} \end{pmatrix} \quad (11)$$

Where

$$\mathbf{X_n} = \begin{pmatrix} x_1^n \\ x_2^n \\ \vdots \\ x_p^n \end{pmatrix}$$

$$\mathbf{Y_n} = \begin{pmatrix} y_1^n \\ y_2^n \\ \vdots \\ y_q^n \end{pmatrix}$$

$$\mathbf{Z_n} = \begin{pmatrix} z_1^n \\ z_2^n \\ \vdots \\ z_r^n \end{pmatrix}$$

Here,

$$\mathbf{X_n} \in \mathbf{R}^p \ (n = 1,2,\cdots), \ \mathbf{Y_n} \in \mathbf{R}^q \ (n = 1,2,\cdots),$$
$$\mathbf{Z_n} \in \mathbf{R}^r \ (n = 1,2,\cdots), \ \mathbf{A_{11}} \in R^{p\times p}, \ \mathbf{A_{12}} \in R^{p\times q}$$
$$\mathbf{A_{13}} \in R^{p\times r}, \ \mathbf{A_{22}} \in R^{q\times q}, \ \mathbf{A_{23}} \in R^{q\times r}, \ \mathbf{A_{33}} \in R^{r\times r}$$

These are re-stated as:

$$\mathbf{W_n} = \mathbf{A}\mathbf{W_{n-1}} \quad (12)$$

Where

$$\mathbf{W_n} = \begin{pmatrix} \mathbf{X_n} \\ \mathbf{Y_n} \\ \mathbf{Z_n} \end{pmatrix}$$

$$\mathbf{A} = \begin{pmatrix} \mathbf{A_{11}}, & \mathbf{A_{12}}, & \mathbf{A_{13}} \\ \mathbf{0}, & \mathbf{A_{22}}, & \mathbf{A_{23}} \\ \mathbf{0}, & \mathbf{0}, & \mathbf{A_{33}} \end{pmatrix}$$

$$\mathbf{W_{n-1}} = \begin{pmatrix} \mathbf{X_{n-1}} \\ \mathbf{Y_{n-1}} \\ \mathbf{Z_{n-1}} \end{pmatrix}$$

IV. PURCHASE HISTORY INVESTIGATION AND NUMERICAL CALCULATION

Jewelry/Accessory purchase history investigation is executed.

First of all, the framework of jewelry/accessory purchasing via on-line shopping is as follows.

- On-line shop: Ciao! / Happy gift

Host site: http://www.happy-gift.jp/

Branch site: http://www.rakuten.co.jp/ciao/

http://store.shopping.yahoo.co.jp/b-ciao/index.html

Managed by Cherish Co. Ltd.

- Customers: all over Japan (Every Prefecture)
- Data gathering period: April 2008 – May 2011
- Order number: 4411 (limited to the order number which has repeated order)
- Main residents of customers
- Tokyo 11.9%
- Kanagawa 8.7%
- Osaka 6.0%
- Aichi 5.8%
- Chiba 5.7%
- Saitama 5.4%

The share of Tokyo capital area consists of 31.7%.

- Sales goods:

Necklace / Pendant

Pierced earrings

Ring

Bracelet / Bangle

Brooch

Necktie Pin

Miscellaneous （Package/Ribbon etc.）

- Classification of goods by price

Rank	Price(Yen)
Necklace / Pendant	
N6	40001～
N5	～40000
N4	～30000
N3	～20000
N2	～15000
N1	～10000
Pierced earrings	
P6	24001～
P5	～24000
P4	～16000
P3	～10000
P2	～6000
P1	～2000
Ring	
R6	40001～
R5	～40000
R4	～30000
R3	～20000
R2	～15000
R1	～10000
Bracelet / Bungle	
B6	40001～
B5	～40000
B4	～35000
B3	～30000
B2	～15000
B1	～10000

We have made an analysis about Necklace/ Pendant in another paper. Therefore we pick up Pierced earrings, Ring and Bracelet / Bungle in this paper.

The total number of shifts in one genre is as follows.

Necklace / Pendant	2181
Pierced earrings	567
Ring	1205
Bracelet / Bungle	458

The shift status is as follows.

Case1 Pierced earrings

① Number of shift from P1 to P1 : 166
② Number of shift from P1 to P2 : 8
③ Number of shift from P1 to P3 : 1
④ Number of shift from P1 to P4 : 3
⑤ Number of shift from P1 to P5 : 5
⑥ Number of shift from P1 to P6 : 0
⑦ Number of shift from P2 to P1 : 9
⑧ Number of shift from P2 to P2 : 184
⑨ Number of shift from P2 to P3 : 21
⑩ Number of shift from P2 to P4 : 6
11 Number of shift from P2 to P5 : 0
12 Number of shift from P2 to P6 : 0
13 Number of shift from P3 to P1 : 4
14 Number of shift from P3 to P2 : 12
15 Number of shift from P3 to P3 : 42
16 Number of shift from P3 to P4 : 13
17 Number of shift from P3 to P5 : 0
18 Number of shift from P3 to P6 : 0
19 Number of shift from P4 to P1 : 5
20 Number of shift from P4 to P2 : 2
21 Number of shift from P4 to P3 : 12
22 Number of shift from P4 to P4 : 55
23 Number of shift from P4 to P5 : 1
24 Number of shift from P4 to P6 : 1
25 Number of shift from P5 to P1 : 2
26 Number of shift from P5 to P2 : 1
27 Number of shift from P5 to P3 : 2
28 Number of shift from P5 to P4 : 2
29 Number of shift from P5 to P5 : 6
30 Number of shift from P5 to P6 : 0
31 Number of shift from P6 to P1 : 0
32 Number of shift from P6 to P2 : 0
33 Number of shift from P6 to P3 : 0
21 Number of shift from P6 to P4 : 2
22 Number of shift from P6 to P5 : 0
23 Number of shift from P6 to P6 : 1

Total: 567

Case2 Ring

① Number of shift from R1 to R1 : 332
② Number of shift from R1 to R2 : 55
③ Number of shift from R1 to R3 : 21
④ Number of shift from R1 to R4 : 1
⑤ Number of shift from R1 to R5 : 1
⑥ Number of shift from R1 to R6 : 2
⑦ Number of shift from R2 to R1 : 61
⑧ Number of shift from R2 to R2 : 503
⑨ Number of shift from R2 to R3 : 28
⑩ Number of shift from R2 to R4 : 0
11 Number of shift from R2 to R5 : 1
12 Number of shift from R2 to R6 : 6
13 Number of shift from R3 to R1 :13
14 Number of shift from R3 to R2 :38
15 Number of shift from R3 to R3 :86
16 Number of shift from R3 to R4 : 0

17 Number of shift from R3 to R5 : 0
18 Number of shift from R3 to R6 : 1
19 Number of shift from R4 to R1 : 0
20 Number of shift from R4 to R2 : 0
21 Number of shift from R4 to R3 : 0
22 Number of shift from R4 to R4 : 1
23 Number of shift from R4 to R5 : 0
24 Number of shift from R4 to R6 : 0
25 Number of shift from R5 to R1 : 1
26 Number of shift from R5 to R2 : 1
27 Number of shift from R5 to R3 : 0
28 Number of shift from R5 to R4 : 0
29 Number of shift from R5 to R5 : 5
30 Number of shift from R5 to R6 : 1
31 Number of shift from R6 to R1 : 3
32 Number of shift from R6 to R2 : 9
33 Number of shift from R6 to R3 : 0
34 Number of shift from R6 to R4 : 0
35 Number of shift from R6 to R5 : 1
㊱ Number of shift from R6 to R6 : 34
Total: 1205

Case3 Bracelet / Bungle

① Number of shift from B1 to B1 : 139
② Number of shift from B1 to B2 : 22
③ Number of shift from B1 to B3 : 9
④ Number of shift from B1 to B4 : 0
⑤ Number of shift from B1 to B5 : 0
⑥ Number of shift from B1 to B6 : 0
⑦ Number of shift from B2 to B1 : 20
⑧ Number of shift from B2 to B2 : 182
⑨ Number of shift from B2 to B3 : 10
⑩ Number of shift from B2 to B4 : 0
11 Number of shift from B2 to B5 : 0
12 Number of shift from B2 to B6 : 0
13 Number of shift from B3 to B1 : 4
14 Number of shift from B3 to B2 : 6
15 Number of shift from B3 to B3 : 65
16 Number of shift from B3 to B4 : 0
17 Number of shift from B3 to B5 : 0
18 Number of shift from B3 to B6 : 0
19 Number of shift from B4 to B1 : 0
20 Number of shift from B4 to B2 : 1
21 Number of shift from B4 to B3 : 0
22 Number of shift from B4 to B4 : 0
23 Number of shift from B4 to B5 : 0
24 Number of shift from B4 to B6 : 0
25 Number of shift from B5 to B1 : 0
26 Number of shift from B5 to B2 : 0
27 Number of shift from B5 to B3 : 0
28 Number of shift from B5 to B4 : 0
29 Number of shift from B5 to B5 : 0
30 Number of shift from B5 to B6 : 0
31 Number of shift from B6 to B1 : 0
32 Number of shift from B6 to B2 : 0
33 Number of shift from B6 to B3 : 0
34 Number of shift from B6 to B4 : 0
35 Number of shift from B6 to B5 : 0
36 Number of shift from B6 to B6 : 0
Total: 458

The shift to P1 to P3 in $\mathbf{X_b}$, $\mathbf{X}$, for example, is expressed as follows when one event arises.

$$\mathbf{X} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}, \mathbf{X_b} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}$$

Substituting these to Equation (7), we obtain following equations. We state and analyse them by each case.

Case1 Pierced earrings

$$\hat{\mathbf{A}} = \begin{pmatrix} 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 6 & 1 & 0 & 0 & 5 \\ 2 & 2 & 55 & 13 & 6 & 3 \\ 0 & 2 & 12 & 42 & 21 & 1 \\ 0 & 1 & 3 & 12 & 184 & 8 \\ 0 & 2 & 5 & 4 & 9 & 166 \end{pmatrix} \begin{pmatrix} 3 & 0 & 0 & 0 & 0 & 0 \\ 0 & 13 & 0 & 0 & 0 & 0 \\ 0 & 0 & 77 & 0 & 0 & 0 \\ 0 & 0 & 0 & 81 & 0 & 0 \\ 0 & 0 & 0 & 0 & 220 & 0 \\ 0 & 0 & 0 & 0 & 0 & 183 \end{pmatrix}^{-1}$$

$$= \begin{pmatrix} \frac{1}{3} & 0 & \frac{1}{77} & 0 & 0 & 0 \\ 0 & \frac{6}{13} & \frac{1}{77} & 0 & 0 & \frac{5}{183} \\ \frac{2}{3} & \frac{2}{13} & \frac{5}{7} & \frac{13}{81} & \frac{3}{110} & \frac{1}{61} \\ 0 & \frac{2}{13} & \frac{12}{77} & \frac{14}{27} & \frac{21}{220} & \frac{1}{183} \\ 0 & \frac{1}{13} & \frac{3}{77} & \frac{4}{27} & \frac{46}{55} & \frac{8}{183} \\ 0 & \frac{2}{13} & \frac{5}{77} & \frac{4}{81} & \frac{9}{220} & \frac{166}{183} \end{pmatrix} \quad (13)$$

Total number of upper shift from P1 : 17
Total number of lower shift from P1 : -
Total number of upper shift from P2 : 27
Total number of lower shift from P2 : 9
Total number of upper shift from P3 : 13
Total number of lower shift from P3 : 16
Total number of upper shift from P4 : 2
Total number of lower shift from P4 : 20
Total number of upper shift from P5 : 0
Total number of lower shift from P5 : 7
Total number of upper shift from P6 : -
Total number of lower shift from P6 : 2

We can observe that the upper shift from P1 and P2 is dominant and on the contrary, the lower shift from P4 and P5 is dominant.

This implies that customers buy rather cheap goods at first for the trial, and after confirming the quality, they make the upper shift in selecting brands.

After reaching higher brands, they buy cheaper goods and that leads to a lower shift in brand selection.

Hearing from customers, we can also find that she buys pierced earrings for herself and confirms the quality. After that, she makes gift by selecting upper brand. Sometimes she buys lower brand goods for herself after making gift.

That scene can often be seen and the result shows its sequence well. When the shop owner introduces new brand goods, he/she has to determine the price. If it is not reasonable, customers do not select their brand position as the shop owner assumes. These are confirmed by the brand shift transition, which forces the shop owner to re-consider the price and brand position of the new brand goods.

Case2 Ring

$$\hat{\mathbf{A}} = \begin{pmatrix} 34 & 1 & 0 & 1 & 6 & 2 \\ 1 & 5 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 86 & 28 & 21 \\ 9 & 1 & 0 & 38 & 503 & 55 \\ 3 & 1 & 0 & 13 & 61 & 332 \end{pmatrix} \begin{pmatrix} 47 & 0 & 0 & 0 & 0 & 0 \\ 0 & 8 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 138 & 0 & 0 \\ 0 & 0 & 0 & 0 & 599 & 0 \\ 0 & 0 & 0 & 0 & 0 & 412 \end{pmatrix}^{-1}$$

$$= \begin{pmatrix} \frac{34}{47} & \frac{1}{8} & 0 & \frac{1}{138} & \frac{6}{599} & \frac{1}{206} \\ \frac{1}{47} & \frac{5}{8} & 0 & 0 & \frac{1}{599} & \frac{1}{412} \\ 0 & 0 & 1 & 0 & 0 & \frac{1}{412} \\ 0 & 0 & 0 & \frac{43}{69} & \frac{28}{599} & \frac{21}{412} \\ \frac{9}{47} & \frac{1}{8} & 0 & \frac{19}{69} & \frac{503}{599} & \frac{55}{412} \\ \frac{3}{47} & \frac{1}{8} & 0 & \frac{13}{138} & \frac{61}{599} & \frac{83}{103} \end{pmatrix} \quad (14)$$

Total number of upper shift from R1 : 80
Total number of lower shift from R 1 : -
Total number of upper shift from R 2 : 35
Total number of lower shift from R 2 : 61
Total number of upper shift from R 3 : 1
Total number of lower shift from R 3 : 51
Total number of upper shift from R 4 : 0
Total number of lower shift from R 4 : 0
Total number of upper shift from R 5 : 1
Total number of lower shift from R 5 : 2
Total number of upper shift from R 6 : -
Total number of lower shift from R 6 : 13

We can observe that the upper shift from R1 is dominant and on the contrary, the lower shift from R2, R3 and R6 is dominant.

This characteristic is common in each brand genre.

Case3 Bracelet/ Bangle

$$\hat{\mathbf{A}} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 65 & 10 & 9 \\ 0 & 0 & 1 & 6 & 182 & 22 \\ 0 & 0 & 0 & 4 & 20 & 139 \end{pmatrix} \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 75 & 0 & 0 \\ 0 & 0 & 0 & 0 & 212 & 0 \\ 0 & 0 & 0 & 0 & 0 & 170 \end{pmatrix}^{-1}$$

$$= \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{13}{15} & \frac{5}{106} & \frac{9}{170} \\ 0 & 0 & 1 & \frac{2}{25} & \frac{91}{106} & \frac{11}{85} \\ 0 & 0 & 0 & \frac{4}{75} & \frac{5}{53} & \frac{139}{170} \end{pmatrix} \quad (15)$$

If the determinant of the matrix is 0, we cannot calculate the inverse matrix. But we have made an analysis when the new brand came into the market, where there was no before data and could not calculate inverse matrix.

Setting very small event ε and making $\varepsilon \to 0$, we found that we could calculate such situation by setting diagonal 0 data to 1 [6].

Total number of upper shift from B1 : 31
Total number of lower shift from B 1 : -
Total number of upper shift from B 2 : 10
Total number of lower shift from B 2 : 20
Total number of upper shift from B 3 : 0
Total number of lower shift from B 3 : 10
Total number of upper shift from B 4 : 0
Total number of lower shift from B 4 : 1
Total number of upper shift from B 5 : 0
Total number of lower shift from B 5 : 0
Total number of upper shift from B 6 : -
Total number of lower shift from B 6 : 0

We can observe that the upper shift from B1 is dominant and on the contrary, the lower shift from B2 and B3 is dominant.

V. APPLICATION OF THIS METHOD

There may arise following case. Consumers and producers do not recognize the brand position clearly. But analysis of consumers' behaviour let them know their brand position in the market. In such a case, strategic marketing guidance to select brand would be introduced.

Setting in order the brand position of various goods and taking the suitable marketing policy, enhancement of sales would be enabled.

VI. REMARKS

We have made an analysis before [7]. Hereinafter comparison with the previous research is executed, mainly focusing on Pierced earrings, Ring and Bracelet / Bungle.

		Previous Research	Research in this Paper
Data gathering period		October 2006 - May 2009 (32 months)	April 2008 – May 2011 (38 months)
Order Number		3438	4411
Total number of Shits in one genre	Necklace / Pendant	615	2181
	Pierced earrings	117	567
	Ring	161	1205
	Bracelet / Bungle	22	458

We can observe that the repeated purchasing has increased for several times compared with the former research period.

In particular, Bracelet / Bungle has increased tremendously compared with other genres. It is because shop owner has introduced new products of leathered pair Bracelet into the market and they made a great hit.

Now, we compare the contents of the upper shift and the lower shift in each genre.

A. Pierced Earrings

〈 Previous Research 〉

	P1	P2	P3	P4
Upper shift	-	0	2	2
Same Rank movement	2	1	3	14
Lower shift	4	3	4	1
Summary	6	4	9	17
Share (%)	5.1	3.4	7.7	14.5
	P5	P6	Summary	Share (%)
Upper shift	4	6	14	12
Same Rank movement	38	29	87	74.4
Lower shift	4	-	16	13.7
Summary	46	35	117	-
Share (%)	39.3	29.9	-	-

〈 Research in this paper 〉

	P1	P2	P3	P4
Upper shift	-	0	2	13
Same Rank movement	1	6	55	42
Lower shift	2	7	20	16
Summary	3	13	77	71
Share (%)	0.5	2.3	13.6	12.5
	P5	P6	Summary	Share (%)
Upper shift	27	17	59	10.4
Same Rank movement	184	166	454	80
Lower shift	9	-	54	9.5
Summary	220	183	567	
Share (%)	38.8	32.3	-	-

Compared with the former one, the share of P3 has increased greatly, while P1 made a big decrease. Consumers tends to have bought rather “upper middle” class items.

B. Ring

〈 Previous Research 〉

	R1	R2	R3	R4
Upper shift	-	1	1	0
Same Rank movement	1	6	3	4
Lower shift	5	7	3	2
Summary	6	14	7	6
Share (%)	3.7	8.7	4.3	3.7
	R5	R6	Summary	Share (%)
Upper shift	1	4	7	4.3
Same Rank movement	64	41	119	73.9
Lower shift	18	-	35	21.7
Summary	83	45	161	
Share (%)	51.6	28	-	-

〈 Research in this paper 〉

	R1	R2	R3	R4
Upper shift	-	1	0	1
Same Rank movement	34	5	1	86
Lower shift	13	2	0	51
Summary	47	8	1	138
Share (%)	3.9	0.7	0.1	11.5
-	R5	R6	Summary	Share (%)
Upper shift	35	80	117	9.7
Same Rank movement	503	332	961	79.8
Lower shift	61	-	127	10.5
Summary	599	412	1205	
Share (%)	49.7	34.2	-	

Compared with the former one, the share of upper shift has increased greatly. The number of the upper shift of R5 and R6 is a big one, therefore it effected well. As for each rank, the share of R4 and R6 has increased greatly, while R2 and R3 made a big decrease.

C. Bracelet / Bungle

〈 Previous Research 〉

	B1	B2	B3	B4
Upper shift	-	0	0	0
Same Rank movement	0	0	0	1
Lower shift	1	0	0	0
Summary	1	0	0	1
Share (%)	4.5	0	0	4.5

	B5	B6	Summary	Share (%)
Upper shift	0	1	1	4.5
Same Rank movement	6	12	19	86.4
Lower shift	1	-	2	9.1
Summary	7	13	22	
Share (%)	31.8	59.1		

〈 Research in this paper 〉

	B1	B2	B3	B4
Upper shift	0	0	0	0
Same Rank movement	0	0	0	65
Lower shift	0	0	1	10
Summary	0	0	1	75
Share (%)	0	0	0.2	16.4
	B5	**B6**	**Summary**	**Share (%)**
Upper shift	10	31	41	9
Same Rank movement	182	139	386	84.3
Lower shift	20	-	31	6.8
Summary	212	170	458	-
Share (%)	46.3	37.1	-	-

Compared with the former one, the total number of sales increased greatly. We can observe an impact of a great hit of leathered pair Bracelet. We can clearly see the increase of the share of upper shift. As for each rank, the share of B4 and B5 has increased greatly, while B6 made a big decrease.

Rather middle class rank increased the share on the whole for each of them.

The movement from Necklace / Pendant to these genres may be considered.

The shift among genres is the next step research to be investigated.

VII. CONCLUSION

It is often observed that consumers select the upper class brand when they buy the next time.

Suppose that the former buying data and the current buying data are gathered. Also suppose that the upper brand is located upper in the variable array. Then the transition matrix becomes upper triangular matrix under the supposition that the former buying variables are set input and the current buying variables are set output.

There may also be the case that customers select lower brand to seek suitable price when they have chosen higher brand. Then it may compose items of lower triangular matrix. Utilizing jewelry/accessory purchasing history record of on-line shopping (especially we focus on pierced earrings, ring, bracelet/bangle) over three years, above structure was investigated and confirmed. Comparison with our previous research was also executed. Some interesting results are obtained.

Various fields should be examined hereafter.

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