A Study on

Estimating Method

of

Market Structure and Consumers Behavior

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Hiromi Yamada

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Estimating Method

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Market Structure and Consumers Behavior

by
Hiromi Yamada

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Under the supervision of
Professor Kazuyuki Teramoto

Department of Industrial Engineering,
Aichi Institute of Technology
Toyota, Japan

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Abstract

The ever-increasing growth in the 20th century which continued for a long time in the second half failed, and the industrial society of Japan has entered the time when tomorrow is obtuse. In order that variances among companies have spread, the meaning in which even the same industry gets to know the tendency of the whole industry has faded. It was over at the time that consists as a corporation if you enforce a similar thing to peer companies. This means the necessity that each company has original tactics and strategics has increased. Therefore, companies have to do development of new products by knowing both consumer needs and choice behavior. For this reason, companies need to collect data widely from consumers and to analyze them scientifically and statistically. Moreover, it is also important to study the theoretical methodology of marketing.

In this paper, five models are utilized to understand the market structure and consumer behavior.

1. Conjoint Analysis
2. Entropy Model and Herniter Model
3. Conjoint Analysis and Herniter Model
4. Huff Model
5. Huff Model and Herniter Model

The above five models would contribute to new product development, estimate of future market structures and consumers behavior. By such kinds of knowledge, manufactures or companies could have good opportunities to market new products.

Finally, the results derived from this thesis are summarized and future studies are described.

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Chapter 1

Introduction

In the present world economic situation, the process of globalization made it impossible to predict which companies in which countries would become competitors. Also, the market is oversaturated with similar products. Therefore, it has become very important to consider and estimate the method of getting consumers' attention. Moreover, the family disposable in come is limited, so the consumers are very careful during the selection of their purchases.

The main objective of the thesis is to support companies with the process of providing new products to the market. There are many methods to investigate consumers' needs, behavior and market structure from the development of products to their selling. The most important problem which companies are facing is to find out what kinds of products will be sold on the market. There are several methods of approaching such problems. The following five techniques are utilized in this thesis.

1. Using Conjoint Analysis, the final concept of an optimal product is given and the importance of the attribute and the level are analyzed.
2. For further discernment of consumer preferences, Entropy Model and Herniter's Entropy Model (Herniter's Model) are used.
3. Using Conjoint Analysis, the final concept of an optimal product is given and the importance of the attribute and the level are analyzed. Thereafter, Herniter Model is used for a further discernment research of the consumer preference for the attribute and the level.
4. Using Huff Model, the probability of consumers patronizing a particular shop is calculated and the number of average consumers is calculated from the result.
5. Using Huff Model, the probability of consumers patronizing a particular shop is calculated and the number of average consumers is calculated from the result. Thereafter, Herniter Model is used for a further discernment research of the consumer preference for number of average consumers.

1.1 Review of Literatures

This thesis explains the method of estimating the market structure and the consumers' choice behavior. First, the place of purchases was researched, and then the selection process was analyzed.

In this section, the results of the present mathematical marketing models summarized. For the product experimental design it is very important to clarify the level of consumers' preference of the products attributes. The Conjoint Analysis, which is one of the marketing research techniques, is mainly used in such a situation (Luce and Tukey (1964)). Using the orthogonal array, the consumer preferences are analyzed, and their levels for some attributes (e.g., country, day of departure, length etc.) are measured. Several product plans, including different levels of attributes, were proposed by Katahira (1989).

The entropy model has been considered in many fields of marketing science and applied to the studies of share prediction and evaluation of selection probabilities. Using this model, Herniter (1973) divided consumers into two strata; the non-fixed stratum of those who have not decided their purchases, and the fixed stratum of those who purchase only one brand, and explained the market structure of the non-fixed stratum by calculating the stratum ratio. This has greatly developed the theory of consumer demand. Ito (1987) calculated the weight ratio of several factors for women preferences in fashion. Using the algorithm and maximum entropy principle in information theory, Gensch and Soofy (1995) evaluated the selection probability and examined the marketing structure. Brockett et al. (1995) investigated the effectiveness of information theory as a statistical approach to use in marketing research, and applied it to the logarithm linear model, entropy model, logit model and brand switching model. Using this model, Teramoto (1999) also calculated the selecting rate of several factors for women preferences in perfume.

The main purpose of the thesis is the estimation of the probability that a customer will come to a particular store. In this thesis the method of probability and statistical theories are used to estimate the number of customers and to predict the amount of sales. In the present there have been many theories regarding the amount of sales. Reilly (1929) proposed the low of retail attraction which is a formula to explain the spared of goods in commercial area. Converse (1949) presented the formula of branch point from 1943 to 1948 based on Reilly's Law. Huff (1964) subdivided commercial areas into some business places which are retail accumulations such as shopping centers, department stores and supermarkets, and examined durable goods in addition to daily necessities. Aida (1993) used Huff Model to estimate the made of the geographic convenience of stores. Using the results of Huff Model. Asano (1994) estimated the number of visitors to stores. Itakura (1998) propagated the usage of modified Huff Model.

In general, all the theories: Conjoint Analysis, Herniter Model and Huff Model are used separately. This work, however proposes combining those models to make further estimation methods of the market structure and the consumers' choice behavior.

1.2 Organization of Thesis

This section describes the organization of this thesis. This thesis is divided into Introduction, Chapters 2-6, Conclusions and Bibliography.

Firstly, in Chapter 2, preferences of product attributes of consumers are clarified using the Conjoint Analysis. Travel plan of undergraduate student are given as an example. Using the orthogonal array, the consumer preferences are analyzed, and their levels for some attributes (e.g., country, day of departure, length) are measured. Next, several plans, including different levels of attributes, are proposed and an optimal plan is presented. Moreover, the presented optimal plan is estimated to the error of the calculation value.

Chapter 3 makes the analysis of market share structure of cars for young men, using Entropy Model and Herniter Model. Preferences for six factors of selected kinds of cars are analyzed (engine performance, design, price, comfort of drive, safety, and others). The factors of preferences for each item are investigated on the market, and then, by applying collected data to entropy model and

Herniter Model, their rates are numerically obtained. There are two groups of consumers. One is the fixed stratum, where the consumers choose the factor according to any criterion, and the other is the non-fixed stratum, in which consumers choose the factor according to two or more criteria. It is understood that more than 60 % of the consumers choose cars according to already decided preferences.

In Chapter 4, the combination of Conjoint Analysis and Herniter Model is proposed. Herniter Model is used for a further discernment research of consumers' preference for the optimal plan obtained through the Conjoint Analysis. As a result, the important factor (attribute and level) in an optimal plan becomes clearer.

In Chapter 5, the number of consumers is estimated by using modified Huff Model. Special attention was paid to parking space in the convenience store. The increase of the number of consumers when parking space was increased was estimated.

In Chapter 6, the combination of Huff Model and Herniter Model is proposed. Herniter Model is used for a further discernment research of consumers' preference for the estimate of number of consumers obtained through Huff Model. A geographical convenience model of stores is considered, using modified Huff Model. The ratios that consumers choose stores and the number of average visitors are calculated. As a result, the market structure from which shops are chosen as consumers becomes clearer.

Finally, in Chapter 7, summarizes the results obtained through this thesis and states briefly several remaining and future problems to be solved.

Chapter 2

Evaluation of the Part Worth in Conjoint Analysis

When a new product is being designed, the evaluation of the consumers' understanding and acceptance of the present products are extremely important. For the product experimental design it is very important to clarify the level of consumers' preference of the products attributes. The conjoint analysis, which is one of the marketing research techniques, is mainly used in such a situation. In the conjoint analysis, several plans including different levels of attributes are proposed. However, the error is included in the analytical result to the part worth.

In this chapter, the error to the part worth of conjoint analysis is considered to be applied badness, and evaluation its influence is proposed.

2.1 Introduction

The time when any marketed product sells is over. Now only products which fulfill the needs of consumers can sell. In order to respond to consumers' needs, makers have to research consumers' preferences of products, services and their selection criteria of products.

The conjoint analysis measures the degree of importance which is given to particular aspects of a product or service. It is a technique which gives the concept for the development of a new product. It is very difficult and rare that the consumers are totally satisfied with the goods they obtain. For example, good items seem to be expensive, or inexpensive items seem to be of poor quality. Then, the consumers' behavior while making the purchase was observed and through that the priority of choice-value or quality was understood. While changing the levels of attributes the consumers were asked to set the order of their preferences. This kind of optimization is called *conjoint analysis method* (Luce and Turkey (1964), Muto and Shinsuke (1986), Green and Srinivasan (1990)).

In conjoint analysis, it was not discussed about the error that should have been included in part worth conventionally. In this chapter, the influence of the error on the part worth of the conjoint analysis is evaluated by using the F value.

2.2 Features of Conjoint Analysis

The conjoint analysis is a technique based on not asking consumer opinion directly. Even the consumers themselves are not sure what they exactly want, and so, a new method of analysis of consumers' preferences has surfaced, in which rather than asking direct questions, the selection process is observed. This is called *behavior analysis* (Katahira (1989)). When the reason for the product selection is asked to the consumer, it answers only in the principle *the quality is excellent* or *the maker is well known*. The maker cannot believe such an answer. Even when buying something at a special sale or at a great discount, many people would still give the same routine answers. The conjoint analysis has thought different from the method that analyzes other consumers' preferences. The approach of the conventional methods attaches importance to reason, and the principle. On the other hand, the approach of the conjoint analysis is an approach for attaching importance to the sensibility, and canvassing the real intention. The conventional methods analyze the general answers coming out of objective comparison, while conjoint analysis bases its results on analyzing the subjective direct comparison of one profile against another.

The conjoint analysis is shown by the following flow chart. (Asano (1999))

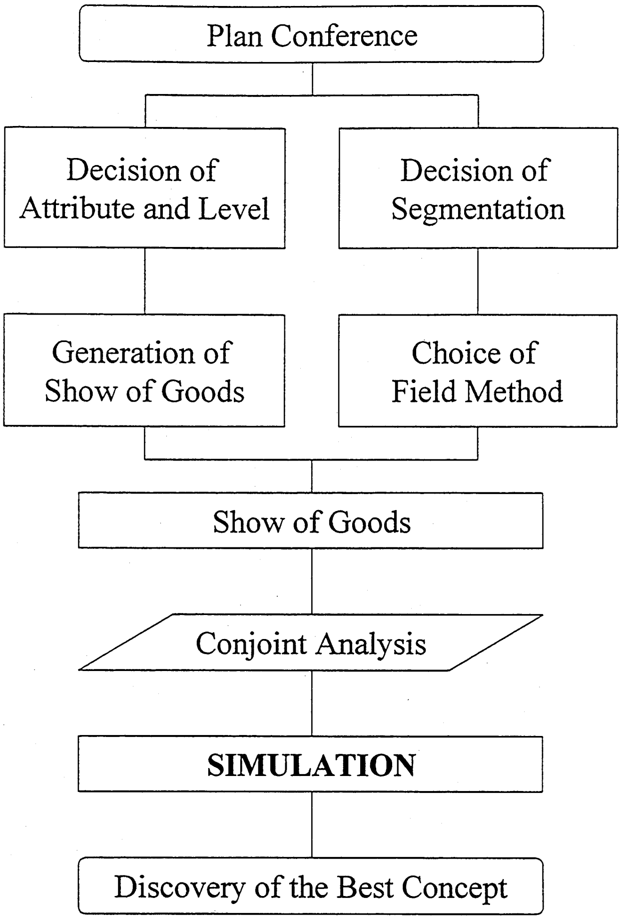

Figure 2.1 Flow Chart of Conjoint Analysis

2.3 Attribute and Level

In this chapter, conjoint analysis about the overseas travel plan to undergraduate students are made into the example.

When conjoint analysis is done, the attribute and the level of the product should be decided. Because both attribute and level have the influence on the plan of the product, both of them should be clear and precise. Then, in order to set up concrete standards, research is done on the market. The attribute and the level are determined in Table 1. In this research, 3 attributes have 2 levels, one has 5 levels, and one has 3 levels. If all of possible types were presented, there would be the total of 2x2x2x5x3=120 kinds. Timewise and physically it would be difficult to directly compare all 120 profiles. Using the orthogonal array of an experimental design, the number of profiles is reduced to 24.

Table 2.1 Attribute and Level of the Overseas Travel Plan

Attribute	Level
A. Country	1 = Korea (Seoul) 2 = Singapore 3 = Hong Kong 4 = Taiwan (Taipei) 5 = Thailand
B. Number of visited countries or (visited) cities	1 = One place 2 = Two places
C. City sightseeing	1 = Included 2 = Not included
D. Day of departure	1 = Weekend 2 = During the week
E. Length	1 = Three days 2 = Five days 3 = Seven days

2.4 Application of Conjoint Analysis

(1) Making of Questionnaire Survey Form

The questionnaire survey is done for undergraduate students, and obtains the answers of 75 (Male:64, Female:11). The method of answering the questionnaire survey in this research puts the order on 24 profiles in order that wants to be purchased. Moreover, when the questionnaire survey form was made, the following two disposals were done.

Attribute A: Country was made a concrete description as subjects imaged it easily when level was done with "Two places" about attribute B: Number of visited countries or cities (Table 2.2).

Table 2.2 Concrete Description

	One place	Two places
	Korea (Seoul)	Korea (Seoul, Pusan)
	Singapore	Singapore, Malaysia
Attribute A	Hong Kong	Hong Kong, Macau
	Taiwan (Taipei)	Taiwan, (Taipei, Gaoxiong)
	Thailand	Thailand, Vietnam

(2) Conjoint Analysis

When the research participants rank the presented profiles, the part worth is calculated according to the following procedures:

1. Conversion of preference order into continuous data.
2. Setting of design matrix.
3. Calculation of part worth by method of least squares.

If this procedure is applied to a general multiple regression analysis, then only by assuming the design matrix which consists of the combination of "0" and "1" to be an explanatory variable, the dependent variable is the preference order.

For example, from three attributes with 2 levels each, 4 profiles are made. It is assumed that the subject do ranking from the 1st to the 4th according to the preference order. If the value of inverse order of this ranking is assumed to be a dependent variable, the obtained regression coefficient w_1, w_2, and w_3 are the part worth of each level in conjoint analysis in Figure 2.2 (Okamoto (1999)).

Design Matrix | Part Worth | Conversion Value of Preference Order

$$\begin{bmatrix} 0\ 0\ 0 \\ 0\ 1\ 1 \\ 1\ 0\ 1 \\ 1\ 0\ 1 \end{bmatrix} \times \begin{bmatrix} W_1 \\ W_2 \\ W_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 4 \\ 3 \\ 1 \end{bmatrix}$$

Figure 2.2 Calculation Method of Part Worth

Table 2.3 Part Worth of the Overseas Travel Plan

Attribute	Level	Part worth
A	1	0.528
	2	2.024
	3	0.751
	4	-1.288
	5	-1.956
B	1	0.991
	2	-0.991
C	1	2.214
	2	-2.214
D	1	0.325
	2	-0.325
E	1	-0.490
	2	0.137
	3	0.353

This table is calculated using the data gathered from the male undergraduate students.

(3) Calculation of F Value

The F value is calculated as follows:

$$F\,(\mathrm{A, L}) = u^2 / \varepsilon^2 \tag{2.1}$$

A: Attribute

L: Level

u: Part worth

ε: Error term

Table 2.3 does not clarify the error of part worth. If the error of part worth is large the particular, level is not the best option for an overseas travel plan.

An elementary matrix was made from Table 2.4 in order to reveal an error for part worth using multiple regression analysis (Table 2.5).

The part worth and error of the overseas travel plan is shown in Table 2.6.

Table 2.4 Ranking of Profiles

Profile No	Country	Number of visited countries or (visited) cities	City sightseeing	Day of departure	Length	Average ranking	Estimate ranking
2	Singapore	One place	Included	Weekend	Five days	6.734	6.808
3	Hong Kong	One place	Included	Weekend	Seven days	7.594	7.865
1	Korea (Seoul)	One place	Included	Weekend	Three days	7.875	8.931
21	Singapore	Two place	Included	During the week	Seven days	8.859	9.225
15	Taiwan (Taipei)	One place	Included	Weekend	Seven days	8.938	9.461
14	Taiwan (Taipei)	One place	Included	Weekend	Five days	10.000	9.677
9	Korea (Seoul)	Two place	Included	During the week	Seven days	10.859	10.720
20	Korea (Seoul)	Two place	Included	During the week	Five days	11.328	10.936
19	Hong Kong	Two place	Included	During the week	Three days	11.344	11.341
13	Thailand	One place	Included	Weekend	Three days	13.016	11.415
5	Singapore	One place	Not included	During the week	Five days	12.031	11.886
7	Taiwan (Taipei)	Two place	Included	During the week	Three days	12.922	12.937
6	Hong Kong	One place	Not included	During the week	Seven days	13.188	12.943
8	Thailand	Two place	Included	During the week	Five days	13.266	13.420
10	Singapore	Two place	Not included	Weekend	Three days	14.141	13.847
4	Korea (Seoul)	One place	Not included	During the week	Three days	13.766	14.009
11	Hong Kong	Two place	Not included	Weekend	Five days	14.516	14.492
12	Korea (Seoul)	Two place	Not included	Weekend	Seven days	15.266	14.499
18	Taiwan (Taipei)	One place	Not included	During the week	Seven days	14.766	14.539
17	Taiwan (Taipei)	One place	Not included	During the week	Five days	15.609	14.755
23	Taiwan (Taipei)	Two place	Not included	Weekend	Five days	14.578	16.088
16	Thailand	One place	Not included	During the week	Three days	15.266	16.493
22	Taiwan (Taipei)	Two place	Not included	Weekend	Three days	17.359	16.716
24	Thailand	Two place	Not included	Weekend	Seven days	16.766	16.983

Table 2.5 Result of Multiple Regression Analysis

Number of sample	24	Independent variable number	9	Degree of freedom	14
Square of correlation coefficient	0.949	Multiple correlation coefficient adjusted for the degrees of freedom	0.916	Standard error of computation value	0.858

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	α_9
Regression coefficient (Part worth)	12.500	0.528	2.024	0.751	-0.845	0.991	2.214	0.325	-0.490	0.137
Error of regression cofficient		0.351	0.397	0.397	0.279	0.177	0.177	0.177	0.253	0.256
Standard regression cofficient		0.125	0.402	0.149	-0.261	0.341	0.762	0.112	-0.138	0.039
Error of normal regression cofficient		0.083	0.079	0.079	0.086	0.061	0.061	0.061	0.071	0.072
Partial regression cofficient		0.373	0.806	0.451	-0.629	0.832	0.958	0.441	-0.460	0.142
F value		2.265	26.007	3.580	9.162	31.550	157.377	3.385	3.764	0.288

Table 2.6 Part Worth and Error of the Overseas Travel Plan

Attribute	Level	Part worth	Error	F value
A	1	0.528	0.351	2.265
	2	2.024	0.397	26.007
	3	0.751	0.397	3.580
	4	-1.288	0.279	9.162
	5	-1.956	0.397	24.312
B	1	0.991	0.177	31.550
	2	-0.991	0.177	31.550
C	1	2.214	0.177	157.377
	2	-2.214	0.177	157.377
D	1	0.325	0.177	3.385
	2	-0.325	0.177	3.385
E	1	-0.490	0.253	3.764
	2	0.137	0.256	0.288
	3	0.353	0.254	1.927

(4) Calculation of Contribution Rate

The contribution rate is calculated as follows: The variance of the k-th attribute is calculated as

$$V_k = \frac{1}{m_k} \sum (u_j - \bar{u})^2 \quad (k = 1,2,\cdots,n) \tag{2.2}$$

where

m_k is the number of levels of the k-th attribute,
u_j is partial effect value of the j-th level,
$\bar{u}$ is the average of u_j (j=1,2,···,m).

Next, we estimate the contribution rate C_k of the k-th attribute as follows:

$$C_k = \frac{V_k}{\sum_{l=1}^{n} V_l} \times 100 \qquad (k = 1,2,\cdots,n) \tag{2.3}$$

That is, with the contribution rate of an attribute, the variance ratio of the part worth of each attribute (Muto and Asano (1986), Urban and Hauser (1993)) is calculated.

Table 2.7 shows the contribution rate.

Table 2.7 Contribution Rate

Attribute	Contribution Rate
A	23.557%
B	12.280%
C	61.247%
D	1.318%
E	1.598%
Total	100.000%

2.5 Considerations

(1) Results of Analysis

If the combination of the optimal level is made as well as a conjoint analysis conventionally, it becomes Table 2.8.

Table 2.8 Optimal Level

Attribute	Level	Part worth
A	Singapore	2.024
B	One place	0.991
C	Included	2.214
D	Weekend	0.325
E	Seven days	0.353

If an optimal level to each attribute is simply obtained, it becomes for the attribute "Country" the highest part worth is "Level: Singapore", for the attribute "Number of visited countries or visited cities" the highest part worth is "Level: One place", for the attribute "City sightseeing" the highest value is "Level: Included", for the attribute "Day of departure" the highest value is "Level: Weekend", and for the attribute "Length" the highest value is "Level: Seven days".

However, the error is included in the part worth of each level. It cannot be said that Table 2.8 is a combination of the optimal level when this error is disregarded.

(2) Influence of Error

The applied badness in conjoint analysis was considered to be an error, and the influence of the error on each attribute (level) is evaluated. In the case of Attribute A: Country (Level: Singapore) Attribute B: Number of visited countries or cities (Level: One place), and Attribute C: City sightseeing (Level: Included), judging from the F value, error is significant enough. It can be thought that the high part worth is preferred regarding Attribute D: Day of departure (Level: Weekend) and Attribute E: Length (Level: Seven days) because they have almost the same error.

Therefore, it can be judged that the error is not influencing the combination of an optimal level (Table 2.9).

Table 2.9 Optimal Level and Error

Attribute	Level	Part worth	Error	F value
A	Singapore	2.024	0.397	25.992
B	One place	0.991	0.177	31.437
C	Included	2.214	0.177	156.462
D	Weekend	0.325	0.177	3.371
E	Seven days	0.353	0.254	1.931

However, when overseas travel plans are actually made, the following attributes show a significant level, therefore should be included in the plans: attribute A: Country (Level: Singapore), attribute B: Number of visited countries (Level: One place), and attribute C: City sightseeing (Level: Included). The preferences of undergraduate students are quite divided on the remaining two attributes, attribute D: Day of departure (Level: Weekend) and attribute E: Length (Level: Seven days) thus those attributes statistically are not significant.

2.6 Conclusions

As a result of the analysis, the following optimal plan is made: It is significant that in the attribute "Country" the highest part worth is "Level: Singapore", in the attribute "Number of visited countries or visited cities" the highest part worth is "Level: One place", and in the attribute "City sightseeing" the highest value is "Level: Included", judging from the F value. The main points obtained through conjoint analysis for undergraduate students are:

1. It should include city sightseeing.

2. It should be to only one country.

3. The countries most often chosen are Singapore, Hong Kong, and Korea, in that order.

The contribution rate (Table 2.7) reached about 97.1% with those three attributes. It should be noted that, judging from the F value (error), statistically significant are only the first three attributes. However, even though the Table 2.8 gives the optimal plan, it does not necessarily mean that it is ideal for everybody. The main reason is that part worth for attribute B is relatively low. Thus, in conjoint analysis it is very beneficial to evaluate the F value (error) of the part worth.

Appendix

Profile	1	2	3		24
Country	Korea (Seoul)	Singapore	Hong Kong		Thailand
Number of visited countries or (visited) cities	One place	One place	One place		Two place
City sightseeing	Included	Included	Included	…	Not included
Day of departure	Weekend	Weekend	Weekend		Weekend
Length	Three days	Five days	Seven days		Seven days

Chapter 3

Evaluation of Preferences Using Herniter's Entropy Model

This chapter investigated preferences of male university undergraduate students regarding ten kinds of used cars. The reason for the choice was given from among six factors: engine performance, design, price, comfort of drive, safety and others. The factors of preferences for each car are investigated on the market, and by applying collected data to the Herniter's Entropy Model (Herniter Model), their rates are numerically obtained. There are two strata of consumers; one selects mainly according to one factor of preferences, and the other selects according to several factors. It is shown that more than 61.6% of the students have already decided the main factor of their preferences. The remaining 38.4% of the students decide their purchases according to several criteria, or are undecided until the final purchase.

3.1 Introduction

The entropy model has been considered in many fields of marketing science and applied to the studies of share prediction and evaluation of selection probability.

In the report of Ueda (1988), it was shown, using the many factors influence theory, that the influence of the price and the selling trend was quite big. Gensch (1995), using the information theory algorithm and maximum entropy principle, evaluated selection probability and examined the technique using real marketing data. Brockett (1995) researched the effectiveness of information theory approach for various problems of market research regarding model selection, logarithm linear model, entropy model, logit model and brand switching model. Ito (1987) calculated the weight rate of several factors for womens' preferences in fashion using the entropy model. Herniter (1973) employs entropy model and divides consumers into two strata: the non-fixed stratum, those who have not decided their purchases, and the fixed stratum, of those who purchase only one brand, and explained the market structure of the non-fixed stratum by calculating the stratum rate develops a theory to demand.

This chapter investigated preferences of male university students regarding ten kinds of cars. The reason for the choice was given from among six factors: engine performance, design, price, comfort of drive, safety and others. The consumers can be divided into two strata: one is of the consumers who choose according to only one factor, and the other of consumers who choose according to several factors. In this chapter the main attention is given to the second stratum and to further distinctions within it.

The calculation of the preference rate of each factor in the fixed stratum and the non-fixed stratum is done using the Herniter's Entropy Model (Herniter Model).

3.2 Results of Questionnaire

10 popular cars in Japan were selected from a catalogue. To investigate the properties of cars preferences, male university students are given some useful information which explains engine performance, design, price, comfort of drive, safety and others, and asked the following two questions:

1. Do you like or dislike these cars? (The students were asked to put a mark on any cars they liked and disliked, regardless of the number.)
2. By what reasons do you answer question 1? Select one factor from: engine performance, design, price, comfort of drive, safety and others.

The questionnaire was conducted on 131 male university students, and Table 3.1 gives the results of the question No.1. The positive and negative answers were not as polarized as one would expect. Further, Table 3.2 gives the results of question No.2, where n_{si} : number of answerers who like the s cars by factor i, r_i : factor selection rate in the non-fixed stratum inside, h_s : rate of liking cars s. It is shown that 32.43% of male university students decide their favorite cars according to the design.

Table 3.1 Preferences Rate of Car

Brand S	Like: Number of persons n_s	Like: Rate h_s (%)	Dislike: Number of persons n_s	Dislike: Rate h_s (%)
MR-S	57	8.53	74	11.53
LEGACY	78	11.68	53	8.26
ODYSSEY	88	13.17	43	6.70
RX-7	57	8.35	74	11.53
LEOPARD	45	6.74	86	13.40
STEPWGN	79	11.83	52	8.10
COROLLA	62	9.28	69	10.75
ESTIMA	72	10.78	59	9.19
SOARER	61	9.13	70	10.90
SKYLINE	69	10.33	62	9.66
Total	668	100.00	642	100.00

Table 3.2 Preferences Rate of Factors

Contributing factor i / Car name s	Number of answers according to selection factor n_{si}: Engine performance	Design	Price	Comfort of drive	Safety	Others	Total	Preferences Rate h_s (%)
MR-S	52	81	28	27	23	28	239	10.23
LEGACY	51	78	23	23	21	38	234	10.01
ODYSSEY	29	81	35	35	29	34	243	10.40
RX-7	45	72	26	30	29	30	232	9.93
LEOPARD	27	72	23	24	24	35	205	8.77
STEPWAGON	29	81	25	32	31	43	241	10.31
COROLLA	35	62	51	31	30	32	241	10.31
ESTIMA	25	83	22	32	28	35	225	9.63
SOARER	39	71	26	19	25	41	221	9.46
SKYLINE	54	77	29	25	29	42	256	10.95
Total	386	758	288	278	269	358	2,337	100.00
q_i	16.51%	32.43%	12.32%	11.89%	11.51%	15.31%		

3.3 Herniter Model

There are generally two types, two strata, of consumers. In one stratum they choose a product according to only one from among these factors: engine performance, design, price, comfort of drive, safety and others. Consumers in the other stratum choose a product according to several factors.

To analyze a market structure, it is necessary to form a market model as a starting point. For instance, the inside structure of market could be investigated on the basis of preferences rate of brands. One method is an entropy model that indicates the vagueness of consumers' preferences. Further, the Herniter Model is applied to preferences rate, and selecting behaviors of consumers can be investigated in detail (Herniter (1973)).

(1) Non-Fixed Stratum

Suppose that i (i=1,2,3,4,5,6) represents factors of car; 1: engine performance, 2: design, 3: price, 4: comfort of drive, 5: safety and 6: others. Letting r_i be the selecting rate of factor i in the non-fixed stratum, the selecting rate of car s (s=1,2,…,10) is

$$h_s \equiv \sum_{i=1}^{6} \frac{n_{si}}{\sum_{t=1}^{10} n_{ti}} \times r_i \qquad (s=1,2,\ldots,10). \tag{3.1}$$

Further, the selecting rate of factor i is, from data,

$$q_i \equiv \frac{\sum_{s=1}^{10} n_{si}}{\sum_{j=1}^{6}\sum_{s=1}^{10} n_{sj}} \qquad (i=1,2,3,4,5,6). \tag{3.2}$$

Thus, to minimize the problem, the following is considered:

$$D_1 \equiv \sum_{i=1}^{6} r_i \times \log \frac{r_i}{q_i}, \tag{3.3}$$

under the condition h_s is given in (3.1).

The above problem can be solved by the iterative scaling method of Darroch and Ratchiff (1972), and the following algorithm of computing procedure is given:

Step 0: Compute the selecting rate of watch s for factor i by

$$a_{si} \equiv \frac{n_{si}}{\sum_{t=1}^{10} n_{ti}} \qquad s=1,2,3,\ldots,10;\ i=1,2,3,4,5,6. \tag{3.4}$$

Step 1: Give the 0-th approximate probability of r_i by

$r_1^{(0)} = q_1 = 0.1652$, $r_2^{(0)} = q_2 = 0.3243$, $r_3^{(0)} = q_3 = 0.1232$,

$r_4^{(0)} = q_4 = 0.1190$, $r_5^{(0)} = q_5 = 0.1151$, $r_6^{(0)} = q_6 = 0.1532$.

Step 2: Compute the 1-th approximate probability of r_i by

$$\begin{aligned} h_1^{(0)} &= \sum_{i=1}^{6} a_{1i} \times r_i^{(0)} \\ &= 0.1347 \times 0.1652 + 0.1069 \times 0.3243 + 0.0972 \times 0.1232 \\ &\quad + 0.0971 \times 0.1151 + 0.0855 \times 0.1151 + 0.0782 \times 0.1532 \\ &= 0.1023, \end{aligned}$$

$$\begin{aligned} r_1^{(1)} &= r_1^{(0)} \times \prod_{j=1}^{10} \left(\frac{h_j}{h_j^{(0)}} \right)^{a_{j1}} \\ &= 0.1652 \times (0.0853/0.1023)^{0.1347} \times (0.1168/0.1001)^{0.1321} \\ &\quad \times (0.1317/0.1040)^{0.0751} \times (0.0853/0.0993)^{0.1166} \\ &\quad \times (0.0674/0.0877)^{0.0699} \times (0.1183/0.1031)^{0.0751} \\ &\quad \times (0.0928/0.1031)^{0.0907} \times (0.1078/0.0963)^{0.0648} \\ &\quad \times (0.0913/0.0946)^{0.1010} \times (0.1033/0.1095)^{0.1399} \\ &= 0.1610. \end{aligned}$$

Step 3: Continue until probability r_i converges. In this case,

$r_1 = 0.035$, $r_2 = 0.366$, $r_3 = 0.052$, $r_4 = 0.226$, $r_5 = 0.072$, $r_6 = 0.249$.

(2) Herniter Model

Let p_i (i=1,2,3,4,5,6) be the selecting rate of factor i in the fixed stratum and p_7 be that of several factors. Then, to minimize the problem, the following is considered:

$$D_2 \equiv \sum_{i=1}^{6} p_i \times \log\frac{p_i}{0.0950} + p_7 \times \log\frac{p_7}{0.4302}, \tag{3.5}$$

under the condition.

$$p_i + p_7 \times r_i = q_i \qquad (i = 1,2,3,4,5,6). \tag{3.6}$$

By the same computing method, the solution is easily given by

p_1=0.152, p_2=0.184, p_3=0.103, p_4=0.033, p_5=0.087, p_6=0.057, p_7=0.384.

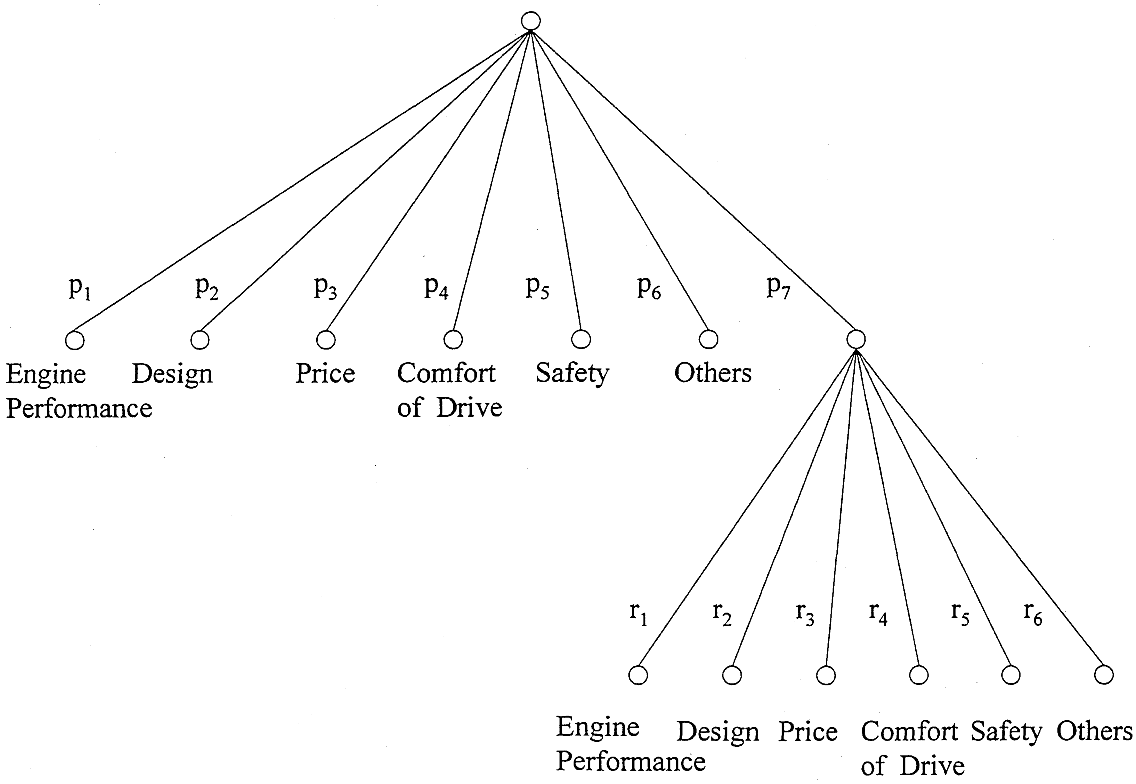

Figure 3.1 Tree of the Herniter Model

3.4 Conclusions

As a result of this chapter, it is understood that more than 60 % of the consumers select cars according to already decided preferences. The percentages of each factor are as follows: design is 18.4 %, engine performance is 15.2 %, price is 10.3 %, safety is 8.7 %, comfort drive is 3.3 % and others are 5.7 %. As for the preference factor among the non-fixed stratum, 36.6 % of consumers select according to design, 22.6 % according to comfort drive, 7.2 % according to safety, 5.2 % according to price, 3.5 % according to engine performance and 24.9 % according to others. Attention should be paid to the fact that although it was though that the non-fixed stratum would be 61.6 %, actually it was 38.4 %. In addition, in non-fixed stratum the percentage of selecting according to engine performance and price are very low, only about 3.5 % and 5.2 %, while in the fixed stratum they occupied 15.2 % and 10.3 %, respectively. Engine performance and price are the factors which can not be ignored during the product development. It has been understood that in the case of cars, a high percentage of customers already decide their preferences, and the order of factors in their preferences is design, engine performance, price, safety, comfort drive and others. From those results, it follows that classification analysis of preference according to Herniter Model is very effective for analyzing of consumer behavior.

Appendix

MR-S	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
LEGACY	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
ODYSSEY	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
RX-7	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
LEOPARD	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
STEPWAGON	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
COROLLA	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
ESTIMA	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
SOARER	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others
SKYLINE	Like, Dislike	Engine performance, Design, Price, Comfort of drive, Safety, Others

Please select 3 of your favorite cars in the order of your preferences.

1-No.______ 2-No.______ 3-No.______

Chapter 4

Herniter Model to Optimal Plan of Conjoint Analysis

The conjoint analysis is a method that analyzes consumers' preference, and obtains an optimal plan. And, Herniter employs entropy model and divides consumers into two strata: the non-fixed stratum, those who have not decided their purchases, and the fixed stratum, of those who purchase only one brand, and explained the market structure of the non-fixed stratum by calculating the stratum rate develops a theory to demand. The optimal plan obtained by the conjoint analysis is sure also to separate into fixed stratum and non-fixed stratum.

In this chapter, it proposes the application of Herniter Model to an optimal plan of the conjoint analysis.

4.1 Introduction

When the new product is designed, it is important to know evaluating to consumers' current product. It is important for the product experimental design to clarify the degree of consumers' preferences of the products attributes. The conjoint analysis, which is one of the marketing research techniques, is mainly used in such situations. Moreover, the generation that purchases products has greatly changed, and the market structure has become complicated. New product development has to turn scrupulous attention into sudden change and diversification of a market. The factor which plays on important role while consumers make purchases is the "quality requirement". When a new product is developed, we have to find its quality requirement. It is important to find out what degree of quality the consumers expect of the product. The entropy model is used to maximize the possibilities of a choice under certain limitations of the free will. The purpose of this chapter is to estimate the structure of the variable to specify the quality requirement of the new product using the conjoint analysis and the entropy model. As a result, it was understood that the conjoint analysis and the entropy model are effective methods to estimate the quality requirement.

4.2 Application According to Conjoint Analysis

The part worth x_{ij} is received as the result of attribute i and level j. If the level of attribute 1 is j, the level of attribute 2 is k,..., the level of attribute p is m, then according to the sum $a_{jk...m}$ of part worth of each attribute, the definition

$$a_{jk\cdots m} = x_{1j} + x_{2k} + \cdots + x_{pm} \tag{4.1}$$

is given.

The explanation is given on the following example. There are 3 attributes (p=3), where attribute 1 has 2 levels (c(1)=2), attribute 2 has 3 levels (c(2)=3), and attribute 3 has four levels (c(3)=4).

Each level in those three attributes carries out more partial effect as shown in (a), (b) and (c) of Figure 4.1. From this figure it can be seen that (x_{12}) which is the part worth of the level 2 of an attribute 1, and the part worth (x_{22}) of the level 2 of an attribute 2, the part worth (x_{33}) of the level 3 of an attribute 3, and part worth (x_{34}) of the level 4 of an attribute 3 are all negative.

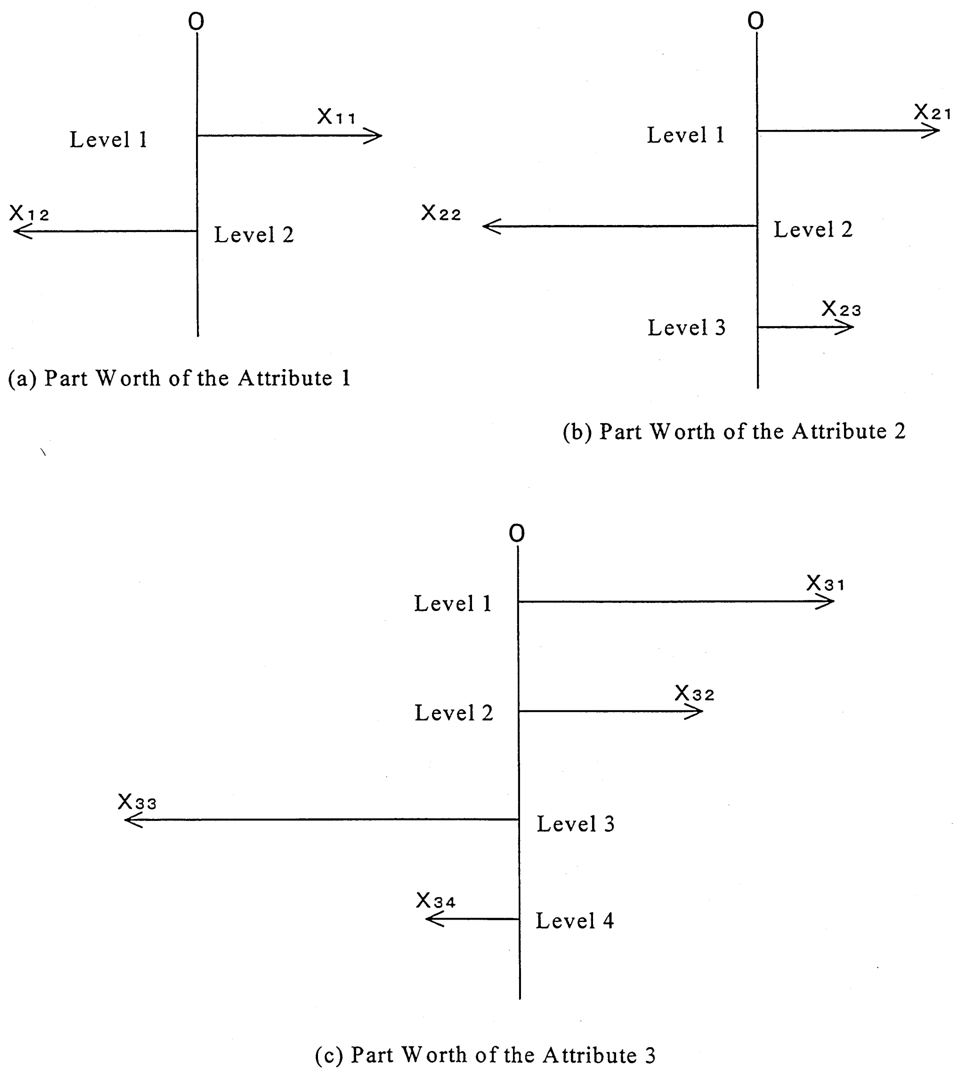

Figure 4.1 Part Worth

4.3 Calculation of Contribution Rate

The calculation of the contribution rate is performed as follows.

First, variance of the k-th attribute is calculated using the formula (4.2).

$$V_k = \frac{1}{m_k}\sum (u_j - \overline{u})^2 \quad (k = 1,2,\cdots,n) \tag{4.2}$$

m_k is the number of levels of the k-th attribute,
u_j is partial effect value of the j-th level,
$\overline{u}$ is the average of u_j (j=1,2,･･･,m).

Next, the following formula estimates the contribution rate Ck of the k-th attribute. However, the attribute k = 1, 2, …, n.

$$C_k = \frac{V_k}{\sum_{l=1}^{n} V_l} \times 100 \tag{4.3}$$

That is, with the contribution rate of an attribute, the variance ratio of the part worth value of each attribute is calculated.

4.4 Attribute and Level of the Cup Ramen

In the conjoint analysis, the variable that describes the specifications of a product is called "attribute" and the concrete value is called "level". Because both attribute and level have the influence on the plan of the product, both of them should be clear and precise.

Then, in order to set up concrete standard research was done on the market. From there, as shown in Table 4.1, the attribute and the level were determined.

Table 4.1 Attribute and Level of the Cup Ramen

Attribute	Level
A. Taste	1 = Soy sauce 2 = Miso 3 = Boned Pork 4 = Curry
B. Quantity	1 = S (38g) 2 = M (78g) 3 = L (103g) 4 = LL (143g)
C. Noodle	1 = Thin noodle 2 = Thick noodle
D. Type	1 = Uncooked type 2 = Dry type
E. Preparation Time	1 = 1 minute 2 = 2 minutes 3 = 3 minutes 4 = 4 minutes
F. Lid	1 = Yes 2 = No
G. Price	1 = 88 Yen 2 = 143 Yen 3 = 168 Yen 4 = 200 Yen

In the present research 3 attributes have 2 levels each, and 4 attributes have 4 levels each. If all of the possible types were presented, there would be the total of 2048 kinds 2x2x2x4x4x4x4=2048. Doing a research on all 2048 kinds would be physically and timewise impractical, if not impossible.

Therefore, using the orthogonal array of an experimental design, the number of types was narrowed down to 16.

The part worth of the cup ramen is shown in Table 4.2.

Table 4.2 Part Worth of the Cup Ramen

Attribute	Level	Part Worth
A	1	0.334
	2	0.484
	3	0.470
	4	-1.288
B	1	-3.148
	2	0.847
	3	1.307
	4	0.993
C	1	0.029
	2	-0.029
D	1	0.186
	2	-0.186
E	1	0.546
	2	0.753
	3	0.034
	4	-1.333
F	1	-0.357
	2	0.357
G	1	1.304
	2	-0.005
	3	0.036
	4	-1.335

The following Table 4.3 shows the contribution rate in this chapter.

Table 4.3 Contribution Rate

Attribute	Contribution Rate
A	9.83%
B	58.81%
C	0.02%
D	0.92%
E	11.67%
F	3.38%
G	15.38%
Total	100.00%

From those results the optimal plan was made and it is shown in Table 4.4.

Table 4.4 Optimal Plan

Attribute	Level
Taste	Miso
Quantity	L (103g)
Noodle	Thin; Thick
Type	Uncooked type
Cooking Time	2 minutes
Lid	Yes
Price	88 Yen

4.5 Herniter Model

There are generally two types of consumers. In one stratum they choose a product according to only one from among these factors: miso, L (103g), 2 minutes or 88 Yen. Consumers in the other stratum choose a product according to several factors.

To analyze a market structure, we need to form a market model as a starting point. For instance, we could investigate the inside structure of market on the basis of preferences rate of brands. Further, we apply an entropy model of Herniter (Herniter Model) to preferences rate, and can investigate selecting behaviors of consumers in detail.

The attribute with high ratio of contribution was chosen in the optimal plan derived from the consequence of the conjoint analysis. Table 4.5 was made from the order data and the part worth of those levels. The model of this chapter is shown in Figure 4.2.

Table 4.5 Preferences rate of Factors

Level i / Profile s	Miso	L (103g)	2 minutes	88 Yen	$\sum_{i=1}^{4} n_{si}$	h's
Model 2	0.00	0.00	1251.49	2167.25	3418.74	15.96%
Model 3	0.00	1770.99	0.00	0.00	1770.99	8.27%
Model 5	574.02	0.00	893.06	1546.54	3013.62	14.07%
Model 6	643.24	0.00	0.00	0.00	643.24	3.00%
Model 7	509.17	1374.96	0.00	0.00	1884.13	8.79%
Model 8	668.89	0.00	0.00	0.00	668.89	3.12%
Model 11	0.00	2144.79	1235.67	0.00	3380.46	15.78%
Model 12	0.00	0.00	0.00	1740.84	1740.84	8.13%
Model 14	0.00	0.00	1000.74	0.00	1000.74	4.67%
Model 15	0.00	1953.97	0.00	1949.48	3903.45	18.22%
$\sum n_{si}$	2395.32	7244.71	4380.96	7404.11	21425.10	100.00%
$\sum\sum n_{si}$		21425.10				
q_i	11.18%	33.81%	20.45%	34.56%		

(1) Non-Fixed Stratum

Suppose that i (i=1,2,3,4) represents factors of cup ramen; 1: miso, 2: L(103g), 3: 2 minutes, and 4: 88 yen. Letting r_i be the selecting rate of factor i in the non-fixed stratum, the selecting rate of profile s (s=1,2,…,10) is

$$h_s \equiv \sum_{i=1}^{4} \frac{n_{si}}{\sum_{t=1}^{10} n_{ti}} \times r_i \quad (s=1,2,\ldots,10). \qquad (4.4)$$

Further, the selecting rate of factor i is, from data,

$$q_i \equiv \frac{\sum_{s=1}^{10} n_{si}}{\sum_{j=1}^{4}\sum_{s=1}^{10} n_{sj}} \qquad (i=1,2,3,4). \tag{4.5}$$

Thus, we consider the problem that minimizes

$$D_1 \equiv \sum_{i=1}^{4} r_i \times \log \frac{r_i}{q_i} \tag{4.6}$$

under the condition h_s is given in (4).

We can solve the above problem by the iterative scaling method of Darroch and Ratchiff, and give the following algorithm of computing procedure:

Step 0: Compute the selecting rate of profile s for factor i by

$$a_{si} \equiv \frac{n_{si}}{\sum_{t=1}^{10} n_{ti}} \tag{4.7}$$

s = 1, 2, 3, …, 10; i = 1, 2, 3, 4.

Step 1: Give the 0-th approximate probability of $r_1^{(0)}$ by

$r_1^{(0)} = q_1 = 0.1118$, $r_2^{(0)} = q_2 = 0.3381$, $r_3^{(0)} = q_3 = 0.2045$, $r_4^{(0)} = q_4 = 0.3456$.

Step 2: Compute the 1-th approximate probability of $r_i^{(1)}$ by

$$\begin{aligned} h_1^{(0)} &= \sum_{i=1}^{4} a_{1i} \times r_i^{(0)} \\ &= 0.0000 \times 0.1118 + 0.0000 \times 0.3381 + 0.2857 \times 0.2045 + 0.2927 \times 0.3456 \\ &= 0.1596, \end{aligned}$$

$$\begin{aligned} r_1^{(1)} &= r_1^{(0)} \times \prod_{j=1}^{10} \left(\frac{h_j}{h_j^{(0)}} \right)^{a_{j1}} \\ &= 0.1118. \end{aligned}$$

Step 3: Continue until probability r_i converges. In this case,

$r_1 = 0.1118$, $r_2 = 0.3381$, $r_3 = 0.2045$, $r_4 = 0\ 3456$.

(2) Mathematization of Herniter Model

Let p_i (i=1,2,3,4) be the selecting rate of factor i in the fixed stratum and p_5 be that of several factors. Then, we consider the problem that minimizes

$$D_2 \equiv \sum_{i=1}^{4} p_i \times log \frac{p_i}{0.1302} + p_5 \times log \frac{p_5}{0.4793} \tag{4.7}$$

under the condition.

$$p_i + p_5 \times r_i = q_i \quad (i = 1,2,3,4). \tag{4.8}$$

Here, q_i is assumed to be a variance ratio of part worth.

By the same computing method, the solution is easily given by

$$p_1=0.0066, p_2=0.2556, p_3=0.0448, p_4=0.2591, p_5=0.4339.$$

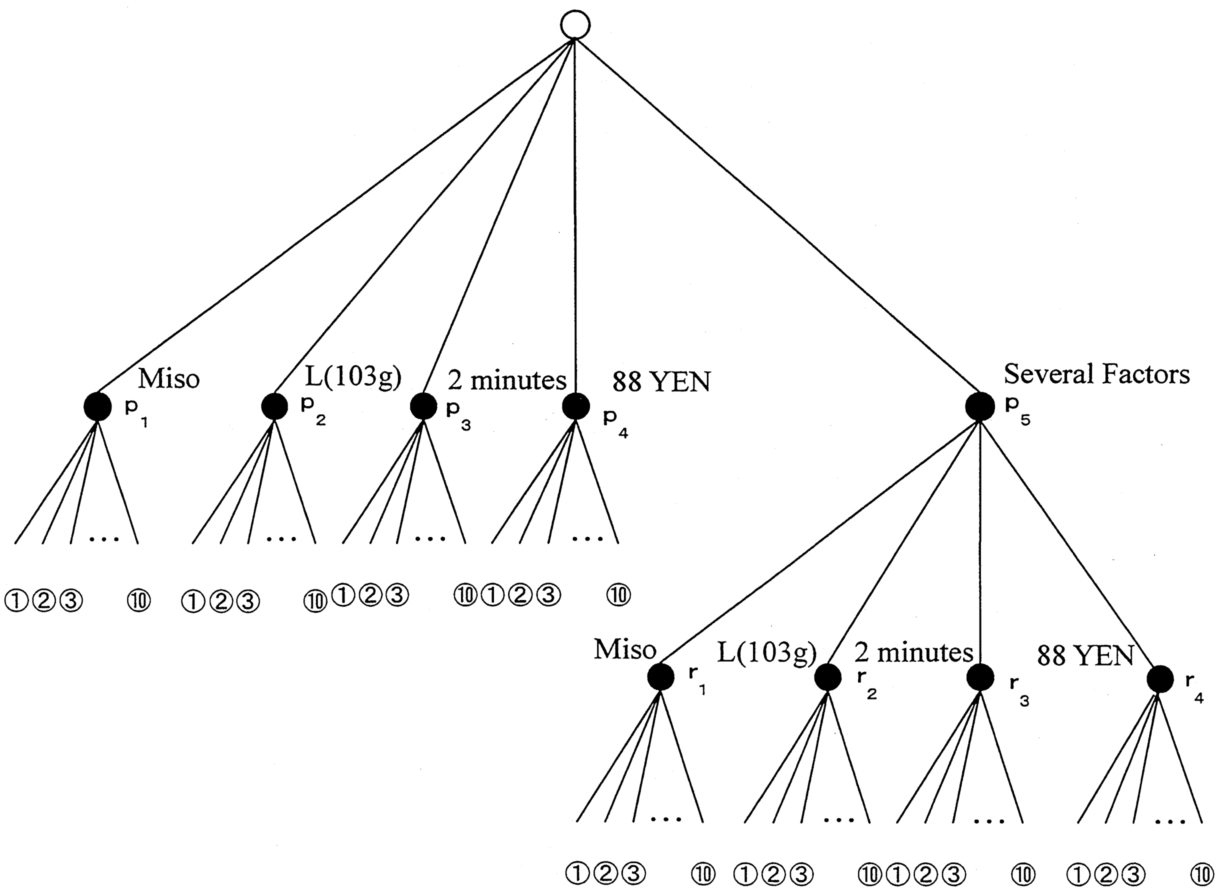

Figure 4.2 Tree of the Herniter Model

4.6 Conclusions

There are generally two types of consumers. One type is the consumers who choose the product after they have selected the main factor (level) this is the fixed stratum. The other type is the consumers who choose the product while hesitating on the factors (level) this is the non-fixed stratum. Therefore, the optimal plan obtained by the conjoint analysis should also be divided into the fixed and non-fixed stratum. In this chapter, the percentage of the fixed and non-fixed strata is obtained. Using the entropy model it was obtained that the customers belonging to the fixed and non-fixed strata could be roughly divided into half. The actual percentage of the customers belonging to the non-fixed stratum was 43.39%. As a result, the percentage of customers in the non-fixed stratum who choose the product according to each attribute is obtained. The results for each attribute are as follows: taste (miso) - 11.18%, quantity (L:103g) - 33.81%, cooking time (2 minutes) - 20.45% and price (88 yen) - 34.56%. It has been understood that in the fixed stratum quite a lot of customers (34.56%) put the price as the most important factor. Throughout the chapter it has been noticed that using both conjoint analysis and Herniter Model is very beneficial for the new products compliment each other and help to realize the mechanisms during the consumers' decision process.

Appendix

Model	1	2	3		16
Taste	Miso	Soy sauce	Miso		Curry
Quantity	143g (LL)	78g (M)	103g (L)		38g (S)
Noodle	Thin noodle	Thick noodle	Thin noodle		Thick noodle
Type	Uncooked type	Dry type	Uncooked type	…	Dry type
Cooking Time	2 minutes	2 minutes	2 minutes		1 minute
Lid	Yes	No	Yes		No
Price	88 Yen	88 Yen	88 Yen		143 Yen

Chapter 5

The Estimation of Consumers Attraction Using Huff Model

In this chapter the ability to attract consumers to residential street type convenience stores was estimated using modified Huff Model. Several aspects of selected convenience stores were researched: store space, parking space, average consumer number per day etc. Basing on this data and presuming the parking space were increased, the expected number was estimated. As the result, if 63 m^2 of parking space (enough for 3 cars) were added to a convenience store, then the expected number of consumers could increase by about 600 per day.

5.1 Introduction

Convenience stores in Japan have become an important part of daily lives of a great number of people. In 1980 there were over 10,000 convenience stores nationwide, and in 1998 there were about 48,000 stores with annual sale of about 7 billion yen. However, according to the "Research of Convenience Stores and Mini Supermarkets", published in June 1998 by Nihon Keizai Shinbun Inc., the increase rate of the convenience store in the fiscal year 1997 was the lowest since the research was started in 1974. With the increase in the number of sores the competition became very intense, and some convenience store collapsed. So, the problem of increasing the number of consumers has become very acute.

This chapter estimates the increase of the number of consumers to a residential area convenience store after the parking space is enlarged.

5.2 The Method of Trade Area Grasp

(1) Huff Model

Huff Model is a theoretical model measuring the probability of attracting consumers devised by an American economist, Dr. David Huff from the University of Texas. Until then the retail location theory was based on using the municipal units (city, town, ward, etc.). Also, there have been used two other laws: Riley Retail Law (Riley (1929)) and Converse Law (Converse (1949), stating that in order to estimate the number of consumers, the distance to the store and the population are needed. Huff added to those laws a very important element, namely the store retail area. Using the following equation, he estimated the probability of attracting consumers (Huff (1964)):

$$P_{ij} = \frac{\dfrac{S_j}{T_{ij}^{\lambda}}}{\displaystyle\sum_{j=1}^{n} \frac{S_j}{T_{ij}^{\lambda}}} \qquad (5.1)$$

where P_{ij} = the probability of a consumer at a given point of origin i traveling to a particular shopping center j;

S_j = the size of a shopping center j (measured in terms of the square footage of selling area devoted to the sale of a particular class of goods);

T_{ij} = the travel time involved in getting from a consumer's travel base i to a given shopping center j; and

λ = a parameter which is to be estimated empirically to reflect the effect of travel time on various kinds of shopping trips

The main feature of the Huff Model is the addition of the spatial dimension to a model of consumers' choice behavior.

(2) Traffic Resistance Parameter

A traffic resistance parameter λ is an acceleration parameter of the resistance factor (brake) related to the traffic conditions between the consumers house and the store, such as a major road, a railroad, a steep hill, a river etc. This parameter λ changes depending not only on geographic element but also according to the shopping items.

Table 5.1 Estimated Value of Parameter λ

Item	λ	Down rate (%)
Processed foods	2.282	20.6
Perishable foods	2.146	22.6
Daily clothing (under wear)	2.108	23.2
Women's and children's clothing	2.056	24.0
Shoes, foot gear, and bags	2.036	24.4
Everyday household goods	2.030	24.5
Men's clothes	1.983	25.3
House electric appliances	1.602	32.9
Furniture and interior	1.588	33.3

Most people shop for the articles of daily use near their houses, but it is understandable to go to the distant stores in the case of buying expensive goods, like furniture etc.

The value of λ for each item shown in Table 5.1 was estimated by Japan Industrial Policy Research Institute, based on empirical data (Japan Industrial Policy Research Institute (1979)).

(3) Modified Huff Model

The former Department of Trade and Industry (presently Ministry of Economy, Trade and Industry) modified the Huff Model, and Large-Scale Retail Stores Council used it as the standard model for local screening of locations for branches of major stores.

The difference with Huff Model is fixed the numeric value of a traffic resistance parameter to "2", and having changed the "time" to commercial accumulation to the "distance."

As contents, "The probability which the consumer who lives in one area purchases by one commercial accumulation is proportional to the scale of store space, and in inverse proportion to the square of the distance which reaches there", and is expressed with the following formulas (Ministry of International Trade and Industry (1990)).

$$P_{ij} = \frac{\dfrac{S_j}{D_{ij}^{2}}}{\sum_{j=1}^{n} \dfrac{S_j}{D_{ij}^{2}}} \tag{5.2}$$

$$E_j = P_{ij} \times C_i \tag{5.3}$$

P_{ij} = the probability of a consumer at a given point of origin i traveling to a particular shopping center j;

D_{ij} = the distance involved in getting from a consumer's travel base i to a given shopping center j; and

S_j = the size of a shopping center j (measured in terms of the square footage of selling area devoted to the sale of a particular class of goods);

E_j = the trading area of a particular firm of agglomeration of firms j, that is, the total expected number of consumers within a given region who likely to patronize j for a specific class of products of services;

C_i = the number of consumers residing within a given gradient i.

Modified Huff Model has the demerit that the difference has appeared to accuracy by having fixed a traffic resistance parameter to "2". However, the setting in the traffic resistance parameter that had been very often said to be difficult was eliminated, and it contributed to the spread of Huff Model.

5.3 The Estimation of Consumers Attraction Using Modified Huff Model

(1) Analysis of Current State

In this chapter, "Modified Huff Model" was used for the estimation of consumer attraction for two reasons. It was a comparison of convenience store with few differences in office hours and the sales item, etc. And it is a comparison of convenience stores in the same town".

First, a questionnaire survey was carried out at 10 convenience stores in a Nagoya suburb town. The questions (Table 5.2) were:

1. The store space
2. The parking space (in numbers of spaces)
3. Daily average number of consumers.

In the estimation of the consumer attraction of the residential street type convenience store, the residential population and the number of households in the trade area are the most important.

Table 5.2 Questionnaire Survey Data of Convenience Stores

Store	Store space (m^2)	Parking space (stand)	Number of those who average come to a store per day
A	82.50	2	540
B	105.27	9	800
C	99.00	12	800
D	108.90	4	1,300
E	113.00	6	800
F	125.40	4	1,300
G	108.90	0	-
H	102.30	6	-
I	105.60	9	-
J	102.30	4	-

The trade area of the convenience store is different according on the location, but in general it can be said that it is small, ranging from radius of 400m to 600m, according to Ichihara (1995). Therefore, a circle of 400m in radius is drawn from the center of each store (Itakura (1988)). The areas covered by the circles of two or more stores are noticed. Moreover, using the data from the population census, the residential population is calculated. (Note 5.1)

Next, in order to recalculate the total store space, the parking space is added to the store space. The calculation method was devised by Masaki Tomoda. This method is called "Tomoda Method". According to this method, one parking space is converted into 21m^2 of the store space (Ichihara (1995)). The data is then calculated using the formulas (5.2) and (5.3). Through the multiplication of P_{ij} (The probability of a consumer shopping at the particular store) by the population of the area, the expected number consumers are received. It is shown in Table 5.4. Moreover, the daily average number of consumers (received through the questionnaire) is divided bt the P_{ij} and the ratio is obtained. It is shown Table 5.5. Moreover, the actual number of consumers per day is not equal to the expected number of consumers. This is because certain segments of population (e.g. samall babies, senior citizens, physically handicapped etc.) do not visit the convenience stores as offen as the general population.

After looking at the questionnaire data, it is clear that the number of daily consumers and the P_{ij} are quite different from the other stores. When looking closely at the information regarding the stores D and F, the fact that those two stores are near a national main road with heavy traffic was realized. Since not only the local residents, but also the travellers on the road frequent the stores, the results for those stores may be skewed. Except for the stores D and F, the average P_{ij} ratio is 0.215. The data of the stores G, H, I and J were not received, but the daily average number of consumers can be estimated by multiplication of th P_{ij} 0.215.

Table 5.3 Restated Store Space

Store	Store space (㎡)	Total area (including recalculated parking space) (㎡)
A	82.50	124.50
B	105.27	294.27
C	99.00	351.00
D	108.90	192.90
E	113.00	239.00
F	125.40	209.40
G	108.90	108.90
H	102.30	228.30
I	105.60	294.60
J	102.30	186.30

Table 5.4 The Expected Number of Consumers (Current State)

	One district	Two district	Three district	…	69 district	70 district	71 district	The expected number of consumers
A	713.518	45.787	282.478					2,039
B	440.482	788.213	546.525					5,768
C								4,011
D								1,517
E								3,118
F				…				2,940
G								1,685
H								3,147
I			268.107		426.000	99.000	42.000	2,684
J								2,544

Table 5.5 The Expected Number of Consumers and Ratio

Store	Number of those who average come to a store per day	The expected number of consumers	Ratio
A	540	2,039	0.265
B	800	5,768	0.139
C	800	4,011	0.199
D	1,300	1,517	0.857
E	800	3,118	0.257
F	1,300	2,940	0.442
G	-	1,685	-
H	-	3,147	-
I	-	2,684	-
J	-	2,544	-

(2) The Estimation of Consumers' Attraction

There can be many factors influencing the consumers' attraction, like the chain name (Circle-K, Lawson, and FamilyMart etc), variety of goods, staff's attitude toward the consumers etc. Because during the actual selection those many factors are overlapped, it is very difficult to estimate all of them.

The fundamental idea of Haff Model is that "If the store space is expanded, the consumer attraction ratio grows, too". This idea was applied to this estimation. The estimated increase in the daily number of consumers are based on the ratio of daily average number of consumers, obtained from the questionnaire from each convenience store, and the expected number of consumers.

According to the results of the questionnaire, the store space of the convenience stores are relatively similar. Using Tomoda method, the parking space for each car is converted into $21m^2$ of store space, and the total store space is recalculated.

In this analysis the expected numbers of consumers are estimated for two stores, G and J. If the parking space was increased by 3, 6, or 9 spaces, now would that affect the expected number of consumers. If must be noticed that store G has no parking lot, and that the trade area of store J overlaps with the trade area of another stores. The municipality is which those stores are located is divided into 71 smaller distincts. The combined tares area of those two stores (in the radius range 400m to 600m) cover 19 of those distincts, so the calculation of the expected number of consumers were obtained only for those 19 distincts (Table 5.6, Table 5.7, Table 5.8, and Table 5.9).

At the store G at the present these is no parking space. If there was made some parking space for 3 cars, the expected number of consumers world increase by 600 peoples daily. At the present the expected number of consumers at the store G is about 1685 peoples. After multiplying it by 0.215 (average of the ratio), the result is 362, the actual number of consumers coming daily the store. If 3 parking spaces are added, the total store space will increase by $63m^2$, and after recalculating the total store space, the expected number of consumers becomes 2275. The multiplication $2275 \times 0.215 = 489$, so the actual number of consumers per day will increases by 127 peoples.

Similarly, if the parking space for 3 cars is added at the store J, the expected number of consumers rises by 400, and the actual number of consumers will increase by 80 peoples.

Table 5.6 The Expected Number of Consumers (Three Increase)

	Five district	Six district	Seven district	…	65 district	66 district	67 district	The expected number of consumers
A	58.582	380.347	416.321					-
B								-
C								-
D								-
E	210.488							-
F				…	209.102			-
G	123.947	195.298	248.820			259.765	687.303	2,275
H	164.586	400.355	465.972			456.235	465.697	-
I	76.460							-
J					414.898			2,919

Table 5.7 The Expected Number of Consumers (Six Increase)

	Five district	Six district	Seven district	…	65 district	66 district	67 district	The expected number of consumers
A	54.651							-
B								-
C								-
D								-
E	196.413							-
F				…	179.026			-
G	157.993	248.587	314.644			313.322	770.781	2,732
H	153.555	373.027	431.137			402.678	382.220	-
I	71.325							-
J					444.974			3,214

Table 5.8 The Expected Number of Consumers (Nine Increase)

	Five district	Six district	Seven district	…	65 district	66 district	67 district	The expected number of consumers
A	51.227	331.742	358.527					-
B								-
C								-
D								-
E	184.114							-
F				…	156.499			-
G	187.854	295.142	371.307			355.566	828.892	3,100
H	143.981	349.115	401.279			360.434	324.108	-
I	66.887							-
J					467.501			3,456

Table 5.9 Change the Expected Number of Consumers

Store	Current state	Three increase	Six increase	Nine increase
G	1,685	2,275	2,732	3,100
J	2,544	2,919	3,214	3,456

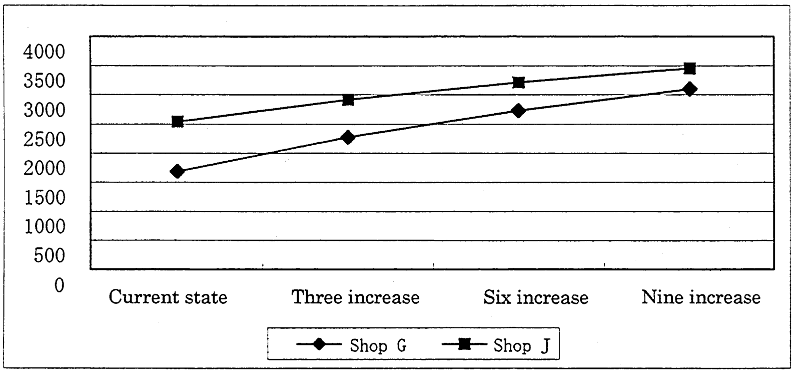

Figure 5.1 Transition of Shopping the Expected Number of Consumers

5.4 Conclusions

In this chapter the attention was paid to the parking space of residential street type convenience stores, and based on shopping proceeding probability, the estimation of consumer attraction has been done.

It is true that the number of consumer is also affected by factors others than the parking space. They have not been carefully estimated here, but several important ones can be mentioned: population density type of neighborhood (private houses, housing projects, apartment houses etc.) type of road (main avenue vs. local street), the street divider. While those factors do affect the number of consumers, it has been shown that shopping proceeding probability will increase it the parking space is enlarged.

Note (5.1)

Survey data in 1998

Trade area internal abode population: 29,453 people (71 districts)

Chapter 6

The Analysis of Consumers Choice Behavior Using Huff Model and Herniter Model

In this chapter, it proposes the application of Herniter Model to the result of modified Huff Model.

In Nagoya, like in many large cities, there are several department stores. Consumers have a chance to choose the store where they go shopping. Using Huff Model, the probability of consumers going to particular stores was calculated: A is 16.01%, B is 2.58%, C is 19.71%, D is 18.65%, E is 19.59% and F is 23.47%.

Next, the selection method was evaluated. Looking from the choice behavior point of view, consumers can be divided into 2 strata. One is the fixed stratum, where the consumers choose the store according to any criterion, and the other is the non-fixed stratum, in which consumers choose the store according to two or more criteria. These results can be obtained by using Herniter Model.

As the result, the percentage of fixed stratum and non-fixed stratum is 70.19% and 29.81%.

6.1 Introduction

The sales amount of the department store in Japan decreases gradually. Moreover, many stores, where prices are cheap and qualities are good, have opened in the near suburbs. To compete with these stores, the department store kept the large stock of goods, and developed original brands. In addition, there is a department store where a new store is actively enhanced on part, too. However, it is difficult the amelioration and to remodel it afterwards if a new store is opened. When a new store is opened, a wide study in a lot of situations is necessary beforehand.

This chapter estimates the probability of consumers who go shopping to department stores in Nagoya city, using modified Huff Model. This model is a type of calculation designed for evaluating the probability of consumers patronizing a particular store. Based on the data of floor spaces, populations and time distances, we compute the selection rates of consumers for 6 department stores in Nagoya city. This method would be possible to estimate the selection rates of department stores from a little data such as floor spaces and distances. Moreover, this would be useful to estimate the losses of other existing stores when a new store is planning to open in this area.

Next, looking from the selection behavior point of view, consumers can be divided into 2 strata. One is the fixed stratum, which is the consumers choose the store according to any criterion, and the other is the non-fixed stratum, in which consumers choose the store according to two or more criteria. These percentages can be obtained by using Herniter Model.

6.2 Huff Model

Huff (1964) subdivided a commercial area into some business places which are retail accumulations such as shopping centers, department stores and supermarkets as one unit, and examined individual goods in addition to shopping goods. Further, he investigated populations, distances and retail areas of business places, and formed the probability model in which the formula is given by

$$P_{ij} = \frac{\dfrac{S_j}{T_{ij}^{\lambda}}}{\displaystyle\sum_{j=1}^{n} \frac{S_j}{T_{ij}^{\lambda}}}, \tag{6.1}$$

where P_{ij} = the probability of a consumer at a given point of origin i traveling to a particular shopping center j;

S_j = the size of a shopping center j (measured in terms of the square footage of selling area devoted to the sale of a particular class of goods);

T_{ij} = the travel time involved in getting from a consumer's travel base i to a given shopping center j; and

λ = a parameter which is to be estimated empirically to reflect the effect of travel time on various kinds of shopping trips.

Ministry of Economy, Trade and Industry in Japan modified Huff Model as follows: Probabilities that consumers buy something in a business area is in proportion to its area and is in inverse proportion to square of distance to its area (Ministry of International Trade and Industry (1990)). This is called modified Huff Model. At present, most consumers move to their destination by automobiles, trains and buses. Thus, it would be practical in actual fields to use the time taking to destination in place of distance.

There are 6 department stores in Nagoya city. We collect the data of floor spaces and amount of sales for each store in Table 6.1, populations of districts in Nagoya city and environs cities, and time distances from a main station to each store in Table 6.2. Using these data, we compute the probabilities that consumers in districts and cities go shopping to each store in Table 6.3.

Table 6.1 Floor Space, Capital and Sales of Stores

	Floor Space	Capital	Sales Amount (million yen)
A	55,429	10,000	6,113
B	8,929	2,720	1,750
C	69,909	973	8,411
D	67,090	4,962	3,647
E	67,814	2,028	6,161
F	104,709	9,765	11,121

(Ref. Japan Department Store Associations (May 2002))

Table 6.2 Populations of City and Time Distances from Main Station

City and District	Household	Population	Time Distance / Easy of Transportation		
			Nagoya (A, B, E)	Sakae (C,D)	Yabacho (F)
Chikusa ward	70,703	149,917	11	7	10
Higasi ward	31,002	66,179	11	11	12
kita ward	69,663	167,008	10	5	6
Nishi ward	58,985	140,556	15	13	20
Nakamura ward	60,681	133,945	1	7	11
Naka ward	35,714	65,549	4	0	1
Syouwa ward	50,839	105,567	10	7	6
Mizuho ward	44,617	103,700	17	14	17
Atsuta ward	26,874	62,926	7	12	10
Nakagawa ward	80,336	211,413	12	16	19
Minato ward	56,973	151,735	20	14	13
Minami ward	59,756	146,998	10	13	12
Moriyama ward	58,518	156,323	22	17	19
Midori ward	75,753	209,994	13	16	15
Meitou ward	65,779	153,950	23	19	21
Tenpaku ward	65,021	153,713	19	16	15
Kasugai	106,445	291,024	20	17	23
Seto	47,211	132,345	32	25	28
Ichinomiya	92,794	276,096	10	16	17
Tsushima	21,813	65,846	12	18	21
Kounan	32,921	98,244	20	30	34
Tokai	37,564	100,702	18	22	21
Okazaki	117,477	340,417	34	37	36

(Ref. Yahoo Japan and Aichi-Prefecture (January 2002))

Table 6.3 Probability that Consumers Go to A – F

City and District	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)
Chikusa ward	9.28	1.50	28.91	27.74	11.36	21.22
Higasi ward	15.52	2.50	19.57	18.78	18.99	24.63
kita ward	5.71	0.92	28.80	27.64	6.98	29.95
Nishi ward	14.84	2.39	24.92	23.92	18.16	15.77
Nakamura ward	40.81	6.57	1.05	1.01	49.92	0.64
Naka ward	0.52	0.08	42.31	40.60	0.64	15.84
Syouwa ward	7.89	1.27	20.31	19.49	9.65	41.40
Mizuho ward	12.63	2.03	23.49	22.54	15.45	23.86
Atsuta ward	24.09	3.88	10.34	9.92	29.47	22.30
Nakagawa ward	22.08	3.56	15.67	15.04	27.02	16.64
Minato ward	8.40	1.35	21.63	20.76	10.28	37.57
Minami ward	19.38	3.12	14.47	13.88	23.72	25.43
Moriyama ward	11.04	1.78	23.32	22.38	13.51	27.97
Midori ward	18.40	2.96	15.32	14.70	22.51	26.11
Meitou ward	12.09	1.95	22.34	21.44	14.79	27.39
Tenpaku ward	11.23	1.81	19.98	19.18	13.75	34.05
Kasugai	13.82	2.23	24.13	16.91	16.91	19.75
Seto	11.23	1.81	23.21	22.28	13.74	27.72
Ichinomiya	24.98	4.02	12.31	11.81	30.56	16.33
Tsushima	24.39	3.93	13.67	13.12	29.84	15.05
Kounan	24.17	3.89	13.55	13.00	29.58	15.80
Tokai	18.43	2.97	15.56	14.93	22.54	25.57
Okazaki	16.24	2.62	17.30	16.60	19.87	27.37

Table 6.4 shows the shares of department stores. It indicates that the department store F has the highest share. There can be several reasons for this. One reason is that the store is big. Another could be that its shares in the remote distance are high. A store C has the second highest store, because the shares in the areas near that store are high and the transportation is better than to other department stores. The shares of the department store C and D are almost the same. The share of the department store E is high in the suburbs because of good transportation from those areas. The shares of the department store B is much lower than or other stores, because its floor space is very small.

Table 6.4 Shares of Department Stores

Department Store	Share
A	16.01%
B	2.58%
C	19.71%
D	18.65%
E	19.59%
F	23.47%

Using the above results, we estimate expected number of consumers to each store, which is given by

$$T_j = \sum_{i=1}^{n} (P_{ij} \times C_i), \tag{6.2}$$

where T_j = the trading area of a particular firm of agglomeration of firms j, that is, the total expected number of consumers within a given region who likely to patronize j for a specific class of products of services;

P_{ij} = the probability of an individual consumer residing within a given gradient i shopping at j; and

C_i = the number of consumers residing within a given gradient i.

Table 6.5 Expected Number of Consumers

Department Store	Expected number of consumers
A	563,553
B	90,785
C	673,615
D	628,257
E	689,521
F	820,248

6.3 Herniter Model

Looking from the selection behavior point of view, consumers can be divided into 2 strata. One is the fixed stratum, where the consumers choose the store according to one criterion, and the other is the non-fixed stratum, in which consumers choose the store according to two or more criteria. One method is an entropy model that indicates the vagueness of consumers' preferences. Further, we apply a Herniter Model to preferences rate, and can investigate selecting behaviors of consumers in detail. In this chapter, the percentage of a stratum (fixed stratum) where the department store visited from the beginning in the proceeding expected number shown by Huff Model had been decided, other department stores, and hesitant stratums (non-fixed stratum) is obtained using Herniter Model. In this chapter, "estimation of sales amount according to district (Table 6.6)" and "expected number of consumer according to district (Table 6.7)" were used as consumers' preference rate.

Table 6.6 Estimation of Sales Amount According to District

District s	Sales amount of each department store n_s						Total	Rate
	A	B	C	D	E	F		h_s (%)
Chikusa ward	155	44	538	236	156	438	1,567	4.21
Higasi ward	258	74	364	160	260	509	1,625	4.37
kita ward	95	27	536	236	96	619	1,609	4.32
Nishi ward	247	71	464	204	249	326	1,561	4.20
Nakamura ward	680	194	19	9	685	13	1,600	4.30
Naka ward	9	2	787	346	9	327	1,480	3.98
Syouwa ward	131	38	378	166	132	855	1,700	4.57
Mizuho ward	210	60	437	192	212	493	1,604	4.31
Atsuta ward	401	115	192	85	404	461	1,658	4.46
Nakagawa ward	368	105	291	128	371	344	1,607	4.32
Minato ward	140	40	402	177	141	776	1,676	4.51
Minami ward	323	92	269	118	325	525	1,652	4.44
Moriyama ward	184	53	434	191	185	578	1,625	4.37
Midori ward	306	88	285	125	309	539	1,652	4.44
Meitou ward	201	58	416	183	203	566	1,627	4.37
Tenpaku ward	187	54	372	164	189	703	1,669	4.49
Kasugai	230	66	449	144	232	408	1,529	4.11
Seto	187	54	432	190	188	573	1,624	4.37
Ichinomiya	416	119	229	101	419	337	1,621	4.36
Tsushima	406	116	254	112	409	311	1,608	4.32
Kounan	402	115	252	111	406	326	1,612	4.33
Tokai	307	88	289	127	309	528	1,648	4.43
Okazaki	270	77	322	142	272	565	1,649	4.43
Total	6,113	1,750	8,411	3,647	6,161	11,120	37,202	100.00

Table 6.7 Expected Number of Consumers According to District

Contribution Factor i / District s	A	B	C	D	E	F	$\sum_{i=1}^{6} n_{si}$	Rate h_s (%)
	The expected number of consumers n_{si}							
Chikusa ward	13,912	2,249	43,341	41,587	17,031	31,812	149,932	4.33
Higasi ward	10,271	1,654	12,951	12,428	12,567	16,300	66,171	1.91
kita ward	9,536	1,536	48,098	46,161	11,657	50,019	167,007	4.82
Nishi ward	20,859	3,359	35,027	33,621	25,525	22,166	140,557	4.06
Nakamura ward	54,663	8,800	1,406	1,353	66,865	857	133,944	3.86
Naka ward	341	52	27,734	26,613	420	10,383	65,543	1.89
Syouwa ward	8,329	1,341	21,441	20,575	10,187	43,705	105,578	3.05
Mizuho ward	13,097	2,105	24,359	23,374	16,022	24,743	103,700	2.99
Atsuta ward	15,159	2,442	6,507	6,242	18,544	14,032	62,926	1.82
Nakagawa ward	46,680	7,526	33,128	31,797	57,124	35,179	211,434	6.10
Minato ward	12,746	2,048	32,820	31,500	15,598	57,007	151,719	4.38
Minami ward	28,488	4,586	21,271	20,403	34,868	37,382	146,998	4.24
Moriyama ward	17,258	2,783	36,455	34,985	21,119	43,724	156,324	4.51
Midori ward	38,639	6,216	32,171	30,869	47,270	54,829	209,994	6.06
Meitou ward	18,613	3,002	34,392	33,007	22,769	42,167	153,950	4.44
Tenpaku ward	17,262	2,782	30,712	29,482	21,136	52,339	153,713	4.43
Kasugai	40,220	6,490	70,224	49,212	49,212	57,477	272,835	7.87
Seto	14,862	2,395	30,717	29,486	18,184	36,686	132,330	3.82
Ichinomiya	68,969	11,099	33,987	32,607	84,375	45,086	276,123	7.97
Tsushima	16,060	2,588	9,001	8,639	19,648	9,910	65,846	1.90
Kounan	23,746	3,822	13,312	12,772	29,061	15,523	98,236	2.83
Tokai	18,559	2,991	15,669	15,035	22,698	25,750	100,702	2.91
Okazaki	55,284	8,919	58,892	56,509	67,641	93,172	340,417	9.82
$\sum n_{si}$	563,553	90,785	673,615	628,257	689,521	820,248	3,465,979	100.00
$\sum\sum n_{si}$			3,465,979					
q_i	16.26%	2.62%	19.44%	18.13%	19.89%	23.67%		

(1) Non-Fixed Stratum

Suppose that i (i=1,2,3,4,5,6) represents factors of department store; 1: A, 2: B, 3: C, 4: D 5:E and 6: F. Letting r_i be the selecting rate of factor i in the non-fixed stratum, the selecting rate of district s (s=1,2,...,23) is

$$h_s \equiv \sum_{i=1}^{6} \frac{n_{si}}{\sum_{t=1}^{23} n_{ti}} \times r_i \qquad (s=1,2,\ldots,23). \tag{6.3}$$

Further, the selecting rate of factor i is, from data,

$$q_i \equiv \frac{\sum_{s=1}^{23} n_{si}}{\sum_{j=1}^{6}\sum_{s=1}^{23} n_{sj}} \qquad (i=1,2,3,4,5,6). \tag{6.4}$$

Thus, we consider the problem that minimizes

$$D_1 \equiv \sum_{i=1}^{6} r_i \times log \frac{r_i}{q_i}, \tag{6.5}$$

under the condition h_s is given in (6.3).

We can solve the above problem by the iterative scaling method of Darroch and Ratchiff (1972), and give the following algorithm of computing procedure:

Step 0: Compute the selecting rate of district s for factors i by

$$a_{si} \equiv \frac{n_{si}}{\sum_{t=1}^{23} n_{ti}} \qquad s=1,2,3,\ldots,23; i=1,2,3,4,5,6. \tag{6.6}$$

Step 1: Give the 0-th approximate probability of r_i by

$$r_1^{(0)} = q_1 = 0.1626,\ r_2^{(0)} = q_2 = 0.0262,\ r_3^{(0)} = q_3 = 0.1944,$$

$$r_4^{(0)} = q_4 = 0.1813,\ r_5^{(0)} = q_5 = 0.1989,\ r_6^{(0)} = q_6 = 0.2367.$$

Step 2: Compute the 1-th approximate probability of r_i by

$$h_1^{(0)} = \sum_{i=1}^{6} a_{1i} \times r_i^{(0)}$$
$$= 0.0247 \times 0.1626 + 0.248 \times 0.0262$$
$$+ 0.0643 \times 0.1944 + 0.0662 \times 0.1813$$
$$+ 0.0247 \times 0.1989 + 0.388 \times 0.2367$$
$$= 0.0433 ,$$

$$r_1^{(1)} = r_1^{(0)} \times \prod_{j=1}^{23} \left(\frac{h_j}{h_j^{(0)}} \right)^{a_{j1}}$$
$$= 0.1626 \times (0.0433/0.0421)^{0.0247} \times (0.0191/0.0437)^{0.0182}$$
$$\times (0.0482/0.0432)^{0.0169} \times (0.0406/0.0420)^{0.0370}$$
$$\times (0.0386/0.0430)^{0.0970} \times (0.0189/0.0398)^{0.0006}$$
$$\times (0.0305/0.0457)^{0.0148} \times (0.0299/0.0431)^{0.0232}$$
$$\times (0.0182/0.0446)^{0.0269} \times (0.0610/0.0432)^{0.0828}$$
$$\times (0.0438/0.0451)^{0.0226} \times (0.0424/0.0444)^{0.0506}$$
$$\times (0.0451/0.0437)^{0.0306} \times (0.0606/0.0444)^{0.0686}$$
$$\times (0.0444/0.0437)^{0.0330} \times (0.0443/0.0449)^{0.0306}$$
$$\times (0.0787/0.0411)^{0.0714} \times (0.0382/0.0437)^{0.0264}$$
$$\times (0.0797/0.0436)^{0.1224} \times (0.0190/0.0432)^{0.0285}$$
$$\times (0.0283/0.0433)^{0.0421} \times (0.0291/0.0443)^{0.0329}$$
$$\times (0.0982/0.0443)^{0.0981}$$
$$= 0.1842.$$

Step 3: Continue until probability r_i converges. In this case,

$r_1 = 0.1390$, $r_2 = 0.0218$, $r_3 = 0.0521$, $r_4 = 0.4897$, $r_5 = 0.1699$, $r_6 = 0.1275$.

(2) Herniter Model

Let p_i (i=1,2,3,4,5,6) be the selecting rate of factor i in the fixed stratum and p_5 be that of several factors. Then, we consider the problem that minimizes

$$D_2 \equiv \sum_{i=1}^{6} p_i \times log \frac{p_i}{0.0984} + p_7 \times log \frac{p_7}{0.4093}, \tag{6.7}$$

under the condition.

$$p_i + p_7 \times r_i = q_i \qquad (i = 1,2,3,4,5,6). \tag{6.8}$$

By the same computing method, the solution is easily given by

p_1=0.1212, p_2=0.0197, p_3=0.1789, p_4=0.0353, p_5=0.1482, p_6=0.1986, p_7=0.2981.

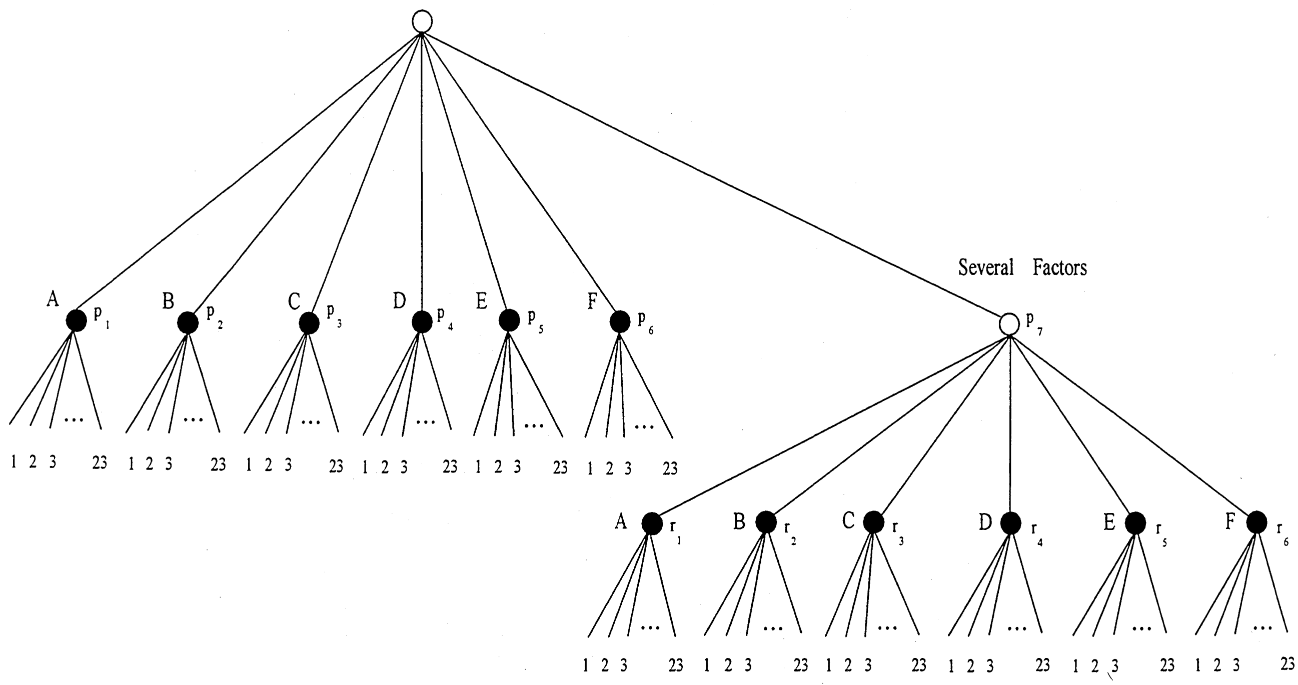

Figure 6.1 Tree of the Herniter Model

6.4 Conclusions

As the result, the percentage of fixed stratum and non-fixed stratum is 70.19% and 29.81%. The possibility that a consumer will go to a particular department store within the fixed stratum is as follows: A is 12.12%, B is 1.97%, C is 17.89%, D is 3.53%, E is 14.82% and F is 19.86%. Within the non-fixed stratum the possibility that a consumer will choose a particular store is as follows: A is 13.90%, B is 2.18%, C is 5.21%, D is 48.97%, E is 16.99% and F is 12.75%. Since the percentage for the fixed stratum is very high (70.19%) it can be said that when consumers go to a department store, they have already decided which store they will go to. Special attention should be paid to the department store D. This store does not have any particular strength or characteristics, so within the fixed stratum its share is relatively low. However, it is often seen as an alternative store, so many consumers may end of visiting it, as it is shown in the non-fixed stratum.

From this chapter it was understood that to understand the market structure and the mechanisms of consumers' preferences, the application of the combination of Huff Model and Herniter Model is very beneficial.

Chapter 7

Conclusions

This thesis has suggested the following five scientific techniques in order to grasp the method of estimating market structure and consumers choice behavior.

1. Conjoint Analysis
2. Entropy Model and Herniter Model
3. Conjoint Analysis and Herniter Model
4. Huff Model
5. Huff Model and Herniter Model

While discussing Conjoint Analysis, undergraduate students' preferences for trips abroad were estimated. As a result, the following optimal plan is made: It is significant that in the attribute "Country" the highest part worth is "Level: Singapore", in the attribute "Number of visited countries or visited cities" the highest part worth is "Level: One place", and in the attribute "City sightseeing" the highest value is "Level: Included", judging from the F value. The contribution rate reached about 97.1% with those three attributes.

It should be noted that, judging from the F value (error), statistically significant are only the first three attributes. However, the optimal given plan does not necessarily mean that it is ideal for everybody. The main reason is that part worth for attribute B is relatively low. Thus, in Conjoint Analysis it is very beneficial to evaluate the F value (error) of the part worth.

While discussing the Entropy Model and Herniter Model, consumers' preferences regarding car selection where estimated. Using those two models, it is understood that more than 60 % of the consumers select cars according to already decided preferences. The percentages of each factor are as follows: design is 18.4 %, engine performance is 15.2 %, price is 10.3 %, safety is 8.7 %, comfort drive is 3.3 % and others are 5.7 %. As for the preference factor among the non- fixed stratum, 36.6 % of consumers select according to design, 22.6 % according to comfort drive, 7.2 % according to safety, 5.2 % according to price, 3.5 % according to engine performance and 24.9 % according to others. Attention should be paid to the fact that although it was though that the non-fixed stratum would be 61.6 %, actually it was 38.4 %. In addition, in non-fixed stratum the percentage of selecting according to engine performance and price are very low, only about 3.5 % and 5.2 %, while in the fixed stratum they occupied 15.2 % and 10.3 %, respectively. Engine performance and price are the factors which can not be ignored during the product development. It has been understood that in the case of cars, a high percentage of customers already decide their preferences, and the order of factors in their preferences is design, engine performance, price, safety, comfort drive and others.

From those results, classification analysis of preference according to Herniter Model is very effective for analyzing of consumers behavior.

While discussing Conjoint Analysis and Herniter Model, consumers' preferences regarding the selection of instant ramen (noodles) where estimated. According to the results, the consumers' can be divided into the fixed and non-fixed stratum. The percentage of the fixed and non-fixed strata is obtained.

Using Herniter Model it was obtained that customers belonging to the fixed and non-fixed strata could be roughly divided into half. The actual percentage of the customers belonging to the non-fixed stratum was 43.39%. As a result, the percentage of customers in the non-fixed stratum who choose the product according to each attribute is obtained. The results for each attribute are as follows: taste (miso) - 11.18%, quantity (L:103g) - 33.81%, cooking time (2 minutes) - 20.45% and price (88 yen) - 34.56%. It has been understood that in the fixed stratum quite a lot of customers (34.56%) put the price as the most important factor.

It has been noticed that using both Conjoint Analysis and Herniter Model is very beneficial for the new products compliment each other and help to realize the mechanisms during the consumers' decision process.

While discussing Huff Model, the attention was paid to the parking space of residential street type convenience stores, and based on shopping proceeding probability, the estimation of consumer attraction has been done.

It is true that the number of consumer is also affected by factors others than the parking space. They have not been carefully estimated here, but several important ones can be mentioned: population density type of neighborhood (private houses, housing projects, apartment houses etc.) type of road (main avenue vs. local street), the street divider. While those factors do affect the number of consumers, it has been shown that shopping proceeding probability will increase it the parking space is enlarged.

While discussing Huff Model and Herniter Model, consumers' preferences regarding departments stores where established the consumers' can be divided into fixed stratum and non-fixed stratum. As the result, the percentage of fixed stratum and non-fixed stratum is 70.19% and 29.81% respectively. The possibility that consumers will go to a particular department store within the fixed stratum is as follows: A is 12.12%, B is 1.97%, C is 17.89%, D is 3.53%, E is 14.82% and F is 19.86%. Within the non-fixed stratum the possibility that consumers will choose a particular store is as follows: A is 13.90%, B is 2.18%, C is 5.21%, D is 48.97%, E is 16.99% and F is 12.75%. Since the percentage for the fixed stratum is very high (70.19%) it can be said that when consumers go to department stores, they have already decided which store they will go to.

It is very beneficial to combine and to use Huff Model and Herniter Model in understanding the mechanism of market structure and consumers' preferences.

To summarize, it can be said that, there are several estimating methods of market structure and consumers' behavior:

1. Conjoint Analysis: Conjoint analysis is a very useful method of obtaining the optimal planning, because consumers' preferences for several aspects of products can be quantitatively evaluated.
2. Entropy Model and Herniter Model: Consumers can be divided to the 2 strata (fixed stratum and non-fixed stratum) and the market structure can be evaluated.
3. Conjoint Analysis and Herniter Model: Combination of Conjoint Analysis and Herniter Model is very beneficial for introduction of new products that compliment existing products and to realize the mechanisms during the consumers' decision process.
4. Huff Model: An average number of consumers that come to stores can be calculated according to floor spaces and time distances.
5. Huff Model and Herniter Model: In the understanding the market structure and the mechanisms of consumers' preferences, the application of the combination of Huff Model and Herniter Model is very beneficial.

The above five techniques are very efficient and beneficial in the actual performance of the analysis of consumers' preferences, and thus, they can directly influence the success of products on the market.

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Chapter 2

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