Development of a Price Promotion Model for Online Store Selection

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Abstract. There are many customer concerns related to online shopping, such as the inability to view actual products and the possibility of dishonesty. Online shopping nevertheless has the advantage of generally low prices. Effective price promotion that considers both customer concerns and price advantage is important for online stores. We developed a store selection model for both online stores and brick-and-mortar stores. We also conducted a survey to test the store selection model. Finally, we propose an effective price promotion method for each type of store.

Keywords: store selection model, price promotion, brand selection model, maximum likelihood estimation, multinomial logit model.

1 Introduction

Online stores have an advantage over brick-and-mortar stores in that they have reduced personnel expenses and land costs. This allows them to keep prices low, even without the advantage of economies of scale. Although online shopping has the advantage of generally low prices and the convenience of buying goods from home, there are many other customer concerns, such as the inability to view actual products and the possibility of dishonesty. An unknown online store that offers extremely low prices might give rise to customer concerns. In contrast, if an online store offers the same prices as a brick-and-mortar store, then the online store would be placed at a disadvantage due to the many potential customer concerns, in spite of the convenience of buying goods from home. Accordingly, an effective price promotion strategy is needed for online stores, one that considers both the possibility of customer concerns and the advantages of discounted prices.

Price Sensitivity Measurement (PSM) analysis investigates responses to product pricing. The following four questions allow us to derive five indices (Table 1) for a given product:

- What price would be too cheap for this product?
- At what price would you be concerned about product quality?
- What price would be too expensive for this product?
- At what price would you consider this product too expensive to buy?

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Table 1. An index to constitute price range

Upper price	The upper price at which the product would not be purchased
Lower price	The lower price at which the product would not be purchased
Most suitable price	The price most accepted by consumers
Compromise price	The price which it is not ideal, but a compromise
Acceptable price range	The range from the upper price to lower price

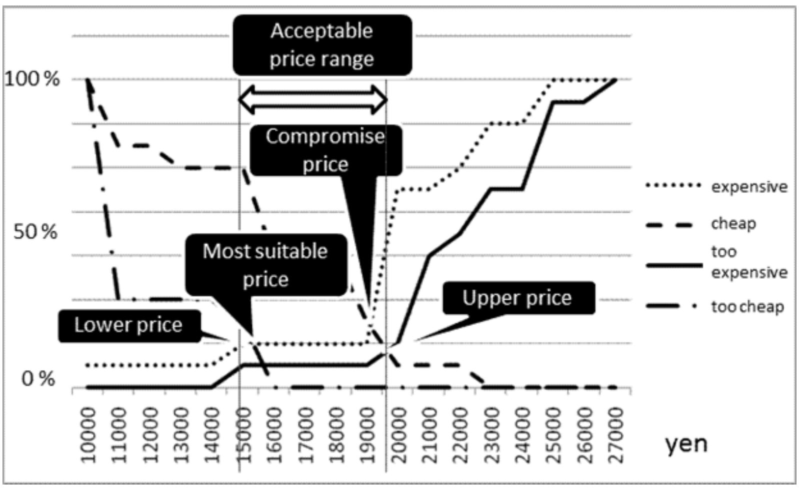

Fig. 1. Representation of PSM analysis

Figure 1 shows an accumulation graph of the number of respondents at the prices on the horizontal axis. The points of intersection of the four curves give the indices listed in Table 1. We can use PSM analysis to find the price that causes consumers to feel uneasy about the quality of the product. Each index is found at a single point, however, so comparison of multiple objects is difficult.

On the other hand, the brand choice model can show the price promotion effect of the product through the magnitude of utility. McFadden's [1] multinomial log it model formulates choice probability on the assumption that consumers choose brands whose utility is the highest. Although many brand selection models assume that utility simply increases as price decreases, Kiuchi [2] plots utility on two graphs by using a

Weibull distribution function for utility of price. In one graph, utility decreases if the price is too low because of concerns about quality. In the other graph, utility increases as price decreases. In this model, utility can be plotted against the ratio between wholesale price and retail price for each good, and we can gain insight into effective price promotion methods for each product.

This model considers brand selection of products, but also considers consumer behavior related to selecting a store to purchase the product. In this study, we analyze the effectiveness of price promotions for different stores using Kiuchi's model, shifting the model target from brand selection to store selection. When doing so, store utility must incorporate the concept of the product in this model, as it is formed through the sale of many products.

The aim of this study is to build a store selection model that considers price promotion for each store, and to propose an effective price promotion method for each store. We use a Wei bull distribution-type function for part of the utility function price to consider reactions to the two types of prices mentioned above. Furthermore, we test the proposed price promotion method by conducting a questionnaire survey on purchases and applying the results to the proposed model.

2 Conventional Study

We shall first explain the utility function of Kiuchi's study. This is a brand choice model that considers price receptivity. A feature of this study is that utility is plotted on two graphs using a Weibull distribution function for the partial utility of price. In one graph, utility decreases if the price is too low because of concerns about quality. In the other graph, utility increases as price decreases. The following is the product utility equation, given a consumer h buying a product i in the term t.

$$V_{it}^{h} = \alpha_i + \beta_i \mathbf{X}_{it} + f(AP_i) \quad . \tag{1}$$

$$f(AP_i) = \eta_i \delta_i AP_i^{\delta_i - 1} \exp\left(-\gamma_i AP_i^{\delta_i}\right) - C_i \quad . \tag{2}$$

α_i is a particular constant of the product i.

β_i is a respondent parameter.

$\mathbf{X}_{it}$ is a binary variable, indicating whether the product i has POP advertisement in the term t.

AP_i is the price rate of the product i.

δ_i, γ_i are shape parameters.

η_i is a parameter that is adjusted such that integration of the Weibull distribution function is 1.

C_i is a constant that expresses the domain of negative numbers.

3 Store Selection Model

3.1 Choice Probability

Here we develop a store selection model using a multinomial logit model. We then consider the utility of each store. The following is the equation for the utility of the stores, when a consumer *n* buys a product *j* from a store *i*.

$$U_{ij}^{n} = V_{ij}^{n} + \varepsilon_{ij}^{n} \tag{3}$$

V_{ij}^{n} is the settled part of U_{ij}^{n}.

ε_{ij}^{n} is the probability part of U_{ij}^{n}.

We presume that each ε_{ij}^{n} obeys the same double exponential distribution for independence. Then, the following is the equation for the probability in which a consumer *n* will buy a product *j* from a store *i*.

$$P_{j}^{n}(i) = \frac{\exp\left(V_{ij}^{n}\right)}{\sum_{k} \exp\left(V_{kj}^{n}\right)} \tag{4}$$

3.2 Utility Function

We developed the store selection model referring to Kiuchi's model. This allows us to include in the model consumer concerns related to online stores by using a Weibull distribution function for utility of price. The following is the equation for the utility of the stores when a consumer *n* buys a product *I* in the term *t*.

$$V_{ij}^{n} = \alpha_{i} + f\left(AP_{ij}\right) \tag{5}$$

$$f\left(AP_{ij}\right) = \eta_{i}\delta_{i}AP_{ij}^{\ \delta_{i}-1}\exp\left(-\gamma_{i}AP_{ij}^{\ \delta_{i}}\right) \tag{6}$$

α_{i} is a particular constant of the store *i*.

AP_{ij} is the price rate of the product *j* in the store *i*.

δ_{i}, γ_{i} are shape parameters.

η_{i} is a parameter to adjust restriction such that integration of the Weibull distribution function is 1.

3.3 Estimation Method

We used the maximum likelihood estimation as the estimation method. The following is the equation for the likelihood function *L*.

$$L = \prod_{i}^{I}\prod_{j}^{J}\prod_{n}^{N} P_j^n(i)^{y_{ij}^n} \tag{7}$$

y_{ij}^n is a dummy variable for store selection. If a consumer n buys a product j in store i then y_{ij}^n is 1, otherwise y_{ij}^n is 0.

The following is the equation for the logarithm likelihood function.

$$\ln L = \sum_{i}^{I}\sum_{j}^{J}\sum_{n}^{N} y_{ij}^n \left[\exp\left(V_{ij}^n\right) - \ln\left[\sum_{k=1} \exp\left(V_{kj}^n\right)\right]\right] \tag{8}$$

We find $\alpha_i, \eta_i, \delta_i, \gamma_i$ when the logarithm likelihood function is maximized.

We set α_3 to 0 when estimating, because α_i is the relative difference for three stores.

4 Application of Store Selection Model

4.1 Questionnaire

We sent out questionnaires related to purchasing to test the store selection model. The questionnaire concerned home appliances purchased in January2010. The data covered 1,000 purchases. We received 100 valid responses covering 10 types of products. The three stores examined were Yodobashi Camera, Amazon.com, and Good Price. Yodobashi Camera is a famous Japanese general merchandising store for electronics. Amazon.com is a well-known online shopping site. Good Price is a relatively unknown online shopping site. We used two online stores in the questionnaire, because we assumed different results would be obtained from a comparison of a well-known online store and an unknown online store.

4.2 Estimation

Table 2 shows the estimated parameters for each store.

Table 2. Estimated parameters

	α_i	η_i	δ_i	γ_i
Yodobashi Camera	0.83	11.79	3.25	11.80
Amazon.com	-0.14	20.16	2.37	11.05
Good Price	0.00	11.55	5.62	27.75

Next, we consider estimated parameters and utility functions. We can analyze the change in utility for a given price rate by developing a store selection model, and we can calculate choice probabilities using Equation 2. We can therefore consider the effect of price promotion for each store by comparing utilities.

First, we analyze the constants α_i. In Table1, α_1 is the highest of the three stores, because of Yodobashi Camera's popularity with consumers. α_2 is lower than α_3, on the assumption that consumers attitude towards Amazon.com as a source for buying home appliances is midway between those of Yodobashi Camera and Good Price.

4.3 Price Promotion

Figure 2 shows a utility function graph for each store. Table 3 lists price rates on maximum utility for each store. In the hypothesis, utility decreases if the price is too low because of concerns about quality in online stores. This confirms the phenomenon in brick-and-mortar stores as well.

The utility for each store is in a range from 0.80 to 1.00, showing that price promotion is not effective.

Yodobashi Camera's utility is higher than the others in a range from 0.45 to 1.00. Yodobashi Camera's market share is high, and it has a large number of customers as compared with online stores. Thus, it is not necessary for Yodobashi Camera to use price promotions in a range from 0.45 to 1.00.

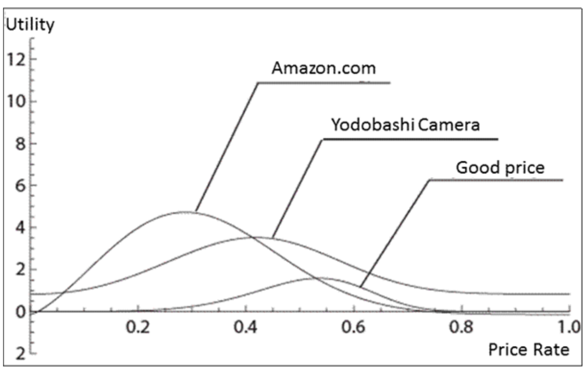

Fig. 2. Utility function graphs

Table 3. Price rates on maximum utility

	AP*
Yodobashi Camera	0.42
Amazon.com	0.29
Good Price	0.53

Next, we consider the situation of online stores. Good Price has the lowest acceptable area of all the stores, because we assume that its popularity is very low and consumers therefore trust it less. When the price rate is about 0.55, Amazon.com's utility is equal to Yodobashi Camera's utility. In addition, when the price rate is less than 0.40, Amazon.com's utility is highest. When the price rate is less than 0.80 for Yodobashi Camera, it is ideal for each online store to approximate the price rates shown in Table 3, because the market share of online stores decreases.

When the price rate is less than 0.80 for Yodobashi Camera.

5 Conclusion

We developed store selection model by considering price promotion and sent out questionnaires related to purchasing to test the store selection model. The following conclusions were provided from a questionnaire.

First, utility showed little change in a range from 0.80 to 1.00. Therefore, price promotion is not effective in that range.

Second, when price rates are less than 0.80, it is ideal for each store to approximate the price rates shown in Table 3. In particular, if the price rate is less than 0.80 for Yodobashi Camera, online stores should reduce prices lest they be deprived of market share.

Third, online stores must implement measures other than price promotion to gain greater market share.

In this way, we consider price promotion by comparing each store's utility. We hope that this knowledge contributes to the performance of price promotion for stores.

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