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Abstract

We estimate a mixed logit demand model for the Japanese digital content market and measure willingness to pay for service attributes. We find that the willingness to pay for an extra unit of service quality ranges from 62 Yen to 83 Yen per month. Meanwhile, the switching cost, a measure of disutility from switching to other service providers is estimated as 340 Yen (\$3) per month, which is approximately the same as the current monthly subscription fee.

Key words: Mixed logit, Hierarchical Bayesian model, Japanese Digital Content Market

JEL Code: D12, L86, C11, C35

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I. Introduction

In this paper we estimate a mixed logit demand model for the digital content within the Japanese PC and mobile markets and measure consumer's willingness to pay for service attributes. We first estimate a demand function for digital contents using a hierarchical Bayesian model (Allenby, 1997, Train 2001) and analyze how the service attributes related to digital content affect the utility levels of Japanese consumers. We then use the estimated parameters in the demand function to measure consumers' willingness to pay for each specific service attribute. In particular we are interested in measuring of the consumers' willingness to pay for switching to another content provider. Usually such switching behaviors are influenced by switching costs, which are defined as any perceived disutility a consumer would experience from switching service providers (e.g., Klemperer, 1987).

We find that the service attributes of digital content have significant effects on the consumer utility and the preferences that these consumers develop for service attributes are distributed with a large variance across the population. We also find that willingness to pay for more robust content was 83 Yen per month and that for content update frequency was 62 Yen per month. Meanwhile, the overall consumer switching

cost was 340 Yen (about US\$3) per month, which is approximately the same as the current content subscription fee of 300 Yen per month. We also find that the switching is highly correlated with the service quality levels provided by competing content providers.

II. Market and Data

We collected data using a choice-based conjoint (CBC) survey to examine consumers' preferences regarding digital content. In the analysis, each surveyed consumer was presented with several hypothetical offers by content providers and was asked to identify which offer they would choose. Additionally, for each set of hypothetical offers, respondents were also given the choice to reject all offers provided.

For this research, respondents were recruited from mobile and PC content subscribers in Japan. In total, n=826 respondents were required from Tokyo-based Macromill Inc.'s 1.8 million member subscriber panel. On this panel, 45% (n=372) of respondents were female and the other 55% were male. The average age of respondents was 33 years with a standard deviation of 8.9 years. In total, all 47 prefectures and wards across Japan were represented. The survey was fielded in March 2006, using an Internet-based survey interface. Respondents answered demographic questions about themselves along with a total of 15 conjoint analysis choice questions based on competing brands, prices, and levels of service quality. The price attribute represented the monthly subscription fee for digital content, and had six levels which increased in 100 Yen per month increments, ranging from level

1, “free” (or 0 Yen per month) to level 6, “500Yen per month”. The content robustness attribute represented the richness of the content provided, and had five levels, ranging from level 1, “much less robust content than my current content provider”, to level 5, “much more robust content than my current content provider”. Finally, the content update attribute represented the frequency at which new content is added to an existing digital content service. This attribute consisted of six levels ranging from level 1, “content is updated less than once a month” to level 6, “content is updated every day.”

III. The Model

We estimate consumer utility from content use with a mixed logit model, which provides a flexible specification for representing the distribution of preferences in the population and the choices of each customer (Bhat, 1999; Brownstone and Train, 1999; Train, 1998; Lee et.al, 2006).

Consider a choice among alternatives $J=1, 2, \dots, J$ in choice situations $t=1, 2, \dots, T$.

Then the utility that consumer i obtains from choosing choice j in situation t is

$$U_{njt} = \beta_n' x_{njt} + \varepsilon_{njt} \quad (1),$$

where ε_{njt} is the iid extreme value error term and β_n denotes the value that each consumer places on the attributes and is normally distributed with mean b and variance W , i.e., $\beta_n \sim N(b, W)$. β_n varies randomly among consumers, reflecting the range of consumer preferences regarding service providers' attributes. x_{njt} represents a vector of choice characteristics that includes price and the dummy for switching, content robustness, and content update. The switching dummy is equal to 1 if a consumer chooses an alternative to her present service provider and 0 otherwise. We can then rewrite the utility function as follows.

$$U_{njt} = \beta_{n1}Price_{njt} + \beta_{n2} \cdot Switching + \beta_{n2} \cdot ContentRobustness_{njt} + \beta_{n4} \cdot ContentUpdate_{njt} + \varepsilon_{njt} \quad (2)$$

where β_{nk} is the consumer n 's coefficients for attribute k . We estimate the mixed logit model using the hierarchical Bayesian method (Allenby 1997, Train 2001, Train et al. 2003).

Suppose that a study has priors on b and W . The prior on b is assumed to be normal with an unboundedly large variance while the prior on W is assumed to be inverted Wishart with K degrees of freedom and scale matrix I , the K -dimensional identity matrix. We can then denote consumer n 's chosen alternative through all time as $y'_n = (y_{n1}, y_{n2}, \dots, y_{nT})$. The chosen alternatives across the entire sample are then represented as $Y = (y_1, y_2, \dots, y_T)$. Then the conditional on β_n , i.e., the probability of consumer n 's observed choices, is

$$L(y_n | x_n, \beta) = \prod_t \frac{\exp(\beta' x_{ny_{nt}})}{\sum_j \exp(\beta' x_{njt})} \quad (3)$$

The unconditional probability is the integral of $L(y_n | b, W)$ over all values for β :

$$L(y_n | b, W) = \int L(y_n | \beta) \phi(\beta | b, W) d\beta \quad (4),$$

where $\phi(\beta | b, W)$ is the normal density with mean b and variance W . $L(y_n | b, W)$ is the mixed logit probability. The posterior distribution of b and W is

$$K(b, W | Y) \propto \prod_n L(y_n | b, W) k(b, W) \quad (5),$$

where $k(b, W)$ is the prior on b and W , i.e., normal for b times inverted Wishart of W .

Our goal is to obtain information on the population distribution of preferences associated with each attribute of digital content providers. For this purpose, we take draws from the posterior distribution to get information about the posterior. We use Gibbs sampling to take draws which are taken sequentially from the conditional posterior of each parameter given the previous draw of the other parameters. The

sequential of draws from the conditional posteriors converges to draws from the joint posterior.

We assume that the parameters in the utility function are distributed normally. In many applications, however, such an assumption may be inappropriate. A normal distribution for a price coefficient implies that some consumers prefer higher prices. Willingness to pay for an attribute can be unboundedly high for consumers whose price coefficients are near zero, because willingness to pay is the coefficient of the attribute divided by the price coefficient (Train et. al, 2003). In this paper, we therefore transform the price coefficient to lognormal distribution such that the price coefficients for all consumers have the same sign. In estimation, the negative of price data is entered such that the coefficient on price is positive for all consumers. We can therefore interpret the positive coefficient as the preference for price reduction.

IV. Results

Table 1 represents the estimated parameters in the mixed logit model. These are the means of the 1000 draws of b and of the diagonal elements of W . From the classical perspective, these are the estimated population means and variance of β_n . All the estimates are significant. At the mean, switching has a negative effect on utility. Content robustness and content updates have positive effects on utility. In particular, the highly significant variances indicate that parameters do indeed vary in the population. This also suggests that the mixed logit model is more appropriate than a logit model that imposes the same coefficients for attributes across consumers. The mixed logit technique allows each coefficient to have a mean and variance in the population, while standard logit contains fixed coefficients, which is equivalent to a

mixed logit with zero variances.

Table 2 presents the mean and variance of coefficients. Two thousands draws of β_n were taken from a normal distribution with mean equal to the estimated value of b and variance equal to W . Each draw of β_n was then transformed to obtain a draw of coefficients as shown in Table 2. Table 3 shows the distribution of population for each coefficient. For 78.6% of the population, switching to other service providers produces a negative effect on utility. A similar proportion of the population, 78.3%, prefers content robustness while the rest of the population dislikes it. Content update produces positive utility for 76.5 percent of population, which means that it produces negative utility for the remaining 23.5 percent.

Table 4 presents correlations among coefficients. It indicates that switching is positively correlated with content robustness and content update. This suggests that even though switching to another provider is costly, consumers are willing to switch insofar as other brands provide more robust content and content which is updated more frequently. Switching is positively correlated with reduction in price. If other service providers charge high prices, consumers will not switch. The results also show that switching is correlated more strongly with content robustness than with other attributes.

As Table 2 indicates, 78.6% of the population suffers utility loss from switching to other content providers. Therefore, without compensation, consumers will not switch. How much, then, should they be compensated? Table 5 shows the estimated consumers' willingness to pay for each attribute. The willingness to pay for each attribute is calculated as the marginal utility of each attribute, $\partial U_{njt} / \partial x_{njt}$,

divided by the negative of the derivative of utility with respect to price, i.e., the price coefficient. Willingness to pay for switching providers, i.e., the switching cost, is negative 340 Yen (US\$3) per month. This amount is approximately the same as the current monthly subscription fee for mobile digital content of 300 Yen per month. Meanwhile, for content robustness and content update, consumers are willing to pay 83 Yen and 62 Yen a month more for each unit of increase, respectively.

V. Conclusion.

In this paper we estimated consumers' utility function for the Japanese mobile and PC content market and analyzed how service attributes affected the consumers' utilities. To the best of our knowledge, this is the first attempt to analyze the digital content market quantitatively. We find that the consumers are willing to pay a large monthly fee, which is slightly higher than their current monthly subscription fee to not switch to other content providers. Additionally, we find that consumer switching behaviors are largely affected by the service attributes provided by competing content providers. The results imply that high quality service makes it possible for service providers to charge high monthly fees and prevent consumer switching.

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Table1. Estimation of Population Parameters

	Mean of β	Variance of β
Price	-0.3764 (0.0472)	1.0568 (0.0987)
Switching	-1.2590 (0.0818)	2.3754 (0.2340)
Content Robustness	0.3064 (0.0217)	0.1508 (0.0155)
Content Update	0.2276 (0.0184)	0.0997 (0.0107)
Log likelihood	-7122.63	

Note: The numbers in parentheses are standard errors

Table 2. Mean and Variance of Coefficients with Transformation of normal

	Mean	Variance
Price	1.1522	2.6851
Switching	-1.2671	2.4493
Content Robustness	0.2990	0.1616
Content Update	0.2284	0.0973

Table 3. Share of population for coefficients with Transformation of normal .

Coefficient	Shares strictly below zero and at zero(%)
Price	0.0
Switching	78.6
Content Robustness	21.7
Content Update	23.5

Table 4 Correlations among coefficients with transformation of normal

	Price	Switching	Content Robustness	Content Update
Price	1.00	0.120	0.108	0.008
Switching		1.00	0.361	0.222
Content Robustness		1	1	0.272
Content Update				1

Table 5 Willingness-to-Pay (Unit: 100 Yen/month/unit)

	Mean	Median	Variance
Switching	-3.40	-3.36	0.26
Content Robustness	0.83	0.82	0.02
Content Update	0.62	0.61	0.01