

## Quantifying the Benefits to Internet Users Derived from Online Applications<sup>1</sup> インターネットアプリケーションの便益計測

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The objective of this study is to estimate the benefit from using the Internet and its applications available online. With a flat-rate scheme that is common under the broadband access (FTTH, DSL, CATV, etc.) in Japan, it is difficult to measure consumer surplus with traditional economic methodology as a usage-sensitive market price does not exist. Internet users can enjoy online applications as many/much as they want. In this situation, subscribing and using the Internet means that Internet users buy a bundled commodity at a certain fixed price for the services they want, which are included in the package. In this study, we tried to unbundle the composite commodity (i.e. Internet service as a whole) into the applications available on the Internet and measured the Willingness to Pay (WTP) for those applications.

We applied a Stated Preference (SP) method for analyzing data and used a Random Parameter Logit Model for estimating WTP for each of such applications as emailing, web browsing and content downloading. The estimated WTP for availability of e-mail and web browsing over PC are ¥ 2,709 and ¥ 2,914 respectively while average broadband access service costs approximately ¥ 4,000 in Japan.

本研究では、インターネットを利用したアプリケーションを使うことによる利用者の便益を計測することを目的とする。現在、我が国においては定額制のブロードバンド・サービスが普及しており、各アプリケーションを利用する際の個別の市場価格というものがない。定額制のため利用者はアプリケーションを使いたいだけ使うことができる。つまり、インターネットアクセスというサービスを購入することはネット上で無料で利用できる各種アプリケーションのパッケージを購入していることであり、個別のアプリケーションに対する利用者の評価は、通常の市場分析による方法では計測が困難である。

本研究では、コンジョイント手法を活用し、個別のアプリケーションに対する利用者の評価の計測を試みた。具体的には、表明選好データをランダム・パラメータ・ロジット・モデルを使って分析した。対象としたアプリケーションは、メール、ウェブ閲覧、音楽ダウンロード、動画視聴の4つであり、各アプリケーションのWTPを計算すると、メールは2,709円、ウェブ閲覧は2,914円と、両者の合計で5,600yenに達し、平均的なブロードバンド接続の月額料金を上回ることがわかった。

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## 1. Introduction

Since commercial Internet access service was introduced in 1994, the penetration rate of Internet users had risen to 68.5% by 2006 in Japan and more than 87million people are viewed as users of the Internet<sup>5</sup>. In the process of expanding the number of Internet users, both network infrastructure and availability of online applications have been developed very rapidly. And in the present broadband access environment, people can enjoy a wide variety of online applications over the Internet ranging from e-mail to video programs<sup>6</sup>. With respect to broadband network services such as FTTH, DSL, CATV and FWA, the number of broadband service subscribers had catapulted to more than 26 million households by March, 2007<sup>7</sup>. With the broadband service, it is common to apply a flat-rate for access to the Internet and users are not required to pay any additional fees for the many online applications and services once they have paid the flat-rate. Those applications and services include e-mail, web browsing, word processing, spreadsheet, etc.

While people use these online applications and services at no additional cost, they do anticipate obtaining certain benefits from these applications and services. In other words, the benefits that users enjoy by accessing the Internet do not come from line access per se which they pay for but from online applications that are generally supplied for free. At the same time, attributes such as e-mail or web browsing are provided as a bundled service and it is difficult to derive the value of each application from a Revealed Preference (RP) data<sup>8</sup> of bundled services. In these circumstances, it is difficult to measure consumer surplus with an ordinary economic approach as there is no usage-sensitive market price for each of the online applications. Thus, few studies have been conducted to measure consumers' surplus for these online applications.

One approach to deal with this matter could be an idea to introduce opportunity cost, i.e. cost of time. However, this method has a problem because it does not take the difference in the characteristics of online applications into consideration and treats them as identical as long as the time spent for these services is the same. Alternatively, we will estimate consumers' surplus derived from the Internet usage and online applications by applying a stated preference method. We shall adopt a conjoint method to deal with the stated preference in which we systematically vary combinations of levels of each attribute such as availability of e-mail, web browsing and downloading content (music and/or video).

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<sup>5</sup> White Paper, Ministry of Internal Affairs and Communications, Japan

<sup>6</sup> The volume of traffic data of broadband users has also expanded rapidly from 269.4 Gigabits per second (Gbps) in September, 2004 to 636.6Gbps in November, 2006. (Data from six main ISP in Japan)

<sup>7</sup> The number of broadband subscribers was 3.9 million in March 2002, 9.4 million in 2003, 15.0 million in 2004, 19.6 million in 2005, 23.3 million in 2006 and 26.4 in March 2007. (Ministry of Internal Affairs and Communications)

<sup>8</sup> In many cases, only available data as RP is internet access line fee.

## **2. Data**

### **2.1 Stated Preference**

Considering that there is no market price for many online applications, it is thought to be appropriate to use a Stated Preference (SP) method which can apply even to the measurement of consumer benefits of nonexistent goods<sup>9</sup>. The method for surveying SP data can assume difference forms, including the pairs-comparison method, rank-order method, and choice-based method. Each method translates the nature of the commodity into a set of attributes and makes virtual commodities to control the levels of the attributes. This method is based on the multi-attribute approach originally proposed by Lancaster (1966) which regards the utility of consumption to be dependent not on the consumption of the commodity itself but on the consumption of the attributes of the commodity. As it is recommended that the number of attributes should be restricted to as few as possible, preferably less than seven, to avoid confusing the respondents<sup>10</sup>, we selected the six attributes listed in Table 1 that we considered to be the most influential in the consumer's choice of Internet usage.

### **2.2 Conjoint Analysis**

Conjoint analysis, which is one of the stated preference methods, has been applied in many study areas. Hensher (2001), for example, applied this method to automobile travel evaluation. Layton (2000) used this technique in environment research. Marketing is one of the most popular research areas for conjoint analysis (Huber and Train 2001). In the conjoint analysis, researchers firstly make hypothetical bundles of several attributes describing the characteristics of a commodity or a service, and then ask respondents to state their preferences for some hypothetical alternatives selected from the full set of combinations of alternatives. A statistical technique is applied to the responses in order to analyze the relative importance of the attributes.

Since this study aims to measure WTP for each attribute such as availability of e-mail and web browsing, respondents are asked whether or not to choose one of the packaged alternatives bundling either one level of monthly charges, access line speed, availability of e-mail etc., in addition to the question asking the option not to subscribe to the Internet. Details of the attributes and their levels shown in table 1 are as follows:

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<sup>9</sup> the common criticism of the SP method is the hypothetical nature of the questions and respondents' choice.

<sup>10</sup> Huber et al. (1991) recommends that the number of attributes should be restricted to about six.

**Table 1: design of the conjoint analysis**

		Levels			
		1	2	3	4
Attribut es	Monthly charges	¥1,000	¥2,000	¥3,000	¥4,000
	Access speeds	Narrow Band	Broad Band		
	e-mailing	Available	Not available		
	Web browsing	Available	Not available		
	Music downloading	Available	Not available		
	Video downloading	Available	Not available		

A) monthly charges

This attribute ranges from ¥1,000 yen to ¥ 4,000 yen which we chose based on our pre-test survey. Considering the fact that many applications can be used free of charge once a subscription is made to the Internet, the monthly charge includes the access fee plus (anticipated) applications' fee which are available under a his/her option choice. Be mindful of the fact that the charge of the contents downloaded is not included in this monthly charge and respondents are informed that additional payment may be necessary.

B) Access speeds

This attribute outlines the transmission speed of access lines that subscribers can enjoy when they access the Internet.

C) e-mailing

This represents the availability of e-mailing services. While the number of online applications available now is increasing such as SNS and VoIP, we chose e-mailing, web browsing, music downloading and video downloading as the key applications since it is thought that the usage rates among the Internet users of those applications are higher than those that of new emerging online applications.

D) Web browsing

This also represents the availability of the web browsing service, which includes searching, posting and exchanging information.

E) Music downloading

This attribute is related to the availability of downloading service of music that is provided through the Internet. Streaming service is included in this category. Respondents are informed that additional payment should be necessary for this attribute.

F) Video downloading

This attribute is related to the availability of downloading service of video which is becoming popular rapidly. YouTube is the typical applications users can enjoy.

As it is impossible to ask the preference for all possible combinations of the attributes, we have extracted minimum sets of the attributes (i.e., the profiles) in accordance with the orthogonal design method. Seven questions were asked to each respondent, to each of which he/she was requested to make his/her best choice from among three service package profiles arbitrarily selected from the profiles and one profile with no usage.

The choice experiment exercise was pretested several times, in which respondents were queried about their understanding of terminology; whether they felt they could meaningfully evaluate the hypothetical portability services, and their attitudes about the number and presentation of the choice experiments. Some changes in wording and price levels were made after the first pretest, and no changes were made in the last pretest.

**2.3 Data collection**

We conducted an online survey from Dec 25, 2007 to Dec 27, 2007. The questionnaire was composed of 11 face sheet questions and 7 choice questions. The number of respondents was 1,000, who had registered in advance as a member of a survey panel for Internet surveys. As we used the survey panel, there could be a bias in terms of age and/or sex. Therefore we collected same number of data samples from each category as shown below, and then calculated the weight we should use according to the distribution of the Internet users in terms of age and sex in Japan<sup>11</sup>. In addition, there could be differences in preference towards Internet applications between Internet users and non users. Those differences, if any, may give us upward bias in our estimation, since we use samples collected from the respondents who actually using the Internet.

**Table 2: Sample DATA**

Number of samples collected							% of Internet user distribution in Japan					
	Age					total	age					total
	<30	<40	<50	<60	60>=		<30	<40	<50	<60	60>=	
Male	100	100	100	100	100	500	16.1	10.3	10.2	9.6	6.3	52.54
Female	100	100	100	100	100	500	15.6	9.9	9.5	8.3	4.2	47.46

<sup>11</sup> “Survey of household’s usage on information and communication services”, Ministry of Internal Affairs and Communications (2006)

### 3. Model

#### 3.1. Random Parameters Logit Model

We applied the discrete choice model which is based on the random utility theory. According to the random utility framework proposed by McFadden (1974)<sup>12</sup>, utility  $U$  is composed of the deterministic component and the random component. That is:

$$U = V + \varepsilon$$

where  $V$  denotes the deterministic core, and  $\varepsilon$  denotes the random component.

This study applies the Random Parameters Logit (RPL) model (or Mixed Logit Model) as it is natural to suppose that an evaluation for each online application is not same among individuals. The RPL model captures the variations of preferences by introducing stochastic terms into the coefficients, which are created by deviations from mean preferences. The RPL model allows these coefficients to be correlated with each other across the attributes.

The RPL model specifies the issue for individual  $n$  who faces  $j$  alternatives to maximize utility function  $U_{nj}$ ,

$$U_{nj} = \beta_n' x_{nj} + \varepsilon_{nj}$$

where  $x_{nj}$  is a vector of preferences as a set of attributes when individual  $n$  choose alternative  $j$

$\beta_n$  is a vector of parameters to be estimated

$\varepsilon_{nj}$  is iid extreme value

As the distribution of  $\beta_n$  is unknown, it is common to estimate parameters of the distribution function by assuming parametric probability distribution function. In this study we allow the coefficients vector  $\beta_n$  whose elements are  $\beta_{n,x}$  be distributed normally across the population with mean vector  $b$  and variance covariance matrix  $W$ .

Individual  $n$  will choose alternative  $j$  if and only if  $U_{nj} > U_{nk}$  for any  $j \neq k$ . With the RPL model, we assume  $\varepsilon_{nj}$  be iid extreme value and the probability of individual  $n$  choosing alternative  $j$

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<sup>12</sup> McFadden (1974) pioneered the concept of the model that values the effects of the explanatory variables from consumers' choice data

who is facing  $\beta_n$  can be described as

$$L_{nj}(\beta_n) = \frac{e^{\beta_n' x_{nj}}}{\sum_k e^{\beta_n' x_{nk}}}$$

As  $\beta_n$  is unknown and has a probability distribution, if we let the distribution function of  $\beta_n$  be  $f(\beta)$ , then the probability of individual  $n$  choosing alternative  $j$  out of  $J$  alternatives is

$$P_{nj} = \int \frac{\exp(U(\beta_{nj}, X_j))}{\sum_{j=1}^J \exp(U(\beta_{nj}, X_j))} f(\beta) d\beta$$

### 3.2. Specification of the utility function

We specify the utility function as below and assume the distribution of  $\beta_n$  be normal distribution. We also assume that  $\beta_{price}$  is non stochastic variable as we should calculate WTP.

$$U_{nj}(\beta_{nj}, X_j) = \beta_{n,sp} SPEED_j + \beta_{n,ml} MAIL_j + \beta_{n,web} WEB_j \\ + \beta_{n,dlm} DLM_j + \beta_{n,dlv} DLV_j + \beta_{price} PRICE_j + \varepsilon_{nj}$$

where

$U_{nj}(\beta_{nj}, X_j)$  is the utility of individual  $n$  in the case of choosing alternative  $j$

$SPEED$  : Access line speed of alternative  $j$

$WEB$  : Dummy variable for the availability of web browsing

$MAIL$  : Dummy variable for the availability of e-mail

$DLM$  : Dummy variable for the availability of downloading music

$DLV$  : Dummy variable for the availability of downloading video

$PRICE$  : Monthly charge for alternative  $j$

$\beta_{device} \sim \beta_{price}$  are coefficients for the variables shown above

As we mentioned above, the random disturbance  $\varepsilon_{nj}$  is assumed to have an iid extreme value.

#### 4. Estimation results

We preceded the maximum simulated likelihood (MSL) method for estimation by setting 1000 Halton draws. Furthermore, since a respondent repeatedly completes seven choice questions, we consider the data a kind of panel data. Thus, we apply a standard random effect method in which random draws are repeatedly reused for the same respondent.

Before we estimate the RPL model, we also estimated the conditional logit (CL) model (Table 3). Table 3 shows that all the coefficient parameters except the music downloading are statistically significant with appropriate sign.

**Table 3: Estimation Results (Conditional Logit)**

p<0.10 \*, p<0.05 \*\*, p<0.01 \*\*\*

Variables	Coefficient	S.E.	t-value	p-value	
SPEED	0.1223	0.0084	14.6400	0.0000	***
MAIL	1.1810	0.0400	29.5320	0.0000	***
WEB	1.3374	0.0422	31.6600	0.0000	***
DLM	0.0475	0.0380	1.2520	0.2106	
DLV	0.1251	0.0345	3.6230	0.0003	***
PRICE	-0.0005	0.0000	-28.5400	0.0000	***

Estimation results of the RPL model are shown below (Table 4 and Table 5). Table 5 shows that the RPL model is an appropriate model for this analysis as all of the standard errors of the random coefficients are statistically significant in deviating from 0.

From Table 4, we can see that price (the monthly charge) has a negative effect on the choice probability as anticipated. The coefficients with stochastic distribution are evaluated at the mean value. The coefficients of e-mailing, web browsing and video downloading are statistically significant at the 1.0% level while that of music downloading is at the 5.0% level. These results are considered to be natural because many current Internet users actually use these applications<sup>13</sup>.

<sup>13</sup> New applications have been continuously introduced to the market such as social network society (SNS) and consumer generated media (CGM). In this sense, e-mail, web browsing, downloading music and downloading video are not all applications available on the Internet. From our pre-interview we conducted prior to this survey, however, many interviewees said e-mail and web browsing were the main reasons to use Internet and we have chosen these four applications because of the technical restriction of analysis.

**Table 4: Estimation Results (Random Parameter Logit)**

p&lt;0.10 \*, p&lt;0.05 \*\*, p&lt;0.01 \*\*\*

Variables	Coefficient	S.E.	t-value	p-value	
Random parameters in utility functions					
SPEED	0.2202	0.0158	13.9690	0.0000	***
MAIL	2.0798	0.0932	22.3060	0.0000	***
WEB	2.2370	0.0993	22.5380	0.0000	***
DLM	0.1512	0.0624	2.4220	0.0154	**
DLV	0.3387	0.0567	5.9780	0.0000	***
Nonrandom parameters in utility functions					
PRICE	-0.0008	0.0000	-30.1080	0.0000	***

**Table 5: Standard deviations of parameter distributions**

p&lt;0.10 \*, p&lt;0.05 \*\*, p&lt;0.01 \*\*\*

Variables	Coefficient	S.E.	t-value	p-value	
Derived standard deviations of parameter distributions					
SPEED	0.2200	0.0190	11.5890	0.0000	***
MAIL	1.5620	0.1043	14.9750	0.0000	***
WEB	1.8227	0.1098	16.5940	0.0000	***
DLM	0.8123	0.0963	8.4380	0.0000	***
DLV	0.8193	0.1179	6.9510	0.0000	***

In this study, the price factor as a monthly charge for packaged services has been included in the estimation equation. As the random utility function is described in a linear equation, the willingness to pay (WTP) for each service can be calculated by dividing the coefficients of services by the coefficient of the price<sup>14</sup>. This can be illustrated in the following simple formula:

$$\partial PRICE / \partial z = -\partial U / \partial z * \partial PRICE / \partial U = -(\beta_{device} \sim \beta_{dlv}) / \beta_{price}$$

where  $z$  denotes: SPEED, MAIL, WEB, DLM, DLV

Table 6 shows the WTPs for the applications available on the Internet. The WTP for e-mail

<sup>14</sup> As the random utility function allows the coefficients to be distributed, these WTPs illustrate those of the average individual.

service is about ¥2,700 and that of web browsing is about ¥2,900 and the amount adding them up exceeds the average cost of monthly broadband access charge in Japan<sup>15</sup>. These two functions can be considered as key fundamental applications (“killer contents”) for Internet users.

**Table 6: Willingness to Pay (WTP)**

SPEED	¥286.84	***
MAIL	¥2,708.77	***
WEB	¥2,913.55	***
DLM	¥196.93	**
DLV	¥441.16	***

## 5. Conclusion

In this study we showed that the total WTPs for both e-mail and web browsing applications exceeds the cost of having broadband Internet access.

We conducted this study in order to analyze the present consumers’ behavior and estimate their WTPs derived from the Internet usage and online applications. The findings we show in this study will change as Internet applications and new technology develop. For instance, no one had anticipated the use of pc as a music player or TV or telephone. In the future, as new applications such as net shopping, net auction, online gaming, web logging and SNS have further being developed and disseminated, the composition of applications that Internet users evaluate highly will change. Herein we have merely calculated the WTPs of online applications employing the conjoint method, such that there may be another approach to measuring consumers’ evaluation for online applications by considering usage time (opportunity cost).

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<sup>15</sup> The price depends on various consumer package services. In simple, the actual flat-rates for broadband access is ranging from approximately ¥2,000 to ¥4,000 for ADSL (1Mbps~50Mbps).

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