# Analysis of Consumers' Choices and Time-Consumption Behaviors for Various Broadcasting and Telecommunication Convergence Services

Daeyoung Koh and Jongsu Lee

**In this study, we analyzed consumers' choices of various broadcasting and telecommunication convergence services and time consumption for chosen services by using survey data. A multivariate probit model was used to model consumers' choices of various broadcasting and telecommunication convergence services, and an ordered probit model was used to model consumers' time consumption for chosen services. Factors affecting consumers' choices and time-consumption behavior were identified, and simulation results of market competition and substitution were obtained. Based on these results, it was found that for the time being, consumers are highly locked into existing broadcasting services and are likely to become more price-sensitive to the new broadcasting and telecommunication convergence services. Also, the ways in which individual characteristics affect choices and time consumption were found to be very diverse service by service.**

**Keywords: Broadcasting and telecommunication convergence services, multiple choice, time consumption, substitution and competition, multivariate probit model, ordered probit model.**

## I. Introduction

Previously, although broadcasting services and telecommunication services looked similar in many aspects, they experienced somewhat different paths of development. However, saturation and stagnation in both markets, development of new technologies, and diversified consumer needs for services with incorporation of various functionalities are converging broadcasting and telecommunication into a common category.[1)] Recently, both fixed-line-based and mobile- or wireless-based telecommunication companies (TELCOs) like Korea Telecom (KT) or SK Telecom have been entering into the service market with convergence between broadcasting and telecommunication industries, where previously only broadcasting service providers, such as terrestrial broadcasting companies (KBS, MBC, and so on), (multiple) service operators ((M)SOs) with analog cable, or Skylife with satellite broadcasting, existed. They are introducing differentiated broadcasting and telecommunication convergence services with advanced or unique features, such as Internet protocol TV (IPTV), mobile broadcasting services like satellite digital multimedia broadcasting (SDMB), and mobile broadcasting services provided through the mobile voice networks. Confronting market entries from the telecommunication sector, previous broadcasting service

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1) In general, in mathematics, convergence is used as a term representing the approach toward a definite value, a definite point, a common view or opinion, or toward a fixed or equilibrium state. However, in our study, convergence represents the digital IT convergence which is prevalent phenomena in IT sectors that the distinction between two different industries, products, or services is getting blurred due to such reasons as technology development, consumer needs, etc [1].

  

providers are also introducing new services, such as digital terrestrial, digital cable, or terrestrial digital multimedia broadcasting (TDMB), which is a mobile broadcasting service.

With the introduction of such various new services, the distinction between broadcasting and telecommunication industries is becoming more and more obscure, which is leading to the creation of a new market with a different competition structure. At the same time, both broadcasting and telecommunication industries have major social and cultural effects and impact the economy as a whole. Therefore, analyzing the structure of the new emerging market combining both broadcasting and telecommunication services is meaningful to all associated parties, including R&D managers, service providers, contents providers, device developers, advertisers, policy makers and regulators, and so on.

On the other hand, saturation of the two markets alters and intensifies the competition structure which necessarily moves the center of the market from suppliers to consumers.[2] Therefore, it would be worth analyzing consumer behavior and its implications for future market conditions with respect to both the previous broadcasting services and new converged ones.[3]

In this study, we predict consumer behavior and possible changes in market competition and structure. We use survey data regarding consumers' stated choices of and daily time consumption for various broadcasting and telecommunication convergence services in the near future market. We attempt to examine what factors affect consumers' choices and time consumption behavior, and how these factors affect them. Also, we examine whether there are differences in the direction of the impact of those factors on choices and time consumption.

One possible major change in consumer choice behavior with the introduction of new broadcasting and telecommunication convergence services is simultaneous subscription to more than one service.[4] In this study, by using a multivariate probit model that can reflect consumers' multiple choices, we analyze various consumer choice patterns beyond the choice of only one service.

As for the daily time consumption for chosen services, we apply an ordered probit model by using categorical ranges of continuous time consumption. Additionally, to analyze the complementarity or substitutability in time consumption and to check whether there are differences between choice and time-consumption models, we include consumers' simultaneous time consumption for other broadcasting services in addition to the same individual characteristics used in the choice model. This allows us to examine which broadcasting service is more likely to be used heavily, what factors affect the amount of time consumed, what effects the simultaneous choices or simultaneous time consumption of the other broadcasting services have on a specific broadcasting service, and whether there really are differences between choice and time-consumption models in terms of the effects of individual characteristics.

This study is organized as follows. In section II, we review previous studies and identify the unique aspects of our study. In section III, the methodologies we use are described. The results of estimation and simulation are presented and examined in section IV, and section V concludes this paper.

## II. Literature Review

Previous related studies can be divided mainly into two groups. One group analyzed consumer adoption of particular new broadcasting and telecommunication convergence services, while the other focused more on substitution and competition among previous and new broadcasting services.

There are quite a few previous studies regarding consumer adoption of particular new broadcasting and telecommunication convergence services, such as digital terrestrial broadcasting, digital cable, IPTV, Webcast, or mobile broadcasting [4]-[8]. For mobile broadcasting, many recent studies attempted to identify factors affecting adoption of mobile broadcasting such as TDMB or SDMB [9]-[15]. However, most of them focused on the adoption of one particular new broadcasting and telecommunication convergence service. This leads to critical limitation in finding implications related to substitution or competition among previous and new broadcasting services, which is very important from the perspectives of regulators, service providers, and developers.

There have been some other previous studies focusing on substitution and competition among previous and new broadcasting services. In [16] and [17], substitution and competition between analog cable and satellite broadcasting was analyzed. Considering analog cable, satellite broadcasting, and even digital cable broadcasting, [18] analyzed the effect of direct broadcast satellite service on the demand for analog and digital cable services. The study in [19] predicted the

2) In [2], the competitiveness of broadband over power line was analyzed, which is a case of convergence between telecommunications and electricity sectors, considering consumer preferences as the most important factors.

3) In [3], several intrinsic characteristics of innovations were defined that influence an individual's decision to adopt or reject an innovation. They are relative advantage, compatibility, complexity, triability, and observability. Among them, especially in case of our study, relative advantage and complexity matter very much. Relative advantage indicates how improved an innovation is over the previous generation. Complexity indicates whether the innovation is too difficult to use. New broadcasting and telecommunication convergence services are superior to the previous broadcasting services in technological aspects, while they are more complex and require consumers to make some effort to learn how to use them, which can lead to a switching barrier.

4) For example, it will be possible for some consumers to choose digital cable to watch movies in their homes while simultaneously subscribing to any kind of mobile broadcasting service to watch sports events when they are on the move.

competition between SDMB and TDMB. However, these studies are limited in that they only considered one new broadcasting service, digital cable, or only competition between new services. Recently, many new broadcasting and telecommunication convergence services have appeared, including fixed services, like digital terrestrial and IPTV, and mobile services, like SDMB and TDMB, which have different backgrounds and characteristics. Thus, these studies lack overall analysis regarding what kind of relationships those various new and previous broadcasting services are likely to have in the near future.

To summarize, although analysis with an overall approach considering quantitative substitution, competition, or complementarity among various new and previous broadcasting services is required, no such study has been carried out. Moreover, no previous study has taken into account the possibility of consumers' multiple choice behavior. Also, no study has focused on consumers' time-consumption behavior, despite its importance.

Our study has the following distinctive points and contributions compared with the previous studies. Rather than focusing on the adoption of one particular new broadcasting and telecommunication convergence service, our study includes various new and previous broadcasting services and examines substitution, competition, and complementarity among them. Also, our study provides ample implications by analyzing consumers' time-consumption behavior. Using multivariate probit model, our study considers the possibility of consumers' multiple choices, and predicts various switching patterns from previous broadcasting services. This approach enables us to identify more detailed information on changes in the market structure rather than the simple aggregate market share of each service.

## III. Methodology

### 1. Survey Description

The survey was conducted by Dongseo Research in May of 2008, in Seoul, Korea, with 500 respondents, all of whom used at least one analog terrestrial, analog cable, or satellite broadcasting service at that time. They were chosen with a proportional base to be sufficiently representative. A one-to-one interview method was used by well-trained interviewers for reliability. To model both consumers' choices and time consumption, a specially designed questionnaire was used. In our survey, the respondents were first asked to choose which among five categories of broadcasting services they were most likely to use in near future, while making more than one choice simultaneously was allowed. The shown categories and brief descriptions of broadcasting services included the following:

- *Previous broadcasting services,* which have been used by the respondent until now, which include analog terrestrial broadcasting, analog cable, and satellite broadcasting services with the current monthly service charge;[5)]
- *Digital terrestrial broadcasting*, which is an improvement over analog terrestrial broadcasting in terms of quality and function but requires a digital TV and is provided by the same analog terrestrial broadcasting providers with no charge or a monthly service charge of 2,000 won[6)] ($0 or $1.93[7)]);
- *Digital cable*, which is an improvement over analog cable in terms of quality and function but requires a digital TV and is provided by current analog cable providers (SOs or MSOs) with a monthly service charge of 10,000 won or 15,000 won ($9.66 or $14.49);
- *IPTV*, which is an improvement compared to analog cable in terms of quality and function but requires a digital TV and is likely to be mainly provided by TELCOs with a monthly service charge of 15,000 won or 20,000 won ($14.49 or $19.32 );
- *Mobile broadcasting services*, which include SDMB, TDMB, and mobile broadcasting through mobile networks with a monthly service charge of 10,000 won or 12,000 won ($9.66 or $11.59).

Next, respondents were asked to report their expected average daily time consumption for each selected broadcasting service after reporting their current average daily time consumption for the services they use. Other socio-demographic data was also obtained.

### 2. Model Specification

#### *A. Modeling Consumers' Choices of Broadcasting Services*

To reflect the multiple or simultaneous choice behavior of consumers for new and previous broadcasting services, we employ a multivariate probit model [20]-[24]. We assume utility to be composed of the deterministic part, which is a linear combination of an alternative specific constant, monthly service charge, individual characteristics and their coefficients, and the stochastic part:

$$U_{nj} = ASC_j + (\beta_{\text{price}} + \beta_{\text{new}} New_j) Mon\_Char_{nj} + \sum_{k}^{K} \beta_{jk} X_{njk} + \varepsilon_{nj}, \quad (1)$$

5) We asked the respondents to report their current monthly service charges for the previous broadcasting services they use, if any. For example, for a respondent who currently uses analog cable with the monthly service charge of 8,000 won, the monthly service charge of the alternative that represents previous broadcasting service in our survey becomes 8,000 won for that respondent.

6) We divided the sample into two groups while presenting two different monthly service charges for each service for each group to provide sufficient variation and greater realism.

7) $1 = 1,035 won as of May 2008

Table 1. Individual specific variables and their descriptions.

| Variables | Descriptions | Mean | STD |
|---|---|---|---|
| DigitalTV | 1 if respondent has digital TV, 0 otherwise | 0.33 | 0.47 |
| Sub_Broad | 1 if respondent subscribes to high-speed (over 10 Mbps) broadband access service, 0 otherwise | 0.31 | 0.46 |
| Mon_Rental | Average monthly frequency of renting media like VHS or DVD titles (freq./month) | 0.79 | 1.53 |
| Use_PremChan | 1 if respondent uses any fee-paid premium channel or VODs in current previous broadcasting services, 0 otherwise | 0.13 | 0.33 |
| High_Edu | 1 if respondent graduated from university, 0 otherwise | 0.44 | 0.49 |
| Gender_Male | 1 if respondent is male, 0 otherwise | 0.49 | 0.50 |
| Age_under30[a)] | 1 if age of respondent is under 30, 0 otherwise | 0.21 | 0.40 |
| Age_bet3040[a)] | 1 if age of respondent is between 30 and 40, 0 otherwise | 0.28 | 0.45 |
| Age_over50[a)] | 1 if age of respondent is over 50, 0 otherwise | 0.25 | 0.43 |
| Income_bet23[b)] | 1 if average monthly income of respondent is between 2 mil. and 3 mil. won ($1,932-2,898), 0 otherwise | 0.31 | 0.46 |
| Income_bet34[b)] | 1 if average monthly income of respondent is between 3 mil. and 4 mil. won ($2,898-3,864), 0 otherwise | 0.34 | 0.47 |
| Income_over4[b)] | 1 if average monthly income of respondent is over 4 mil. won (over $3,864), 0 otherwise | 0.18 | 0.38 |

a): reference is age between 40 and 50, b): reference is average monthly income under 2 mil. won (under $1,932) ($1 = 1,035 won as of May 2008)

where $j$ = Prev, Dterr, Dcab, IPTV, Mobile ($J$=5). Here, $n$ represents the consumer $n$, and $j$ represents the broadcasting service $j$ among previous broadcasting services, such as analog terrestrial, analog cable, and satellite broadcasting (Prev), and new broadcasting and telecommunication convergence services, such as digital terrestrial (Dterr), digital cable (Dcab), IPTV (IPTV), and mobile broadcasting services, such as SDMB or TDMB (Mobile). Also, $U_{nj}$ represents consumer $n$'s utility obtained from service $j$; $ASC_j$ is a(n) service(alternative) specific constant for service $j$, which reflects the average intrinsic preference for service $j$; $\beta_{\text{price}}$ is a coefficient for the monthly service charge of service $j$, $Mon\_Char_{nj}$, which is specified to be common for all services and reflect the mean effect; $\beta_{\text{new}}$ is a coefficient for the interaction between $Mon\_Char_{nj}$ and the dummy variable, $New_j$, which is 1 if service $j \neq$Prev and 0 otherwise. This reflects the difference in price sensitivities between new and previous broadcasting services. Here, $\beta_{jk}$ is a coefficient for the $k$-th individual characteristic $X_{njk}$, which is specified to reflect the service specific effect of the individual characteristic. For $K$'s individual specific variables, we include age, gender, education level, average monthly income, retention of digital television (TV), subscription to high-speed (faster than 10 Mbps) broadband access service, average monthly frequency of renting media such as VHS or DVD titles, and use of any fee-paid premium channel or video-on-demand (VOD). Individual specific variables are specified in the model as described in Table 1. Here, $\varepsilon_{nj}$ is an unobserved disturbance term for the utility from service $j$. With this random utility, we assume that

$$Y_{nj} = \begin{cases} 1, & \text{if } U_{nj} > 0, \\ 0, & \text{otherwise}, \end{cases} \tag{2}$$

where $Y_{nj}$ is consumer $n$'s observed choice regarding service $j$. By (2), observed choice and random utility which is latent are linked, and this holds for all other services and utilities. $\varepsilon = \{\varepsilon_{n\text{Prev}}, \varepsilon_{n\text{Dterr}}, \varepsilon_{n\text{Dcab}}, \varepsilon_{n\text{IPTV}}, \varepsilon_{n\text{Mobile}}\}'$ are assumed to follow joint multivariate normal distribution with mean 0 and covariance matrix Σ. Usually, the covariance matrix Σ is set as a correlation matrix due to the identification problem [20], [21], [23]. The estimated correlation matrix can reflect relationships among unobserved factors that affect choices of services. Maximum likelihood estimation is used for parameters.

### B. *Modeling Consumers' Time Consumption for Chosen Broadcasting Services*

To model consumers' daily time consumption for specific broadcasting services chosen, we use an ordered probit model. Following the approach used in [23], the time consumption for each chosen broadcasting service, which is originally continuous, is transformed into discrete ordered data.[8)] We assume that

$$W_{nj}^{*} = \sum_{i}^{J-j} \omega_{ji} W_{ni} + \sum_{k}^{K} \alpha_{jk} X_{njk} + \delta_{nj}, \tag{3}$$

8) Time consumption for each chosen broadcasting service is conditional to participation in some broadcasting services, thus the probability of a consumer's participation in a specific broadcasting service and time consumption for the chosen service can be determined by multiplying the choice probability from the multivariate probit model by the conditional time-consumption probability from the ordered probit model.

Table 2. Estimation results of multivariate probit model for the choice of each broadcasting service.

| Variables | *j*=Prev | | *j*=Dterr | | *j*=Dcab | | *j*=IPTV | | *j*=Mobile | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | *t*-value | Coeff. | *t*-value | Coeff. | *t*-value | Coeff. | *t*-value | Coeff. | *t*-value |
| Common effect[a)] | | | | | | | | | | |
| *Mon_Char* | −0.4822*** | −3.52 | | | | | | | | |
| *New*Mon_Char* | −0.0622*** | −2.86 | | | | | | | | |
| ASC[b)] | 0.7204*** | 9.32 | −2.0210*** | −5.17 | −0.9521*** | −4.01 | −2.3116*** | −7.34 | −1.1351*** | −5.12 |
| DigitalTV | −0.1022 | −0.24 | 0.8534*** | 4.03 | 0.6121*** | 4.43 | 0.3851* | 1.78 | 0.3351** | 1.99 |
| Sub_Broad | −0.0242 | −0.66 | 0.1561* | 1.15 | 0.4522*** | 2.75 | 0.5381*** | 6.24 | 0.2881** | 2.08 |
| Mon_Rental | 0.0966** | 1.97 | −0.1402*** | −2.72 | −0.2137*** | −3.11 | −0.0493* | −1.72 | −0.0095 | −0.61 |
| Use_PremChan | 0.0825 | 1.02 | −0.0911*** | −2.29 | 0.4108** | 1.98 | 0.8322*** | 3.39 | 0.0551 | 1.23 |
| High_Edu | −0.0364 | −0.03 | 0.0507 | 1.09 | 0.1102 | 0.24 | 0.1001 | 0.51 | 0.1033* | 1.88 |
| Gender_Male | −0.1107 | −0.27 | −0.1222 | −1.43 | −0.0621 | −1.13 | 0.1703 | 0.71 | 0.3509*** | 3.12 |
| Age_under30 | 0.0383 | 0.11 | −0.2234* | −1.83 | −0.1004 | −0.67 | 0.4723*** | 5.44 | 0.4612*** | 4.13 |
| Age_bet3040 | −0.2501** | −1.99 | −0.3321* | −1.92 | −0.0879 | −0.89 | 0.1995*** | 3.01 | 0.0733*** | 4.51 |
| Age_over50 | 0.0912 | 1.08 | −0.3632* | −1.71 | 0.0122 | 0.22 | 0.0034 | 0.18 | −0.2278* | −1.79 |
| Income_bet23 | −0.0427 | −0.38 | −0.3911* | −1.92 | 0.1772* | 1.76 | 0.1931** | 1.91 | −0.1745 | −0.61 |
| Income_bet34 | 0.1120 | 0.11 | −0.6882*** | −2.44 | 0.1808*** | 3.23 | 0.0022 | 0.39 | 0.1901* | 1.75 |
| Income_over4 | −0.1367 | −0.91 | −0.4099* | −1.73 | 0.0222* | 1.71 | 0.2543* | 1.79 | 0.0101** | 2.10 |
| Correlation | | | | | | | | | | |
| Prev | 1 | | | | | | | | | |
| Dterr | 0.1671*** | 2.33 | 1 | | | | | | | |
| Dcab | −0.0149 | −0.57 | 0.6823*** | 14.31 | 1 | | | | | |
| IPTV | 0.0833 | 0.46 | −0.0299 | −0.42 | −0.2778*** | −2.90 | 1 | | | |
| Mobile | −0.0911* | −1.71 | 0.0900** | 2.11 | −0.0321 | −0.9171 | 0.5702*** | 8.22 | 1 | |

a): common to all services, b): alternative specific constant, ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level

where $W_{nj}^{*}$ is a latent variable for consumer $n$'s time consumption for chosen broadcasting service $j$, and $\delta_{nj}$ is a disturbance term following normal distribution with mean 0 and variance 1. Here, $J-j$ denotes all the other services except service $j$. In (3), observed simultaneous time consumption for other chosen broadcasting services, $W_{ni}$, if any, are included in addition to the same individual characteristic variables as those used in the choice modeling part, $X_{njk}$. By this specification, we analyze whether there is any significant relationship between time consumption for a specific chosen broadcasting service and simultaneous time consumption or choices of other broadcasting services.[9)] The observed realization of $W_{nj}^{*}$, $W_{nj}$ is linked to $W_{nj}^{*}$ according to the boundary parameters $\mu_l$ ($l$ = 1, 2, 3) by assuming that each realized discrete level for $W_{nj}$ represents the time consumption for the specific broadcasting service:

$$W_{nj} = \begin{cases} 0-1 \text{ hour}, & \text{if } W_{nj}^{*} < \mu_1, \\ 1-2 \text{ hours}, & \text{if } \mu_1 \le W_{nj}^{*} < \mu_2, \\ 2-3 \text{ hours}, & \text{if } \mu_2 \le W_{nj}^{*} < \mu_3, \\ \text{over 3 hours}, & \text{if } \mu_3 \le W_{nj}^{*}. \end{cases} \quad (4)$$

Maximum likelihood estimation is used. For detailed description of an ordered probit model, see [25] and [26].

## IV. Results and Findings

### 1. Estimation Results of Choice Model and Findings

Estimation results from the multivariate probit model are shown in Table 2. Factors identified to significantly affect the choice of each broadcasting service can be seen by service. For

9) For example, if $\omega_{ji}<0$ and significant, it means that the more time consumed on service $i$, the less time is likely to be consumed on service $j$, which results in a substitutionary relationship between service $i$ and $j$.

previous broadcasting services, factors found to be significant are the ones that affect maintaining the previous ones, while for new broadcasting and telecommunication convergence services, factors found to be significant are the ones that affect their adoption. Based on the coefficients identified to be significant, types of consumers who are likely to maintain the previous service or adopt new ones can be identified by each service.

First, from the relative magnitudes of alternative specific constants, previous broadcasting services are preferred on average the most, followed by digital cable, mobile broadcasting, digital terrestrial, and IPTV. Being significantly negative, the coefficient of interaction term *New*Mon_Char* shows that consumers are likely to become more price-sensitive to the new broadcasting and telecommunication convergence services compared to the previous broadcasting services. We will give more detailed discussion of consumer preferences when we explain the simulation results. Remarkably, among various individual specific variables, retention of digital TV and subscription to high-speed broadband access service were found to have clearly different influences on overall new broadcasting and telecommunication convergence services compared with previous broadcasting services. Consumers with digital TV and high-speed broadband access service are more likely to be early adopters of new broadcasting and telecommunication convergence services. With regard to content consumption, monthly frequency of renting media like VHS or DVD titles negatively affects the adoption of some of the new fixed broadcasting and telecommunication convergence services, while it positively affects the maintenance of previous broadcasting services. Current use of any of the fee-paid premium channel or VODs in previous broadcasting services positively affects the adoption of digital cable and IPTV, while it negatively affects the adoption of digital terrestrial service.

Among basic socio-demographic variables, consumers with high monthly income are more likely to quickly adopt new broadcasting and telecommunication convergence services with monthly charges (Dcab, IPTV, Mobile), and male consumers with higher education prefer mobile broadcasting. Consumers below the age of 40 tend to prefer IPTV and mobile broadcasting to the other services.

Next, from the estimated correlations in Table 2, there are some significant correlations[10] among choice of services. Note that correlations between digital terrestrial and digital cable, and between IPTV and mobile broadcasting are fairly high at 0.68 and 0.57, respectively. This means that unobserved factors of these new broadcasting and telecommunication convergence services are likely to cause each pair to be subscribed to simultaneously.

Table 3. Simulation results for choice probabilities (%).

| Service | Overall | Choose only one service | Multiple choices with other services |
|---|---|---|---|
| Prev | 47.5 | 38.9 | 8.6 |
| Dterr | 14.3 | 7.6 | 6.7 |
| Dcab | 26.1 | 14.7 | 11.4 |
| IPTV | 12.1 | 5.3 | 6.8 |
| Mobile | 25.1 | 9.3 | 15.8 |
| Multiple choice probabilities between services with high correlation | | | |
| Dterr-Dcab | 4.6 | | |
| IPTV-Mobile | 5.0 | | |

## 2. Simulation Results for Competition and Substitution: Predictions and Findings

Based on the estimated results, we predict how competition and substitution will progress in the near future. For this estimation, choice probability of each broadcasting service is simulated with 10,000 draws from the multivariate normal distribution with mean 0 and estimated correlation matrix. For the individual characteristic variables, sample means are used, and monthly service charges are assumed to be 7,000, 2,000, 15,000, 20,000, and 12,000 won (6.76, 1.93, 14.49, 19.32, and 11.59 dollars) for Prev, Dterr, Dcab, IPTV, and Mobile, respectively. Final results are shown in Table 3.[11]

According to the simulation result, as expected from alternative specific constants, consumers are more likely to be locked into previous broadcasting services, while digital cable TV, mobile TV, digital terrestrial broadcasting, and IPTV follow. Although various new broadcasting services are being introduced with superior and unique features, we cannot be too optimistic in predicting substitution patterns between previous and new services and the speed of market growth of new broadcasting services.[12] For successful transition to the new

10) Correlations among choices of services were not dealt with in previous studies focusing on only one particular service. Not considering the significant correlations among choices of broadcasting services properly can lead to biased conclusions. Existence of these significant correlations can justify our using a multivariate probit model for various broadcasting services.

11) Since all of the respondents in our study use at least one of the previous broadcasting services, choice probabilities in Table 3 can be interpreted as transition or switching probabilities from the previous broadcasting services to the corresponding choice states in near future.

12) From the perspective of diffusion theory in [3], we can speculate on the reason for this result as follows. First, in terms of relative advantage, although new broadcasting and telecommunication convergence services certainly provide many outstanding functionalities, consumers may not regard adopting or switching to new services as advantageous because of their higher prices and higher price sensitivities related to them. Also, in terms of complexity, totally new or too many functionalities of new services may be too complex for consumers and prevent them from adopting or switching to the new services easily.

broadcasting and telecommunication convergence market, various schemes are required to relax consumers' high lock-in and lessen the switching cost. One way to ease consumer lock-in and lower the entry barrier to the new market is deregulation. If policy makers and regulators impose less strict regulations on new broadcasting and telecommunication convergence services, then consumers can easily switch to them.

As shown in Table 2, along with the high lock-in problem, consumers are very sensitive to the high prices of new services. Thus, service providers of new broadcasting and telecommunication convergence services should offer various promotions and pricing schemes that can address these issues, such as lowering the service charge of a new broadcasting and telecommunication convergence service by bundling it with services in other categories. Also, they should not establish business strategies with too much optimism about revenues and profits from the new broadcasting and telecommunication convergence services.

Technology developers should devise interfaces of new broadcasting and telecommunication convergence services that consumers can use with ease and that are not too different from interfaces that have been used for a long time in previous broadcasting services.

As seen in Table 3, it is remarkable that mobile broadcasting has a considerably high choice probability. This implies that mobile broadcasting, which has mobility that no other service had before, will surely have a considerable proportion of the near future broadcasting service market.

To examine the substitution pattern in more detail, the results of the multivariate probit model show predictions of various multiple choices of broadcasting services.

There are clear differences in compositions of consumers who choose only one service among previous and new services. In choice of previous broadcasting services, consumers with only previous broadcasting service are the majority. In contrast, for the new broadcasting and telecommunication convergence services, the probability of choosing more than one is relatively high. Compared with other combinations, multiple choice probabilities between digital cable and digital terrestrial, and between IPTV and mobile broadcasting are high. Remarkably, the majority of consumers who choose mobile broadcasting tend to show multiple choice behaviors, most of which are between new broadcasting and telecommunication convergence services and mobile broadcasting.[13)]

Considering the results related to consumers' multiple choice behaviors, more in-depth analysis and strategies regarding substitution and complementarity among various services will be required for service providers of new services. Also, cooperation or M&A with other service providers with services in complementary relationships should be taken into account more actively. In addition to continuous technology development of mobile communications and devices, technology developers related to mobile broadcasting can concentrate more on organizing services and contents to complement fixed services by utilizing its mobility.

13) This implies that unlike the case of voice telecommunication, in which fixed-mobile substitution is taking place, fixed-mobile substitution is not likely to occur in short time for broadcasting services, and mobile broadcasting will serve more as a complement to fixed services.

## 3. Estimation Results of Time-Consumption Model and Findings

In terms of daily time consumption for broadcasting and telecommunication services, consumers using digital terrestrial broadcasting have the heaviest usage of 2.07 hours a day on average, followed by 1.96 hours of digital cable, 1.66 hours of previous broadcasting services, 1.15 hours of IPTV, and 0.77 hour of mobile broadcasting. This implies that consumers adopting narrowcasting-like services, such as IPTV or mobile broadcasting spend less time compared to others.

Next, estimation results for time consumption for each broadcasting service are shown in Table 4. For each service, separate ordered probit models are estimated using subsamples that chose the correspondent broadcasting service in the choice model part. Factors identified to significantly affect the time consumption for each chosen broadcasting service can be seen by service. The factors with significant coefficients with positive (negative) signs mean that they are likely to increase (decrease) the time consumption for the corresponding service. In general, compared to the result of the choice model, fewer significant individual specific variables are found, and they affect time consumptions in more diverse patterns. While some affect both choice and time consumption in the same direction, many others do not. Meanwhile, all threshold parameters ($\mu_j$) for each service are highly significant, indicating that the discrete choices are indeed ordered as expected.

We examine the results in more detail while comparing them with the results of the choice model. First, we examine the coefficients of simultaneous consumption that are significant. The results show that most of the significant coefficients are negative. This implies that the more time a consumer spends on other services, the less he or she would spend on the concurrent service, so substitutability holds in terms of time consumption. However, while digital cable and digital terrestrial are substitutable with each other in time consumption, they are strongly complementary in terms of choice as shown in Table 3. For IPTV and mobile broadcasting, a complementary relationship holds in both choice and time consumption.

Next, we examine the coefficients of individual characteristic

Table 4. Estimation results of ordered probit model of time consumption for each chosen broadcasting service.

| Variables | *j*=Prev | | *j*=Dterr | | *j*=Dcab | | *j*=IPTV | | *j*=Mobile | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | *t*-value | Coeff. | *t*-value | Coeff. | *t*-value | Coeff. | *t*-value | Coeff. | *t*-value |
| Simultaneous consumptions on other services | | | | | | | | | | |
| $W_{n\text{Prev}}$ | | | −0.1146 | −0.77 | −0.0833 | −0.63 | −0.7747*** | −3.68 | −0.1965* | −1.90 |
| $W_{n\text{Dterr}}$ | −0.5521*** | −5.26 | | | −0.0627*** | −2.82 | 0.1905 | 0.84 | −0.2234* | −1.95 |
| $W_{n\text{Dcab}}$ | −0.4436*** | −5.45 | −0.4655*** | −4.50 | | | −0.3596 | −1.08 | −0.0446 | −0.34 |
| $W_{n\text{IPTV}}$ | −0.3432** | −2.08 | −0.1994 | −0.96 | −0.3495 | −1.46 | | | 0.2287** | 2.01 |
| $W_{n\text{Mobile}}$ | −0.0585 | −0.29 | −0.0375 | −0.14 | −0.2045 | −0.93 | 0.2436 | 0.77 | | |
| DigitalTV | 0.1512 | 0.74 | −0.0218 | −0.08 | −0.1892 | −0.77 | 0.1974 | 0.49 | −0.1695 | −0.64 |
| Sub_Broad | 0.1747 | 1.00 | 0.6967*** | 2.76 | 0.7705*** | 3.16 | −0.0926 | −0.19 | 0.0846 | 0.32 |
| Mon_Rental | 0.1001*** | 2.32 | 0.1357 | 1.01 | 0.0137 | 0.09 | 0.2206 | 1.21 | 0.1443 | 1.57 |
| Use_PremChan | 0.1109 | 0.56 | 0.5433* | 1.86 | 0.5339*** | 2.33 | −0.9870 | −1.27 | −0.0207 | −0.09 |
| High_Edu | 0.1853 | 1.29 | −0.0769 | −0.31 | −0.1509 | −0.82 | −0.0874 | −0.23 | −0.0159 | −0.07 |
| Gender_Male | −0.2732** | −2.07 | 0.1676 | 0.76 | −0.2722* | −1.88 | 0.6012** | 2.09 | −0.2112 | −1.06 |
| Age_under30 | −0.0322 | −0.20 | 0.1432 | 0.55 | 0.2974 | 1.24 | 0.5245 | 1.23 | 0.3146 | 1.33 |
| Age_bet3040 | 0.2857* | 1.78 | 0.2262 | 0.74 | 0.3711* | 1.72 | 0.8589* | 1.91 | 0.2583 | 0.87 |
| Age_over50 | 0.4043*** | 2.31 | 0.1886 | 0.62 | 0.4295* | 1.75 | −0.3334 | −0.58 | 0.5604 | 1.47 |
| Income_bet23 | 0.3419* | 1.85 | 0.4399* | 1.88 | 0.7935*** | 3.09 | 0.8956* | 1.88 | 0.1945 | 0.69 |
| Income_bet34 | 0.1699 | 0.85 | 0.2257 | 0.70 | 0.5994** | 2.05 | 1.3505*** | 2.48 | 0.5012 | 1.59 |
| Income_over4 | 0.1011 | 0.44 | 0.6635** | 2.17 | 0.7136*** | 2.31 | 1.1809*** | 2.32 | 0.4632 | 1.46 |
| $\mu_1$ | 0.2134*** | 5.27 | 0.3087*** | 7.30 | 0.5912*** | 6.23 | 0.8542*** | 5.03 | 1.7808*** | 12.36 |
| $\mu_2$ | 0.7985*** | 12.17 | 0.6932*** | 14.29 | 1.7409*** | 16.93 | 2.1418*** | 9.73 | 2.4111*** | 12.98 |
| $\mu_3$ | 1.8100*** | 17.23 | 1.7425*** | 18.18 | 2.6337*** | 19.86 | 3.0776*** | 8.71 | 3.2554*** | 8.69 |

***: significant at 1% level, **: significant at 5% level, *: significant at 10% level

variables while comparing them with the results of the choice model. Unlike the results of the choice model, retention of digital TV and subscription to high-speed broadband access services do not affect the time consumption significantly for most services. One exception is that consumers with subscriptions to high-speed broadband access are more likely to spend more time for digital terrestrial and digital cable. Monthly frequency of VHS or DVD rentals does not affect time consumption; however, it has a positive impact on the time consumption of previous broadcasting services. While being male is not a good predictor for choices, it has a significant negative impact on time consumption for previous broadcasting services and digital cable and a positive impact on time consumption for IPTV. Current use of any of the fee-paid premium channel or VODs in previous broadcasting services has a positive impact on time consumption for digital cable but negative impact on time consumption for digital terrestrial service.

In contrast to the individual characteristics previously mentioned, there are some additional individual characteristic variables that show similar patterns to the choice model. Education level does not significantly affect time consumption for any service. The younger a consumer is, the more time he or she is likely to spend on IPTV and mobile broadcasting. Consumers with higher income are more likely to spend more time on new broadcasting and telecommunication convergence services such as digital terrestrial, digital cable, and IPTV.

## V. Conclusion

In this study, we analyzed consumers' choices among various broadcasting services and daily time consumption for chosen broadcasting services when convergence between broadcasting and telecommunication sectors takes place and various new broadcasting and telecommunication convergence services are introduced to substitute the previous broadcasting services. We identified factors affecting consumers' choice of remaining in old broadcasting services or adopting various new

broadcasting services along with daily time consumption for chosen broadcasting services. Also, we attempted to predict competition and substitution in the broadcasting and telecommunication convergence service market in near future, and compared effects of individual characteristic variables between models of choice and time consumption.

The main findings of our study are the following. For the time being, consumers are locked into the previous broadcasting services in spite of the introduction of new broadcasting and telecommunication convergence services with superior and unique features. Also, they are likely to become even more price-sensitive to the new broadcasting and telecommunication convergence services which might carry somewhat higher service charges. Therefore, the transition of the market needs to be carefully predicted to enhance its growth and profitability.

Among the choices of previous broadcasting services and new converged services, consumers with new services are likely to choose more than one service, whereas for a large proportion of consumers subscribing to previous broadcasting services, it is their only choice. While mobile broadcasting has a considerably high choice probability due to its unique mobility, which is remarkable, the majority of its consumers tend to show multiple choice behaviors, most of whom are between new broadcasting and telecommunication convergence services and mobile broadcasting.

The estimation results of how individual characteristics affect choices and time consumption diverged by service. Many individual characteristics affect choice and time consumption in different directions. Some services are substitutable in terms of time consumption even though they are complementary in terms of choice. Thus, broadcasting service providers, content providers, advertisers, and technology developers have to consider the large differences among early adopters and the relationships among various broadcasting services when establishing their business or R&D strategies.

We only analyzed the linear effects of individual characteristics on choices and time consumption; however, there can be quadratic effects or interaction effects with attributes of services such as service charges. Also, choice and time consumption were modeled and analyzed independently without considering endogeneity. These limitations should be considered in future research. Despite the limitations of this study, we hope that the obtained implications can help associated players in this dynamic era of broadcasting and telecommunication convergence.

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