Analysis of Consumer's Purchasing Behavior on ICT Devices and Convergence Services in Korea

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Abstract　　The purpose of this research is to analyze consumers' choice behavior with regard to information and communication technology(ICT) devices and related services. This research focuses on the relationships not only within each category but also among different categories by considering multiple choice situations in a variety of categories simultaneously. The multivariate probit model with demographic variables and the alternative specific constant model with variance-covariance matrix are estimated using survey data; moreover, the multi-dimensional scaling method is utilized for the presentation of the relationship map. It is evident from the results that some devices and services have a complementary or substitute relationship each other. This study can provide useful information for the development of new products and services by understanding and predicting consumer's behavior.

Keywords: consumer's purchasing behavior, ICT devices, convergence services, relationship between ICT devices and services

정보통신기기와 융합서비스에 대한 소비자 구매행태 분석

신 정 우, 김 창 섭, 이 미 숙

요 약　　본 연구는 정보통신 기기 및 관련 서비스에 대한 소비자들의 구매행태를 분석하고, 다양한 정보통신 기기 및 서비스 간의 상관관계를 파악하고자 한다. 본 연구는 다양한 제품과 서비스의 다중선택 상황을 동시에 고려함으로써, 각 제품 및 서비스 그룹 내의 상관관계뿐만 아니라 그룹 간의 상관관계도 추가적으로 살펴보고자 한다. 분석자료는 소비자 설문조사를 통해 수집하였으며, 인구통계학 변수를 고려한 다변량 프로빗 모형(Multivariate Probit Model)과 분산-공분산 행렬(Variance-covariance Matrix)을 분석하기 위한 대안상수 모형(Alternative Specific Constant Model)을 각각 추정하였다. 또한 다차원척도 분석(Multi-dimensional Scaling Method)을 이용하여 제품 및 서비스 간의 관계도를 도식화하였으며, 다양한 정보통신 기기 및 서비스 간의 대체 또는 보완 관계를 도출하였다. 본 연구는 소비자들의 구매행태를 이해하고 예측함으로써 신제품과 서비스의 개발에 유용한 정보를 제공할 것으로 기대된다.

주제어: 소비자 구매행태, 정보통신기기, 융합서비스, ICT 매체와 서비스 상관관계

I. Introduction

The emergence of various information and communication technology(ICT) devices and services has led to increase interest in new technologies. The term of convergence also contributed to the attention, which refers to the affiliation of disparate fields such as internet services, broadcasting services, and manufactured products. Producers are increasingly releasing and selling new types of convergence devices(Eastwood, 2006), and convergence products have different effects with every new functionality they add(Gill, et al., 2009). From this perspective, a quantitative analysis of consumers' preferences and cross-category analysis for ICT devices and convergence services can provide valuable input for dealing with market situations. Companies will have more useful implications of marketing if they possess more information on consumers' purchasing behavior(Iyengar, et al., 2003).

Consumers select a combination of ICT devices and related services due to the mutual relationships among them, rather than considering isolated products/services. However, previous researchers on consumer preferences do not consider cross-category relationships comprehensively(Song, et al., 2003; Shin, 2006; Lee, et al., 2006; Lee, et al., 2011; Choi, et al., 2013). Though some researches analyze consumers' purchasing behavior by considering cross-category relationships, they consider a limited range of products and services(Gupta, et al., 1999; Rice, et al., 2003; Park, et al., 2008; Lee, et al., 2009; Park, et al., 2010; Shin, et al., 2014). Thus, it can be said that information on

consumer's behavior is not still enough, since a body of previous researches have focused on limited products or services.

The purpose of this research is to analyze consumers' choice behavior with regard to ICT devices and convergence services. Especially, this research focuses on the relationships not only within each category but also among different categories. By considering multiple choice situations in a variety of categories simultaneously, we can overcome the limitations of previous studies and control the endogeneity problem to achieve a more realistic result. Figure 1 illustrates the basic concept of this research.

The remainder of this paper is organized in the following manner: Section 2 presents the theoretical background and literature review. Section 3 explains the methodology and data utilized for empirical analysis. Section 4 presents the estimation results as well as the main finding of this study. Section 5 describes the relationship map among products/services. Finally, section 6 provides the summary and conclusion.

II. Literature Review

To investigate consumer's purchasing behavior of new technologies or its products, two main theories have been developed such as the theory of reasoned action(Fishbein, et al., 1975) and the theory of planned behavior(Ajzen, et al., 1986). Based on these theories, technology adoption model(Davis, 1986) has been developed in the perspective of information system. A representative technology adoption model is the diffusion of innovations(Rogers, 1962; Bass,

1969) with aggregated market data. On the other hand, most previous researches on consumer's purchasing behavior of ICT devices and services use several discrete choice models with individual stated preference data.

For example, Shin(2006) used the logit model to analyze the effect of demographic and technological variables on consumer demand for internet protocol television(IPTV), excluding the effects of existing internet and broadcasting services. Lee, et al.(2006) analyzed the demand for large screen television in Korea, without considering other ICT devices and services. Choi, et al.(2013) used the mixed logit model to analyze consumer preferences for tablet PCs, without considering other smart devices and services. In addition, Lee, et al.(2011) also used the mixed logit model to estimate consumer preferences and demand for next-generation DVD players without

considering related ICT devices such as TV and home theater. Although Song, et al.(2003) developed a methodology to analyze consumer preferences by reflecting on both consumer heterogeneity and forward-looking behavior, it is restricted to a single product category. In summary, these previous researches analyze consumer preference without considering cross-category relationships comprehensively.

Though some researchers consider a cross-category analysis due to the mutual relationship among products and services, the scope of them is not sufficient to analyze the convergence effect among products and services. For instance, Gupta, et al.(1999) found that products purchased independently can actually influence each other due to indirect network externality. They attempted to examine consumer choices of digital television and related products simultaneously,
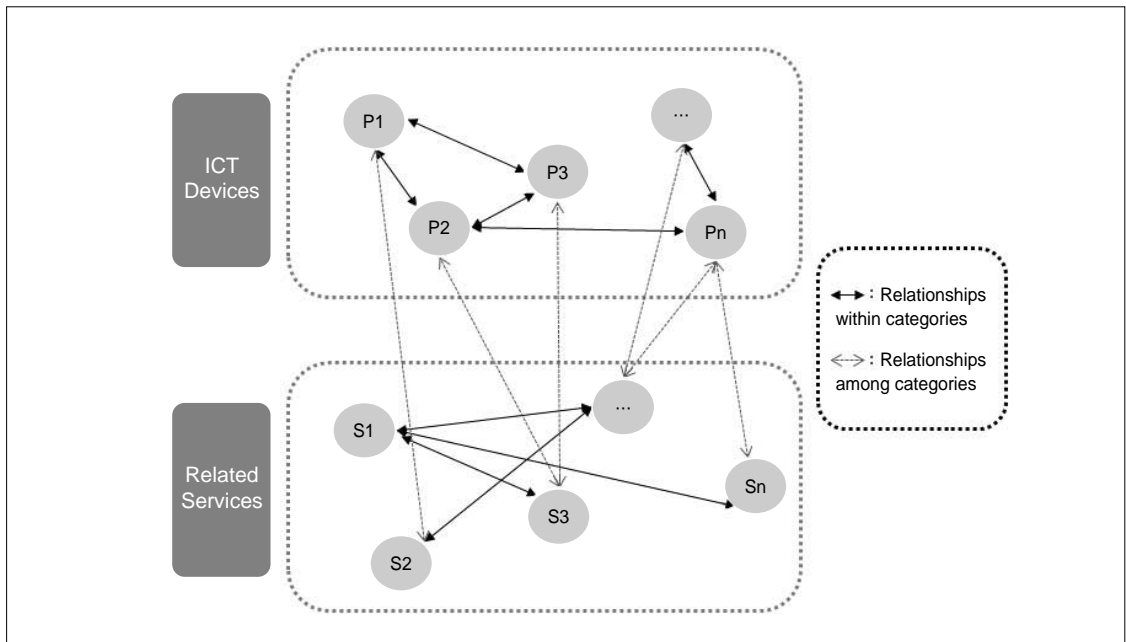
<Figure 1> The basic concept of this study

but the scope of their study is insufficient to analyze the inter-relationships among a broad range of convergence services. Similarly, Rice, et al.(2003) analyzed these relationships within certain categories, particularly between internet usage and mobile phone usage. To evaluate the impact of socio-demographic variables, they divided consumers into several categories: users vs. non-users, continuous users vs. short-term users, and so on. Further, Lee, et al.(2009) considered mobile phones, MPEG audio layer-3(MP3) players, and digital cameras to analyze the diffusion of a convergence product.

Recently, Shin, et al.(2014) found the key attribute of cloud computing services, which are a type of emerging ICT, and analyzed the cross-category relationships between cloud computing services and each terminal device. However, they considered a limited range of terminal devices such as smartphones and smart pads and did not include related services. In particular, Park, et al.(2008) consider a value chain among digital content, networks, and devices in an effort to analyze digital usage. They simultaneously consider a variety of products and services in different categories. In their estimation, they use a multivariate probit model(MVP) to analyze the relationship among digital content, networks, and devices. Similarly, Park, et al.(2010) analyze consumer's purchasing behavior of mobile phones and contents by focusing on the inter-relationships among them.

Although there has been a body of previous literature on consumer choice of ICT devices and related services, it can be said that most of them have only addressed choices of limited products,

services, and categories. To complement the limitation of previous studies on consumer preference of ICT devices and services, this study considers not only within inter-related products, but also between products in different categories.

Ⅲ. Methodology

1. Model specification

This study uses the MVP model to consider the multiple choice situation suggested by Chib, et al.(1998), Edwards, et al.(2003), and Baltas(2004). Although the multivariate logit model could analyze multiple choice data(Hausman, et al., 1984; Boztug, et al., 2006), it cannot derive complementary or substitutive relationships among product categories due to the assumption of independence from irrelevant alternatives(IIA). As the MVP model does not assume the IIA property, the analysis of the relationships among various alternatives proves useful. For example, Manchanda, et al.(1999) and Koh, et al.(2010) employed the MVP model to analyze complimentary and coincidental relationships among multicategory products by considering consumer's heterogeneity. In addition, Kim, et al.(2009) also used the MVP model to analyze the relationships among home appliances.

The MVP model can be applied not only to single category products/services(Edwards, et al., 2003), but also to multicategory products/services (Manchanda, et al., 1999). For example, Rao, et al.(1978) uses the MVP model for the issues related to market segmentation and product design. Seetharaman, et al.(2005) consider several models(MVP, multivariate logit,

multivariate hazard, and bundle choice model) for analyzing multicategory choice situations, and state that the MVP model has the advantage of enabling analysis of cross-category relationships. Therefore, the MVP model is appropriate for analyzing the relationships among ICT devices and related services in this study.

The research model is based on the random utility model(McFadden, 1973). The MVP model assumes that all consumers behave in a manner that maximizes their utility. Consumer i's utility function U_{ij} for alternative j is described as given in equation(1).

$$(1) \quad U_{ij} = V_{ij} + \varepsilon_{ij} = a_j + \sum_{k=1} \beta_{jk} X_{jk} + \varepsilon_{ij}$$

Determinant part V_{ij} consists of an alternative specific constant(ASC), a_j, and the effect of attribute k on alternative j. The distribution of stochastic part ε_{ij} can be assumed differently depending on the situation. Consumer i purchases product or service j only if $U_{ij} > 0$. Therefore, purchasing behavior can be described by two cases: purchase($y_{ij}=1$) or not($y_{ij}=0$), as shown in equation(2).

$$(2) \quad y_{ij} = \begin{cases} 1, & \text{if } U_{ij} > 0 \\ 0, & \text{if } U_{ij} \leq 0 \end{cases}$$

If the stochastic part ε_{ij} is assumed to have a normal distribution $N(0,\Omega)$, the relationship between alternatives can be analyzed by the signs and sizes of their correlation coefficients(Manchanda, et al., 1999).

This research considers two types of the MVP model: one contains demographic variables as a dependent variable and the other is an alternative specific constant(ASC) model. The model with demographic variables can be expressed as equation(3).

$$(3) \quad \begin{aligned} U_{nj} = &a_j + \beta_{j,edu} D_{j,edu} + \beta_{j,residence} D_{j,residence} \\ &+ \beta_{j,family} X_{j,family} + \beta_{j,income} X_{j,income} \\ &+ \beta_{j,house} D_{j,house} + \varepsilon_{nj} \end{aligned}$$

where $D_{j,edu}$, $D_{j,residence}$, $D_{j,house}$ represents the dummy variable for educational level($D_{j,edu}=1$ for higher than university graduate), region($D_{j,residence}=1$ for the south area of Seoul), and type of house($D_{j,house}=1$ for apartment), respectively. Other variables such as $X_{j,family}$ and $X_{j,income}$ indicates the number of family members and household income, respectively.

This study utilizes a Bayesian estimation method to overcome the numerical problem for the MVP model(Edwards, et al., 2003). By using a Bayesian estimation method with Gibbs sampling, researchers can overcome the weakness of the maximum likelihood estimation(MLE). For example, the Bayesian estimation method can derive a solution of global maximization, while the MLE estimators can be converged to local optimization according to the initial value(Allenby, et al., 1998; Huber, et al., 2001; Edwards, et al., 2003; Train, 2003).

2. Data

This study uses data from the "TEMEP

<Table 1> Demographics of samples

Characteristics		Ratio (%)	Characteristics		Ratio (%)
Gender	Male	47.4	Average Income (10,000 Korean won)	under 299	16.9
	Female	52.6		300 ~ 399	33.2
Age	under 29	20.3		400 ~ 499	22.5
	30 ~ 39	24.5		500 ~ 599	14.4
	40 ~ 49	26.2		over 600	13.0
	over 50	29.0	Region	Southeast	26.5
Education	High school graduate	52.5		Southwest	24.3
	In college	8.1		Northeast	27.8
	University graduate	39.4		Northwest	21.3
Size of Family	1	2.7	Size of House (pyeong)	under 19	19.9
	2	10.0		20 ~ 29	52.0
	3	24.3		30 ~ 39	20.3
	4	53.9		40 ~ 49	5.3
	over 5	9.1		otherwise	2.5

Household ICT/Energy Survey(THIES) 2008" conducted in August 2008 by the Technology Management, Economics, and Policy Program of Seoul National University, Korea. This survey was conducted among 1,000 households in Seoul through one-to-one interviews to investigate the present status of purchase and ownership for home appliances and related services in each household. The questionnaire was a well-structured one and the purposive quota sampling method was used to extract samples based on income, gender, age, and regions. Table 1 presents the demographics of samples, and the basic statistics appear to be reasonable.

Among the demographic variables in Table 1, this study uses education level, income level, size of family, regional area, and type of house as explanatory variables. Consumer's purchasing behavior for ICT devices and related services could differ on the basis of the residential environment, education, and economic level. For the variables on residential environment, this study considers regional area, size of family, and type of house. Regional area is defined as 1 for the southern area of Seoul, and type of house is defined as 1 in the case of an apartment. For the education variable, the education level is defined as 1 for higher than university graduate. The economic variable indicates the average monthly income of each household.

Table 2 presents the alternative list of assessing the relationships among ICT devices and related services. Survey data for a total of 945 households is used, excluding households that were unable to provide necessary information. The rates of households containing analog cathode-ray tube(CRT) TVs, desktop computers, and high-speed internet

<Table 2> Penetration rate of ICT devices and related services for 945 households

Categories	Products/services	Penetration rate(%)
TV	Analog CRT TV	76.5
	Digital CRT TV	13.9
	Projection TV	7.1
	LCD TV	15.7
	PDP TV	7.3
Appliances related to TV	Home theater	8.0
	DVD player	28.8
PC	Desktop PC	98.1
	Laptop	11.5
Phone	Telephone	85.2
	Mobile phone	96.3
	PDA, etc.	3.3
Camera	Film camera	41.0
	Digital camera	77.7
Portable devices	MP3 players	20.5
	PMPs	2.1
	Video game consoles	7.4
Phone service	Internet videophone service	0.5
Internet service	High-speed internet service	98.4
	Wireless internet service	2.8
	Mobile internet service	9.9
Broadcasting service	Terrestrial broadcasting service	73.2
	Cable TV broadcasting service	76.1
	Satellite broadcasting service	2.3
	DMB	0.8
Convergence service	IPTV	2.9

services are 76.5%, 98.1%, and 98.4%, respectively. This statistic demonstrates that the majority of households possess the infrastructure to use internet network services.

Ⅳ. Estimation Results and Main Findings

1. The effect of demographic variables on consumers' purchasing behavior

For the estimation of the MVP model, several demographic variables including education, residential area, number of family members, household income, and type of housing are considered. Table 3 presents the estimation results for two MVP models.

The estimation results of consumer preferences for ICT devices and services including demographic variables reveal that the households with high income are likely to select items such as projection TV, LCD TV, home theater, DVD player, laptop, digital camera, and cable TV broadcasting services. In addition, the coefficient in the ASC model indicates the average and relative consumer preference for alternatives. In

<Table 3> Estimation results of ICT devices and services

Category			MVP model including independent variables						ASC model
			Constant	Education	Residential area	Number of family	Household income	Type of house	Constant
TV	Analog CRT TV	1	0.5615**	−0.3657**	−0.4259**	0.2168*	0.0001	0.0125	0.7462**
	Digital CRT TV	2	−0.8291**	0.2498**	0.2996*	0.0208	−0.0002	−0.2423*	−1.0874**
	Projection TV	3	−1.2476**	0.1724*	0.1777	−0.0574	0.0007**	0.2577*	−1.4646**
	LCD TV	4	−0.9517**	0.0774	−0.1461	−0.0492	0.0006*	0.028	−1.0024**
	PDP TV	5	−1.5198**	0.1017	0.0322	0.1603*	0.0004	0.2787*	−1.4493**
Appliances Related to TV	Home Theater	6	−1.6406**	0.2574**	−0.1301	−0.0471	0.0008**	0.4632**	−1.4040**
	DVD Player	7	−1.0146**	0.2885**	−0.1815	−0.0854	0.0009**	0.2508**	−0.5577**
PC	Desktop PC	8	1.9437**	−0.3186	0.1087	0.2632	−0.0001	0.2729	2.0765**
	Laptop	9	−1.5261**	0.3752**	−0.4511**	−0.14	0.0014**	−0.1727	−1.1983**
	Palmtop or UMPC	10	−4.1391**	0.7989	1.5093	0.3786	−0.0043	0.5169	−3.1477**
PC Peripherals	Printer	11	−0.0752	0.2151**	−0.2406**	0.0959**	−0.0003**	0.2036**	0.3511**
	Scanner	12	−0.4809**	0.1511*	−0.3649**	−0.1306**	0.0002	0.1081	−0.9972**
Phone	Telephone	13	−0.7287**	−0.1376**	0.1794*	0.4553**	0.0004*	−0.0309	1.0395**
	Mobile Phone	14	2.0972**	0.4077**	−0.1265	0.0501	0.0001	0.1657	1.7764**
	PDA etc.	15	−2.4434**	0.0673	0.2823	0.128	−0.0003	−0.3309**	−1.8252**
Camera	Film Camera	16	−0.7591**	−0.0534	−0.1108	0.1303**	0.0001	0.0599	−0.2271**
	Digital Camera	17	0.177	0.2246**	0.065	−0.0141	0.0005**	0.0163	0.7572**
Portable Device	MP3 Players	18	−0.9151**	0.3919**	−0.3706**	−0.0373	0.0002	−0.1303	−0.8204**
	PMPs	19	−1.9109**	0.2865*	−0.0189	0.0774	−0.0006	0.1105	−2.0086**
	Video Game Consoles	20	−1.4458**	0.2635**	−0.2637**	0.2246**	−0.0005	−0.1946*	−1.4332**
Phone Service	Internet Videophone Service	21	−3.1715**	0.7273**	−1.4822**	0.1852	−0.0012	−0.0381	−2.5543**
Internet Service	High−speed Internet Service	22	0.9968**	−0.0469	−0.5772**	0.3307**	0.0018	0.4061	2.1302**
	Wireless Internet Service	23	−2.9536**	0.3981*	−0.9475**	−0.0384	0.0014	0.1209	−1.9164**
	Mobile Internet Service	24	−0.7564**	0.3727**	−0.1298	−0.0766	0	−0.2237*	−1.2778**
Broadcasting Service	Terrestrial Broadcasting	25	−0.0646	0.108	0.3075**	0.0282	0.0001	0.4532**	0.6187**
	Cable TV	26	1.7855**	−0.3720**	−0.4136**	−0.0747	0.0009**	−0.4856**	0.7102**
	Satellite Broadcasting	27	−4.7175**	0.4422	0.6371**	0.1994	0.0002	−0.3914	−1.9816**
	DMB	28	−4.2933**	1.1114**	0.0401	0.184	−0.0004	−0.4533	−2.3635**
Convergence Service	IPTV	29	−3.4861**	0.2617	−0.0256	0.1693	−0.0005	0.275	−1.8960**
	Home Network Service	30	−6.3220**	−0.2171	1.695	0.1126	0.0003	0.8133	−2.8425**

**,*: Statistically significant at 5% and 10% level

other words, it shows which products/services are accorded higher preference within the category. From the last column in Table 3, analog TVs have the highest constant in the TV products category—76.5% of families already own analog TVs. Apart from analog TVs, consumers prefer LCD TVs, digital TVs, PDP TVs, and projection TVs in that order within TV products. These results are similar to findings by Park, et al.(2008) that LCD TVs will enjoy competitive advantage in the future broadcasting environment. DisplaySearch(2011) also demonstrates that the market share of LCD TV is continuously increasing.

In the phone category, including internet videophone services, consumers use mobile phones more frequently than fixed phones due to the rapid development of the mobile phone service market. In the broadcasting category, including convergence services, consumers prefer cable TV, terrestrial broadcasting, IPTV, satellite broadcasting, and digital multimedia broadcasting(DMB) services, in that order. Hence, these results reveal strong competition among cable TV broadcasting services, terrestrial broadcasting services, and IPTV in the future broadcasting service market. Since this survey was conducted in October 2008 after an IPTV enforcement ordinance in July 2008, the estimated results might be reflective of consumers' expectations.

In the internet services categories, consumers prefer high-speed internet services, mobile internet services, and wireless internet services, in that order. This

result implies that mobile internet services developed more rapidly than wireless internet services in 2008. However, this is a very different result compared to the current market situation in 2014. It shows how the technological development and change in consumer's tastes can affect the market of product/services. In other categories, consumers prefer digital cameras to film cameras, printers to scanners, and laptops to palmtops(we do not consider desktop computers).

2. The relationships within categories of ICT devices/services

This study derives the variance-covariance matrix to evaluate the relationships among and within ICT devices and service categories by using the ASC model. The variance-covariance matrix in the ASC model reflects all effects which come from purchasing behavior without the average effect, and serves as the basis for complementary/substitutive relationships. Table 4 presents the results of the variance-covariance matrix analysis. Because this study uses data pertaining to current possessions at home, a positive(or negative) correlation in the variance-covariance matrix represents a higher probability of simultaneous possession(or non-possession) within categories, respectively.

For example, in the TV category, analog TVs have a substitutive relationship with digital TVs, projection TVs, LCD TVs, and PDP TVs. In particular, analog TVs show

strong substitutive relationships with digital TVs and LCD TVs. As mentioned in Park, et al.(2008) and DisplaySearch(2011), there is a consistent substitution effect between analog TVs and LCD TVs. In the phone category, mobile phones have a substitutive relationship with fixed phones. According to the International Telecommunication Union(2011), the number of subscribers to fixed phones has decreased since the 1980s, while the number of subscribers to mobile phones has increased rapidly.

In the broadcasting services category, terrestrial broadcasting services have a strong substitutive relationship with cable TV broadcasting services, because cable TV broadcasting service providers can transmit terrestrial broadcasting services. In addition, satellite broadcasting and cable TV broadcasting services have a strong substitutive relationship due to the variety of content that they provide. However, in 2008, terrestrial broadcasting services had a complementary relationship with satellite broadcasting services, because satellite broadcasting providers could not retransmit terrestrial broadcasting services.[1]

Further, IPTV does not only have a complementary relationship with terrestrial broadcasting and satellite broadcasting services, but also a substitutive relationship with cable TV broadcasting services. Since IPTV downloads video on demand(VOD) over the internet,

consumers who do not have time to watch real-time broadcasting programs can use IPTV to watch VOD via download. Conversely, it can be substituted by cable TV broadcasting services, which provides terrestrial broadcasting programs occasionally.

In terms of internet services, mobile internet services have a complementary relationship with wireless internet services. These results are consistent with the results of Choi, et al.(2013) that consumers prefer to have both wireless internet and mobile internet services, rather than only wireless internet. In the portable devices category, MP3 players have a complementary relationship with both PMP and video game consoles. This implies that households who possess PMP or video game consoles also tend to possess MP3 players. For cameras, film cameras have a substitutive relationship with digital cameras. In the PC category, desktop computers have a strong substitutive relationship with laptops. Such results based on the 2008 survey data still appear to be reasonable in the current market situation of ICT devices and services.

3. The relationships among various categories of ICT devices/services

This section focuses on the correlations among categories of ICT devices and services

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1) Since the broadcasting commission permitted retransmission of terrestrial broadcasting programs in 2009, satellite broadcasting providers did not have certain rights on this issue before 2009. Although satellite broadcasting providers contracted retransmission with terrestrial broadcasting providers in 2004, they are required to enter into contracts with terrestrial broadcasting providers in each region.

<Table 4> Variance-covariance matrix of ASC model

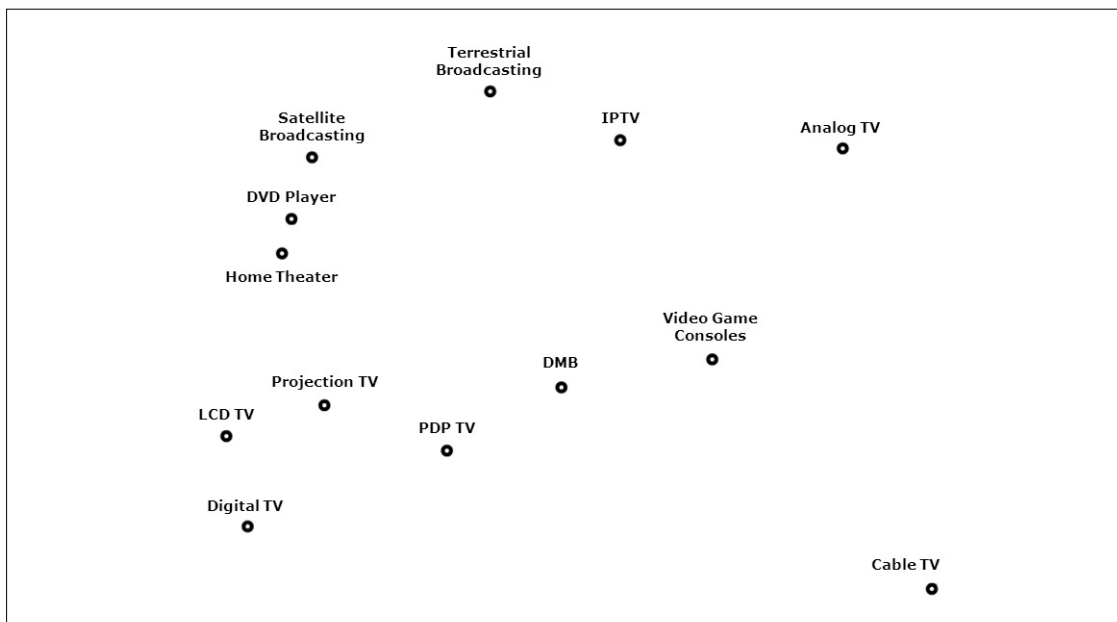| Category		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Analog CRT TV	1	1																													
Digital CRT TV	2	-0.61**	1																												
Projection TV	3	-0.17**		1																											
LCD TV	4	-0.46**			1																										
PDP TV	5	-0.16**				1																									
Home Theater	6	-0.23**			0.42**	0.26**	1																								
DVD Player	7	-0.25**	0.10*	0.15**	0.34**	0.22**	0.65**	1																							
Desktop PC	8	0.28**	-0.28**						1																						
Laptop	9	-0.23**	0.15*	0.16*	0.19**		0.24**	0.29**	-0.67**	1																					
Palmtop or UMPC	10										1																				
Printer	11				0.13**			0.11**				1																			
Scanner	12		0.15**					0.11*				0.34**	1																		
Telephone	13											0.13**		1																	
Mobile Phone	14		0.22*				0.22*	0.20**						-0.28**	1																
PDA, Smart Phone	15	-0.35**	0.32**					0.17*	-0.24**	0.20*		0.10*		0.27**		1															
Film Camera	16	0.22**		0.21**				0.08*				0.22**		0.21**			1														
Digital Camera	17	-0.13**		0.14*	0.15**	0.16*	0.13*	0.15**				0.21**			0.16*		-0.31**	1													
MP3 Players	18									0.23**		0.16*	0.18**	-0.11*	0.36**	0.21**	-0.13**	0.20**	1												
PMPs	19							0.19*		0.21*		0.22**	0.19*		0.25**				0.47**	1											
Video Game Consoles	20											0.20**		0.17**	0.27**			0.29**	0.28**		1										
Internet Videophone Service	21	-0.27*			0.38**		0.24**	0.39**	-0.32*	0.44**		0.20*					0.19**		0.30**	0.38**		1									
High-speed Internet Service	22				0.28*													0.21*					1								
Wireless Internet Service	23				0.25**		0.24**	0.38**	-0.44**	0.60**						0.23*			0.32**	0.40**		0.56**		1							
Mobile Internet Service	24											0.16**		-0.17**	0.36**	0.21**	-0.13**	0.36**	0.41**	0.24**	0.28**	0.36**		0.26**	1						
Terrestrial Broadcasting	25			0.18**	-0.13**					-0.12*			-0.14**										-0.25**			1					
Cable TV	26					-0.18**														-0.18*	0.15*		0.22**			-0.55**	1				
Satellite Broadcasting	27	-0.23**					0.21*	0.32**		0.24**										0.24*		0.29**		0.28**		0.21**	-0.57**	1			
DMB	28																			0.30**		0.31*		0.26**	0.23**				1		
IPTV	29						0.18*	0.29**		0.30**							0.19*		0.38**	0.38**	0.21**	0.31**		0.33**	0.18*	0.21**	-0.31**	0.41**		1	
Home Network Service	30																														1

**, *: Statistically significant at 5% and 10% level

using the variance-covariance matrix in Table 4. Consumers who subscribe to internet videophone services tend to buy LCD TVs, laptops, MP3 players, and PMPs together. Due to the development of PMPs with WiFi functionality, the complementary relationship between internet videophone services and PMP appears to be increasing in significance. In addition, consumers who use high-speed internet services tend to buy LCD TVs and digital cameras together, thereby enabling them to upload pictures from digital cameras and display them clearly on the LCD monitor. These results are consistent with the finding from Park, et al.(2011) that consumers prefer high definition monitors and high-speed internet services when they buy smart devices such as smartphones, tablet PCs, and smart TVs.

With regard to wireless internet services, consumers tend to use it with LCD TVs, portable devices(PDA, etc.), and internet videophone services. Because PMP, portable devices, and internet videophone services are all based on internet services, wireless internet services have a complementary relationship with these items. Consumers can also access various content via wireless internet services, and LCD TVs enable a clear visualization of all this content. Mobile internet services have a complementary relationship with various devices/services such as MP3 players, PMPs, video game consoles, internet videophone services, and mobile phone devices based on their mobility.
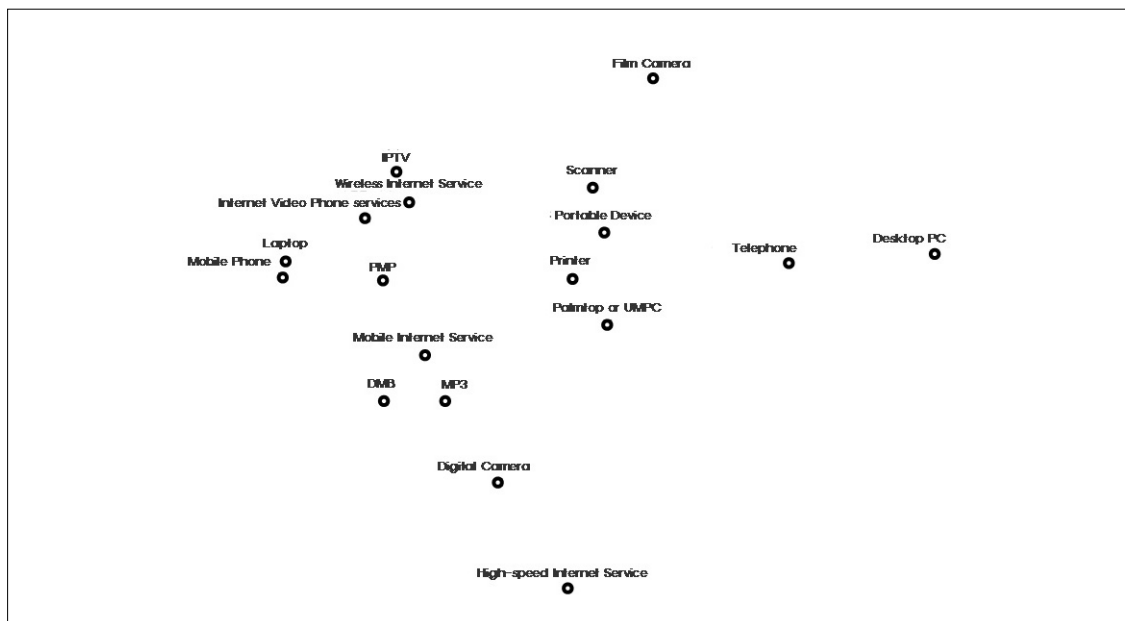
It is evident from the results that PMPs

<Figure 2> MDS analysis of broadcasting products and services

have a substitutive relationship with cable TV broadcasting services, but a complementary relationship with satellite broadcasting services, DMB, and IPTV, respectively. This is because PMPs that include DMB functions can provide terrestrial broadcasting services. With regard to IPTV, consumers who use IPTV tend to buy home theater and DVD player components together because of their desire to create an environment for viewing various media contents. Between the two categories of internet and broadcasting services, there is a high probability that consumers subscribe to both cable TV broadcasting and high-speed internet service, or both satellite broadcasting and wireless internet services. Consumers who use DMB services tend to use wireless internet services and mobile internet services together.

Ⅴ. Multi-dimensional Scaling Analysis

This section describes the relationship map between/within ICT devices and services using the multidimensional scaling(MDS) method, which graphically presents consumer demand for ICT devices and services. Baouraki, et al.(1996) provide some managerial implications by assessing consumer preferences via the multidimensional and multicriteria methods. Carroll, et al.(1989) demonstrate how the MDS method can be applied to consumer preference data.

The first part of this analysis involves broadcasting services and products, including TV products, DVD players, home theaters, video game consoles, broadcasting services, DMB, and IPTV. Figure 2 illustrates that consumer's demand for analog TV is different

<Figure 3> MDS analysis of ICT devices and services

from other TV products such as projection TVs, LCD TVs, PDP TVs, and digital TVs. Terrestrial broadcasting services have a strong substitutive relationship with cable TV broadcasting services, but are positioned close to satellite broadcasting services. With regard to IPTV, it is relatively close to terrestrial broadcasting services and satellite broadcasting services, and further away from cable TV broadcasting services. DVD players and home theaters are closer to satellite broadcasting services than other broadcasting services, and also relatively close to projection TVs and LCD TVs in the category of TV products.

The second part of this analysis involves IT devices and services such as PC products, PC peripherals, cameras, MP3 players, PMP, internet services, phone services, DMB, and IPTV. Figure 3 presents the results of the MDS analysis for ICT devices and services. Mobile internet services have a close relationship with DMB, MP3 players, and PMPs. Moreover, internet videophone services are close to wireless internet services, IPTV, and laptops.

The abovementioned results can provide useful information for a marketing strategy such as the development of a products-services package or advertisement of creative bundle products. In addition, the estimated results help to ascertain not only observable consumer preferences but also unobservable and unpredictable demand. Hence, this information can be used meaningfully for the new product strategy of convergence.

Ⅵ. Summary and Conclusion

In this study, we analyzed consumer's purchasing behavior for ICT devices and related services in each household and derived the relationship within/among their categories. For the empirical analysis, the MVP model was employed under multiselection conditions using survey data. Two types of the MVP model were considered: the first was the model that employed demographic variables and the second was the ASC model with variance-covariance matrix. By simultaneously considering various ICT devices and services, a more realistic and reasonable result could be obtained without the endogeneity problem.

From the estimation results, it is evident that demographic variables of each household, like average income, can affect the possession and usage of ICT devices and services. Consumers typically have a high preference for analog TV, mobile phones, cable TV, and high-speed internet services within each category. As shown in Figure 1, the relationships within categories were derived from the variance-covariance matrix of the ASC model. For example, some ICT devices and services have a complimentary relationship(terrestrial and satellite broadcasting; IPTV and terrestrial/satellite broadcasting; mobile and wireless internet; MP3 player and PMP/video game) or substitutive relationship(analog TVs vs. digital/LCD TVs; mobile phones vs. fixed phones; cable TV vs. terrestrial/satellite broadcasting; IPTV vs. cable TV; film camera

vs. digital camera; desktops vs. laptops) with each other. In other words, consumers are more likely to use some of those items together that have complementary relationships, while they do not possess some of those items together that have substitutive relationships.

Furthermore, as shown in Figure 1, the cross-category relationships are also derived from the variance-covariance matrix of the ASC model. In other words, there is a potential relationship among different categories of ICT devices/services. Each household tends to possess or use certain items together, such as internet videophone services with LCD TV/laptops/MP3 players/PMPs, wireless internet with LCD TVs/portable devices/internet videophone, mobile internet with various portable devices, IPTV with home theater/DVD player, etc. Thus, the results of this study may provide useful information for understanding the relationship among ICT devices and services, not from the perspective of supply but from the perspective of consumer demand. This study can also provide some managerial implications for companies to develop new products and services by predicting consumer behavior and reducing market uncertainty.

Notwithstanding the theoretical and empirical implications of this study, there is room for improvement. As mentioned above, this study estimates the MVP model using consumer survey data pertaining to 2008. Therefore, the estimated results can be different from the latest trends or current market situations. In particular, the emergence of smartphones critically affects ICT devices and the market for related services. A comparison of our estimated results to the current situation reveals that some results are reasonable, while other results show a gap due to technological development and passage of time. If the latest data on the actual possession of ICT devices/services in each household is available, it may be possible to update the results of this study and obtain a picture of the change in consumer demands over time.

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