

**Analysis on the new Competition in the Saturated Residential Broadband
Access Market: Using stated preference data in Korea**

Daeyoung Koh^a, Yeonbae Kim^{a*}, and Jeong-dong Lee^a

a: Ph.D. Candidate, Associate Professor, and Research Professor, Techno-Economics and Policy Program, Seoul National University

***: Contact author**

Techno-Economics and Policy Program, Seoul National University, Shillim-Dong San56-1, Gwanak-Gu, Seoul151-742, South Korea

Phone: +82-2-880-8683

E-mail: kimmy1234@freechal.com

Fax: +82-2-880-8389

Abstract

In this paper, we attempt to predict the future of broadband access market where new convergence access technologies and additional services are introduced, based on consumer preferences. Conjoint analysis and mixed logit model is used for estimation. From the results, consumers value convergence access technologies such as PLC and wireless LAN, and TV-related service. However, valuation on new beneficial features of convergence access technologies is not enough to overcome their technological inferiorities in data transfer speed and quality stability at current technological stage. Additionally, consumer preferences are so heterogeneous that differentiated business strategies are required. Finally, some managerial and policy implications are presented.

Keywords: Broadband, Saturated market, Convergence access technologies, Additional services, Consumer preferences

1. Introduction

Recently, global broadband access markets have grown up so fast¹, and are being

¹ Among OECD countries, Netherlands (7.22%), Switzerland (7.20%), Norway (6.92%), Luxembourg (6.35 %) showed the fastest growth in 2004 (OECD, 2004).

switched from narrowband gradually. Among many countries, Korea has shown so remarkable fast growth that now in 2005, 12.2 million people which corresponds to 25.5 per 100 people, subscribe broadband access services.

However, unlike the global trend, Korea is now facing very unique situation that the previous fast growth stops and saturation of market is being reached². In this saturated broadband access market, competition is getting more and more fierce, which pushes firms to strive to seek strategies for survival and further growth, and government to maintain fair competition, promote innovation, and find new driving force for national growth, unlike the former policies just focused on promoting broadband usage mainly.

In addition to this situation, new convergence access technologies and additional services are being introduced into this market. They are expected to bring drastic change to the saturated broadband access market. Power line communication (PLC), convergence between electricity industry and IT telecommunication industry, and wireless LAN(WLAN), one of the fixed-wireless convergence services are good examples for the new convergence access technologies. Also, real time (electricity usage) auto metering report (AMR) service, Voice over Internet Protocol (VoIP), and TV related services are examples of new additional services which can complement the existing access service. They may act as new profit source, driving force for further growth, and competitive factor. Generally, they are offered as a form of bundle, for example, Triple play service (TPS).

The emergence of convergence access technologies and the additional services have both significant meaning or benefits and limitations or uncertainties for the broadband access market. They can increase consumer welfare by giving more choices and meeting the consumers' diverse needs. Also, convergence access technologies can increase consumers' utilities by their own beneficial features such as availability to connect multiple terminals with more ease, less restriction on the location to connect a terminal to the network, and wireless connectivity)

Thanks to those benefits, they can lead the current market situation with high concentration to more competitive one. Consequently, they are expected to accelerate the innovation by more competition, and to give additional benefits to the consumers at last.

Also, they can decrease the degree of digital divide problem. For example, PLC is now regarded as the very technology that will solve the cost problem related to

² Korea had growth rate of 0.65 %, which is the fourth slowest one among OECD countries in 2004 (OECD, 2004).

providing broadband access to the alienated areas, because of the ubiquity of power lines.

However, there are many limitations and uncertainties for related industries in addition to those mentioned benefits. Because convergence access technologies and new additional services are not as mature as extant access technologies, they may not be stable enough to meet the regulatory requirements on frequency interference, frequency usage, emissions of electromagnetic wave. Also, they are not enough in technological level to meet consumers' needs for data transfer speed or quality stability yet, which are getting more and more important in the saturated market. In addition to the technological regulation issues, there are other regulation issues such as transition of market power from other related industry to the convergence access technologies (by cross-subsidy or market foreclosure), or bundling and allowance of TV service for access company. Unsettling of policies and regulations will aggravate more uncertainties and irregularities affecting the effectiveness and competitiveness of convergence access technologies and additional services.

As a result, because of these limitations and uncertainties, as well as significance and benefits, no one can predict with certainty how these new convergence access technologies and additional services will affect the current saturated broadband access market. Therefore, we thought that it will be worth to analyze more carefully what will be the possible future of this saturated broadband access market, considering the introduction of new convergence access technologies and additional services.

There are a lot of literatures dealing with broadband access market, while not many previous literatures dealing with the new convergence access technologies or additional services. Additionally, if any, they are mainly focusing on the regulation or policy, or supply sides, while not analyzing demand side very much. Among previous literatures, Tongia (2004) analyzed the competitiveness of PLC against other mature technologies such as xDSL and Cable, while considering additional services as well. Unfortunately, he spent most part of the paper analyzing cost and supply side, dealing with demand side less significantly.

Consumer preference in demand side is the most important factor in determining the direction of broadband access market change. In the saturated broadband access market, consumers get more power and take initiatives in choice because of the increased technological maturities and harsher competition between service providers.

Therefore, in this paper, we attempt to predict the saturated broadband access market in the near future, when new convergence access technologies and additional services are introduced, based on quantitative information about consumers' preferences for important attributes composing broadband access service. By doing this, our research can supplement other valuable previous researches related to broadband access market including Tongia (2004) sufficiently.

To get information about consumers' preferences, we use conjoint analysis in which respondents are asked to choose or rank hypothetical alternatives. For estimation, mixed logit model based on Bayesian approach with Gibbs sampling is used. Since mixed logit model can reflect the degree of the heterogeneity in consumers' preferences, which is significant in the saturated market, it is suited for the purpose of our research.

From the empirical estimation results, we examine how consumers prefer the important attributes of broadband access services, how much consumers value beneficial features the new convergence access technologies offer, and to what extent heterogeneity in consumer preferences exists. Based on this information, some implications for business strategies, policy and regulation are presented.

This paper is organized as follows: in section 2, market situation in Korea and features of each access technology are described. In section 3, main issues of this research are presented, and in section 4, methodology, model specification, and survey data are explained briefly. In section 5, estimation results are shown, and in section 6, main findings and implications related to the main issues are given. Finally, section 7 ends up with concluding remark.

2. Residential Broadband Market Situation in Korea and Features of Access technologies

Market Situation

Residential Broadband access market in Korea is reaching saturation, and stopping the previous fast growth. [Figure 1] exactly shows this saturation.

[Figure 1]

In the firms' aspects, KT is taking a market dominating share of 61 %. Next to the KT, Hanaro telecom, merging the third company, Thrunet, is the second biggest

company. Service Operator(SO)s are increasing their market shares gradually by offering bundle between cable TV and broadband access service at very low price, and Triple play service (TPS) with ease. In brief, this saturated broadband market is confronting an age of keener competition than ever before.

In the aspects of access technologies, xDSLs are occupying most part of the market, and cable is getting more subscribers thanks to the low usage rate. Additionally, for apartment houses built lately, apartment LAN, a pseudo FTTH technology, is getting quite a number of subscribers.

Access Technologies

In this section, various access technologies are compared mainly by meaningful factors for consumers, based on current (2005) technological level. Considered access technologies are, xDSL, Cable, PLC, WLAN, Satellite³, and factors are data transfer speed, quality stability (or degrade), new beneficial features offered by convergence access technologies, and other miscellaneous factors.

[Table 1]

Among access technologies, xDSL and Cable are mature and stable in terms of technological development. xDSL which includes ADSL, VDSL, and other types of DSLs, is very suitable for the dense residential environment like Korea. Cable is generally provided by local SOs, while big company such as Hanaro telecom, also offers it. The biggest advantage of cable is that it is easy to be offered as a bundle with TV service at very low price. Satellite technology is very inferior in data transfer speed and other features to other access technologies. Therefore, it does not make a big market. However, since it can provide broadband access service to anyplace where the satellite can cover, it is one of the practicable alternatives dissolving digital divide with low cost.

Among new convergence access technologies, PLC provides broadband access over power line, owing to the development of data transmitting technologies, and effort of electricity supplier to find new profit source. Since power lines exist

³ Apartment LAN, a pseudo FTTH, did not make a big market at the time of our research, and also users are restricted to those living in apartment house built very recently. Therefore, until now, it is rather a matter of supply side than that of consumer side. However, sooner due to the high quality, it will become one of the major broadband access technologies. Consequently, in this research, it was not considered seriously, which may become a weak point.

almost everywhere in the house, cost for establishing the network is very low. Also, it is available for consumers to connect multiple terminals without any burdensome wire, which is required for xDSL or cable. In addition, due to the ubiquity, it has less restriction on location to connect the terminal to the network, compared with xDSL or Cable. However, unfortunately, it needs a lot of improvement in data transfer speed and quality stability to compete against the current stable access technologies.

WLAN also has new beneficial features as PLC has. Additionally, since it has wireless connectivity, it gives moderate mobility and makes consumers free from burdensome wires more efficiently. Therefore, depending on technological development, it will become possible to expand the area of broadband access to the wireless market, and potentially be able to change the whole broadband access market. For example, WLAN can cause dramatic change for the wireless telecommunication sector if it is combined with VoIP. Like PLC, WLAN also has many issues related to whether the usage of free frequency range, 2.4 GHz, should be paid for, and whether the permission for bundle with other broadband accesses such as xDSL or mobile broadband can be justified. Again, it needs a lot of improvement in data transfer speed and quality stability in addition to security and imperfect mobility.

3. Main Issues

In our research, following issues are considered mainly.

- *Consumer preferences for important attributes of broadband access service in the saturated broadband market*
- *Valuation on the novel beneficial features of new convergence access technologies*
- *Degree of heterogeneity in consumer preferences in the saturated broadband market*
- *Proper business strategies in the saturated broadband access market*
- *Proper Policy or Regulation in the saturated broadband access market*

Consumer preferences for important attributes of broadband access service in the saturated broadband market

How much consumers value important service attributes (data transfer speed, quality stability, monthly cost, access technologies, and additional services) in the saturated broadband access market, will help service providers to set their strategies in R&D and marketing, which is critical for their survival and further growth. Simultaneously, it will be a key guideline for policy makers to set the direction of policies and regulations proper for this saturated market.

Valuation on the novel beneficial features of new convergence access technologies

To know whether the new convergence access technologies can affect the saturated market, and how much they will, we should examine how much consumers value the new beneficial features such as wireless connectivity, less restriction on location to connect the terminal, and availability to connect the multiple terminals. Also, to evaluate the competitiveness of convergence access technologies more practically, it should be concerned whether the amount of consumers' valuation on those beneficial features is enough to overcome the inferiority in data transfer speed and quality stability at current technological stage.

Degree of heterogeneity in consumer preferences in the saturated broadband market

Whether consumer preferences are heterogeneous or homogeneous is important to determine the direction of business strategies. Especially, in saturated market with keen competition, differentiating services from others is very important for survival and further growth.

Proper business strategies in the saturated broadband access market

Service providers confront very uncertain situation because of the keen competition and introduction of new convergence access technologies and additional services. Under this condition, business strategies based on obtained implications for previous issues have special meaning for their survival and further growth. For example, from the results on the consumer preference for important attributes of broadband access service, business strategies such as which attribute should be improved prior to the others, or what kind of bundle is proper between specific additional service and access technology, or to what extent and to what

direction the provider should differentiate themselves from others, can be induced.

Proper Policy or Regulation in the saturated broadband access market

Policy makers also face new situation in the saturated market. Rather than focusing on previous policies for promoting the growth of the market, they should focus on establishing fair competition environment, promoting innovation by introducing new technologies, and seeking new driving force for further growth, while maintaining a neutral point of view to technologies. Like business strategies, policy and regulation implications based on the results from issues above have important meanings.

4. Methodology

In our research, PLC, AMR, TV (IP-TV) service which have not been introduced into the market yet, are dealt with. Therefore, conjoint analysis, suitable for new product, is used. In conjoint analysis, respondents are asked to choose or rank hypothetical products or services composed of many attribute levels. By using estimation methodologies, consumer preferences are estimated quantitatively.

In our research, respondents are asked to rank alternatives. The reason is that it reduces the sampling cost by obtaining more information from each respondent compared with 'only one' choice. Generally, rank-ordered logit model is used for estimation. However, since it can not reflect the heterogeneity of consumer preferences, mixed logit model is used instead. In mixed logit model, each estimated coefficient reflecting consumer preferences has its own distribution and is able to represent the correlation both between coefficients and between alternatives. Therefore, it is free from the disadvantages of rank-ordered logit model in fixed coefficient for all consumers and ratio between choice probabilities of two alternatives being independent from other irrelevant alternative (IIA assumption).

To estimate mixed logit model, there are two approaches, one of which is classical approach (Brownstone and Train (1999), Layton (2000), Calfee *et al.* (2001), and Carlsson (2003)), and the other Bayesian approach with Gibbs sampling (Allenby and Rossi (1999), Chiang *et al.* (1999), Huber and Train(2001), and Train (2003)). We use Bayesian approach because of some advantages in estimation compared with classical approach. We can avoid direct evaluation of the

nontrivial likelihood function that are required with classical methods, and desirable estimation properties, such as consistency and efficiency, can be attained under more relaxed conditions using Bayesian procedures compared with classical methods. Finally the results of Bayesian procedures can be interpreted simultaneously from both the Bayesian and classical perspectives, drawing on the insights afforded by each tradition (Train, 2003, Train and Sonnier, 2003).

Model Specification

Assume that individual i faces a choice among J alternatives in each of T choice sets in a survey and the individual is asked to rank the alternatives in order of preference. We can represent the person's utility from alternative j in choice set t as follows:

$$U_{ijt} = \beta_i' X_{ijt} + \varepsilon_{ijt}$$

where X_{ijt} is the vector of attributes associated with alternative j , β_i is a vector of unknown parameters (the coefficients of attribute vector X_{ijt}), and ε_{ijt} is a random disturbance. The random disturbance (ε_{ijt}) is assumed to have an independent and identical extreme value distribution. The coefficients vector, β_i , is assumed to be distributed normally across the population with mean vector b and variance-covariance matrix W (unbounded normal distribution).

In this contingent-ranking conjoint analysis, we can adopt the same procedure as in Train (2003) for Bayesian estimation. But there is a minor change that we need to calculate the probability of the individual's sequence of rankings, which is used in the Metropolis-Hasting (M-H) algorithm, instead of the probability based on the response of the most preferred choice as in Train (2003). The probability of person i 's observed sequence of rankings is:

$$L(r_i = \{r_{i1}, \dots, r_{iT}\} | \beta) = \prod_{t=1}^T \prod_{j=1}^{J-1} \frac{e^{\beta' X_{ijt}}}{\sum_{k=j}^{k=J} e^{\beta' X_{ikt}}}$$

where $r_{it} = \{r_{i1t}, r_{i2t}, \dots, r_{iJt}\}$ is the vector of individual i 's ranking responses of the choice sets in descending order of preference in period t .

Since the unbounded normal distribution is not appropriate for the coefficients of monthly cost and desirable attribute that is valued by all customers, we assume the other distributions for those kinds of coefficients. An unbounded normal distribution for the coefficients implies that some share of the population actually prefers higher monthly cost, and there are users who dislike the higher level of "desirable attributes" without additional cost. In this application, we assume that the coefficient of monthly cost has a log-normal distribution and the coefficients of the attributes such as AMR, VoIP, TV service, and data transfer speed have normal distribution censored from below at zero. Reversely, since users do not prefer the unstable quality, we assume quality stability (actually, it was shown as the degree of quality degrade in survey) to have normal distribution censored from above at zero.

The transformation for lognormal and normal censored from below at zero are $C = \exp(\beta)$ and, $C = \max(0, \beta)$ respectively. Normal distribution censored from below at zero is useful for coefficients of an attribute to which some customers are indifferent and other customers find desirable (Train and Sonnier, 2003).

When a transformation is used for bounded distributions of a coefficient, utility is specified as follows:

$$U_{ijt} = C(\beta_i)'x_{ijt} + \varepsilon_{ijt}$$

where C is a transformation.

There are minor changes in the estimation procedure with this transformation. The probability of the individual's sequence of ranking, which is used in the M-H algorithm, should be changed based on transformed β_i (Train and Sonnier, 2003).

Survey and Data

Survey was conducted in 2005, for 500 respondents aging from 20 to 60, living in metropolitan (Seoul, 186 respondents), urban(Daejeon, 232 respondents), and rural (country sides, Yangchon Myeon, Gochon Myeon, Shilchon Myeon in Kyunggi-do,

totally 82 respondents) regions. These regions are quite different in population density⁴, and accessibility⁵. To guarantee the reliability of complex conjoint survey, 1-to-1 interview method by experts was used. [Table 2] shows attributes, their levels, and some brief descriptions. They are access technologies including convergence access technologies, additional services, data transfer speed, quality stability (degrade), monthly cost, all of which reflect the main issues referred to in section 3 appropriately.

[Table 2]

Note that beneficial features of convergence access technologies such as wireless connectivity, less restriction on location to connect the terminal, and availability to connect multiple terminals without any burdensome wire, are not included in the conjoint card directly. The reason is that since each access technology has its own beneficial features or not, and can be categorized by the existence of them, consumer preferences for each access technology can reflect the consumers' valuation on beneficial features.

Of course, to achieve this, respondents should be aware of whether each access technology has those beneficial features, and what kind of special beneficial features that access technology has. Therefore, we categorized each access technology by their special features in survey, and asked interviewers to explain these features to the respondents clearly.

We used fractional factorial design to choose totally 25 cards. Then we divided them into 5 sets with 5 cards, and accordingly, the respondents are asked to rank the cards from 1 to 5, and to repeat 5 times. For more information, see Appendix.

5. Estimation Results

To estimate the coefficients of dummy variables for access technologies and additional services, satellite, no additional service were chosen as base attribute levels. Accordingly, coefficients for access technologies and additional services represent the relative consumer preferences..

⁴ Metropolitan area (Seoul) : 16,994 persons/km² (very dense) Urban area (Daejeon) : 2,666 persons/km² (moderately dense) Rural area (countryside in Kyunggi) : Estimated under 762 persons/km²(Kimposhi) for Yangchon and Gochon, under 326 persons/km² (Kwangju gun) for Shilchon (not dense)

⁵ In rural area, some kinds of access technologies such as ultra high speed VDSL or Cable access are not available to some degree

For estimation, in our research, 20,000 Gibbs sampling draws were conducted. Again, the first 10,000 draws were discarded, and among next 10,000 draws, 1,000 draws of every 10 iteration were used for inference. Mean of these 1,000 draws for b and diagonal elements of W are shown in [Table 3].

[Table 3]

From the Bayesian perspective, these are posterior means of b and the diagonal elements of W ; from the classical perspective, these represent the estimated mean and variance of the β_i s in the population. In our research, we adopt the classical perspective to interpret the results.

From [Table 3], we can see that the estimates are generally significant. Also, all the variances (W) are significantly large values compared with means (b), which means that there is a large degree of heterogeneity in consumer preferences. This can justify our using mixed logit model.

Because b and W are mean and variance of β_i in the population according to the classical perspective, the distribution of the coefficient for each variable (attribute) is obtained through simulation on the estimated values of b and W . 2,000 draws of β_i were taken from normal distribution with mean equal to the estimated value of b and variance equal to the value of W . Each draw of β_i was then transformed to obtain a draw of coefficients. [Table 4] shows means and variances of these coefficients.

[Table 4]

The result shows that variance of monthly cost is very large, which means that quite different patterns of response to price will be found among consumers. Additionally, consumers value the new convergence access technologies such as PLC and WLAN, and TV service generally. Surprisingly, cable, which is the second dominant access technology in the current market, is not preferred even to satellite, and VoIP, which is considered as one of the killer application, is not preferred much as well.

On the other hand, the willingness-to-pays (WTPs) which are welfare change estimates for changes in attributes are shown also in [Table 4].

Here, again WTP for TV service is very high, so WTP for guaranteeing quality stability is. Also, in general, WTPs for additional services are large compared with

those for access technologies, emphasizing the importance of offering bundle service in saturated broadband access market.

To analyze the distributions of coefficients further, we estimated the share of respondents who prefer or dislike some attribute levels, and who are indifferent, as shown in [Table 5]

[Table 5]

TV service is valued very much by a large portion of the consumers, and it will be a very important killer application for service providers to make more profit or prevent consumers from switching to other services. Meanwhile, VoIP is not valued much by most consumers.

For quality stability, a large proportion of consumers get disutility from the quality degrade. Oddly, for data transfer speed, there are quite a large number of consumers who are not sensitive to the increase of data transfer speed by 1 Mbps.

An additional advantage of using mixed logit model is that it can represent the correlation between coefficients or marginal utilities of the attribute levels so that it can also represent a more realistic substitution pattern. [Table 6] shows those correlations between attribute levels.

[Table 6]

From [Table 6], consumer preferences for WLAN and xDSL are highly correlated, and consumer preferences for all additional services are also highly correlated. This information may help the differentiated business strategies.

6. Discussion and Implications

How do consumers prefer the important attributes of broadband access services in the saturated broadband access market?

In this saturated broadband access market, consumers are so price-sensitive. Despite the low preference for cable, recent high growth rate of SOs with low price supports it. From the preference order of WLAN, PLC, xDSL, Satellite, and Cable, it is revealed in this study that consumers have positive attitude toward the convergence access technologies, and it seems that there will be not much lock-in

to the previous access technologies themselves.

And it is revealed that 64.5 % consumers prefer additional services being bundled to services without any additional service. However, among additional services, VoIP is not preferred so much. It seems that in the saturated broadband access market, due to the high level of telecommunication infrastructure and low price for fixed telecommunication, VoIP may not attract general consumers by itself. Meanwhile, from the results of correlation, it can be preferred when it is bundled with other additional services, which means it should be provided as a bundle with other additional services simultaneously. Also, it is revealed that consumers have so high WTP for TV related service that it will become the most important killer application and in the broadband access, and that convergence between telecommunication and broadcasting will be realized surely in the near future on the broadband access services. Since AMR has quite high WTP as a bundle, it can add the potential competitiveness of PLC due to advantages in technological side and cost side as well.

Although consumers have rather small WTP for incremental increase of data transfer speed by 1Mbps, when the data transfer speed reaches very high level such as 50~100 Mbps, which is very likely to happen soon, the amount of total WTP for data transfer speed will become very large. Accordingly, it plays a very significant role on consumers' choice. However, the point that should not be overlooked is that consumers also value the quality stability very much in addition to data transfer speed. From the estimated results, on average, quality degrade by 1 level can offset the WTP for increase of data transfer speed by 2.36 Mbps. That is to say, while consumers value the increase of data transfer speed very much, they may get much disutility from quality degrade at the same time, which is very likely to occur when the data transfer speed is increased to a large degree for some broadband access services.

How much do consumers value the new beneficial features of convergence access technologies? And how can the valuation affect the saturated broadband access market?

As mentioned in section 4, consumers' valuation on new beneficial features of convergence access technologies is inferred from the estimation results on consumer preferences for access technologies, rather than directly estimated. From estimation results, convergence access technologies, WLAN and PLC, are

preferred to xDSL, Cable, and satellite on average. Also, WLAN with one more clear beneficial feature, wireless connectivity, is preferred to PLC. From these results, we can know that less restriction on location to connect a terminal, availability to connect multiple terminals without any burdensome wire, and wireless connectivity are valued by consumers. As a result, in virtue of these beneficial features, it is clearly confirmed that new convergence access technologies have their own potential competitiveness from the perspective of consumers.

However, new convergence access technologies are inferior in data transfer speed and quality stability, which are considered very important by consumers, to the extant stable access technologies. At current technological level, for quality stability, the difference between convergence access technologies and the extant access technologies is at least over 1 level, and for data transfer speed, difference is only admissible for some limited number of services which is old-fashioned. To consider this, the relative amount of disutility from these disadvantages may be larger than that of additional utility from the new beneficial features. Consequently, for the time being, when new convergence access technologies are being introduced into this saturated broadband access market, it seems that they may not affect the market to a large degree for themselves, because the primary attributes for consumers' choices for broadband access services are still data transfer speed and quality stability, not the additional, beneficial features from convergence access technologies.

Are consumer preferences heterogeneous in the saturated broadband access market? and if so, to what extent are consumer preferences heterogeneous?

From the estimation results, it is confirmed that in this saturated market, consumer preferences are highly heterogeneous, and especially for monthly cost. On average, sensitivity to monthly cost is very high, whereas due to the large variation, some consumers may be not so price-sensitive. This can emphasize the importance of differentiated business strategies.

On the other hand, when the magnitude of mean and variance are compared, the extent of heterogeneity differs between each attribute in that relative to the preferences for other attributes, preference for data transfer speed and quality stability are less heterogeneous. It means that the way in which consumers consider those attributes is similar. Consequently, this result of less heterogeneity

emphasizes the previous implication that except for the prices, for the time being, the most important features of the broadband access services are still data transfer speed and quality stability.

What will be the proper business strategies for service providers in the saturated broadband access market?

[Table 7] shows the summarized implications from previous issues, some of which are helpful to induce proper business strategies. In this section, based on these implications, some business strategies are being proposed.

[Table 7]

First of all, current prevailing strategies of lowering price and increasing data transfer speed may work well and look inevitable. However, they may not help very much increasing profits since to increase data transfer speed much investment is required to upgrade the network and lowering price reduce the profit. To complement those strategies, managing additional differentiated strategies parallel may become more profitable. For example, maintaining a moderate data transfer speed, while guaranteeing quality stability, and pricing a little bit more can be one of the considerable options. From estimation results, since there are a group of consumers who have high WTP for guaranteed quality stability and less price sensitivity, it seems reasonable.

Next, for the time being, convergence access technologies are better to be bundled as a complementary “last-1-mile” access to the other mature access technologies or to be positioned for a niche market service. Especially, for xDSL service providers, if WLAN can be improved to the moderate technological level and it does not add too much monthly cost, bundle between xDSL and WLAN may become potentially competitive since they show high positive correlation in consumer preferences.

Since consumers prefer the existence of additional services in general (64.5%⁶), bundle offering will become an inevitable choice for service providers in this saturated market. However, since the extents of preferences for additional services are quite different, a different approach to each additional service is desirable. Since VoIP alone is not valued much in the saturated broadband access market with

⁶ As 35.5 % consumers prefer “no additional service”, 64.5% consumers prefer the existence of additional services regardless of what it is.

high level of telecommunication infrastructure, while being preferred when other additional services are bundled together⁷, it should be provided as a form of bundle such as Triple Play service or more(ex. QPS). AMR has been on doubt whether there is any incentive for consumers to use it, although it will surely help the electricity power supplier managing the power supply effectively and reducing the cost for reporting power usage. However, from our results, there are some consumers who are willing to pay for it. Maybe the primary reason is that recently security problem is getting more and more serious. On the other hand, AMR is technologically conformed to PLC very well compared with other access technologies. Therefore, in our research, it is found that bundle between AMR and PLC may be a good choice both from consumers' side and electricity power suppliers' side. Bundling TV service is necessary because many consumers have high WTP. Also, this shows another possible future that the main terminal for using broadband access service can change from desktop PC to TV to some degree. Therefore, this possible future trend should be considered as well for service providers. On the other hand, now bundling TV service with broadband access service is allowed only for cable service providers in Korea. Whether it is allowed for xDSL or PLC providers as well can determine the competitiveness of them. It is related to the policy or regulation, so it will be discussed later in more detail. From technological aside, to provide TV service with high quality requires high data transfer speed (at least over 6 Mbps) or large bandwidth, which is a bottleneck of PLC or low rank services of xDSL(ex. ADSL light with 1~2 Mbps). Different from them, cable does not suffer from this problem. So, for the time being, cable will enjoy the benefit from bundle with TV service.

What will be the policy and regulation implications from the consumer preferences in the saturated broadband access market?

Finally, policy and regulation implications will be presented according to the next three issues.

- *Transition of significant market power from other industries & Bundle offering by the incumbent dominant service provider*
- *Guarantee of quality stability*

⁷ from result on preference correlations in [Table 6], it is revealed that VoIP is preferred when consumers prefer TV and AMR.

- *Approval of providing TV service equivalently*

Transition of significant market power from other industries

PLC enables electricity providers to enter into the telecommunication market. Generally, electricity providers have significant market power, so there have been many concerns about its transition. However, from our results, PLC is not expected to affect the broadband market to large extent. Therefore, too strict ex-ante entry disapproval by regulation may not be required. Rather, if relieving the concentration of the market is a primary concern, allowing the entry or supporting PLC to be improved in data transfer speed or quality stability is more desirable. Additionally, since beneficial features certainly have the positive effect on consumer welfare, if incumbent broadband access providers want to use it as a “last mile” solution, even though they have significant market power currently, it may be allowed.

With respect to bundle offering by the dominant service provider, although at present, bundle between WLAN and xDSL is not so popular, the future of that bundle is likely to be different, considering recent technological progress and WLAN’s potential. Considering the high correlation between preferences for xDSL and WLAN, and significant market power of providers of that bundle, it needs to be examined whether some policy or regulation is required. In addition, appropriating frequency domain around 2.4 GHz free of charge should be discussed sooner.

Guarantee of quality stability

From our results, it is clearly seen that consumers feel quite large disutility from the frequent quality degrade. Especially, realized data transfer speeds for many broadband access services are reported to be quite different from the noticed or advertised ones in catalog by many reasons, which leads to dissatisfaction⁸. Under this circumstance, in order to increase consumer welfare, and to drive motivation for innovation, it may be desirable to report the comparison between realized data transfer speed and that on catalog officially or to impose some duties on quality stability (like the restriction on guaranteeing quality stability of VoIP). However, to

⁸ There is an official website called *Benchbee* that reports the realized data transfer speed and the ratio of quality degrade for each broadband access service.

consider current stagnation, keen competition, and financial status of service providers in the saturated market, too strict duties on quality stability can depress the motive to improve and compete for data transfer speed. It may not be desirable in the sense that increasing data transfer speed is one of the most feasible ways to increase the consumer welfare. Rather, there is a certain economic incentive for service providers to offer services guaranteeing quality stability in pursuit of consumers' quite high WTP for quality stability. Accordingly, rather than harsh regulation on guaranteeing quality stability, it will be more desirable to report the real data transfer speed officially and regularly to the public on fair conditions, and to let the quality stability problem solved in the market with sufficient incentives, through consumers' choices.⁹ If some service provider succeeds in guaranteeing proper quality stability, and the public is well informed of this fact by regular and official report on quality stability, this innovative provider will win the market. Again, this will promote the other providers' efforts to improve the quality stability, increase the degree of competition, and finally increase consumer welfare effectively, which is suited for the aim of policy and regulation.

Approval of providing TV service equivalently

In Korea, it is being debated very hotly whether TV service is allowed for other broadband access networks in addition to cable. Now it is expanded to the conflicts among various interest groups such as organizations and political groups related to telecommunication and broadcasting convergence. Although this argument itself is beyond our research, one thing sure is that from our results, at least from the consumers' views, if TV service is provided through various access technologies, consumer welfare is increased owing to the diversification of choices meeting heterogeneous needs.

However, it should be warned that if there is no difference, it can cause a redundant investment of social resources. Also, equivalent regulation on various TV services should be imposed in advance. Now, for cable to provide TV service, many kinds of strict regulations exist, while if TV service is allowed for other access, there is no such strict regulation or if any, less regulation. In addition, SOs

⁹ There is already an official system by government called SLA which imposes some guarantees on data transfer speed. For example, under that system, for ADSL light service (1~2Mbps), if realized data transfer speed does not reach at least 0.5 Mbps, service provider should give the refund by 30 % of the price. However, it is limited in the sense that it is not applied to new high speed services (over 50Mbps), and there is no official report that not many consumers know the real data transfer speed and the existence of that system.

providing TV service through cable at present are poor compared with xDSL or potential PLC providers. So, environment for fair competition should be premised by relaxing strict regulations on SOs to the same level as other potential TV service providers first, and then approving other accesses' TV service.

7. Conclusion and Summary

In our research, based on quantitative information about consumer preference, we attempt to predict the future of the saturated broadband access market when new convergence access technologies and additional services are being introduced. Also we attempt to suggest some requirements for business strategies, policy and regulation. Specifically, to achieve this purpose, we examine: 1) consumer preferences for the important attributes of broadband access service 2) consumers' valuation on the new beneficial features of convergence access technologies 3) heterogeneity in consumer preferences in saturated broadband access market.

From the estimation results, it is found that while consumers clearly value the beneficial features of the new convergence access technologies, the degree of the valuation is not enough to overcome the inferiority in data transfer speed and quality stability at current technological level, which leads to insufficient competitiveness against the other mature access technologies. As a result, it can be concluded that for the time being, they may not affect the saturated broadband access market to a large degree. For additional services, it is revealed that consumers prefer the existence of additional services, and have very high willingness-to-pay for TV related service, while do not for VoIP. This means that in saturated market with high level of telecommunication infrastructure, rather than VoIP, TV related service is more likely to become the key additional service. Accordingly, discussion about allowance for TV related service on every path is urgent, especially in Korea. Also, it is revealed that consumer preferences are highly heterogeneous, while consumer preferences for data transfer speed and quality stability are less heterogeneous.

Our research is unique in the sense that considering previous mature technologies, new convergence access technologies, and additional services simultaneously, we attempt to analyze the future of the broadband access market based on quantitative information about consumer preferences, especially in the saturated broadband access market. According to this uniqueness, our results can be considered as one of the valuable future guidelines reducing uncertainties in the markets which are

still growing or about to face saturation, and the introduction of new convergence access technologies or additional services.

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Factors	Access technologies				
	xDSL	Cable	PLC	WLAN	Satellite
Data transfer speed ^a	1~ 50 Mbps	1~30 Mbps	1~4 Mbps	4~6 Mbps	1 Mbps
Quality stability	high	moderate	poor	poor	poor
Location for connection	restricted	restricted	less restricted	less restricted	restricted
Connection of multiple terminals	with wires	with wires	without any wire	without any wire	with wires
Wireless connectivity	no	no	no	yes	no
Miscellaneous	<ul style="list-style-type: none"> ▫ suitable for dense regions ▫ 80 % users use light ADSL(1~4Mbps) 	<ul style="list-style-type: none"> ▫ not so stable in the dense regions ▫ usually bundled with cable TV ▫ very low price 	<ul style="list-style-type: none"> ▫ recent development of 200Mbps modem ▫ good match with AMR 	<ul style="list-style-type: none"> ▫ need for Access point machine ▫ poor transparency through walls 	<ul style="list-style-type: none"> ▫ need for plate antennae ▫ only used in some alienated regions

[Table 1] Comparison between access technologies by factors important for consumers

a: For data transfer speed of each access technology, there are many varieties of services. And those ranges shown here based on the catalogs of service providers in 2005

Attribute	Attribute Level
Monthly Cost (won (U.S \$) ^a)	20,000 (19.26), 40,000 (38.53) , 60,000 (57.80)
Access Technology	XDSL
	CABLE
	PLC
	WLAN
	Satellite
	No additional service
Additional Service	AMR
	VoIP
	TV service ^c
Quality Stability ^b (times of degrade per hour)	0, 2, 4
Data Transfer Speed (Mbps)	1, 5, 15, 30

[Table 2] Attribute and attribute levels used in survey

a: U.S \$ 1 = 1080 won (in January 18th , 2005)

b: In survey, quality stability was shown as times of degrade per hour

c: TV service includes IP-TV, Cable TV or other forms of TV related services depending on what access technology is used

Variable	Mean	of β (b)	t-value	Variance of beta (W)	t-value	
Mon_Cost	-1.459	*	-14.653	2.639	*	8.760
XDSL	0.204	*	3.302	0.709	*	6.819
CABLE	-0.214	*	-3.799	0.573	*	7.378
PLC	0.312	*	5.649	0.622	*	7.058
WLAN	0.354	*	5.559	0.729	*	6.226
AMR	-0.712	*	-2.361	2.276	*	3.995
VOIP	-2.194	*	-5.455	5.039	*	3.711
TV	0.237	**	1.960	1.939	*	4.055
DEGRADE	-0.214	***	-1.927	0.864	*	3.929
SPEED	0.013	*	2.714	0.069	*	9.384

[Table 3] Estimation results of b and W

*: significant at 1 % level

**: significant at 5 % level

***: significant at 10% level

Variable	Mean of $C(\beta)$	Variance of $C(\beta)$	Mean of WTP ^a (10,000 won (\$))	Standard Deviation of WTP
Mon_Cost	-0.8329	5.7196	----	----
XDSL	0.2189	0.7265	1.101(10.2)	6.290
CABLE	-0.2084	0.5898	-0.991(-9.2)	5.546
PLC	0.3264	0.5891	1.451(13.4)	5.740
WLAN	0.3604	0.7402	1.980(18.3)	6.578
AMR	0.3275	0.4250	2.003(18.5)	6.360
VOIP	0.1819	0.3535	1.035(9.6)	4.979
TV	0.6750	0.7625	3.480(32.2)	7.094
DEGRADE	-0.2693	0.2065	1.267(11.7)	3.305
SPEED	0.1085	0.0234	0.553(5.1)	1.179

[Table 4] Mean and variance of transformed coefficients, $C(\beta)$, and mean and standard deviation of WTP

a: WTP is calculated as negative ratio of each transformed coefficient for specific attribute level to transformed coefficient of Monthly cost draw by draw

Attribute level	Share of consumers with preference(or dislike)		Share of consumers with indifference		Share of consumers with the highest preference	
Mon_Cost	Dislike	100.0%		0.0%		---
XDSL		59.8%		0.0%		20.5%
CABLE	Preference	39.1%	Indifference	0.0%	Among	11.6%
PLC	compared with	66.8%	compared with	0.0%	access	29.8%
WLAN	Satellite	66.9%	Satellite	0.0%	technologies	26.6%
Satellite		----		----		9.4%
No Additional Service	Preference	----	Indifference	----	Among	35.5%
AMR	compared with	32.3%	compared with	67.8%	additional	13.9%
VOIP	No Additional Service	15.9%	No additional Service	84.2%	services	3.3%
TV		58.9%		41.1%		47.4%
DEGRADE	Dislike	40.7%		59.3%		---
SPEED	Preference	53.0%		47.1%		---

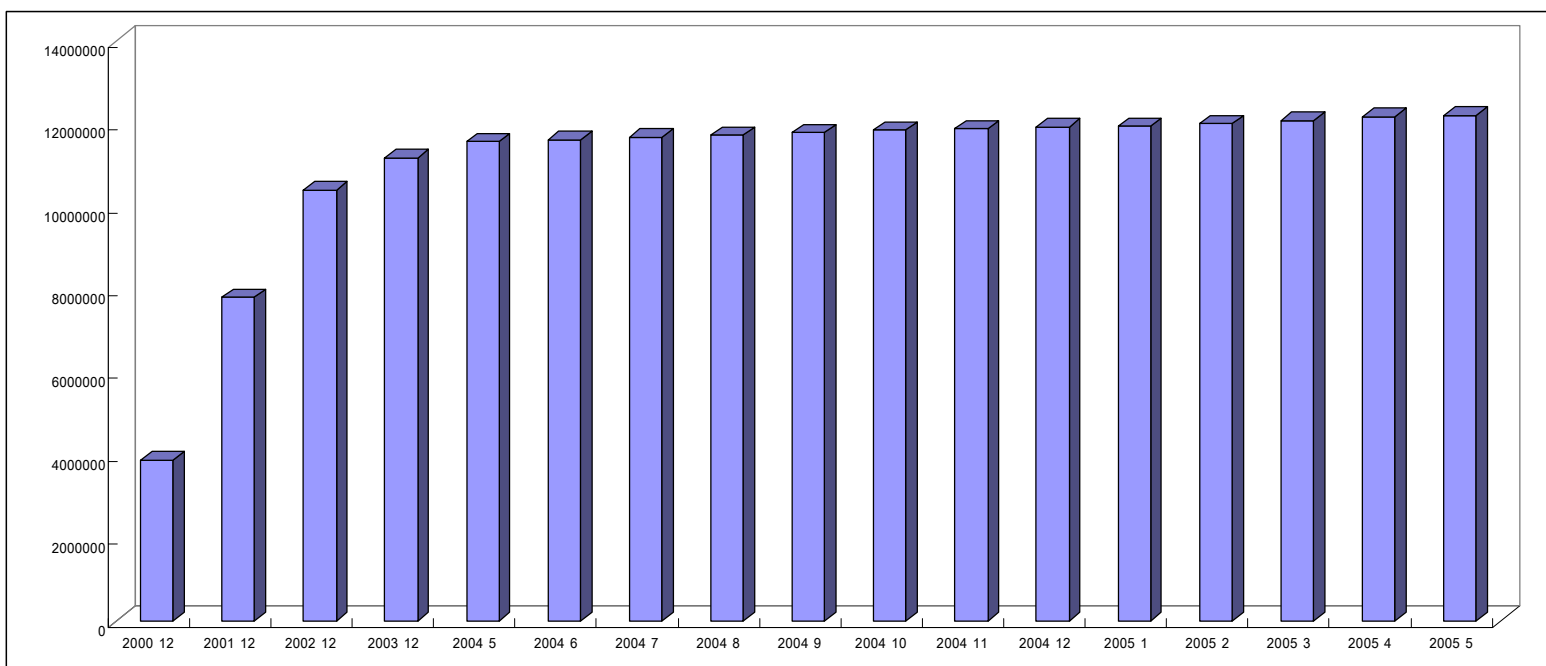
[Table 5] Share of Population for coefficients

Mon_Cost	1									
XDSL	0.0056	1								
CABLE	-0.0222	0.3355	1							
PLC	0.0358	0.3403	0.0342	1						
WLAN	-0.0537	0.6266	0.266	0.3914	1					
AMR	-0.1231	0.1816	-0.091	0.0876	0.2628	1				
VOIP	-0.0564	0.2304	-0.0747	0.1905	0.2336	0.5859	1			
TV	-0.0135	0.2932	-0.1967	0.3487	0.3595	0.4603	0.5035	1		
DEGRADE	0.0594	0.1937	-0.0266	0.4265	0.2074	0.0236	0.1896	0.2778	1	
SPEED	0.0413	0.0808	-0.2372	0.2119	0.1103	0.0456	0.1296	0.2303	0.1964	1

[Table 6] Correlation between preferences for attribute levels

Issues	Obtained Implications
Preference for attributes	<p>Large sensitivity to monthly cost on average</p> <p>Relative preference for convergence access technologies to other mature access technologies</p> <p>Existence of preference for additional services</p> <p>Especially large WTP for TV service</p> <p>Rather small WTP for VoIP</p>
Valuation on beneficial features	<p>Prevailing importance of both data transfer speed and quality stability</p> <p>High positive correlation between preferences for all additional services</p> <p>High positive correlation between preferences for xDSL and WLAN</p> <p>Clear valuation on beneficial features of convergence access technologies</p> <p>Potential competitiveness of convergence access technologies</p> <p>Insufficient valuation on beneficial features compared with inferiority in data transfer speed and quality stability at current technological level</p> <p>Less competitiveness of convergence access technologies for the time being</p>
Heterogeneity in preference	<p>Existence of large heterogeneity in consumer preferences in general</p> <p>Especially large heterogeneity in consumer preferences for monthly cost</p> <p>Less heterogeneity in consumer preferences for data transfer speed and quality stability</p>

[Table 7] Helpful implications from previous issues for business strategies, policy and regulation



[Figure 1] Change in number of broadband subscribers in Korea

Appendix. Example of conjoint cards used in the survey

Card Number	1	2	3	4	5
Access technology	xDSL	PLC	WLAN	Cable	Satellite
Additional service	No additional service	AMR	VoIP	TV service	No additional service
Quality degrade	0 time per hour	4 times per hour	2 times per hour	2 times per hour	4 times per hour
Data transfer speed	30 Mbps	5 Mbps	15 Mbps	5 Mbps	1 Mbps
Monthly cost	40,000 won (38.53 \$)	20,000 won (19.26 \$)	60,000 won (57.80 \$)	20,000 won (19.26 \$)	40,000 won (38.53 \$)
Rank	()	()	()	()	()