

# A Study on the effect of Spectrum difference between Cellular and PCS from Mobile Telecommunication Customer's perspective

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## 국문요약

국내 이동통신 서비스 제공업체는 하나의 셀룰러 사업자, 두개의 PCS 사업자가 있다. 국내 이동통신 시장의 특징으로서 셀룰러 사업자가 가입자 기준 시장 점유율 50% 이상을 장기간 점유하고 있다. 또한, 2004년 셀룰러 사업자의 당기 순이익 기준 시장 점유율은 80%를 상회하고 있다. 따라서 이러한 시장 구조의 원인을 규명하는 것은 의미 있는 연구라 하겠다.

셀룰러 사업자가 할당 받은 주파수 대역의 특징으로 망 구축에 투자하는 비용측면에서 우위에 있음을 상기해 보았을 때, 우리는 할당 받은 주파수 대역과 기업 성과에 어떠한 관계가 있음을 유추해 볼 수 있다. 이를 증명하기 위해 우리는 소비자의 관점에서 고객 만족도가 고객 재 가입의향에 긍정적 영향을 끼쳐 소비자의 재가입 행동이 결정되는 연구 모형을 무선인터넷 만족도, 가격 만족도, 부가 서비스 만족도, 통화 품질 만족도, 경쟁사의 이미지를 반영하여 구성하였다. 이 연구모형에 통제변수로서 이동통신사별 할당 주파수 사용 대역이 상이함에 대한 인지를 통제변수로 사용하여 이의 영향을 함께 판별해 보았다.

본 연구의 목적은 1) 이동통신 소비자 재가입 행동을 결정짓는 요인들간 관계를 분석 하고, 2) 할당된 주파수 대역이 소비자 재가입 행동에 미치는 영향을 규명하며, 3) 연구 모형을 구조방정식을 사용하여 검증하는 것이다. 구조방정식은 변인들간의 상호 관계를 밝혀내는데 유용한 방법이라고 할 수 있으므로 본 연구에 적용되었다. 연구의 함의와 한계에 대해서는 본문에서 언급하고자 한다.

**핵심어 :** 이동통신 주파수, 고객만족, 고객유인, 구조방정식(SEM)

## Abstract

The purpose of this study lies in understanding how the spectrum assigned for each mobile operator affects the consumers of mobile service. For this purpose, we have observed the change of path coefficient in the structural equation, using control variables.

However, the structure of the mobile service market in Korea has become fixed. Considering this tendency and the conclusion of this study, the "lock-in effect" occurs seriously in the mobile service market in Korea. It can be explained by the fact that CS(Customer Satisfaction) of the cellular subscribers little affects customer loyalty but the market dominance of the cellular service in the actual market has continued for a long time.

In this study, we figured out a strong prejudice about call quality, which is caused by spectrum difference among competitors. Cellular subscribers tends to believe that call quality of their cellular service is better than that of PCS. In addition, we found that PCS operators can catch customer's retention by investment into network in order to increase call quality.

**Key words :** Telecommunication spectrum band, customer satisfaction, customer retention, SEM

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## I . Introduction

The mobile services market has achieved unprecedented fast growth in the telecommunications market. Korea has also experienced explosive growth over the last 10 years. Looking at the industry size, there were 1 million subscribers in January 1995. However, this increased to 36.5 million subscribers by the end of 2004, or 76% of the total Korean population. Comparing the wire and wireless communication services market, mobile communication subscribers(23.4 million) exceeded that of fixed communication subscribers (21.2 million) in 1999. Sales revenue amount has shown the same trend-1,200 billion won from the wireless communication market and 1,100 billion won from the fixed communication market in 2000.

The mobile services market in Korea is a competitive market in appearance, with a monopoly of cellular service providers and a duopoly of PCS providers, as PCS operators enter the existing mobile service market Cellular service provider occupied 51% and 55% market share respectively in terms of the number of subscribers and sales revenue at the end of 2005. Their market share is as much as 70.5%, when it is based on net income for the year.

Currently, PCS operators insist a worsening of the "tipping" phenomenon, in that more and more subscribers are subscribing to the monopolistic cellular service provider since they have superiority in the spectrum quality, monopolize the best spectrum due to the acquisition and merger of Shinsegi Telecomm, and enjoy the effect of market preoccupation and externality of the network.

On the other hand, the incumbent(cellular service provider) maintains that spectrum efficiency difference between 800MHz and 1,800MHz is 1.2~1.3 times only, contrary to the assertion of new entrances, and argue that eventually no difference will exist since the different radio usage fee has been applied.

There have been many arguments about whether the market monopoly by the cellular service provider stems solely from the endogenous competitiveness difference or exogenous factors, regardless of service provider's choice or efforts. Seong(2004) showed that incumbent' M&A had harmed fair competition in

telecommunication market in Korea. <sup>1)</sup>

Kim et al(2004) argued the tipping phenomenon in the mobile service markets was caused by qualitative difference of the spectrum. Hwang(2004) identified the assigned spectrum caused mobile operators to have different investment cost. Continuous contention is expected over the direct effect of monopolizing the excellent spectrum that has a high quality but low cost.

However, the effect on consumers and the market from the perspective of indirect affect has been overlooked to some extent. That is, the “tipping” phenomenon also exists in the endogenous factors. In other words, the incumbent(cellular service provider) pre-occupied valuable customers like heavy users, and created high customer loyalty and brand image. They spent 2~4 times more on marketing expenses than the late starters because they were better financially equipped, they utilized a membership system that provided better benefits to subscribers, and achieved subscriber lock-in effects through non-price competition.

Therefore, this study is designed to find out that the “tipping” phenomenon of dominant service provider(cellular service provider), which is observed in the mobile services market in Korea, affects the exogenous factors by spectrum superiority and monopoly, as well as endogenous factors by the indirect affect of exogenous factors. For this, we will study how consumer’s recognition of the quality differences in spectrum bandwidth affects customer satisfaction (CS) and customer retention (CR).

Through this study, we can look into the market tipping phenomenon in the mobile service market from the exogenous factors –monopolistic usage of the “good spectrum” bandwidth, as well as the endogenous influence by indirect effects of customer perspectives. It is also expected to provide the base for the government’s policy-making such as strict discriminatory price control against the dominant service providers, from the perspective of fair competition and increasing efficiency in the mobile service market in Korea, and the discriminatory imposition of access fees and spectrum usage fees to create an equal playing field for cellular and PCS providers.

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<sup>1)</sup> On the contrary, Kwon, Nan-hoon (2005) asserted that the tipping phenomenon is weak at theory and actual proof.

## II. Characteristics of Korea mobile telecommunication market and the allocated spectrum

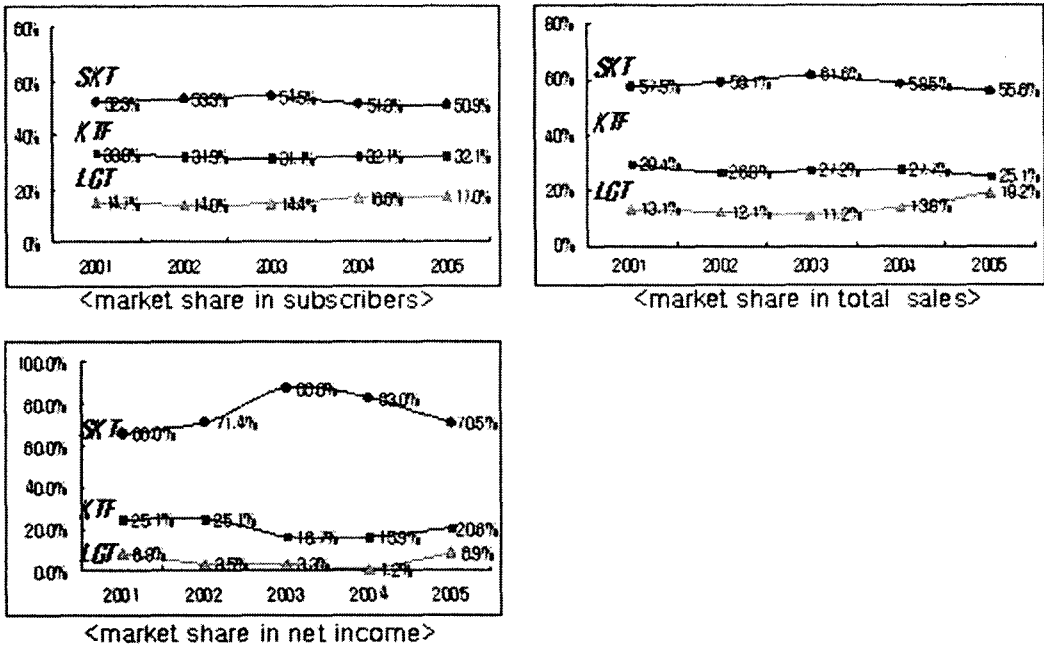
The mobile service in Korea started from a monopolistic system with the government-owned Korea Mobile Telecom (KTM) in 1984. From 1996, between two and five service providers have competed and after several time mergers and acquisitions, SKT monopolize the cellular service market, whereas KTF and LGT form a duopoly in the PCS(Personal Communications System) market.

〈Table 1〉 Changes of mobile operators in Korea

Year	Major Details	No. of Service Providers
1984	KTM starts a mobile service in May	1
1994	KTM is privatized to SK Telecom	1
1996	Shinsegi Telecomm creates duopoly in cellular market in April	2
1997	3 PCS providers KTF, LGT and Hansol start their service	5
2001	KTF acquires Hansol in May	4
2002	Monopolistic cellular market is created on February, when SKT acquires SST	3

As five new service providers started business in 1997, competition to get new subscribers was tough, but resulted in a quantitative increase of subscribers from 6 million in 1997 to 29 million at the end of 2001, 60% of the total population. However, the handset subsidy, distribution channel rebate, and enormous marketing expenses faced by service providers proved a serious financial blow to these new entrants in the market. Eventually, service providers began mergers and acquisitions, with KTF's acquisition of Hansol Telecomm in 2001, and SKT's acquisition of Shinsegi Telecomm in 2002.

One of the permission conditions that the government imposed on SKT, which was a market dominant player, was to reduce its market share based on the number of subscribers from 50% at that time to less than 50%. However, SKT's market share was below 50% temporarily at the time of permission, and shown a steady increase since then. In particular, SKT had a 58.5% market share in 2004 in terms of the sale revenue, and occupied as much as 83% market share, based on the net profit for the year.



〈Figure 1〉 Market dominance indices of the mobile operators in Korea  
 (source: each firm's financial statement)

The natural monopoly of the mobile service industry has been explained as an economy of scale and the presence of indispensable equipment. Various asymmetric controls are imposed on the market dominant players to enhance consumers' convenience and fair competition. To control the predatory or non-predatory pricing strategies of cellular service provider against PCS providers, a pricing permission system for cellular service provider was implemented. The difference in access charges of SKT and PCS providers was increased in 2002, the handset subsidy was

prohibited in 2003, phone numbers were made portable between various carriers, and a different radio usage fee was applied.

Notwithstanding all these asymmetric measures to control the dominant market players and to establish fair competition, cellular service provider's market share, based on the number of subscribers has hardly changed, as shown in Figure 1. The difference in the market share based the net profit for the year is becoming even larger.

As the "tipping" phenomenon continues, because the fair competition policy in the current mobile market has not obtained good results, PCS operators have raised the issue of "spectrum" as a fundamental reason for the tipping phenomenon. Kim et al (2004) studied the relationship between mobile market structure and assigned spectrum, and argued that assigned spectrum was one of the key factors to bring on tipping phenomenon.

As Gruber' study (2003) implied, it should be cautiously determined that who has the right to use spectrum because of the scarcity of the radio spectrum. However, the case of Korea is quite peculiar. Cellular operator have monopolistic usage right of 800MHz, and PCS operators have utilized 1800MHz. The cellular spectrum (800MHz) has a better spectrum quality in factors like diffraction and coverage than PCS spectrum (1800MHz). Therefore, it requires less investment and has reduced maintenance costs.

The monopoly of the best spectrum results in enables competitiveness reproduction on a progressive scale, preoccupation with loyal customers, and higher customer loyalty and brand image. Additionally, PCS operators point out that the dominant firm utilizes enormous funds, causing market tipping and a revenue gap between mobile service providers since 2001.

On the other hand, the cellular service provider maintains that investment difference due to spectrum bandwidth is insignificant, and that there is actually no difference among service providers since a differentiated radio usage charge is applied, and that this difference stems from internal capabilities in areas such as sales and technological innovation.

### III. Research Model

It is a critical issue in the mobile service market that service providers should enhance CS(Customer Satisfaction) and lead it to CR(Customer Retention), due to continuous technology innovation and tough competition. Especially, consumer's usage experience affects CS and CR significantly in case of the usage-dependent service like contract goods. Therefore, many studies are carried out to see how and how much CS affects a company's achievement or CR. (Gerpott, 2001, Kim et al., 2004; Kim et al., 2004)

However, these studies related to mobile service focused on the customer's behavior putting the case of that operators have same call quality, which is the most important factor in service quality. There is a difference in call quality since service providers use different spectrum bandwidth SKT, which uses the cellular spectrum, whereas KTF and LGT uses PCS spectrum. Generally, a low spectrum is believed to provide better network quality such as diffraction and coverage.

Customer's actual recognition of the spectrum quality significantly affects their evaluation of the quality of the mobile service, CS and CR. This chapter reviews the inter-relationship between CS and CR, based on the existing study results, and sets up a model of how consumer recognition of spectrum quality affects consumer behavior.

#### 1. Literature Review

Various studies on consumer behavior, which follow the flow of that CS influences firm performance or CR, have been carried out in the market. Previous studies show that CS affects the degree of customer loyalty and leads to an increase in company's performance or CR.

Gerpott et al.(2001) analyzed the flow of that CS affects loyalty, and loyalty influences CR in mobile service subscribers in Germany. Using the structural equation (SEM), they found that CS significantly affects CR, that CS of the specific

mobile operator can be enhanced by reducing the service charge and improving the call quality, and that increased CS affects customer's loyalty and in turn affects CR. They also discovered that service charge and call quality affect CR by 47% in mobile service.

On the other hand, HSU and Balasubraminian(2002) concluded that service provider's investment in mobile communication facilities affects the service quality, which in turn affects firm performance (market share). In this study, they proposed and verified the model that infrastructure, assets, plant investment, and operating expenses affects operation efficiency and CS, by applying BVC (Barua's Biz Value Complementarity) to the U.S. market. However, this study has a shortcoming, in that the relationship between each proposed variable was not clarified, due to an insufficient number of samples.

Kim et al.(2004) found that the market share in the mobile service market significantly affects performance (EBITA) of the specific company, using a regression analysis of 25 mobile service markets.

However, studies about consumer behavior in the mobile communication market and its determining factors are not sufficient. Table 2 shows a summary of the existing study results.

<Table 2> Related previous studies and their constructs

Author	Basic Approaching Method	Dependent variables	Independent variables	Key findings
Grepott, Rams, Schindler (2001)	CS > CL > CR SEM analysis	CR	Personal Benefits, price, quality, customer care, image of competitors, new terminal, phone number consistency	CS affects CR through CL and three constructs are differential constructs. Price, quality, PB, image of competitors determine CR.
Hsu, Balasubramanian (2002)	BVC(Business Value Complementarity) model Canonical analysis	Firm performance (Market share)	Infrastructure cost, Assets, Operating expense, plants investment, operational efficiency, CS	Infrastructure cost, operational efficiency, and CS have an effect on performance.
Kim, Cha	Service	Financial	Perceived Service	Improvement of wireless



(2003)	quality) CS) CL) performance PLS (Partial Least Square)	Performance	quality, CS, CL,	Internet, variety of price can make customer more loyal to a company.
Venkatesh amy K. Smith, Arvind Rangaswamy (2003)	SES (Service Encountered Satisfaction) )CS) CL	CL	Ease of obtaining information, spectrum of use, prior experience, SES, CS	External variables affect CS, and CS influence CL. Online medium could help companies build a loyal customer base. Providing well-designed online links to products and service can increase loyalty.
Kim, Park, Jeong (2004)	CS) CL SEM	CL	Service quality, switching cost, CS, switching barrier	CS, switching barrier influence CL. Service quality, value-added service, and customer support affect CS.
Wang, Lo, Yang (2004)	Core competencies firm) performance SEM with PLS	Firm performance	Marketing, technology, integrative competencies, market turbulence, technology turbulence	External factor affect company's performance.
Kim et al. (2004)	SCP(Structure-Conduct-Performance) Regression	EBITA margin	Market share, HHI, Destity, Area, ARPU, GDP, penetration	Market share, ARPU affect a firm's performance. There is as strong relationship between market power and performance.

## 2. Hypothesis

Based on the existing studies on how CS affects CR, this study proposes a research model that reflects the characteristics of the mobile service, and reviews how the consumer recognition of the spectrum that are assigned to each mobile operator affects the consumer's way of thinking and behavior, based on the following hypothesis.

*H1: Satisfaction about wireless Internet usage would affect CS with the mobile*

*service.*

The interest in and demand of consumers for wireless Internet is gradually increasing throughout the world. According to Wireless Internet Usage status research(2004), the wireless Internet usage rate in Korea reached 40.2% at the end of March 2004, which showed that consumers' interest expanded from voice to data. Kim and Cha(2003) found that enhancing the quality of wireless Internet could increase consumer loyalty to wireless Internet, which will in turn enhance company performance. The following measurements are used to figure out the degree of satisfaction for wireless Internet

- Easy to connect: Websites can be accessed easily and correctly
- Stable in usage: Not disconnection or downtimes
- Easy to manipulate: Menu or terminal handling is easy
- Connection quality: Fast connection and transmission speeds
- Easy to access: Content and screen layout are good.

*H2: Satisfaction regarding handset quality would affect CS with the mobile service.*

Gerpot, et al. (2001) have attempted to prove that the desire for a new handset could affect CR. However, their study didn't consider CS with users' current handset. We will verify that customer's satisfaction with the handset in their possession has an interrelationship with the mobile service they subscribe to.

*H3: Satisfaction regarding mobile communication price would affect CS with the service.*

The hypothesis that the service price would affect consumer's behavior and decision-making has been studied and verified for a long time. Preceding studies (2001, 2003) in the mobile service sector have shown that the service charge affects the mobile service. Therefore, this study also tries to verify that the service charge affects CS.

*H4: Satisfaction regarding customer care would affect CS with the service.*

The scope of mobile service is expanding from voice calls to data, and changing to provide A/S and various additional services. In particular, mobile operators in

Korea offer various economic benefits to their subscribers. For example, a mobile service operator can provide discount for various services and entertainment, like theaters, restaurants, and entertainment parks. The fourth hypothesis suggests that CS with economic benefits affects CS of mobile service.

*H5: Satisfaction regarding voice service quality (network quality) of the mobile communication would affect CS with the service.*

Mobile communication could be distributed extensively throughout the world owing to voice communication using the wireless network. Gerpott et al.(2001) and Kim et al.(2004) and analyzed that the service quality of the mobile communication area affects CS. In this study, the voice service quality of a mobile service is measured by the following 3 items.

- Easy to make a call: Connection to the subscribing mobile service is easy and accurate.
- Stable calling: The subscribing mobile service is not interrupted while talking on the phone.
- Call quality: The subscribing mobile service provides good sound quality while talking on the phone.

*H6: Image of competitors would negatively affect CS with the mobile service.*

More than three players provide cellular or PCS service in one country throughout the country. In Korea, three big players provide the mobile service. Consumers can obtain convenient services from several service providers, and have the opportunity of switching to another service provider. Gerpott et al. (2001) concluded that a competitor's image can negatively affect subscriber loyalty. Therefore, the sixth hypothesis is that the image of competitors would negatively affect CS with the mobile service.

*H7: Image of competitors would negatively affect CR with the mobile service.*

From the viewpoint of the service provider, it is important that the mobile service subscriber continuously receives the service from the specific service

provider. Kim et al.(2004) analyzed that a switching barrier exists in the mobile service. That is, they indirectly found that the image of a competitor could affect the continuity of the mobile service. Therefore, the seventh hypothesis is that a competitor's image would negatively affect CR with the mobile service.

*H8: CS would affect CR.*

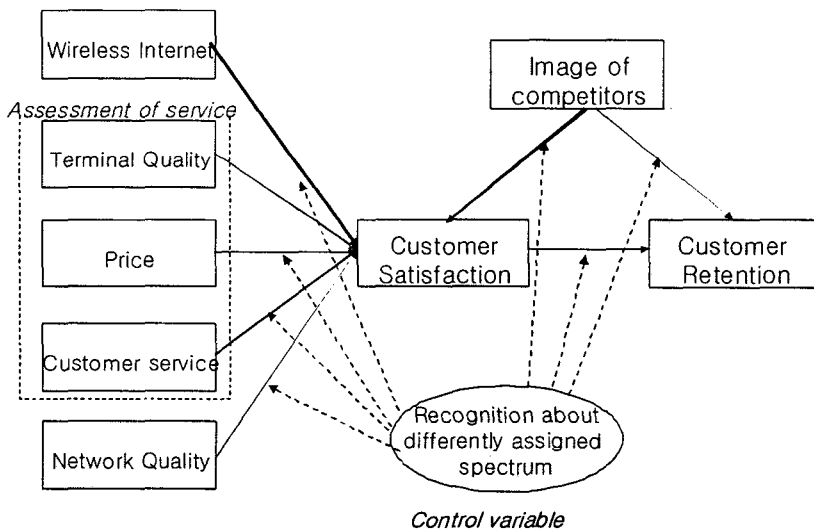
Gerpott et al. (2001) and HSU and Balasubraminian (2002) concluded that CS could affect CR or firm performance in the mobile service market. This study also proposes the hypothesis that CS affects CR, and previous studies found that CS affects customer loyalty. This study considers that CR contains the concept of the degree of loyalty. As a result, it is taken as the eighth hypothesis.

Table 3 summarizes definition of each variable, and Figure 2 shows the research model based on the above hypotheses.

<Table 3> Definition of Measurements

Variable name	Operational definition	Measurement item
Wireless Internet	CS with wireless Internet service	Easy to connect, stable in usages, easy to manipulate, connection quality, easy to access
Terminal Quality	CS with the handset	CS with the handset
Price	Satisfaction with the mobile service charge	CS with price
Customer care	CS with handset A/S and various additional benefits	CS with additional services
Network Quality	CS with the call quality	Easy to make a call, stable calling, call quality
Image of Competitors	Image of competitors	Image of competitors
Customer Satisfaction	Customer reaction to the state of fulfillment, and customer	CS

	judgment of the fulfilled state	
Customer Retention	Maintaining Business relationship established between a supplier and a customer	CR
Recognition of different spectrum	A customer's level of recognition about allocated spectrum for mobile carriers	Recognition of the difference of the spectrum bandwidth allocated for each mobile operator



<Figure 2> Research model

### 3. Control Variables

As mentioned in the preface, different spectrum have been assigned to each mobile operator in Korea. Consequently, CS can be affected by a fixed idea or recognition about the call quality, instead of the call quality experienced by the customer. Because this study is designed to understand the characteristics of the mobile service based on the current studies about how CS affects CR, control variables are grouped into the consumer group that recognizes different spectrum

bandwidth allocation for each mobile operator, and the one that does not recognize it. The recognizing group is the consumer group that is conscious of the effect of spectrum bandwidth on call quality. The customer group sample that recognizes the assigned spectrum and the one that does not recognize it have the following characteristics.

<Table 4> Customer Segmentation by recognition about assigned spectrum for mobile carriers

	Cellular Service User	PCS Service User	Total
Users recognizing the difference of spectrum assigned to each mobile operator	Case (A) (N=401)	Case(C) (N=377)	N=778
Users not recognizing the difference of spectrum assigned to each mobile operator	Case(B) (N=146)	Case(D) (N=149)	N=295
Total	N=547	N=526	1073

#### 4. Data collection

A questionnaire survey was taken over one week from May 23rd to June 10th, 2005, together with a nationwide interview. The respondents were given sufficient information so that the survey could proceed without difficulty. A total of 1,244 samples were collected, and 1,073 valid samples were selected after discarding invalid answers. Table 5 summarizes the demographic characteristics of the respondents.

<Table 5> Descriptive statistics of responded characteristics

Measure	Items	spectrum	Percentage
Gender	Male	524	49%
	Female	549	51%
Age	11~20	236	22%
	21~30	377	35%
	31~40	262	24%
	41~50	145	14%
	Over 51	44	4%
	Unknown	9	1%
Occupation	Specialist	109	10%
	Official worker	141	13%
	Sales	42	4%
	Manufacturing/labor worker	24	2%
	Civil servant/Education	84	8%
	Self-employed	84	8%
	Housewife	93	9%
	Student	374	35%
	Others	114	11%
Unknown	8	1%	
Education	Middle school or less	26	2%
	High school	211	20%
	College or higher	442	41%
	Unknown	394	37%

Summarizing the characteristics of the respondents, most of the respondents are the highly educated, and in their 20s. Consequently, it can be said that the sample corresponds well to the demographic characteristics of Korea.

#### IV. SEM(Structural Equation Model) Analysis

##### 1. Confirmatory Analysis

Before starting SEM analysis, we conducted a Comfirmatory Factor Analysis to verify convergent validity and attempted to reconstruct the four composite factors

using principal component analysis varimax rotation. The results are summarized on Table 6.

(Table 6) Convergent validity and internal consistency reliability

Construct	Items	Factor 1	Factor 2	Factor 3	Cronbach's alpha
Wireless Internet	easy to access	.783	6.743E-02	.117	.8334
	stable in usage	.745	.258	3.070E-02	
	easy to connect	.744	.244	6.835E-02	
	connection quality	.742	7.146E-02	.232	
	easy to manipulate	.730	.133	.179	
Network Quality	easy to make a call	.178	.874	.165	.8841
	stable calling	.211	.838	.204	
	call quality	.235	.836	.214	
Assessment of service	customer care	.107	.160	.742	.5958
	price	.174	-2.206E-02	.679	
	terminal quality	.141	.243	.657	
Image of Competitors	image of competitors	-4.183E-02	-.316	-.498	none

As can be seen, convergent validity of the constructs is demonstrated by the fact that all factor loadings exceed 0.5 on their own construct, except the image of competitors. Because it constituted only one question, we were not able to check discriminate validity. Discriminate validity is demonstrated by the fact that there is no cross-construct loading that exceeds 0.5. Even though one factor was not satisfied with the recommended discriminate validity value, we decided to consider it as one of the research variables because we did a confirmatory factor analysis.

## 2. SEM analysis

We conducted Structural Equation Modeling (SEM) analysis using AMOS 4.0 to



test the casual model since the model is multi-phase. SEM is able to examine the relationship between concepts that cannot be directly measured, since the sub-model can process factor analysis, regression analysis, and path analysis in an integrated manner simultaneously. Additionally, if the causal sequence model among component concepts can be verified using the SEM, extensive suitability can be evaluated for the causal sequence model, and all causal sequences can be measured and evaluated. This study uses AMOS 4.0 and SPSS 10.0 to verify research hypotheses.

Table 7 summarizes the overall fitness of our research model.

〈Table 7〉 Fit indices for the measurement model

Measurement	Recommended Criteria	Measurement model
Chi-square	-	72.737
p-value	> 0.05	0.000
Degree of freedom	-	12
GFI	>0.9	0.973
AGFI	>0.9	0.938
CFI	>0.9	0.934
REMSA	<0.05	0.082
NFI	>0.9	0.922

The chi-square test sensitively responds to the size of the statistical data, if the number of samples becomes more than 200. Generally, if the sample size is big enough and the test target model is well supported by the theory, a chi-square test is not recommended to apply to the statistical data amount. This model has the sufficient sample size (1,073) and is based on a reliable theoretical background. Therefore, even though the p-value is 0.00 according to the chi-square test, and the null hypothesis is abandoned, judgment is temporarily postponed that model suitability cannot be accepted.

The grounds that the model is valid to some extent can be found at CFI and NFI, among indices that indicate model suitability. Generally, if the GFI, NFI, and CFI values of the model are over 0.9, the model can be accepted as persuasive.

1) Affects on the behavior of mobile service subscribers

Table 8 shows the hypothesis verification result that applies the SEM to the factors affecting CS and CR in the mobile service market

<Table 8> The results of hypothesis tests

Hypothesis	Effects	Structural coefficient	t-value
H1	WI > C_S	0.020	0.477
H2	T_Q > C_S	0.186***	11.033
H3	PRICE > C_S	0.258***	16.445
H4	CUS_CARE > C_S	0.325***	17.305
H5	N/W_Q > C_S	0.198***	6.849
H6	IMG_CMP > C_S	-0.005	-0.485
H7	IMG_CMP > C_R	-0.355***	-13.691
H8	C_S > C_R	0.445***	4.424

\*\*\*: Significant at  $\alpha = 0.001$

As shown in table 7, all of hypotheses except H1 and H6 are supported. According to the analysis, factors that affect CS are found to be CS with the additional services provided by mobile communication (customer care), CS with the call quality, and CS with the handset (by this order). Considering that voice calls combined with portability is an indispensable service of the mobile service, customer care has the strongest influence ( $\beta=0.325$ ,  $t\text{-value}=17.305$ ), followed by satisfaction with the price ( $\beta=0.258$ ,  $t\text{-value}=16.445$ ), according to the SEM analysis result. This result re-confirms that mobile service subscribers are sensitive to price. Third, the satisfaction with the call quality affects CS in relatively small way ( $\beta = 0.198$ ,  $t\text{-value}=6.849$ ), compared with the existing studies. This result implies almost

all the mobile service subscribers in Korea might be satisfied with call quality. In the other words, it can be understood that the mobile communication market in Korea has already reached maturity and consumers have experienced sufficient call quality. On the other hand, Hypothesis 1 was not supported ( $\beta=0.020$ ,  $t\text{-value}=0.477$ ), since consumers are not using wireless Internet on a full scale, and its effect is insignificant.

Additionally, CS affects CR most significantly ( $\beta=0.445$ ,  $t\text{-value} = 4.424$ ). It reminds us again that an increase in CS is critical in improving CR. However, the image of competitors negatively affects CR as expected ( $\beta=-0.355$ ,  $t\text{-value} -13.691$ ), which implies strong competition in the mobile communication market, and switching cost is lower to a large extent. It also means that marketing activities and brand image management are important for the mobile operators.

2) Affects on customer behavior by different recognition of the spectrum bandwidth in the mobile service market

Next, we will see how the effect of recognition of spectrum assignment, in terms of cellular and PCS. Recognition of the consumer group A, B, C and D is used as a control variable.

*Case A* means one of the cellular service usage groups that recognizes different spectrum assignment to each mobile operator, where as *Case B* means the groups have no recognition. Table 8 shows the hypothesis verification result by separating case A and B, by applying constraint to the control variables.

<Table 9> The effect of control variables in the case of cellular service subscribers

Hypothesis	Effects	Case (A), N= 401		Case (B), N=377	
		Structural coefficient	t-value	Structural coefficient	t-value
H1	WI > C_S	0.014	0.258	0.272**	2.582
H2	T_Q > C_S	0.150***	5.526	0.187***	3.390
H3	PRICE > C_S	0.273***	11.403	0.259***	5.777

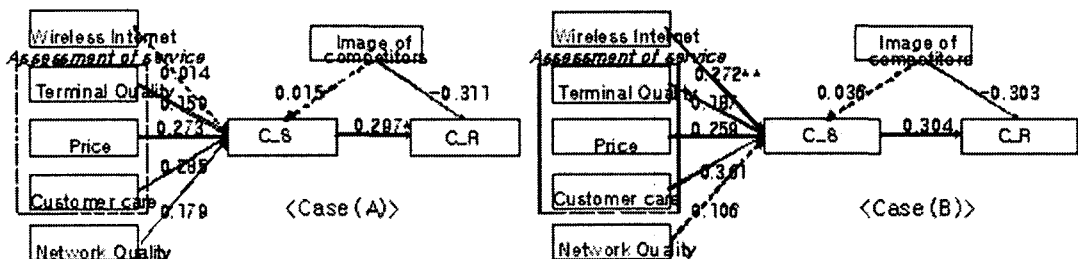
H4	CUS_CARE > C_S	0.285***	8.854	0.361***	7.159
H5	N/W_Q > C_S	0.179***	4.259	0.106	1.428
H6	IMG_CMP > C_S	0.015	0.792	0.036	1.260
H7	IMG_CMP > C_R	-0.311***	-6.560	-0.303***	-3.959
H8	C_S > C_R	0.297*	1.888	0.304*	1.667

\*\*\*: Significant at  $\alpha = 0.001$ , \*\*: Significant at  $\alpha = 0.05$ , Significant at  $\alpha = 0.01$

We found that the degree of satisfaction with customer service affects CS of the cellular service consumer most significantly ( $\beta=0.285$ , t-value=8.854,  $\beta= 0.361$ , t-value= 7.159), regardless of recognizing the spectrum difference allocated to each mobile operator. Satisfaction with the price affects CS next ( $\beta=0.273$ , t-value=11.403) for the group of case A, whereas satisfaction with wireless Internet affects CS next ( $\beta=0.272$ , t-value=2.582) for the group of case B.

The noteworthy point is that satisfaction with call quality does not contribute to overall satisfaction to a larger extent. Especially, the effect of satisfaction with the call quality on CS was found to be insignificant in terms of statistics, in the case B.

It was found that the image of competitors affects CR most seriously, regardless of case A and B ( $\beta=-.311$ , t-value=-6.560,  $\beta=-0.303$ , t-value=-3.959), which implies strong competition in the mobile service market in Korea. Figure 3 schematizes the path coefficient of each factor. In the figure, the dotted line implies that the value is insignificant statistically at the level of significance of 0.01, and the solid line implies the value is significant statistically.



(Figure 3) Results of Structural Equation modeling with control variable for cellular service subscribers

Case C means one of the PCS usage groups recognizes the different spectrum allocation for each mobile operator, where as Case D means there is no recognition. Table 9 shows the hypothesis verification result by separating case C and D by applying constraint to control variables.

<Table 10> The effect of control variables in the case of PCS service subscribers

Hypothesis	Effects	Case (C), N=146		Case (D), N=149	
		Structural coefficient	t-value	Structural coefficient	t-value
H1	WI > C_S	0.038	0.499	-0.448*	-1.958
H2	T_Q > C_S	0.221***	8.109	0.200***	4.191
H3	PRICE > C_S	0.309***	11.569	0.178***	3.905
H4	CUS_Care > C_S	0.280***	8.932	0.431***	8.950
H5	N/W_Q > C_S	0.141**	2.786	0.517***	3.325
H6	IMG_CMP > C_S	-0.019	-1.164	0.010	0.354
H7	IMG_CMP > C_R	-0.317***	-6.383	-0.218**	-2.768
H8	C_S C_R	0.494**	2.780	0.799**	3.093

\*\*\*: Significant at  $\alpha = 0.001$ , \*\*: Significant at  $\alpha = 0.05$ , \*: Significant at  $\alpha = 0.01$

Comparing case C and case D, PCS subscribers show the different results. Looking more closely, factors that affect CS in the case C were price ( $\beta=0.309$ , t-value=11.569), customer service ( $\beta=0.280$ , t-value=8.932), handset ( $\beta=0.221$ , t-value=8.109), and call quality ( $\beta=0.141$ , t-value=2.786) ,in that order.

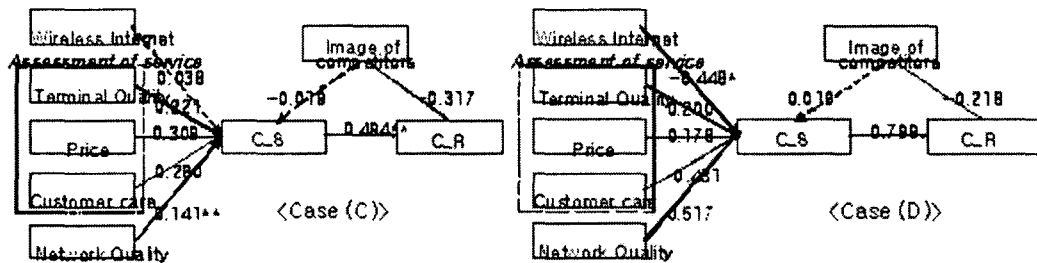
On the other hand, those from of case D were found to be call quality ( $\beta=0.517$ , t-value=3.325), wireless Internet ( $\beta=-0.448$ , t-value=-1.958), customer service ( $\beta =0.431$ , t-value=8.950), and handset ( $\beta=0.200$ , t-value=4.191), in that order.

The explanatory power of satisfaction with the call quality (network quality) regarding CS was quite different for the two groups. Network quality affects in the case C significantly in terms of statistics ( $\beta=0.141$ , t-value=2.786), whereas that of case D was behind case C. On the other hand, satisfaction with wireless Internet negatively affects CS for case D ( $\beta=0.448$ , t-value=-1.958) but it does not

significantly affect case C in terms of statistics ( $\beta=0.038$ ,  $t\text{-value}=-0.499$ ).

Looking at the effect of CS on CR by separating it into case C and D, the consumer of case D shows a relatively high level ( $\beta=0.799$ ,  $t\text{-value}=3.093$ ), which implies that the spectrum difference much affects the consumer consciousness about cellular service and PCS.

It is proposed that the image of competitors significantly affects consumer consciousness, regardless of constraint by control variables. Figure 4 schematizes the path coefficient of each factor. In the figure, the dotted line implies that the value is insignificant statistically at the level of significance of 0.01, and the solid line implies the value is significant statistically.



(Figure 4) Results of Structural Equation modeling with control variables for cellular service subscribers

Table 11 shows the summary of the analysis result.

〈Table 11〉 Order of factors that affect CS

	Cellular User		PCS User	
	Case (A)	Case(B)	Case(C)	Case(D)
Order of factors that affect CS	Cus_Care(1) Price(2) NW_Q(3) Ter_Q(4)	Cus_Care(1) WI(2) Price(3) Ter_Q(4)	<b>Price(1)</b> <b>Cus_Care(2)</b> <b>Ter_Q(3)</b> <b>NW_Q(4)</b>	NW_Q(1) WI_I(2) Cus_Care(3) Ter_Q(4)
Order of factors that affect CR(Including indirect effect)	Img_CMP(1) C_S(2) Cus_Care(3) Price(4) NW_Q(5)	Img_CMP(1) C_S(2) Cus_Care(3) W_I(4) Price(5)	C_S(1) Img_CMP(2) Price(3) Ter_Q(4) NW_Q(5)	C_S(1) NW_Q(2) W_I(3) Cus_Care(4) Img_CMP(5)

The point that we need to pay attention to here is that the importance of factors affecting CS shows much variation, depending on whether PCS users are aware of the spectrum difference or not, compared with cellular service users. We propose the illusion (bias) about the spectrum difference as the reason. The result implies the reason why cellular service in the domestic mobile service market occupied a larger market share than the PCS service was the active marketing activities of cellular service providers as well as the technical characteristics of the cellular service. Through these marketing activities, consumers were educated that there was a difference in the spectrum difference among mobile operators, and came to have a prejudice that the cellular service was superior to PCS for a long time. As a result, the effect of call quality on CS by the PCS subscribers recognizing the different spectrum bandwidth becomes relatively low.

CS of the consumer group not recognizing the difference is considerably affected by the call quality, which tells us that recognition of general users regarding call quality of PCS is seriously distorted. In conclusion, it is proven that consumer's prejudice about the call quality of PCS and cellular service actually exists.

It is newly found that customer's loyalty does not affect CS as much as other studies have found. Compared with other studies, customer's loyalty weakly affects CR. Especially, CS->CR relationship is weak for the cellular service consumer group,

compared with that of PCS. The reason for this can be attributed to strong competition in mobile service market in Korea.

## V. Conclusion

The purpose of this study lies in understanding how the spectrum assigned for each mobile operator affects the consumers of mobile service. For this purpose, we have observed the change of path coefficient in the structural equation, using control variables. The mobile communication market in Korea has already reached maturity (67% of the respondents replied that they received the mobile service longer than 3 years), and the switching barrier felt by the consumer is lower than in the past because of Mobile Number Portability (MNP).

However, the structure of the mobile service market in Korea has become fixed. Considering this tendency and the conclusion of this study, the "lock-in effect" occurs seriously in the mobile service market in Korea. It can be explained by the fact that CS of the cellular subscribers little affects customer loyalty but the market dominance of the cellular service in the actual market has continued for a long time.

In this study, we figured out a strong prejudice about call quality, which is caused by spectrum difference among competitors. Cellular subscribers tends to believe that call quality of their cellular service is better than that of PCS. In addition, we found that PCS operators can catch customer's retention by investment into network in order to increase call quality.

Limitations of this study are as follows. First, this study considers the special characteristics of the mobile service market in Korea. As mentioned above, other countries do not allow a monopoly of a specific bandwidth. Therefore, it is unreasonable to apply the results of this study directly to other countries. Second, there could be other factors than the ones considered in this study. There is a possibility that the demographic characteristics could affect the control variables. In addition, one of the weakness of our study is that we didn't verify the relationship



between customer's retention and their actual behavior.

To overcome these limitations, more studies are needed with regards to the change in consumer consciousness before and after implementing MNP, and the separation of the voice call supported area into normal space and difficult space, to analyze how the spectrum characteristics affect the consumer group in more detail. Additionally, identifying the difference between heavy users and light users would be meaningful.

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*운영석*

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한국정보통신대학원에서 통신경영을 전공하고 현재 한국전자통신연구원, 네트워크경제연구팀에서 이동통신시장의 공정경쟁을 위한 정책 방향 연구를 하고 있다. 관심분야는 유무선컨버전스 및 주파수 정책 분야이다.

*조병선*

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미국 Univ. of Kansas에서 거시경제학 분야로 박사학위를 취득하고 현재 ETRI 네트워크경제연구팀 팀장을 수행하고 있다. 주요 연구분야는 정보통신경제, IT 산업분석 및 예측, 주파수정책 등이다.

*하영욱*

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한국정보통신대학원에서 통신사업자간의 M&A 전략에 관한 논문으로 통신경영 학위를 받았고, ETRI에서 홈네트워킹 마케팅전략을 수행 하였고 현재 주파수 전략에 관련한 연구를 수행하고 있다. 주 관심분야는 주파수정책, 유무선 컨버전스, 통신방송융합정책 등이다.