

Mobile Telecommunications Market Regulations and Carrier Performance: The Korean Case

Chuhwan Park, Sung-Soo Han, and Wang-hun Seok

This paper qualitatively and quantitatively examines the effectiveness of regulations currently in place in the Korean mobile telecommunications market by comparing their intended objectives with the actual outcome, particularly with respect to the performance of market participants. The results show that the regulations have generally been effective in lowering the average revenue per user of carriers. However, the managed competition efforts of the government have also resulted in increased revenues for the top two carriers in the market without significantly affecting their general business operations.

Keywords: Mobile telecommunications industry, regulatory effectiveness, multiple regression model.

I. Introduction

Regulation in the telecommunications market is generally considered both necessary and indispensable; this is principally due to the special characteristics of this market, including its tendency towards a natural monopoly, the existence of essential facilities, its colossal initial capital costs, and the economies of scale. These characteristics also explain the historical development of the telecommunications market in Korea, which was state-controlled until the 1990s. Korean telecommunications firms were quasi-state corporations and were managed by government agencies. Because telecommunications is an infrastructure industry, government involvement was necessary to some degree to ensure the sound growth of this sector. Competition was introduced to the Korean telecommunications sector only since the 1990s with the market entry by private companies. Although entry barriers were removed and the market was opened to latecomers, latecomers were unable to viably compete against incumbent public corporations that held a crushing advantage over them in terms of market share (both on the basis of subscribers and sales), capitalization, and network coverage. As a solution to this imbalance and to generate an environment in which effective competition could occur, the Korean telecommunications authority opted for asymmetric regulation; that is, it imposed regulatory restrictions only on the incumbents and not on the latecomers. Asymmetric regulation, although employed for both the fixed and mobile telecommunications markets, has not been applied to the same extent or degree for the two markets. This difference is mainly a reflection of the monopolistic fixed market dominated by Korea Telecom (KT) and the oligopolistic mobile market involving several carriers with the majority of the market share.

Manuscript received Mar. 19, 2009; revised Sept. 30, 2009; accepted Oct. 19, 2009.

Chuhwan Park (corresponding author, phone: +82 53 810 2717, email: chuhwan@ynu.ac.kr) and Wang-hun Seok (email: muylsi2@ynu.ac.kr) are with the Department of Economics and Finance, Yeungnam University, Gyeongsan, Rep. of Korea.

Sung-Soo Han (email: sshan@etri.re.kr) is with the Technology Strategy Research Division, ETRI, Daejeon, Rep. of Korea.
doi:10.4218/etrij.10.0109.0179

Whatever the exact rationale for this regulatory approach is, asymmetric regulation has performed crucial functions; it has created an environment conducive to effective competition, the efficient allocation of resources, and the efficient distribution of market revenues, where all of these outcomes generally advance the public interest.

Not all researchers concur with this view. According to the studies in [1] and [2], asymmetric regulation does not necessarily generate intended benefits. Asymmetric regulation is not, they asserted, designed to create or preserve an effective competitive environment; it seeks to defend consumer interest by protecting certain specific competitors and is thus ineffective. In [3], Choi expressly advocates the elimination of all asymmetric regulatory constraints, which, in his opinion, do not promote fair competition. Contrary to their stated objectives, what asymmetric regulations really achieve, Choi argues, is managed competition. In [4], Park, a staunch champion of asymmetric regulation, argues that this regulatory approach is necessary, for instance, to narrow the competitive gap between the incumbents and the latecomers in the mobile market, a gap which stems from the discrepancies in the time of market entry, the size of the subscriber base (especially in terms of quality subscribers), and capital size. According to Yi [5], asymmetric regulation is neither perfect nor completely ineffective or irrelevant. He claims that this regulatory approach, although inadequate in its current form of implementation, is necessary, and he proposes that efforts be made to minimize the competitive distortions this approach causes in favor of latecomers at the expense of incumbents. Few researchers have thus far called into question the need for asymmetric regulation itself. The issue has generally been how the regulation should be implemented and what the regulatory focus should be.

This paper analyzes, both qualitatively and quantitatively, the effects of regulation on the Korean mobile telecommunications market. We qualitatively examine the manner in which the regulatory measures in six different areas that are currently implemented in the mobile market have influenced the market and whether these measures have brought about their intended effects. In addition, we quantitatively assess the effect of regulation on the average revenue per user (ARPU) of mobile carriers via multiple regression and panel analysis. That is, the content of regulatory measures is quantified to analyze the effects on the performance of the three mobile carriers currently operating in the market in Korea. We expect this study to add to an objective understanding of whether and in what ways the current regulations have contributed to the correction of structural distortions in the telecommunications industry. We also expect it to provide regulators with basic reference data

that may prove helpful in deciding future regulatory directions.

II. Literature Review on the Relationship between Regulation and Market Performance.

Prior attempts to determine the relationship between regulation and market performance have been rare and limited in scope. The majority of previous works addressing this topic have either compared the status of the market prior to and following the introduction of a regulatory scheme or have discussed market regulations in countries outside Korea as case studies. Additionally, many of the case studies have been more concerned with identifying regulatory flaws than with measuring regulatory effects on market performance. This skewed research focus may be explained in part by the fact that it is difficult to measure the effect of regulation in terms of market performance. In addition, different countries have different regulatory environments, and this requires researchers to construct an analytical framework for each country to be evaluated.

Among works addressing regulatory systems in countries outside Korea, [6] provides an overview of pricing regulations in the US fixed-line telecommunications market, describing the regulatory approaches adopted by individual states as well as historical regulatory trends. In [7], Seong and Kwon explore the relationship between incentive regulation and competition in regional telecommunications industries in the US via data envelopment analysis. They determine that incentive regulation explains the gaps in efficiency between carriers and competition is a critical policy variable in explaining the differences in allocative efficiency. On the basis of these results, they conclude that both incentive regulation and competition are necessary to enhance economic efficiency. In [8], Kim conducted a study assessing the latest regulatory trends in fixed-line telecommunications pricing in the UK, arguing that network access is gradually replacing tariff regulation as the regulatory focus. In [9], Lee and others examine essential facilities regulations in the US, the EU, and Japan. They report that telecommunications regulators in these countries have been removing the factors that might potentially hinder competition in accordance with the essential facilities doctrine and are expanding the scope of essential facilities. Finally, they recommend that an identical approach should be adopted by the telecommunications market.

With regard to the broader question of telecommunications privatization, Warford and others [10] estimated the effect of privatization on competition via a fixed-effects model. The results of this study reveal that privatization exerts a positive effect on the number of lines (more subscriber lines exist in

regions where the prevailing telecommunications market had been privatized). Walsten and others [11] conducted a panel analysis to estimate the effects of privatization, competition, and regulation on telecommunications markets in 30 developing countries. The results show that competition positively influences the number of lines per capita, access capacity, the number of public telephone booths per capita, and call prices in all 30 countries studied. The study also suggests that the effects of privatization are particularly positive when coupled with regulation. However, the estimation of the fixed effects of regulation using panel data concerning several countries is somewhat questionable with regard to methodological validity, considering how widely regulations vary among countries.

III. Effects of Mobile Market Regulations

1. Assessment of the Effectiveness of Mobile Regulations

Measures aimed at limiting market shares constitute a rather doubtful regulatory strategy with regard to their practical effectiveness. Currently, measures to artificially limit the market shares of mobile carriers are coupled with carriers' internal strategies to reduce their own market shares. SK Telecom (SKT), for instance, is terminating contracts with low-quality subscribers in an effort to shrink its subscriber base. "Low-quality subscribers" here refers to both subscribers with low credit ratings and those with past due bills. Over the short term, the termination had elicited improvements in revenues for SKT. If we examine the three-year period from 2000, the year in which this strategy was initially implemented (which coincides with the start of telecommunications mergers), to 2003, SKT's market share grew from 56.7% in 2001 to 60.4% in 2003, a 3.7% increase. The market share of Korea Telecom Freetel (KTF), however, declined 2.1% over the same period, from 30.5% to 28.4%. The market share of LG Telecom (LGT) also dropped by 1.8% during this period, from 12.9% to 11.1%.

Although we cannot automatically attribute these changes in market shares to regulatory intervention and its consequent influence on SKT's behavior, it is undeniable that the regulation played some role in enabling the dominant supplier to realize excess profits during this period. The effort to regulate the distribution of market shares, therefore, proved not only unsuccessful but also generated effects contrary to those intended. The associated rules, as a result, were subsequently repealed.¹⁾

1) The restriction policy vis-a-vis incumbent market shares hindered incumbent market activities from July 2000 to June 2001, when SKT merged with Sinsegi Telecom (in 2000), resulting in a total market share of over 50%. This policy resulted in a negative effect that was counter to the market-mechanism, such as the narrowing of consumer choice and violations in corporation activity.

The price regulations also helped SKT to further increase its revenues, which is opposite of the intended effect. During the five-year period prior to the implementation of the approval requirements on call tariffs (prior to 2002), SKT's basic charges and call rates dropped significantly as the result of heavy competition. However, since 2002, the rate of decline in prices visibly slowed.²⁾

The benefits elicited by current measures for the prevention of predatory pricing (thereby preventing monopoly) also remain unclear. In a mobile market, it is practically impossible for a carrier to practice predatory pricing or monopolistic pricing. This is not only the consequence of regulatory surveillance, but is also due to the existence of alternative suppliers that can provide substitute services. A carrier would typically opt for predatory price cutting (establish its prices below marginal cost) in an attempt to keep competitors at bay and discourage new suppliers from entering the market. When and if the carrier attains a monopolistic position in the market, it can then engage in monopolistic pricing to recoup the previously incurred losses. However, in a heavily regulated market such as the one in Korea, it appears unlikely that SKT would be able to price LGT or KTF out of the market.

It is also unlikely that SKT would engage in monopolistic pricing even if it had the authority to set its own prices. Unlike in the fixed-line market, there is no involvement of essential facilities in the mobile market. Hence, there is no persuasive reason why subscribers should stay with SKT over KTF or LGT if SKT were to charge higher prices for the same services provided by KTF or LGT. This notwithstanding, considering how the tariff approval requirement continues to remain in force, it probably has been effective in preventing monopolistic or predatory pricing by SKT. Although it is effective, the current price cap is set at a level that allows SKT to realize excess profits, and this is indicative of possible allocative inefficiency. In other words, consumers are forced to pay the maximum prices allowed by this regulation while the prices could still be lowered. If a regulatory scheme undermines consumers' interest, this is a sufficient reason to revise the scheme or to search for a new alternative.

With respect to the restrictions on handset subsidies, their principal objective is to prevent the excessive financial burden this competitive strategy can place on latecomers to the mobile market. Before 2000, handset subsidy competition was the principal cause of losses by latecomers to the Korean mobile

2) With respect to the basic prices and calling prices of each carrier, they have been decreasing continuously since SKT merged with Sinsegi (from 18,000 won to 15,000 won, and to 13,000 won in 2004). The latecomers KTF and LGT had to cut the price in phases (from 16,500 and 15,000 won to 13,000 and 12,000 won in 1997, respectively). Thus, before the three carrier competition, the range of price reductions was larger; afterwards, the competition has been slowing, along with the basic price decreases.

market. Since the introduction of restrictive rules banning or limiting the practice of handset subsidies, visible improvements have been observed in the net incomes of KT and LGT, the two latecomers. The decision to impose restrictions on handset subsidies was prompted by the persistent losses incurred by the PCS providers that had then newly entered the market because these losses were traced to the competitive subsidy programs that magnified their costs. After the implementation of related rules in 2001, the effect was more or less immediate, and the latecomers' revenue performance had improved rapidly as a result. Thus, the handset subsidy restrictions could be considered to have delivered intended benefits.

Per regulations related to intercarrier access pricing and the calculation of access costs, the fact that the disparity in access charges has been significantly reduced as compared to the past speaks positively about their effectiveness. Related regulations have been extensively revised for the better as well. The reduced price disparity has been accompanied by an overall decline in access prices, which, in turn, caused end-user prices (basic charges and call rates) to drop; this is doubtless a positive development. The current access pricing scheme is certainly far from perfect or ideal, and the manner in which access charges are established still leaves much to be desired in terms of fairness. Access pricing is an area that requires the constant attention of regulators, as a less than fair pricing arrangement can result in moral hazard on the part of carriers that benefit from the arrangement.

The number portability program has been the direct cause of a massive switching of providers. Since the introduction of the program in December 2005, a cumulative total of 8,510,749 subscribers have switched their subscribers. By carrier, 2,738,844 subscribers left their incumbent providers in favor of SKT, 3,350,520 in favor of KTF, and 2,421,385 in favor of LGT.³⁾ However, this massive redistribution of subscribers has not induced a commensurate change in the distribution of market shares or the Herfindahl-Hirschman indices. Related changes were negligible at best during the period spanning from 2004 to 2007. It may, therefore, be fairer to say that the redistribution of subscribers among the three carriers, and particularly the change in favor of LGT, was induced not so much by the number portability scheme as by the improvements in LGT's own marketing performance. LGT continuously released new affordable call products during this

same period, enabling it to win over some of the SKT customers. Subsequent to the implementation of the number portability scheme, while KTF's market share based on the number of subscribers remained virtually unchanged, SKT's shrank and LGT's grew. The majority of customers who left SKT during this period appear to have moved to LGT. In this regard, the number portability program may have achieved its intended objective of lowering switching barriers in the mobile market, mitigating the lock-in effects benefiting the incumbent and creating an environment for effective competition. As number portability also induces carriers to competitively slash their prices and release new products, it has benefited both the switching customers and the customers choosing to remain with their incumbent providers. After the introduction of the number portability program, SKT was no longer the sole leader in the mobile market in terms of new product and service release, and the latecomers have been quickly catching up. This indicates that the program has been helpful in bringing about effective competition.

2. Empirical Analysis

A. Explanation of Variables

The variables used in this study are explained in Table 1. The first step in a multiple regression analysis is the selection of independent and dependent variables. Independent variables are exogenous variables that are already provided, whereas dependent variables are the variables that are influenced by the independent variables.

In this respect, the ARPU could be a proxy variable. This is because, in the case of basic monthly fees, price setting is closely regulated by restrictions preventing potential monopolistic activities by the dominant businesses, and the latecomers' entry into the market is facilitated through a report system. These restrictions allow customers to use more services because the consumer cost of mobile phone use (that is, the basic monthly fee) is lowered. The cellular-phone subsidy restriction minimizes excessive competition among companies, thereby preventing the costs involved in such activities to be reflected in higher customer prices. Since the connection fee restriction also focuses on the distribution efficiency that reflects a reduction in the fee, the dependent variable reflects our opinion, in that the ARPU is appropriate.

Two types of independent variables were selected for this study: regulation-related independent variables and variables related to market participants' behavior. With regard to regulation-related variables, we considered only those regulations that were implemented over the eight-year period from 2000 to 2008. For the types of regulations, we considered the price restrictions imposed on the largest mobile carrier and

3) With respect to the status of net number portability subscribers in 2004, SKT had 1,560,736, KTF had 461,106, and LGT had 1,099,576. The net increases in the number portability subscribers in 2005 for SKT, KTF, and LGT were 8,533, -53,554, and 1,413,093, respectively (in 2007, the numbers for SKT, KTF, and LGT were 28,773, -241,860, and 2,384,867, respectively). In terms of the market share by the number of subscribers from 2004 to 2007, SKT had decreased by 0.8% from 51.3% to 50.5%, KTF had decreased from 32.1% to 31.5%, and LGT had increased by 1.4% from 16.6% to 18.0% (Source: Korea Telecommunications Operators Association).

Table 1. Explanation of variables.

Abbreviation	Variable	Data (period and source)
ARPU	Average revenue per user	SKT: 2000 – 2Q 2008 KTF: 2001 – 4Q 2007 LGT: 2001 – 4Q 2007 IR data of respective companies
DUM1	Dummy 1 (dummy variable for price regulations)	SKT: 2000 – 2Q 2008 Data related to basic charges for periods until 2006 was obtained from the statistics published in the website of the Ministry of Information and Communication. Data for the subsequent periods was obtained from SKT's website.
DUM2	Dummy 2 (dummy variable for access pricing regulations)	Carrier-specific data for 2000 to 2007 was collected from the statistics published in the website of the Ministry of Information and Communication.
SUB	Subsidy (handset subsidies)	Sales promotion expenses reported in the IR materials of respective carriers from 2001 to 4Q 2005 were used as proxy variables for the cost of handset subsidies.
CAP	Capital investment	SKT: 2000 – 2Q 2008 KTF: 2001 – 4Q 2007
AD	Advertising	LGT: 2001 – 4Q 2007 IR data of respective companies

the access pricing regulations that were applied to all carriers to reduce overall mobile communications prices. Both of these regulatory measures may be understood as initiatives to promote the welfare of mobile telecommunications users. Measures aimed at the promotion of competition in the market were also considered. The principal purpose of the handset subsidy regulation is to prevent this marketing strategy from distorting competition and to curb the excessive consumption that this strategy encourages. Preventing SKT from gaining an insurmountable competitive advantage using its overwhelming financial resources is another objective of this measure. It is difficult to accurately assess the effectiveness of price regulations, considering how the average annual decline in SKT's basic charges⁴⁾ has remained virtually unchanged since 2000. Nevertheless, we assigned a value of 1 to the related dummy variable, equating it with a stiffening of price regulations, for any year in which SKT lowered its basic charges. Meanwhile, we set the value of the dummy variable to 0, equating it with an easing of price regulations, for years in

4) Basic charges, for the purpose of this paper, indicate all charges excluding call charges. The basic charges utilized in this study correspond to the standard basic charges by SKT, effective during the considered periods.

which no decline in SKT's basic charges was noted.

Likewise, with regard to access prices, we calculated an average rate of decline, and any period during which the rate of decline was below this average was considered a period in which the regulatory control of access pricing was relaxed, setting the related dummy variable as 0. By the same token, any access price decline larger than the average rate was treated as an indication of a stiffer regulation, and a value of 1 was assigned to the dummy variable. The average rate of decrease in access charge was calculated for each of the three carriers. A value of 1 was assigned when the rate of decrease in a given period was above the average, and a value of 0 was assigned when the rate of decrease was below the average. A reduction in basic price and access charge reduces the ARPU of a company.

As for the handset subsidy restrictions, to apply a uniform standard for all three carriers, handset subsidy-related expenditures were taken from the accounting data of the respective companies. For the second and third quarters in 2001, when the ban on handset subsidies became law and the related expense category disappeared from mobile operators' financial statements, we utilized as the proxy variable the portion of the sales promotion cost treated as the cost of attracting new subscribers.⁵⁾ With regard to KTF and LGT, the proxy variable was utilized for the entire period studied because there was no financial data for these companies prior to 2001.⁶⁾

Independent variables unrelated to regulation, such as advertising and capital investment, were also selected to estimate the ARPU effects of advertising and the economy of scale realized through increased CAP. See the descriptive statistics of variables in Tables 2 and 3.

B. Data

The data utilized in this analysis was collected from quarterly IR materials containing ARPU information. The data pertaining to the handset subsidy-related costs (cost of attracting new subscribers), the costs of advertising, and CAP was also obtained from the IR materials and was appropriately modified prior to use. The data relating to the net subscriber growth attributable to number portability, basic charges, and intercarrier access charges was obtained from the website of the Ministry of Information and Communication (now the Korea Communications Commission).

5) The rationale behind this choice is that the goal of handset subsidies is to attract new subscribers. However, we acknowledge that using the cost of attracting new subscribers as the proxy variable is a potentially problematic decision in that not all related expenditures are accounted for as handset subsidies.

6) IR materials were mostly available from 2001 and onwards. For the data prior to this date, the absence of a statistical database rendered it difficult to construct dummy variables. Therefore, we used the relevant figures reported in the respective companies' IR materials instead by appropriately modifying them to suit the purposes of this study.

Table 2. Statistics of variables.

	Basic charge (Thousand won)			ARPU (Thousand won)			Access price (won)			Advertisement (Billion won)			Subsidy (Billion won)			Capital investment (Billion won)		
	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT
00	18	17	16	42.3	N/A	32.8	68.9	N/A	73.6	54.0	N/A	18.2	31.7	N/A	1245.8	457.5	N/A	62.3
01	16	16	16	37.6	39.6	34.4	63.6	65.7	65.7	69.0	29.3	6.3	24.5	96.5	620.3	284.0	282.3	98.0
02	15	15	15	44.0	39.0	32.7	45.7	53.5	59	110.0	36.0	12.6	45.3	52.5	64.3	491.0	282.5	90.0
03	14	14	13	44.5	39.0	32.2	41	48	52.8	90.3	28.5	14.6	43.4	31.0	30.8	424.0	238.8	112.3
04	13	13	13	43.5	40.1	36.7	31.8	47.7	58.5	82.1	27.5	15.0	51.2	71.8	78.3	401.5	264.9	84.3
05	13	13	12	44.2	41.0	38.7	31.2	46.7	55	65.2	25.8	12.1	48.1	91.0	97.3	366.5	178.4	83.5
06	13	13	13	44.6	40.5	35.7	33.1	40.1	47	75.2	29.5	12.7	60.2	116.0	159.5	379.5	304.1	96.8
07	13	13	13	44.4	40.7	35.6	32.8	39.6	45.1	76.2	32.0	11.7	78.5	226.3	266.8	464.0	277.5	155.3
08	N/A	N/A	N/A	43.0	N/A	N/A	N/A	N/A	N/A	63.9	N/A	N/A	90.4	N/A	N/A	302.5	N/A	N/A

Table 3. Descriptive statistics of the variables.

	Basic charge (Thousand won)			ARPU (Thousand won)			Access price (won)			Advertisement (Billion won)			Subsidy (Billion won)			Capital investment (Billion won)		
	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT	SKT	KTF	LGT
Mean	13.7	13.5	13.9	40.0	35.1	43.3	48.8	54.7	39.9	29.8	12.1	81.2	97.9	188.1	50.2	261.2	102.9	401.5
Med	13.0	13.0	13.0	40.1	35.6	44.2	47.7	55.0	33.1	29.3	12.6	76.2	91.0	97.3	48.1	277.5	96.8	401.5
Max	16.0	15.5	16.0	41.0	38.7	44.6	65.7	65.7	63.6	36.0	15.0	110.0	226.3	620.3	78.5	304.1	155.3	491.0
Min	12.5	12.0	13.0	39.0	32.2	37.6	39.6	45.1	31.2	25.8	6.3	65.2	31.0	30.8	24.5	178.4	83.5	284.0
S.D.	1.3	1.2	1.2	0.8	2.3	2.5	8.9	7.2	11.8	3.3	2.9	15.2	63.3	205.8	16.5	41.6	25.1	68.2

This data was modified for the purpose of this study. A log value was employed for the ARPU variables, handset subsidy, advertising, and CAP to rule out heteroscedasticity.⁷⁾ The dummy variables were utilized without adjustments. As a result of adding AR(1), we solved the first-order autocorrelation by the Durbin-Watson value, which converged closely to 2.⁸⁾

7) In cases where there is a possibility of heteroscedasticity, we utilized White's heteroscedasticity test as a residual test after the completion of OLS regression analysis in order to determine whether the Prob/chi-square value of the R2 statistics of observations permits the null hypothesis to be rejected at common significance levels. When the null hypothesis was not rejected, we concluded that there was no heteroscedasticity. When the null hypothesis was rejected, we conducted an additional round of OLS estimation, this time assuming the existence of heteroscedasticity consistent coefficient covariance in the OLS estimation, with the aid of Eviews.

8) The solution measure according to the problem of autocorrelation in the model is to add an independent variable by finding a time-lag variable of holding autocorrelation and to build a differentiation equation by using the Cochrane-Orcutt method. Since the former has a limitation in collecting the independent variable that can solve the problem of autocorrelation, the autocorrelation is eased by selecting the latter. This solved the autocorrelation problem of error through the first-order autocorrelation instead of the Cochrane-Orcutt method. As a result, the Durbin-Watson value converged closely to 2. The reason for using AR(1) to solve the first-order autocorrelation is that the AR(1) method is a more powerful method and does not show a large discrepancy from the Cochrane-Orcutt method.

C. Model Specification

To determine how the independent variables affect the various dependent variables, we performed a multiple regression analysis using the following model:

$$\ln(\text{ARPU}_{it}) = \alpha_0 + \beta(\text{DUM1}_{it}) + \delta(\text{DUM2}_{it}) + \theta \ln(\text{SUB}_{it}) + \tau \ln(\text{CAP}_{it}) + \varphi \ln(\text{AD}_{it}) + \varepsilon_{it}, \quad (1)$$

where it can be SKT, KTF, or LGT.

Equation (1) is set for an oligopolistic model which explains how the independent variables influence the ARPU variable. The independent variables include regulation variables, handset subsidies, advertisement, and capital investment. The estimation coefficients have three pairs of estimators represented by the coefficients δ , θ , and τ . Here, φ denotes 3 by 1 vectors, and the independent variables represent 1 by 3 vectors except for β .

It is difficult to perform the Hausman test by finding proxy variables, even though there may be an endogeneity between the dependent and independent variables, such as the

connection rate control or advertisement. Therefore, we focused on finding a common point and a different point through panel regression analysis. The sample data comprised 34 observations utilized for SKT (from the first quarter of 2000 to the second quarter of 2008). The sample also included 28 observations for KTF and LGT (from the first quarter of 2001 to the fourth quarter of 2007). Eviews 4.1 was employed as an analytical tool.

D. Serial-Correlation LM Test (Breush-Godfrey)

To verify whether the errors of different equations are contemporaneously correlated, the Breush-Godfrey LM test was carried out with a lag of 4 entered. The test results are presented in Table 4. The null hypothesis of the test is that there is no serial correlation in the residuals up to order 4. The test rejects the hypothesis that there is no serial correlation up to order four, implying that the LM test indicates that the residuals are serially correlated and the equation should be re-specified.

Based on the LM test result, (1) was transformed into a panel analysis for identifying the effects of market activities and government regulations. In this panel analysis, we performed a fixed effect analysis by using the SUR method, which identifies the error relationship among businesses.

Table 4. Breusch-Godfrey correlation LM test.

	F-statistic	Obs*R-squared
SKT	0.671 (0.630)	6.783 (0.100)*
KTF	4.198 (0.040)**	18.288 (0.001)***
LGT	1.719 (0.238)	12.482 (0.014)**

() refers to p-value. ***: <0.01, **: <0.05, *: <0.1.

IV. Results

The results of the multiple regression model are shown in Table 5. In the case of price restriction, SKT is shown to be directly regulated by it, and the reductions in the basic monthly fees show a negative relation which has lowered the ARPU. In comparison, since KTF and LGT have been able to provide services at a lower basic monthly fee, price restriction has had a positive effect on the ARPU of these companies. However, the result for LGT is statistically insignificant since it was rejected within the significance level of 1%.

With respect to the connection rate restriction, SKT (as the primary recipient of the asymmetric restriction) has paid the highest fees for connecting other telecommunications services; this is reflected in a negative relation or a lowered ARPU when the connection rate restrictions were tightened. The connection

Table 5. Results from multiple regression.

Dependent variable: $\ln(\text{ARPU}_i)$			
	ARPU _{SKT}	ARPU _{KTF}	ARPU _{LGT}
constant (p-value)	13.05005 (0.000)***	13.14066 (0.000)***	14.82568 (0.000)***
DUM1 _{SKT} (p-value)	-0.00049 (0.9409)	0.001122 (0.928)	0.034184 (0.0062)***
DUM2 _{SKT} (p-value)	-0.00225 (0.8541)	0.015491 (0.3599)	0.11426 (0.0006)***
DUM2 _{KTF} (p-value)	0.125269 (0.0126)**	-0.02232 (0.6682)	-0.16144 (0.0477)**
DUM2 _{LGT} (p-value)	-0.12882 (0.0248)**	0.044308 (0.5688)	0.284888 (0.0177)**
$\ln(\text{SUB}_{SKT})$ (p-value)	-0.0006 (0.4670)	0.002807 (0.2143)	0.012497 (0.0006)***
$\ln(\text{SUB}_{KTF})$ (p-value)	-0.00962 (0.5366)	-0.00124 (0.9234)	0.021609 (0.1988)
$\ln(\text{SUB}_{LGT})$ (p-value)	-0.00649 (0.4610)	-0.00804 (0.3935)	-0.00918 (0.5303)
$\ln(\text{AD}_{SKT})$ (p-value)	0.02601 (0.1768)	0.024638 (0.2892)	-0.09344 (0.0086)***
$\ln(\text{AD}_{KTF})$ (p-value)	-0.04486 (0.0187)**	0.018603 (0.311)	0.083808 (0.0041)***
$\ln(\text{AD}_{LGT})$ (p-value)	-0.10539 (0.0776)*	-0.15538 (0.0063)***	-0.17097 (0.0078)***
$\ln(\text{CAPSKT})$ (p-value)	0.01841 (0.0039)***	0.00275 (0.7163)	-0.01763 (0.1015)
$\ln(\text{CAP}_{KTF})$ (p-value)	0.010463 (0.3911)	0.023745 (0.0617)*	0.011399 (0.4205)
$\ln(\text{CAP}_{LGT})$ (p-value)	0.00724 (0.5378)	-0.01456 (0.3216)	0.035441 (0.0700)*
AR1 (p-value)	0.530441 (0.0026)***	0.943622 (0.0000)***	0.980551 (0.0000)***
R ²	0.965787	0.836535	0.964196
Observations	27	27	27
D.W.	2.016941	2.188280	2.108301
Residual ADF-test (p-value)	-5.284667 (0.0011)***	-7.309080 (0.0000)***	-4.432810 (0.0088)***

***: <0.01, **: <0.05, *: <0.1.

rate differential between SKT and KTF has continually decreased and the differential between SKT and LGT has been large. In this regard, the connection rate restriction has a positive relation to KTF and a negative relation to LGT. KTF has not been free from the restriction; the restriction has had a negative effect on KTF's ARPU. The rise in the connection rates of SKT and LGT has had a positive effect on the ARPU of KTF. It appears that LGT, the smallest of the three carriers, has been least affected by the restriction; the restriction has a positive effect on LGT's ARPU, perhaps because LGT's connection rates are relatively high. If the connection rate

restriction of KTF, the number 2 carrier, was tightened, the difference in the connection rates between LGT and KTF would be significantly reduced, leading to a lower ARPU for LGT.

The mobile-phone subsidy restriction has had a negative effect on the ARPU of all three carriers (more profitability as they do not need to provide as much subsidy). SKT's ARPU increases when other companies reduce their cellular-phone subsidies. KTF's ARPU increases when SKT increases its subsidy. LGT's ARPU increases when SKT and KTF increase their subsidies.

SKT's ARPU has had a positive relation with advertisement expenses. KTF's ARPU increases as its advertisement expenses increase. LGT's ARPU, however, decreases with an increase in its advertisement expenses. This suggests that advertisement activities do not significantly influence the sales of the smallest latecomer, LGT.

Facility investments have generally increased the ARPU of companies and contributed to the economies of scale. SKT's ARPU increases when other companies' networks increase; SKT may be able to connect more subscribers using these networks. We propose that this is because SKT's frequencies differ from those of the latecomers. Since KTF is a competitor of LGT, KTF's ARPU would be negatively impacted if the subscriber coverage of LGT was enlarged by increasing facility investments. In addition, LGT has a negative relation to SKT's coverage increases.

We performed a panel analysis using the data collected regarding the three companies. We applied the fixed-effects and seemingly unrelated regression (SUR) analysis. The fixed-effects model assumes that the difference in the cross section data is fixed rather than random. Since the same random effect model (at the time of randomly extracting cross section data to represent a large population) is not suitable, we used the fixed-effects model. SUR is a set of related regression equations even though they do not appear related. SUR provides useful information, such as regression errors, that can affect each other in any given time period.

SUR is appropriate for this study. Although the three companies provide the same service and the asymmetric restrictions affect these companies differently to the benefit of the late starters, the restrictions on a specific company may influence other companies as well. This influence impacts the errors rather than manifesting itself on specific independent variables; thus, there could be a relationship between the errors. The first-order autocorrelation was solved through AR (1) after considering an autocorrelation problem between the errors of three items.

According to the fixed SUR analysis results presented in Table 6, the basic monthly fee restriction placed on SKT generally has a positive effect on the ARPU of carriers. This is

Table 6. Results from the panel analysis (fixed SUR).

Dependent variable: $\ln(\text{ARPU}_i)$			
	Fixed SUR		Fixed SUR
constant (p-value)	13.35074 (0.0000)***	$\ln(\text{AD}_{\text{SKT}})$ (p-value)	-0.004 (0.6944)
DUM1_{SKT} (p-value)	0.006858 (0.0977)*	$\ln(\text{AD}_{\text{KTF}})$ (p-value)	0.001817 (0.8443)
DUM2_{SKT} (p-value)	0.020616 (0.0173)**	$\ln(\text{AD}_{\text{LGT}})$ (p-value)	-0.15168 (0.0001)***
DUM2_{KTF} (p-value)	0.024536 (0.4228)	$\ln(\text{CAP}_{\text{SKT}})$ (p-value)	0.009887 (0.0057)***
DUM2_{LGT} (p-value)	-0.01572 (0.6543)	$\ln(\text{CAP}_{\text{KTF}})$ (p-value)	0.013813 (0.0017)***
$\ln(\text{SUB}_{\text{SKT}})$ (p-value)	0.001682 (0.0359)**	$\ln(\text{CAP}_{\text{LGT}})$ (p-value)	0.012012 (0.0492)**
$\ln(\text{SUB}_{\text{KTF}})$ (p-value)	0.003196 (0.6435)	AR1 (p-value)	0.839524 (0.0000)***
$\ln(\text{SUB}_{\text{LGT}})$ (p-value)	-0.00765 (0.1848)		
R^2		0.999983	
Observations		81	
D.W.		1.792605	
Residual ADF-test (p-value)		-4.180710 (0.0157)**	

***: < 0.01, **: < 0.05, *: < 0.1.

a statistically significant result as the estimation variable was rejected within 10% of the significance level. During the time that the connection fee restriction has been asymmetrically applied, the gap has gradually been reduced. The ARPU has increased as the restrictions on SKT and KTF have been tightened, and the ARPU has decreased as the restrictions on LGT have been tightened. This suggests that the connection fees charged by SKT and KTF have been lowered, resulting in a decreased connection rate differential between them and LGT while their respective market shares have remained high. The excess profit accrued by LGT prior to restriction has been reduced as the rate differential has decreased. This means that, even with discounts, there are not many factors that can reduce the ARPU of SKT and KTF because the subscriber base of SKT and KTF is relatively large and stable. LGT, however, is in a different position; increases in call volume due to discount pricing would actually raise its cost and negatively affect its ARPU because such increases would result in heavier commutation service traffic. The cellular-phone subsidy restriction has a positive relation with the ARPU of SKT and KTF; the restriction has a negative relation with that of LGT. This suggests that, in a situation where SKT and KTF control over 80% market share, the restriction would mean reductions

in expenses without significant impact on their subscriber base, contributing positively to the ARPU of the companies.

Advertisement has a negative relation with the ARPU of SKT and LGT; it has a positive relation with that of KTF. This reflects the steady decrease in the advertisement expenses of SKT and LGT over the years (except 2005) and a steady increase in KTF's advertisement expenses. KTF's ARPU did not change between 2006 and 2007, whereas it increased continuously in the past. This suggests that KTF's advertisement expenses were mostly translated into additional expenses, not increased revenues, whereas the reductions in the advertisement expenses for SKT and LGT have resulted in better ARPU for these companies by reducing overall expenses.

The ARPU of all three companies has generally increased from facility investment. This is because the additional users arising from such investments could be accommodated by the expanded network coverage, reflecting the benefits of the economies of scale and scope.

V. Conclusion

This study examined the relationship between the various restrictions implemented by the regulators of the Korean mobile telecommunications market and the resulting effects of those restrictions. The basic monthly fee restriction and the connection rate restriction improved the exclusive fee prevention and the distribution efficiency of the monopolistic companies due to the negative relation to the ARPU of the companies. However, the cellular-phone subsidy restriction that has been in place since 2000, in conjunction with an agreement among the companies, has limited competition among the companies.

KTF's ARPU increases when SKT increases its subsidy. LGT's ARPU increases when SKT and KTF increase their subsidies. SKT and KTF have enjoyed a positive advertisement effect as their advertisement efforts show a positive relation with the ARPU, whereas LGT has faced a negative advertisement effect as its advertisement effort shows a negative relation with its ARPU. Positive economic effects of scale and scope brought about by facility investment are indicated for all three companies.

According to the panel analysis results, the basic monthly fee restriction placed on SKT has generally produced a positive effect on the ARPU of all carriers. This suggests that the market environment had been made more favorable to SKT and KTF as the connection rate differential has decreased between them and LGT through the connection rate restriction.

The cellular-phone subsidy restriction has a positive relation with the ARPU of SKT and KTF; the restriction has a negative relation with LGT's ARPU. The restrictions have been

generally effective in improving the efficiency of distribution by lowering the ARPU of the companies. With ongoing convergence in the telecommunications industry, the scope of the asymmetric regulations has been gradually reduced. The government needs a clear policy guide so that an effective competitive environment can be maintained. With respect to fee restriction, the basic monthly fees were reduced sufficiently, and direct intervention through a government policy may not be necessary because the carriers already have a range of non-basic monthly fee systems. In terms of the cellular-phone subsidy restriction, it may be necessary to establish an effective monitoring system to ensure that such costs are not translated into higher customer fees, while allowing companies to freely use subsidies to promote their businesses.

We propose these conclusions with some reservations. This is because there may be certain problems associated with potential endogeneity, the usage of unstable time-series data, and the lack of statistical data, although dispersion, the correlation of error, and multicollinearity were solved within the model. As such, future study may be warranted to more reliably estimate data based on a simultaneous structural equation system for the resolution of potential endogeneity problem using comprehensive statistical data.

References

- [1] S.-K. Choi, "Special Issue: Fair Competition and Asymmetric Regulation in Telecommunications Market," *Society of Industrial Organization*, vol. 10, no. 3, 2002, pp. 107-125.
- [2] S. Wallsten, "An Econometric Analysis of Telecom Competition, Privatization, and Regulation in Africa and Latin America," *J. Industrial Economics*, vol. 49, no. 1, 2001, pp. 1-19.
- [3] S.-K. Choi, "Special Issue: Fixed-Mobile Convergence and Regulatory Policy; Asymmetric Regulation under Fixed Mobile Convergence: Fair Competition or Managed Competition?" *Society of Industrial Organization*, vol. 11, no. 1, 2004, pp. 1-23.
- [4] J.-W. Park, "Competition and Asymmetric Regulation in Mobile Telephone Market," *Society of Industrial Organization*, vol. 11, no. 1, 2003, pp. 49-75.
- [5] S.-S. Yi, "Special Issue: Competition and Regulation in the Mobile Telephony Market," *Society of Industrial Organization*, vol. 10, no. 2, 2002, pp. 99-118.
- [6] J. Kwak and S. Yun, "Price Regulation in the US Fixed-line Telecommunications Market," *Inf. Commun. Policy*, vol. 17, no. 12, 2005, pp. 1-27.
- [7] N. Seong and T. Kwon, "Incentive Regulations, Competition and Economic Efficiency in the US Local Telecommunications Market," *Korea Telecommun. Policy Review*, vol. 14, no. 1, 2007, pp. 81-118.
- [8] N.-S. Kim, "The Latest Price Regulation Trends in the UK Fixed-

Line Telecommunications Market,” *Inf. Commun. Policy*, vol. 15, no. 9 (Serial No. 324), 2003, pp. 1-13.

- [9] J. Lee, J. Byeon and K. Oh, “KISDI Issue Report: International Trends in Essential Facilities Regulation and Implications,” *KISDI Research Paper Series*, vol. 2003, no. 14, 2003, pp. 1-55.
- [10] R. Warford, J. Saunders and B. Wellenius, *Telecommunications and Economic Development*, World Bank, Washington, DC, 1993.
- [11] S. Wallsten, “An Empirical Analysis of Telecom Competition, Privatization, and Regulation in Africa and Latin America,” *World Bank Policy Research Working Paper*, no. 2136, 1999.



Chuhwan Park is an assistant professor in the Department of Economics and Finance at Yeungnam University. He received the MA in 1995 from the Western Illinois University, Illinois, USA, and the PhD in 1999 from the Pennsylvania State University, Pennsylvania, USA. Since he

finished the PhD program, he has been involved with many projects on IT economics analysis, regional economics, and economic policy. Now, he is interested in the economic analysis of public R&D expenditures and technological innovation in terms of IT growth.



Sung-Soo Han is a director of the Techno-Economics Research Department at ETRI. He received the BA, MA, and PhD degrees in strategic management from Hanyang University, Seoul, Korea. Since joining ETRI in 2000, he has been involved with many projects on marketing

strategy, industrial analysis, business strategy building of the IT sector. Now, his research interests are dynamic management of IT business, needs evolution modeling, synthesis model of firm performance, and commercialization of technology.



Wang-hun Seok is an MA candidate in economics at Yeungnam University, Gyeongbuk, Rep. of Korea. He received the BA degree in economics and finance from Youngnam University. Since joining the MA program in 2008, he has been involved many projects on the industrial

analysis of IT and the broadcasting sector. Moreover, he has published many academic papers related IT and economics since 2008. His research interests are regional economics and IT related subjects in terms of theory and empirical analysis.