The source of excess momentum in technology standard adoption : The case of third generation mobile communication in South Korea

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Abstract

Mobile communication industry in South Korea has been developed from second generation CDMA technology to third generation technologies. The standards of mobile communication technologies were selected by government's policy intervention. Particularly, the government established policies for activation of third generation mobile communication even though the level of third generation technology was insufficient to be diffused. In this study, we examine whether the market of third generation mobile communication reveals the excess momentum or not, and analyze the effects of government policy intervention on consumer's adoption.

Keywords: third generation mobile telecommunication, technology standard, government policy intervention, excess momentum

1. Introduction

Telecommunication industry in South Korea has one of world's leading technologies, although the beginning of the industry was quite behind. By now, some developing countries are benchmarking South Korean cases, as best practices. While the factors leading to world's leader in telecommunication industry are various, a number of studies state standardization of

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the telecommunication technologies played an important role as a strategic instrument (Seong, 2004; Yoo, Lyytinen, and Yang, 2005; Lee, Lim, and Song, 2005; Jho, 2007). These results are derived by the national-level efforts, such as *de jure* standardization driven by government and supports by a number of firms involved in the telecommunication industry.

In a similar context, telecommunication policies are also applied to the evolution of the mobile communication standard, from second generation, CDMA, to third generation, WCDMA, WiBro, and 1xEVDO revision A. Although standard in 3G technologies is better than in 2G in terms of technological specifications, the implementations of and the investments to the 3G technologies were insufficient. Nevertheless, proactive policies – subsidies only for 3G technologies – made users adopt 3G technologies, leading to large installed base. Most users had to adopt 3G technologies, which reduced their utilities because the performance of 3G was not as perfect as 2G. These immature technologies caused the excess momentum.

The excess momentum means an inefficient adoption caused by a next generation technology which is not fully implemented or is immature. Studies on the excess momentum have similar context on the excess inertia, and both reveal the inefficient states of markets. Farrell and Saloner (1986) compare the private and the social incentives when consumers are considering adoptions between incompatible technologies. They prove the excess momentum and the excess inertia stay in equilibria with the states of the inefficient adoption. They analyze these inefficiencies are caused by the existence of installed base and the penguin effect, and welfare effects along with the technology adoption. A number of studies concerning the excess momentum are derived from this research. For example, Choi (1996) analyzes the role of converters using the modified model in Farrell and Saloner (1986). He does not support the common idea that a converter can make technology transition easier. Rather, he supports this converter induces the excess momentum leading to the inefficient market.

Katz and Shapiro (1992) conduct the analysis on the product introduction and the price setting where the installed base is important to the market. They examine various conditions in which make the excess momentum occur. De Bijl and Goyal (1995) also examine various conditions where the excess momentum exists in terms of technological innovation. These studies use the concepts of Fulfilled-expectations equilibria. Recently, Clements (2005) represents that inefficient technology standard adoption can be always possible. He explains the conditions in which the excess momentum occurs using another term, the overadoption.

However, it is hard to find similar topics concerning policy intervention and following excess momentum which this study tries to focus. Although Cabral and Kretschmer (2007), and Maier and Ottaviani (2007) analyze the effects on the standard adoption after government's policy intervention, their models are relatively limited. Especially, the current study adopts the level of technology maturity in order to verify the excess momentum observed in the inefficient market.

The purpose of this paper is to examine whether 3G technology standards in Korea reveal the excess momentum or not. In-depth studies of existing literature concerning the excess momentum are at first reviewed and summarized, and a new model based on existing literature is presented in order to apply to the analysis. Furthermore, this paper will point out that the main reason of the excess momentum is standard policies done by government intervention, i.e. a form of *de jure* standardization, which once is one of the effective sources to succeed in developments of technologies.

The remainder of this study is as follows. First of all, the processes of mobile communication standardization in both 2G and 3G from government's viewpoint will be reviewed. Based on these backgrounds, main assumptions and a model will be established in order to issue the excess momentum caused by government intervention. Additional implications and suggestions will be followed.

2. Standardization in second generation

Telecommunication industry usually begins as the state of natural monopoly, and so does it in South Korea. The government started the first generation mobile communication service in 1984, and privatization occurred in 1994. Around the time, a plan for transition to second generation mobile communication service was started with the participation of diverse actors. At this moment, various events were occurred in the process of selecting 2G mobile communication technology standard[2]. In brief, CDMA technology, development of which had been driven by government in South Korea, was selected as a 2G mobile communication standard. This means that although various stakeholders – domestic and international firms, institutes, and specific organizations – participated in the process of standard-setting,

[2] Seong (2004), Yoo et al. (2005), and Jho (2007) explain the process of selecting 2G technology standard in different viewpoints.

government and standard-setting organization in South Korea played important roles to make a final decision. As de Vries (2005) states, this can be seen governmental standards in a standard classification, and in a sense *de jure* standards.

The selection of CDMA led by government can be analyzed in various ways, but the literature generally reveals successful results. Seong (2004) explains the selection of CDMA standard in advance made mobile communication industry more stable, and consequently the industry could achieve great growth. Yoo et al. (2005) analyze the development of CDMA with actor network theory, which consists of factors such as regulatory regime, innovation system, marketplace, and standard. An undeniable fact is that CDMA standard guides South Korea to be a leading country in mobile communication industry.

3. Transition to third generation

Sometimes third generation mobile communication is distinguished between 3G and 3.5G. 3G technologies began in early 2000s, and 3.5G technologies include HSDPA, WiBro, and 1xEVDO Revision A, services of which recently started. In the current study, the effort of government on the standardization will be only focused by 3G viewpoint, while the excess momentum will be only focused by 3.5G. In the model of current study, however, 3G will be used generally as a term.

As 3G was basically oriented to the global service, government in South Korea needed to approach to the standard-setting process more flexibly. Thus, double standard and voluntary adoptions for the industry were observed in the early stages. However, government intervened in 3G standard-setting process with various ways, not having been revealed ostensibly. For example, the official government for mobile communication industry, Ministry of Information and Communication (MIC), allowed service providers to adopt one of two standards voluntarily, synchronous technology (CDMA-based) or asynchronous technology (GSM-based) in the beginning. Eventually, however, MIC forced at least one service provider to adopt synchronous technology that was succeeding technology of CDMA[3].

This means the approach that government had already conducted in 2G standard-setting was also realized in 3G standard-setting similarly. In other words, government intended to

[3] The process of selecting 2G technology standard can be also seen in Seong (2004), Yoo et al. (2005), and Jho (2007)

choose a technology standard as a form of *de jure* standardization. Unfortunately, the results were not achieved as expected similar to CDMA in 2G. The 3G technologies themselves were not diffused widely, and even one of service providers waived the license for operating 3G services (Lee, Kwak, Kim, and Kim, 2009). Consequently, the government's intervention to 3G market where service providers should consider international competition produced poor results.

Meanwhile, another intervention by government can be seen in 3.5G mobile communication. Technologies such as HSDPA, WiBro, and 1xEVDO revision A are competing in this 3.5G market. However, WiBro cannot support voice-based service, and strictly 1xEVDO revision A is an extension version of 2G. In the current study therefore, only HSDPA technology will be focused. After launching 3.5G services in 2008, government started to support with several policies in order to activate HSDPA and to draw firms' investments. For example, device subsidy, and permission for bundling service were approved. As a consequence, a lot of users adopted 3.5G mobile communication. However, 3.5G technologies were technically insufficient at that time[4], and this was reflected in the survey for customer satisfaction done one year after launching the services[5]. This means the government's intervention to the technology standard adoption only raised consumers' dissatisfaction. In addition, the effects gained by the intervention in 2G standard-setting could not be obtained any more.

Until now, we have observed the processes of technology standard adoption in mobile communication in South Korea. Next, a model with assumptions that can explain the real situation will be presented.

4. Basic setup

There exists two technologies, A and B. technology A is incumbent, B is new one, and both are incompatible. Utilities gained by each technology are represented by θ_A and θ_B. Technology B is basically superior to technology A, $\theta_A < \theta_B$. In the early time, as only A

[4] A survey for mobile communication service quality evaluation by Korea Communication Commission (successor of MIC) in 2009 reports that the rate of success for voice call is 97%, while for video call is 93%, typical services of 2G and 3G, respectively. We can infer that the level of 3G technologies was lower when the 3G services started.

[5] http://www.etnews.co.kr/news/detail.html?id=200805210041

exists, all consumers adopted A. That is, A has installed base, which in the current study is normalized in 1. After specific time, technology B was introduced to the market. As B was insufficient technically, the level of maturity was considered, δ ($0 < \delta \leq 1$). If $\delta = 1$ then $\theta_A < \delta\theta_B$, and if δ is lower than 1, then we cannot measure.

Prices are assumed to be exogenous and same for each service[6]. Therefore, prices are not considered in each utility. Meanwhile, as network externalities exist in this market, consumers will consider network externalities of each service when they buy. These will be added to consumer's basic utility as an additional term. Consequently, the utility that consumer has is expressed by addition with basic benefit of each service and benefit of network externalities;

$$u(i,t) = \theta_i + k(n_{it}), \quad i = A, B$$

Here, $k(n)$ represents network externalities with a form of decreasing returns to scale. n_i is users of technology *i*.

Meanwhile, government announces a policy in order to support technology B. The policy intervention is expressed by a form of subsidy. In other words, the government gives subsidies to consumers who buy technology B in order to decrease price. This can be represented by subsidy *s* adding to consumer utility. Therefore, utility of technology B with level of maturity is as follows.

$$u(B,t) = \delta(t)\theta_B + k(n_{it}) + s$$

In the current study, new users are not considered. The reason is to describe the real mobile communication market in South Korea, where already saturated in 2G technology[7]. Consequently, we can notice that users who want to adopt 3G technology standards are switched from 2G technology. Farrell and Saloner (1986) compare private and social incentives with a model considering only technology transition where new users are not

[6] When mobile communication firms in South Korea try to change prices of services, they should receive government's approval (for dominant firm), or declare them. Therefore, prices can be assumed to be exogenous.

[7] After April 2004 to May 2010, growth rate of monthly subscribers are around 0% except only one month (http://www.ktoa.or.kr).

considered. They assume users who try to switch are in Poisson process, while uniform distribution is considered in the current study. The numbers of users who have switched are noticed by the number of 'number portability.' Though monthly differences exist[8], the variation is relatively insignificant.

In the analysis, we consider consumer's adoption comparing both technologies in period *t*. For each period, constant consumer choose to either (1) adopt B or (2) stay A, and the number of switchers is determined by the difference of utilities.

5. Expected result

In the current study, the form of government policies in both 2G and 3G mobile communication standard is reviewed, and later the effects of interventions on the technology standard adoption of consumers will be examined. Using these results, government can apply to its policy direction such as technology policy and standardization processes.

For further studies, comparison with the process of 2G technology adoption would be needed. Measuring both processes, the optimal adoption time can be derived. And diverse models are helpful to elaborate various conditions. For example, the current study only assumes that both technologies are incompatible. In case of partly compatibility or full compatibility, another result can be derived. In addition, various ways of government policies can be considered as well.

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