Facilities to Service based Competition, not Service to Facilities based, for Broadband Penetration and Investment: A Comparative Study between the United States and South Korea

I. Introduction

The growth of broadband penetration has been a worldwide concern. Because broadband has considerable spillover effects on our economy and society, many governments are striving to achieve high broadband diffusion and investment. As a "required infrastructure enabler" (OECD, 2008b), broadband enhances productivity, expands new realms of businesses, and creates innovation and globalization. It is also related with efficacy of democracy by widening the digital divide and generating a new participation gap across social strata (Hargittai & Walejko, 2008). Considering all of these socioeconomic implications, broadband is an important issue which calls for more empirical research.

In order to increase broadband penetration and investment, it is necessary to have competition among broadband providers. However, characterized by network economy, the broadband industry is dominated by a few incumbents who enjoy high entry barriers, built up with strong economies of scale and technological externality. Since it is difficult by nature for competition to take place in network industry, many governments have stepped in to promote competition by facilities-based or service-based entry[1] in broadband industry. Service-based entry policy is adopted by most countries, though facilities-based competition is regarded as the most desirable mode of competition, because the former is assumed to facilitate entry and foster competition within a relatively short period of time through leasing incumbents' networks compared to the latter. Contrary to assumptions, however, previous studies have found mixed research results about the effect of service-based competition on broadband diffusion. By questioning inconsistencies in previous results, the present research attempts to find how broadband policy affects broadband penetration.

Along with broadband diffusion, investment needs to be considered as well. The reason why both aspects are discussed together is that the policy to achieve either one can have negative effect on the other. Against the logic of service-based competition which assumes that open

access to incumbents' networks facilitates broadband penetration, opposing theory raises that service-based competition undermines industry's incentive to invest in facilities, which deters having upgraded, high-speed broadband services. Since there is trade-off between the two competing theories, policies which promote only one side, i.e. penetration or investment, are crippled to achieve broadband service with "high capacity at low price to more of the population" (Berkman, 2010). Therefore, in addition to broadband penetration, the present research asks a question of how broadband policy shapes investment in the market.

Besides policy, there are various factors which affect broadband penetration and investment such as geography, population density, income, and education. These given, non-policy variables were found to explain around 75 to 85 percent of the performance of broadband industry (Berkman, 2010), but the present research concentrates on the remaining 15 to 25 percent which might be determined by policy factors. Depending on the policy, some countries might show better or worse outcome than expected from given factors. Since this study is not to find what variables affect broadband outcome, but to find which policy factors contribute to attaining the goal of high penetration and investment, the focus is on policy, admitting the impact of non-policy factors on broadband deployment. Additionally, policy factors in this research are sided on the supply of broadband, not the demand. Policies to promote demand through education or free access to computers or Internet are out of scope of this study. This study indirectly discusses demand since it is influenced by price and quality (Berkman, 2010) which are mainly decided by the supply side. The main concentration of the present study is policy factors related to the supply of broadband.

Within the pre-determined scope of this research, case studies have been chosen as the methodology in order to have differentiated and profound understanding of broadband access by country. Selected cases are the United States and South Korea both of which experienced facilities and service-based competition. Based on a deeper analysis of each country, this study expects to find how the market structure shaped by broadband policies has affected the performance of the broadband industry.

This research starts in chapter II with a discussion of the importance of broadband, as well as the necessity for government intervention to increase competition in the broadband market. Chapter III has a literature review on broadband policy in the wholesale market, and

chapter IV suggests research questions. Chapter V explains why the case study method is chosen and why the two countries are selected as cases. Before dealing with the research questions, institutional differences between the U.S. and Korea are discussed in chapter VI, since policies are the product of institutions. Then, case studies and comparisons of the two countries are developed in chapter VII, followed by discussion and conclusion in chapters VIII and IX, respectively.

II. Broadband as a Network

Why is broadband important? Broadband, as a network, is the most fundamental infrastructure in the Information Age; it is like the railroad in the era of Industrialization. The railroad connected remote places together, facilitated the nationwide transportation of raw materials, products and people, propelled the growth of industries, and ultimately contributed to enhancing our quality of life. While the railroad is a means to carry people and things, broadband is a means to convey information. It has a strong impact on almost every sector that depends on the provision of information and, at the same time, expands new realms of business such as e-commerce, online education, and online health services with increased bandwidth.

By enabling more intensive use of information technologies, broadband reinforces the impact of the Internet on our economy, produces more innovation and globalization of services, and increases productivity (OECD, 2008b). Broadband as a network contains network effect which means that benefits depend positively on the total number of people on the network (Church et al., 2008). According to the 2009 report from the World Bank, every 10 percent increase in broadband penetration increases 1.21 percentage points in per capita GDP growth of high-income economies and 1.38 percentage points in case of low and middle income economies (Qiang et al, 2009).

Besides its positive economic impact, unequal diffusion of broadband affects our society by aggravating the digital divide and social inequality. For example, broadband can widen the gap between urban and rural inhabitants, high and low-income employees, and information haves and have-nots (Windhausen, 2009). Digital inequality can generate a participation gap, under-represent (or over-represent) certain groups of people, and finally undermine the efficacy of

democracy. Therefore, considering broadband's strong spillover effect on our economy and society, an increase in broadband penetration and investment is one of the top priorities in most governments' agendas.

In order to increase broadband penetration and investment, policies to foster competition in the wholesale market have been implemented in most countries, rather than completely leaving the extent of broadband participation to the market itself. Government intervention seems to be needed in the broadband industry, since broadband bears the characteristics of a network economy. The network industry has high barriers to entry because of its high fixed cost, low marginal cost, and first-mover advantages. It is almost impossible for facilities-based newcomers to provide similar levels of service at the same cost without the help of incumbents who already enjoy strong economies of scale and technological externality (White, 1999). Therefore, the high entry barrier tends to generate a monopolized market which usually cream skims, imposes high price, refuses to interconnect, and invests less without government intervention. According to Economides (2004, p.2), regulation can be introduced to the market "where competition cannot be achieved by market forces, where deviation from efficiency is deemed socially desirable, and where the social and private benefits are clearly different." In view of these three criteria for government intervention, broadband policies are likely to be necessary to lower the entry barrier and create competition for the growth of broadband diffusion and investment.

While the "internal logic" of the technology, i.e. the innate characteristics of the broadband network, is similar across nations, the "external logic," i.e. the logic of the socio-cultural environment surrounding the technology, is different by countries (Sawhney, 1999). It is the interaction between the two logics that shapes the development of technology. Even though the technology itself is the same, the outcome produced by the technology shows great variance by country because of the difference in the "external logic" that decides the way to appropriate technology in a certain society. The potential of technology is not up to the technology itself, but to the policies, the product of political, economic, social, and cultural consensus, which reminds the importance of policy.

III. Literature Review

Governments can promote competition in the industry through five competitive forces. They can decrease the entry barrier and control the bargaining power of suppliers or buyers. Additionally, they can increase rivalry among existing firms and support substitute products with regulations, tax incentives, or subsidies (Porter, 1980). Among these five ways, most governments have chosen to lower barriers to entry and increase the number of competitors in order to foster competition in the broadband wholesale market. There are two main modes of competition designed by entry policy to the broadband industry: facilities-based and service-based competition.

a. Facilities-based Competition

Facilities-based competition is the competition between "the vertically integrated platforms providing closely substitutable services entirely over their own infrastructure" (Maldoom et al., 2005, p.33). It can be regarded as platform competition (or infrastructure competition), including intra-modal competition among multiple platforms with similar technologies and inter-modal competition among platforms with different technologies but similar retail services, such as DSL and cable networks (Maldoom et al., 2005).

Many governments pursue facilities-based competition in the broadband industry (OECD, 2008a) because it has several advantages. Under facilities-based competition, broadband providers can enjoy flexibility and create innovation by having full control in setting service features provided by infrastructure investments (Bourreau & Dogan, 2004). According to Christodoulou & Vhahos (2001), being independent of incumbents' network, entrants have no limitation in the choice of price, service, and technologies, and can provide the most satisfying service mix to consumers. Moreover, platform competition requires less government intervention than service-based competition (Bourreau & Dogan, 2004) because the service offering is up to the decision of operators. Though facilities-based competition can cause duplicative investments in infrastructure (Laffont & Tirole, 2000), it increases long-term efficiency due to less regulation and more service flexibility, and, at the same time, better serves consumer needs with differentiated products as compared to service-based competition.

Based on previous studies (Aron & Burnstein, 2003; Maldoom et al., 2003; Bourreau & Dogan, 2004; Distaso et al., 2004; Picot & Wernick, 2007; Wallsten, 2007), there is consensus that facilities-based competition increases broadband penetration. It is also regarded as the most desirable mode of competition that government can promote in broadband industry. However, with facilities-based entry, it is presumed to be hard to achieve broadband deployment in extensive areas within a short period of time (Laffont & Tirole, 2000). This is because a large sunk cost is required to build infrastructure and new entrants cannot afford to compete with incumbents who enjoy lower average costs obtained by economies of scale and already retain a substantial number of subscribers stemming from a first-mover advantage. For these reasons, service-based competition has been introduced as a stepping stone towards facilities-based competition.

b. Service-based Competition

Service-based competition is competition among companies which rely partially or entirely on the facilities or the services of other operators (Bourreau & Dogan, 2004; Picot & Wernick, 2007). It includes both resale of incumbents' wholesale end-to-end products (access-based competition) and leasing of unbundled local loops (mandatory unbundling) [2]. The application of mandatory unbundling varies slightly by country, but this study follows the typology of local loop unbundling defined by the Organization for Economic Co-operation and Development (OECD). OECD (2003b) classifies local loop unbundling into the following categories: full unbundling, line sharing (or shared access), and bitstream access[3]. Based on this technological classification, service-based entry covers resale, bitstream access, line sharing, and full local loop unbundling. The entrants' discretion for product differentiation increases along the continuum from the resale of wholesale end-to-end access to the leasing of unbundled local loops.

While facilities-based entry is subject to high sunk costs, strong scale economies, and first-mover advantages, partial-leasing or resale of incumbents' facilities can abate these entry barriers. In addition, according to Kim et al. (2006), partial-leasing introduces competition faster than facilities-based entry and allows potential competitors to learn and experience the broadband industry with lower risk. Moreover, entrants can respond flexibly to the unexpected

consumer demand because they are not tied to a particular technology or upfront investment (Maldoom et al., 2005). According to Hausman and Sidak (2005), mandatory unbundling is based on the rationale that it lessens broadband subscription prices and promotes future facilities-based investment by raising competition in both retail and wholesale markets. This rationale has been examined by previous research, producing unexpected results about the effect of service-based competition on broadband penetration and investment.

i. Broadband Penetration

As we will see below, while facilities-based competition has been found to consistently increase broadband penetration, there are mixed results as to whether service-based competition has a significantly positive impact on broadband diffusion.

Conducting a statistical regression analysis of 100 countries during 2001 with data from the International Telecommunication Union (ITU), Garcia-Murillo (2005) found that mandatory unbundling[4] was positively correlated with broadband[5] availability. 76 percent of countries without an unbundling obligation did not provide broadband access, while 67 percent of countries with an unbundling regulation had broadband access during the study period. Though she did not find a significant relationship between unbundling and the number of broadband subscribers, whether unbundling was required or not was a significant predictor for broadband deployment. In line with Garcia-Murillo's (2005) research, Ford & Spiwak (2004) found that States with lower rates for unbundled local loop access had higher broadband[6] availability in the U.S. Counting the number of broadband providers by zip code within the State from 2002 to 2003, they concluded that higher local loop prices decreased the number of zip codes served by at least one broadband provider (universality) and also the number of zip codes having at least four broadband providers (competitiveness). This result supported the argument that service-based competition did not dampen broadband deployment and, rather, increased consumer choice for broadband providers. Since broadband availability to consumers is not necessarily equal to broadband penetration, these findings provide a weak but implicit support to the positive relationship between service-based competition and broadband penetration.

The direct impact of mandatory unbundling on broadband diffusion was found in the more recent research. Using data from OECD over the period of 2000 to 2005, Grosso (2006)

found that the broadband penetration rate of OECD countries with local loop unbundling[7] was 0.32 percent[8] higher than that of OECD countries without mandatory unbundling. His explanation of this result was that unbundling lowered entry barriers and increased the number of firms. As a result, increase in competition decreased prices and increased the level of demand for broadband services, which is the intended consequence of the service-based competition policy.

Not only quantitative analysis but also qualitative research suggested the positive effect of service-based competition on broadband diffusion. Through case studies examining cross-sectional trends of penetration rates and access technologies in 2006, Picot and Wernick (2007) found that mandatory unbundling played an important role in having high broadband[9] penetration throughout Europe. Especially in some EU Member States, such as France, which did not have alternative cable infrastructure for broadband access during the study period, the strong-handed regulations for service-based competition were found to be a major factor of enhancing broadband penetration. Case studies of Japan and Denmark also found that unbundling policies contributed to accelerating the growth of broadband penetration in these countries. According to Ure (2003), unbundling regulations of 2000 rendered Japan with the world's lowest network charges for shared lines, which led to the ten-fold increase in the number of subscribers from 2000 to 2003. In the case of Europe, while the market share of new entrants offering DSL lines ranged from 0 to 4 percent in 2002, new comers in Denmark accounted for 21 percent at the same year. Denmark's success in having a competitive market structure was attributed to the extended application of unbundling regulations in 2001 (Ismail and Wu, 2003).

However, other studies produced opposite findings that service-based competition has no significant impact on broadband diffusion or even decreases the penetration. Conducting regression analysis of 30 OECD countries from 1999 to 2003, Wallsten (2007) did not find any statistically significant relationships between full local loop unbundling and broadband[10] penetration. Bauer et al. (2003) did the cross-sectional analysis using the 2001 data of OECD countries and came to the conclusion that the cost conditions of network deployment and the retail price of broadband service affected its diffusion, but competition in the telecommunications market did not have meaningful impact on broadband uptake. Rather, competition was negatively correlated with the broadband penetration rate. Since service-based competition policy aims to promote competition by lowering the network-building cost, the conclusions of Bauer et al. (2003) has a mixed implication on the effectiveness of service-based

competition. According to Hazlett (2006), when the U.S. government partly deregulated incumbents' digital subscriber line (DSL) service from the unbundling obligation in 2003[11], DSL penetration increased in absolute terms and relative to cable growth. The unbundling policy functioned as a deterrent of broadband diffusion rather than the facilitator in this case.

These contrasting results about the effect of service-based competition on broadband diffusion appear to stem from the difference in the following aspects[12]. First, different study periods can produce different results. Since it was the year of 2000 when broadband penetration rate ─ in terms of the number of subscribers per 100 inhabitants measured by OECD ─ went beyond the threshold of one percent, the history of broadband is slightly longer than ten years. Therefore, one or two years' difference of the study period in this emerging industry can seriously affect the research result. Additionally, the definition of broadband and its penetration is relevant to the results. There is no single, common definition of broadband: OECD and ITU define broadband by the speed of 256 Kbps download capacity or higher, while the European Commission sets the threshold of the download capacity at the speed of 144 Kbps. The Federal Communications Commission (FCC) defines broadband as the high-speed lines with 200 Kbps or higher in at least one direction. The definition of broadband penetration has diverged into two measures: the number of subscribers per 100 capita and the penetration rate per household. Though these two measures are highly correlated, they can generate differences in research results, which is discussed further in the methodology chapter. The scope of mandatory unbundling is also an important factor influencing the result. Under the spectrum of unbundling from resale to bitstream access, line sharing, and full local loop unbundling, there are variances by research regarding which form of unbundling to cover for analysis. Lastly, the point of time when the service-based competition policy was introduced might affect its impact on broadband penetration. Since broadband as a new technology follows the diffusion curve though it is closely linked to the availability of broadband, at what point on the diffusion curve the unbundling policy is adopted might distort the effectiveness of the policy. If the policy was implemented in the period of 'early majority,' there is some possibility that the penetration was increased not because of the policy effect but because of the effect of diffusion curve. Therefore, rather than penetration, market competition, which was assumed by many studies as a requirement to increase penetration, might explain the policy effect directly, reducing the bias from diffusion curve.

Considering these factors, the present study adopts a long period of analysis from the introduction of broadband to the latest (as far as the official data is available), a shared definition of broadband across studies, diverse measures of broadband diffusion, and a broad scope of mandatory unbundling. In order to minimize the effect of diffusion curve, the relation of service-based competition policy to market competition is taken into account, rather than the relation of the former to broadband penetration. Taken together, the present study attempts to determine whether service-based competition is the best alternative to facilities-based competition in order to boost broadband penetration within a relatively short period of time.

ii. Broadband Investment

Along with the high penetration, high broadband investment is another goal that governments have striven to achieve via broadband policies. By introducing service-based competition, governments expected entrants to climb the ladder of investment from reselling incumbents' facilities to leasing unbundled loops and finally to building their own platforms (Crandall & Sidak, 2007). This process is called the "stepping-stone hypothesis" whose focus is on the change of investment made by entrants, not by incumbents. Theoretically, the stepping-stone hypothesis allows entrants to earn revenue by leasing incumbents' facilities and investing that revenue to establish new networks (Hausman & Sidak, 2005), which consequently promotes competition with incumbents and affects their investment decisions.

Analyzing the change in local loop unbundling lines as a percentage of total CLEC lines over the period from 2002 to 2006 against 15 European countries, Crandall and Sidak (2007) observed that new broadband service providers in France and Italy clearly moved up from bitstream access to local loop unbundling. This escalation indicated that entrants made investments in constructing partial facilities, not remaining dependent on incumbents' infrastructure, which consequently supports the stepping stone hypothesis. A learning effect through unbundling practices might help entrants have high efficiency in future network investments (Bourreau and Dogan, 2004), but this was limited to the cases of France and Italy in Europe (Crandall and Sidak, 2007).

Except for a few studies, many found counter-evidence that service-based competition fails to lead entrants to invest in facilities and finally deters facilities-based competition. Christodoulou & Vlahos (2001) drew a conclusion from an empirical simulation based on the U.K. data that the service-only entry did not boost early competition in the residential voice services. This result was found to stem from customers' stickiness to incumbents' service and from the unappealing lease price of unbundled networks to entrants who expected the price to be much lower.

Crandall and Sidak (2007) found that the share of local loop unbundling lines of broadband against the entrants' total lines decreased in Denmark, Finland, Germany, Greece, Ireland, and the Netherlands from 2002 to 2006 in the same research aforementioned. Moreover, the shares of resale and bitstream access increased over the same time period in these countries, which shows that entrants are not climbing up but going down the ladder of investment.

Based on a formal dynamic model, Bourreau and Dogan (2004) claimed that the low rental price of unbundled loop in high-bandwidth services makes entrants prefer service-based competition to investment in their own facilities. This is because lower lease prices generate more profits to entrants and these profits become an opportunity cost against which have to consider building their own facilities. As a consequence, low unbundling lease price can result in delaying investment in facilities.

This phenomenon is also found in the study by Hazlett (2006). He found that, while facilities-based lines of new entrants grew by only 20 percent from 2000 to 2003, unbundled network elements-platform[13] (UNE-P) lines escalated by 300 percent during the same period in the U.S. This rapid increase of UNE-P lines resulted from the low UNE-P price, which simultaneously discouraged new entry as well as capacity expansion or quality upgrades of lines by incumbents. Observing the quick dominance of UNE-P lines over the total CLEC lines, Hazlett (2006) interpreted that mandatory unbundling crowded out new networks and investments, directly contradicting to the expectation of service-based competition policy.

All in all, the stepping-stone hypothesis, one of the main reasons for adopting service-based competition, has not been well supported by previous studies. The literature shows consistently that the price of leasing facilities is a decisive factor affecting entrants' decision

whether or not to invest in facilities and when to invest. One opinion suggests that a high unbundling rate would foster entrants' investment by decreasing the opportunity cost for giving up profits earned from the difference between the cost of leasing lines and revenues from providing broadband service (Bourreau and Dogan, 2004). Another viewpoint is that an increase in unbundling price finally lessens competition because the lease price is "a cost for the entrant and revenue for the incumbent" (Laffont and Tirole, 2000). Yet another claims that the increase in resale rate or the decrease in unbundling price does not lead resale-based entrants to climb the ladder of investment but, rather, drives them out of the market (Crandall and Sidak, 2007). The reason is that they enjoy profits raised by a low resale rate, but avoid risk from investing more.

In addition to setting the unbundling price, flexible pricing of both resale and unbundled local loops with gradual rate increases (Christodoulou & Vlahos, 2001) and sunset clauses for service-based entry (Bourreau & Dogan, 2004) have been discussed as facilitators to fulfill the stepping-stone hypothesis. Since most of the earlier studies about the stepping-stone hypothesis were based on telephone companies, whether the hypothesis holds in the broadband industry needs more study with other policy considerations.

IV. Research Questions

The present study deals with how the competition in the wholesale market affects broadband penetration and investment. Based on the literature review, service-based competition is regarded as a necessary and inevitable step to realize facilities-based competition because of the characteristics of the broadband as a network. In reality, most countries adopted service-based competition and have attempted to move into the facilities-based competition. Few studies have addressed the possible policy option of introducing facilities-based competition first and then turning to service-based competition. Questioning the unidirectional approach from service-based to facilities-based competition, the present research starts by examining how the direction of policy implementation affects broadband penetration.

Additionally, previous studies had inconsistent results on the question of whether the service-based entry policy increases broadband penetration and investment. Especially, the stepping-stone hypothesis, the main rationale of service-based entry policy, is not well supported

by the up-to-date findings. Considering that many countries rely on service-based competition assuming its drive in broadband uptake, it is important to examine the relationship between the service-based competition policy and market competition as well as the influence of service-based competition on investment. Research questions for the present study are below:

RQ1. Does the direction of policy implementation, from facilities-based to service-based competition policy or vice versa, affect broadband penetration?

RQ2. What is the relationship between service-based competition policy and market competition in the broadband industry?

RQ3. What is the effect of service-based competition policy on investment?

The present research explores the first research question through a comparative analysis between the United States and Korea. Each mode of competition, facilities-based and service-based, has advantages and disadvantages. Based on the literature review, facilities-based competition policy is regarded to provide better service to consumers, but not to facilitate new entry. On the contrary, service-based competition policy is assumed to decrease entry barriers, but can delay or deter the facility investment of both incumbents and entrants. Whether the order of implementing the policy contributes to the decrease in disadvantages that each policy has and to the increase in broadband penetration is the main point of this research question.

The caveat here is that not the broadband deployment but the penetration which is linked to the demand side is considered, though the present study focuses on the wholesale market, i.e. supply side. The reason is that OECD, the main data source of the present research, provides only penetration rate and demand is largely affected by retail price and quality (Berkman, 2010) which are decided by the supply side. Considering both supply and demand, Bauer et al. (2003) found that significant factors influencing broadband diffusion on the demand side were "preparedness" ─ i.e. attitudes toward information technology and savvy to use it ─ and population density. However, they did not find a causal relationship between preparedness and penetration. Additionally, population density was closely related to the network deployment cost, the major determinant of supply side. Therefore, the present study assumes that competition policy in the broadband wholesale market is closely related to penetration (demand) as well as deployment (supply).

The second research question can be addressed by comparing the situations before and after the policy change within each country. This temporal comparison within a country helps to find the effect of broadband policies on competition without being concerned about the impact of basic conditions such as population density and income. Whether competition in the industry increased during the period of service-based competition in each country will add evidence to the second research question which has had mixed answers from previous studies.

The last research question is related to the stepping-stone hypothesis. How the investment of entrants has changed accordingly to the change of the mode of competition will be examined. Most previous studies rejected the hypothesis and found that the mandatory line sharing policy undermines the incentive of investment, which implies that facilities-based competition might stimulate investment. Experiences of the United States and Korea with the two forms of competition can have implications for the investment stimulation assumption of facilities-based entry policy as well as for the stepping-stone hypothesis of service-based competition policy.

Through exploring these research questions, the present study attempts to find how the broadband market structure, established by competition policy, affects the market performance, measured by broadband penetration and investment. The comparative study between the cases of the United States and Korea can help to discover common institutional factors that generate better performance of broadband policies.

V. Method

In this study, broadband is defined as sufficient bandwidth to permit combined provision of voice, data, and video with a download speed of 256Kbps or faster (OECD, 2009). This definition is commonly used by ITU and OECD, which allows comparisons among countries as well as across studies, except for a few studies which used data from ECTA (European Competitive Telecommunication Association) and FCC. Broadband access covers platforms such as DSL, cable modem, ISDN (integrated services digital network) lines, and fiber optic cables[14], all of which provide faster download speed of 256Kbps[15]. The present research deals with only fixed, wired connection, not including wireless technology.

Broadband penetration is the percentage of DSL, cable modem and other wired broadband providers over the nation's total population. It is measured in terms of both per capita and per household because of the difference in their strengths and weaknesses. The number of subscriber lines per capita includes both business and household subscriptions, while the percentage of households with broadband connections does not consider business subscriptions (Berkman, 2010). However, a per household measure is more valid since fixed broadband is usually subscribed by household unit rather than by individual unit (Berkman, 2010). To increase measurement validity, the present study applied both per capita and per household measures.

Broadband investment is indirectly measured by capital expenditure of entrants and their capital expenditure to revenue ratio over time. Since many of the broadband providers were telecommunication companies, it is hard to separate investment only made for broadband from the overall capital expenditure spent in both narrowband and broadband. Admitting this limitation, the present research attempts to find the effect of service-based competition policy on entrants' overall capital expenditure. Though broadband investment can be operationalized into broadband speed which is regarded as a crucial outcome of investment (Wallsten, 2007), this study does not adopt broadband speed as a measure of investment. The reason is that the data of broadband speed is not sufficient to do time-series analysis and contains a gap with actual speed since it is based on advertised speeds reported by company (Wallsten, 2007). In addition to the capital expenditure of entrants, that of incumbents is also considered to find whether service-based competition offers disincentive to incumbents.

To address research questions of the present study, a case study is selected as a research method. Since policies are made on top of pre-existing conditions ─ such as population density, income, and education (Bauer et al, 2003; Wallsten, 2007) ─ factors shaping broadband penetration and investment are not easily simplified and captured in econometric work (Bauer et al, 2003) or statistical analysis. However, case studies allow a differentiated and deeper understanding of broadband policies by country, as suggested by Picot and Wernick (2007).

Cases of the present research are from the United States and South Korea. The U. S. mostly abandoned its service-based competition policy through the FCC's Triennial Review Order of 2003 which was later refined by the Triennial Review Remand Order of 2004. Since the U.S. broadband policy has been shaped incrementally through multiple appeals in judicial

litigation of the FCC's order, it is hard to assert that FCC overturned the entire policy from service-based to facilities-based competition at a specific period of time with its full determination. However, considering that it was the Triennial Review Order (FCC, 2003) which freed incumbent local exchange carriers (ILECs) from unbundling rules in the broadband market and ruled to phase out line sharing within three years, the present research regards this order as the declaration of policy change into facilities-based competition as do several previous studies (Ure, 2003; Hausman & Sidak, 2005; Wallsten, 2007). Contrary to the policy direction of the U.S., Korea, which had successfully implemented a facilities-based entry policy, later adopted a service-based entry policy in 2002 under the strong initiative of the MIC (Ministry of Information and Communication). Before 2002, entrants had to establish their own networks without any unbundling requirements imposed on the incumbent, KT (Korea Telecom). Though new-comers' geographic coverage of broadband network was smaller than the incumbent's, they were able to attract consumers by their newer FTTC (fiber-to-the-curb) network. At present, entrants can lease local loops and have bitstream access through the adoption of service-based competition.

Based on the definition of concepts and the methodology of the present research, official data from the OECD, FCC, and KCC (Korea Communications Commission) are used to explore the research questions. OECD, of which both the United States and Korea are member states, has published annual fact books such as 'OECD Communication Outlook' and 'OECD Information Technology Outlook.' These publications contain information about telecommunication market size by platform and relevant regulatory issues such as competition and unbundling. The databases provided on the Web site of OECD, named 'OECD Broadband Portal,' 'OECD Key ICT Indicators,' and 'OECD Telecommunications Database,' have statistical data about broadband penetration from 1999 to 2008. The analysis on broadband policies of each country is based on the archival data available from the Web sites of FCC and KCC. Specifically, the FCC develops broadband policies and reports biannual statistical analysis on broadband access through the Wireline Competition Bureau. In the case of Korea, besides the KCC, governmental agencies, such as KISDI (Korean Information Society Development Institute) and KISA (Korea Internet and Security Agency), provide broadband-related research.

Applying these data resources, the change of broadband policy in the first research question is analyzed by focusing on the change in broadband penetration before and after the transition in the mode of competition. In order to address the second research question, service-based competition policy of each country is explored in detail. Along with the broadband penetration rate per se, this study also considers the change in the number of broadband providers and in the Herfindahl-Hirschman Index (HHI)[16] by technology during the period of service-based competition. HHI has been used to measure inter-platform competition by Distaso et al. (2006). As for the third research question, broadband investment can be measured by capital expenditure of broadband providers. Also considered is the change in the share of resale and local loop unbundling lines against total lines in relation to the price of unbundled networks. With the subject matter of the policies themselves, other factors affecting the design and choice of policy options are covered under the category of broadband policy (see Figure 1).

<Figure 1> Broadband Policy and the Outcome of Broadband Policy by research question

	Broadband Policy	Outcome of Broadband Policy
RQ1 (Direction)	Policy Change (Service-based ↔ Facilities-based)	Change in broadband penetration (per capita and per household) before and after the policy transition
RQ2 (Competition)	Service-based Competition Policy	Number of broadband providers HHI by technology based on broadband subscribers per 100 inhabitants
RQ3 (Investment)	Service-based Competition Policy	Capital expenditure Share of resale and local loop unbundling lines

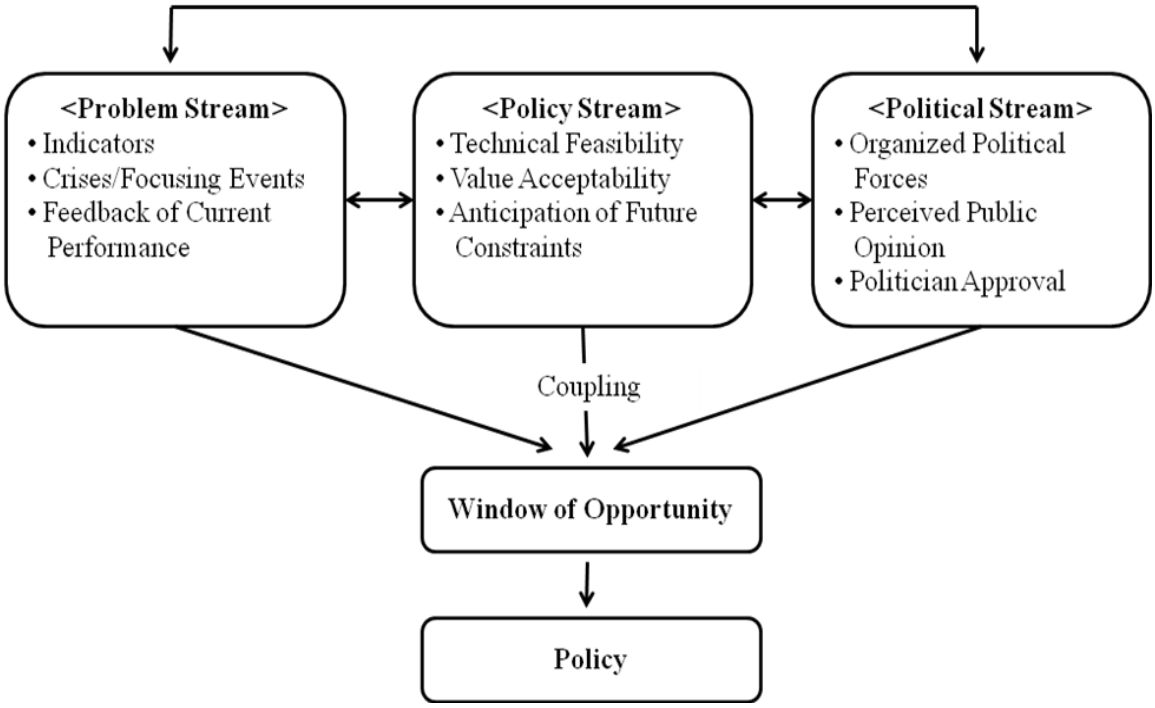
VI. Institutional Difference between the U.S. and South Korea

Before dealing with research questions, it is important to consider the institutional difference between the U.S. and South Korea. Since policy outcomes are not the full product of policy itself but the product of the "combination of institutional arrangements" (Bauer & Cherry, 2006), political, legal, and economic aspects are to be considered ─ including policy itself ─ to have an entire understanding of outcomes. Some comparative studies among countries took into

account preexisting (or given) conditions such as geography, population, education, and income, but the present study excludes these factors from its analysis. There are some countries such as Denmark, Netherlands, and Korea which have higher broadband penetration than expected based on estimation of non-policy factors, and their over-performance is explained by the effect of policy (Berkman, 2010). The goal of this research is to explore these policy measures and find common policy factors affecting broadband penetration and investment in two countries. Therefore, rather than focusing on the unchangeable, non-policy factors, this study concentrates on policy, policy outcomes, and institutional conditions which explain how a certain policy is adopted and why a similar policy has different outcomes across nations.

In order to have an overview of institutional variables in the policy decision-making process, Kingdon's (2003) model[17] provides a useful analytical framework (Cherry, 2000) which conceptualized the recurring pattern of policy adoption process. According to Kingdon's model, policy is adopted when the 'window of opportunity' is opened by coupling all three streams, 'problem, policy, and political streams': the rise of a problem on the policy agenda, the suggestion of a policy solution for the problem, and political acceptance of the proposed policy. Each stream is not only governed by its own institutional factors but also interacts with each other (see Figure 2).

<Figure 2> Kingdon's Model of Policy Decision-making Process



Source: Adapted from Cherry (2000)

The U.S. and Korea had gone through different trajectories of the decision-making process regarding broadband policy and practiced a contrasting direction of policy implementation: service to facilities-based competition without national broadband plan in the U.S. and facilities to service-based competition with a large-scale plan in Korea. Institutional differences which led to this contrast is analyzed by applying Kingdon's model over the period between the introduction of broadband and the change of policy, i.e. between the late 1990s and early 2000s.

Under the preexisting rules ─ the Telecommunications Act of 1996 and Local Competition Order of 1996 in the U.S. versus the plan for Korea Information Infrastructure (KII) of 1993 and the Framework Act on Information Promotion of 1995 in Korea ─ focusing events raised problems in the existing regime of broadband policy in both countries. In the U.S., the collapse of the dot-com boom in 2000 betrayed the expectation of policy makers that large investment would be made in building the infrastructure of broadband (Lasar, 2010). Rather, the crisis of the information technology market rapidly increased entrants' dependence on leasing UNEs which were much cheaper and less risky than investing in the broadband facilities at that

time. This distortion of service-based competition (Bauer & Cherry, 2006) which was misused to avoid financial difficulties, not to prepare for entering facilities-based competition, triggered the reconsideration of the unbundling regime.

In Korea, it was the severe financial crisis at the end of 1997 that provoked government to focus on the broadband industry as a new stimulating sector (Lee et al., 2003; Choudrie & Lee, 2004; Lee & Chan-Olmsted, 2004). This crisis as a turning point transformed the driving force of the national economy from shipbuilding and automobile industries to information and technology industry (Lee et al., 2003). The main problem at that time was to boost the supply of broadband, which was introduced in 1998, within a short period of time to lead the recovery of the overall economy. The impact of the economic crisis on broadband diffusion is well depicted by the Business Week (2000): "the transformation would have been much slower but for the 1998 financial trauma. The very event opened the way for radical changes that would have been unthinkable three years ago."

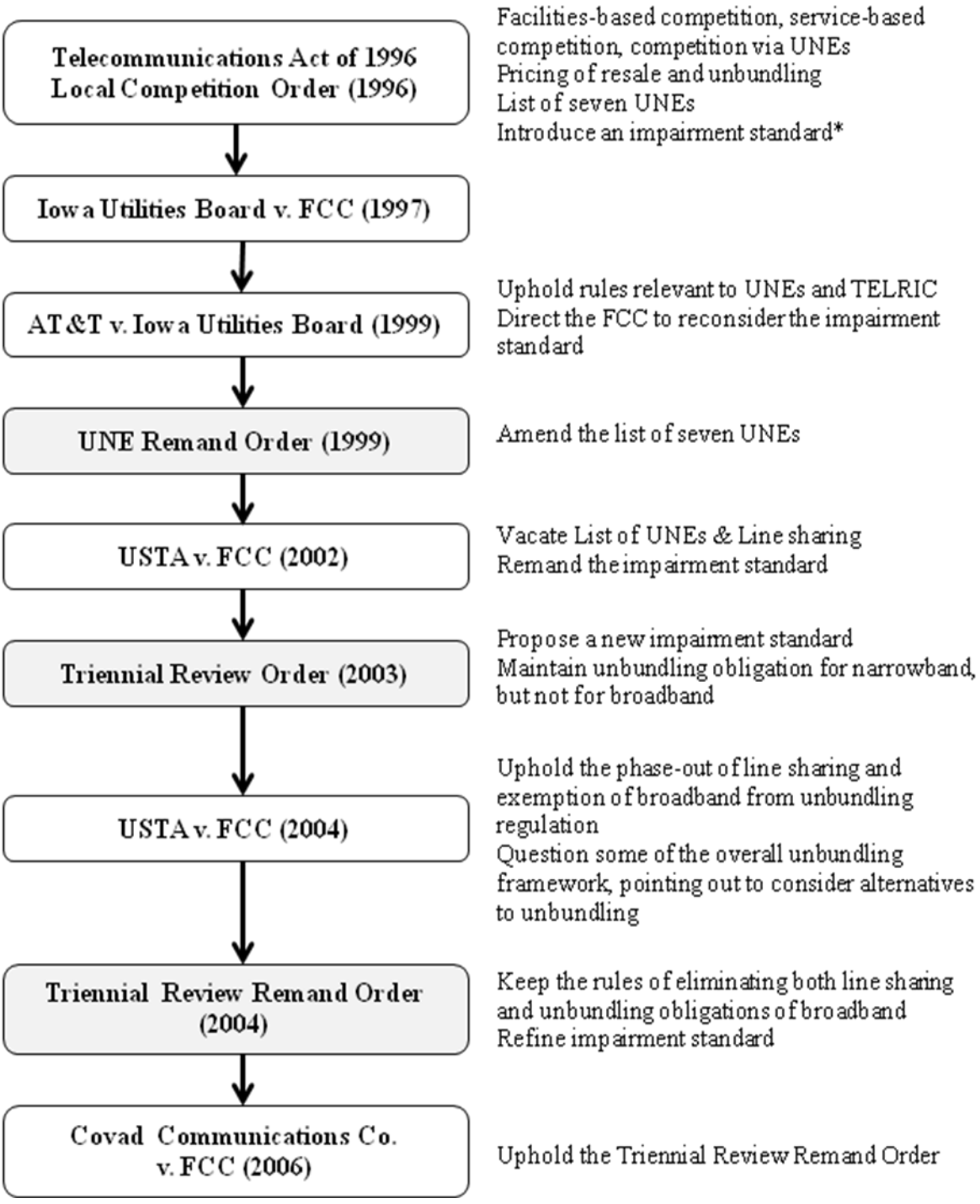
Having different experiences in the 'problem stream,' the two countries headed down different paths in the 'policy stream' as well. In the U.S., unbundling regulation was framed as technically infeasible to implement. Policy makers were influenced by ILECs' claim that the UNE-P price was too low to even cover the cost of building networks (Bauer, 2005) and had a detrimental effect on their financial balance sheets. Moreover, the likely appearance that cable's voice over Internet protocol service might outperform telephone companies' voice service (Bauer & Cherry, 2006) gave weight to ILECs' argument for the economic unsustainability of mandatory unbundling. Large-scale government investment or subsidy was not considered as an alternative since it was not compatible with the values of policy specialists as well as the general public who has traditional antipathy against the intervention of government in the private sector. Close interaction with the 'political stream,' the 'policy stream' ended up with a hands-off policy, revoking unbundling regulations against broadband and leaving the broadband deployment to the market.

In contrast to the U.S., government funding was a viable policy option in Korea. The 'policy stream' suggested 'Cyber Korea 21 of 1999' which set the basic direction for a knowledge-based society, based on the KII of 1993, a comprehensive plan for a national broadband backbone. 'Cyber Korea 21' intended to encourage infrastructure investment by

incumbents and entrants, provide financial support for the construction of networks, and promote universal access to the Internet and digital literacy (Frieden, 2005). Government loans amounted to 1,080 million dollars in total from 1999 to 2005 (Choudrie & Lee, 2004), which were offered to the new and existing broadband facilities providers. This huge investment contributed to the early establishment of entrants and activated facilities-based competition in the broadband market.

The 'political stream' played an active role in the decision-making process of the U.S. The main authority of broadband service is the FCC, an independent regulatory agency, which was established based on the Communication Act of 1934. The FCC adopts, implements, and enforces rules through a notice-and-comment process[18] and parties concerned can submit comment, place petition for reconsideration to the FCC, or make an appeal against the rules to the U.S. Court of Appeals based on the Administrative Procedures Act. Allowed by this procedure, resisters to the FCC policy have had considerable influence on the FCC's decision by investing in lawyers, lobbyists, and politicians (Whitt, 2009). Among the resisters, it is the incumbents who are the most vigorous and influential suppliers of relevant information, which explains why the FCC has had an historic tendency to lean towards the interests of incumbents (Whitt, 2009). Moreover, the incumbents are not the government-owned corporations as in Korea but the private companies franchised by the government, which means the incumbents are less inclined to follow the lead of the government than a public corporation like KT. In addition to the active role of strong interest groups, the FCC was swayed by court decisions. From the Local Competition Order of 1996 to the Triennial Review Remand Order of 2004, there were several court battles and the FCC's corresponding responses (see figure 3), resulting in the change of its policy from service-based competition to the removal of broadband unbundling regulation which incumbents argued for. In 2006, these battles seemed to come to an end by the court decision of Covad Communications v. FCC which upheld the FCC's Triennial Review Remand Order.

<Figure 3> The History of Court Ruling and FCC Decision



Note: Colored are decisions made by the FCC in response to court rulings. Impairment standard is applied to determine which network elements have to be unbundled.

Source: adapted from Bauer (2005)

Different from the U.S., the "political stream" in Korea well supported the policy option designed from the "policy stream" (Atkinson et al., 2008). The then MIC[19], whose head was an expert of information technology, was in charge of broadband service under the supervision of the Informatization Promotion Committee[20], a top-level decision-making body chaired by the Prime Minister. Based on the full support of the administration and its expertise in the relevant field, the MIC had a strong, centralized power to drive the broadband deployment plan, unlike the commission system of the FCC. Moreover, the nationwide consensus to overcome the financial crisis in 1997 justified the introduction of 'Cyber Korea 21' which was to create new businesses and jobs by building national infrastructure and improving connectivity (ITU, 2003).

In the U.S., the dynamics among the three streams, failing to couple each other, did not open the "window of opportunity" to introduce a national broadband plan, but led to incremental change from service to facilities-based competition around 2003. However, in Korea, under the initiative of the strong government as a "direct regulator" (Shin, 2007), the "policy and political streams" were united to launch and implement a comprehensive plan for broadband deployment as a way to solve the urgent problem of the financial crisis. This coupling of the three streams opened the "window of opportunity," resulting in the adoption of a policy to make a large investment for broadband supply. After both DSL and cable broadband gained significant ground which had been fostered by governmental investment, service-based competition was introduced in 2002, along with the full privatization of KT.

<Figure 4> Application of Kingdon's Model to Broadband Policy Decision-making

	U.S.	Korea
Preexisting Rules	- Telecommunications Act of 1996 - Local Competition Order of 1996 → Service-based competition	- Korea Information Infrastructure (KII) of 1993 - Framework Act on Information Promotion of 1995 → Facilities-based competition
Problem Stream	- Collapse of dot-com bubble in 2000 - Distortion of service-based competition by entrants Through leasing incumbents' facilities, entrants sought to avoid financial difficulties, not to prepare for investment in their own facilities.	- Financial crisis at the end of 1997 - Focus on broadband industry as a new stimulating sector to lead the recovery of overall economy
Policy Stream	- Framed as economically infeasible to implement unbundling regulation (low UNE-P price, competition from cable VoIP) - Not compatible with the values of policy makers and general public for large-scale government investment - Ended up with hands-off policy affected by the interaction with political stream	- Designed 'Cyber Korea 21 of 1999,' a specific plan based on the KII of 1993 - Offered government loans to broadband facilities providers
Political Stream	- Active resisters to the FCC decisions lobbying to lawyers and politicians - FCC's dependence on information provided by incumbents' - Incumbents as a franchise - Court decisions	- Strong initiative and expertise of the MIC - Full support from the highest level of the government - Incumbents as a government-owned company - Nationwide consensus to overcome financial crisis
Window of Opportunity	- Not opened for introducing a national broadband plan	- Opened
Policy Adoption	- Incremental change from service to facilities-based competition around 2003	- Adopted 'Cyber Korea 21 of 1999' - Later moved on to service-based competition in 2002 after the soft-landing of entrants with the government investment

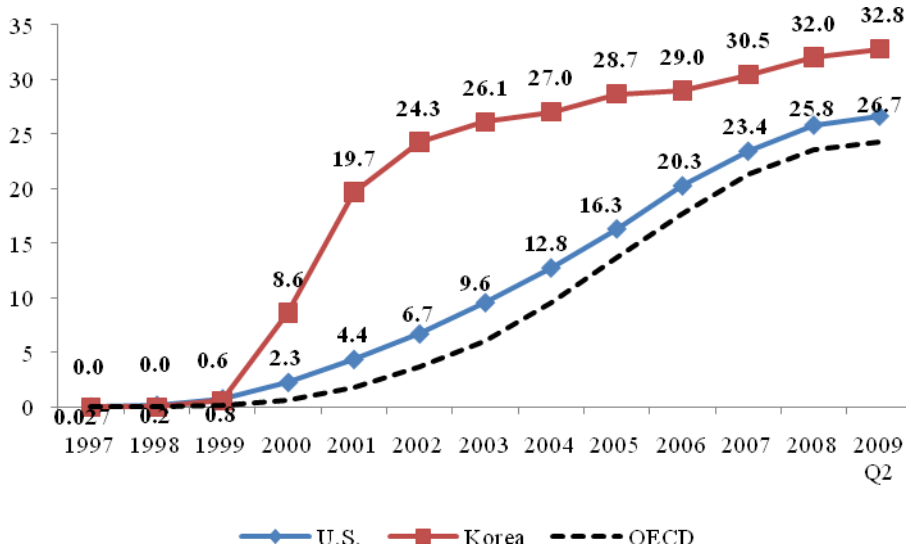
VII. Results

a. The Impact of the Direction of Policy Change

i. The Trend of Broadband Penetration over Time

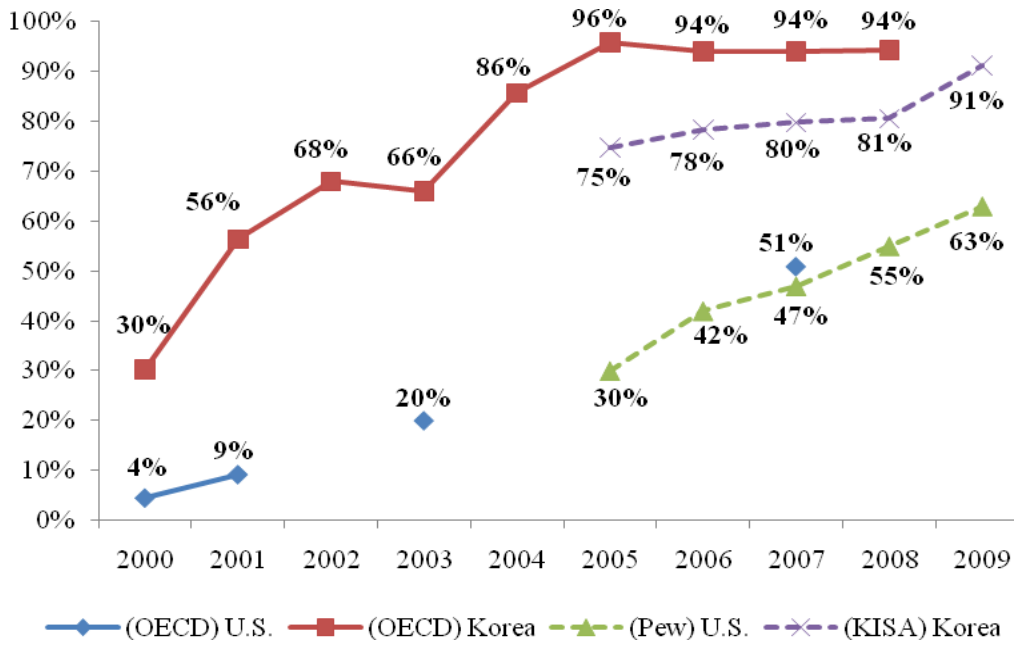
Using the data from OECD, the trend of broadband penetration shows a clear contrast between the U.S. and Korea in terms of both per capita (see figure 5) and per household (see figure 6) measures. While the U.S. had a steady rate of increase in broadband diffusion throughout the period of 1997 to 2009, Korea had a slow rate of increase from 2002 to 2009 after a soaring growth of broadband uptake between 1999 and 2001, the period when facilities-based competition was in place. The comparison with the average penetration rate of other OECD countries also presents how early and rapidly broadband diffusion took place in Korea.

<Figure 5> Broadband Penetration per capita*(1997-2009)



* Broadband subscribers per 100 inhabitants
Note: Broadband was introduced in the U.S. in 1997 and in Korea in July 1998. The data of 2009 covers the period of January to June. The data of the OECD includes 28 countries except for the U.S. and Korea.
Source: OECD

<Figure 6> Broadband Penetration per household (1997-2009)



Note: The OECD data of Korea for 2000 to 2003 included broadband access modes such as xDSL, cable and other fixed and wireless broadband via computers. As of 2004, data also included mobile phone access.
The OECD data of the U.S. was available for only 2000, 2001, 2003, and 2007.
Since the data from OECD is not clean and sufficient, the author added the household penetration data from the 'Home Broadband Adoption 2009' of the Pew Internet for the U.S. and the 'Survey on the Internet Usage (2009)' of Korea Internet and Security Agency (KISA). Both data included xDSL, cable and other fixed and wireless broadband via computers except for mobile phone access.
Source: OECD, Pew Internet, KISA

Though the rate of change in broadband penetration of the U.S. and other OECD members has been higher than that of Korea from 2002, the penetration rate per capita of these countries is far lower than the latter. The penetration rate per capita of the U.S. was 26.7 in the second quarter of 2009, while that of Korea was 32.8. This gap was even greater in terms of household penetration which better depicts the real configuration of broadband diffusion in the residential area than per capita data: 91 percent of total households in Korea subscribed to wired or wireless broadband service, far ahead of the U.S.'s 63 percent.

The reason of the slower broadband diffusion of Korea than that of the U.S. from 2002 is hard to figure out whether it stemmed from the policy change to service-based competition or from the effect of diffusion curve nearing to the saturation. However, in the case of Korea, it seems to be facilities-based competition that accomplished rapid broadband diffusion within short period of time, not service-based competition which was assumed to do so. This is in line with the conclusion made by Lee and Chan-Olmsted (2004) that facilities-based competition

seemed to work better than local loop unbundling in inducing competition as well as speeding up the broadband deployment.

ii. **Facilities-based Competition and Government Investment**

The early boost of broadband penetration in Korea is likely to stem from the facilities-based competition and government investment. These two contributors were pointed out by many previous studies (Choudrie & Lee, 2004; Lee & Olmsted, 2004; Picot & Wernick, 2007; Atkinson et al., 2008) , but a few went further to examine the dynamics of establishing facilities-based competition and functions of government subsidy which led to successful infrastructure competition. To shed light on these hidden processes, it is important to explore first the history of KT, the incumbent telecommunication company monopolizing the market.

Established in 1981, KT was a quasi-public corporation whose largest share holder was the Korean government. Since 1987 when the government designed a long-term plan to privatize KT, the government began to gradually sell its share of KT and came to possess less than 50 percent in 1997. After the privatization of KT was designated as the top 100 national agenda in 1998, the government sped up selling its share and finally, in 2002, KT became privatized without any share left in the hands of the government (Choi et al., 2005).

While KT privatization was in progress, in 1997 the MIC licensed Hanaro Telecom as a new local telecom service provider to compete with KT through the public application procedure (Picot & Wernick, 2007). Hanaro launched its broadband service in 1999, a year later than Thrunet. Thrunet, established in 1996, was the first mover which introduced the broadband service in Korea. Two entrants were able to lease cable facilities from the Korea Electric Power Corporation (KEPCO), a government-owned company. Partly from KEPCO and partly from their own government-funded facilities, Thrunet provided broadband service mainly through cable modem and Hanaro through both cable modem and DSL (Park et al., 2002).

Government did not impose any specific regulation related to the broadband service on the incumbent KT until 2002, except for some general rules imposed on cable network owners and facilities-based service providers[21]. Instead of regulating the incumbent with unbundling

obligations or other rules, the Korean government took the opposite route to support new entrants with low-cost loans under the national broadband plan such as 'KII' and 'Cyber Korea 21.' Loans were offered to the broadband service providers with the condition that providers invest an equal amount to set up their own infrastructure (Atkinson et al., 2008). Through this effort, Thrunet and Hanaro were able to take 56.2 percent and 33.3 percent, respectively, of the total broadband subscribers[22], while the market share of KT was 5.1 percent in 1999 (Choi et al., 2005). The leased access to cable modem of KEPCO helped entrants expand their subscriber base, but the main contributors of entrants' early success seemed to be the large investment from the government and the eliminated uncertainty of the market with the vision set by the national broadband plan[23]. These laid the groundwork for facilities-based competition, which induced "competition in pricing, infrastructure development, and quality of service" (Atkinson et al, 2008).

While the entrants already gained substantial ground in the market around 1999, KT launched its DSL service in December 1999. Initially, KT focused on ISDN-2, i.e. narrowband technology (Park et al., 2002), to confront with the high-rent extraction[24] (Berkman, 2010), but later changed to DSL service. KT did not publicly state why they made the transition from ISDN-2 to DSL, but several reasons could be found based on the analysis of its political and economic circumstances at that time. Though government's blueprint was released to privatize KT in 1987, it was from 1999 when the government actively propelled its implementation of privatization. Recognizing privatization near to come, KT might become more concerned about its future revenue source than the rent extraction. Moreover, the fierce competition from entrants who developed innovative services with DSL, such as "bundling broadband as a free addition to its basic telephone subscription" (Kushida & Oh, 2007), provoked KT to launch broadband service which was at least comparable to the entrants'. KT's decision was also to meet the general recognition of the public that DSL was a must-have technology to get access to the Internet at that time (Telechoice, 2002). Additionally, government funding was provided to deploy broadband facilities, not narrowband infrastructure which KT initially planned to set up. These putative reasons were likely to lead KT to choose DSL, the more upgraded technology than ISDN, without known external pressure. It seemed to be not the regulation on the incumbent, but the competition from the new facilities service providers and government subsidy for high-

technology broadband deployment that forced the incumbent to invest in newer facilities (Berkman, 2010).

The rapid increase in broadband penetration during the period of 2000 to 2001 in Korea might have resulted from the launch of KT's DSL service in December 1999. In spite of its late entry after the entrants settled down, KT was able to expand the pie of subscribership with its overwhelmingly large network, aggressive marketing, and high brand recognition and became the top broadband service provider from the third quarter of 2000 (Park et al., 2002). Along with KT's market power, the harsh price competition among the three facilities service providers drove the retail price down (Lee et al., 2003) and contributed to the sharp increase of broadband penetration per capita from 0.6 percent in 1999 to 24.3 percent in 2002. At the same year, the market share of KT reached 47.3 percent of the total numbers of subscribers, while Hanaro and Thrunet had 27.6 percent and 12.5 percent, respectively[25].

At that time, the rising concern for excessive price competition and network overbuild led the government to introduce service-based competition. In order to preempt the growing market, all three companies provided broadband services on a low flat fee bases[26] to subscribers (Lee et al., 2003), which led the average revenue per user to plunge down and increased the financial burden along with the capital expenditure of building facilities (Choudrie & Lee, 2004). Moreover, the privatization of Powercom[27], a cable network owner, from KEPCO in 2000 was likely to aggravate competition among facilities-based service providers (Choudrie & Lee, 2004). For these reasons, government transformed its broadband policy in 2002 from facilities to service-based competition which required resale, bitstream access, line sharing, and full local loop unbundling.

Based on the service-based competition policy, KT had to provide its nationwide local loop to other players at prices below costs[28] for the purpose of deterring duplicative investment in network construction and promoting competition of broadband deployment in rural areas where cable networks were not sufficiently laid out (Picot & Wernick, 2007). Additionally, government asked KT, as a condition of its privatization, to construct broadband facilities in rural areas by subsidizing KT with a total of 926 million dollars from 2001 to 2005 under the 'Digital Divide Closing Plan' (Berkman, 2010). These national strategies reduced costs for

broadband service providers to offer business in rural areas (Atkinson et al., 2008) and contributed to having high broadband coverage across the whole nation.

iii. **Service-based Competition without Government Leadership**

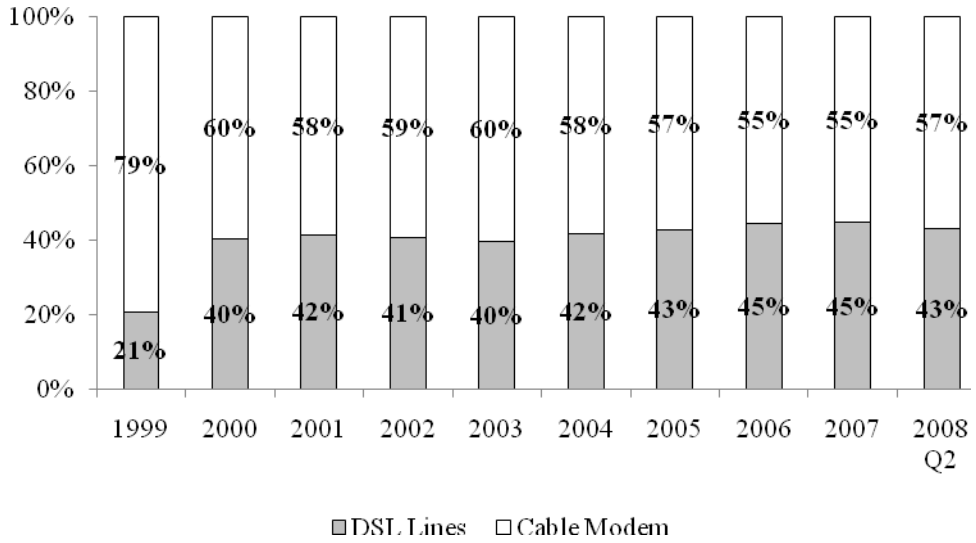
In contrast to the Korea's early boost of broadband penetration prompted by facilities-based competition and government investment, the U.S. showed a steady but far lagging increase of broadband diffusion under the seeming service-based competition. Though the FCC introduced service-based competition from the beginning of broadband deployment[29], its effectiveness has been questioned because of the constant challenge from incumbents and a series of court decisions[30] which slowly weakened the initiative of the FCC to implement unbundling regulations. Before the FCC's declaratory ruling of 2005 following the decision of the Supreme Court to designate cable modem service as an information service, it was the period of confusion for eight years from 1997 to 2005, which contributed to the slow growth of broadband diffusion.

The main reason for the failure of early uptake of broadband in the U.S. seems to be the extension of unbundling obligation to broadband without strong leadership of the government or the FCC. Service-based competition is widely accepted by policy makers under the assumption that it might lower entry barriers and increase broadband penetration within a relatively short period of time compared to the facilities-based competition. However, the caveat here is the role of the government. Countries which made a success of high broadband penetration under the regime of service-based competition were Japan and France, both of which had strong authority of government (Wallsten, 2007). The function of the government as a strong arbitrator is essential in implementing service-based competition. The reason is that close cooperation between incumbents and entrants who seek access to the network is necessary for local loop unbundling, considering that it requires the sharing of information about network and individual customers to process the request for installation and disconnection of services and to determine who is responsible for the faulty network element (OECD, 2003b). Therefore, an arbitration mechanism or the intervention of the government is needed to successfully implement service-based competition.

However, as analyzed with the Kingdon model at chapter VI, the structure and operation of the FCC as a commission composed of five commissioners make hard to have substantial leadership. Moreover, Americans are wary of big government and have a sense of antipathy against the intervention of the government into the private sectors. Consequently, unbundling regulations ─ which were even more stringent and far-reaching compared to other countries before the revision (Bauer, 2005) ─ ended up inoperable to the broadband services and unsuitable with the institutional characteristics of the U.S.

In addition to the discrepancy between the institutional characteristics of the U.S. and the role of the FCC demanded by implementing service-based competition, the weak position of the incumbents, i.e. ILEC, relative to the cable modem in the broadband market in terms of the number of subscribers (see figure 7) might have made more difficult to carry out mandatory unbundling. Moreover, the asymmetric regulations between DSL and cable modem service seemed to aggravate the difficulties of imposing an unbundling obligation on incumbents: FCC confirmed DSL as a regulated 'telecommunications (common carrier) service' in 1999, while cable modem service was regarded as a deregulated 'information service' without unbundling and non-discrimination obligations (Bauer & Cherry, 2006). The inferiority of DSL service to the cable modem service in both the market and regulatory areas[31] was likely to lead the incumbents to appeal to the courts, which consequently undermined the effectiveness of the service-based competition.

<Figure 7> The Composition of Broadband Penetration by access technology in the U.S. (1999-2008 Q2)



Source: OECD

Note: Broadband penetration rate is based on the number of subscribers.

Rather than regulating incumbents, offering financial incentives to entrants or competitors seems to be more workable in the case of the U.S. Compared to implementing unbundling regulations, it needs less governance by the FCC and does not directly have negative effects on incumbents. Additionally, government subsidy internalizes network externalities which the market fails to take into account. Just as other networks such as railroad and telephone have had, broadband has a considerable spillover effect on our national economy. Potential returns from this effect by using broadband are worthwhile for government spending in its deployment.

This logic was supported by the research of OECD (2009c) which found that savings of 0.5 to one percent of costs in each of four sectors ─ education, health, transportation, and electricity ─ over ten years, resulting directly from using broadband, justified costs of building a national, fibre-based broadband network in OECD member countries. This result implied the necessity of government investment to internalize social returns of broadband connectivity and to minimize bottlenecks hindering broadband diffusion and its impact on other sectors. Not only from the aspect of cost-saving but also from the viewpoint of social surplus, early investment in

broadband for faster and broader diffusion almost doubled the benefits derived from high speed access and spillover effects in other sectors ─ shopping, entertainment, commuting, telephone, and telemedicine (Crandall and Jackson, 2001). Assuming the same start and end point of broadband penetration rate, the earlier the growth rate reaches the peak, the larger was the amount of consumer and producer surplus over the same period of time because of the network effect (Crandall and Jackson, 2001).

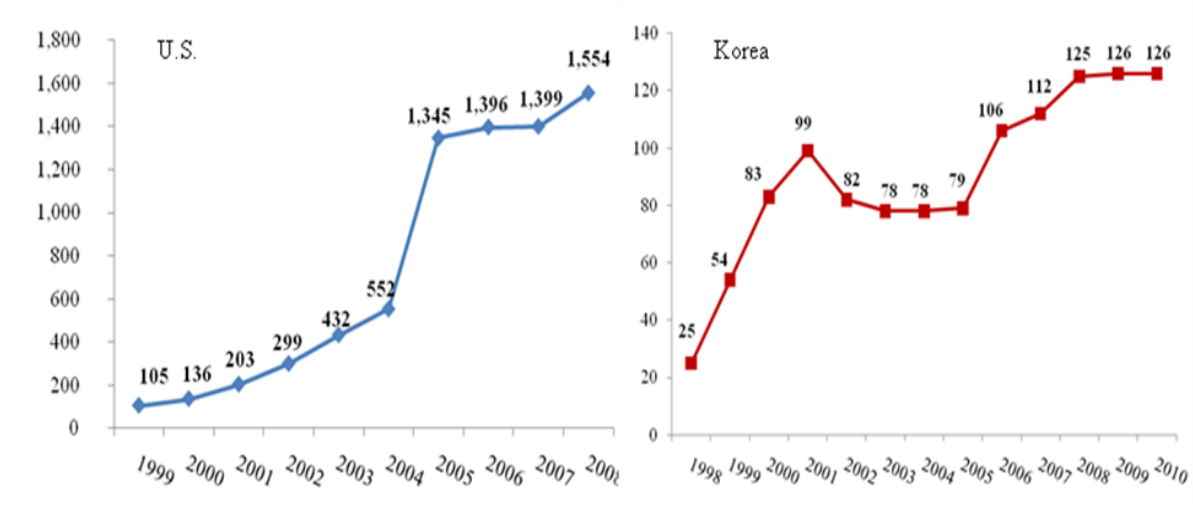
Considering these research results and the characteristics of the U.S. institutional development as well as the case of Korea, 'facilities-based competition' rather than 'service-based competition,' along with 'government investment to entrants' rather than 'unbundling obligations on incumbents,' might contribute to faster and higher penetration of broadband in the U.S. Though subsidies were granted sporadically by local governments for the construction of facilities in the U.S., the investment in broadband supply was not organized on a national level (Picot & Wernick, 2007). The absence of a large-scale, top-down blueprint for broadband deployment in the U.S. appears to be dependent on the past path of network development, considering that infrastructures such as railroads and telephone networks have been historically built up in an "decentralized, uncoordinated, and bottom-up manner" (Sawhney, 1999) in the U.S. However, the more efficient and stronger network effect of broadband than any other previous networks does not allow the U.S. to wait for the market to set up the nationwide infrastructure. By introducing a national broadband plan covering the allotment of subsidy or loan, government can reduce the uncertainty of the market and lower the entry barrier by relieving entrants of huge upfront, installation cost.

b. Relationship between Service-based Competition Policy and Market Competition

The trend in the number of broadband service providers over time shows that service-based competition did not appear to contribute to the increase in market competition in the two countries. In the case of the U.S., the number of broadband service providers skyrocketed by three times within a year from 2004 to 2005 when the Supreme Court declared the elimination of mandatory unbundling against broadband infrastructure. Also in Korea, it was during the period of facilities-based competition from 1998 to the early 2002 that the Internet service providers

including narrowband increased rapidly. While service-based competition policy is assumed to facilitate entry to the market by leasing incumbents' networks to entrants, the reality turns out to be different at least in the cases of this study (see figure 8).

<Figure 8> The Number of Internet Service Providers (1998-2010)



Note: The U.S. data is based on the high-speed lines whose speeds are over 200 kbps in at least one direction. The data includes ADSL, SDSL, cable modem, traditional wireline, fiber, satellite, fixed and mobile wireless, and power line. According to FCC, for data through December 2004, only those providers with at least 250 lines per state were required to file. The data of Korea includes XDSL, cable modem, ISDN, dial-up, and wireless since the data of broadband-only providers was not available.

Source: FCC, KISA

The big leap in the number of providers from 2004 to 2005 in the U.S. can be partly attributed to the change of policy. In 1999, the FCC confirmed that DSL is classified as a 'telecommunication service' which is subject to unbundling and non-discrimination obligations. However, cable modem service was regarded as an 'information service' in the FCC's 2002 declaratory ruling and the Supreme court upheld the FCC's decision in National Cable and Telecommunications Association v. Brand X Internet Services (2005). This asymmetric regulation between DSL and cable modem services was ended by designating DSL also as an 'information service' in the FCC's Triennial Review Order of 2003 and its declaratory ruling in August 2005 (Bauer & Cherry, 2006), after the Supreme Court's aforementioned decision about cable modem service in June. Additionally, in response to the ruling of United States Telecom Association (USTA)[32] v. FCC in 2002, the Triennial Review Order eliminated the broadband unbundling rules and planned to phase out line sharing rules gradually during the three-year

period from 2004 to 2006. Moreover, new fiber deployment such as fiber-to-the-premises and fiber-to-the-curb as well as hybrid copper-fiber loops were exempted from the unbundling obligations, leaving only the narrowband, i.e. stand-alone copper local loops, subject to the mandatory unbundling (OECD, 2003b). The Triennial Review Order of 2003, followed by the Triennial Review Remand Order of 2004 reflecting the court decision of the second USTA v. FCC, was the indication of the advent of facilities-based competition.

This change of policy direction freed incumbents from offering their facilities at the low UNE price and gave incentive to make investment in infrastructure. As of 2005, ILECs upgraded and expanded their networks, showing a big increase in the number of ADSL and fiber lines compared to 2004 (see figure 9). The large investment of ILECs, which was shrunk during the period of service-based competition, was accompanied by the sharp growth of DSL service providers in 2005 (see figure 10). Though acknowledging that many other factors affect companies' investment decision besides policies, facilities-based competition policy appears to be more effective in promoting competition rather than service-based competition in the U.S.

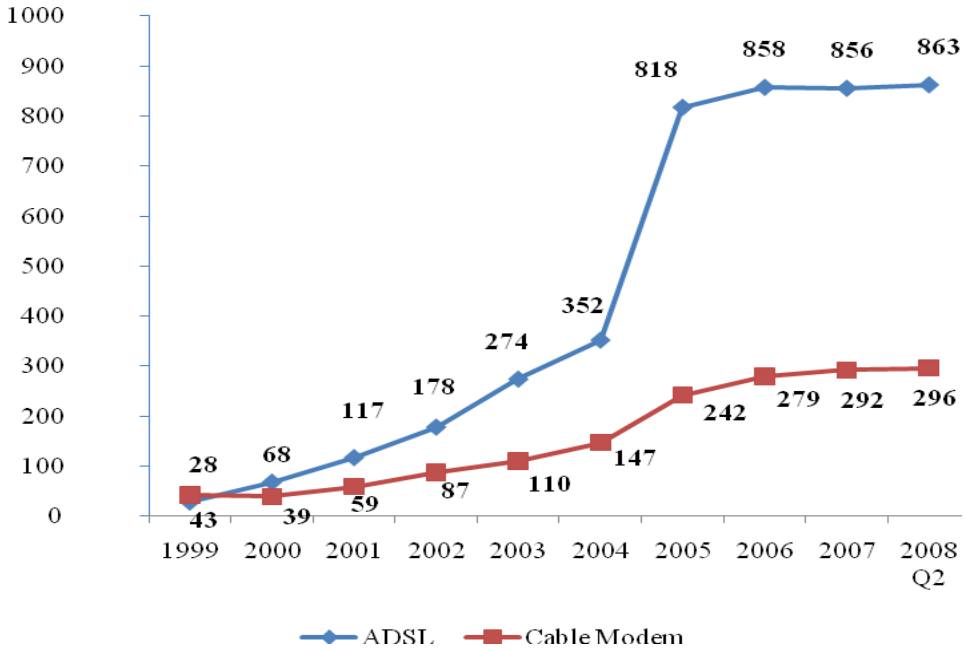
<Figure 9> The Number of Advanced Services Lines* (1999-2008 Q2)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 Q2
ADSL	186	675	1,369	2,178	3,037	5,696	15,921	21,144	25,244	26,132
(% change)		263%	103%	59%	39%	88%	180%	33%	19%	4%
Cable Modem	877	2,194	4,395	8,342	15,327	20,892	26,294	31,594	36,165	37,849
(% change)		150%	100%	90%	84%	36%	26%	20%	14%	5%
Fiber	37	63	84	108	116	157	297	893	1,845	2,344
(% change)		71%	33%	28%	7%	36%	89%	201%	107%	27%

* Advanced services lines are defined as the lines with the speed over 200kbps in both directions.

Source: adapted from FCC

<Figure 10> The Number of DSL and Cable Modem Services Providers in the U.S. (1999-2008 Q2)



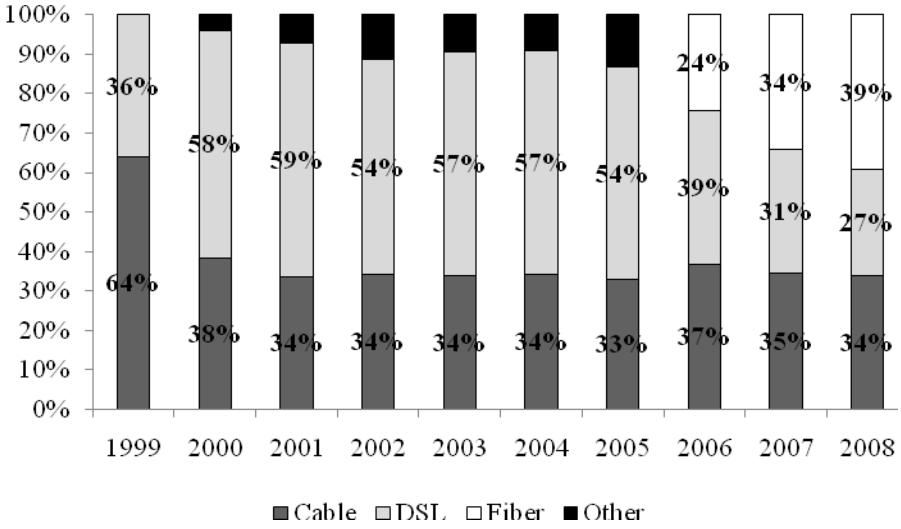
Source: FCC

Note: The U.S. data is based on the high-speed lines whose speeds are over 200 kbps in at least one direction. The data includes ADSL, SDSL, cable modem, traditional wireline, fiber, satellite, fixed and mobile wireless, and power line. According to FCC, for data through December 2004, only those providers with at least 250 lines per state were required to file.

The case of Korea seems to be in line with the case of the U.S. Since 2002, the number of Internet service providers (including both broadband and narrowband) decreased, contrary to the rapid increase until 2001. The year of 2002 as the turning point was the time when service-based competition was implemented. In spite of the effort to promote entry of newcomers and cool off the heated facilities-based competition through unbundling rules, the increasing financial burden of entrants and overall economic downturn seemed to produce unexpected outcome: the number of providers declined, and the merger and acquisition by major Internet service providers took place (KISA, 2002). The exit or sale of narrowband service providers might have also contributed to the decrease in providers. In 2006, the number of providers increased by 34.2 percent from 79 providers in 2005. This growth seems to be stemmed from the increase in fiber lines that were upgraded from incumbents' DSL and built by new entrants with new technology. As the market competition escalated along with the increasing number of providers, the number

of fiber network subscribers accounted for 24 percent among total broadband subscribers in 2006 (see figure 11). The cases of both the U.S. and Korea are unlikely to support that service-based competition policy has a positive effect on the increase in competition in terms of the number of providers.

<Figure 11> Market Share by Technology in terms of the number of broadband subscribers in Korea (1999-2008)



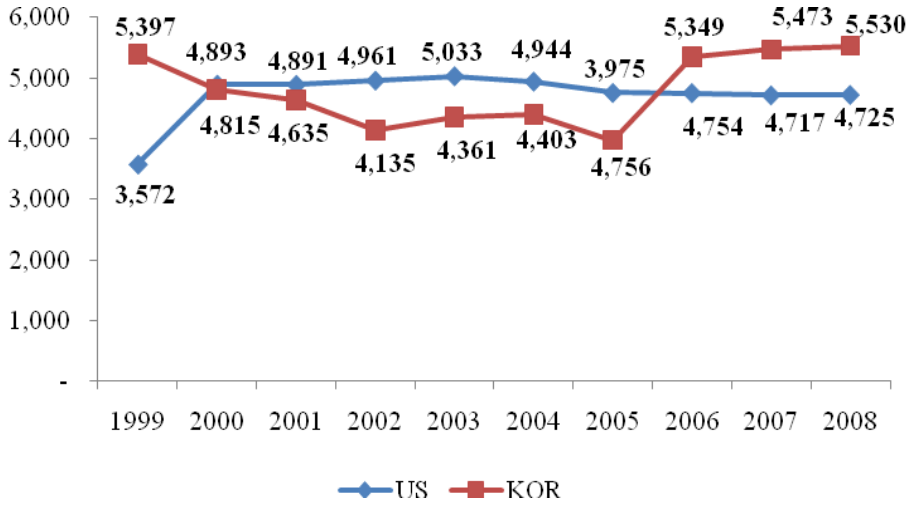
Source: adapted from OECD[33]

Note: "Other" broadband technologies include satellite broadband Internet, fibre-to-the-home Internet access (until 2005), ethernet LANs, and fixed wireless subscribers.

Additionally, service-based competition seemed not to contribute to the increase in inter-platform competition. In order to measure the competition by technology, i.e. DSL / fiber and cable modem, the present study uses HHI with the market share of each technology in terms of the number of broadband subscribers. Broadband industries in both countries were highly concentrated since their HHI are far above the reference point of 1,800 (see figure 12). Besides the similarity in the level of concentration, difference existed in the trend of concentration in the two countries. While HHI was in a decreasing trend since 2003 when unbundling rules were vacated in the U.S., in Korea, HHI decreased during the period of facilities-based competition but increased since 2003. Though HHI showed a slight variance over time, the consistency of the increasing HHI under the regime of service-based competition seems to imply the negative impact of unbundling regulations on platform diversity in both countries. Neither the number of

providers nor the competition between platforms increased in the two countries, which fails to render support for the rationale of service-based competition.

<Figure 12> HHI by technology (DSL/fiber and cable modem) in terms of the number of subscribers (1999-2008)

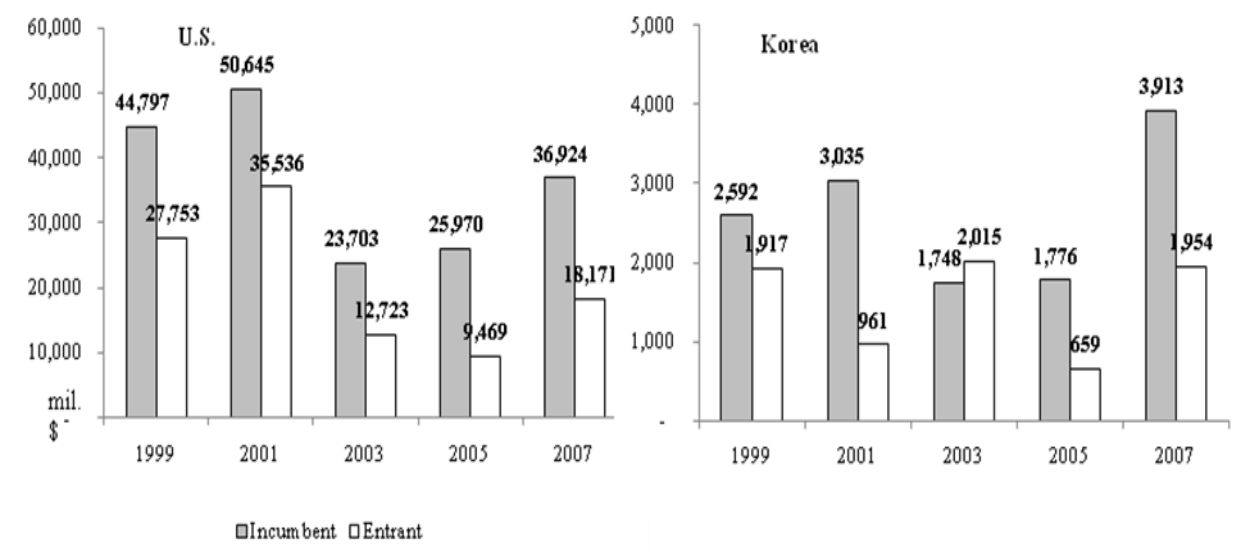


Note: The number of fiber line subscribers are added to that of DSL subscribers, since mostly DSL is upgraded to fiber line.

c. The Effect of Broadband Competition Policy on Investment

The trend in capital expenditure of incumbents and entrants is examined to find the effect of broadband competition policy on investment throughout the biennial period from 1999 to 2007. Despite the confounding factors stemming from the dot-com bubble and its crash in the U.S. and government investment in Korea, it seemed to be clear that both incumbents and entrants of the U.S. increased their investments after the elimination of unbundling obligations and that Korean incumbents made a huge investment from 2005 since the fiber networks constructed after 2004 were exempted from mandatory unbundling (see figure 13). These phenomena indicate that service-based competition policy might have functioned as a disincentive to incumbents' investment. Moreover, it seems to have a negative impact on entrants' investment as well, considering the increase in the share of UNEs against the total lines of CLECs in the U.S., which rejects the stepping-stone hypothesis.

<Figure 13> Capital Expenditure (1999-2007)



Note: The data is about major public telecommunication operators and Internet service providers with revenues greater than 1 billion dollars, which includes both narrowband and broadband services. OECD provides the data of capital expenditure every two years through its biennial editions of Communications Outlook.

Source: adapted from OECD Communications Outlook (2001, 2003, 2005, 2007, 2009)

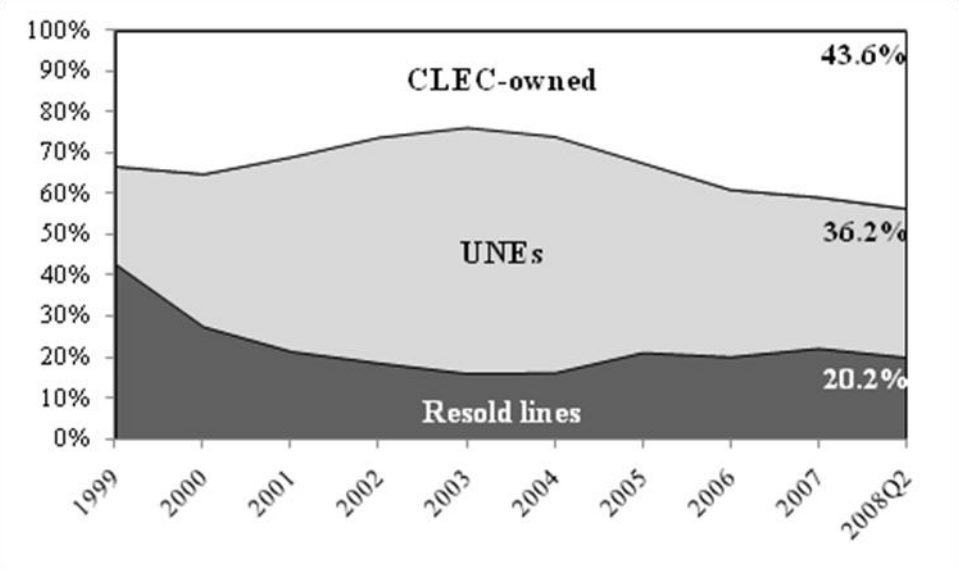
In the case of the U.S., the absolute amount of capital expenditure of both incumbents and entrants was higher during the period of service-based competition and recorded the lowest in 2003 when the FCC was to change its policy toward facilities-based competition. The dot-com boom and the post-bubble stock market crash in the early 2000s can, in part, explain the sudden rise and decline of the broadband investment (Frieden, 2005). Another contribution to the drop of investment in 2003 might be unbundling regulations which caused the level of investment to be far lower than that of other telecommunication industries at that time even considering the collapse of dot-com bubble (Hazlett, 2006). After 2003, capital expenditure of ILECs and CLECs increased gradually ─ partly because of the upgrading to ADSL aforementioned in the second research result ─ which is can be a counter-example to the assumed effect of service-based competition on investment.

The trend in proportion of resale, UNEs, and owned facilities of CLECs from 1999 to 2008 shows that entrants did not climb the ladder of investment in the time of service-based competition. Rather, the percentage of UNEs against total lines of CLECs constantly increased and reached the peak in 2003, while that of CLECs' owned facilities kept shrinking. It was after

the Triennial Review Order that the share of UNEs began to decrease. In the Order, the FCC planned to vacate the line-sharing rule within a three-year period through increasing its lease price by 25 percent in the first year, 50 percent in the second year, and 75 percent in the last year (Bauer, 2005), eliminating the whole rule in 2006. Along with the phase out of the line-sharing rule, the abolition of mandatory unbundling imposed on broadband helped to increase CLEC-owned facilities. Though it is hard to find cause-and-effect relationship between the policy and the market, this series of entrants' movement in the past ten years indicates that the stepping-stone hypothesis, which assumed the increase of entrants' investments in facilities by depending less on incumbents' networks, is not well supported in the case of the U.S.

One thing to take into account is that the decreasing share of resale and increasing share of UNEs do not imply the climbing ladder effect of service-based competition policy (see figure 14). This phenomenon might have taken place simply because the price of UNE-P was lower than that of resale. UNE-P price was based on the total element long-run incremental cost (TELRIC), which is a forward-looking economic cost of an ideally efficient new network (Christodoulou & Vlahos, 2001). Since technological improvement lowers price below the costs which incumbents actually paid for building the network in the past, TELRIC rates were less than ILECs' actual costs. However, the resale price was set by deducting avoided costs of the ILECs ─ cost savings from marketing and customer service by reselling to others ─ from the regulated retail price, which calculated to be higher than UNE-P price (Hazlett, 2006). Though UNE-P regulations, focusing on voice competition, were not directly related to broadband, they negatively affected broadband investment by reducing incumbents' profits with a lower rate (Wallsten, 2005) as well as increasing entrants' dependence on cheap UNEs.

<Figure 14> Proportion of Resale, UNE, and Owned Facilities of CLECs in the U.S. (1999-2008)



Source: FCC

Note: Bitstream access was not adopted in the U.S. This data includes both narrowband and broadband facilities. According to the FCC, only LECs with at least 10,000 lines in a state were required to report through December 2004. Beginning with the June 2005 data all LECs are required to report. UNE includes UNE loops leased from an unaffiliated carrier on a stand-alone basis and also UNE loops leased in combination with UNE switching or any other unbundled network element. CLEC-owned lines are provided over "last-mile" facilities.

In the case of Korea, it was hard to find a certain pattern in the graph, unlike the case of the U.S. During the period of facilities-based competition, entrants lowered their capital expenditure. However, considering the financial support from the government which is not counted in the number of capital expenditure, it is hard to assert that entrants were practically passive to build their own networks. The introduction of service-based competition seemed not to lessen investment incentives of the incumbent, KT, and entrants, since both of them recovered and even increased their investment level in 2007 after the decrease in 2005. This fluctuation seems to imply that service-based competition, which was adopted after the full stretch of facilities-based competition, might not have affected investment decision of both the incumbent and entrants. Whether service-based competition helped to increase investment or not is unclear, it seems obvious that the incumbent raised its investment in fiber networks since 2005, affected by the exemption of the fiber lines constructed after 2004 from the unbundling obligation (Son et al., 2008). Overall, the cases of the U.S. and Korea show that service-based competition policy

has high possibility of contributing to the disinvestment of incumbents in addition to the rejection of the ladder-climbing by entrants.

VIII. Discussion

It was the U.S. which invented the Internet and had high penetration rate of telephone and cable networks. However, the U.S. was ranked 15th in terms of broadband penetration per capita and 19th in terms of the average advertised download speed among 30 member countries of OECD in its latest statistics. Studying this under-performance of the U.S. than expected, a series of recent research, conducted by the Information Technology & Innovation Foundation (Atkinson et al., 2008), OECD (2009c), and Berkman Center for Internet and Society (2010), suggested the necessity of government subsidy through the analysis of successful cases of other countries. The present research is also in line with this suggestion by concluding that government investment contributed to lessening entry barriers and establishing facilities-based competition in the case of Korea.

Dating back to the history of the U.S., the construction of the network such as the railroad and telephone was left to the market in a bottom-up manner. Though this incremental process can contribute to creativity and innovation, it is not efficient enough to deploy networks across the whole nation, especially in the U.S. whose copper loop lengths are the longest among 13 OECD countries incurring more costs for high-quality broadband supply (Atkinson et al., 2008). Moreover, private companies tend to do cream-skimming by focusing their services on highly populated areas because of the characteristics of network industry: once they set up the network, they can easily amortize the high fixed, set-up cost by expanding customer base with a negligible marginal cost. The more the subscribers, the lower the average costs are for network building, which results in the isolation of sparsely populated, rural areas from broadband services. Since the market size of rural areas usually seems to be not large enough to sustain several broadband service providers, government can offer financial incentives to a selected provider as a condition of deploying broadband in those neglected areas, just as the case of KT. Considering the large geography with dispersed population and the market failure for rural broadband service, government intervention seems inevitable in the U.S. as well.

However, large-scale government investment and a national broadband plan accompanied are not the natural or familiar way that the U.S. has dealt with network deployment historically. Each country has its own institutional characteristics embedded in the politic, economic, social, and cultural aspects. From this institutions are policies produced. According to Anderson (1985; citing from Sawhney, 1999), the American problem-solving style is incremental, not synoptic, without a large-scale blueprint. Since policies are dependent on past trajectories of the country, the policy orientation toward government investment seems to evoke negative responses in the U.S. However, considering its exponential spill-over effects on other industries, it is important to have government leadership for faster and wider broadband penetration which market itself is not good at because of market uncertainty and cream-skimming strategy. The spill-over effect can be estimated through the case of Korea. Korea implemented 'Cyber Korea 21' from 1999 to 2002, the key plan for the growth of broadband penetration, and made a considerable achievement: the number of IT companies increased by 128 percent after the practice of 'Cyber Korea 21' and the amount of IT product also grew by 125 percent (see figure 15).

<Figure 15> The Comparison between Before and After the Implementation of 'Cyber Korea 21'

	No. of IT Companies	No. of IT Employees	IT Product	GDP Share	IT Export	Trade Surplus
1997 (before)	1,360	410,000	75.5 trillion won	8.60%	31 billion dollars	9 billion dollars
2002 (after)	3,101	670,000	170 trillion won	14.90%	46 billion dollars	16 billion dollars
% Change	**128.0%**	**63.4%**	**125.2%**	**73.3%**	**48.4%**	**77.8%**

Note: IT stands for information technology.

Source: Choi et al. (2005)

Along with the wired broadband, the penetration of wireless network is growing, but it does not mean that the importance of wired broadband is decreasing because each technology has advantages and disadvantages. Wireless network allows convenience stemmed from mobility and fewer wires, but it is regarded as less secure and slower than wired network and sometimes causes unexpected drop-out of the connection. Contrary to this, wired network has faster transfer rate and higher capacity, but less mobility. These technological differences confine applications

and software which are able to use in each mode of technology. Unless the difference disappears, the needs for wired broadband network are likely to exist irrespective of the wireless network diffusion.

While the first broadband transition from narrowband headed for universal access, the step toward next generation network is intended to have high speed connection. Since the success of the later transition depends on the preceding achievement, it is getting more important to have well-designed broadband policy at present.

IX. Conclusion

The present research attempted to find i) whether the direction of policy implementation affects broadband penetration, ii) what the relationship is between service-based competition policy and market competition, and iii) whether service-based competition has positive effect on investment. In order to explore these questions, case study which allows analysis in depth is used as a methodology. Selected cases are the United States and South Korea, since the two countries show opposite route of broadband policy implementation from service to facilities-based competition or vice versa, having the transition almost at the similar point of time, i.e. 2003 in the U.S. and 2002 in Korea.

Through the comparison between the U.S. and Korea, the present research came up with a conclusion about the first research question that facilities to service-based competition might contribute to having higher broadband diffusion than service to facilities-based competition. In Korea, facilities-based competition with government investment contributed to having the early peak in broadband diffusion. Instead of imposing unbundling obligation against incumbents, government offered financial support to entrants under the national broadband plan. The innovative service provided by the new funded players seemed to entice the incumbent to launch upgraded technology, which triggered harsh competition among facilities providers, leading to the sharp increase of broadband penetration. In order to deter the overbuild of infrastructure and abate financial burdens of players, service-based competition was introduced after the set-up of facilities-based competition in the market. Contrary to Korea, the U.S. followed the general policy flow from service-based competition to facilities-based. Initially, the FCC designed

stringent mandatory unbundling rules, but active resistance from ILECs ─ suffering from asymmetric regulations with cable modem service and having weak market position ─ and a series of court decisions gradually undermined the FCC's leadership to implement the rules. Since service-based competition demands strong government to arbitrate conflicts between incumbents and access seekers, it was not successfully implemented under the institutions of the U.S. Considering these historical configuration of the two countries from 1998 to 2009, service-based competition might be neither a must to facilitate broadband diffusion nor a pre-requirement to introduce facilities-based competition.

As for the second research question, the relationship between the service-based competition policy and market competition is likely to be negative in the cases of both the U.S. and Korea. The number of broadband service providers showed a big leap during the period of facilities-based competition in two countries. In the case of the U.S., the number of providers increased more than twice after the transition to facilities-based competition, along with the upgrade of technology to ADSL. In the case of Korea, after the rapid increase of providers in the time of the facilities-based competition, the merger and acquisition led to the decrease of the number of providers in Korea and the rebound took place after fiber networks were exempted from the unbundling obligations. Service-based competition is unlikely to increase inter-platform competition between DSL/fiber and cable modem as well. Market concentration by technology was kept declining after the peak of 2003 in the U.S., while concentration increased after 2002 in Korea. Though policy is not the only and direct cause of the phenomena in the market, service-based competition seems to rarely contribute to the increase in competition at least in the cases of this study.

The third research question of investment in facilities is related to the context of stepping stone hypothesis. Both incumbents and entrants constantly raised the amount of capital expenditure after unbundling obligations were eliminated in the U.S. Entrants did not climb the ladder of the investment from resale to UNEs and finally to their owned facilities under the service-based competition regime. Rather, they went down the ladder by increasing the lease of UNEs and decreasing the construction of their owned facilities. In line with the case of the U.S., in Korea, capital expenditure of incumbents increased rapidly after 2004 when fiber networks were freed from the mandatory unbundling. Through these descriptive analyses, the cases of the

two countries suggest that service-based competition policy is likely to generate disinvestment of both incumbents and entrants.

Though confined to the cases of the U.S. and Korea, the overall results of this research imply that service-based competition policy is unlikely to increase either competition or investment in the broadband industry. This conclusion raises doubt on the commonly accepted policy flow which assumed service-based competition as a segue way to the ideal facilities-based competition. According to the literature, service-based competition policy was designed to increase broadband penetration through facilitating the entry of broadband providers to the market and facilities-based competition policy was to offer differentiated products with more service flexibility. However, contrary to this expectation, facilities-based competition policy appears to spur higher broadband diffusion by lowering entry barriers with financial support of government in the case of Korea. Service-based competition, which seemed to be unsupportive to promote broadband diffusion in the case of the U.S., can function to deter overbuild of facilities and lessen financial burden of broadband providers after the set up of facilities-based competition which seems to help promote competition and give incentives to construct networks. Overturning the viewpoint of the literature, the present study suggests the role of service-based competition as an enhancer for service quality and that of facilities-based competition with government investment as a booster of early and rapid broadband diffusion.

The recent effort of the U.S. to establish a national broadband plan[34] with government investment seems to be a right step to take for nationwide broadband diffusion. Considering the institutional characteristics of the U.S., service-based competition which calls for strong government initiative is not likely to fit with the past trajectory of the U.S. Rather than imposing obligations against incumbents who have full resources and strong power, providing financial incentives to entrants appears to cause less resistance from the incumbents. Moreover, economically, government subsidy internalizes network externalities produced from broadband network, which the market fails to count in, and maximizes social surplus. As a fundamental infrastructure in the Era of Information, broadband network has significant influence on our democracy, society, and economy, indicating how critical the broadband policy is.

Based on the case study whose conclusion is drawn from descriptive analyses, not from cause-and-effect findings, this research has its limitation to generalize any analyses beyond the

cases of the U.S. and Korea. Additionally, it is hard to assert that policy change is the direct cause of the change in the market since various factors affect the decision-making process of the players. However, new perspective raised by case analysis can enrich our discussion and make a contribution to the literature by raising subsequent studies for further generalization.

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[1] These two terms will be explained in detail in chapter III. For brief overview, facilities-based competition is the competition among platforms with different or same technologies such as digital subscriber line and cable modem. Service-based competition is the competition among companies which borrow facilities from other operators.

[2] The definition of service-based competition is different by researchers. While Bourreau & Dogan (2004) and Picot & Wernick (2007) include both resale and local loop unbundling in service-based competition, Bauer (2005) defines only resale as service-based competition. Given that resale is usually regarded as access-based competition, which is one type of service-based competition, the author agrees with Bourreau & Dogan (2004) and Picot & Wernick (2007).

[3] Further description on each type of local loop unbundling is provided by OECD (2003b, p.7-8) as below.

- "Full unbundling occurs when the copper pairs connecting a subscriber to the main distribution frame are leased by a new entrant from the incumbent. The new entrant takes total control of the copper pairs and can provide subscribers with all services including voice. The new entrant can also enhance the copper pairs by adding ADSL technology. The incumbent still maintains ownership of the unbundled loop and is responsible for maintaining it."

- "Line sharing allows the incumbent to maintain control of the copper pair and continue providing some services to a subscriber while allowing an access seeker to lease part of the copper pair spectrum and provide services to the same subscriber. Line sharing allows the incumbent to continue to provide telephone service while the competitor provides broadband (xDSL) services on the same copper pair."

- "Bitstream access provides ISPs with a wholesale xDSL product from the incumbent. With bitstream access, the incumbent maintains control over the subscriber's line but allocates spectrum to an access seeker. The incumbent provides the ADSL technology and modems so that new entrants have no management control over the physical line and are not allowed to add other

equipment…. unlike full unbundling and line sharing, the access seekers can only supply the services that the incumbent designates."

[4] By defining unbundling policies as "requiring incumbent providers to rent their networks as unbundled network elements at low prices established by a government regulatory agency," Garcia-Murillo (2005) did not confine unbundling to local loop unbundling, but extended it to features, functions, and capabilities provided by means of facility or equipment as listed in 47 U.S.C. 153.

[5] Garcia-Murillo (2005) defined broadband as 512kbps download stream speed.

[6] Ford & Spiwak (2004) did not explicitly state their definition of broadband. As they used the data from the FCC, it can be assumed that they considered broadband as the high-speed lines over 200 kbps in at least one direction, following the definition of broadband made by the FCC.

[7] Local loop unbundling in the research of Grosso (2006) included full unbundling, line sharing, and bitstream access, following the definition made by OECD.

[8] Though the percentage, 0.32, itself appears to be minimal, this figure is meaningful considering that it was produced by the statistical regression analysis with the adjusted R-squared 0.84. The model was composed of penetration as a dependent variable and Herfindhal-Hirschman Index (a concentration index), GDP per capita, fixed internet penetration, and unbundled local loop as four independent variables.

[9] Picot and Wernick (2007) used the broadband data collection of European Union which defined broadband by the speed of 144 Kbps download capacity.

[10] Since Wallsten (2007) used the data from OECD for broadband penetration, it can be assumed that broadband is defined by the speed of 256 Kbps download capacity.

[11] This is related to the Triennial Review Order which was adopted in February 2003 and released in August 2003, though it was not explicitly stated by Hazlett (2006).

[12] For example, Grosso (2006) and Wallsten (2007) both analyzed 30 OECD countries using statistical regression analysis with the data from OECD in the early 2000s, but produced contradictory results about the relationship between mandatory unbundling and broadband penetration.

[13] According to the Local Competition Order of 1996, unbundled network elements include i) local loops, ii) network interface devices, iii) local and tandem switching, iv) interoffice transmission facilities, v) signaling networks and call related databases, vi) operations support systems, and vii) operator services and directory assistance (Bauer, 2005). Later, vii) operator services and directory assistance were eliminated from the unbundled network elements by the UNE Remand Order of 1999 (Bauer, 2005). UNE-platform is a package that offers all unbundled network elements in a program (Hazlett, 2006).

[14] Broadband delivery technologies are explained in detail in DotEcon and Criterion Economics (2003, pp. 12-25).

[15] Detailed explanation about why broadband is defined with the download speed of 256Kpbs can be found in OECD (2009b, p. 38).

[16] HHI is a measure of market concentration. According to the U.S. Department of Justice, a market whose HHI is less than 1,000 is considered competitive. If this index is between 1,000 and 1,800, the market is regarded as moderately concentrated. When HHI is over 1,800, the market is defined as highly concentrated.

[17] Detailed explanation about Kingdon's model is provided in Kingdon (2003).

[18] The main rule-making process of the FCC is: Public Notice (PN) or Notice of Inquiry (NOI), Notice of Proposed Rulemaking (NPRM), Further Notice of Proposed Rulemaking (FNPRM), Report and Order (R&O), Petition for Reconsideration (PR), and Memorandum Opinion and Order (MO&O). For detailed explanation about each step, refer to http://www.fcc.gov/rules.html.

[19] Ministry of Information and Communication was reorganized into partly the Ministry of Knowledge Economy and partly the Ministry of Culture, Sports, and Tourism in 2008.

[20] The Informatization Promotion Committee was established in 1996 and made suggestions and evaluations of information technology projects (ITU, 2003). It was upgraded into the Presidential Council of Information Society chaired by the President in 2009, doing similar functions as before.

[21] Since KT owned cable network, it was not allowed to offer services through its cable network based on the "structural separation of conduit and content" which all cable businesses were bound to (Ismail & Wu, 2003; Picot & Wernick, 2007). Additionally, KT was required to observe mandatory interconnection from the local and long distance exchange like all other facilities-based service providers (Lee & Chan-Olmsted, 2004).

[22] KT did not own the local loop facilities of multi-unit dwellings which are possessed by landlords (Atkinson et al., 2008)

[23] Several studies (Atkins et al. 2008; Berkman, 2010) explicitly supported the thought that government subsidy, rather than open access to cable modem, was the main factor introducing facilities-based competition in Korea.

[24] According to McChesney (1987, p.103), rent extraction can take place when a politician exercises his right to impose costs on private actors, which reduces rents from capital that companies created or invested themselves. In order to cope with rent extraction, companies tend to hesitate to invest in valuable specific capital.

[25] Source: The Ministry of Information and Communication

[26] There was no rule for a minimum tariff which is commonly established to prevent predatory pricing.

[27] According to government decision that KEPCO as a public corporation should not run telecommunication business, KEPCO spun off its cable network and established the privatized Powercom in 2000. Though Powercom launched its broadband service after five years, its privatization raised concern about severe competition.

[28] The unbundling price, i.e. UNE-P price ─ which was set below the cost by TELRIC ─ was one of the reasons that incumbents in the U.S. made an appeal to the court regarding service-based competition.

However, in Korea, there was no severe conflict as the U.S. because of the following putative reasons: KT was government-owned till its privatization of 2002, its market share was around 50 percent in terms of the number of broadband subscribers in 2002, and the MIC, with a full support from the head of the government and its expertise in the field, had a strong leadership to carry out its decision.

[29] Telecommunications Act of 1996, Local Competition Order (1996)

[30] These court decisions are Iowa Utilities Board v. FCC (1997), AT&T v. Iowa Utilities Board (1999), USTA v. FCC (2003), and USTA v. FCC (2004) (Bauer, 2005).

[31] Unlike the U.S., Korea did not have asymmetric regulations between DSL and cable modems and implemented service-based competition when the incumbent, KT, gained a substantial share of the market in terms of the number of broadband service subscribers.

[32] United States Telecom Association was representing the ILECs (Bauer, 2005).

[33] OECD redefined its classification of categories by technology in 2006, separating fiber lines from 'other' category. However, this change did not affect the configuration of fiber diffusion, since it was in 2006 when fiber lines were widely deployed and adopted by subscribers in Korea.

[34] The FCC submitted "Connecting America: The National Broadband Plan," a 20 billion dollars, 10-year plan to have nationwide high-speed Internet service, to the Congress on March 16th, 2010.