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論文題目	Empirical Analysis of the Deployment of Wired and Wireless Broadband Services: Focusing on Promoting Factors
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学位論文の要旨

This dissertation addresses the empirical analysis of the deployment of wired and wireless broadband services, especially focusing on promoting factors.

Promoting rapid nationwide deployment of broadband services has become an important national agenda for many countries, including Japan, Korea, the U.S. and the EU, for example. It is for overcoming the recession after the Lehman Shock and for transforming from a legacy economy into a new era through implementing broadband services and their applications. It is the same as the events occurred mainly in the beginning of 19th Century when many developed countries constructed building roads, highways and railroads. Currently Japan has implemented a scheme aimed at providing broadband connections to every household by 2015 under the name of New Broadband Super Highway (*Hikari-no-michi*) Plan, while the U.S. has been pressing ahead with a National Broadband Plan, the objective of which is to provide 100Mbps broadband services to 100 million households by 2020. A Digital Agenda for Europe promotes 30Mbps broadband access in whole EU population and 100Mbps broadband access in 50% population in EU by 2020.

The purpose of this dissertation is to conduct an empirical analysis to identify factors promoting broadband services adoption. The deployment of broadband throughout a nation requires many funds and years just similar to the wired phone, which took much investment and around 100 years even in developed countries. Subscriber lines of wired broadband services are essential facilities. Identifying the factors of promoting broadband services adoption can contribute to reduce costs and time for broadband adoption. Broadband services are provided by two networks, wired and wireless. The

wired network provides more stable communications and higher speed than the wireless network. On the other hand, the wireless network, especially the 3G (Third Generation) network, provides broadband service with mobility in almost nationwide especially in Japan and Korea. The wireless network has the feature that it costs less than the wired network, because it does not require essential facilities. This dissertation analyzes the factors promoting both of wired and wireless broadband services.

As for the analysis of factors promoting wired broadband services adoption, we focus especially on FTTx in OECD 30 countries. There is no previous study which mainly focused on FTTx in the multi-national framework. As FTTx is not independent of other competing broadband services such as CATV (BB) and DSL, we analyze not only FTTx but also CATV (BB) and DSL. Those three technologies are provided via subscriber lines, which are also termed by essential facilities, and the three technologies have the following networks: (1) CATV (BB) is provided via existing coaxial cable, which is used for cable TV; (2) DSL is provided via copper local loop in nationwide in almost all OECD 30 countries, which is used for the wired phone; and (3) FTTx is provided by fiber local loop which is newly installed for FTTx. In this analysis, by considering the diffusion ratios of three broadband technologies, OECD 30 countries are categorized into types, that is, "CATV (BB) type," "DSL type" and "FTTx type." According to each category, the following hypotheses are proposed for the factors promoting each broadband service: (1) the number of subscriber of CATV as broadcasting in the year of 2000, in other words, the initial condition, promoted CATV (BB) adoption; (2) open access obligations upon copper local loop promoted DSL adoption; (3) inter-platform competition between CATV (BB) and DSL promoted the adoption of those two technologies; (4) relative connection speed of FTTx to DSL; and (5) business strategy of operators for investment into FTTx promoted FTTx adoption. Then, the above hypotheses are empirically verified and the migration processes among three services are also examined. The methodology of empirical analysis is based on panel data models, which particularly take care of the endogeneity problem using the instrumental variable method. And the results of empirical analysis reveal that three technologies are substitutes. The results of this dissertation will provide an important basis for constructing national broadband policy in individual countries.

As for the analysis of the deployment of Japanese FTTx, we considered the distinction between single house and condominium. In the FTTx market in Japan, single house occupies around 60 or 70 percents of whole FTTx market, and rest is the share of condominium. We also considered the competition status of each geographical area,

East and West of Japan, where the business territories of two dominant carriers, namely NTT East and West. In the East of Japan, NTT East dominates around 70 or 95 percents FTTx share of in each prefecture. On the other hand, in the West of Japan, NTT West takes around 50 or 75 percents of FTTx share in each prefecture. The result of estimation indicates that (1) FTTx has been promoted through competition with other technologies, such as CATV(BB) and DSL; (2) FTTx has also been promoted through competition of carriers inside FTTx; (3) in comparison with East and West Japan, East Japan is more competitive than West Japan in especially latest two years. The result of this dissertation will indicate important bases for the policy of Japanese FTTx deployment.

As for the analysis of factors promoting wireless broadband services adoption, we selected the Japanese 3G phone. Japan is the most 3G prevailed countries as well as Korea. The ratio of 3G in whole mobile phones is close to 100% in Japan. And the wireless 3G phone provides around one Mbps or up to more than 10Mbps with mobility in almost nationwide, depending on the several standards. The Japanese 2G mobile phone was equipped with the variety of functionalities other than voice services. This characteristic has been passed on to the 3G mobile phone. Considering these background, the dissertation focuses the value-added services of 3G phone in Japan. The factors of the diffusion are represented by value-added services such as FeliCa, which enables m-payment, data roaming services, and full music downloads. Panel data analysis of the three main carriers, which occupy over 90% of the Japanese mobile market, is utilized. In order to control the network effect as well as the endogeneity of variables, the Arellano-Bond dynamic panel estimation is adopted. As a result, the launch of the iPhone 3G, FeliCa, data roaming, full music downloads, and the flat rate are revealed to have affected the diffusion of the 3G mobile in Japan. In particular, iPhone 3G, full music downloads, and the flat rate are the native value-added services initiated by the 3G broadband network. The results, reflecting the importance of value-added services, can be applied not only to the next generation mobile development (4G), but also to the promotion of 3G networks in other countries.

The results of this dissertation indicate the important bases for national broadband plan in each country. In fact, policy making scheme considering Plan-Do-Check-Act (PDCA) Cycle have been implemented as EU Directive in 2002 including market definitions and remedies (i.e. regulations) in EU nations and Assessment of Competition in the Telecommunications in Japan. Applying the factors derived from this dissertation allow nations or regulators to promote broadband services adoption with effective.

論文審査の結果の要旨

近年、先進各国で、Cable modem、ADSL、FTTH（光ファイバ）からなるブロードバンドの普及が進展し、経済社会の情報化が加速している。しかし、これらの3種のブロードバンドの構成は各国により異なる。各国はそれぞれ歴史的、文化的、経済的要因が異なるが、特にブロードバンド政策の相違も大きいと思われる。本論文は、新しいデータに基づいて、新しい統計的分析法を駆使して、国際的な枠組みでブロードバンドの普及要因を比較検討するものである。

第2章では、本論文と関連する国際的な枠組み、時系列による分析を中心とする先行研究のサーベイがなされている。第3章では、分析の基礎となるブロードバンドの3つの種類ごとに普及要因が詳細に検討されている。第4章は、OECD30各国でのブロードバンドの普及要因が、2000年代でのデータに基づいて、パネルデータ分析を用いて緻密に検討されている。普及に関する5つの仮説が設定され、それを検証している。推定結果からは、料金やスピードといった経済変数については、通常の場合を満たすことが示された。ブロードバンドの3種のサービス間では競争により普及は促進されているが、ADSLとFTTxの市場では、寡占的である方が普及を促進していると、通常とは異なる結果を得ている。他方、アンバンドル等の規制と普及については、ADSLで規制緩和が普及を促進しているが、他方FTTxではアンバンドルといった規制緩和をしない国の方が普及が進んでいると極めて示唆に富む結論を得ている。最後に、FTTHの普及には、日本、韓国、オーストラリアのように事業者がメタルの加入者回線の巻き取りを宣言することが要因として抽出された。

第5章では、日本の国内でのFTTHの普及要因の分析がなされている。第6章は、世界に先駆けて普及した日本の3G携帯電話の普及課程を、精密な回帰分析により分析している。分析手法としては、NTTドコモ、au、およびソフトバンクの携帯電話3社を用いるパネルデータ分析である。説明変数としては、①所得・料金といった経済変数、②3G携帯電話で可能となった音楽配信、ワンセグ放送、電子マネー等のe-ペイメント、③高速大容量の通信を可能にした技術、④ナンバー・ポータビリティといった競争政策を挙げている。日本の3Gの普及に関する初めての精緻な分析といえる。

以上の各章は、国際学会で発表され、第6章は国際的なジャーナルに掲載されている。これが本博士論文の質的な高さを証明しているといえよう。

以上から、本論文は博士の学位に値するものと判定する。