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**Conference Paper**

## Designing workable mobile broadband policies

2015 Regional Conference of the International Telecommunications Society (ITS): "The Intelligent World: Realizing Hopes, Overcoming Challenges", Los Angeles, USA, 25th-28th October, 2015

**Provided in Cooperation with:**

International Telecommunications Society (ITS)

*Suggested Citation:* Tsai, Hsin-yi Sandy; Bauer, Johannes M. (2015) : Designing workable mobile broadband policies, 2015 Regional Conference of the International Telecommunications Society (ITS): "The Intelligent World: Realizing Hopes, Overcoming Challenges", Los Angeles, USA, 25th-28th October, 2015, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/146336>

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## **Designing Workable Mobile Broadband Policies: Theory and Evidence**

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Paper prepared for presentation at ITSLA2015

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## ABSTRACT

The importance of accessing the Internet anywhere anytime has been high on the agenda of policy makers and businesses. Despite this awareness of the importance of mobile broadband access, there continue to be significant differences in mobile broadband adoption and uses among countries. Although many studies have examined the factors affecting broadband penetration rates, few studies thus far have focused on mobile broadband. Consequently, reasons for the gap on mobile broadband penetration rates among countries and potential remedies to address them remain muddy. This paper uses Qualitative Comparative Analysis (QCA) to systematically examine factors related to mobile broadband penetration. Policies and other economic and social factors usually interact with each other. QCA allows a systematic examination of the complexity of various combinations of policy and economic factors. This allows a deeper understanding of necessary and/or sufficient conditions for higher mobile broadband (high speed mobile Internet) penetration rates. The results reveal the complexity of the interaction of various conditions for mobile broadband penetration. The findings suggest that there are multiple paths toward high mobile broadband penetration, each depending on the context of institutional and non-institutional factors. An appropriate combination of spectrum policy, market access conditions, and supplementary policies to support access to disadvantaged regions and groups remains critical and has noticeable effects on sector outcomes.

*Keywords:* QCA (Qualitative Comparative Analysis), broadband penetration, adoption

## **Designing Workable Mobile Broadband Policies: Theory and Evidence**

The importance of accessing the Internet anywhere anytime has been high on the agenda of policy makers and businesses. By 2015 47.2% of users accessed the Internet on mobile broadband connections, compared to 10.8% via fixed access platforms. Despite this awareness of the importance of mobile broadband access, there continue to be significant differences in mobile broadband adoption and uses among countries. Adoption rates range from over one hundred subscriptions by 100 inhabitants (e.g., Singapore, Finland, and Japan) to less than ten percent (e.g., Kenya, Peru, and Pakistan). Even if important contextual factors such as average income and the availability of fixed access are taken into consideration, great differences persist. Managers and policy makers can benefit from a clear understanding as to which of these differences can be mitigated by business and policy choices. Although many studies have examined the factors affecting broadband penetration rates, few studies thus far have focused on mobile broadband. Consequently, reasons for the gap on mobile broadband penetration rates among countries and potential remedies to address them remain muddy.

The challenges are both theoretical and empirical. Mobile broadband needs to be examined in the broader context of the ICT ecosystem. Moreover, comparative research in institutional economics has revealed that market conditions, policies and regulations typically interact in “constellations”. Understanding these interdependencies is an important precondition for drafting appropriate policy and business strategies. Traditional econometric analysis or clustering approaches are inappropriate to unveil these constellations. We therefore use a novel methodological approach that better complements our theorizing about the roles of institutional arrangements on sector outcomes.

This paper builds on Bauer (2015) and Tsai (2015) and expands the theoretical framework and geographic scope of the analysis. The theoretical contribution is the development of a dynamic model within which the effects of public policy and management decisions can be analyzed. In this framework, it is possible to analyze the complementarity and substitutability relations among policy and arrangements and their interaction with business decisions. Supply and demand-side factors, including spectrum policies, mobile broadband universal service policies, urban population, income per capita, education, and other related factors, are taken into account.

### **Factors Influencing Mobile Broadband Adoption**

The main purpose of this paper is to fill the knowledge gaps mentioned above by examining factors influencing mobile broadband adoption. Specifically, what are the roles of policies with regard to mobile broadband uptake? Having adequate policies that help build up the infrastructure and the market can be critical to broadband penetration. Policy and regulation have important effects on the investment in broadband markets (Bauer & Shim, 2012; Cawley, 2014; Dkhil, 2014). Although many countries plan to increase broadband penetration rates, there is no clear evidence as to what kind of policies and regulations are necessary and/or sufficient for improving mobile broadband (high speed Internet) penetration rates. Past studies of fixed broadband access found that the availability of broadband universal service, public private partnership (PPP), local loop unbundling, competition, and other supply and demand-side economic factors such as prices, affected penetration rates (ACPLI, 2009; Bauer, Kim, & Wildman, 2003; Briglauer & Gugler, 2013; Cava-Ferreruela & Alabau-Munoz, 2006; Cava-Ferreruela & Alabau-Muñoz, 2004, Haucap, Heimeshoff, & Lange, 2014; Jakopin, 2009; S. Lee,

2006; S. Lee & Brown, 2008). Many studies have also been done with regard to factors related to mobile voice service penetration (Harald Gruber, 2001; Harald Gruber & Verboven, 2001).

However, few studies have paid attention to the factors influencing mobile broadband penetration (S. Lee, Marcu, & Lee, 2011; Sangwon Lee & Lee, 2014; Yates, Gulati, & Weiss, 2013) or adoption (Gerpott, 2011; Liu & Li, 2010).

Past studies found that policies, regulatory factors and economic factors impacted mobile broadband penetration rates. Mobile broadband-related policies such as spectrum policies (Chapin & Lehr, 2011), broadband universal service, and standardization policies (S. Lee, Marcu, et al., 2011) were found to affect mobile broadband penetration. S. Lee et al. (2011) examined the factors affecting fixed and mobile broadband penetration by using OECD data and found that standardization policies and urban population were the most important factors for mobile broadband diffusion, while income, education, and prices were not statistically significant predictors to mobile broadband penetration. Yates et al. (2013) found that countries with higher mobile broadband penetration rates generally had encouraged competition in telecommunication markets. Lee and Lee (2014) found that platform competition was important for smartphone adoption in OECD countries while platform openness and prices were critical for both OECD and BRICS (Brazil, Russia, India, China, and South Africa) countries (Sangwon Lee & Lee, 2014). Gerpott (2011) and Liu and Li (2010) both conducted surveys to understand what affected individuals' decisions on adopting mobile broadband and found that the perceived advantages of mobile Internet were critical for mobile Internet adoption. Basically, competition and platform openness, prices (which are related to the degree of competition with more intense competition typically related to a lower level of prices and/or a higher degree of price differentiation), and

the perceived advantages of mobile broadband are important factors for mobile broadband adoption.

Several of the factors affecting mobile broadband penetration are likely similar to those affecting fixed broadband (e.g., the intensity of competition). However, mobile broadband is probably also affected by additional factors that are unique to mobile services. Compared with fixed broadband, mobile broadband penetration is likely also influenced by factors such as spectrum management policies. Therefore, lessons for the design of good policy for mobile broadband cannot necessarily be drawn from insights on fixed broadband studies alone.

Developments in broadband markets are outcomes of the interplay between supply and demand (Lemstra & Melody, 2014b). From the findings of previous studies on fixed broadband penetration, one would expect that supply-side economic factors, such as competition (Harald Gruber, 2001) and population density (S. Lee et al., 2011), which influence the cost and price of service provision will also affect the penetration of mobile broadband. Demand-side factors, such as income, education, and digital skills, also affect mobile broadband penetration. However, the relative importance of individual factors and of their interaction has not yet been identified clearly. Therefore, in this study, our overarching research question is: whether policy choices are instrumental for higher mobile broadband penetration. If so, this study aims at understanding whether any policies and policy combinations are sufficient or at least necessary for having higher mobile broadband penetration rates.

To examine the factors affecting mobile broadband penetration, a novel approach will be used in the paper. Most broadband penetration studies were conducted by using regression analyses and case studies. Especially the former set of studies typically focuses on the effects of single policy choices on outcomes. However, policy interventions and other factors are typically

related to each other. Specifically, looking at policy-related factors, they are most of time interacting with other supply and demand factors. In principle, this can be captured by interaction terms in regression analyses. Practically, given the large number of variables and potential combinations involved, this may be practically impossible to use interaction terms to analyze policy factors. It was also found that the factors affecting broadband diffusion vary at different stages of adoption (Kyriakidou, Michalakelis, & Sphicopoulos, 2012). The factors affecting broadband diffusion in technologically developed countries and technologically developing countries differed (Gulati & Yates, 2012).

This empirical challenge can be overcome by using Qualitative Comparative Analysis (QCA), which combines the advantages of quantitative analyses and case studies. Primarily developed by Charles Ragin (1987; 1994; 2000), QCA is a relatively new method to analyze data. It has been used in several fields in social science (Marx, Rihoux, & Ragin, 2014), such as political science and business management. In QCA, cases are converted into a set of “conditions” and “outcomes” to analyze causal relations using principles of set theory. QCA is effective in examining the interdependence and complexity of various conditions/policies and stakeholders. This comparative method is especially useful for policy discussions, because policy-making is related to many different institutions, often of great diversity. By examining the patterns of similarities and differences across cases, QCA seeks to systematically uncover the causal relationships among conditions and outcomes (Basurto & Speer, 2012). Therefore, a QCA policy comparison study will be included as part of this paper.

In order to identify the relationship among predictors and mobile broadband penetration rates, longitudinal data will be analyzed in this paper. Fuzzy-set QCA will be used for data analyses. For the QCA analysis, the focus will be on examining whether and how different

broadband-related regulations/policies, such as mobile broadband universal service, spectrum management policies, and other economic factors (competition, education, and income) affect mobile broadband penetration in OECD countries. In 2014, 34 countries were members of the OECD<sup>1</sup>. By using panel data from these 34 countries for years 2009-2013, we can examine the importance of individual predictors and of interactions between them.

## **Methods**

To examine the causal relationships among mobile broadband penetration and the factors that influence it, a fuzzy-set qualitative comparative analysis (fsQCA) will be conducted for the 34 OECD countries in order to examine whether individual policies or such policies in combination affect broadband penetration. QCA allows for a systematic examination of which, if any, kinds of policies are necessary and/or sufficient for having higher mobile broadband adoption.

QCA is a relatively new method to analyze data. QCA is both case-oriented (Kim & Lee, 2008) and variable-oriented (Ragin, 2008). On the one hand, similar to case studies, QCA looks into cases and compares the similarities and differences among cases (Basurto & Speer, 2012). On the other hand, similar to econometric approaches, QCA also takes variables into consideration and examines the relationship among variables (including the independent and dependent variables). Therefore, QCA can be considered a combination of quantitative and qualitative analyses. Different from case studies, in QCA, cases are described as a set of conditions and outcomes to analyze causal relations (C. C. Ragin, 1987, 2000; Rihoux & Ragin,

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<sup>1</sup> These 34 countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

2009). In QCA, the independent variables (factors) are called “conditions” (Basurto & Speer, 2012). The relationship between these conditions and the outcomes (the dependent variables) is examined using set theoretical relations. Causality in this context is a “multiple conjunctural causation” (Rihoux & Ragin, 2009, p. 17) that, different from traditional statistical techniques, is nonlinear and non-probabilistic.

QCA allows analyzing institutional arrangements as combinations of factors that can include multiple policy decisions, not just a single component (e.g., a single variable). OCA is based on set theoretical relations (Ragin, 1987). It has been formulated using crisp sets (csQCA, a unit is either a member of a set or not) and fuzzy sets (fsQCA, membership in a set is a matter of degree) (Ragin, 2000). csQCA uses Boolean logic and assigns each condition a 0 (absence) or 1 (presence) for set membership. In contrast, fuzzy-set QCA uses the interval between 0 and 1 for each condition (Kent, 2008). Fuzzy-set QCA is good for institutional analysis because it recognizes that policy and institutional variables are not always dichotomous (e.g., present or absent). Taking universal service objective as an example, if we only use a dummy variable to represent the policy, we might find that all countries have this policy. However, there is a degree of difference on the scope of this objective. Some countries might only include private land lines into universal service objective while some might include the private land lines, public pay phones, public cell phones, and private cell phones into the objective. In this case, using fsQCA will be more appropriate than using csQCA because it can better capture the variety of policies.

### ***Data***

Data was collected from 34 OECD countries using information from various sources, such as the World Bank, the International Telecommunication Union, and regulatory agencies directly. As

an empirical method the paper uses Qualitative Comparative Analysis (QCA) to systematically examine these factors. Policies and other economic and social factors usually interact with each other. OCA allows a systematic examination of the complexity of various combinations of policy and economic factors. This allows a deeper understanding of necessary and/or sufficient conditions for higher mobile broadband (high speed mobile Internet) penetration rates. Such knowledge can then be utilized to draft appropriate policies and strategies.

### *Operational Measures*

*Mobile Broadband Penetration (MB)*. The main outcome variable – mobile broadband penetration rate – was the OECD wireless broadband subscriptions per 100 inhabitants. Mobile broadband subscription is “mobile subscriptions that advertise data speeds of 256 kbit/s or greater” (OECD, 2015a). The data were retrieved from the OECD website (for year 2009-2013). For year 2003-2009, the available data are the total 3G cellular mobile subscriptions in OECD countries. However, more than half of the countries did not have mobile broadband until 2008. Therefore, data for years 2009-2013 were analyzed in this study. The lowest subscription was calibrated to 0.05 and the highest was calibrated to 0.95, while the average score was calibrated to 0.5. The reasons that 0.05 and 0.95 were used were because that using 0.0 and 1.0 as the membership values will correspond to negative (0.0) and positive (1.0) infinity for the log of the odds. Therefore, in fsQCA, 0.05 and 0.95 are used as a full non-membership and a full membership, respectively (Ragin, 2007).

*Universal Service – Mobile Broadband Universal Service (MBUSO)*. Countries with mobile broadband universal service were coded as 1 and countries without mobile broadband universal service were coded as 0. Data were collected from the ITU website (available for year 2009-2013).

*Voice Universal Service (VUSO)*. Four kinds of voice universal services were counted, including fixed line private residential service, fixed line public payphone service, public mobile payphone service, and individual mobile cellular service. Countries with only one service included in their universal service definition received the score of 1, with two services received the score of 2, etc. For their membership calibration, the membership for countries with only one service included was calibrated to 0.05, with two services was calibrated to 0.5, and for those with three services was 0.95. The cut-off point is having two services included in their universal service definition.

*Spectrum Policies*. Spectrum sharing and the presence of policies supporting of technological neutrality was included in the analysis.

- *Technology neutrality (TECH)*: Data for 2012-2013 were collected from ITU. Countries with technology neutrality regulation for mobile broadband services were coded as 1 and countries without the regulation were coded as 0.
- *Spectrum sharing (SHARE)*: ITU data (available for year 2013 only). Countries with spectrum sharing regulation for mobile broadband services were coded as 1 and countries without the regulation were coded as 0.

*Roaming Regulation (ROAM)*. Countries with roaming regulation for mobile broadband services were coded as 1 and countries without the regulation were coded as 0. Data for 2012 and 2013 were collected from the ITU website.

*Regulatory Quality (QUALITY)*. The indicator used for regulatory quality was collected from World Bank (years 2009-2013). The indicator was measured based on the government's quality of public services and civil service, its independent from political pressures, the quality of policy-making and implementation, and the credibility of the government's commitment to such policies.

*Competition among Mobile Broadband Providers (MHHI).* Mobile broadband competition was measured by calculating the competition of major mobile networks (years 2009-2013). The data were collected from the Ovum database. Ovum is an international telecommunication research organization (<http://www.ovum.com>). The competition indicator used in this study is the HHI (Herfindahl-Hirschman Index) of the mobile market share of subscriptions in a country. The minimum HHI was calibrated to 0.05 and the maximum was calibrated to 0.95, while the average score was calibrated to 0.5. *Fixed Broadband Inter-platform Competition (FBHHI).* Fixed broadband competition was measured by using an inter-platform HHI (Herfindahl–Hirschman Index). Inter-platform HHI was calculated by squaring the subscriptions for each broadband technology (including DSL, Cable, Fibre, and other) divided by the total subscriptions of all technologies, and then adding all of these squared values (see below 4):

$$HHI = (S_{DSL}/S_{total})^2 + (S_{cable}/S_{total})^2 + (S_{fiber}/S_{total})^2 + (S_{other}/S_{total})^2 \quad (4)$$

with  $S_{total}$  = subscriptions of all technologies

Similar to the mobile competition HHI, the minimum HHI was calibrated to 0.05 and the maximum was calibrated to 0.95, while the average score was calibrated to 0.5. The data was collected from the OECD.

*Fixed Broadband Penetration (BB).* The relationship between fixed broadband subscription and mobile broadband and mobile broadband use will also be examined (available for year 2003-2013). The OECD fixed broadband subscriptions per 100 inhabitants was used to measure fixed broadband penetration. The data was retrieved from the OECD website. The lowest subscription was calibrated to 0.05 and the highest was calibrated to 0.95, while the average score was calibrated to 0.5.

*Price (PRICE)*. The price for subscribing to monthly mobile broadband service (price per MB). Data was retrieved from Ovum Data. The lowest price was calibrated to 0.05 and the highest was calibrated to 0.95, while the average price was calibrated to 0.5.

*Cost (proxied by Population Density) (PD)*. Population density was collected from the United Nations (<http://data.un.org/Data.aspx?d=PopDiv&f=variableID%3A14>) (for year 2000, 2005, and 2010). It was calibrated by using the minimum population density of OECD countries as 0.05 (non-membership) and the maximum as 0.95 (full membership). The average of population density was calibrated to 0.5.

*Urban Population (URBAN)*. The portion of urban population was collected from World Bank. The lowest score was calibrated to 0.05 and the highest was calibrated to 0.95, while the average score was calibrated to 0.5.

*Income (INCOME)*. Gross national income per capita was collected from the OECD website (for year 2005-2013) (OECD, 2014). Income was calibrated by using the minimum income as 0.05 (non-membership) and the maximum as 0.95 (full membership). The average of income of OECD countries was calibrated to 0.5.

*Education (EDU)*. Share of population with tertiary education attained by ages 25-64 was used for the measure of education (OECD, 2013a) (for year 2000, 2005, and 2010). Education was calibrated by using the minimum as 0.05 (non-membership) and the maximum as 0.95 (full membership). The average of education of OECD countries was calibrated to 0.5.

*Digital Skills (SKILL)*. Problem solving in technology-rich environments was used to indicate digital skills of each country (OECD, 2013b). This skill measures “the ability to use digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks” (OECD, 2013, p. 2). Data are available for

year 2012. The lowest score was calibrated to 0.05 and the highest was calibrated to 0.95, while the average score was calibrated to 0.5.

## **Results**

### *Necessary Conditions*

In QCA, a consistency score of .8 (or above) is normally used to identify the necessary conditions for an outcome. As mentioned above, necessary conditions are present whenever the outcome is present (but they may also be present in other cases with other outcomes). In the language of set theory: outcomes are subsets of the necessary conditions. By using QCA analysis, we found that for the observations in the studied sample, having technology neutrality (consistency = .87), higher quality of regulation (consistency = .82), higher fixed broadband penetration rates (consistency = .8), higher urban population (consistency = .81), higher mobile market competition (a less concentrated market, consistency = .83), and higher education level (consistency = .87) had consistency scores higher than .8. Therefore, in the countries in our dataset these are necessary conditions to have higher mobile broadband penetration rates (see Table 1). These are conditions that most countries that had higher mobile broadband penetration share. In other words, countries that had higher mobile broadband penetration rates also exhibited these conditions.

**Table 1 Necessary Conditions**

	Consistency	Coverage
MBUSO	0.177339	0.594762
VUSO	0.652301	0.618640
<b>TECH</b>	<b>0.866511</b>	<b>0.634286</b>
SHARE	0.774380	0.624667
ROAM	0.149618	0.490000
<b>QUALITY</b>	<b>0.824816</b>	<b>0.715878</b>
<b>BB</b>	<b>0.808543</b>	<b>0.745429</b>
PD	0.787694	0.589309
<b>URBAN</b>	<b>0.806509</b>	<b>0.692199</b>
FBHHI	0.580092	0.630162
~ FBHHI <sup>2</sup>	0.783371	0.631417
MHHI	0.635774	0.666978
~MHHI <sup>3</sup>	<b>0.825451</b>	<b>0.683330</b>
PRICE	0.547030	0.622535
<b>EDU</b>	<b>0.830744</b>	<b>0.784109</b>
INCOME	0.731248	0.805941
SKILL	0.695603	0.895873

### *Sufficient Conditions*

In addition to the necessary solutions, QCA can also examine whether any conditions are sufficient for the outcome to happen. As mentioned above, sufficient conditions are conditions

<sup>2</sup> “~” indicates the absence (non-membership) of a factor/condition. In this case, it indicates lower fixed broadband HHI (a more competitive fixed broadband market).

<sup>3</sup> In this case, ~MHHI indicates a more competitive mobile market.

that once are satisfied, the outcome can be present. These conditions are subsets of the outcomes (as shown in Figure 6 and 7). When these conditions are present, a country will have higher mobile broadband penetration rates. Owing to the complexity of the combinations of various factors (15 factors in total), only complex and intermediate solutions were generated by QCA (see Tables 2 and 3).

In this solution, broadband universal service was absent, but a more comprehensive voice universal service policy was present, along with higher regulatory quality, higher fixed broadband penetration, a more concentrated fixed broadband market, lower urban population, high income, lower education, the presence of technology neutrality policy and spectrum sharing, no roaming regulation, high digital skills, and low prices. This solution had coverage 0.35 and consistency score of 0.77. That is to say, 35% of the membership of the outcome (mobile broadband penetration) could be explained by this solution. This path points out the complexity of the combination of these 15 factors.

As indicated in the necessary conditions, having technology neutrality policy, high regulatory quality, high fixed broadband penetration, high mobile market competition, high education, and high urban population were necessary conditions. In this model, we found that education and urban population were absent. However, this solution had a relatively low coverage (.35). According to the solution, when education was absent (having lower education level), it is important to have higher income and lower price for mobile broadband services to increase the demand for subscribing mobile broadband, and the mobile market needs to be more competitive and the voice universal service policy should be more comprehensive.

**Table 2 Complex Solutions for the Complete Model**

--- COMPLEX SOLUTION ---  
 FREQUENCY CUTOFF: 1  
 CONSISTENCY CUTOFF: 0.77

	RAW COVER AGE	UNIQUE COVERA GE	CONSISTE NCY
1 ~MBUSO*VUSO*QUALITY*BB*FBHHI*~MHHI*~PD*~URBAN*INCOME*~EDU*TECH*SHARE*~ROAM*SKILL*~PRICE	0.35	0.35	0.77
SOLUTION COVERAGE: 0.35 SOLUTION CONSISTENCY: 0.77			

**Table 3 Intermediate Solutions for the Complete Model**

--- INTERMEDIATE SOLUTION ---  
 FREQUENCY CUTOFF: 1  
 CONSISTENCY CUTOFF: 0.77

	RAW COVE RAGE	UNIQUE COVER AGE	CONSIS TENCY
1 ~PRICE*SKILL*~ROAM*SHARE*TECH*~EDU*INCOME*~URBAN*~PD*~MHHI*FBHHI*BB*QUALITY*VUSO*~MBUSO	0.35	0.35	0.77
SOLUTION COVERAGE: 0.35 SOLUTION CONSISTENCY: 0.77			

Overall, the results of both the necessary and the sufficient solutions indicate the importance of having more intense service-based competition in mobile market. Having higher service-based competition in fixed broadband has been identified as one of the main reasons that Denmark and Sweden had high fixed broadband penetration rates (Forzati & Mattsson, 2015; Henten & Falch, 2015).

## **Conclusion**

In conclusion, the results reveal the complexity of the interaction of various conditions for mobile broadband penetration. For one, the preliminary findings suggest that there are multiple paths toward high mobile broadband penetration, each depending on the context of institutional and non-institutional factors. Second, the work reveals that very few sufficient policy instruments are available that can effectively achieve higher adoption as many available policy instruments only establish necessary conditions, that is, they cannot guarantee higher adoption. Nonetheless, an appropriate combination of spectrum policy, market access conditions, and supplementary policies to support access to disadvantaged regions and groups remains critical and has noticeable effects on sector outcomes.

## References

- ACPLI. (2009). Barriers to broadband adoption: A report to the Federal Communications Commission.
- Basurto, X., & Speer, J. (2012). Structuring the calibration of qualitative data as sets for qualitative comparative analysis (QCA). *Field Methods*, 24(2), 155–174.
- Bauer, J. M. (2015). “Governing the mobile broadband ecosystem”, *International Telecommunications Policy Review*, 22(2), 1-22.
- Bauer, J. M., Kim, J. H., & Wildman, S. S. (2003). *Broadband Uptake in OECD Countries: Policy Lessons from Comparative Statistical Analysis*. Paper presented at the 14th European Regional Conference of the International Telecommunications Society ITS, Finland, Helsinki.
- Bauer, Johannes M, & Shim, Woohyun. (2012). Regulation and innovation in Telecommunications. *Quello Center for Telecommunications Management and Law, Working Paper*, 1–12.
- Briglauer, W, & Gugler, K. (2013). The deployment and penetration of high-speed fiber networks and services: Why are EU member states lagging behind? *Telecommunications Policy*, 37(10), 819–835.
- Cava-Ferreruela, I., & Alabau-Muñoz, A. (2004, September). *Key constraints and drivers for broadband development: A cross-national empirical analysis*. Paper presented at the the 15th European Regional Conference of the International Telecommunications Society (ITS).
- Cava-Ferreruela, I., & Alabau-Munoz, A. (2006). Broadband policy assessment: A cross-national empirical analysis. *Telecommunications Policy*, 30(8), 445–463.

Cawley, R. (2014). *The influence of European Union policies and regulation*: Cambridge University Press.

Chapin, J., & Lehr, W. (2011). *Mobile broadband growth, spectrum scarcity, and sustainable competition*. Paper presented at the TPRC.

Dkhil, I. (2014). Investment in Fixed Broadband Networks and Access Regulation in Developed and Developing countries: Panel Data Applications. *Available at SSRN 2511514*.

Forzati, M, & Mattsson, C. (2015). Ch 7. Sweden. In W. Lemstra & W. H. Melody (Eds.), *The Dynamics of Broadband Markets in Europe* (pp. 136–162). Cambridge, UK: Cambridge University Press.

Gerpott, Torsten J. (2011). Attribute perceptions as factors explaining Mobile Internet acceptance of cellular customers in Germany—An empirical study comparing actual and potential adopters with distinct categories of access appliances. *Expert Systems with Applications*, 38(3), 2148–2162.

Gerpott, Torsten J. (2011). Attribute perceptions as factors explaining Mobile Internet acceptance of cellular customers in Germany—An empirical study comparing actual and potential adopters with distinct categories of access appliances. *Expert Systems with Applications*, 38(3), 2148–2162.

Gruber, H. (2001). Competition and innovation: The diffusion of mobile telecommunications in Central and Eastern Europe. *Information Economics and Policy*, 13(1), 19–34.

Gruber, H. (2001). Competition and innovation: The diffusion of mobile telecommunications in Central and Eastern Europe. *Information Economics and Policy*, 13(1), 19–34.

- Gruber, H., & Verboven, F. (2001). The evolution of markets under entry and standards regulation—the case of global mobile telecommunications. *International Journal of Industrial Organization*, 19(7), 1189–1212.
- Gulati, G. J., & Yates, D. J. (2012). Different paths to universal access: The impact of policy and regulation on broadband diffusion in the developed and developing worlds. *Telecommunications Policy*, 36(9), 749–761. doi: 10.1016/j.telpol.2012.06.013
- Haucap, J., Heimeshoff, U., & Lange, M. R. (2014). *The impact of tariff diversity on broadband diffusion: An empirical analysis*. DICE Discussion Paper.
- Jakopin, N. M. (2009). Drivers and inhibitors of countries' broadband performance—A European snapshot. *Telecommunication Markets*, 187–206.
- Kent, R. (2008). Using fsQCA: A brief guide and workshop for fuzzy-set qualitative comparative analysis. *Department of Marketing, University of Sterling*, 2008-2010.
- Kim, K., & Lee, Y. (2008). A qualitative comparative analysis of strategies for an ageing society, with special reference to pension and employment policies. *International Journal of Social Welfare*, 17(3), 225–235.
- Kyriakidou, V., Michalakelis, C., & Sphicopoulos, T. (2012). Driving factors during the different stages of broadband diffusion: A non-parametric approach. *Technological Forecasting and Social Change*, 80(1), 132–147. doi: 10.1016/j.techfore.2012.07.001
- Lee, S. (2006). Broadband deployment in the United States: Examining the impacts of the platform competition. *The International Journal on Media Management*, 8(4), 173–181. doi: 10.1207/s14241250ijmm0804\_3
- Lee, S., & Brown, J. S. (2008). Examining broadband adoption factors: an empirical analysis between countries. *Info*, 10, 25–39.

- Lee, S., Marcu, M., & Lee, S. (2011). An empirical analysis of fixed and mobile broadband diffusion. *Information Economics and Policy*, 23(3), 227–233. doi: 10.1016/j.infoecopol.2011.05.001
- Lee, Sangwon, & Lee, Seonmi. (2014). Early diffusion of smartphones in OECD and BRICS countries: An examination of the effects of platform competition and indirect network effects. *Telematics and Informatics*, 31(3), 345–355.
- Lemstra, W., & Melody, W. H. (2014a). *Chapter 1 Introduction*: Cambridge University Press.
- Lemstra, W., & Melody, W. H. (2014b). *Research context and perspective*: Cambridge University Press.
- Liu, Y., & Li, H. (2010). Mobile internet diffusion in China: an empirical study. *Industrial Management & Data Systems*, 110(3), 309–324.
- Marx, A., Rihoux, B., & Ragin, C. (2014). The origins, development, and application of Qualitative Comparative Analysis: the first 25 years. *European Political Science Review*, 6(01), 115-142.
- OECD. (2015a). OECD (2015), Wireless mobile broadband subscriptions (indicator). from <http://data.oecd.org/ict/wireless-mobile-broadband-subscriptions.htm>
- Ragin, C. C. (1987). *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*. Berkeley, CA: University of California Press.
- Ragin, C. C. (1994). *Constructing social research: The unity and diversity of method*. Thousand Oaks: Pine Forge Press.
- Ragin, C. C. (2000). *Fuzzy-Set Social Science*. Chicago, IL: The University of Chicago Press.

- Ragin, C. C. (2008). Qualitative Comparative Analysis Using Fuzzy Sets (fsQCA). In B. Rihoux & C. Ragin (Eds.), *Configurational Comparative Analysis* (pp. 87–121 ). Thousand Oaks, CA.
- Rihoux, B., & Ragin, C. C. (2009). *Configurational comparative methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, . Los Angeles, CA: Sage Publications.
- Tsai, H.-Y. S. (2015). Go mobile go everywhere!? The roles and effects of mobile broadband policies, Ph.D. dissertation, Michigan State University, East Lansing, MI, USA.
- Yates, D. J, Gulati, G. J., & Weiss, J. W. (2013). *Understanding the impact of policy, regulation and governance on mobile broadband diffusion*. Paper presented at the System Sciences (HICSS), 2013 46th Hawaii International Conference on.