An assessment of Mobile Broadband Access in Indonesia: a Demand or Supply Problem?

Ibrahim Kholilul Rohman and Erik Bohlin

Chalmers University of Technology
Gothenburg, Sweden

***Abstract*—Previous studies conclude that broadband plays an important role in stimulating economic growth by generating new employment, and improving access to health and education. However, most of these analyses are conducted for developed countries, with little attention being paid to developing countries. This study aims to find out which factors should be considered, following the assertion by the ITU (2010) that broadband, especially mobile broadband, should be developed further to narrow the gap between developed and developing countries. Moreover, this study questions whether the digital gap in broadband access is merely a demand or supply problem. The demand side is represented by income level, which is closely related to affordability issues, while the supply side is indicated by the impact of different geographical characteristics which shows the different stage of infrastructure development. To operationalize this aim, a *Probit* regression models the decision to subscribe to mobile broadband as a function of income and geographical area, as well as other control variables. The results indicate that income is less important than geographical area in explaining mobile broadband access. The study proposes that the supply -side factor related to infrastructure development should be prioritized as the focus of broadband policy in the short term.**

***Index Terms*—Mobile broadband, demand, Probit.**

I. INTRODUCTION

THE more widespread adoption of broadband and related technologies has generated a significant economic dividend. ITU [1] considers broadband a catalyst for growth, stressing that it is the next tipping point for generating jobs, driving growth and productivity, and underpinning long-term economic competitiveness, as well as the most powerful tool to meet the Millennium Development Goals. Many studies have supported this view. Crandall et al. [2], for instance, show that approximately USD 63.6 billion of the capital expenditure in the U.S. economy has been accumulated through broadband development, while Lehr et al. [3] found that technology augmented economic growth (incremental employment growth) by as much as 1.5 percent in the U.S. Summarizing the studies in some of the developed countries, Katz (2009) [4] shows that the multiplier of broadband is around 1.4 to 3.6 for the economy, indicating the significant impact of the diffusion of broadband for generating output enlargement.

With regard to the current development of broadband deployment, the gap between high-income countries and lower income countries is clearly visible. The high-income countries had achieved a 20 percent penetration rate by the end of 2007, with the upper middle obtaining 5 percent of the penetration rate. The lower middle income and lower income were left behind with a 1 percent penetration rate. Figure 1 shows the disparity in broadband penetration between the groups.

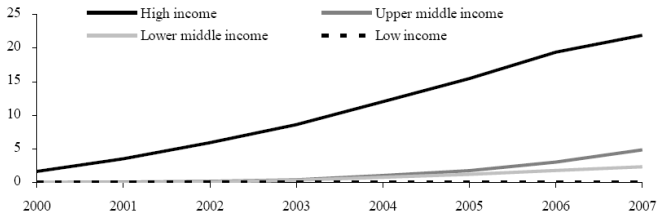

Fig. 1: Broadband penetration rate between groups of countries (Source: Infodev (2010))

From Figure 1 it can be concluded that without accelerating the supply and demand for broadband access, developing countries require more time to catch up with the broadband sector gap. Therefore, the investigation to determine the factors that affect broadband access is important, especially in answering which factors play important roles between the demand side and the supply side. Moreover, the need to investigate the impact of broadband development is also important, as the issue is relatively recent for developing countries, which has meant that fewer investigations have been conducted in country-to-country analyses and case studies [5].

In addition, when discussing the type of technology, it is often proposed that wireless technology plays an increasingly prominent role in the expansion of rural telecommunication networks in developing countries [6, 7]. More importantly, mobile technologies not only offer a substantial cost

The authors are with the Division of Technology and Society, Department of Technology Management and Economics, at the Chalmers University of Technology, in Gothenburg, Sweden. Ibrahim Rohman can be contacted at Ibrahim.rohman@chalmers.se.

advantage over fixed-line infrastructure for rural networks, but they are also better suited to service the demands of rural low-income populations [8]. In relation to this, ITU [1] stated that while high-speed Internet is still out of reach for many people in low-income countries, mobile telephony is becoming ubiquitous, with access to mobile networks now available to over 90 percent of the global population. ITU's new data indicate that, of the estimated 5.3 billion mobile subscriptions at the end of 2010, 3.8 billion will be in the developing world. In conclusion, mobile phone penetration in developing countries now stands at 68 percent, and the benefits of broadband will be even greater once adequate and affordable access is available.

Of the limited studies on developing countries, the recent study published in "Information and Communication Development 2009" reports on the substantial impact of broadband development in these countries (The World Bank in [9]). The report shows that a 10 percent increase in the penetration rate of broadband will boost the Gross Domestic Product (GDP) by 1.38 percent. Not only will broadband improve the level of productivity through remote monitoring, logistics management, and online procurement, it will also provide an increasingly vital device for accessing information to stipulate economic activity and ensure the implementation of good governance [10]. Thus, the impact on developing countries is more critical and moves beyond merely the economic impact, namely the GDP.

In addition, there are two concurrent aspects of equal importance as determinants. On the one hand, the supply -side analysis places great emphasis on the need to provide wireless networks and infrastructure, whereas, on the other, from the demand perspective, affordability and, thus, income has to be put as an important factor [11]. Income is still widely regarded as a major driving force for the diffusion, because many developing countries have a per capita income of less than 10 percent of those of developed countries. Consequently, only a limited proportion of the population in countries with a highly skewed income distribution can afford broadband. The reason is that when annual broadband expenditure is priced at more than 2-5 percent of a household's income, broadband is considered unaffordable [12].

This study aims to answer the research question: How can mobile broadband access in Indonesia be investigated by comparing the influences of the demand and supply sides? This research question identifies the important factors to be considered in the development of mobile broadband access, with greater emphasis on the question of whether income and/or geographical characteristics matter in determining access. The paper consists of the following sections: Section 1 is an introduction and Section 2 discusses previous empirical studies of broadband analyses. The methodologies of the study and data analysis are elaborated in Section 3, while the results are showed in Section 4. Section 5 concludes the study.

II. THE EMPIRICAL ANALYSIS OF BROADBAND DEMAND

Together with other socio-economic variables, it is generally conceived that income is an important factor in determining the level of diffusion of ICT devices. Hausman et al. [13] and Rappoport [14] argue that household income is a critical predictor of broadband adoption. Cadman and Dineen [15] found that broadband penetration in the OECD is strongly influenced by income, with a 1 percent increase in income leading to a 0.78 percent increase in demand. This is consistent with the study by Rosston and Savage [16].

A study by Jackson et al. [17] employs a nationwide mail survey and aims to construct a profile of residential Internet access and investigate consumer preferences for bundled attributes in the U.S. The conclusions are that demand attributes and willingness to pay (for speed, always on, and reliability) vary between high and low-income users with higher income users' value attributes being higher than those of lower income users. Besides this, the study shows that the willingness to pay for the speed attribute also increases with income.

Many studies place importance on the geographical area variable when determining broadband access (Rappoport [14] and Steinberg et al. [18]). Rosston and Savage [16] conclude that rural households value connection speed at approx. USD $3 more per month than urban households. The study also stresses that the availability of broadband connection largely depends on the urbanization rate, whereas ubiquitous broadband is also supported by a sufficient number of businesses and households to justify the cost of extending broadband services to that region. Therefore, even though the dichotomy between urban-rural also reflects the demand -side factor, when it affects the infrastructure development, the notion can also reflect the supply -side factor adopted in this study.

In the context of developing countries, the importance of geographical area is also a consideration in the study by Srinuan et al. [19], which investigated the determinants of the digital divide in ASEAN countries with the conclusion that beside the significant impact of income, geographical area is also an important factor in determining the digital divide. This means that as more people live in urban areas, the digitization index will increase. Thus, digitization policy also depends on how governments prioritize the infrastructure sector as part of the road map of development programs.

With regard to broadband development in Indonesia, the White Paper by the Ministry of Communication and Information [20] reports in detail on the current state of development of the telecommunication sector in Indonesia. In view of the diffusion of Internet access, it is reported that during 2007-2008, the proportion of households with internet connection increased from 5.58 percent to 8.56 percent, even though the figure is still dominated by Java, which recorded a penetration rate of 9.95 percent in 2008. The report also elaborated that except for Maluku and Papua, the majority of internet access is connected through DSL (approx. 60 percent), whereas dial-up is still used as the means of

connection by 30 percent of the users. Given the current situation, efforts are still needed, especially to achieve the goal set by the government, as mandated in the National Middle Term Development Planning (*Rencana Pembangunan Jangka Menengah Nasional*, RPJMN) [21]. The document set the target to achieve 30 percent broadband connection, 50 percent Internet penetration, and 75 percent broadband penetration for cities and regional capitals by the end of 2015.

Moreover, having achieved a penetration rate for mobile phones of 70 percent at the end of 2009, it is believed that mobile broadband is an effective device to narrow the gap between digital connections in Indonesia. Sabry [22] argued that mobile telephony is the preferred broadband technology in emerging markets due to the ability to offer a quick and easy approach to address broadband demand. Given the limited capacity of maximum throughput, however, a fixed technology scale should also be developed for high-density areas and greater bandwidth demand, as the complementary policy. The challenge of developing mobile broadband in Indonesia is addressed by Santosa [23] who points out several obstacles regarding this issue. The main reason concerns the operators, who have difficulties ensuring quality of service, especially 3G and mobile Internet services, due to the declining profit margins of operators, as a result of more intense tariff competition. Therefore, an understanding of the pattern of mobile broadband access will not only be an important agenda for policy issue but also a crucial input for telecom players and operators.

III. THE DEMAND MODEL

In this study, the investigation into mobile broadband access adopts the typical choice model commonly used in telecommunication demand estimation. The model can be found in Perl [24], Train et al. [25], Bodnar et al. [26], Train et al. (1989), and Taylor and Kridel [28]. The model basically measures the probability of being a subscriber of telecommunication devices (telephony, internet, etc.) as a function of some independent variables. For this study, the model is drawn in equation 1 below, employing the Probit model.

$$Prob\ (Y = 1|x) = G(\beta_0 + \beta_1\ age + \beta_2 income + \beta_3 georaphical\ area + \beta_i other\ control\ variable) \quad (1)$$

From equation (1), it can be inferred that the Probit model estimates the likelihood of being a mobile broadband user (Y=1), which is influenced by some socio-economic characteristics as the independent variables. Equation 1 is basically an access demand estimation of the interplay of the impact between the demand side and the supply side. A Similar discussion can be found in Koutrompis [29] for the case of the simultaneity of the broadband demand, and Thurman [30], Bettendorf and Verboven [31] for the more basic endogeneity problem when estimating the demand equation. Thus, in this study, the access demand for mobile broadband is affected by income (demand side) and geographical area (supply side). A couple of additional variables are also added to explain the likelihood of being a mobile broadband subscriber following previous studies; marital status, education and specific occupation, and bearer of payment. A complete derivation of the Probit model and the investigated variables are presented in the Appendix.

The independent variables in this study are chosen following similar studies in technology adoption. Morris and Venkatesh [32], for instance, suggest that age is the key element in the adoption of new technology. Their study shows that older people have "a perception of new technology and subjective norms" to a more significant degree than younger people do, especially during long periods of observation. In relation to age, Pagani [33] stressed that different age groups led to differently perceived values toward technology adoption. The study by Varian [34] described that the occupation and typical users influence the decision to access broadband, as well as typical heavy internet users. The latter is also part of the conclusion, based on the study by Jackson [17], which states that high-speed users value the attributes of internet access and usage more highly than other users do. The study also shows the importance of other independent variables, for instance, age and education. With regard to education, it was found that respondents with a college degree value speed more, thus, the willingness to pay is positively correlated with education level. This conclusion is also echoed by Burton and Hicks [35], who state the importance of the education variable as one of the main determinant when estimating broadband demand.

The data in this study were collected from the survey conducted by Ericsson Consumer Lab, Regional South East Asia office in Kuala Lumpur, Malaysia, launched in 2009.The survey comprises answers by 3470 respondents on the four main islands of Indonesia (Java, Sumatera, Kalimantan, and Sulawesi) to more than 800 questions. The survey was carried out using a face-to-face method between the interviewer and the respondents and aimed to describe the characteristics of ICT access and usage. This section on mobile broadband is only one part of the whole data collection concerning other ICT devices: cellular, fixed line, TV, Cable TV, computer, etc.

The point of interest in this study, and the dependent variable of the model, is mobile broadband subscribership. The survey reveals that only 5.2 percent of the respondents currently subscribe to mobile broadband. Having collected answers from 3470 respondents, this proportion leads to a conclusion that only 180 respondents currently subscribe to mobile broadband in this sample. This proportion is reasonably consistent with that reported by the ITU [1]. At the end of 2009, the penetration of mobile broadband was recorded as 3.5 percent (7.95 million subscribers), which was an increase on the previous figures in 2008, which were only 1.47 percent (3.3 million subscribers). It is therefore reasonable to have a penetration rate of about 4-5 percent in Indonesia in 2009, based on the survey figure.

Two independent variables that are important in this study

are explained further. The variable of household expenditure is used as the proxy for income and is divided into four classes. Based on this classification, almost 40 percent of the respondents are in the first category (lower expenditure), 9 percent in lower middle income, and 5 percent and 2.5 percent represent the upper middle and higher incomes respectively. In terms of the geographic variable, the distribution of the sample is centered on Java Island and its main cities (Jakarta, Bandung, Semarang, and Surabaya). This is understandable, given the distribution of the population in Indonesia, which is also concentrated in these areas. The other cities investigated in this study are Medan, which represents the western part of Indonesia (Sumatera Island), and Makassar and Balikpapan, which represent the eastern part of Indonesia (Sulawesi and Kalimantan Island). Of the respondents in the survey, 65 percent live in Java, giving the best proxies concerning the actual distribution of the population. Amid the disproportion of the sample, this study is able to picture the actual population distribution in Indonesia. The Central Bureau Statistics of Indonesia (BPS) [36] reported that the distribution of the population over the 32 provinces is not even. Almost 59 percent of the total population inhabits Java, an island with an area covering only 7 percent of the total land area of the country. The rest, 41 percent, inhabits the other islands. In contrast, Papua with an area covering about 19 percent of the total land area is inhabited by only 1 percent of the total population. The survey also shows that there is a huge disparity in access, with 82 percent of mobile users living in an urban area. This data suggest unavailability of the existing wireless technology infrastructure to enable subscription from a rural one, which is also confirmed by the report by the Indonesian National Regulatory Agency (NRA), BRTI [23].

As discussed earlier, the decision to subscribe to mobile broadband is predicted by employing other socio-economic variables. In terms of education level, 5.7 percent obtained a higher education degree, which means that they have at least graduated from high school (*Sekolah Menengah Atas*, SMA). The respondents are quite well distributed in terms of age classification, denoted by the proportion of age1 (<25 years old), age2 (25-39 years old) and age3 (40 years old<). The proportions are quite similar, with age1 slightly below the other groups and age3 slightly over-represented. The detail explanation regarding independent variables in this study is presented in the Appendix.

IV. RESULTS AND DISCUSSION

As presented earlier, this study emphasizes broadband access in Indonesia, in particular for determining the supply and demand side as the important drivers. To obtain the range of the supply -side investigation, Model 1 generalizes the urban vs. rural classification; Model 2 explains the differentiation between Java vs. non-Java, while Model 3 observes the difference in terms of cities. The results are presented in Table 1.

Table 1 Access Demand Equation Estimates

Variables	Model 1	Model 2	Model 3
Male	0.014*	0.013*	0.014*
Higher education	0.089*	0.085*	0.084*
Age1	0.059*	0.059*	0.057*
Age2	0.029*	0.031*	0.028*
Expenditure2	-0.02*	-0.022*	-0.019*
Expenditure3	0.006	-0.004	0.005
Expenditure4	-0.009	-0.011	-0.008
Urban	0.023*		
Java		0.027*	
Jakarta			0.041*
Bandung			0.036***
Surabaya			0.065**
Semarang			0.066*
Medan			-0.003
Makassar			0.002
Balikpapan			-0.003
Batam			-0.005
Heavy internet users	0.057**	0.043***	0.054**
Married	-0.031*	-0.033*	-0.029*
Own payment	0.019*	0.019*	0.016*
Technician	0.003	-0.007	0.004
Manager	0.137*	0.11*	0.123**

Note: *, **, *** denotes the significant at 1%, 5% and 10%.

Table 1 shows the Probit output from equation 1. Among the control variables, which consist of age, gender, and education, all the variables are found to be consistent in explaining the likelihood of being a mobile broadband subscriber. Age has a positive impact, indicating that teenagers and people of middle age have a higher likelihood of being subscribers (6 percent and 3 percent higher respectively) compared with the elderly. A higher educated respondent has 8-9 percent greater likelihood of being a subscriber, whereas gender gives a 1.3-1.4 percent greater edge for males to be subscribers. Married respondents are 3 percent less likely to be subscribers than unmarried respondents. This study confirms a priory hypothesis showing that the specific occupation of manager has the highest likelihood of broadband access, whereas this impact does not exist for technician. The impact

of heavy internet users (defined by users on the 60th percentile of Internet usage within the sample of the study) is also important, and they are 6 percent more likely to be subscribers than the rest of the sample. In addition to that, respondents who pay the billing of mobile phone on their own have the higher likelihood as the mobile broadband users.

While there are many aspects can be drawn on the other interesting independent variables, the analysis in this study centers on the comparison between the demand side and the supply side. Income (proxied by expenditure), as the demand -side variable, plays a less important role in determining the likelihood of being a mobile broadband subscriber. The results show that a middle-lower income respondent has a lower likelihood of being a subscriber, but there is no statistical evidence explaining the conclusion for the higher income user. In contrast, geographical area plays a more important role based on the model. The urban respondent is 2 percent more likely to be a mobile broadband subscriber than a rural respondent (Model 1). If the dummy for geographic location is represented by Java and non-Java, the inference indicates that a respondent living in Java is 2.7 percent more likely to be a mobile broadband user. In addition, if the dummy for the geographical location is represented by cities, the results find, accordingly, that Surabaya, Semarang, Jakarta, and Bandung are the spots of the market, while Batam, Medan, and Balikpapan are not statistically significant.

V. CONCLUSION

The study is motivated by the evidence that broadband has undoubtedly contributed to economic development. Yet, there are still few studies investigating the broadband economy in developing countries that make the investigation important. In addition, supported by the fact that mobile broadband is becoming more important in closing the broadband gap between developed and developing countries, the observation on mobile broadband access is an important agenda. Furthermore, the study aims to identify the demand and supply factors that determine mobile broadband access. Two variables are proposed to obtain this aim, with income being used to represent the affordability issue, thus explaining the demand -side factor, whereas geographical characteristics are used to mimic the disparity in infrastructure development and, thus, show the impact of the supply -side factor.

The study concludes that income plays a less important role in its effect on mobile broadband access than geographical area, indicating that affordability is not an issue to further develop broadband. The importance of geographical characteristics confirms the studies by Rappoport [14] and Steinberg, Degagne and Dough [18]. The fact that urban areas, and Java and its cities, are more developed in terms of broadband development leads to a need to develop infrastructure more evenly throughout the country. A schema for Universal Service Obligation (USO) is therefore needed, for instance, the type of partnership between the government and the private sector.

Realizing that infrastructure provision in telecommunications requires such huge investment, future research should be carried out in an attempt to identify the willingness to pay (WTP) for broadband and the demand for broadband usage in each region. This is important as a measurement for further policy, regarding type of technology and dispersion of infrastructure development. Such a method with the ordered probit model will be used to find characteristics of usage based on the technological aspect, speed level and price, whereas the multinomial logit will be adopted to find the type or variety of internet services used by the respondent in each region.

APPENDIX: DERIVATION OF THE PROBIT MODEL

In the data for which a random sample is available, the sample mean of this binary variable is actually an unbiased estimate of the unconditional probability that the event happens. Thus, letting y denote the binary dependent variable, the probability of a success event can be explained by the following equation (1).

$$\Pr(y = 1) = E(y) = \frac{\sum_i y_i}{N} \quad (1)$$

Where N is the number of observations in the sample, the probability equation from (1) can be translated into the Probit model in the following equation (2) and (3).

$$\Pr(y = 1|x) = G\ (\beta_1 + \beta_2 X_2 + \cdots + \beta_k X_k \quad (2)$$

$$\Pr(y = 1|x) = G\ (x\beta) \quad (3)$$

Where G is a function taking on values strictly between zero and one: $0 < G(z) < 1$, for all real numbers z. The model is often referred to in general terms as an index model, because $\Pr(y = 1|x)$ is a function of the vector x only through the index. The fact that $0 < G(x\beta) < 1$ ensures that the estimated response probabilities are strictly between zero and one. G is a cumulative density function that monotonically increases the index z. The function of G can be presented below

$$G\ (x\beta) = \Phi\ (x\beta) \equiv \int_{-\infty}^{x\beta} \phi(v)dv \quad (4)$$

where

$$\phi(v) = \frac{1}{\sqrt{2\pi}} \exp\ (-\frac{v^2}{2}) \quad (5)$$

G is the standard normal density to ensure that the probability of success is strictly between zero and one for all the values of the parameters and the explanatory variables.

Variable Definition

Variable	Definition	Definition
MOBILE	Dummy	MOBILE is a respondent who uses a mobile phone to connect to the Internet using either a desktop, laptop, or mobile phone (at least a device).
URBAN	Dummy	The dummy variable of geographical location, where d_urban=1, refers to urban. The reference (based dummy) is non-urban.
List city names	Dummy	Indicates whether the respondent is living in a particular city. There are 8 cities in the observation: Jakarta, Bandung, Semarang, Surabaya, Balikpapan, Medan, Batam, and Makassar. Thus, d_jakarta=1 denotes that the respondent lives in Jakarta. The reference (based dummy) is other cities.
LIST ISLANDS	Dummy	Shows whether the respondent is living on a particular island. Thus, d_jawa=1 shows that the respondent is living on Java. The reference (based dummy) is other islands.
AGE25 AGE2539 AGE40	Dummy	Each dummy refers to the classification based on 3 categories of age: (a) Age1 refers to age <25; (b) Age2 ranges between 25 and 39; (c) Age3 refers to age 40 and up; and (d) Base dummy is age3.
MALE	Dummy of gender	Shows male-female category. Thus, d_male=1, respondent is a male. The reference (based dummy) is female.
SIZE	Household member	Number of household members
d_high_edu	Education attainment	Regrouped from the global category of education (primary, high school, college, and post graduate). d_high_edu denotes respondent attained/completed high school education (d_global_edu>2). The reference (based dummy) is lower education.
d_hhe_g1 d_hhe_g2 d_hhe_g3 d_hhe_g4	Household expenditure	Each variable refers to the global expenditure classification. The lower group denotes expenditure up to IDR. 900.000/month, the middle group represents the expenditure between the interval of IDR 900.000 and IDR 1750,000. The highest expenditure group is IDR 2,500,000 and above. Based dummy is g1 as the reference.
HINTERNET		The variable refers to the heavy internet users. The reference (base dummy) is a non-heavy user
d_manager d_technician		The dummies refer to a particular type of occupation. The reference (base dummy) is neither a manager nor a technician.

Descriptive Statistics

Code	Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
MOBILE	Mobile broadband ownership, 1 = Yes, 0 = No	3470	0.051	0.221	0	1
MALE	Gender, 1 = Yes, 0 =N0	3470	0.485	0.499	0	1
HED	Education degree, HED = Higher education (education > 9 years)	3470	0.056	0.231	0	1
AGE25	Teenager (age <25)	3470	0.271	0.444	0	1
AGE2539	Middle age (25-39)	3470	0.392	0.488	0	1
AGE40	Older people (40 <)	3470	0.336	0.472	0	1
LSPEND	Lower expenditure	3470	0.386	0.487	0	1
LMSPEND	Lower medium expenditure	3470	0.094	0.292	0	1
MSPEND	Medium expenditure	3470	0.050	0.218	0	1
HSPEND	Higher expenditure	3470	0.025	0.158	0	1
URBAN	Geographical area	3469	0.594	0.491	0	1
HINTERNET	High internet usage	3470	0.022	0.147	0	1
MARRIED	Marital status (1 =Yes, 0= No)	3469	0.695	0.460	0	1
d_own_pay	Paying the bill themselves	3470	0.399	0.489	0	1
TECHNICAN	Occupation as a technician	3470	0.140	0.347	0	1
MANAGER	Occupation as a manager	3470	0.012	0.113	0	1

ACKNOWLEDGMENT

We are very grateful to Ericsson Consumer Lab, South-East Asia, for the data and advices during the study. The authors are responsible for all remaining errors.

REFERENCES

[1] International Telecommunication Union. (2010, October 19). ITU. Retrieved September 08, 2011, from News room-Press release: http://www.itu.int/net/pressoffice/press_releases/2010/39.aspx

[2] Crandall, R W, C L Jackson, and H J Singer. *The Effect of Ubiquitous Broadband Adoption on Investment, Jobs and US Economy*. Washington, D.C, Criterion Economics, L.L.C., 2003.

[3] Lehr, W, C Osorio, S Gillet, and M Sirbu. "Measuring Broadband Economic Impact." *The 33rd Research Conference on Communications, Information and Internet Policy*. Arlington, VA, 2006

[4] Katz, R. (2009). Estimating broadband demand and its economic impact in Latin America. *The 3rd ACORN-REDECOM Conference*. Mexico City.

[5] Infodev. (2010). *Broadband policy for developing countries*. ESW Concept Notes, Washington, DC.

[6] Reynolds, T., & Samuels, A. (2004). Building digital bridges with emerging technologies. *Digital Bridges Symposium*, Seoul: International Telecommunication Union (ITU).

[7] Galperin, H. (2004). Wireless Networks and Rural Development: Opportunities for Latin America. *The Latin American Studies Association Conference*. Las Vegas.

[8] Proenza, F. J. (2006). The road to broadband development in developing countries is through competition driven by wireless and Internet telephony. *Information Technologies and International Development*, 3(2), 21-39.

[9] The World Bank. (2009). *Information and communications for development 2009: Extending reach and increasing impact*. Washington DC: The World Bank.

[10] Kelly, T., Mulas, V., Raja, S., Qiang, C., & Williams, M. (2009). What role should governments play in broadband development? *The infoDev/OECD workshop on "Policy Coherence in ICT for Development"*. Paris.

[11] Magpantay, E. (2010). ICT Infrastructure and households statistics. *International Seminar on Information and Communication Technology Statistics*. Seoul: International Telecommunication Union (ITU).

[12] Handler, D. P., & Grossman, R. (2009). *The role of income distribution and broadband penetration in developing countries*. Cisco IBSG.

[13] Hausman, J., Sidak, J., & Singer, H. (2001). Residential demand for broadband telecommunications and consumer access to unaffiliated Internet content providers. *Yale Journal on Regulation*, 18(1), 129-173.

[14] Rappoport, T., & Taylor, L. D. (2002). Willingness to pay and the demand for broadband services. *ICFC Conference*. San Francisco.

[15] Cadman , R., & Dineen, C. (2008). *Price and income elasticity of demand for broadband subscriptions: a cross-sectional model of OECD countries*. Norwich: SPC Network.
[16] Rosston, G. L., Savage, S. J., & Waldman, D. M. (2010). Household demand for broadband Internet in 2010. *The B.E. Journal of Economic Analysis & Policy*, 10(1), Article 79.
[17] Jackson, M., Lookabough, T., Savage, S., & Waldman, D. (2010). *Broadband demand study: Final Report. Telecommunication Research Group*, University of Colorado.
[18] Steinberg, S., Degagne, R., & Gough, M. (2008). Broadband demand aggregation: Planning broadband in rural Northern California. *The ESRI User Conference Proceedings*. San Diego.
[19] Srinuan, C., Rohman, I. K., Srinuan, P., & Bohlin, E. (2010). Digital divide in ASEAN countries: explaining the gap. In P. Gugler, & J. Chaisse (Eds.), *Competitiveness of ASEAN countries*. London: Edward Elgar.
[20] Kementrian Komunikasi dan Informatika. (2010). *Komunikasi dan informatika Indonesia: whitepaper 2010*. Jakarta: Kementrian Komunikasi dan Informatika, Republik Indonesia.
[21] Kementrian Perencanaan Pembangunan Nasional. (2010). Rencana Pembangunan Jangka Menengah (RPJM) Nasional. Jakarta: Bappenas.
[22] Sabry, W. (2010). *Broadband wireless access Indonesia: Peluang tantangan*. Jakarta: Alcatel Lucent, Masyarakat Telekomunikasi (Mastel).
[23] Santosa, S. P. (2010). The acceleration of economic development through fixed broadband network. Jakarta: Masyarakat Telekomunikasi (Mastel).
[24] Perl, L. J. (1978). *Economic and demographic determinants of residential demand for basic telephone service*. London: National Economic Research Associates, Inc.
[25] Train, K. E., McFadden, D. L., & Ben-Akiva, M. (1987). The demand for local telephone service: a fully discrete model of residential calling patterns and service choices, *Rand Journal of Economics*, 18, 109-123.
[26] Bodnar, J., Dilworth, P., & Iacono, S. (1988). Cross-sectional analysis of residential telephone subscription in Canada. *Information Economics and Policy*, 3, 359-378.
[27] Train, K., Ben-Akiva, M. and Atherton, T. (1989), 'Consumption Patterns and Self-selecting Tariffs', Review of Economics and Statistics 71, 62-73.
[28] Taylor, L. D., & Kridel, D. (1990). Residential demand for access to the telephone network. In A. de Fontenay, & M. H. Shugard (Eds.), *Telecommunications Demand Modeling* (pp. 105-117). Amsterdam: Elsevier Science/North Holland.
[29] Koutrompis, P. (2009). The economic impact of broadband on growth: a simultaneous approach. *Telecommunication Policy*, 33, 471-485.
[30] Thurman, W. (1986). Endogeneity Testing in a Supply and Demand Framework. *Review of Economics and Statistics*, 68, 638–646.
[31] Bettendorf, L., & Verboven, F. (1998). *Competition on the Dutch coffee Marmet*. The Hague: Central Planning Bureau.
[32] Morris, M., & Venkatesh, V. (2000). Age differences in technology adoption decision: Implications for a changing workforce. *Personnel Psychology*, 53(2), 375-403.
[33] Pagani, M. (2004). Determinants of adoption of third generation mobile multimedia services. *Journal of Interactive Marketing*, 18(3), 46-59.
[34] Varian, H. R. (2001). The demand for bandwidth: Evidence from the INDEX project. In R. W. Crandall, & J. H. Alleman (Eds.), *Broadband: Should We Regulate High-Speed Internet Access?* Washington, D.C: Aei-Brookings Joint Center for Regulatory Studies, American Enterprise Institute.
[35] Burton, M. L., & Hicks, M. J. (2005). *The residential and commercial benefits of rural broadband: Evidence from Central Appalachia*. Charleston: West Virginia Development Office.
[36] Badan Pusat Statistik (BPS). (2004). *Country paper. Official statistics and its development in Indonesia.* Jakarta: BPS.
[37] Davis, B., Caccappolo, G., & Chaudry, M. (1973). An econometric planning model for AT& T. *Bell Journal of Economics and Management Science*, 4(1), 29-56.
[38] DG Postel, Government of Indonesia. (2008). *Statistics of Post and Telecommunication*. Jakarta.
[39] Dobell, A., Taylor, L., Waverman, L., Liu, T., & Copeland, M. (1972). Telephone communications in Canada: demand, production, and investment decisions. *Bell Journal of Economics and Management Sciences*, 3(1), 175-219.
[40] International Telecommunication Union. (n.d.). ITU. Retrieved September 9, 2011, from ITU News Magazine: http://www.itu.int/itunews/manager/display.asp?lang=en&year=2008&issue=01&ipage=WT_ICT_indicator&ext=html
[41] Taylor, L. D. (1994). *Telecommunications demand in theory and practice*. Dordrecht: Kluwer Academic.

Ibrahim Kholilul Rohman is a PhD candidate at the Division of Technology and Society, Chalmers University of Technology in Sweden. Erik Bohlin – who is currently the chair of International Telecommunication Society – acts as the main supervisor. He obtained his bachelor degree in Economics from the Faculty of Economics, University of Indonesi,a in 2002. Afterwards, he worked at the Institute for Economic and Social Research, Faculty of Economics, University of Indonesia as a researcher. In 2006, he obtained a master's degree in Monetary Economics from the same university.

In 2008, Ibrahim obtained a scholarship from the Ministry of Communication and Information Technology, Government of Indonesia, to pursue a PhD degree in Sweden. During this study, he has worked on several projects, including the Mobile Barometer Survey 2011 which was conducted by Chalmers University of Technology and NTT DoCoMo. This survey aims at investigating the future demand of cellular services in the Japanese and Swedish market. He was also involved in a collaborative study between Chalmers, Ericsson and Arthur D. Little on the assessment of speed impact to the economy. His study focuses on pricing, demand analysis and impact assessment.

Erik Bohlin is Professor and Head of the Division of Technology & Society, Department of Technology Management & Economics at Chalmers University of Technology, Gothenburg. He has published in a number of areas relating to the information society - policy, strategy and management.

He is Chief Editor of Telecommunications Policy; Chair of the International Telecommunications Society; Member of the Scientific Advisory Boards of Communications and Strategies, the International Journal of Management and Network Economics, the Nordic and Baltic Journal of Information and Communication Technologies, and Info - the Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media; Member of the Scientific Committee of the Florence School of Regulation (Communications & Media); Research Fellow of the Institute of Management, Innovation and Technology (IMIT) and Member of the Royal Academy of Engineering Sciences.

Erik Bohlin obtained his graduate degree in Business Administration and Economics at the Stockholm School of Economics (1987) and his Ph.D. at Chalmers University of Technology (1995).