Analysis of direct public policy toward broadband:

A demand and supply perspective

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Abstract: Stimulating broadband diffusion has appeared to be a significant national agenda in both developed and less developed countries. Regulation which contribute to create an investment-friendly regulatory environment has long been adopted by policy-makers and captured much attention among academic researchers as well. While in recent years, there has been strong interest among governments in non-regulatory public intervention for the purpose of galvanizing broadband deployment and adoption. However, only a handful of articles has been explicitly contributed to analyze the ex post effectiveness of those policies for broadband promotion, which mainly due to a number of reasons that include the difficulty of gathering adequate information for a numbers of countries. The paper examines the motives of government intervention in supply side and demand side respectively. It also considers the performance of those policies. Empirical analysis presents that demand side policies have significantly positive impact on broadband penetration.

Keywords: public policy; broadband diffusion; supply-side; demand-side

1. Introduction

The benefits of broadband use have been widely realized and broadband diffusion is one of the items at the top of the topic for information and technology related polices of governments worldwide. Broadband penetration has followed different paths in different countries and regions. Several scholars have been studied the factors that affect the adoption of broadband. Most of the papers have been focused on the regulations in the communication industry (Cambini, 2009) and the socio-economic broadband determinants of broadband adoption (Chaudhuri and Flamm (2007), Rappaport et al (2003), GAO (2006)),). However, the worldwide countries have been anxiously pursuing public policies to promote broadband uptake and the upgrade of existing networks (the ambitious government strategy-National Broadband Network (NBN)-in Australia, for instance). Various policies have been adopted by different countries over time.

Due to the difficulty of gathering appropriate information for a number of countries sufficient to make the policy analysis valid in a context which is adjusted over time, there is a lack of both theoretical and empirical analysis exactly focusing on the policy side of broadband debate.

Although only limited articles have been explicitly contributed to assessing ex post effectiveness of direct public policies for broadband promotion. Authors have suggested that the public direct interventions in the telecommunication industry need to be given special attention. A comparative study on broadband policy among EU countries by Bohlin (2009) also suggest that public intervention can, under certain conditions, be an effective tool to be applied. Similarly, the qualitative study by Troulos et al. (2011) turn out to an optimistic conclusion on the influence of public policies. In addition, a later empirical study by Belloc et al. (2012), covering 30 OECD countries over the period 1995-2010, shows that while both supply-side and demand-side policies have a positive effect on broadband penetration, their relative impact depends on the actual stage of broadband diffusion.

While the above articles indicate a positive attitude to the effectiveness of public policy, academic finding are not uniform. Contradictory results are find in some research. An empirical study by Bauer et al. (2003), performing 30 OECD countries in 2001, shows that variables related to public intervention do not turn out to be statistically significant. Besides, Aizu (2002) similarly reports that government policies do not have much influence in promoting broadband use though a more qualitative comparative research of broadband diffusion in Asia.

Thus, it suggests that there is a continued role for the public policy. Uncovering the different factors that affect broadband adoption in a country and the how the public policies take place may guide a policy maker's choices of the most effective instruments and this was one of the major motivation for the current study. Keeping in mind the motivation, this study tries to look into the policy design for broadband adoption promotion. By reexamination of the public policies which have been implemented in selected countries, it is found that demand-side policies play a critical role in broadband development and countries with a commitment to demand-side intervention have better performance in broadband uptake. In particular, some countries (e.g., Australia) without demand-side policies exerted huge gap between DSL coverage rate and adoption rate.

The study is structured as follows. Section 2 briefly reviews the authors previous finding by reexamination of the public policies, both demand-side and supply-side policies and programs. Then, hypothesis derived from the observation was presented, following with a theoretical discussion about the possibility of the proposed hypothesis. In order the test the hypothesis, section 3 illustrates the methodology and data used in this study.

2. Previous study and Hypothesis proposition

2.1 Context

It is observed that governments in a global scale, targeting stimulating the broadband penetration rate, have been intervened into the broadband market on the supply side or/and demand side, how the intervention works can be described as follow.

The reason behind the unsatisfactory broadband uptake rate is that, on the supply side, there is high roll-our cost for operators to provide broadband service as well as the uncertain profitability. While, on the demand side, the value allocated on broadband by consumer is underestimated, which means the reservation price are under the supply price. In this case, public player could intervene either complementing the consumers' increased willingness to pay or subsidizing infrastructure construction by means of a contribution to operators' roll-out cost (Fig. 1).
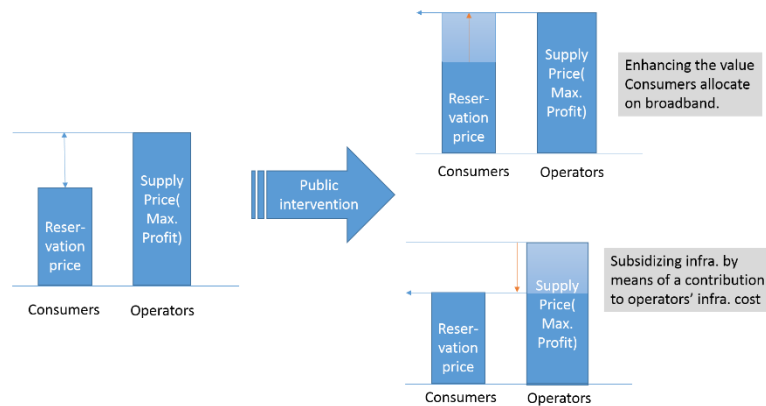

Fig.1 Public intervention on demand side and supply side

Then, we may come up with the doubt: comparing the two measures, do the demand side policy and supply side policy have same effect of promoting broadband uptake?

Based on the finding in the author's research, by reexamination of the direct public polices in UK, Sweden, Korea, and Australia, it is find that demand-side policies play a

critical role in broadband development. Countries with a commitment to demand-side intervention have prominent performance in broadband uptake. Korea, UK and Sweden have placed emphasis on demand-side policies along with their supply-side intervention. In contrary, countries with little effort to generate demand showed a huge gap between coverage and adoption. Australia where broadband adoption was very low despite the high availability of DSL before 2006. Correspondingly, Australia government did not employ any demand-side policies to generate broadband demand until 2006, in which a series of programs were established and per-customer subsidies were provided to ISPs offering services.

As such, hypothesis is proposed: demand side policies are more productive than supply side policies in stimulating broadband adoption.

2.2 Theoretical discussion: is the hypothesis possible?

When public player decide to intervene to stimulate broadband uptake, subsidizing consumers through demand side policies or supporting operators by means of supply side policies became the focus of the debate. Each means has advantages and limitations. If decision is made to subsidize operators by lowering the infrastructure cost that companies have to pay and provide incentives to encourage them to increase broadband coverage, public player will be confronted with asymmetric information about the applicants' operation situation and the uncertain demand of potential users, which leads to a loss of public expense. However, it might work in the short term comparing to the demand side intervention particular if the access to broadband is not available. In contrast, the demand side policies may face the extra loss of involving consumers into the system. Public programs aiming to raise the consumers' willingness to pay may not directly leads to the growth of broadband uptake because of the inelastic demand. We may consider that some consumers who perceived the usefulness of broadband by ICT education program still may not subscribe broadband service due to the budget constraint. Nevertheless, involving consumers into the system means let market mechanisms do their best. Operators are selected by the market rather than the public player. Once the loss demand side loss can be covered by increased efficiency brought by market mechanism, demand side policies present productive and even more productive than supply side policies (Fig. 3). Certainly, letting the coverage driven by market demand generates a time lag, the effectiveness of demand side policies is not expected to be observed promptly. Because once operators determine to invest, it takes
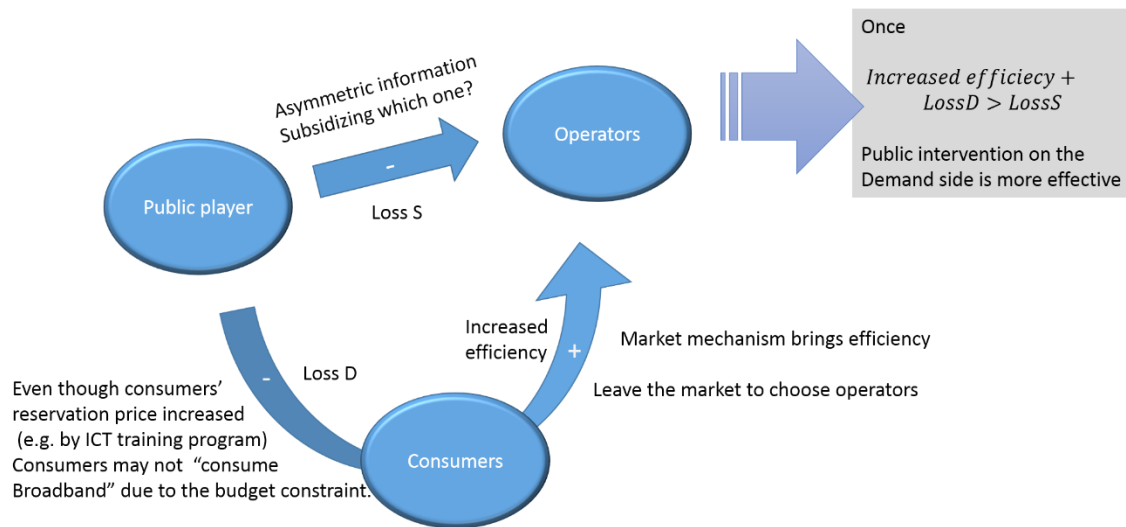
time to construct the broadband line.

Fig. 2 How the public player intervene on supply side and demand side

Demand for broadband is primarily conditioned and driven by Internet and PC penetration.

3. Methodology and data

3.1 Setting

Since the public intervention paths are discussed, we may further consider the hypothesis that demand side policies are more productive than supply side policies in stimulating broadband adoption is true under what conditions.

3.1.1 Competitive broadband market

When there is a competitive market for broadband, it is assumed the more elastic the demand is, the less loss will be generated in demand side which leads to the more productive demand side policies. On the supply side, we assume that the obvious gap between coverage and adoption rate corresponds to the asymmetric information between public player and operators. The obvious gap between coverage and adoption had existed in many OECD countries in which DSL and Cable Modem service are full competitive (ITU, 2011). Therefore, it is supposed the distinct disparity between coverage and adoption rate reflects the extent of asymmetric information between and operators so as to make the inequation in Fig.2 true.

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Then we have the following sub-hypothesis.

H1: In competitive market, demand side policies is more productive than supply side policy.

H1a: Demand side policies have positive impact on broadband adoption rate.

H1b: The impact of demand side policies on broadband adoption rate is greater than supply side policies.

3.1.2 Partial competitive and monopoly market

When market competition is limited, and consumers' demand for broadband is inelastic, it is indicated that demand side policies do not hold their advantages any more.

In this case, demand side policies are not expected to be more productive than supply side policy.

H2: When there is no full competition, partial competition or monopoly, in the broadband market, demand side policies is not more productive than supply side policy.

H2a: Demand side policies do not have significant impact on broadband adoption rate.

3.2 Regression analysis

This regression analysis of current study focused on the competitive market. The study intends to test the hypothesis with regression analysis on data of 30 OECD countries in which the broadband market is full competitive (ITU, 2012). In order to verify the hypothesis proposed in the previous section, estimation model is generated as follows.

$$ln(\text{penetration}_{it}) = \beta_0 + \beta_1(Supplypolicy_{it}) + \beta_2(Demandpolicy_{it}) + \beta_3\ln(Urbanization_{it}) + \beta_4\ln(GDP_{it}) + \beta_5\ln(Density_{it}) + \beta_6\ln(EDU_{it}) + a_i + u_{it}$$

Where penetration$_{it}$ is the fixed broadband subscribers per 100 people of country i in year t. Urbanization$_{it}$ is the population in the largest city calculated by percent of urban population. GDP$_{it}$ is measured in current U.S. dollars. Density$_{it}$ represents population density by people per aq.km of land area. EDU$_{it}$ reflects the education condition by % gross of tertiary school enrollment. In this equation, $Demandpolicy_{it}$ is dummy variable. 1 denotes country i initiated demand side policies which results in increasing consumers' willingness to pay in at year t. $Demandpolicy_{it} = 0$ shows there was no such policies. Similarly, $Supplypolicy_{it}$ is dummy as well, I is where county I implemented supply side policies which aiming to stimulating broadband uptake by supporting operators and 0 otherwise. One other thing to note is that it is

assumed that once the country's demand side policy is taken, the effect is durative, which implies that the dummy variables of the country are compiled into 1 since the year the policy was first initiated. Therefore, positive coefficient of $Demandpolicy_{it}$ and $Supplypolicy_{it}$ indicates that broadband adoption was promoted by demand side policies and supply side policies.

In the estimation, yearly panel data for 30 OECD countries from 2001 to 2011. The independent variable is the number of fixed line broadband subscriptions per 100 inhabitants, as reported by ITU (ITU, 2012). When broadband was first introduced to the market, countries with little broadband service yields a long tail of small values in the distribution of the number of subscriptions per 100 people. Therefore, the natural logarithm of this penetration variable is take to be the dependent variable in the regression analysis. The independent dummy variables, demand side policy and supply side policy are compiled based on information gathered on the different sorts of broadband promotion policies adopted, from both demand and supply sides, over the period the year broadband first introduced in the country to 2011 in 30 countries. Sources of information have been used including academic papers, institutional reports, national and international reports, national regulator's report. In addition, since country profile exerts influence on the country's broadband diffusion, other control variables, including urbanization, GDP, population density and tertiary school enrollment rate are taken into consideration. Those data are obtained from World Bank World Development Indicators.

In competitive market:
If the coefficient for demand side policy should turn out to be statistically significant, the results would support the hypothesis (H1a).
If the coefficient for demand side policy should turn out to be significantly greater than the coefficient for supply side policy, the results would support the hypothesis (H1b).

Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Penetration	330	16.31267	11.4072	0	39.96368
SuppPolicy	316	.6613924	.4739868	0	1
DemPolicy	300	.76	.4277967	0	1
Urbanization	330	76.37579	10.55231	54.7814	97.48542
GDP	330	31495.12	12537.22	8693.539	88796.88
Density	330	139.3587	131.896	2.526978	512.6572
Edu	272	61.63424	18.11022	10.19767	103.8725

4. Estimation Results

Then, the study intends to test the hypothesis with regression analysis on data of OECD countries in which the broadband market represents full competitive. The method used here is a panel data using national data, after estimating the fixed effect model and a random effect model. Fixed effect model is selected according to the Hausman test.

The coefficients showing the effect of policy variables are presented in the first two rows of Table 2. The first row of data reports the coefficient for the supply side policy is positive, but not statistically significant, indicating the presence of supply side policies have not significantly promoted broadband penetration in OECD countries. The next row presents that the coefficient for the demand side policy is positive and statistically significant at the 0.01 level. This finding support the H1a that Demand side policies have positive impact on broadband adoption rate. And results of F-test shows that the coefficient of supply side policy and demand side policy are not significantly different, which provide no evidence to support the H1b.

Table 2 Results of estimation

Dep. Var. lnPenetration	Coef. (Std. Err.)
SuppPolicy	0.1909275(0 .130296)
DemPolicy	0.6086203 (0.1861367)[***]
LnUrbaniza~n	-1.053473(0.6483561)
LnGDP	4.357826 (0.5149556)[***]
LnDensity	5.017832 (2.265844)[**]
LnEdu	2.478755 (0.6914154)[***]
_cons	-70.2597 (13.13188)[***]
Number of obs. 240 Country effects Fixed Time effects Fixed F-stat 91.69 Prob.>F 0.000 R-Squared 0.806	

Statistical significance *0.1 **0.05 ***0.01

Note: standard errors are heteroskedasticity robust

5. Discussion and Conclusion

The study examined the government intervention in the broadband market by means of demand side policies which aiming to raise people's willingness to pay for the broadband services, and supply side policies targeting lower the operators' cost of infrastructure construction. How those two different instruments work are analyzed. For supply side policy, a loss appears due to the asymmetrical information between public players and operators. It is not surprised that pubic decision is made based on the operators' application for the support. However, as a public player does not have better information than operators, relying on the public player to select operators to be support will generated a loss in efficiency. On contrary, demand side policy stimulates broadband adoption by subsidizing consumer with increased reservation price on broadband service. A loss also should have be generated because of the incomplete transformation of public players' input. This might be easy to understand when we consider that people received ICT training with increase value allocated on broadband may remain not subscribing broadband service either as a result of budget constraint or being satisfied with the current narrowband. However, leaving the consumers to choose operators brings extra efficient owning to the market mechanism. Certainly, it does not work under monopoly market.

Based on those theoretical consideration, issues regarding the effect of policies are examined. Concerns are raised that should demand side policies and supply side policies have alike effect on broadband penetration or not. Further, should demand side policies express more significant in stimulating broadband uptake when the market is competitive enough or not. Then, the study applies econometric analysis so as to test and verify the hypothesis.

The difficulty of gathering adequate information for a number of countries to sufficiently represent policy variables makes empirical analysis of policies arduous. The current study tries to providing some concerns that may constitute the basis for effective policy interventions. Dummy variables are employed to statistically test the effect of public policy in the regression analysis. Results shows the positive effect of demand side policies on broadband penetration are directly confirmed which provides strong evidence of H1a. Although the hypothesis H1b that the impact of demand side policies on broadband adoption rate is greater than supply side policies is not supported by the econometrical results, the coefficient of supply side policies which is not statistically significant indicates that the impact of supply side policies is not as well as demand side policies. It also reflects a contradictory to the fact that government interventions have been historically allocated on supply side and deserve some discussion. However, what the results firmly suggest is the importance of demand side policies to encourage und-user adoption for effective penetration of the technology to take place. This is consistent with other studies (Jeanjean, 2010; Goolsbee, 2003), that have indicated that demand-side subsidies had a better impact on penetration than supply-side subsidies.

It might be doubted that user's high willingness to pay does not make sense if broadband service is not available, or say there is no access to the broadband network. By rethinking of the manners in which demand side policies and supply side policies work, it is observed that operators investment incentive for infrastructures can be induced by the increased of consumers' willingness to pay which generated by demand side policies. The insignificant effect of supply side polices may be partly explained by noting that the dependent variable does not measure broadband coverage but subscriptions, nonetheless generally more subscriptions should correspond to greater infrastructure availability.

There are certain limitations of the study that need to be addressed. The information gathered across a number of countries is not exhaustive. Dataset might not cover some

countries with limited information available. In addition, the hypothesis concerning the partially market are need to be tested. Thus, further step should be to improve the methodology to cover those problems, and empirical researches are required to test the hypothesis H2 proposed in this preliminary work.

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