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THE MOBILE BROADBAND AND FIXED BROADBAND BATTLE IN SWEDISH MARKET: COMPLEMENTARY OR SUBSTITUTION?

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Abstract

This paper aims to investigate the current broadband situation in Swedish market, in particular whether the mobile broadband (MBB) is a complementary or substitute service to fixed broadband (FBB) by using multinomial logit model. The data is collected from the Post- och telestyrelsen (PTS) survey in 2009 together with a secondary data on price of broadband service for each service providers. The findings indicate that price and type of housing are the major determinant for broadband connections. In addition, the living area and service provider affect the probability of using broadband. Considering the own price elasticities, cable is more inelastic compared to DSL, LAN/Fiber and MBB while the cross price elasticities show that MBB is complementary service to FBB in Sweden at this stage. However, the cross price elasticities of FBBs and MBB report that there is high possibility that MBB could be substitution service to FBB in the near future.

Keywords

Mobile broadband, Fixed broadband, Complementary, Substitution

Introduction

Broadband development can bring substantial benefits to the productivity, education, e-inclusion and economic development of society in general. Innovative productive practices in business, government, education, health care and daily life are now critically dependent on the ability to communicate information quickly and independently. Together, the potential benefits at national, individual and organizational levels contribute to something of a consensus that the adoption of broadband should be promoted (Trkman et al., 2008).

The key role of broadband is providing an effective means to deliver information and digital services to subscribers connected to either fixed-line or wireless networks. The tradition broadband service is fixed broadband (FBB) which has developed and upgraded from the dial-up telephone modem to Asymmetric Digital Subscriber Line (ADSL) or broadband connection through cable or fiber while the services that are delivered via wireless network is mobile broadband (MBB)[1]. It enhances consumer access to information because of the technology's 'any place' at 'any time' attributes (Cheong and Park, 2005).

The introduction of high-speed mobile Internet access to an increasing number of countries further boosts global Internet access, increasing the societal value of the network. In fact, MBB subscription has increased steadily, surpassing FBB subscription in 2008. At the end of 2009, there were an estimated 640 million MBB subscribers (ITU, 2009). In several European countries the number of MBB subscriptions has shown an annual growth of several hundred percent. The rapid subscription growth since the introduction of third-generation (3G) services is in part attributed to the significant increases in transmission speeds, which are particularly useful for data services. For example, 3G devices are more efficient at enabling e-mail and for downloading content from the Internet (Gans et al., 2005). Furthermore, MBB provides an alternative mode of access to customers residing in underserviced or remote areas without an adequate fixed broadband infrastructure.[2] MBB can also use as the main household Internet by using USB modem to access to mobile network. In addition, the introduction of flat rate subscriptions with a monthly fee typically in the rage of 10-20 Euro is one reason for rapid development of mobile broadband (Mölleryd et al., 2009).

Sweden has been launched its ambitious and government support on national ICT infrastructure program since 2000. The Swedish government supported for upgrading and investments in fixed broadband infrastructure in the whole country till December 2007 (Eskelinen et al., 2008).This is one of reasons that Sweden has historical lead in term of FBB penetration rates among OECD countries (OECD, 2009).

In term of MBB, the number of MBB subscriptions will surpass 1 million during 2009 (about 10% penetrations). With the same growth rate 2 million subscriptions can be expected within next 3-4 years (Mölleryd et al., 2009). MBB can play a substantial role into the broadband market that was previously predominated by DSL and cable. Although FBB have enjoyed a premium due to high speed Internet capacity which also influences demand for access but MBB seems to have more advantage compare to fixed broadband in term of mobility, compatibility and quality of service to support this burgeoning growth in demand for Internet service.

This study uses data obtained from a nationwide mail survey of Swedish household in 2009 by the Swedish telecom regulator (Post- och telestyrelsen-PTS) together with a secondary data on price of broadband service for each service providers to examine household demand for broadband Internet

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1 MBB refers to an Internet connection that supports data, voice and video information at high speeds through mobile devices (Ergen, 2009).

2 Traditional and fixed broadband access was initially supplied through a digital subscriber line (DSL) and cable modem technology, that is, access with no mobility characteristics. These technologies utilize the twisted-pair copper wire of the local loop of the public switched telephone network (PSTN).

access. Data are used to investigated profile of household broadband access service and use, and gain insight into how important price, size of household, education and income are in the household choice of service. Empirical results provide information for telecom regulator in order to revise the existing broadband market definition and gain insight of market dominant position of incumbent provider. Also, the results may useful for broadband service providers to understand Internet usage of household. This paper is organized as follows. Section 2 discusses the previous studies on FBB and MBB relationship. The current situation on Swedish broadband market is presented in Section 3. The empirical evidence from the survey is described in Section 4. Section 5 explains the estimation model. Section 6 analyzes and discusses the estimation results, while the conclusion is provides in Section7.

2. Literature review and state of practice

There are a number of papers that have analyzed the relationship between mobile and fixed line telephony in particular, only few papers have investigated connection between MBB and FBB. The discussion in this section will start with the relationship between mobile and fixed line telephone first and then the implication on relationship between FBB and MBB will be discussed.

The paper by Vogelsang (2010) presents the survey of literature on the issue of fixed to mobile substitution (FMS). FMS means the replacement of fixed-line services with mobile services (Albon, 2006) or the use of mobile instead of fixed phone for calls or access to telecom services (Vagliasindi et al., 2006). Vogelsang finds that theoretical models explaining FMS are scarce and are inconclusive regarding the balance between substitution and complementarity of fixed and mobile sectors. Empirical explanations hinge on the interaction of positive cross- elasticities of demand and reductions in mobile relative to fixed communication prices (Ahn and Lee (1999), Grajek and Kretshmer (2009), Garbacz and Thomson (2005, 2007) and Narayana (2008)). FMS is also supported by relative declines in mobile network costs, network effects in demand and quality improvements of mobile services (Yong and Song (2003), Heimshoff (2008), and Briglauer et al. (2009)).

In contrast to FMS, there are few papers which discussed about the relationship within FBB and between FBB and MBB. Many studies have analyzed the demand and behavior of using FBB, for example, Madden and Simpson (1997) and Savage and Waldman (2005). The first study by Madden and Simpson (1997) investigates the determination of demand for FBB subscription in Australia. The results are estimated through the logit regression model and indicate that household income, the installation fee, age, occupation of household head and household size significantly influence the pattern of broadband subscription. Similar to Savage and Waldman (2005), they investigate household awareness of high-speed Internet access and profile Internet access and use. Their results show relatively high awareness of cable modem and DSL availability. Preference for high speed access is apparent among high income household and college education. In addition, reliability of service, speed, and always- on connectivity are important determinant factors for willingness-to-pay of consumers.

Due to the availability of broadband technologies, several studies estimated the extent of retail demand elasticity for particular FBB access types such as DSL and cable so far. For example, Crandall et al. (2002) use nested-logit discrete choice model to estimate the own-price elasticity of demand for DSL service and the cross-price elasticity of demand for cable modems service with respect to DSL service. They find that DSL and cable modems are in the same market since demand for DSL service is price elastic. Rappoport et al. (2003) investigate this phenomenon in the US Internet service market by taking the narrowband into account. The result is similar to the previous study. In addition, Ida and Kuroda (2006) analyze the demand for broadband in Japan. They include five internet access alternatives that are available in Japan: narrowband (dial-up and ISDN), DSL, cable, and fiber to the home (FTTH). The result reveals that DSL is independent of other services but actively competing with narrowband, cable and FTTH.

The recent paper by Cardona et al. (2009) consider substitution patterns on broadband market and demand estimations in Austria by using survey data. Their results suggest that DSL and cable are part of the same market at the retail and wholesale level. This is supported by evidence from other countries such as the UK, the US, Portugal and Malta. In addition, the question whether BB delivered via mobile networks by means of UMTS and HSDPA is part of the same market as DSL and cable. Survey evidence from end of 2006 suggests that this is not the case. However, they mentioned that there is an increased competitive pressure from MBB on FBB network connections from the recent development in Austria market. Despite this evidence they conclude that MBB is in a too early stage of development to draw firm conclusions on market definition.

To sum up, previous literature shows that relationship between FBB and MBB might be similar as what has happened between the fixed and mobile market. The method that usually uses to determine substitution and complementary goods is an estimation of cross price elasticity of demand of those products or services. Most previous studies employed both survey data which conduct in national basis.

Since the magnitude of MBB is growing, it has important implications for several regulatory issues including competition, infrastructure planning and investment decision. For example, service providers can design corporate strategies to mitigate the extent of fixed and mobile broadband substitution. It might affect the competition and market definition finally. Providers can apply the similar strategy in broadband market since some of providers provide both fixed and mobile service. These lead to reason that why competition in broadband market is interesting to investigate.

3. Current situation in Swedish broadband market

As mentioned in Introduction part, Sweden has a high percentage of household with Internet access compared to other European countries. At the end of 2009, 86 percent of household in this country can access internet from home while only 65 percent of household in EU 27 could connect to the internet from home. Moreover, there is 79 percent of household internet connection in Sweden using broadband connection and 15 percent use dial-up connection (Eurostat, 2009).

The consequence of the Swedish broadband strategy is also resulted in increased broadband infrastructure, in particular fixed infrastructure, to be available for internet broadband usage. The broadband penetration including FBB and MBB is growing overtime from 0.88 per 100 inhabitants by the end of 2000 to 40 per 100 inhabitants at a mid of 2010 (See Figure 2 and 3).

Due to well developed fixed telephony infrastructure, the majority of broadband access in Sweden is xDSL via fixed telephony infrastructure which is similar to other European countries. There were more than 40 percent of broadband subscribers using this type of connection in 2010.

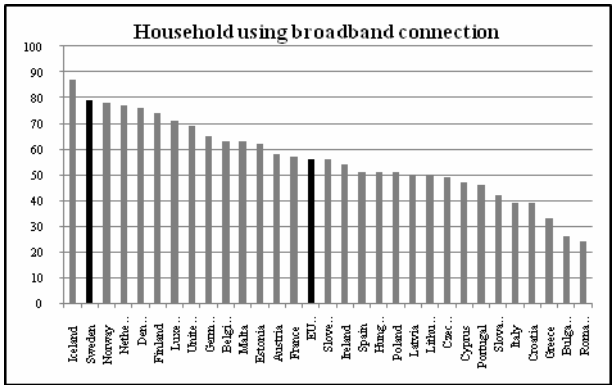
The Swedish government and telecom regulatory authority pay attention also in MBB development. In 2007, the regulator proposed broadband strategies including an upgrade of Universal Mobile Telecommunications System (UMTS) to High Speed Package Access (HSPA)[3] to promote broadband access by mean of wireless service. This upgrade could raise the transmission rates both downstream and upstream. This helps mobile broadband to become a common way of accessing to the Internet for Swede. In recent years, there is high growth of adoption in MBB and it occurred to be the second way of access with 30 percent of broadband share. Meanwhile the dial-up Internet connection became less popular among several types of Internet connection due to lower speed of connection. It gained less than 5 percent of Internet subscribers in 2010 (See Figure 3).

[3] HSPA is specified to permit transmission rates downstream of 14 Mb per second and 1.9 Mb per second upstream (PTS, 2007).

Although there are several ways to access to broadband Internet services i.e. DSL, cable, fiber, and MBB, there are only seven major market players[4] in this country. For example, Tele2 is an only carrier which offers all kind of Internet connections. Meanwhile Telia which used to be a state owned company is operating in only three main Internet connection including DSL, Fiber, and mobile broadband compared to Tele 2 but Telia gains the highest market share in DSL and MBB.

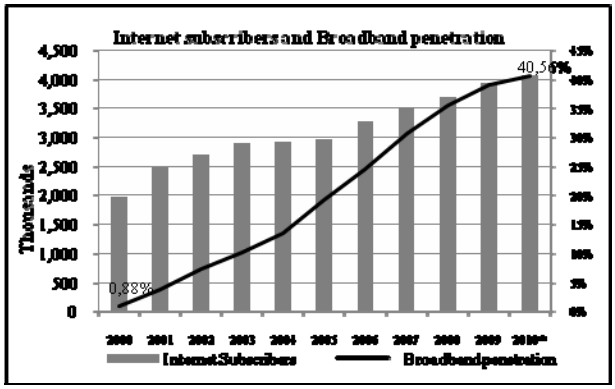
Considering for each type of Internet broadband connection, there are two and three major market players for Cable and DSL service respectively but there are four larger Internet providers in both Fiber and Mobile broadband service. This figure may indicate that there are relative few players which lead to high market concentration in all type of Internet connection except in mobile broadband connection (See Figure 4).

Figure 1 Household using broadband connection



Source: Eurostat (2009)

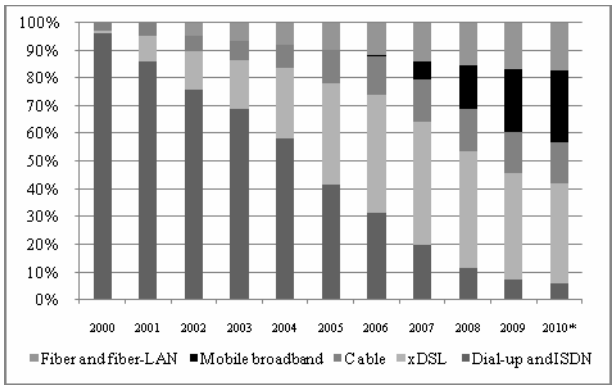
Figure 2 Internet subscribers and penetration in Sweden



Source: PTS statistic portal (2010) Note: * at June 30, 2010

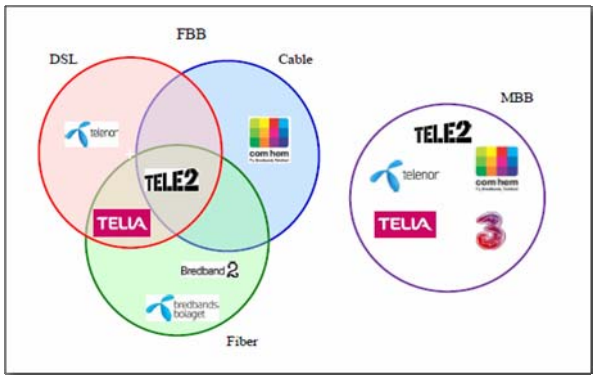
[4] (1) Telia, (2) Tele2, (3) Telenor, (4) Tre, (5) Comhem, (6) Bredbandbolaget, and (7) Breadband 2

Figure 3 Type of Internet connection



Source: PTS statistic portal (2010) Note: * at June 30, 2010

Figure 4 Players in the Swedish broadband market



Source: Compiled by Authors

4. Survey method and data

4.1 Survey questionnaire and data collection

To examine household demand for broadband Internet usage, data was obtained from a random nationwide postal mail survey of Swedish households during August and September 2009. The questionnaire has been prepared in consultation between PTS and TNS SIFO - a research company. The questionnaire consist of about 78 questions which covers several types of telecommunication services, including fixed phone, IP phone, mobile phone and Internet and broadband. However, only 20 of the questions are specifically related to Internet and broadband usage, and 4 of them are used for this study. In addition, 4 questions represents socio-economic background are included.

The sample is encompassing 4 000 individuals, one individual per household. The first stage was a postal mailing of an information letter to the entire sample. The letter informed the respondents about the ability to respond to the survey via a postal questionnaire, or via the Internet using one of the respondent unique ID number and password. For those respondents who after a week not responded to the survey via the Internet was a postal mailing of the questionnaire. Furthermore, there were two postal reminders to those who have not responded to the survey and a final telephone reminder. The response rate in the survey is 56%. Of these, about one third chose to response via the Internet.

The secondary data from the website of service providers also use since the price information for broadband Internet service is not included in this questionnaire. However, the questionnaire provides information about speed and service provider. It can easily double check and get the price information for each broadband Internet usage finally.

4.2 Data and descriptive statistics

In this study, the total number of observation is 2 038 excluding omission and abnormalities. Table 1 presents the percentage of total respondents for each type of Internet access. 40.47% of the respondents are DSL subscribers and followed by LAN/Fiber (15.03%) and MBB (11.47%) respectively.

Table 1 Internet usage and type of connection

Type of Internet connection (N = 2083)	% of total respondents
No Internet access	19.68
Dial-up	2.88
DSL	40.47
Cable	10.47
LAN/Fiber	15.03
MBB	11.47

In term of speed of connection, service providers provide from below 2Mbit/s to over 21 Mbit/s in each Internet connection except MBB which is provided speed of connection maximum at 14 Mbit/s. The survey results indicate that 30.81 % of Internet users connect Internet with speed of connection at 2 Mbit/s -9Mbit/s, 20.03% at below 2 Mbit/s and 18.69% at over 21 Mbit/s as can be seen in Table 2.

Table 2 Internet usage by speed of connections

Speed of connection (N=1438)	% of total respondents
below 2 Mbit/s	20.03
up to 2 Mbit/s	17.68
2 Mbit/s - 9 Mbit/s	30.81
10 Mbit/s - 20 Mbit/s	12.79
21 Mbit+/s	18.69

The survey drew data from 21 counties which covered every part of Sweden. Table 3 confirms that DSL is the dominant Internet access in Swedish broadband market**.**

Table 3 Internet usage by county

County	DSL	Cable	LAN/Fiber	MBB
Stockholm	44.51	20.85	21.41	11.55
Västerbotten	32.08	7.55	47.17	7.55
Norrbotten	47.73	6.82	31.82	13.64
Uppsala	41.89	22.97	17.57	14.86
Södermanland	59.14	9.68	16.13	10.75
Östergötland	50.52	13.40	19.59	13.40
Jönköping	48.57	11.43	11.43	25.71
Kronoberg	52.63	5.26	5.26	26.32
Kalmar*	92.31	0.00	0.00	7.69
Gotland*	55.56	11.11	0.00	22.22
Blekinge	58.82	7.84	9.80	17.65
Skåne	51.82	14.60	15.33	16.06
Halland	60.71	3.57	7.14	17.86
Västra Götaland	55.87	12.10	12.46	17.08
Värmland	45.10	17.65	15.69	13.73
Örebro	51.79	5.36	21.43	16.07
Västmanland*	38.64	20.45	38.64	0.00
Dalarna	54.69	4.69	18.75	14.06
Gävleborg	55.10	4.08	22.45	14.29
Västernorrland	56.82	9.09	9.09	13.64
Jämtland	50.00	3.13	15.63	25.00

Note: * the respondents in some counties do not use some types of Internet connection

However, this study focuses on the Internet broadband usage. The number of respondents who have no Internet access and connect Internet through Dial-up will exclude from this study. Finally, 1,348 respondents are used for further analysis.

Table 4 presents the distributions of sample between male (52.26%) and female (47.74%) and among difference ages are more or less the same. A large percentage of respondents have the education at secondary school (45.78%) and college and university (41.2%). The size of household on average is two persons per household.

Table 4 Socio-economic background

(a) Gender						
	Male	Female				
%	52.26	47.74				
(b) Ages						
	10s	20s	30s	40s	50s	60+
	6.98	15.26	17.98	17.98	19.95	21.85
(c)Education						
	Primary	Secondary	College and university			
%	13.02	45.78	41.2			
(d) Household size						
	1	2	3	4	5	6+
%	18.31	40.71	17.06	15.04	5.45	8.88

The demographic data is used for a cross – tabulation with the type of broadband Internet connection. Younger households (less than 30s) are more likely to have MBB Internet access as shown in Table 5.

Table 5 Internet usage by ages

Age	DSL	Cable	LAN/Fiber	MBB
10s	63.44	6.45	16.13	12.90
20s	35.11	16.03	29.01	19.08
30s	44.33	14.00	22.67	15.67
40s	56.23	13.74	18.21	10.54
50s	58.41	10.03	16.22	11.80
60+	50.55	13.93	11.48	15.57

Note: Cells are percent of respondents in the access category.

There is no clear evidence on the relationship between Internet access and level of education and also between Internet access and household size as shown in Table 6 and Table 7.

Table 6 Internet access by education

Education	DSL	Cable	LAN/Fiber	MBB
Primary	49.30	13.62	14.55	13.62
Secondary	53.92	10.31	18.28	15.01
College and University	47.02	15.72	20.52	13.68

Note: Cells are percent of respondents in the access category.

Table 7 Internet usage by household size

Household size	DSL	Cable	LAN/Fiber	MBB
1	28.99	16.61	28.34	23.13
2	52.22	13.30	15.59	13.88
3	56.63	12.90	16.85	11.83
4	61.79	10.57	18.29	7.72
5	61.54	7.69	12.09	14.29
6 or more	45.10	9.80	27.45	11.76

Note: Cells are percent of respondents in the access category.

If the survey data is classified by the broadband Internet service provider, the descriptive statistic shows that about 40% of the respondents are Telia customer and followed by Comhem and Bredbandsbolaget which obtain market share about 13% of total respondents. Particularly, Telia has a highest market share in DSL (59.90%) and MBB (33.48%), while Comhem gains more market share in Cable (70.56%) than Telia (9.81%) and the same as Bredbandbolaget in LAN/Fiber (25.84%) as shown in Table 8 and 9.

Table 8 Market share of Internet service providers (ISPs)

ISPs	% of respondent
Telia	40.17
Comhem	13.55
Bredbandsbolaget	13.02
Tele2	7.56
Glocalnet	5.29
Tre (3)	3.43
Telenor	2.21
Bredband 2	2.15
Bahnhof	1.69
Alltele	1.45
Ice.net	0.70
Others	8.78

Table 9 ISPs market share in each type of connection

Type of connection	Telia	Bredbandsbolaget	Glocalnet	Tele2	Comhem	Others	
DSL (%)	59.90	14.25	7.97	6.88	3.74	7.25	
	Comhem	Telia	Tele2	Bredbandsbolaget	Others		
Cable (%)	70.56	9.81	4.67	1.40	13.55		
	Bredbandsbolaget	Telia	Bredband 2	Bahnhof	Tele2	Comhem	Others
LAN/Fiber (%)	25.84	15.77	8.39	8.05	6.04	5.03	30.86
	Telia	Tre (3)	Tele2	Telenor	Glocalnet	Bredbandsbolaget	Others
MBB	33.48	21.46	15.45	12.88	5.58	3.43	7.82

Table 10 reveals that the price of the broadband Internet service on average is not much different for FBB and expensive than MBB. The price ranges on average around 289 SEK – 330 SEK per month. From the survey, the price DSL is highest and followed by cable and LAN/Fiber respectively whereas the price of MBB is 238 SEK per month

Table 10 Monthly price of Broadband connection

Type of connection	Mean	Std.	Min	Max
DSL	329.93	17.79	242.00	402.00
Cable	322.42	55.55	229.00	402.00
LAN/Fiber	289.41	78.27	145.00	402.00
Mobile	238.06	39.86	189.00	399.00

Source : PTS (2009) and compiled by authors

5. Econometric model

Microeconometric analyses are traditionally based on revealed preference data obtained from survey asking for actual behavior. The method in this study is similar to the previous studies (Madden et al. 2002, Ida, 2005 and Cardona et al., 2009). Consumer behavior presumed in discrete choice models is based on random utility theory. Let x_{ij} be an attribute vector of good *j* such that individual *i* faces; let β be the impacts of the changes of the attributes; let ε_{ij} be a random component, and then the random utility function of good *j* for individual *i* can be written as

$$U_{ij} = \beta U_{ij} = \beta' x_{ij} + \varepsilon_{ij} . \quad (1)$$

Suppose that good *j* is chosen and that good *k* is not chosen. Individual *i* will choose good *j* to maximize the random utility function, if and only if $U_{ij} > U_{ik}$ for any $k \neq i$.

Since ε_{ij} is a random component of the individual utility function, the probability that individual *i* actually chooses the good (or alternative) *j* is written as $P(U_{ij} > U_{ik})$ for any $k \neq i$. Defining the error term ε_{ij} characterized as independent and identical distribution of extreme value type I. The probability that individual *i* chooses the good *j* is obtained as follows:

$$P_{ij} = P(U_{ij} > U_{ik}) = \exp(\beta' x_{ij}) \Big/ \sum_{k=1}^{K} \exp(\beta' x_{ij})$$

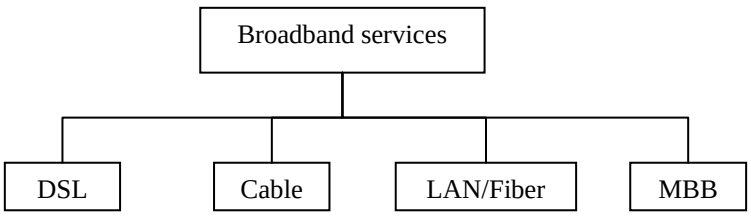
This is called a multinomial logit (MNL) model (McFadden, 1974). The maximum likelihood method is used to estimate this model. Letting D_{ij} be a dummy variable that takes value 1 if individual *i* chooses the good *j* and otherwise 0, then the log likelihood function is

$$L^*(\beta) = \sum_{i=1}^{I} \square \sum_{j=1}^{J} D_{ij} \ln P_{ij} .$$

The maximum likelihood is used for the parameter estimation and obtains the coefficient β . Within this model, the independence of irrelevant alternatives (IIA) assumption is needed. The Hausman test has been conducted and shows that the IIA assumption of MNL is hold. Consequently, the MNL model is appropriate.

To simplify, this study analyze broadband demand using MNL that is a representative discrete choice model. Dependent variables are the four Internet access services: (i) DSL, (ii) Cable modem, (iii) LAN/ fiber and (iv) MBB. Figure 5 depict the preferred MNL considered in this study. Consumers decide which type of Internet access that they prefer: Dial-up, ADSL, Cable modem, LAN/ fiber and MBB.

Figure 5 Decision tree for the model



The independent variables are: (i) monthly fee (price), (ii) household income, (iii) household size, (iv) level of education, (v) gender, (vi) age, (vii) urban city and (viii) Telia. The list of variables developed and included in the model is given in Table 10.

Table 10 Description of variables

Variable	Description	Mean	Std.Dev.
Dummy for type of broadband connection (Dependent variable)	= 1 if the respondent subscribes DSL = 2 if the respondent subscribes Cable = 3 if the respondent subscribes LAN/Fiber = 4 if the respondent subscribes Mobile Braodband		
PRICE	Monthly fee for Internet connection	308.10	53.8318
MALE	=1 if the respondent is male; Otherwise =0	0.5223	0.4996
HHLESS35	= 1, if the respondent is aged less than 35 years; = 0, otherwise	0.3279	0.4696
HHMORE55	= 1, if the respondent is aged more than 55 years; = 0, otherwise	0.2992	0.4580
HHSIZE	Number of household members	2.54	1.2433
ED1	=1, if the respondent has primary school as highest education ; Otherwise =0		
ED2	=1, if the respondent has secondary school as highest education ; Otherwise =0		
HOUSE1	=1, if the respondent renting an apartment ; Otherwise =0	0.2512	0.4338
HOUSE2	=1, if the respondent renting a co-operative apartment ; Otherwise =0	0.2103	0.4077
LINCOME	=1 if the annual household income is less than 200 kSEK; Otherwise =0	0.1177	0.3224
MINCOME	=1 if the annual household income is between 200 - 400 kSEK; Otherwise =0	0.3035	0.4599
URBANCITY	=1, if the respondent living in Stockholm or Göteborg or Mälmo ; Otherwise =0	0.3865	0.4871
TELIA	=1, if the respondent subscribing Telia as an Internet provider ; Otherwise = 0	0.3893	0.4877

6. Estimation results and discussion

Results of the estimated model are shown in Table 11. The model provides a pseudo R^2 statistic which measure goodness of fit of the model 0.3417. It suggests that the model appears to fit well for a cross-section data. In table 11, the marginal effects of the estimated variables show substantial variation across type of broadband connection. The marginal effect measures the partial impact of changes in the corresponding variable on the likelihood of household broadband usage, all other factors constant.

Table 11 Estimation results

	Marginal effect			
Variables	DSL	Cable	LAN/Fiber	MBB
PRICE	-0.0041*	-0.0004*	-0.0018*	-0.0029*
	(0.00043)	(0.00016)	(0.00029)	(0.0003)
MALE	-0.0006	-0.0067	0.0348	-0.0274*
	(0.03139)	(0.01513)	(0.02292)	(0.01362)
HHLESS35	-0.0505	-0.0204	0.0125	0.0585*
	(0.03959)	(0.01682)	(0.02795)	(0.02252)
HHMORE55	0.0290	0.0277	-0.0505*	-0.0062
	(0.04129)	(0.02339)	(0.02951)	(0.01731
HHSIZE	0.0404*	-0.0048	-0.0119	-0.0237*
	(0.01485)	(0.00737)	(0.01097)	(0.00684)
ED1	0.0168	-0.0149	-0.0106	0.0087
	(0.05328)	(0.02289)	(0.04063)	(0.02476)
ED2	0.0305	-0.0291**	0.0041	-0.0055
	(0.03369)	(0.01616)	(0.02467)	(0.01435)
HOUSE1	-0.3491*	0.2381*	0.1817*	-0.0706*
	(0.04344)	(0.04072)	(0.04231)	(0.0117)
HOUSE2	-0.4192*	0.1788*	0.2976*	-0.0572*
	(0.03987)	(0.03674)	(0.04413)	(0.01132)
LINCOME	-0.0825	-0.0245	0.0389	0.0681**
	(0.0632)	(0.02203)	(0.04403)	(0.03839)
MINCOME	-0.0115	0.0025	-0.0206	0.0296
	(0.03661)	(0.01746)	(0.0259)	(0.01821)
URBANCITY	0.051326	0.0185	-0.0623**	-0.0076
	(0.03241)	(0.01619)	(0.02293)	(0.01362)
TELIA	0.1605*	-0.1736	-0.0897*	0.1028*
	(0.03622)	(0.02189)	(0.02591)	(0.02138)
Log likelihood	-1067.785			
Pseudo R^2	0.3417			

Note: Numbers in the parentheses represent the standard deviation and *, ** represent significant at 5% and 10% level respectively

Beginning with DSL connection, the effect of PRICE, HHSIZE, HOUSE1 and HOUSE2 and TELIA have a statistically significant relationship with the probability of household to use the DSL connection. For example, the probability of DSL usage is inversely related to PRICE which is monthly fee. It suggests that if PRICE increase 1% , the probability of using DSL connection will decrease

0.4%. Additionally, the type of housing affects the usage of DSL. If the respondent lives in HOUSE1 or HOUSE 2 which are a renting apartment and a co-operative apartment, the respondent is less likely to use DSL connection compared to the respondent who stays in his own house. However, if the number of household member increases (HHSIZE), the usage likelihood increases. Finally, DSL usage tends to increase when the respondent is the consumers of Telia.

The effect of PRICE on the probability of using cable is same as DSL connection but smaller magnitude. The different determinant factors are HOUSE1, HOUSE2 and ED2. If the respondent lives in HOUSE1 or HOUSE 2 which are a renting apartment and a co-operative apartment, the respondent is more likely to use cable connection compared to the respondent who stays in his own house. However, if respondent obtains a secondary school as a highest education, he is less likely to use cable connection.

For LAN/Fiber connection, the effects of PRICE and HOUSE1 and HOUSE2 on the probability of using LAN/Fiber as the broadband connection are same as cable. Interestingly, there are three different addition factors has been shown in the results. Firstly, the probability of using LAN/ Fiber is lower when the respondent of household is aged 55 years or over (HHMORE55). Secondly, respondent who living in Stockholm, Göteborg or Malmö (URBANCITY) is less likely to use this broadband connection. Lastly, the probability of using LAN/ Fiber tends to decrease if the respondent is the consumers of Telia (TELIA).

Finally, by comparing the MBB and the previous broadband connection it is apparent that change in PRICE has the similar impact to the probability of using MBB. The estimated results also show that MALE, HHSIZE, HOUSE1 and HOUSE2 have a negative statistically significant. The probability of using MBB as a broadband connection is lower if the respondent is male, stay with the bigger size of family and stay in renting apartment or a co-operative apartment. Nevertheless, the probability of using MBB tends to increase if the respondent of household is aged 35 years or less (HHLESS35), get a low-income (LINCOME) and the respondent is the consumers of Telia (TELIA).

To sum up, the changing price is the major determinant for every broadband connection. Type of housing also affect the demand of broadband usage but vary by type of broadband connections. For example, the probability of using cable and LAN/Fiber tends to increase if the respondent lives in a renting apartment and a co-operative apartment but it is not the case for DSL and MBB.

In order to analyze the complementary and substitution between FBB and MBB, own and cross-price elasticity are reported in Table 12. Own price elasticity is the effect on the probability of selecting j due to a change in the price of service j. For example, the elasticity for DSL suggests a 1% increase in price of DSL service will lead to 1.27% decrease in DSL choice probability. Comparing to other broadband connection, DSL is more sensitive in price or elastic. Small cross price elasticities indicate little substitution among broadband connection. The results confirms that the different FBB connection are close substitute each other since the cross price elasticity for DSL to cable, cable to DSL and LAN/Fiber to DSL and are 1.98, 1.42 and 3.28 respectively. Contrary, the cross price elasticity of MBB to DSL is lower than others which may indicate that those users which are still using DSL do not perceive MBB as an equally good substitute. In other words, MBB could not be in the same market as FBB.

Table 12 Own price elasticity and cross price elasticity

Internet connection	Own price elasticity	Cross price elasticity
DSL	-1.272	1.980
Cable	-0.152	1.428
LAN/Fiber	-0.541	3.289
MBB	-0.884	1.369

This evidence is similar to the Small but Significant and Non-transitory Increase in Price test (SNNIP test) which has been done by PTS (PTS (2007, 2010)). The latest decision was made recently that DSL, cable, and LAN/Fiber are in the same wholesale broadband market, while, MBB is not in the same market as FBB. However, there is an increased competitive pressure from MBB on FBB network connections since the cross-price elasticity of MBB to DSL is getting closer to FBB cross price elasticities.

Additionally, broadband service providers in Sweden are almost the same players in both FBB and MBB market. This may suggest that these telecom operators put their efforts to promote FBB and MBB in order to get more revenues. They want to utilize their fixed infrastructure and mobile infrastructure including spectrum to generate revenue as much as they can. It seems that the regulator should not be concerned about their behavior because they compete among each other and the price of FBB and MBB are declining and the quality of services are increasing However, there is a possibility that broadband service providers in Sweden could avoid regulations in FBB market by encouraging people to use more MBB services. This may due to MBB coverage is 100 percent of population and MBB market has less regulations compare to FBB market. This suggests that further analysis is needed since there is a likelihood of competitive pressure from MBB on FBB network connections from the recent development in Swedish broadband market.

7. Conclusion

Sweden is a leading country in broadband development. Broadband penetration rate in this country is relatively high compared to other European countries. Both FBB and MBB Internet connections are available for using in most part of the country. The issue of substitution and complementarity should be considered due to high growth of MBB subscription in recent years. Then, this study has been conducted by using PTS survey 2009 together the secondary about price of broadband services. The model is estimated on state-preference by using multinomial logit model. Through an estimated model the effect of price, socio-economic background, type of housing and service provider on the likelihood of broadband usage is analysed. The results show that the changing price and type of housing are the major determinant for all broadband connection. In addition, the living area and service provider affect the probability of using broadband.

Based on the results of elasticities, cable is less sensitive to price changes for its own price than DSL, LAN/Fiber and MBB. In contrast, the evidences of cross price elasticities show that broadband Internet market in Sweden can be seen as two separate markets at this stage. The FBB connections are close substitute each other while the cross price elasticity of MBB is lower than others. However, the cross price elasticities of FBBs and MBB report that there is high possibility that MBB could be substitution service to FBB in the near future. Thus, the telecom regulator should investigate the complementary and substitution between FBB and MBB closely since it will affect the market definition and competition regulation.

Moreover, the regulator may need to provide clear incentive for investment of new broadband network including fixed and wireless infrastructure and set up an efficient spectrum management designated to improve broadband accessibility.

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