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**Conference Paper**

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21st European Regional Conference of the International Telecommunications Society (ITS): "Telecommunications at New Crossroads: Changing Value Configurations, User Roles, and Regulation", Copenhagen, Denmark, 13th-15th September 2010, No. 33

**Provided in Cooperation with:**

International Telecommunications Society (ITS)

*Suggested Citation:* Srinuan, Chalita; Srinuan, Pratompong; Bohlin, Erik (2010) : The Mobile Broadband and Fixed Broadband Battle in Swedish market: Exploring complementary or substitution, 21st European Regional Conference of the International Telecommunications Society (ITS): "Telecommunications at New Crossroads: Changing Value Configurations, User Roles, and Regulation", Copenhagen, Denmark, 13th-15th September 2010, No. 33, International Telecommunications Society (ITS), Calgary

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**The Mobile Broadband and Fixed Broadband Battle in Swedish market:**

**Exploring complementary or substitution**

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**Abstract**

The mobile broadband (MBB) in Swedish market has become a more attractive opportunity for service providers, with growing demand for ubiquitous broadband connectivity after the mobile operators got 3G license in 2000. MBB seems to have more advantage compare to Fixed broadband (FBB) in term of mobility, compatibility and quality of service. This paper aims to explore the current broadband situation in Swedish market, in particular whether the mobile broadband is a complementary or substitute by using descriptive analysis. The data is collected from the Post- och telestyrelsen (PTS) Survey and the secondary data from PTS during 2002-2009. The findings indicate that the MBB and FBB subscribers remain growing, but the issue of complementary and substitution between MBB and FBB cannot be given an answer at this stage. The crucial problem of comparing MBB and FBB is the different units of measurement. Also, the potential of avoiding regulation by service providers is discussed since the market participants in FBB and MBB services are the same players. The rapid growth of MBB together with a lower degree of regulation in mobile services may attract the market player to put their effort more in MBB market. Moreover, the gap between broadband infrastructure coverage and the usage of this service is huge. Thus, the inefficiency of BB infrastructure utilization becomes another issue that NRAs could consider.

**JEL codes :** D22, L11, L52, L96

**Keywords :** Mobile broadband, Fixed broadband, Complementary, Substitution

## **1. 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 BB should be promoted (Trkman et al., 2008).

The key role of BB 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). MBB refers to an Internet connection that supports data, voice and video information at high speeds through mobile devices (Ergen, 2009). 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 underserved or remote areas without an

adequate fixed broadband infrastructure.<sup>1</sup> In addition, the introduction of flat rate subscriptions with a monthly fee typically in the range of 10-20 Euro is one reason for rapid development of mobile broadband (Mölleryd et al., 2009).

Sweden is one first mover in BB among European countries by launching its ambitious and government support on national ICT infrastructure program since 2000. Also, Sweden is included in the forefront of information societies in general and has considerable technological capacity in the IT sector (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)<sup>2</sup>. In term of MBB, the number of MBB subscriptions will surpass 1 million during 2009 (about 10% penetration). With the same growth rate 2 million subscriptions can be expected within next 3-4 years (Mölleryd et al., 2009).

MBB can be played a substantial role into the BB market that was previously predominated by DSL and CATV. In particular in Sweden, the support from the Swedish government for upgrading and investments in fixed broadband infrastructure in the whole country expired in December 2007. 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.

The key concept running through the literature identified here is the relationship between FBB and MBB. This study attempts to explore the current situation of the relationship between MBB and FBB subscription via previous literature and descriptive analysis. In addition, related problems that National regulatory agencies (NRAs) need to be concern will be identified. The data are collected from the Post- och telestyrelsen (PTS) Survey and the secondary data from 2002-2009. This paper is organized as follows. Section 2 discusses the previous studies on FBB

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<sup>1</sup> 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).

<sup>2</sup> Available on <http://www.oecd.org/sti/ict/broadband> ( accessed on August 27, 2010)

and MBB relationship. The current situation on Swedish broadband market is presented in Section 3. The problems related to finding are explained in Section 4, while the conclusion is provided in Section 5.

## **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 recent 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). Other papers by Crandall et al. (2002), Rappoport et al. (2003) and Ida and Kuroda (2006) have estimated the extent of retail demand elasticities for particular FBB access types such as DSL and cable so far. The results suggest that different types of BB access constrain each other to vary degree.

Cardona et al. (2009) consider substitution patterns on BB 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.

Similar to Swedish market, the Swedish telecom regulator has considered the market definition for BB access by using SSNIP test (PTS (2007, 2010)). The latest decision was made recently that xDSL, cable modem, and fiber and fiber-Land are in the same wholesale broadband market, while, MBB is not in the same market as FBB. However, Carnona et al. (2009) 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.

Previous literature shows that relationship between FBB and MBB might be similar as what has been happened between 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 of previous studies employed both aggregate data which is need a lot of observations and survey data. The studies also were conducted in national basis and cross-countries analysis.

Additionally, FMS leads to cord-cutters or wireless only phenomena. The wireless-only household numbers enter any discussion on the forecasts of demand for triple-play or quad-play services (Rappoport et al., 2009). This suggests that the wireless only phenomena will be another factor that affects the growth of MBB. Then, the accurate estimation of the demand of MBB access becomes an important issue for NRAs, academic researchers and service providers.

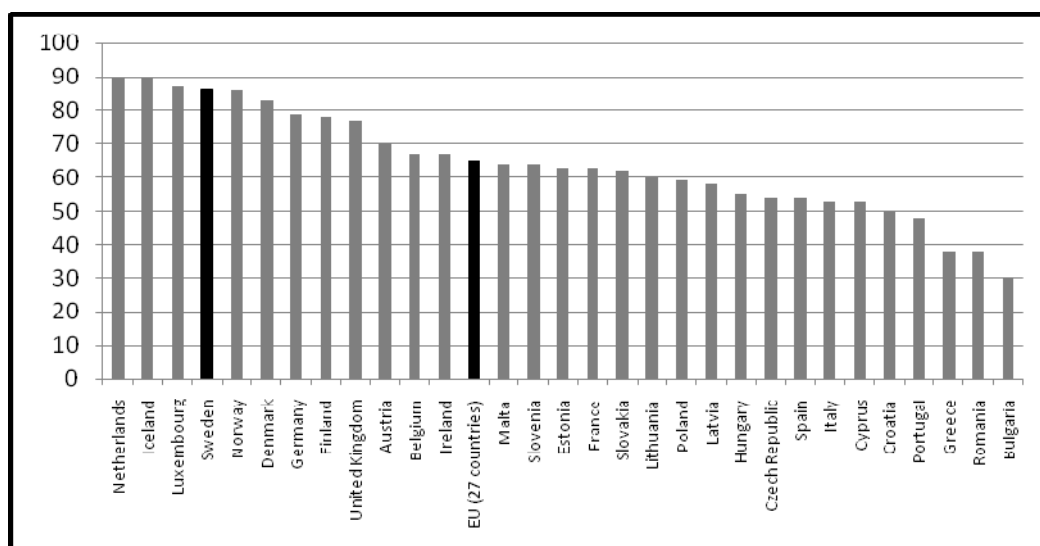
The magnitude of wireless only phenomena is growing. It has important implications for several regulatory issues including competition, infrastructure planning and investment decision. For example, service providers can design corporate strategies to mitigate the extent of FMS

(Zimmerman, 2006). It might affect the competition and market definition finally. Providers can apply the similar strategy in BB market since some of providers provide both fixed and mobile service. These lead to reason that why competition in BB market is interesting to investigate.

### 3. Current situation in Swedish broadband market

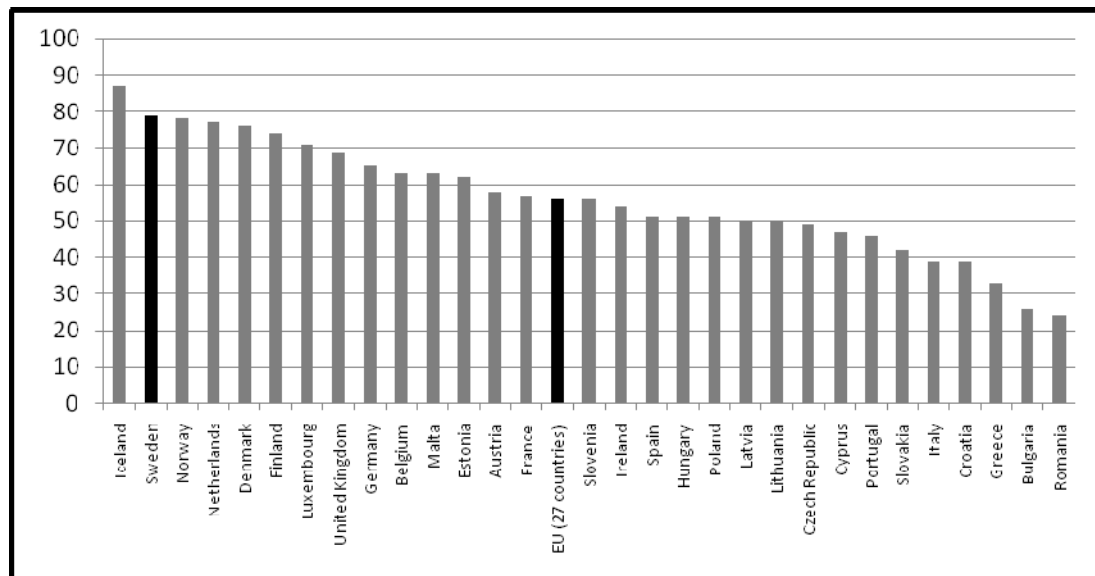
Sweden is considered the country where has high percentage of household with Internet access compared to other European countries. At the end of 2009, 86 percent of household in this country can access Internet from home while about 65 percent of household in EU 27 could connect to the Internet from home (See Figure 1). Moreover, there is 79 percent of household Internet connection using broadband connection (See Figure 2).

In term of broadband policy, Sweden is considered to be the first European country to implement an active broadband policy. In 2000, the Swedish government published an ICT strategy (MIECS, 2000) and this strategy was created to ensure that broadband infrastructure availability throughout the whole country. The key strategy was to provide government funding to foster broadband infrastructure development in 2000 – 2005 (Eskelinen et al., 2008).



Source: Eurostat (2009)

**Figure 1** Level of household Internet access

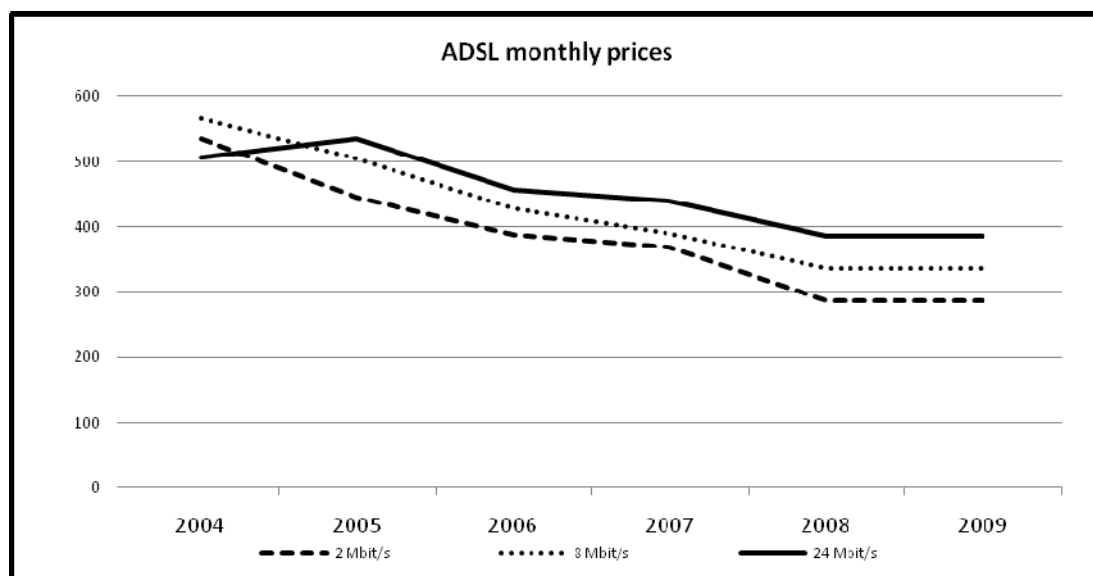


Source: Eurostat (2009)

**Figure 2** Household using broadband connection

The consequence of the Swedish broadband strategy would result in more broadband infrastructure, in particular fixed infrastructure, being available for Internet broadband usage. The broadband penetration is growing overtime from 5 per 100 inhabitants by the end of 2001 to 32 per 100 inhabitants at the end of 2009. The increasing of FBB penetration is the result from broadband development plan and a reduction of FBB prices (see Figure 3).





Source: PTS (2010)

Note: Use Telia's FBB price for each speed to represent prices

**Figure 3** FBB prices for ADSL in Sweden

According to PTS, BB refers to an Internet connection that can be upgraded to a transmission rate downstream of at least 2 Mbps (PTS, 2007). Currently, there are a number of broadband Internet access in Sweden available for end-users i.e. xDSL, cableTV, fiber and fiber-LAN, and mobile broadband via 3G technology. The favorite broadband technology for Swedes is xDSL. There is about 37 percent of broadband connection using this type of technology. Meanwhile only 13 percent of broadband subscribers connect the Internet through cable TV. These may result from DSL cover 98 percent of population but there is 37 percent coverage of household for cable modem in this country.

The UMTS technology or 3G provides wider bandwidth of transmission and higher speed of up- and down load for Internet users. This type of connection becomes a major way to access to Internet in Sweden. At the end of 2009, there are 1.3 million MBB subscribers and this number is 30 percent of broadband connections. The possible reason of rapid MBB diffusion would be the 100 percent coverage of population in 3G services. This would provide the mobility to access to the Internet anywhere.

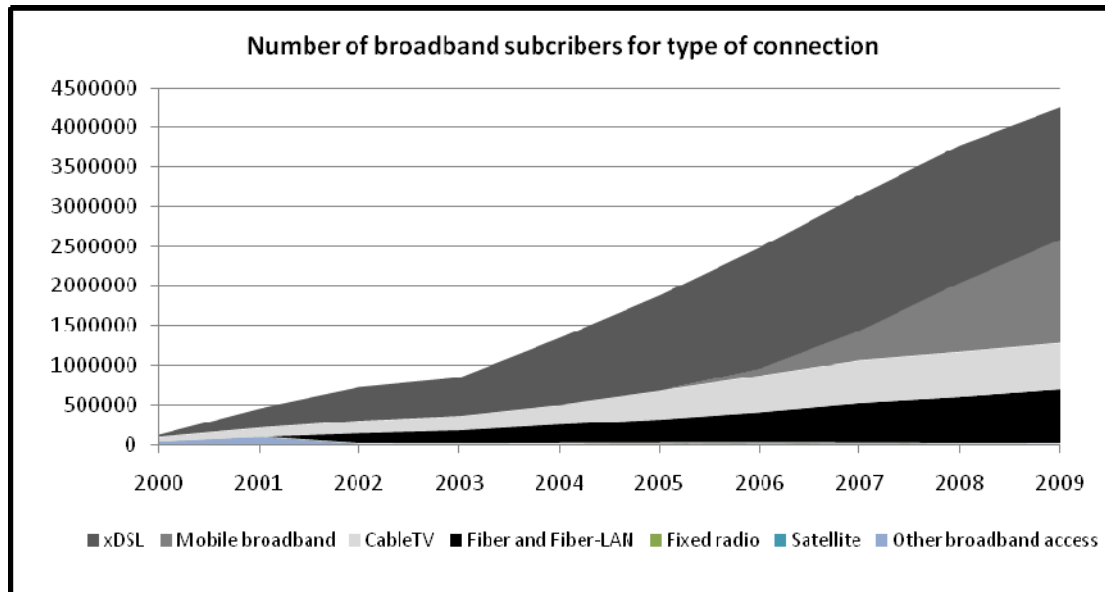
Another new type of access to the Internet is fiber and fiber-LAN. It is increasing overtime since it was introduced. However, a number of fiber subscribers is limited by fiber coverage which only 10 percent of household and mostly they are located in urban area (see Table 1 and Figure 4).

**Table 1** Coverage of broadband each technology in OECD countries at end of 2009

	Coverage (%)			
	DSL	Cable TV	FTTH	3G
Australia	91*	24.3	N.A.	99*
Austria	95**	60**	N.A.	84*
Belgium	99.7**	88*	N.A.	89.9*
Canada	89.3**	93.4**	N.A.	78*
Czech Republic	97*	40**	N.A.	89.8*
Denmark	99**	60**	14**	97*
Finland	96*	40**	14**	80*
France	98.5*	28**	11**	72.5*
Germany	95**	58**	0.4**	80*
Greece	95*	N.A.	N.A.	88*
Hungary	91*	73*	1.3**	56.1*
Iceland	93*	31*	4**	63*
Ireland	90*	34**	1.4**	89*
Italy	95.7*	N.A.	8.6**	92*
Japan	98.6**	N.A.	86.5**	100*
Korea	99.5**	57**	67**	99*
Luxemburg	100*	71**	N.A.	90*
Mexico	92	N.A.	N.A.	N.A.
Netherlands	100**	92*	4.8**	90*
New Zealand	93*	14**	N.A.	97*
Norway	90*	40**	8.3**	90*
Poland	64*	25.4*	N.A.	25.5*
Portugal	100	76**	N.A.	98*
Slovak Republic	78*	24*	20**	81*
Spain	96.1*	60.2**	1.5**	83*
Sweden	97.9*	37.3**	10**	100*
Switzerland	98	75**	N.A.	91*
Turkey	41.4**	13.5**	N.A.	N.A.
United Kingdom	100	49**	N.A.	90*
United States	82**	96**	13.1**	92.3*

Source: OECD (2010) [www.oecd.org/sti/telecom](http://www.oecd.org/sti/telecom)

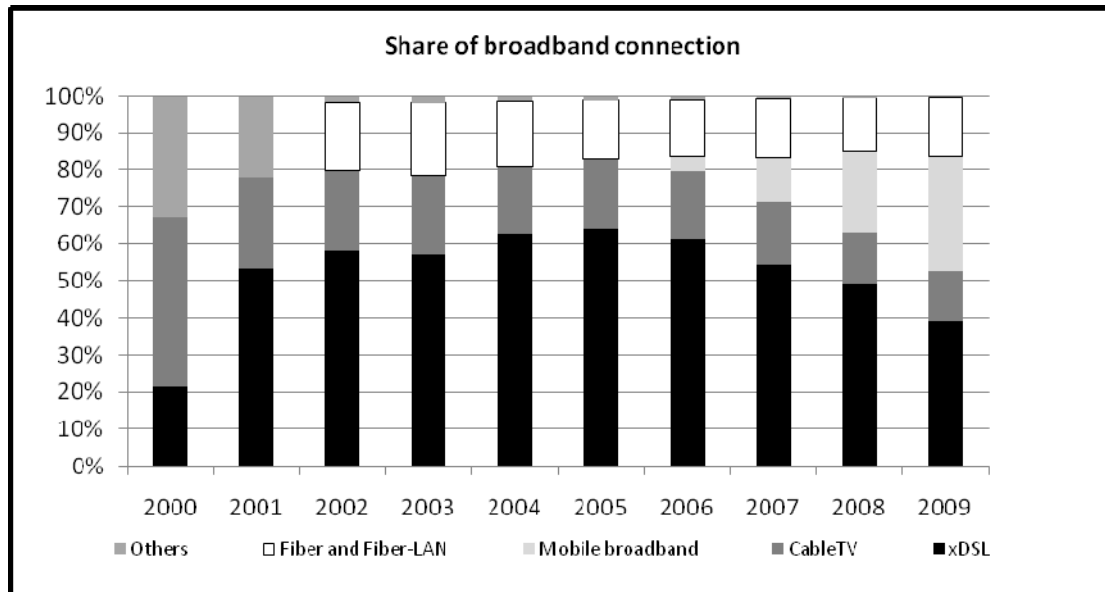
Note: \* per population, \*\* per household



Source: PTS (2010)

**Figure 4** Number of broadband subscribers for type of connection

Consider BB Internet connections, there was almost 50 percent of BB connection made by cable modem at the beginning of the development. xDSL Internet connection became a dominant mean to access Internet since the end of 2001. Interestingly, at the end of 2009 the share of MBB is about 30 percent of BB and it becomes the second rank of BB Internet connection after xDSL (see Figure 5). This point made here is that MBB could be a potential substitution service of FBB. But this issue needs to consider with caution since the different of measurement unit will mislead interpretation and policy recommendation at the end.



Source: PTS (2010)

**Figure 5** Share of BB connections

### *Market players*

For each fixed technology, there are a number of players in Sweden. For example, there are 84 active players in xDSL but there are only three dominant players which gain most of subscribers (see Table 2).

Telia operates in three of four broadband Internet connection and it earns highest subscribers in xDSL service and also MBB services. While Tele2 is the operator who operates in all kind of broadband Internet connections, but it does not earn highest subscriber in any kind of connection. Telenor is also doing businesses in three of four broadband connections but got highest subscribers in fiber and fiber-LAN connection.

Comhem focuses only cableTV business and it operates both cable TV service and broadband Internet services via cable modem. It is a dominant player in cable modem Internet connection.

Hi3G is a new entrant who just entered into Swedish market to operate 3G services in 2002. It also serves MBB service as a main product of the company.

Competition between types of BB connections seems to be intensified, considering the number of active participants. But if we consider concentration ratio or CR3, we will find that only fiber and fiber-LAN and MBB are in competitive environment while xDSL and cableTV connection are not.

**Table 2** Players in FBB and MBB in Sweden

Operators	Broadband			Mobile Internet connection
	xDSL	CableTV	Fiber and fiber-LAN	Mobile broadband
Telia	✓*	N.O.	✓	✓*
Tele2	✓	✓	✓	✓
Telenor	✓	N.O.	✓*	✓
Hi3G	N.O.	N.O.	N.O.	✓
Comhem	N.O.	✓*	N.O.	N.O.
Bredband2 AB	N.O.	N.O.	✓	N.O.
Bahnhof AB	N.O.	N.O.	✓	N.O.
AINMT Sverige AB	N.O.	N.O.	N.O.	✓
Number of active players	84	39	123	11
Number of dominant players	3	2	5	5
Concentration Ratio (CR3)	92	95	52	78

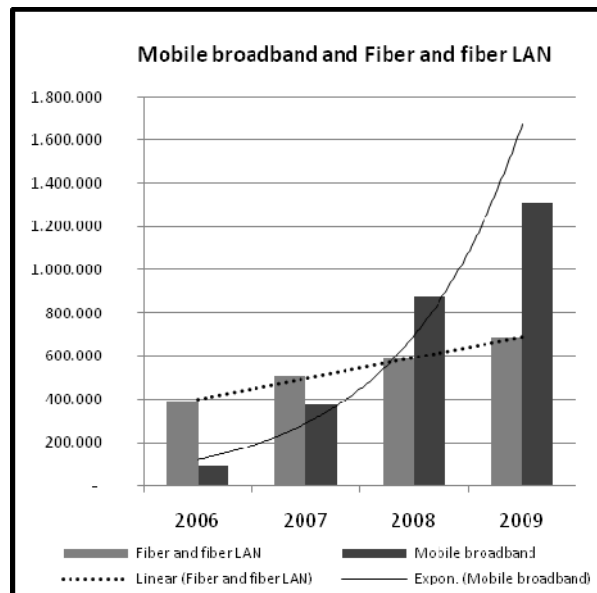
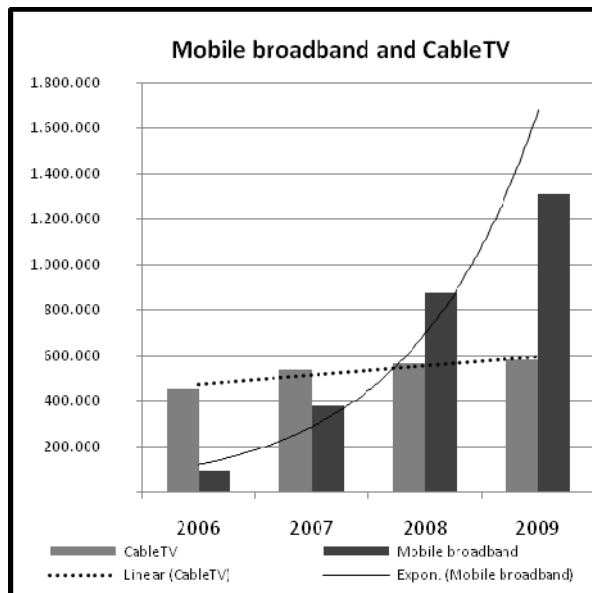
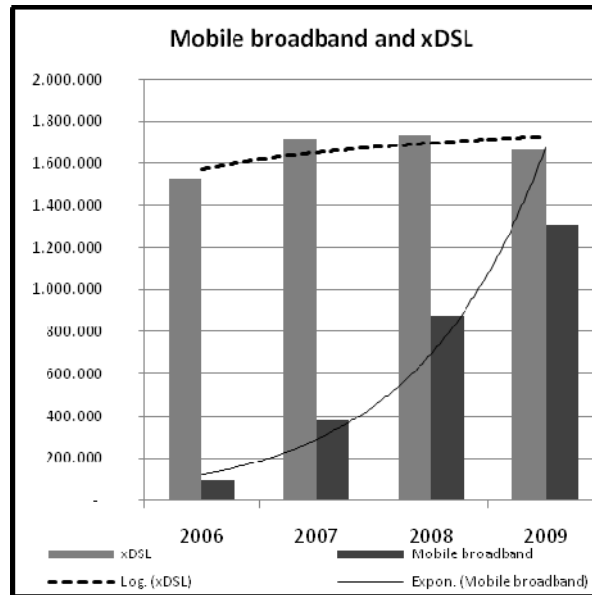
Source: compile by authors

Note: \* Operator who gains highest subscribers and N.O. means operator does not provide that service.

#### 4. What are the problems from current situation?

##### 4.1 Complementary and substitution vs. mismeasurement

To investigate the substitution and complementary services between FBB and MBB, the unit of subscriber measurement should be considered. Although the trends of subscribers of FBB technologies (xDSL, cable and fiber and fiber-LAN) in Swedish market show that number of subscribers of FBB and MBB are rising together with different growth rates which vary by technologies, this study cannot provide a clear answer whether the MBB is substitute or complementary service for FBB (see Figure 6).



Source: PTS (2010)

**Figure 6** Compare trend of MBB with each FBB connection

The main reason is the different type of usage between FBB and MBB. FBB is usually shared by household members. In contrast, MBB is used by an individual subscriber. So, they are not strictly comparable. For example, 32 percent of FBB connection would represent at least 32

percent of FBB penetration or more since the average household size in Sweden is 2.1<sup>3</sup>, thus the potential FBB users is 67.2 percent of population. In case of MBB, 32 percent of MBB connection means MBB users are 32 percent of population. FBB and MBB also have different characteristics i.e. mobility and speed of connection. Moreover, it might be the case that one can use both FBB and MBB which will create 'double counting'. Therefore, when comparing FBB and MBB subscribers in concerning of substitution or complementary services, one could take this point into account.

Comparing MBB and FBB, MBB could be transformed to household subscribers by using framework of Rappoport et al. (2009). Their framework categorized telecom user into three groups i.e. using fixed line as a primary connection, using mobile as a primary connection, and using both fixed line and mobile. This framework can be applied to FBB and MBB. A survey, however, needs to be conducted in order to collect the data with this category.

Additionally, the number of mobile subscribers with data traffic is that reported by PTS (2010) shows that about 2.45 million subscribers use Internet via mobile terminal. However, the numbers of MBB subscribers are reported only 1.31 million subscribers. Most of subscribers who use data traffic are Smartphone users. This may suggest that number of MBB is underestimated since Smartphone user can use their phone as a modem to connect the Internet with similar speed of connection as MBB.

In order to quantify the relationship between FBB and MBB by using the quantitative analysis, NRAs need take the issue of unit measurement into account. NRAs could use the correct information to publish new effective policies and regulations if they have clear distinction between number of FBB subscribers and MBB subscribers and subscribers who use both FBB and MBB connections.

In fact, single-country study may be superior compared to cross-country analysis both in term of price data and other micro-data (if available). As mentioned in the section of literature,

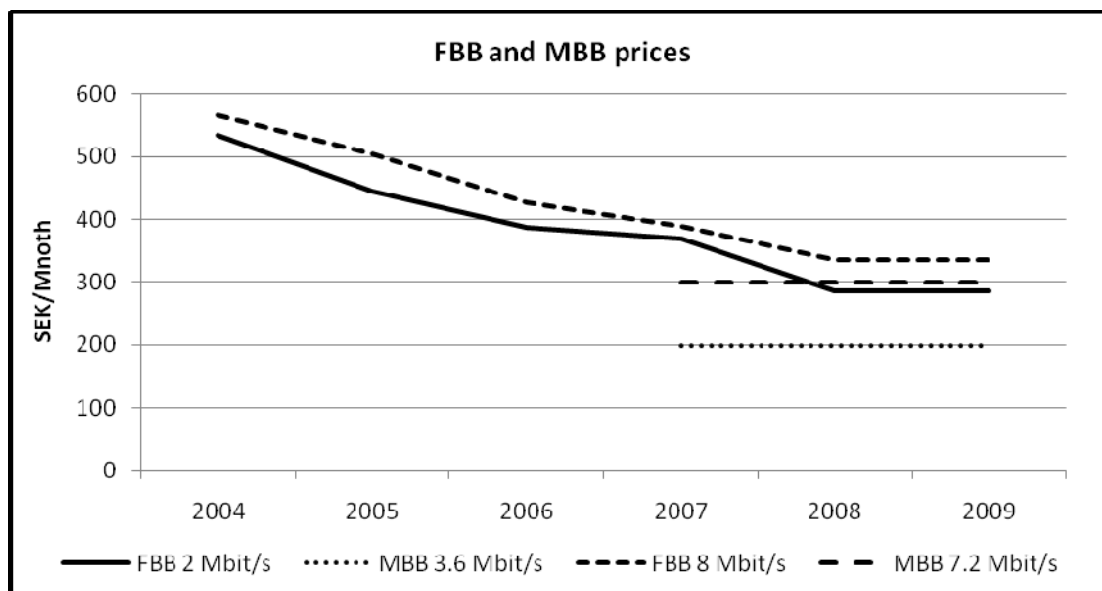
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<sup>3</sup> [http://www.nationmaster.com/graph/peo\\_ave\\_siz\\_of\\_hou-people-average-size-of-households](http://www.nationmaster.com/graph/peo_ave_siz_of_hou-people-average-size-of-households)

NRAs and researchers could apply the idea of FMS by using cross price elasticity of demand either data are collected from secondary data or individual survey. However, MBB service, not only in advanced telecommunication markets like the Swedish market, is in the initial stage of growth both in term of penetration rate (demand) and infrastructure investment (supply). So, the availability of data and quality of data is important for making an analysis.

#### 4.2 Avoiding regulation

This section is based on the facts and trend analysis in the previous section. Telecom providers in BB services in Sweden are almost the same players in both FBB and MBB market. Telia and Telenor operate in xDSL, fiber and fiber-LAN, and MBB while Tele2 provides all kinds of FBB Internet access and MBB. 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 (see Figure 7).



Source: PTS (2010)



### **Figure 7 FBB and MBB prices**

However, there is a possibility that telecom 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. Nonetheless, this trend may not be seen in the near future if the speed of MBB is not equivalence to FBB i.e. xDSL. FBB subscriptions would not prefer to switch to be MBB subscription unless the speed of up- and download are comparable to FBB.

#### ***4.3 Inefficiency of BB infrastructure utilization? : providing access without usage***

Another point to be considered is the BB access and usage. As BB rapidly grows both in terms of traffic and number of subscriptions, the rapid growth of demand will require substantial capacity and infrastructure expansion from network operators. Operators are challenged by the fact that BB is closely related to investments for technology development, quality upgrade, and capacity enlargement and so on. This means that providing BB access needs a large amount of capital expenditure. So, more and more regulatory from NRAs concerns are attracted to the investment issue in the BB market (Cambini and Jiang, 2009).

However, the coverage of FBB and MBB infrastructure available in Swedish market almost 100 percent of population. But the FBB and MBB penetration in Swedish market are about 32 and 10 percent of population. This suggests that the FBB and MBB infrastructure were utilized less than the maximum infrastructure capacity. Then, the role NRAs would need to find the reasons why many Swedes do not want to use BB services. It may either result from unaffordable prices or some other reasons (Levin, 2010).

### **5. Conclusion**

This paper explores the competition situation between FBB and MBB in Sweden by using descriptive analysis. Data sources are collected from PTS since 2002-2009. The results suggest that although the MBB and FBB subscribers remain growing, the issue of complementary and substitution between MBB and FBB cannot be given an answer at this early stage. The

measurement problem is substantial since FBB and MBB have different units of measurement. FBB represents household basis while MBB is individual basis. Also, the market participants in FBB and MBB services are the same players. The rapid growth of MBB combined with a lower degree of regulation in mobile services may influence the market players to put more effort on the MBB market. This would lead to a potential of avoiding regulation by service providers. Additionally, the coverage of FBB and MBB infrastructure available in Swedish market almost 100 percent of population. But the FBB and MBB penetration in Swedish market are still far behind the maximum capacity of infrastructure. Thus, the inefficiency of BB infrastructure utilization becomes another issue that NRAs could consider.

However, there are many fascinating questions related to competition between FBB and MBB that need to be investigated in the future. For example, what are the determining factors of FBB and MBB substitution? and What are the policy consequences of FBB and MBB substitution? These will become possible to answer when more observational data become available. In addition, the answers of these studies will be fruitful for NRAs to regulate BB market better.

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