

Comparative analysis of Fiber-to-the-Home market liberalization in the EU

The case of Denmark, Sweden and the Netherlands

Williams, Idongesit

Published in:
Współczesne Problemy Ekonomiczne

DOI (link to publication from Publisher):
[10.18276/wpe.2017.14-06](https://doi.org/10.18276/wpe.2017.14-06)

Creative Commons License
CC BY-SA 4.0

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Williams, I. (2017). Comparative analysis of Fiber-to-the-Home market liberalization in the EU: The case of Denmark, Sweden and the Netherlands. *Współczesne Problemy Ekonomiczne*, (14), 89-112.
<https://doi.org/10.18276/wpe.2017.14-06>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Idongesit Williams*

Comparative analysis of Fiber-to-the-Home market liberalization in the EU: The case of Denmark, Sweden and the Netherlands

Keywords: FTTH, liberalization, broadband market, Internet infrastructure, Internet regulation

Introduction

This is a conceptual paper that presents a comparative analysis of three Fibre-to-the-Home (FTTH) markets in the EU. These markets are namely Denmark, Sweden and the Netherlands. The study had a dual aim. The first aim was to understand the challenges in the FTTH markets in these countries. The second aim was to identify solution(s) that may support the liberalization of the FTTH market in the EU. The emphasis of this paper is on the FTTH market, though the Fiber-to-the Building (FTTB) is mentioned when discussing the problems in the FTTH market. Different technologies have been adopted to achieve the EU vision 2020 agenda. This is a digital agenda for attaining Universal Access of Next Generation Access (NGA) of at least 30 MBs by 2020. These NGA technologies include FTTH, cable networks (DOCSIS 3.x), Very-high-bit-rate Digital Subscriber Line (VDSL) among others (see Marcus et al., 2009; Falch et al., 2016). Though these NGAs can be used to achieve the EU 2020 agenda, FTTH is the technology that has the capacity to deliver greater bandwidth and data rates – compared to the others. Yet the deployment of this technology is capital intensive.

* Dr. Idongesit Williams, CMI, Aalborg University, e-mail: Idong@cmi.aau.dk

The EU promotes the adoption of competitive markets to deliver telecommunication infrastructure. To facilitate such competition, EU member countries have liberalized their telecommunication market. The liberalization of the market has resulted in encouragement of innovation in the delivery of Internet networks and services in the EU (Pelkams, Renda, 2011). However, from 2008 till now, the deployment of FTTH in the EU has been slow. The countries with the highest penetration of FTTH and FTTB in the EU are Lithuania and Sweden. However, their national FTTH and FTTB penetration are below 40%. In 2015 Lithuania and Sweden recorded 34% and 33% FTTB connections respectively, while Norway and Portugal recorded 23% and 18.5% FTTH connections respectively (FttH Council Europe, 2015).

To aid the development of FTTH infrastructure, Public-Private Partnerships (PPPs) has also been utilized to deal with the capital intensive nature of deploying FTTH (EPEC, 2012; Bourreau et al., 2012). However in markets where PPPs are adopted, the adoption by end-subscribers of FTTH is slow. This can also be seen in cases where supply outstrips demand. The low penetration and slow adoption of FTTH presents a dilemma that is worth investigating – hence the aim of this paper.

To conduct this research, an exploratory research approach was adopted. Data on the rate of penetration of FTTH from EU member countries and the challenges identified in the FTTH market were gathered from secondary data sources. These sources include documentation from the EU Commission, documentation from telecom regulatory bodies of Denmark, Sweden and Netherlands and previous research into the FTTH markets in Denmark, Sweden and the Netherlands. There were follow up interviews with Danish telecom experts to verify the findings. The concept of the Obligatory Passage Point (OPP) from the Actor Network Theory was used to identify what national policy makers expected from their FTTH market actors. This becomes a yardstick to verify, if some of the market actors fulfilled their roles and what was the market outcome. The OPPs in this papers are proposed policies and initiatives. The SWOT analysis is used to put the identified outcome in perspective in order to compare the three markets.

The outline of the paper is as follows. Section 2 explains the rationale for choosing the case. Section 3 presents the literature review on liberalization and FTTH infrastructure development in the EU. Section 4 presents the theoretical approach adopted in the paper. Section 5 outlines the methodology used in the paper. Section 6 outlines the findings and presents the analysis of the findings. This is followed by the discussion section in section 7 and the conclusions in section 8.

Rationale for choosing the three countries

Sweden: Sweden was chosen because it has the second highest FTTB penetration in the EU – even though the FTTH connectivity is lower than the FTTB connectivity as mentioned earlier. Sweden was also worth studying because of the impact of regulatory initiatives that did influence the emergence of a competitive market and a positive outcome towards FTTB penetration (Godlovitch et al., 2015).

Denmark: Denmark was chosen because it is one of the most liberalized markets in the EU. The paradox however, FTTH penetration is low. Its FTTH and FTTB penetration in 2015 were 14% and 15% respectively (FttH Council Europe, 2015). However, other Fixed-Broadband markets seem to be thriving in Denmark. Fixed-Broadband penetration in Denmark, as an example, is reported to be 90% (EU, 2015). This anomalous outcome for FTTH produced curiosity towards understanding how the liberalization policy in Denmark actually affects the FTTH market.

Netherlands: The Netherlands was chosen because its approach to facilitating FTTH is almost similar to the Swedish approach – as will be seen in the report. The Dutch, just like the Danes, have one of the highest Broadband penetration rates in the world (De Bijl, 2011). But their FTTH penetration was a little above 11% in 2015 (FttH Council Europe, 2015). If they adopt the Swedish approach, why do they not have the same results? Or do they have similar problems to Denmark? These made the case of the Netherlands worth investigating in light with the overall research question of this paper.

Some markets where FTTH is adopted in the EU have similar characteristics. Hence the scenarios presented by these three cases present the possibility of identifying some of the challenges affecting the low penetration of FTTH in the EU. The challenges identified here may lead to pointers that could enable the recommendation of policy solutions that could lead to a greater penetration of FTTH in the EU.

Liberalization and the facilitation of FTTH in the EU

Telecom market liberalization in the EU has been shaped by different EU green papers, directives, recommendations and legislations (OECD, 1998; Cave, 2009; Hultkrantz, 2002). These initiatives were – among others – aimed at:

1. The facilitation of regionally converged telecommunications market (Kaiser, 2001).
2. The facilitation of market competition aimed at achieving Universal service of basic services (Mayer-Schonberger, Strasser, 1999).
3. Preventing the emergence of network operators with market power in each member state (ITU, 2002; Cave, 2009).

In the EU and globally, competitive markets have been facilitated via the reduction of market entry barriers, the imposition of Universal Service Obligations (USO), the control of the retail and access prices, and structural separation of P&Ts (Blackman, Srivastava, 2011; Cave, 2009; Christopoulos et al., 2009). The intervention in retail prices was necessary to ensure the affordability of the service for the subscriber. The intervention in access prices was to ensure transparency and non-discriminatory practices with respect to interconnection and Service Level Agreements (SLA) between the players in the wholesale and retail markets.

The decision to liberalize the telecommunication markets in the EU differs from country to country. How and which part of the market was liberalized differed as well. For example, before the EU legislation of 1998, certain member states had liberalized the terminal equipments market. The Netherlands did liberalize their terminal equipment and value added services market in 1998 (OECD, 1998). The Swedish and Danish governments liberalized similar markets in the early 1980s (Hultkrantz, 2002; ITU, 2002). Other EU countries adopted different approaches at different times. Though the approach of these member states towards telecom market liberalization differed, the basic idea of removing market restrictions to enhance competition in various spheres of the telecoms market was the same.

The early results of the EU legislation of 1998 were:

1. The attainment of some form of regulatory convergence aimed at facilitating open markets in the EU (Kaiser, 2001). Member states used the EU legislation as inspiration towards developing their telecommunication markets. However, the differences in regulation in each member state was evident the regulation of competition at the local access networks (Kaiser, 2001; De Bijl, 2011).
2. The success in transforming hitherto monopolistic markets into competitive markets. This is a success attributed to the early stages of telecom market liberalization in the EU that promoted facility based competition (Mayer-Schonberger, Strasser, 1999). From the European Commission's (EC) perspective, this success was as a result of a meticulously designed inter-institutional processes (EC, 2001; Mayer-Schonberger, Strasser, 1999).
3. Tariff and price reduction, delivery of new services and technology (Pelkams, Renda, 2011).

Based on these successes among others, the EU has extended the liberalization policy to the facilitation of NGA networks (Marcus et al., 2009). Competition in the FTTH market – in EU member states – is being facilitated by regulating access or unbundling. These forms of unbundling are facilitated at the active and retail layers using different open access initiatives (See Sadowski et al., 2009; Forzati, 2015; Van Gorp, Middleton, 2010). Such initiatives are prevalent in the UK, Sweden and in the Netherlands (Godlovitch

et al., 2015). Competition at the passive layer is facilitated via infrastructure sharing frameworks, in-building wiring sharing and access to ducts (Godlovitch et al., 2015). These initiatives can be found in France among others. These access regulation initiatives have produced a competitive FTTH market at the passive, active and retail levels. One can therefore say that the regulation of competition has played a significant role in the development of the FTTH market in the EU. Such competition can be found the case of Denmark and many other EU member states (Falch et al., 2016).

The limitation of promoting a competitive market is the challenge of attaining Universal Access for a telecom or Internet technologies within a jurisdiction. This is because rural areas are not commercially viable, hence market players have no incentive to invest there. Bearing in mind the capital intensive nature of developing NGA networks, it is logical to assume that a competitive market will not result in the Universal Access of NGA networks. This presents a challenge towards the attainment of the EU's digital agenda by 2020. Therefore the EU has adopted means of facilitating markets in commercially unviable areas. This is by providing the opportunity for public sector interventions in areas where there are market failures (Marcus et al., 2009). However, the caveat for this developemental approach by the EU is that such interventions should be aimed at facilitating the market (Williams, 2015).

Different EU member states have adopted different approaches to facilitate the market in such areas. This includes the provision of subsidy by the public sector to aid the development of the passive and active FTTH infrastructure. Examples of such initiatives can be seen in Sweden (Williams, 2015). This is contrary to another approach adopted in the Netherlands, where the passive infrastructure is provided by the private sector (Van Gorp, Middleton, 2010). In other cases, EU subsidies, sometimes coupled with subsidies from municipalities, are provided to FTTH market players to facilitate competition at the active and passive layer (Sadowski et al., 2009).

There are other cases where complex arrangements are forged to finance FTTH infrastructure and service delivery in the EU. In such cases regions and municipalities in EU member states engage in Public Private Partnership (PPP) frameworks aimed at facilitating the FTTH infrastructure. The role of the regional and municipal entities could either be coordinating, infrastructure ownership or in providing financial capital to PPP arrangements. The regions and municipal entities facilitate the market by providing either the passive and/or active FTTH infrastruture. In some cases, they procure the services to be delivered via the infrastructure (Williams, 2015). An example of public intervention via PPP is the MetroWeb project in Milan, Italy (EPEC, 2012). This project was necessary because of the lack of incumbent (Telecom Italia) activity in the Area (EPEC, 2012). Hence there was a market failure. According to EPEC (2012), in 1998, a utility company A2A* went into partnership with a telecoms company e.Biscom

to facilitate a 2,700 km Metropolitan Access Network in the Milan municipality. They collaborated with the municipality to develop a passive fiber infrastructure. This infrastructure was then leased to players at the active network layer. The municipality had no financial obligations in the partnership. Their interest in the project was to coordinate it and provide an enabling environment to enable the project's success – as they were partners in the project. However, in the cases studied in this paper, the municipality had financial obligations to the PPP.

Despite the effort of the EU and EU member countries to liberalize the telecommunications market, as mentioned earlier, some markets have enjoyed more coverage than others. In the EU's FTTH market there is greater competition at the retail than the wholesale market. This is because there are greater efforts to regulate competition in the retail than the wholesale market. If there are many players in the wholesale market, then there is greater competition at the wholesale market. If there is lesser competition at the wholesale market, then active layer network operators have fewer options to peer with. This will affect the price the end user has to pay for the service. And these are services that other NGA networks and 4G networks can now deliver. The position of this paper based on the findings is that there should be greater effort in further liberalizing the wholesale market. This may enable FTTH to become attractive and competitive to other NGA networks and Broadband networks – thereby encouraging the greater penetration of FTTH in the EU.

Actor Network Theory

This was a theory popularized by Bruno Latour, Michael Callon, and John Law among others (Latour, 1996; Callon, 1986; Law, 1992). It is a sociological theory. The actor network or the sociology of translation is a theory that explains the process of the emergence and activities identified in socio-technical phenomena (Crawford, 2004). It is a descriptive as well as an explanatory theory. Actor networks are heterogeneous. Its structure evolves continuously as the interest and power relations between the actors evolve. The network in the context of the theory implies a network of actors (Latour, 1996). The theory does not possess a universal framework and it is anti-epistemological. Despite this disadvantage, proponents of the theory, such as Michael Callon, John Law and Bruno Latour have adopted various descriptive techniques towards analyzing actor networks (Callon, 1986; Law, 1992; Latour, 2005).

In this paper, the Actor Network theory is not operationalized as a whole. This is because the purpose of the paper is not to make a socio-technical analysis. Rather a concept of the actor network theory presents an avenue by which the markets in the EU countries can be studied. This concept is called the Obligatory Passage Point (OPP). This

is a concept promoted by Micheal Callon (Callon, 1986). The OPP is the pathway developed by the focal actor on how to solve a problem, the actors needed to solve the problem and the role of each actor towards solving the problem. This concept is part of what Callon calls problematization. In his study of the domestication of scallops and fishermen at the Saint-Brieuc Bay, he identified four events that result in the formation of actor networks (Callon, 1986). These events include problematization, interessement, enrolment and mobilization. At the problematization stage, the focal actor defines the problem and develops a solution to the problem in a way that will be of interest to other actors. The second phase is the Interessement phase. This involves the focal actor negotiating with the supporting actors to accept their role in the network. The third phase is the enrolment stage. This involves the focal actor negotiating partnerships and synergies in the network to enable the proposed solution identified in the problematization phase to take effect. The final stage is the mobilization stage. Here the focal actor forges alliances with allied representatives of the network.

However, tracing these events is not of relevance to the paper, even though it can be applied. But the OPP is relevant. The OPP provides an insight into the vision of the focal actor. In this paper this is the vision of the public sector for the FTTH market. Such visions and action plans are enshrined in national policies or outlined in the development of initiatives – such as PPPs – identified in Sweden, Denmark and the Netherlands. Armed with these OPPs, it is possible to identify the action plan, identify the course of action and examine them alongside with the outcome of the FTTH. Here, one can identify the challenges in facilitating the action plan. One can also compare the market outcomes of each action plan (OPPs) using the SWOT analysis.

Michael Callon's sociology of translation has been used in the study of Internet policies and markets. It has been used to explain the political economy of convergence (Shin, Venkatesh, 2008). It has also been used to analyze the development of 4th generation mobile network in China (Shin, 2015). It has also been used to analyze PPP frameworks suitable for developing rural Broadband networks (Williams, 2015). The use of the OPP as a means of evaluating a market outcome may be a novelty.

Methodology

The philosophical approach adopted in this paper is Interpretivism. Interpretivism helps the researcher to present their view on the development of FTTH market from a regulatory and development point of view. The study is qualitative. It is a multi-case study and an exploratory research. Three cases are chosen for the exploration. These are the Danish, Swedish and Dutch FTTH markets. Most data used for this sources is from secondary sources. These sources include EC, OECD, ITU, the national Regulator of

each country, Google scholar portals and previous empirical research conducted by the researcher. The search involved, searching for various liberalization policies, the telecom regulatory history of each country, market penetration and subscription figures and professional and academic insights into how the FTTH market was shaped. Primary data sources include interviews with Danish telecom experts. These interviews were used to verify data from secondary sources. That is why it is not included in this paper. Based on data gathered on the liberalization of the FTTH market in each of the countries, the penetration and subscription outcomes, a Strength, Weakness, Opportunity and Threat analysis of the OPPs was conducted. Thematic coding and narrative analyses were used as a support to identify themes that make up the SWOT analysis. The wordings used in the SWOT analysis are not the themes but explanation of the themes. The narrative analysis was used to piece together the stories about each country's FTTH market.

Findings/Analysis

The Netherlands' FTTH market

In the Netherlands, FTTH development began about 2008 (De Bijl, 2011). The national regulator OPTA enforced access regulation at the service layer while competition was regulated at the passive and access layer (Sadowski et al., 2006). This was done by ensuring local access (unbundling) via the open access principle (Sadowski et al., 2006; Godlovitch et al., 2015). To ensure the adoption of the open access principle, price caps for local access were enforced by the regulator OPTA (Van Gorp, Middleton, 2010). Reggefiber is the major wholesale supplier of wholesale Broadband in the Netherlands (Van Gorp, Middleton, 2010).

The open access policy served as an overarching OPP towards facilitating FTTH in the Netherlands. It outlined the procedure for providing the provision of access by an existing operator to a competing operator that has no infrastructure in the area. Based on this OPP, collaborations between the municipality, region, private sector, utility companies and cooperatives were designed to facilitate infrastructure development using the open access principle. However, the incentive for infrastructure owners to adopt open access principles is higher if they can earn substantial revenue from the practice. In a situation where open access is not beneficial to the infrastructure owner, the incentive to provide open access is lower. In this scenario, infrastructure providers are more inclined to adopt discriminatory pricing regimes to earn return on investment (RoI). They are also inclined to deny access to competing infrastructure providers based on their own discretion. The adoption of open access policies solves this problems. However, it is important to note that non-discrimination policies have always been a feature in regulating competition in the Netherlands (see OECD, 1998). Based on these measures to

ensure transparency and non-discrimination to the access infrastructure, players that were not previous actors in the market can now participate in facilitating FTTH.

In order to encourage open access and facilitate competition in the access and retail layer in areas that are not commercially viable, the regions and municipalities engage in co-investment activities with housing companies, cooperatives and private network operators towards developing the infrastructure. The co-investments from the public sector include subsidy to the private sector for the project (Sadowski et al., 2009; Kramer et al., 2006). This way, the network operator does not bear the cost of facilitating the infrastructure by themselves. This act increases the desire for the network operator to open access to other players to deploy at the service layer. Various initiatives depicting the aforementioned collaborations are represented in the table below.

Table 1. PPP Frameworks in the Netherlands

	Municipality/ Region	Initiator	Initiated/ Started	PPP Model	Network and service provision		
					network owner	network provision	service provision
1.	Almere	municipality	2001 (2003)	Coordination	Municipality via AlmereFiber Company	First Mile Ventures	UNet (Until 2008)
2.	Amersfoort	municipality	2005 (2006)	Coordination	BreedNet Amersfoort	BreedNet Amersfoort	Casema
3.	Amsterdam	Municipality, PC (GNA)	2003 (2006)	Coordination	Glasvezelnet Amsterdam C.V	BBned	Variety of service providers
4.	Arnhem	SHC (Portaal)/ PC (GNEM)	2006 (2007)	Social Housing Corporation	GNEM	GNEM	XMS
5.	Deventer	SHC (Rentree)	2004 (2006)	Social Housing Corporation	SHC Rentree Via Y3-net	SHC Rentree Via Y3-net	SHC Rentree Via Y3-net
6.	Deventer	PC (Reggefiber)	2007 (2007)	Coordination	NEM Deventer	NEM Deventer	NEM Deventer
7.	Eindhoven	COOP (Onsnet Eindhoven)	2001 (2005)	Cooperative	OnsNet Eindhoven via NEM	OnsNet Eindhoven via NEM	Edutel
8.	Enschede	SHC (Woonplats&Domijin)	2003 (2005)	Social Housing Corporation	Initially SHC via Casanet	Initially SHC via Casanet	KPN-Casanet
9.	Helmond	Municipality	2005 (2006)	Franchise	BBNed	BBNed	BBNed
10.	Naaldwijk	PC (CaiW)	2004 (2004)	Franchise	CaiW	CaiW	CaiW
11.	Nuenen	COOP (OnsnetNuenen)	2001 (2005)	Cooperative	OnsNet Eindhoven via NEM	OnsNet Eindhoven via NEM	EDUTEL
12.	Nijmegen – Hazenkamp	COOP (GlazenKamp)	2005 (2006)	Cooperative	GlazenKamp	GlazenKamp	UCI-KUN (university)
13.	Rotterdam	Municipality	2002 (2006)	Coordination	Glasvezel Rotterdam via Bbned	Bbned	Bbned
14.	Utrecht	COOP (Lomboxnet)	2002 (2004)	Cooperative	Lomboxnet	Lomboxnet	Lomboxnet
15.	Utrecht – Leidsche Rijn	COOP (Kersentuin)	2003 (2004)	Cooperative	Xs4all	Xs4all	Xs4all

PC – private company, COOP – cooperative, SHC – social housing corporation.

Source: adapted from Sadowski et al. (2009); original investigation by Stedenlink 2007, Stratix 2007.

These co-investments arrangements are in the form of PPPs. The design of the PPPs, specifying the actors needed, the responsibilities of the actors and the incentives for the actors is another OPP. This OPP is not overarching as the open access policy. It is more specialized and localized to individual projects. The PPPs are aimed at providing financial and operational capacity to these hitherto disfranchised players in the FTTH market to become players in the market. As part of the co-investment initiatives, the municipality and regions provide subsidies to the cooperatives to help them facilitate the infrastructure (Van Gorp, Middleton, 2010). The financial burden is handled jointly by the municipalities, cooperatives and the private company.

Different PPP arrangements and business models have been crafted out of these collaborations as seen in the table above. Each row represents independent PPPs. The OPP for each PPP is represented in each row. The actors in each PPP and their roles and responsibilities are represented in each OPP. Here one can identify the dynamic roles of the municipalities and other government agencies. Their roles include owning the network outright. In other cases they own the network and lease it as a franchise. In other cases they coordinate the activities of the PPP. Another interesting player with a similar dynamic role are the housing corporations and cooperatives. One would say that they do not possess the financial might, the technical or managerial know how to facilitate FTTH infrastructure. However, they are players that cannot be ignored. This is because they are the demand stakeholders of these projects. Having them on board as active participants in the project enables them to know why they need the FTTH services. Being part of the deployment helps them understand that they can be a part of the retail infrastructure. On the other hand, the network provider either owns, manages or operates the infrastructure based on the design of the PPP.

Despite this effort in extending FTTH to areas where there is market failure, the FTTH subscription in the Netherlands in 2015 was a little above 11% (FTTH Council Europe, 2015). It is not clear what impact the coop had on the overall penetration of FTTH in the Netherlands. Even though the cases mentioned here are not exhaustive.

SWOT analysis on the market outcome from OPPs adopted in the Netherlands

Strengths: Some strengths can be identified in adoption the open access policy and PPPs by the Dutch government. In the Netherlands, the FTTH market is competitive at the service layer. There are also dynamic public, private and civil society collaborations towards delivering the FTTH infrastructure. Here different demand and supply stakeholders collaborate to facilitate FTTH delivery using PPPs. There is no discrimination of non-traditional network operators. Rather, they are empowered to aid the push in the delivery of FTTH. Though Reggefiber has been credited with the idea of involving

housing cooperation (Van Gorp, Middleton, 2010). This is because the company is owned by a real estate company, Reggeborgh. It owns 59% of Reggefiber (Indesteege, 2010). The company is involved in building and operating the passive infrastructure and operating the providing wholesale Broadband services as an active operator.

Another strength is that Government agencies have not shied away from becoming actively involved and even investing in the PPPs. They have also made sure that PPPs are involved in facilitating open access at the service layer. The only difference between the open access principle in the Netherlands and in Sweden is that the access to the active and retail infrastructure is not on equal terms. In the Netherlands, a price cap is placed to avoid the broadband wholesaler from overcharging the retailer. This enables more operators to join the retail market to deliver the retail infrastructure.

Weaknesses: The only clear weakness with the Dutch FTTH market is that there are few players in the wholesale market compared to the retail market. This is not a problem necessarily, but the most visible active player in the wholesale market is Reggefiber, a subsidiary of KPN. Reggefiber is seen as a dominant operator in the FTTH market (Marcus et al., 2009). This presents a scenario of a near monopoly at the wholesale market.

Opportunities: This weakness creates room for further liberalizing the wholesale market. Facilitating more competition in the delivery of the passive and active infrastructure may change the dynamics of the market. This will hasten the penetration of FTTH, as there would be competition in business models, deployment scenarios and retail possibilities. Though the introduction of price caps is a good way of regulating prices, looking for ways of further liberalizing the wholesale market can also serve as a means of regulating prices. In addition to what other researchers may identify as the problem, identifying ways of attracting other major players to compete at the wholesale market should be considered by the Dutch government.

Threats: Though the OPPs have led to the emergence of a competitive FTTH market, there are other alternatives. These include mobile and fixed-Broadband and NGA networks. In the Netherlands LTE coverage in 2016, as an example, is more than 80% (Morris, 2016). Taking into consideration that LTE was rolled out long after FTTH was rolled out in the Netherlands. As mobile telephony evolves, end subscribers will wonder why they need FTTH anyway. But with respect to the market structure, the threat lies with the sustainability of initiatives managed by the housing cooperatives. It also lies with the potential of Reggefiber in the near future becoming a monopoly at the whole sale market. Probably more OPPs to facilitate competition is needed.

Denmark's FTTH market

The Danish case is different from that of the Netherlands. This is because Denmark adopts the regulatory approach towards FTTH development. In the political framework of 1999, the government agreed that the “best and cheapest” means to promoting universal service was to promote competition (ITU, 2002). However, public intervention was frowned upon. But, in January 2016, the government of Denmark did set up a Broadband fund of 300 million DKK for the course of 4 years to promote rural broadband coverage (Falch et al., 2016). One is yet to see what influence this initiative will have on the development of FTTH in rural areas in Denmark.

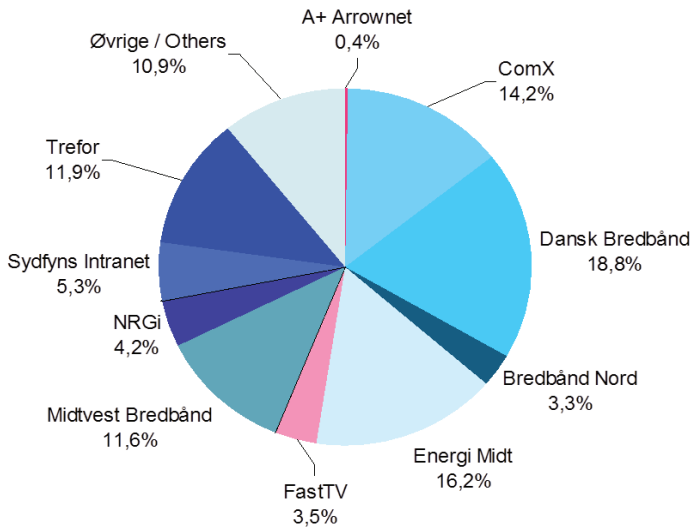
As this facilitation initiative is new, the focus on the analysis in this section will be on the previous competition regulation regime – which still exists. This competition regime serves as the overarching OPP of the Danish government towards the development of FTTH. It is important to note that Denmark is technology neutral and doing very well with regards to Broadband development. However, the focus of this paper is on the FTTH market, which incidentally is not doing so well.

Due to the competition policy in Denmark, there are no restrictions as to who can compete in the Danish telecoms market. As a result, the first entrants into the FTTH market in Denmark were utility (electricity) companies. The advantage the electricity companies had was the possibility of delivering FTTH using their powerline infrastructure (Falch et al., 2016). One of the first market entrants in 2002 was an electricity company called NVE (Pedersen, Riaz, 2009). In the same year, Dansk Bredband, an FTTH company began investing in Denmark. They were later sold to Wao!, a network provider in 2010, due to financial losses (Berlingske Business, 2012).

In 2009, some electricity companies began offloading their FTTH operations to become sole electricity providers (Pedersen, Riaz, 2009). It is important to note that some Danish utility companies are owned by their consumers and others are owned by municipalities. Later, the municipality owned utility companies had to be fully privatized. This is because the Danish government does not permit public intervention in the delivery of telecommunication infrastructure and services (Williams, 2015).

By 2009 utility companies such as Dong energy, EnergiMidt, TRE-For, sydEnergi and other were major players in the market (FTTH Council Europe, 2009). Dong energy only leased its active layer capacity to other market players to provide their Broadband Services. Dong had massive passive layer infrastructure providing coverage to the capital region of Denmark (Falch et al., 2016). By 2009, the activity of the actors under the guidance of the overarching OPP (competitive market) increased. The market share of the then active and retail players – existent then – is represented in Figure 1.

Figure 1. FTTH market share in 2009



Source: National..., 2009.

Within this period (by 2009), the utility companies had invested 5.5 billion DKK in the provision of FTTH infrastructure (National..., 2009). Based on the report from FTTH council Europe, in a research carried out by IDATE, 143,700 subscribers were registered between 2002 and 2009 (FTTH Council Europe, 2009). From 2009 onwards, market consolidations became evident. A market with multiple players was gradually consolidating via horizontal integrations. The biggest consolidation was that of Wao! and the smallest consolidation was that of Stofa.

Before Wao! emerged, there was an initial horizontal integration in Juteland. That was the consolidation of Bredbånd Nord. Bredbånd Nord underwent its own consolidation to gain competitive advantage before joining the Wao! Consortium. Bredbånd Nord's story begins with the horizontal integration of three local energy companies – ESV, ENV and Nyfors – to form Bredbånd Nord. Later, a fiber optic development company HEF Fibernet merged with Bredbånd Nord in 2013 to aid the expansion of its service in Northern Jutland (Bredbånd Nord, 2016).

In 2010 Bredbånd Nord merged with 12 of Denmark's largest companies to form Wao! (FTTH Council Europe, 2011). These companies were: Sydfyns El, Energimidt, Tre-for, Nyfors, SydEnergi, SEA-NVE, Østjysk Energy, Verdo, NRGi, Energi Fyn, HEF Broadband, Galten Elværk, Northern Energy and Bredbåndnord. Dansk Bredbånd was acquired later. This horizontal integration was branded as a marketing and product house for these energy companies (FTTH Council Europe, 2011). Hence they become not only an active market players but also service (retail) providers. This move was seen by

watchers of the market as means towards creating competition for TDC – a passive, active and retail provider – who bought Dong energy's North and eastern Jutland Fiber network in the previous year (BreInstrup, 2012). Today these two companies dominate the Danish FTTH market. But TDC has greater edge based on the extent of its fiber optic backbone infrastructure in the country.

The competition policy as an OPP enabled different actors to align based on interest to fulfill the government's desire (universal service of Broadband). But the downside of the OPP was that it produced an environment that depicts the survival of the fittest. This strategy has not harmed the market per-se as it rather encourages innovation. However, it does not lead to a perfect competition. Neither is it leading towards the Universal Access of FTTH in the next three years. This is based on the market outlook based on the penetration of FTTH in the country. In 2015 the penetration of FTTH in Denmark was almost 15% and the FTTH subscription was 14.5% (FTTH Council Europe, 2015).

SWOT analysis on the market outcome from OPPs adopted in Denmark

Strength: The adoption of the competition policy in the Danish FTTH market has its strengths. TDC and Wao! are able to harness economics of scale to develop the FTTH infrastructure in areas they operate. Though TDC has a much greater coverage than Wao! they are also able to harness the economics of scope in the delivery of their services in areas they operate. The competition policy is not stifling. Just as in the Netherlands, competition is greater in the active and service layer than at the passive layer. This has resulted in innovation in service delivery and competitive pricing of the service (FTTH Council Europe, 2011). Another strength is the entrance of non-traditional network operators into the market. Here utility companies and coops are major players in this market. One would say that cooperatives are also indirect but inconsequential decision-making players, as they own some of the small utility companies.

Opportunities: The opportunity for FTTH lies in the lowering of the market entry barriers at the active layer by encouraging the open access model. Infrastructure sharing at the passive layer coupled with open access policy at the active layer may encourage more competition as seen in Sweden and the Netherlands. This lesson may be useful to other EU countries as well, based on regulatory experiences from Sweden, France the Netherlands and the UK (See Godlovitch et al., 2015). Though the Danish state is joining the foray of providing financial incentives for Broadband development, adopting more innovative ways of liberalizing the FTTH access network delivery would aid the useful utilization of the financial incentives.

Weaknesses: The greatest weakness of the Danish market is also at the wholesale market. It is difficult to declare that competition exists here, when TDC controls this market. Other players in the Wao! consortium are small and serve localized or smaller

areas compared to TDC. TDC does not have the incentive to expand its infrastructure (See Kildebogaard, 2012). The same is applicable to Dong. TDC is a conglomerate that also supplies other NGAs such as cable and vDSL. Dong energy is focused on its core activity of delivering energy. Therefore, the growth of FTTH in Denmark is not as rapid as the growth of other Broadband networks. One would say that the competition policy as an OPP is not an advantage to the FTTH market in Denmark. Though there were attempts to consolidate in order to deliver the infrastructure at the wholesale market, Wao! in some cases needs to interconnect with TDC in some part of the country to extend their infrastructure and deliver their services. And there is the problem of connecting some rural areas.

Threat: The threat with the OPP is competition from substitute NGA's, LTE and 5G development. Operators of FTTH have diversified their operations and the shift is towards the competition at the service layer. This occurs in urban areas and areas where housing cooperation could facilitate connectivity to boost the value of their houses. In rural areas, where there is no incentive to deploy the infrastructure and service, FTTH providers rarely provide their services there. There is the need for a review in the competition policy to facilitate ways and means (New OPPs) on how to make FTTH attractive in the presence of competing technologies in both urban and rural areas.

Sweden's FTTH Market

Sweden was one of the first countries to deploy FTTH in Europe (FTTH Council Europe, 2015). In 1998, 138 municipalities owned fiber optic networks in Sweden (Orbion, 2016). This may explain why FTTH penetration is greater than the FTTH penetration as mentioned in the introduction. The Swedish approach to FTTH facilitation is similar to that of the Netherlands as they also regulate competition of FTTH at service level (Godlovitch et al., 2015). But it is different from the Netherlands because the Swedes regulate access via infrastructure sharing at the access level. At the passive layer, the national infrastructure is operator neutral (Orbion, 2016). So it is safe to say that the Swedish OPP is also that of the open access "On equal terms" policy. The difference between the Swedish approach and the Dutch approach is the conscious effort to ensure that the open access model goes high up to the passive level. There is also the difference between the two countries with respect to granting open access on equal terms.

Competition is regulated at the access level by granting open access on equal terms to service providers to compete both in infrastructure and service delivery (Ahl, 2013). This public initiative promotes competition at the service level by lowering the market entry barrier and doing away with discriminatory practices by the infrastructure owner. This enables more FTTH infrastructure suppliers to deliver their infrastructure in areas

that are not served. As a result different FTTH infrastructure and service providers supply Broadband Internet infrastructure and services in different areas of Sweden. An example of the adoption of the open access model is the case of Stokab AB. They provide FTTH in Stockholm. 100 network and service providers operate on their network (Forzati, Mattsson, 2015). The advantage of the Open access on equal terms is that the policy also enabled Broadband service providers the opportunity to access a wider market than just the urban market.

Though the open access model is promoted at the access level, the policy of adopting shared access has been of great benefit at the wholesale and retail markets in Sweden (EC, 2010). This has resulted in lowering the market entry barrier at the wholesale market. It has resulted in the promotion of competition in the delivery of the fiber optic infrastructure at the National and municipal level. However, the horizontal and vertical integration as evident in Denmark is also evident in Sweden but at city or municipal levels (Forzati, Mattsson, 2015). For example, in Stockholm the remaining major FTTH wholesale infrastructure providers are Stokab and TeliaSonera.

To enable the competition at these wholesale and retail levels, the Swedish Government adopted market incentive mechanisms to facilitate FTTH delivery. National subsidies were provided for the building of national fiber optic backbones and Municipal Area Networks (Lindskog, Johansson, 2005). These incentives provides the possibility for municipalities to encourage local communities – and in some cases old church parishes to – build their networks by forming cooperatives (Williams, 2015). In the urban areas, the municipalities mobilized housing companies and other cooperatives to facilitate FTTH (Forzati, Mattsson, 2015). Some of these municipality initiatives are PPPs, just as in the case of the Netherlands (Williams, 2015). They are also similar to that of the Netherlands in their PPP arrangements. Hence one would say that in some cases project specific PPPs acted as OPPs for the delivery of FTTH. In some of these PPP arrangements, public sector financing via subsidies to the coops and housing cooperatives are provided via EU funding channelled via the regional council and from the municipalities (Lindskog, Johansson, 2005; Williams, 2015). Coops are encouraged to facilitate, own and maintain service infrastructure, while the private sector competes in the delivery of services. The municipality either outsources the building of the infrastructure to the private sector or owns access infrastructure. The PPP arrangements differ as municipalities are permitted to design the PPP as well as design the infrastructure (Williams, 2015).

Hence one would say that there is a great deal of similarity between the Dutch and Swedish approach. But the Swedish approach has resulted in greater results with 35.2% FTTH penetration with greater rural coverage among the three cases (FTTH Council, 2016).

SWOT analysis on the market outcome from OPPs adopted in Denmark

Strength: The adoption of the open access model as an OPP has produced some strengths in the market. The Swedish market is very competitive both in the delivery of passive, active and retail services. This is as a result of the conducive environment created via access regulation as well as providing developmental incentives for the operators. The regulatory incentives include, open access on equal terms (unbundled local access). This regulatory move removes access discrimination in the SLU agreements between the infrastructure owner and the competing access operators. The developmental incentive includes the provision of subsidies at the regional, national and regional levels, to FTTH. This has led to the lowering of market entry barriers at the access level, aiding the expansion of the FTTH infrastructure to homes.

However, as a complementary action to the existing competition, the Swedish Government has adopted PPPs and other interventions for areas that are not commercially viable. Here they have encouraged non-traditional network operators to join and compete in the market as infrastructure owners. The design of PPPs has been a way of not just providing the FTTH infrastructure and services but also establishing and training non-traditional operators. This created demand opportunities for FTTH penetration into rural areas (Orbion, 2016).

For the private sector service infrastructure participants involved, the market exit cost is low, as they can decide to halt delivery of their services in one location and provide it at another location at the retail level. In a highly competitive market this fluidity in shifting operations to areas that are profitable is necessary. This is because another operator will fill the vacuum created by the former operator. And the former operator may find an opportunity to invest in virgin areas with similar OPPs operating there.

The overall strength in this approach is the political will and the active involvement of the Swedish Government to develop FTTH. Though they promote a competitive market, they have adopted a proactive measure by also becoming market players to extend the open access initiative to areas where there were market failures.

Weakness: Though the Swedish case seems successful, there is a mismatch between the actual number of connections and subscriptions. The reasons include the connections to:

1. Summer houses, whose access to connectivity is permanent but service subscriptions are temporal.
2. Connectivity to housing companies. Here there are possibilities of providing connectivity to buildings whose tenants may not subscribe to FTTH.

Another weakness is the horizontal integration of providers providing municipality fiber networks. In Stockholm, as mentioned earlier, the vertical integration has resulted in a duopoly (Forzati, Mattsson, 2015). Though competitive open access agreements will

ensure competition, the possibility of duopolies or oligopolies becoming prevalent is eminent if not checked. The duopolies are not widespread.

Opportunities: The Swedish approach to the facilitation of FTTH provides the opportunity for competition in service tariff, and competition in the nature of FTTH services delivered. Currently there are service platforms in Sweden that provide bundled services to end users. Here end users can decide to do away with a subscription they are not satisfied with. But there is room for more innovations in service delivery.

Threats: The threat to the Swedish FTTH market is the sustenance of the infrastructure in rural areas in the face of low demand. Sweden is a high income earning nation, but keeping the demand for the service alive in rural areas is beyond the ability to pay for the service. It also relies on the usefulness of the service to the user (Williams, 2015). The next threat may be the operational cost by housing corporations in paying access fees for unoccupied houses. Though this is less likely to happen in most urban areas of Sweden due to the high demand for housing, it is a threat that may occur at any point in time.

Discussion

The Netherlands, Denmark and Sweden are at the forefront of FTTH development in the EU. The challenge identified in Sweden is low demand for FTTH in rural areas. In the Netherlands and in Denmark the challenge is on the limited competition at the wholesale market. Assuming there were more Reggefibers in the Netherlands, it is likely that there will be a greater FTTH penetration than there is at the moment. In Denmark, the absence of regulatory measures to ensure the Universal Access of FTTH has resulted in fewer players in the wholesale market.

However, based on the comparisons made in the previous section, one can identify that the Swedish FTTH market is competitive at the passive, active and retail level. The Swedish Government has provided policy incentives to aid the facilitation of each NGA market. Therefore, unlike in the Danish case, FTTH is not identified as “one of the technologies that will provide 30 Mbps to the end user”. Investments are also made by the Swedish Government to promote competition by adopting regulatory and development measures that will aid in the liberalization of the FTTH market at the wholesale and retail markets. Room is also created for a plethora of demand and supply stakeholders to participate in the facilitation of the market. Market participants in Sweden include coops, housing cooperation, municipalities, utility companies and infrastructure specialists (Godlovitch et al., 2015; Falch et al., 2016). These are possible reasons why Sweden is ahead in the delivery of FTTH in Europe, lagging only behind Latvia and Lithuania.

The Dutch market is the next most competitive FTTH market among the cases studied in this paper. The competition at the wholesale market is less than that of Sweden. This is because there are fewer players in this market. The Netherlands telecom markets is highly competitive, with the presence of local and international brands. However, few players in the telecoms market are active players in the FTTH wholesale market in the Netherlands. The adoption of conscious regulatory efforts of promoting open access via infrastructure sharing at the passive layer may be the way to go. This will of course be rejected by the owners of the passive network. But if promoting public good is of paramount interest to the public sector, then such an initiative would not be a bad idea. However, in the situation where the public sector has the financial capacity to facilitate their own passive network to promote such infrastructure sharing arrangements, which could also be a solution.

At the retail market, the situation is different. There is competition in the Dutch FTTH retail market as efforts have been made to lower market entry barriers via access regulation. What also makes the Dutch approach worthy of note are the PPPs involving housing cooperation and the Reggefiber business model. Though the Netherlands is a small country, it is a heavily populated one with respect to its landsize. Extending such PPPs coupled with an infrastructure sharing policy will facilitate a more liberalized wholesale market. This may have a positive impact on the service tariffs provided to the subscribers on the long run.

The Danish FTTH market is less competitive of the three due to vertical and horizontal integrations as explained earlier. But it is a market that has a variety of actors as mentioned earlier. What Denmark needs is a dedicated attention to the FTTH market. Here there is the need to provide incentives for market players that are dedicated to facilitating FTTH. This will require the lowering of market entry barriers to the few areas where there is lack of infrastructure. In areas where there is an existing passive network, TDC and Dong energy should be mandated to share their infrastructure with competitors who are willing to deliver wholesale services to an area that is not served. This is cheaper than having new entrants set up their infrastructure. At the moment, TDC does not have that incentive to do so, hence some regulation is needed. If Denmark were to adopt access regulations to enable competition at the wholesale market, it is likely that it would be one of the fastest growing FTTH markets in the EU.

Based on the comparisons made for the three FTTH markets, facilitating competition at the wholesale market may be one of the solutions to a much more rapid development of the FTTH market in the EU. However, despite the challenges identified in these markets, there are lessons from these markets. There are four in number. There could be more. These lessons were extracted from strengths identified in the SWOT analysis. The four lessons are as follows:

1. Their political agenda: The governments of the three cases studied had clear political agendas towards facilitating high speed Broadband Infrastructure. The Swedes and the Dutch had a more focused agenda towards FTTH, while the Denmark's towards NGAs is technology neutral. However, the commonality in their agenda was the promotion of competition in their respective markets. For the Danes competition was a means of attaining Universal Access. In order to achieve this, their idea as mentioned earlier was to "find the cheapest means" of facilitating the telecom network (ITU, 2002). In Sweden, facilitating e-government and building an information society was their vision. Their idea has been to develop an infrastructure that will support governance and societal development (Regeringskansliet, 2014). In the Netherlands facilitating competition via liberalization was originally aimed at prohibiting cartels (OECD, 1998). These ideologies did affect the various approaches towards the liberalization of their FTTH markets. It also affects how the governments feel the market should be regulated.
2. Technology preferences for achieving the EU 2020 digital agenda: The uptake of 30 Mbps of NGA networks by 2020 is a target that can be achieved by different NGA networks, such as VDSL and DOCSIS 3.0. On the other hand, these NGA networks are cheaper to deploy than FTTH. Hence in Denmark technology neutrality is adopted towards meeting this target. However, in Sweden and in the Netherlands, more effort is made to facilitate the FTTH market. This is because FTTH deliver much more data rates than other NGA networks. It serves as a onetime investment without having to upgrade it as technology changes. This brings up the question of what would one regard as the basic service and which NGA should be given priority to deliver such basic services – with respect to Universal Service policies?
3. Expected Service delivery to the end user: Aside Denmark, the Netherlands and Swedish governments are greatly concerned in the regulation of the last mile access networks. This is to ensure that citizens have the possibility towards adopting not just mobile services but FTTH services as well. Hence both countries have adopted co-investment initiatives and access regulations to achieve this goal. Denmark on the other hand prefers a competitive approach among the different technologies in the market. One would say that this is so because the services delivered by vDSL and cable are capable of providing high quality Broadband services as well. Another issue could be that Denmark prefers to move slowly, taking into consideration the rapid evolution of technology and the size of its market. This is the thought of the researcher. Hence the demand pull approach is preferred to the supply push approach in Denmark.

4. Retail and wholesale access regulation: Aside Sweden, emphasis is not made in development of the wholesale markets in Denmark and the Netherlands. Rather the emphasis is placed in the development of the last mile network. To ensure affordable broadband service delivery, the Dutch and the Swedes have adopted a regulatory and developmental approach towards delivering the last mile. While the Danes adopt a more regulatory approach.

Conclusion

The lessons learnt from each case are simultaneously complementary and diverse. These strengths have been the backbone to the current market picture of FTTH penetration in each country. In the EU and among the cases studied, solutions adopted here are practiced. Based on the research conducted to produce this paper, and as seen in the cases studied, the greater the liberalization of the backhaul market, the greater the FTTH penetration. At the service level, the market entry and exit barriers are low. But at the wholesale level, the market exit barrier is high due to the capital intensive nature of FTTH operations. In this paper, infrastructure sharing at the wholesale level has been proposed as a means of lowering the exit barrier and mitigating the extent of the risk incurred by the wholesale provider. If this occurs, there is the possibility of reduced interconnection charges for the service providers and reduced access fee for the subscriber. FTTH services may become competitive and the desire for the service might grow.

The paper also exposes the fact that FTTH is not a regulatory priority in some EU countries. This is reflected in the Danish case. This is not such a problem if the focus is on NGA networks. In such a case, why bother about FTTH. But in a situation, where it is glaring that FTTH is a more durable NGA network with respect to enhanced data rates, capacity and Quality of Service, it might be wise to consider its long term deployment. This will create the political will regulate the Universal Access for FTTH infrastructure delivery.

In conclusion, ways to accommodate more players in the market or further liberalizing the FTTH market should be considered by EU member states.

References

- Ahl, K. (2013). *Sweden puts in the Fibre in Innovation*. FTTh Council Europe.
- Berlingske Business (2012). *Salg af Dansk Bredbånd udløser giganttab*. Retrieved from: <http://www.business.dk/digital/salg-af-dansk-bredbaand-udloeser-giganttab> (5.06.2016).
- Blackman, C., Srivastava, L. (2011). *Telecommunications Regulations Handbook: Tenth Anniversary Edition*. ITU/InfoDev/World Bank.

- BMW (2009). *The Federal Government's Broadband Strategy*. Retrieved from: <https://www.bmw.de/English/Redaktion/Pdf/broadband-strategy,property=pdf,bereich=bmw,sprache=en,rwb=true.pdf> (6.06.2015).
- Bourreau, M., Cambini, M., Hoernig, S. (2012). Ex ante regulation and co-investment in the transition to next generation access. *Telecommunications Policy*, 36 (2012), 399.
- Bredbånd Nord (2016). *Hvem er Bredbånd Nord*. Retrieved from: <http://www.bredbaandnord.dk/Privat/Hvem-er-Bredb%C3%A5nd-Nord> (5.06.2016).
- BreInstrup, T. (2012). *Dansk Bredbånd solgt til elselskaber*. Retrieved from: <http://www.business.dk/digital/dansk-bredbaand-solgt-til-elselskaber> (5.06.2015).
- Callon, M. (1986). Some elements of a sociology of translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. In: L. John. *Power, Action and Belief: A new sociology of Knowledge* (pp. 196–223). London: Routledge & Kegan Paul.
- Cave, M. (2009). Regulating Telecommunications in Europe: Present and future. In: W.H. Lehr, L.M. Pupillo. *Internet Policy and Economics* (pp. 15–28). Springer.
- Christopoulos, A.S., Mylonakis, J., Vergo, K. (2009). The Liberalization Process of telecommunications and the role of the national regulatory authorities in pricing policy: a case study of Greece. *Problems and Perspectives in Management*, 7 (2), 61–70.
- Crawford, C. (2004). Actor Network Theory. *A-Ritzer Encyclopedia*. Sage Publications.
- De Bijl, P.W. (2011). Broadband Policy in the light of the Dutch Experience with Telecommunications Liberalization. *CPB Dis169cussion Paper*, pp. 1–38.
- EC (2001). *Use of EC competition rules in the liberalization of European Union's Telecommunications sector*. Retrieved from: http://ec.europa.eu/competition/speeches/text/sp2001_009_en.pdf (5.08.2016).
- EC (2010). *Sweden*. Retrieved from: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=3282 (5.08.2016).
- EPEC (2012). *Broadband delivering Next generation access through PPP*. Luxembourg: European PPP Expertise Centre.
- EU (2015). *Broadband Coverage in Europe 2014*. London: IHS VVA Consulting.
- European Commission (2013). *Digital Agenda for Europe*. Retrieved from: <http://ec.europa.eu/digital-agenda/en/future-internet-public-private-partnership>.
- Falch, M., Anders, M., Tadayoni, R., Williams, I. (2016). New Investment models for Broadband in Denmark and Sweden. *Journal of NBICT*, 1, 1–18.
- Forzati, M., Mattsson, C. (2015). *Technical and economic analysis of fiber-based broadband technologies in Stockholm FTTH s. FTTB*. Acreo Swedish ICT Promemoria.
- FTTH Council (2016). *Breaking News from the FTTH conference 2016: Croatia, Germany and Poland join the FTTH Ranking*. Retrieved from: http://www.ftthcouncil.eu/documents/PressReleases/2016/PR20160217_FTTHranking_panorama_award.pdf.
- FTTH Council Europe (2009). *Denmark Sees the light: 90% increase in the Fibre-to-the-Home subscribers in the past year*. Retrieved from: http://www.ftthcouncil.eu/documents/PressReleases/2009/PR2009_Denmark_Final.pdf (5.06.2016).
- FTTH Council Europe (2011). *Wao! A fast – emerging Brand in Denmark's fiber-access sector*. Retrieved from: http://www.ftthcouncil.eu/documents/CaseStudies/WAOO_Update2.pdf (5.06.2016).
- FTTH Council Europe (2015). *FTTH Subscribers in Europe: nearly 15 million homes!* Retrieved from: http://www.ftthcouncil.eu/documents/PressReleases/2015/PR2015_FTTH_Subscribers.pdf (5.07.2016).

- Godlovitch, I., Henseler-Unger, I., Stumpf, U. (2015). *Competition & investment: An analysis of the drivers of superfast broadband*. Bad Honnef: Wik Consult.
- Hultkrantz, L. (2002). Telecommunication Liberalization in Sweden: Is “Intermediate” regulation viable? *Swedish Economic Policy*, 9, 133–161.
- Indesteege, D. (2010). *The Netherlands – Infrastructure and Co-Investment*. Sarajevo: Cullen International.
- ITU (2002). *Competition Policy in Telecommunications: The case of Denmark*. ITU.
- ITU (2015). *ICT Facts and Figures*. Switzerland: ITU.
- Kaiser, R. (2001). Multi-Level Governance and Global market liberalization: The Interdependence of National, European and Multilateral telecommunication policies. *ECISA's Seventh Biennial International Conference madison, Wisconsin, May 31-June 2 2001*, (pp. 1–24). Madison.
- Kildebogaard, J. (2012). *TDC: Danskerne er ligeglade med fiber*. Retrieved from: <https://www.version2.dk/artikel/tdc-danskerne-er-ligeglade-med-fiber-49271> (5.09.2016).
- Kramer, R.D., Lopez, A., Koonen, A.M. (2006). Municipal broadband access networks in the Netherlands – three successful cases, and how New Europe may benefit. *AccessNets '06 Proceedings of the 1st international conference on Access networks 4–6 September 2006*. Athens-Greece: ACM.
- Latour, B. (1996). On Actor-Network Theory: A few clarifications. *Soziale Welt*, 47 (4), 369–381.
- Latour, B. (2005). *Reassembling the Social*. New York: Oxford university press.
- Law, J. (1992). Notes on the Theory of the Actor Network: Ordering, Strategy and Heterogeneity. *Systems Practice*, 5 (4), 379–393.
- Lindskog, H., Johansson, M. (2005). Broadband: A municipal Information Platform: Swedish experience. *International Journal for Technology Management*, 31 (1/2), 47–62.
- Marcus, J.S., Elixmann, D., Wernick, C. (2009). *Next Generation Networks*. Directorate-General for Internal Policies.
- Mayer-Schonberger, V., Strasser, M. (1999). A closer look at telecom deregulation: The European Advantage. *Havard Journal of Law & Technology*, 12 (3), 562–587.
- Morris, A. (2016). *Report: Netherlands best in Europe for LTE coverage, but Hungary takes speed crown*. Retrieved from: <http://www.fiercewireless.com/europe/report-netherlands-best-europe-for-lte-coverage-but-hungary-takes-speed-crown>.
- National IT and Telecom Agency (2009). Broadband regulatory in Denmark. *TRIS Workshop*. National IT and Telecom Agency.
- OECD (1998). *Netherlands – The role of Competition policy in regulatory reform*. OECD.
- Orbion (2016). *Electrical and Fiber Networks for Household FTTH Access: A summary of Swedish experience*. Retrieved from: <http://www.lvm.fi/lvm-site62-mahti-portlet/download?did=189278> (5.09.2016).
- Pedersen, J.M., Riaz, T.M. (2009). Bringing Fiber to the Home to rural areas in Denmark. 2nd International Symposium on Applied Sciences in Biomedical Communication Technologies, 24 27 Nov 2009 (pp. 1–6). Bratislava: IEEE.
- Pelkams, A., Renda, A. (2011). Single EComms Market? No such thing. Namur CRID conference on Telecoms: “The Digital Single Market as EU Telecoms Cinderella”. CEPS Policy Brief.
- Regeringskansliet (2011). *ICT for Everyone – A digital Agenda for Sweden*. Stockholm: Ministry of Enterprise, Energy and Communications.
- Regeringskansliet (2014). *Broadband Strategy for Sweden*. Stockholm: Ministry of Enterprise Energy and Communications Sweden.

- Sadowski, B.M., de Rooij, M., Smits, J. (2006). State Aid, Open Access and Market size: Two cases of FTTH Network Implementation In Dutch Municipalities. *Eindhoven Centre for Innovation Studies, The Netherlands, Working Paper 06.09*, pp. 2–26.
- Sadowski, B., Nucciarelli, A., de Rooij, M. (2009). Providing Incentives for Private Investment in Municipal Broadband Networks: Evidence from the Netherlands. *Telecommunications Policy*, 33 (10–11), 582–595.
- Shin, D.E., Venkatesh, M. (2008). The Political economy of convergence. *Jovnost – The Public*, 15 (1), 23–38.
- Shin, D.Y. (2015). Analyzing the development of 4th Generation mobile in China: Actor Network perspective. *Info*, 17 (1), 22–38.
- Van Gorp, A., Middleton, C. (2010). Fiber to the Home Unbundling and retail competition: Developments in the Netherlands. *Communications and Strategies*, 72 (2nd quarter), 1–21.
- Williams, I. (2015). *Analysis of Public Private Interplay Frameworks in the Development of Rural Telecommunications Infrastructure: A Multi-Case Study*. Aalborg: Aalborg University Press.

Abstract

The penetration of Fiber-to-the-Home (FTTH) in the EU is low. This is because deploying FTTH is capital intensive. The liberalization of the FTTH market in three EU countries is studied in this paper. The aim is to identify the challenges that affect the growth of FTTH in the EU. This is a qualitative study. The Actor Network Theory is used to study the Obligatory Passage Points (OPP) in these markets. SWOT analysis is used as analytical tools to identify the strengths, weaknesses, opportunities and threats in these markets – with respect to the OPPs. Based on the outcome of the study, this paper concludes that competition at the wholesale market aspect of the FTTH market should be given more priority than competition at the retail section of the Fiber-to-the-Home market. This prioritization in regulating competition will enable greater market penetration of Fiber-to-the-Home infrastructure.