Fixed and mobile broadband substitution in the OECD countries – A quantitative analysis of competitive effects

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Abstract

In this paper we analyze the competitive effects between mobile and fixed broadband. We use the Lotka Volterra competition model, known from ecology, to analyze these competitive effects in the OECD area. The results suggest that mobile broadband demand is stimulated by a high demand for fixed broadband services. Hence, the majority of consumers does not view fixed broadband as a substitute for mobile broadband but rather complement their fixed broadband access with a mobile access. Reverse effects, i.e. a positive or negative influence of mobile on fixed broadband diffusion, are not clearly identifiable to the present. The results imply that mobile broadband diffusion at the moment does not strongly affect competition in the fixed broadband market. With regard to competitive strategies, the results suggest that bundling fixed and mobile broadband can indeed provide super-additive customer value.

1. Introduction

Growing data consumption over cellular networks with high data rates (mobile broadband), apart from coming along with the development and offering of a new range of mobile broadband applications, strongly influences the overall broadband access business.

Firstly, mobile broadband represents a potential substitute to the fixed broadband services, i.e. broadband services based on fixed lines such as DSL and cable. The diffusion of mobile broadband therefore could increase inter-platform competition [11]. Since fixed broadband partially is subject to regulation [8], mobile broadband and inter-platform competition must be closely analyzed by regulators [8]. A deeper insight into the competitive effects between mobile and fixed broadband significantly facilitates the design of regulation policies in broadband markets. Secondly, broadband service providers increasingly bundle mobile and fixed broadband access in a combined service offering and try to leverage the complementarities of fixed and mobile broadband [31]. If complementarities do exist, the uptake of mobile broadband potentially increases aggregate broadband penetration [27]. In case of substitution effects, mobile broadband undermine investments into fixed-lined access infrastructure. Further knowledge about competitive effects between mobile and fixed broadband therefore helps telecommunication service providers to design successful service strategies.

In many countries, telecommunication markets with structural entry barriers are subject to regulation [7]. If a company has significant market power in such a market, national regulatory authorities can be obliged to impose appropriate ex ante remedies [12]. The markets, which are subject to regulation, need to be clearly defined in terms of the products and geographical areas, which are included. As market definition is subject to country specific circumstances, this is a non-trivial task. One of the markets regulated in many countries is wholesale broadband access, i.e. the wholesale products which allow alternative broadband providers to offer Internet access services to consumers without owning own access infrastructures [7]. In order to define the wholesale access market, it is, however, not sufficient to focus on the wholesale level. This is because competitive effects between different access technologies on the retail level have an effect on competitive behavior on the wholesale level. This is why competitive effects between fixed and mobile broadband have a high relevancy for regulators. This is, however, a field of research addressed by few researchers up to the present [42].

Apart from regulators, the quantification of competitive effects between fixed and mobile broadband is also of high importance for telecommunication service providers. If they create bundles with both technologies in one product, these competitive effects directly influence optimal pricing and competitive strategies [31]. One generally differentiates between two types of competitive effects: substitution and complementarity [5]. In the case of complementarity, bundling could lead to sub-additive costs and super-additive value [14]. In the case of substitutability, bundling could represent a means to avoid customer churn and revenue erosion [41].
In high developed countries, such as the OECD countries, the state of diffusion of mobile broadband is already advanced [36]. Hence, competitive effects represent an important issue [7] and substantial data is available for analysis. For this reason, we focus our analysis in this paper on the OECD region.

In order to provide new insights into competitive effects between wireless and fixed broadband, we want to address the following research questions in this article:

- Is there a competitive relationship between mobile and fixed broadband in the OECD area?
- Which implications can be derived from the type and strength of this relationship for competition and regulation?

2. Competitive effects between fixed and mobile broadband

With the evolution of broadband technologies, the definition of the lower boundary for broadband data rates evolves as well. For fixed (i.e. stationary) broadband services, we follow the definition provided by [21], which consider services to be broadband, if they allow the access to the Internet with a data rate of greater than 2 megabits per second in at least one direction. With regard to mobile broadband, we adopt the definition of [36] taking into account all 3G services, which enable downstream data rates of 384 Kbps and above [22], to be broadband. The different broadband technologies and substitution research are presented in the following subsection. Thereafter, the prior research on fixed to mobile substitution is discussed.

2.1. Competitive effects between broadband technologies

Fixed broadband services are provided with the following access network technologies [35, 44]:

- **Digital subscriber line (DSL)** is a technology used to provide Internet access over the twisted-pair copper wires of the local telephony networks.
- **Cable Internet** provides access over the local cable television infrastructures, which connect the consumers with cable television headend facilities.
- **Fibre-to-the-home (FTTH)** uses optical fiber within the entire local network up to the customer’s premises.
- **Satellite broadband Internet** uses geostationary satellites to realize the data exchange over the air interface in the downstream as well as in the upstream direction (two-way satellite communication).
- **Ethernet local area network (LAN)** access comprises several standards on the OSI physical and data link layer and is primarily used by business customers.
- **Fixed wireless access** technologies connect fixed locations (customer premise and provider network) over the air interface using different standards such as IEEE 802.11 or Long Term Evolution (LTE).

Mobile broadband uses cellular mobile communication technology standards such as UMTS, HSPA and LTE for providing uninterruptible mobile Internet access [22].

Figure 1 shows the subscription ratios of different broadband technologies to the overall number of broadband subscriptions in the OECD region. As this figure demonstrates, the broadband market is not static. The demand for different technologies may be subject to substitution effects, i.e. subscribers possibly switch between the technologies. Moreover, consumers possibly have more than one subscription. Therefore, there also might be complementarity effects.

![Figure 1: Ratios of broadband technologies in the OECD region (based on [37])]
produce similar results for the Portuguese market. Ida and Sakahari [19] find out that cable and FTTH customers are more willing to substitute as a reaction to price changes than DSL customers.

The research stream about competitive effects between fixed and mobile access technologies deserves a separate section, because it represents the focus of this research. It is discussed in the following.

2.2. Competitive effects between fixed and mobile telecommunication technologies

The research on competitive effects between fixed and mobile telecommunication technologies traditionally dealt with the interaction between fixed and mobile voice services (fixed to mobile substitution) [2]. A comprehensive literature overview about this topic is provided by Vogelsang [48]. He differentiates between a research stream, which uses penetration models, and another stream, which evaluates and interprets the extent, to which consumers would substitute a technology as a reaction to a price change (elasticity of demand). Calculating price elasticities Briglauer et al. [6], for example, find that access is inelastic while calls are elastic. They conclude that fixed to mobile substitution on the access level is no strong enough to justify de-regulation.

Since this article uses penetration models, we concentrate the further discussion on the application of such models. Various authors study the effect of fixed network size on mobile network development with different results. Gruber and Verbongen [16] in an analysis of the voice market in the EU countries between 1992 and 1997 show a significant negative relation between the number of fixed lines and mobile voice penetration. Jang et al. [23] find similar results for the OECD countries and Taiwan for the period from 1980 to 2001. In contrast, Gruber [15] looks at the diffusion of fixed and mobile telephony in Central and Eastern European countries and finds a positive correlation: in countries with a higher fixed network penetration rate, mobile diffusion is also higher. Hamilton [17] reports similar results for the penetration with fixed and mobile lines in Africa between 1985 and 1997.

Only very few researchers include the reverse effect of mobile voice on fixed line penetration in their analysis. Barros and Cadima [4] find a negative, yet very modest effect of mobile on fixed network development. Their results furthermore suggest no effect of fixed on mobile network development. Banerjee and Ros [3] argue that competitive effects between fixed and mobile voice services are subject to change over time. According to this statement, mobile and fixed networks are complements in the early phase of mobile voice diffusion and later become substitutes.

Vogelsang [48] states, that there generally is a lack of research covering the present evolution of mobile and fixed network penetration. Moreover, research addressing the balance between substitution and complementarity of the fixed and mobile sectors is rather scarce. Vogelsang [48] furthermore identifies the need for research on the competitive effects between fixed and mobile broadband. Substitution effects, comparable to the voice market, are likely to emerge between mobile and fixed broadband as well [43].

There are, up to this date, only very few publications, which address this topic: two studies [7, 42] calculate demand elasticities, one study [8] provides descriptive statistics of a consumer survey, Lee et al. [27] use logistic regressions.

Cardona et al. [7] estimated various nested logit models and, on this basis, derive implications for the definition of broadband markets. Their research uses a survey of 4,029 households in Austria, which provides information about the type and characteristics of the Internet connection, monthly expenses as well as respondent characteristics such as age, education and household size. The results show that demand for the broadband services DSL, cable and mobile broadband are rather elastic in areas, in which multiple broadband access types are available. This would imply that these different broadband access technologies are close substitutes. Because the penetration of mobile broadband in Austria, at the time of the survey, still was very low, they did not explicitly study whether DSL and cable together are constrained by mobile broadband. They note that this issue becomes more relevant with the increased uptake of mobile broadband.

In a later study, Cardona et al. [8] further analyze switching behavior in the Austrian broadband market. They provide descriptive statistics on fixed to mobile substitution for the Austrian market by means of a survey of private and business broadband customers. They found that 13.9% of the private households surveyed, which presently use cable or DSL, consider mobile broadband an appropriate substitute. The majority of these households find switching costs to be rather small. 79.1%, however, do not find mobile broadband to be a substitute for fixed broadband. Of the surveyed businesses, 68% percent did not change their fixed broadband connection after purchasing mobile broadband, 3% even expanded their fixed broadband data rates. 12% of the businesses fully substituted fixed broadband with mobile broadband and 16% did not have a fixed broadband connection prior to purchasing mobile broadband. Furthermore Cardona et al. [8] found out, that only 16% of the
businesses planning to subscribe to mobile broadband will at least partially substitute fixed broadband. The results of this research imply that mobile broadband is a substitute to fixed broadband at least to some extent.

Srinuan et al. [42] analyze fixed and mobile broadband substitution in Sweden with a survey on broadband access types, age, education and housing type as well as data on broadband access pricing. They used nested logic models and calculated demand elasticities. They calculated own-price and cross-price elasticities for the broadband technologies DSL, Cable, LAN/Fiber and mobile broadband. Their results suggest that price elasticities vary by geographical area. In areas with a good broadband coverage, in which multiple broadband technologies are available, cross-price elasticities for DSL, cable, fiber and mobile broadband are positive and close to one. This implies that in these areas the different broadband technologies represent close substitutes. In areas, however, in which only DSL and mobile broadband are available, mobile broadband does not seem to be a substitute for DSL. The study by Srinuan et al. [42] solely focusses on Sweden and does not provide a quantification of competitive effects on an international scale. Furthermore, it is a cross-sectional analysis, which does not take into account longitudinal effects.

Lee et al. [27] provide an in-depth analysis of the factors that influence the diffusion of fixed and mobile broadband. They estimate logistic regressions and are able to identify a negative effect of fixed broadband price on mobile diffusion. This result suggests a complementarity between fixed and mobile broadband. They, however, consider this a preliminary result and recommend considering both fixed and mobile broadband technology jointly in one model in order to obtain more precise results. The complementarity, according to Lee et al. [27], is plausible due to the high income of most countries, which were taken into account in their study. The analysis of low-income countries could possibly yield different results. Thompson and Garbacz [45], for example, show that the economic impacts of mobile broadband in low-income countries differ to the economic impacts in high-income countries.

3. Analyzing product diffusion with growth curves

There are various growth models, which are used to analyze and forecast product diffusion [30]. Most of these models, however, do not take into account competitive effects of interrelated products. In the following, the logistic function is presented as a representative of growth curves, which focus on a single product. Thereafter, the concept of competitive effects is introduced and a model is explained, which takes into account such competitive effects.

3.1. Logistic function

According to the logistic function, demand growth is proportional to the untapped market potential as well as the current level of demand ($X_t$). The level of demand is of importance, because the higher this level, the higher the social pressure to adopt the product. For a saturation level $\Omega$, the untapped market potential is calculated as follows: $\Omega - X_t$. The demand growth is modeled with the following function [18, 32]:

$$\frac{dX_t}{dt} = \beta X_t (\Omega - X_t) \quad (1)$$

Solving this differential equation leads to the following growth function [32]. $X_0$ denotes the level of demand at $t=0$.

$$X_t = \frac{\Omega}{1 + \left(\frac{\Omega - X_0}{X_0}\right) e^{-\beta t}}, X_0 > 0 \quad (2)$$

The resulting logistic curve has an S-shape and is symmetric about its point of inflection, at which half the saturation level is reached [30].

3.2. Competitive effects in product growth

A competitive effect can be defined as a relative change of demand for a product in reaction to a change of price for another product [47]. It is, however, possible to detect competitive effects without explicitly taking account pricing by analyzing the diffusion curves of different products [24, 25, 50, 9]. According to Bayus et al. [5] there are three different types of multiproduct interactions. If two products do not have a negative influence on each other, they coexist (1.). If one product substitutes the other whereas the other does not have any influence on the former, one product is crowded out of the market in the long run (2.). If one product substitutes the other and, at the same time, the other has either a positive or a negative influence on the former, the products demonstrate long-term competitive effects resulting in either coexistence or crowding out (3.). These effects are comparable to predator-prey models, which are used to analyze population dynamics [28]. The different combinations of competitive relationships are depicted with examples in Figure 2.
Competitive relationships in the demand for different products can be analyzed with the Lotka Volterra Competition (LVC) model, which is introduced in the following section.

3.3. Lotka Volterra Competition Model

The LVC model was originally designed to model competition, symbiosis and predator-prey relationships in ecology [28]. LVC models consist of two first-order differential equations, which describe the interaction of the two populations. The equations are non-linear and coupled:

\[
\frac{dX}{dt} = \left(a_1 - b_1X - c_1Y\right) \cdot X \quad (3)
\]

\[
\frac{dY}{dt} = \left(a_2 - b_2X - c_2Y\right) \cdot Y \quad (4)
\]

X and Y stand for the two populations, a describes population growth, b quantifies the limitation of the niche capacity for a population and c describes the competitive relationship between the two populations. In order to allow for the analysis of the two populations’ evolution over discrete time, Leslie [28] formulated the following difference equations:

\[
X(t + 1) = \frac{\alpha_1 X(t)}{1 + \beta_1 X(t) + \gamma_1 Y(t)} \quad (5)
\]

\[
Y(t + 1) = \frac{\alpha_2 X(t)}{1 + \beta_2 X(t) + \gamma_2 Y(t)} \quad (6)
\]

Alpha and Beta are the parameters describing growth and saturation for the two populations. The Gammas describe the effect of each population on the evolution of the other. Table 1 distinguishes different types of competitive relationships by the sign of the Gammas.

Figure 2: Competitive relationships between two products [5]

Table 1: Types of competitive relationships (based on [25] and [34])

<table>
<thead>
<tr>
<th>(\gamma_i)</th>
<th>(\gamma_j)</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>Pure competition</td>
<td>Occurs when both species suffer from each other’s existence</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td>Predator prey</td>
<td>Occurs when one of them serves as direct food to the other</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>Mutualism</td>
<td>Occurs in case of symbiosis or a win–win situation</td>
</tr>
<tr>
<td>-</td>
<td>0</td>
<td>Commensalism</td>
<td>Occurs in a parasitic type of relationship in which one benefits from the existence of the other, who nevertheless remains unaffected</td>
</tr>
<tr>
<td>+</td>
<td>0</td>
<td>Amensalism</td>
<td>Occurs when one suffers from the existence of the other, who is impervious to what is happening</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Neutralism</td>
<td>Occurs if there is no interaction whatsoever</td>
</tr>
</tbody>
</table>

3.4. Overview of LVC model application in economics

LVC models have been applied in various areas in economics, mainly in the areas of finance and ICT. In the area of finance, the LVC model has been used to analyze the interrelationship of bonds and stocks [33]. The results of this study indicate a market transformation from a symbiotic relationship between bonds and stocks towards a predator prey relationship with stock sales representing the predators. In a second financial analysis, Lee et al. [26] studied the relationship between the Korean Stock Exchange (KSE) and the Korean Securities Dealers Automated Quotation (KOSDAQ). They considered investment capital to be the limited resource and demonstrated a transformation in the dynamic relationship from predator prey (predator: KOSDAQ) to a symbiotic and finally to a competitive relationship.

In the area of ICT, the LVC model was used to analyze the competitive interrelationship of cellular services and Personal Communication Services (PCS) in the Korean mobile phone market [24]. The results show that whereas PCS demand is positively interrelated with the demand for cellular services, the effect of PCS demand on cellular subscriptions is limited. Kreng and Wang [25] show, that the LVC model fits well to study the competitive relationship between shipments of plasma display panels (PDP) and liquid crystal displays (LCD). The results indicate that, regardless of the size of the displays, LCD shipments positively influence PDP shipments but PDP shipments have a negative effect on LCD shipments. Wulf et al. [50] study substitution effects in the market for IP based TV in Germany. Comparing the diffusion data of an IP TV and an Internet TV service, they demonstrate...
that there are no interrelation effects at the time of analysis. Chiang [9] uses the LVC model to analyze the interrelationship between the usage of 200 mm and 300 mm silicon wafers in the global semiconductor market. Chiang was able to show that the two products have a predator prey interrelationship with the 300 mm generation being the predator.

4. Analysis of competitive effects between fixed and mobile broadband

In order to analyze the interrelationship of the demands for fixed and mobile broadband, we follow a two-step procedure. Following Kim et al. [24], we compare the LVC-model with the monopolistic logistic model. That way, we quantify the additional forecasting power of taking into account the competitive effects.

4.1. Data

Our analyses use data provided by the OECD on broadband subscriptions in the 34 member countries between 2001 and 2009. The information on subscriptions for various fixed broadband technologies (DSL, cable, FTTH among others) in the different member countries is given in [35] and [36]. Data on 3G cellular mobile subscriptions in the individual OECD countries is taken from [36].

![Figure 3: Overall fixed and mobile broadband subscriptions in the OECD region](image)

Figure 3 shows the diffusion curves for the overall fixed and wireless subscriptions in the OECD region.

4.2. Logistic regression

In a first step we want to analyze the broadband demands without taking into account competitive effects. We use the logistic model presented in Section 3.1. In the logistic model, we use a country’s population size in the year t and number of households respectively [37] to quantify the saturation level \( \Omega_{t,i} \) of a country \( i \). Furthermore, the first year for which OECD provided information for a country’s demand was set to \( t=0 \) and the respective demand represents \( X_{0,i} \).

Rewriting Equation (2) and adding the normally distributed, independent random disturbance term \( \varepsilon \), we produce the following equation:

\[
\begin{align*}
\frac{\Omega_{t,i}}{\Omega_{t,i}} - 1 &= \frac{X_{t,i}}{X_{0,i}} - 1 \\
\beta \ln\left( \frac{X_{t,i}}{X_{0,i}} \right) + \varepsilon &= \frac{X_{t,i}}{X_{0,i}} - 1 \\
\frac{1}{\beta} * \frac{X_{t,i}}{X_{0,i}} - 1 &= \ln\left( \frac{X_{t,i}}{X_{0,i}} \right) + \varepsilon
\end{align*}
\]

We furthermore define the following terms:

\[
\alpha = \frac{1}{\beta}
\]

\[
Y_{t,i} = \frac{1}{\Omega_{t,i}} * \ln\left( \frac{X_{t,i}}{X_{0,i}} \right)
\]

Substituting the terms (8) and (9) in equation (7) results in the following equation:

\[
t = \alpha * Y_{t,i} + \varepsilon
\]

Equation (10) is used as a basis for linear regressions for the fixed broadband as well as the mobile broadband demands. The results are shown in Table 2.

<table>
<thead>
<tr>
<th>Regression</th>
<th>Model</th>
<th>Coefficient (( \alpha ))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R²</td>
<td>Standard Error</td>
</tr>
<tr>
<td>Fixed Broadband</td>
<td>0.445</td>
<td>4.731</td>
</tr>
<tr>
<td>Wireless Broadband</td>
<td>0.240</td>
<td>3.068</td>
</tr>
</tbody>
</table>

Table 2: Logistic model regressions

The coefficients of determination (R²) in both cases are below 0.5 implying that the ratio of variance explained by the models to the overall variance of the demand for fixed and mobile broadband is well below 50% in both cases. The standard error values for the
models describe the average deviation of the predicted time values from the real values. The predicted year in the linear regression models (see equation (10)) on average deviates almost 5 years from the correct year in the regression for fixed broadband demand and about 3 years in the regression for mobile broadband. The test for an absence of a linear correlation between the \( \alpha \)-coefficients and the values for fixed as well as mobile broadband demand in both cases rejects this hypothesis. The significance values in the last column in Table 2 show that the null hypothesis is rejected with a certainty of well above 99% in both cases. By calculating the \( \beta \)s for fixed and mobile broadband from equation (8) and including them into equation (2), the broadband demands can be modeled based on the logistic function.

### 4.3. LVC model regressions

In order to determine whether interdependencies between fixed and mobile broadband significantly influence broadband demand, we apply the LVC model introduced in Section 3.3. We carried out nonlinear regressions with the equations (5) and (6).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Standard Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>1.519</td>
<td>.064</td>
<td>1.393</td>
<td>1.646</td>
</tr>
<tr>
<td>Beta</td>
<td>8.224E-9</td>
<td>1.472E-9</td>
<td>5.296E-9</td>
<td>1.115E-8</td>
</tr>
<tr>
<td>Gamma</td>
<td>3.061E-10</td>
<td>4.169E-10</td>
<td>-5.228E-10</td>
<td>1.135E-9</td>
</tr>
</tbody>
</table>

Table 3: LVC model regression for fixed broadband

For estimation we used the Levenberg-Marquardt method [29] with quadratic convergence and parameter convergence each set to 1E-10. For both equations (5 and 6) we carried out multiple regressions varying the start values in order to guarantee that global optima were calculated. Table 3 shows the results for the nonlinear regression of the fixed broadband demand.

The LVC model for fixed broadband has a good fit as \( R^2 \) has a value close to 1. The Alpha-parameter describes the potential unhindered growth with a growth rate of 51.9% each year. Beta and Gamma both take on positive values. In the case of Gamma, this signals a positive, yet small substitution effect: the growth of mobile broadband demand negatively influences the demand for fixed broadband. However, the 95% confidence interval shows, that this value is very close around zero.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Standard Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>1.514E-8</td>
<td>1.243E-9</td>
<td>1.267E-8</td>
<td>1.762E-8</td>
</tr>
<tr>
<td>Beta</td>
<td>-3.152E-8</td>
<td>1.988E-9</td>
<td>-3.548E-8</td>
<td>-2.757E-8</td>
</tr>
</tbody>
</table>

Table 4: LVC model regression for mobile broadband

Table 4 shows the results for the nonlinear regression of the mobile broadband demand. Again, the \( R^2 \) value signals a good model fit. Gamma takes on a negative value. This is ascertained by the fact, that the upper bound of gamma’s 95% confidence interval is negative as well.

In order to visually illustrate the goodness of fit of the LVC model, we exemplarily show the values forecasted with the LVC model in comparison to the real demand values for broadband demand in Japan in Figure 4. We chose Japan for illustration, because it has one of the highest mobile broadband penetration rates in the OECD region [1].

### 4.4. Interpretation

The LVC models, with regard to the results of the regressions, have a far better fit than the logistic models. This suggests that the demands for fixed and mobile broadband indeed do influence each other. Hence, ignoring this cross-influence significantly limits forecasting precision.

The LVC model also further characterizes the way, the demands influence each other. As explained in Section 3.3, one distinguishes different types of competitive relationships by the LVC model’s gamma values. The LVC model regressions narrow down the
possible types of competitive relationships to either a predator prey relationship or a commensalism relationship. In either case, mobile broadband demand benefits from a high demand for fixed broadband services. Hence, the majority of consumers does not view fixed broadband as a substitute for mobile broadband. This can be explained as follows. Consumers with a high demand for broadband services already subscribe to fixed broadband services. With the increasing capabilities of mobile broadband, they can use mobile broadband services to satisfy their demand for mobile connectivity. Whereas fixed broadband services only provide a stationary access, a mobile broadband service enables an uninterrupted mobile access and the consumption of location based services.

As the gamma value of the LVC model regression for fixed broadband access is negative, however close to zero, there is either a predator prey relationship or a commensalism relationship between fixed and mobile broadband. Substitution effects may be explained by the increasing capabilities of mobile broadband connections: as wireless coverage and realizable data rates improve, some consumers indeed may use wireless access as a substitute for fixed access in a stationary context. This result confirms the findings by Srinuwan et al [42], which find that mobile broadband is a substitute for fixed broadband in most geographic areas in Sweden. Our results show, however, that with regard to the entire OECD region, this substitution effect is rather small and can only be confirmed with a likelihood of less than 95%. This can be explained by the limited capabilities of present mobile broadband services with regard to data rate, availability and coverage.

A notable difference in the technological capabilities of fixed and mobile broadband most likely leads to a commensalism relationship for the majority of consumers. In such a constellation, the mobile broadband demand does not have an effect on the fixed broadband demand at all. Our results imply that only few consumers presently substitute a technologically superior fixed broadband service with a mobile broadband service.

From a regulation perspective, the results suggest that on the overall OECD region level, wireless broadband and fixed broadband do not belong to the same market at the moment. Our results, however, do not represent a substitute to classical analyses applied by regulators. It is furthermore possible, that the relationship type, comparable to the case of telephony [3], is subject to change over time. Therefore it is possible that mobile broadband will increase competition in the overall broadband market in the long run.

From a strategy perspective, the positive impact of fixed on mobile diffusion suggests that bundling can indeed create a super-additive value for some customer groups: many customers seem to get additional value out of a combined use of mobile and fixed broadband. Our results, however, do not specifically quantify the value created by offering these two services by one and the same broadband service provider. A single provider can, for example, reduce a customer’s administrative costs (due to a single provider interface) and enable integrated services (such as unified communication).

5. Conclusion

This paper was oriented towards analyzing the competitive effects between mobile and fixed broadband. The number of mobile broadband subscriptions in the OECD area is strongly increasing. With the increasing maturity and diffusion, usage effects are likely not to be limited to mobile broadband consumption but also affect fixed broadband. We used the Lotka Volterra competition model, known from ecology, to analyze these competitive effects in the OECD area. The results suggest that mobile broadband demand is stimulated by a high demand for fixed broadband services. Hence, consumers most often do not view fixed broadband as a substitute for mobile broadband but rather complement their fixed broadband access with a mobile access. Reverse effects, i.e. a positive or negative influence of mobile on fixed broadband diffusion, are not clearly identifiable to the present. The results imply that mobile broadband diffusion in the OECD region at the moment does not strongly affect competition in the fixed broadband market. With regard to competitive strategies, the results suggest that bundling fixed and mobile broadband can indeed provide super-additive customer value.

Many operators of fixed networks are presently considering heavy investments into the rollout of fiber-to-the-home infrastructures. There are large insecurities, whether such investments promise sufficient returns in the long term. Mobile broadband presently does not seem to represent a substitute for fixed broadband and endanger such investments. The degree of differentiation between mobile and fixed technologies in the long term depends on the capacity and quality differences between the technologies as well as on the availability and demand for bandwidth intensive communication services. The so called “4G” technologies for mobile communications, such as LTE advanced, are already capable of providing data rates of up to 1 Gbps. It is, however, hardly foreseeable to which degree and to which customer groups mobile
technologies will actually suffice for consuming the complete range of communication services required.

Our analyses, due to the limited data about mobile broadband diffusion at hand, do not take into account differences between regions or countries in the OECD region. Our results are therefore limited to the overall OECD level and do not allow implications on regional differences due to culture, income or broadband coverage. In accordance with Lee et al. [27] we find it likely that the high average income in the OECD countries is an important explanatory factor for access complementarity, the analysis of low-income countries may likely provide different findings.

In the future, the availability of richer data will allow deeper insights into these aspects and enable analyses like [46] for competitive effects between mobile and fixed broadband. The analyses furthermore focus on broadband demand and do not take into account factors which influence the competition between mobile and fixed broadband providers on the supply side such as organizational culture or market orientation [38].

In order to better understand the factors, which influence competitive effects between mobile and fixed broadband, in-depth causal analyses are required. Factors, which further need to be studied, include age, income, cellular density and data rates among others. Such information is particularly valuable for broadband access providers in the design of customer group oriented offerings.

References


[37] OECD, “OECD Statistics Portal”, http://www.oecd.org/statsportal/0,2639,en_2825_29356_4_1_1_1_1_1,00.html, 2012.


