

# The Impact of Regulatory Frameworks and Obligations on Telecommunication Market Developments

## Analysis of the European and Asian Broadband Markets and Regulatory Frameworks

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**Abstract**—Based on the rising numbers of broadband Internet users and the resulting higher importance of broadband infrastructures, previous analyses often focused on the relation between competitive market behavior and the development of customer broadband penetration rates. Additionally, some prognoses also consider the relation between the development of market concentration and customer prices. Taking into account the focus on both of these connections, the influence of competitive intensities, regulatory frameworks and the broadband development are rarely considered. Here, this paper will especially examine the interrelation between the development of market concentrations and regulatory frameworks on broadband access speeds and different customer prices and price models. Furthermore, impacts of the national regulatory frameworks are not considered in depth. Previous analyses have often examined the influence of regulatory behaviors and decisions on the development of market concentration. However, the impact of national regulatory frameworks on the other named factors is not considered in detail. Therefore, in this paper, we start addressing the named open issues. Due to the paper's status as a work in progress, it will mostly indicate some theoretical background, literature, methodology and some first results of the competitive analysis. Despite increasing competition (based on Hirschmann-Herfindahl values), approximately half of the considered fixed broadband markets still demonstrate huge discrepancies between the incumbent and competitive network operators.

**Keywords**-broadband development; market concentration; Hirschmann-Herfindahl-Index; broadband access speeds, prices and penetration.

### I. INTRODUCTION

As a result of the increasing use of Internet services within broadband Internet infrastructures in daily business and private life, the availability of these services is becoming increasingly important as a location factor [1][2].

In the world and particularly in the considered European and Asian broadband markets, different standards for the provision of broadband infrastructures subsist [3], which are responsible for the various broadband developments. On this account, in each regional/national market, different technical standards of broadband infrastructures, broadband penetrations, market situations and regulatory obligations in fixed-line telecommunication markets can be observed

[1][4]. These differences result by the following reasons: (a) customer broadband demand, (b) prices for broadband services, (c) quality and combination of technologies providing broadband infrastructures (availability of wires and ducts), (d) implementation costs, (e) competition policy, (f) competition, and (g) demography and culture [1][4][5].

Most publications on this topic focus on the analysis of the relationship between: (a) regulatory and governmental frameworks, (b) competition, (c) broadband diffusion and adoption, (d) coverage and (e) penetration [6][7]. Furthermore, various papers deal with considerations regarding (a) the relations between implementation costs and customer prices, (b) operators and different broadband infrastructures, and (c) demand and supply of broadband Internet services [8][9][10]. Yet, the development of broadband does not only depend on the customer adoption and diffusion of broadband infrastructures. Broadband developments include all services and benefits which are targeted to strengthen and process: (a) higher broadband coverage and penetration, (b) higher broadband connection speeds, (c) higher number of offered services, (d) a higher technical standard of the infrastructures, and (e) measures to create acceptable prices for customers and to induce customer broadband demand. The following relations have been rarely considered so far: (a) the influence of competition (market concentration) on the development of broadband access speeds, (b) the influence of competition on the development of customer prices for broadband services, (c) the impact of regulatory frameworks on the market concentrations in broadband networks, (d) the impact of regulatory frameworks on the development of broadband penetration rates, and (e) the influence of regulatory behavior on the customer prices. The regulatory frameworks are considered solely as drivers for the different kinds of competition and the impact of this competition on the development of broadband penetration rates. As mentioned, the other impacts are not considered.

This study will firstly examine the impact of market concentrations on the fixed-line broadband development. Based on this relationship, we will analyze the different types of regulatory frameworks and their influence on competition. In the further steps, we will focus on the influences of the aforementioned factors with the focus being on broadband access speeds. For the evaluation, we have collected secondary data of fixed-line broadband markets in Europe and Asia to conduct a combined cross-sectional and

longitudinal panel data analysis with ordinary least square regressions. The chosen time range of said data will include the years between 2004 and 2015 in order to reflect on the reasons for the different country-specific broadband developments, levels of competition/market concentration and regulatory behaviors over time. Apart from the different regression models, the intensity of competition will be – in a first step – measured through the usage of different economic concentration models. Following this approach, we will discuss how the regulatory frameworks can be examined.

The paper will proceed as follows: based on the introduction, Section 2 will present the literature review and the hypotheses. Section 3 will include the research methodology. Section 4 will indicate the first results of the examinations. After all, we will conclude the paper in Section 5.

## II. LITERATURE REVIEW

Due to the various influence factors described, broadband market conditions and issues of broadband provision, the term of broadband development includes: the development of coverage and penetration of the existing broadband infrastructures, the expansion/upgrade of new and old infrastructures, the changing customer prices for broadband services and the quality of the broadband networks (broadband connection speeds).

Based on liberalizations of the fixed-line broadband markets in developed and emerging countries, various network operators and service providers compete in the provision of broadband Internet accesses and services. In order to address potentially large customer base and to quickly get back the effected expenditures, the operators often focus on broadband developments in regions with high population densities and low implementation costs [9][11], which count as economic efficient areas [10]. This approach significantly reduces the incentives for investments, implementations and upgrades of the existing broadband infrastructures in rural regions with lower population density significantly.

However, in situations when competitors get access to the broadband infrastructure of the incumbent or when the competitors have their own broadband access infrastructure (cable or fiber), the customer prices for broadband services, the broadband diffusion and provision respectively are influenced. Especially in cases of providing access for new entrants and controlled prices, regulatory decisions and behaviors by the governmental authorities could possibly strongly influence the existing market situations.

The opening of existing broadband infrastructures creates an intense price competition, which strengthens the broadband adoption by customers [6][7].

In case of competitive situations in broadband markets, the prices for broadband services decrease and the broadband diffusion and provision increase strongly [6][7]. The competition of different network operators and service providers exert a positive influence on customer adoption of broadband access networks and can be named as one of the key drivers to reach high broadband penetration rates [7].

To sum up the previous findings [6][7], the first hypothesis will examine the relationship between broadband diffusion and the development of market concentrations.

*H1: A stronger competition (higher competitive intensity) leads to higher broadband penetration rates.*

The relationship between (1) competitive intensities and (2a) the development of broadband connection speeds and (2b) customer prices for broadband services has thus far not been considered in greater detail. As a result of the mentioned market conditions, one can assume that competition is a main driver for the development of broadband infrastructures and broadband services. It can be expected that a competitive broadband market structure leads to higher connection speeds, since competitors invest financial resources in new infrastructures and equipment in order to differentiate from existing market players and to get in a better market position in comparison to the incumbent.

*H2: Regional telecommunication markets with a higher level of broadband competition have higher broadband connection speeds.*

The hypothesis expects that more competition leads to faster broadband connection speeds, lower prices and higher penetration rates. If the hypothesis turns out to be true, it can be concluded that in broadband markets with higher concentrations usually strong monopolists and oligopolists try to hold and increase their market shares instead of investing into new infrastructures and push further broadband developments. In the past incumbents are often not forced to grant possible market entrants access to their broadband network. Based on the missing fear of a possible new market entry of a new competitor, the incumbent has no incentive to develop a new or better infrastructure.

Only if the monopolist fears a competitor's market entry or the incumbent is forced to grant the access for new market entrants, it will have an incentive to upgrade the current infrastructure in order to improve the quality of its broadband networks and services.

In addition to the first two described hypotheses, existing competitive intensities in broadband markets could positively impact customer prices for broadband services [8][9][12]. Price reductions influence individual market shares and market power compared to the competitors. In addition, the market entry is made more difficult by the fact that the (potential) new providers achieve lower sales with their end customers at constant costs for the use of the infrastructure of the incumbent [5]. Due to these circumstances, the following hypotheses H3 and H4 will investigate and capture the open issue: *Do customer prices have an impact on broadband developments in regional markets?* Currently, measurements of the relationship between competition, customer broadband prices and broadband penetration are not considering the achieved and the delivered broadband connection speeds [8].

In competitive market situations, competitors decrease their prices to reach a broader customer base. Therefore, the broadband adoption can be positively influenced and will

increase over time. This relationship turns out to be one of the driving indicators for broadband penetration [9]. But operators and providers in competitive market structures have to deal with the issue that enterprises lead a price competition based on the margin of cost coverage, which results in decreasing customer revenues. The influence of competition on customer revenues leads to problems if the network operators have difficulty to provide the financial resources for new investments in broadband infrastructures. Furthermore, companies try: (a) to differentiate their products and (b) to invest in the broadband infrastructure to get into a better market position than competitors [9]. In general, a weaker competition (higher market concentration) leads to higher customer broadband prices and lower investments in infrastructure [9].

Generally, it can be ascertained that prices for broadband services and the adoption of accesses are negatively related [6][13]. However, the prices also depend on the customer's willingness to pay and the demand for broadband services. Since customers are price sensitive, a declining price induces a higher willingness to adopt and use broadband access [9]. So far, researchers have only considered the influence of broadband prices on the development of penetration rates. However, there is currently no evidence regarding the relation between broadband prices and the development of broadband connection speeds.

*H3: A stronger competition leads to lower monthly customer prices for broadband access.*

*H4: Lower customer prices for broadband access lead to a faster development of broadband connection speeds.*

Following the introduction of the presented competitive considerations, the relationships of the regulatory frameworks on the development of (a) market concentrations, (b) customer prices, (c) penetration rates, and (d) broadband connection speeds need to be analyzed too.

Based on the vast range of governmental initiatives and regulatory instruments (e. g., implementation of market liberalization), it is normally intended that the competitive forces rule the market power and market shares on their own [14]-[17]. However, in some cases the market forces are not strong enough to regulate the market and regulatory authorities have to intervene [16]. On the base of different kinds of regulations (especially access regulations), Kiesewetter et al. [18], and Waverman and Koutroumpis [19] found out that regulations directly influence the market concentration in broadband markets. Regulations are able to force the incumbent to open the networks for competitors [20]. Therefore, the existing market structures and especially the market position of the incumbent can be influenced by the implementation of regulations. In this situation, the regulations shall remove burdens and constraints and may overcome the lack of competitive behavior [7][16][20]. A possible change of market structures allows new entrants to enter the market and take the risk of a foreclosure of the incumbent [20]. Hence, the acceleration of competition

should induce a stronger competition with a higher rate of broadband adoptions [6].

*H5: Regulatory behavior and mandatory access regulations will positively enhance competitive market behaviors.*

Supporting the previous explanations, Gruber and Koutroumpis [7], and Wallsten [21] mention the fact that the implementation of regulations (especially unbundling) stimulate higher broadband penetration rates. However, Briglauer and Gugler [5] found that only few regulatory decisions influence broadband penetration rates directly. Possibly, regulations can also negatively impact the development of broadband penetration rates [3].

*H6: Regulatory behavior and mandatory access regulations will positively relate to broadband penetration.*

Furthermore, regulatory authorities are able and allowed to set price regulations. Therefore, they have to check if the incumbent is trying to use his market power to set higher prices than a market with competitive structures. If the incumbent cannot force higher prices, the gained revenues, financial resources and the incentives for further broadband investments will decrease. Also, the new entrants are not willing to invest high amounts, because they cannot set higher prices as the incumbent to get customers [7][20]. On one hand, regulatory authorities have to verify whether the prices are based on the long incremental or opportunity costs [20]. This behavior could discourage possible investments in broadband infrastructures, because the companies do not gain high revenues. On the other hand, governmental authorities support the roll-outs of new infrastructures with different offers of funding [5]. Based on these explanations, we originate the following two hypotheses.

*H7: Regulatory behavior and mandatory access regulations will positively impact stronger broadband developments and higher broadband connection speeds.*

*H8: Regulatory behavior and mandatory access regulations will negatively relate to customer prices.*

### III. METHODOLOGY

As the previous explanations indicate, we will analyze relationships between broadband developments, the respective market concentrations and broadband market regulations in particularly Western European and Southeast Asian markets.

The focus lies on countries of the European Union 28 (EU28) and the Association of Southeast Asian Nations (ASEAN), as well as additional countries such as Switzerland, Japan and the Rep. of Korea. The reason why said regions of the world were selected are as follows: (1) EU28 and ASEAN are regions with (a) multiple countries, (b) a comparable number of inhabitants, and (c) national territories. (2) Like the EU28, the ASEAN system is also

developing to get in the position of a central commission for economic, social, regulatory and juridical resolutions.

For the cross-sectional and longitudinal panel data analysis of the described relationships, we have collected secondary data from: (a) the regulatory authorities of the considered countries, (b) the International Telecommunication Union (ITU), (c) the Organization for Economic Cooperation and Development (OECD), (d) the European Union, (e) telecommunication authorities and ministries, and (f) national institutions and governments. Due to the different sources, the elicitation of the data can vary. Therefore, we test the data validity and reliability with exploratory factor analysis and Cronbach's Alpha to verify the trust in the collected secondary data [22]-[24]. Nevertheless, some discrepancies between the collected data and the anticipated time trend of the data cannot be excluded. Due to few data errors and issues, some of the considered countries are not considered in detail.

The evaluation of the competitive intensities follows different concentration models, (Hirschmann-Herfindahl-Index (HHI), Linda-Index (LI)) which measure the intensity and disparity of the national broadband markets' competition and to compare the different operators' market shares [25]-[28].

The HHI, as one of the most popular models to evaluate market concentrations, will be used to measure the intensity of competition based on absolute key figures. The collected market shares illustrate the number of customers of each of the biggest three providers in relation to the total number of customers in the specific national broadband market [25][26]. The HHI describes the weighted average of concentration and squares the collected market shares (see (1),  $S_i$  describes the market share of each specific network operator,  $i$  describes the considered operator) [26]-[28].

$$HHI = \sum_{i=1}^m S_i^2 \times 10.000 = \sum_{i=1}^m (100 \times S_i)^2 (1)$$

The LI does not reach the same usage and awareness level but the results show how much the market varies from perfect competition (LI-value of 1). Generally, the LI is used to examine the disparity between the biggest and following companies. Therefore, the disparity measures an existence of market dominance and describes if the inequalities between the operators lead to significant changes in the competitive behavior [26]. The LI value is based on a two times calculation and presents a double average index (see (2) and (3), CR stands for the Concentration Ratio, which is the single sum of the market shares of the considered number of network operators,  $i$  describes the considered operator) [26],

which separates the enterprises with significant and insignificant impact on the market enterprises, where the quotient of the market shares reaches the maximum.

$$V_{i,m} = \frac{CR_i}{\frac{1}{CR_m - CR_i}} (2)$$

$$L_m = \frac{1}{m-1} \times \sum_{i=1}^{m-1} V_{i,m} (3)$$

Nevertheless, we may also use the Exponential-Index and Horvath-Index (a) to investigate the collected data with alternative concentration models, (b) to cover the results of the previous named concentration models, and (c) to establish some other possible interpretations of the data base.

Furthermore, we will only examine the developments in the fixed-line broadband markets. Analyses of the market concentration and competitive situation are based on the three largest network operators (according to customers). This is justified by the fact that: (a) there are only three network operators in some of the individual markets [29]; and (b) in markets with a larger number of network operators the influence of these other / smaller network operators is of secondary importance for the competition situation.

The longitudinal analysis, which spans a time range from 2004 to 2015, will also cover some cross-sectional elements to conduct comparisons between the various countries in consideration. The needed data is composed of the network operators' market shares, broadband penetration rates, customer prices and some basic economic facts like Gross Domestic Product (GDP), exchange rates, price parities, households and population density. The hypotheses will be analyzed and estimated using various econometric and panel data techniques. Generally, each hypothesis will be tested by an ordinary least square regression to figure out if the results are significantly able to present the named relationships. For each hypothesis, we define the following regression equations, which can be seen in Table 1. All stated equations will be calculated twice. In the first attempt, we test the regression equation assuming single/multiple linear relationships between the dependent and independent variables. In the second step, we analyze the collected data with logarithmic equation models. Both approaches will be utilized to get a broader understanding of the collected data and the possible relationships.

TABLE 1. REGRESSION EQUATIONS

<p>H1: a) <math>PE_t = \alpha + \beta_1 CI_t + \beta_2 SF_t + \beta_3 PD_t + \epsilon</math>                  b) <math>TPE_t = \alpha + \beta_1 TCI_t + \beta_2 SF_{t-1} + \beta_3 PD_t + \epsilon</math>                  c) <math>PE_{t+1} = \alpha + \beta_1 CI_t + \beta_2 SF_t + \beta_3 PD_t + \epsilon</math></p>	<p>PE – value of the broadband penetration                  TPE – trend based value of the broadband penetration                  CI – values of the competition index (HHI, LI etc.)                  TCI – trend based values of the competition index                  SF – monthly subscription fee                  PD – population density                  BS – broadband connection speeds                  IF – installation fee                  GDPC – Gross Domestic Product per Capita                  RI – regulatory index                  DM – years of membership in EU28 or ASEAN                  B – changing variable term  <math>\epsilon</math> – error term  <math>\alpha</math> – constant                  t – year of consideration                  t-1 – past year of consideration</p>
<p>H2: a) <math>BS_t = \alpha + \beta_1 CI_t + \beta_2 PE_t + \epsilon</math>                  b) <math>BS_t = \alpha + \beta_1 TCI_t + \beta_2 PE_{t-1} + \epsilon</math>                  c) <math>BS_t = \alpha + \beta_1 CI_{t-1} + \beta_2 PE_{t-1} + \epsilon</math></p>	
<p>H3: a) <math>SF_t = \alpha + \beta_1 CI_t + \beta_2 GDPC_t + \beta_3 IF_t + \epsilon</math>                  b) <math>SF_t = \alpha + \beta_1 TCI_t + \beta_2 GDPC_{t-1} + \beta_3 IF_t + \epsilon</math>                  c) <math>SF_t = \alpha + \beta_1 CI_{t-1} + \beta_2 GDPC_{t-1} + \beta_3 IF_t + \epsilon</math></p>	
<p>H4: a) <math>BS_t = \alpha + \beta_1 SF_t + \beta_2 GDPC_t + \epsilon</math>                  b) <math>BS_t = \alpha + \beta_1 SF_t + \beta_2 IF_t + \epsilon</math>                  c) <math>BS_t = \alpha + \beta_1 SF_{t-1} + \beta_2 GDPC_{t-1} + \epsilon</math></p>	
<p>H5: a) <math>CI_t = \alpha + \beta_1 RI_t + \beta_2 GDPC_t + \beta_3 DM_t + \epsilon</math>                  b) <math>CI_{t-1} = \alpha + \beta_1 RI_{t-1} + \beta_2 GDPC_{t-1} + \epsilon</math>                  c) <math>TCI_t = \alpha + \beta_1 RI_t + \beta_2 GDPC_t + \beta_3 DM_t + \epsilon</math></p>	
<p>H6: a) <math>PE_t = \alpha + \beta_1 RI_t + \beta_2 DM_t + \epsilon</math>                  b) <math>TPE_t = \alpha + \beta_1 RI_t + \beta_2 DM_t + \epsilon</math>                  c) <math>PE_{t+1} = \alpha + \beta_1 RI_t + \beta_2 DM_t + \epsilon</math></p>	
<p>H7: a) <math>BS_t = \alpha + \beta_1 RI_t + \beta_2 DM_t + \epsilon</math>                  b) <math>BS_t = \alpha + \beta_1 RI_{t-1} + \beta_2 DM_t + \epsilon</math></p>	
<p>H8: a) <math>SF_t = \alpha + \beta_1 RI_t + \beta_2 GDPC_t + \beta_3 IF_t + \epsilon</math>                  b) <math>SF_t = \alpha + \beta_1 RI_t + \beta_2 GDPC_{t-1} + \beta_3 IF_t + \epsilon</math>                  c) <math>SF_t = \alpha + \beta_1 RI_{t-1} + \beta_2 GDPC_{t-1} + \beta_3 IF_t + \epsilon</math></p>	

IV. FIRST RESULTS

In order to analyze the relationship between competition, broadband connection speeds, customer broadband penetration rates and prices, the intensity of competition (HHI) and the disparity (LI) between the market players will be examined.

For the analysis of the broadband market concentrations, the considered values of the HHI will be separated into the three parts: (1) HHI below the value of 2,000 (low concentration), (2) HHI between the values of 2,000 and 4,000 (moderate concentration), and (3) HHI above the value of 4,000 (high concentration), based on [25]-[28].

Ideally, the fixed-line broadband markets should have stable HHI market concentration values which do not exceed 1,800 over time.

Apart from Japan (divided consideration of NTT East and West), all European countries with low HHI-values below 2,000 are European countries situated in the continent's Northern or Eastern parts (Lithuania, Denmark, Sweden, UK) (see Figure 1, 3, and 4). These countries are also in the Global top ten of highest average broadband connection speeds [30]-[34].

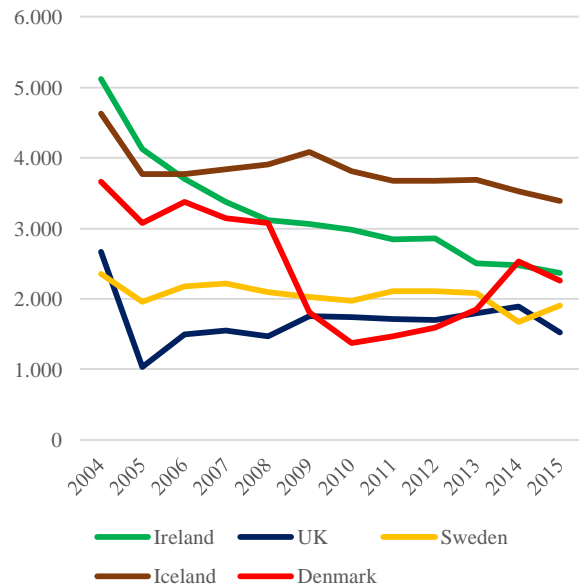


Figure 1. Market concentration of the three biggest fixed broadband network providers in Northern Europe from 2004 to 2015 (x-axis: years; y-axis: HHI values)

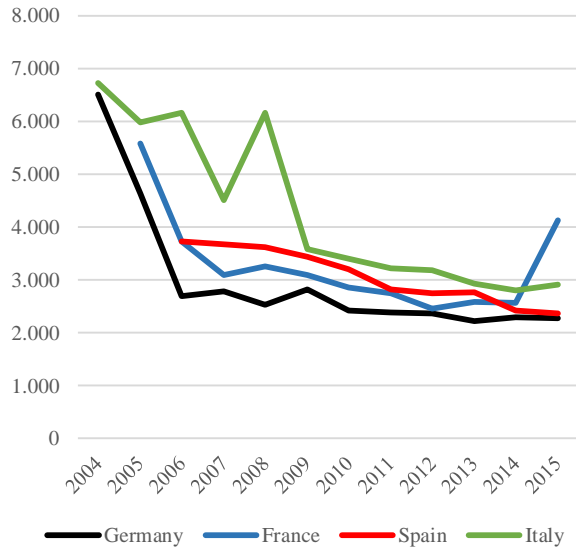


Figure 2. Market concentration of the three biggest fixed broadband network providers in the biggest four Western European countries (except UK) from 2004 to 2015 (x-axis: years; y-axis: HHI values)

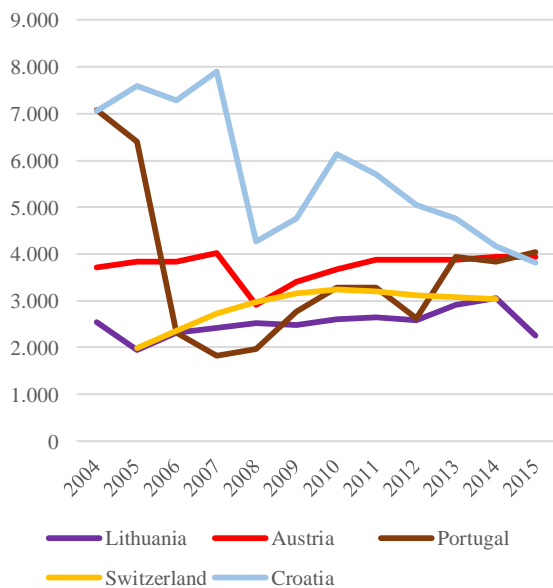


Figure 3. Market concentration of the three biggest fixed broadband network providers of further European countries from 2004 to 2015 (x-axis: years; y-axis: HHI values)

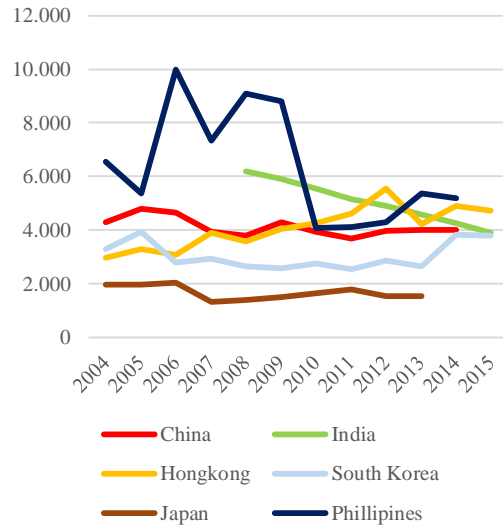


Figure 4. Market concentration of the three biggest fixed broadband network providers of Asian countries from 2004 to 2015 (x-axis: years; y-axis: HHI values)

In general, most fixed-line broadband markets of the EU28 and ASEAN now reach HHI-values between 2,000 and 4,000 and are moderately concentrated. When considering the named period, it can be concluded that market concentrations in most countries have decreased from HHI-values above 4,000 (high concentrated) to moderate concentrated market structures. This development presents diminished market forces and the change of strong monopolistic into rising competitive market structures. Generally, the considered broadband markets are moderately concentrated (e. g., Ireland, Germany, Portugal, South Korea) (see Figure 1, 2, 3, 4). Nevertheless, some countries (Croatia, Iceland, India, Philippines) still have HHI-values above 4,000, which implies that the biggest operators were able to hold their market powers and avoid strong competitive structures (see Figure 1, 3, 4).

Generally, the moderate or high market concentrations in the broadband markets suggest that national regulatory authorities should review the current market behaviors of the existing network operators. To create better competitive and network access opportunities, regulatory authorities could introduce access regulations, which secure possible market entries by competitors.

Nevertheless, two different developments can be mainly comprehended. (1) During the last ten years, the intensity of competition in the most considered broadband markets increased and the previous monopolistic structures could be diminished. (2) In the developed countries, the reduction of the power of the monopolistic incumbent is stronger than in the developing countries and the developed countries also have stronger competitive broadband market structures.

The used Linda-Index describes the disparity between the biggest three operators. In general, higher market concentrations translate into higher disparities between the operators. The disparity can be measured in two different ways. On one hand, the LI examines the discrepancy between

the biggest and second biggest companies in the market and on the other hand, the LI can evaluate the discrepancy between the biggest, the second biggest and third biggest companies in the considered market. Based on the evaluation of the three biggest operators in the broadband markets, we will consider the second option with the inclusion of the second and third biggest companies.

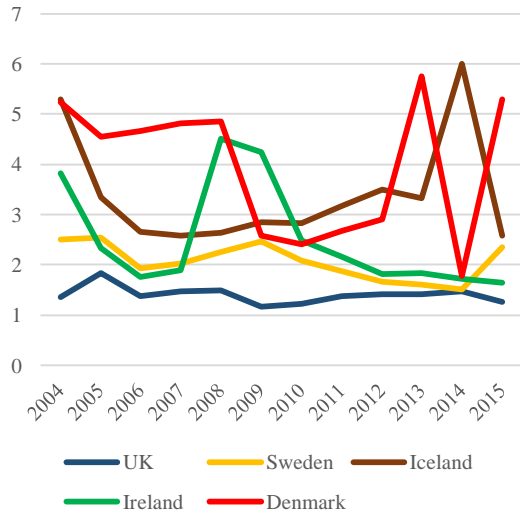


Figure 5. Market concentration of the three biggest fixed broadband network providers in Northern Europe from 2004 to 2015 (x-axis: years; y-axis: LI values)

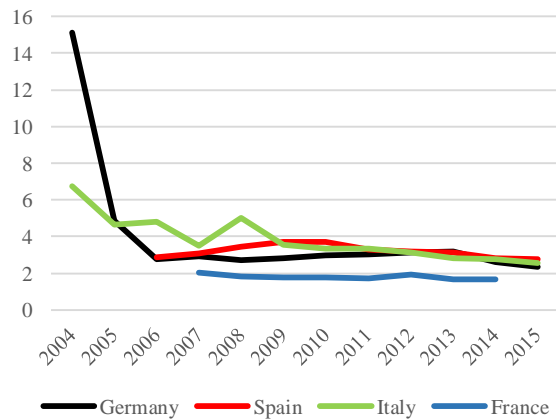


Figure 6. Market concentration of the three biggest fixed broadband network providers in the biggest four Western European countries (except UK) from 2004 to 2015 (x-axis: years; y-axis: LI values)

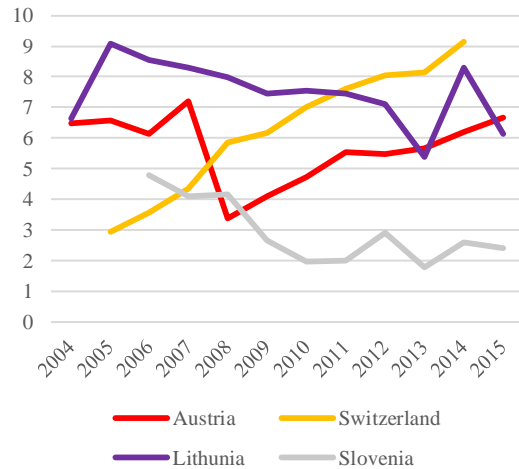


Figure 7. Market concentration of the three biggest fixed broadband network providers of further European countries from 2004 to 2015 (x-axis: years; y-axis: LI values)

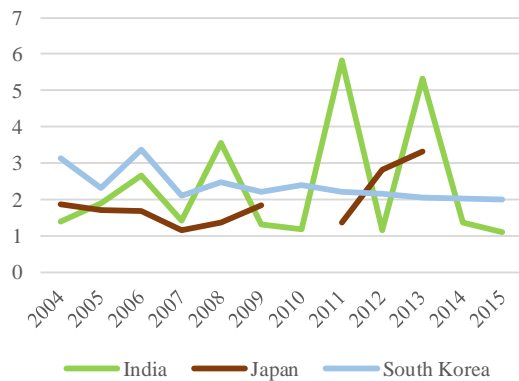


Figure 8. Market concentration of the three biggest fixed broadband network providers of Asian countries from 2004 to 2015 (x-axis: years; y-axis: LI values)

The consideration of the European and Asian fixed-line broadband markets yields LI-values between 2 and 5 for the most countries (see Figures 5, 6, and 8), which indicates that discrepancies between the operators still exist. Nevertheless, the declining trend of the LI-values shows that in most countries the differences between the incumbents and the new market entrants decrease (e. g., Germany, Italy, Slovenia, see Figures 6 and 7). In the future, these broadband markets could reach a nearly equal distributed market power. However, the results also show that the disparities between the network operators in some markets increase (e. g., Austria, Switzerland, see Figure 7). Only in the British market the LI-value is close to 1 and indicates a nearly equal distributed broadband market (between the different market operators) (see Figure 5). Combining this result with the fact that the British market has the oldest history of liberalization, it can be concluded that longer open access market could lead to more equally distributed market shares. This issue needs verification by hypothesis testing and we will include this in

their evaluations. Furthermore, a couple of countries show nearly the same LI-values over the whole-time frame (e. g., France, South Korea, see Figure 6 and 8). The reasons why, on one hand, the disparities are very stable and, on the other hand, they vary, will be investigated in the future.

The variations between European and Asian markets are quite low, but nonetheless the LI-values of a couple of countries present higher values. Therefore, network operators in these countries should compensate more inequalities as far as possible. These discrepancies are not sufficiently to draw conclusions from since the results of the LI-values also vary too strongly among network operators in a couple of countries. In general, the disparity (difference in market power and influence) between the incumbent and the competitors cannot be taken as reason for the different broadband connection speeds and developments. It can be just estimated that a more equal distribution of market power could lead to higher broadband connection speeds.

In the beginning of the regression analyses, the evaluation of the correlations shows that the calculated market concentrations correlate significantly ( $p$ -values below 0.05) with the development of the broadband connection speeds. The result supports the assumption that a stronger competition could lead to higher broadband connection speeds.

In addition, the same significant correlations between broadband penetration rates and market concentrations exist ( $p$ -values below 0.05). The correlations imply that higher competitive intensities and stronger competitive behaviors lead to rising broadband penetration rates.

Due to the correlative relations, it is necessary to prove if a regressive context between the mentioned factors exists.

## V. CONCLUSIONS AND FUTURE WORK

As aforementioned, the status of the paper is a work in progress and therefore, improvements in the results and in ongoing research will be necessary. Currently, we have collected the needed secondary data and have started to analyze the competitive intensities. Following this first overview, we will evaluate the above-mentioned hypotheses using the ordinary least square regressions to test the established regression equations. Additionally, we will measure the different regulatory behaviors of the considered countries and to be able to examine the named relationships in the regression equations.

Despite the named conditions and the different developments in the national broadband markets, the general trend presents increasing competitive structures in the fixed broadband markets. Combining the results of the HHI and LI analysis, the incumbents in each national broadband market have lost market shares and the disparity between the different providers is decreasing. As shown in the results, few countries (especially in Asia) still have very powerful incumbents and a general statement concerning all considered countries cannot be done at this status of work.

At this time in evaluation work, the results are on a preliminary stage, which will be a starting point for the ongoing research.

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