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Implications of the regulation in the implantation process of next generation networks in Spain: analysis in rural versus urban regions

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Abstract
A regulatory regime is dynamic and adapts to all aspects of market evolution: infrastructure development, service catalogue, delivery conditions, market shares of operators and opportunities provided by technology. The present article analyses implications of the regulation of next generation networks (NGN) in two well-differentiated areas in Spain: rural versus urban. Regulation will be applied to fixed networks and broadband Internet access services provided with them, and, within fixed networks, those that have come into existence as a result of access network technologies based on fiber optics. The results can serve as a reference for obtaining a better overview and reaching conclusions regarding what has been a global action over the current period in time for the electronic communications market within the European Union. The conclusions speak of a successful model because objectives to date (2017) are being reached, except for the purely economic aspect of return on investments. A long-term time frame is expected to be in place until 2023. With regard to the future, regulation must continue to address issues that were not issues initially, but which have become fundamental and have begun to be addressed: geographical discrimination, fiber loop unbundling, new wholesale prices resulting from adapting reference offers, and greater control of retail services. As a case of study, this article discusses what is happening in the province of Soria, where there are large uninhabited areas with a high percentage of the territory where the broadband infrastructure is very limited. This situation is opposed in the urban areas where the deployment of new NGN is moving forward quickly.

Keywords Regulation · NGN · Broadband access · FTTH · Rural · Urban · Spain

1 Introduction

In the case of Spain, the origin of the imperfection of the telecommunications market stems from the fact that it initially was a formal monopoly market controlled by the State. The participants in a regulated market are suppliers and users. Both have to see their interests protected, and benefit from regulation. Benefits sought are very diverse and depend on the participant's perspective: deployment of resources, investments harmonized with economic returns, diversity of

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products and services, wholesale and retail prices, quality of services, use of public and private resources, and many more.

Regulation by the government is carried out through the creation of ad-hoc bodies and by means of enforcement of laws and competition law. In the case of Spain, the law arises from the directives of the EU (European Union) and European competition law, which seeks to harmonize markets at all levels of the Union. The impact of market opening on infrastructure investments is a critical ingredient for regulatory reviews [27].

The Spanish free-market did not promote competition on equal terms due to the dominant position of incumbent operators of basic services, huge investments required in the transport network, access network and customer equipment, and difficulties in network deployment, generated by administrations and by owners of infrastructures and buildings. In addition, the spectrum of services (voice services, internet access, network applications, television content) did not justify the differential in residential customer prices for the vast majority of users.

During the last decades, the main constraint on the expansion of broadband networks was the huge economic cost involved. Regulation was one of the strategies used to increase broadband adoption in countries that had difficulty encouraging infrastructure competition [30]. They were only used for long distance connections, for which low attenuation was the determining factor. In the meantime, these costs have been significantly reduced due to improvements in manufacturing processes. As a result of its high performance and cheapness of manufacturing, operators have chosen optical fiber as the solution with which to meet the demands of users.

The Next Generation Network (NGN) or Next Generation Access Network (NGAN) in fixed networks must coexist alongside HFC-based infrastructures, progressively phase out copper-based Old Generation Networks (OGNs), and remove all barriers with respect to broadband access. These types of access will be able to support a bandwidth of more than 300 Mbps and a wide range of new services in need of Internet, while at the same time providing all the traditional services of telephony and data via narrow band transmission.

Nowadays the European community is making significant economic investments to enable broadband connection to homes. Towards this goal, the majority of South-Eastern European governments have proceeded in the establishment of independent Regulatory Authorities [35]. The Spanish government created the Telecommunications Market Commission (CMT), as momentum towards liberation of the sector was beginning. In 2013 the CMT became part of the Spanish National Commission on Markets and Competition (CNMC). The purpose of the CNMC is to establish and monitor specific obligations to be fulfilled by operators in telecommunications markets. Furthermore, it promotes competition by taking the necessary measures to safeguard plurality of services offered, user access to electronic communications, and interconnection of networks and their operation in open network conditions. It monitors the price policy of services and their marketing. It defines necessary wholesale and retail markets and establishes specific obligations for each one. Finally, it advises operators, the government and public administrations on telecommunications and its market in order to prevent, among other things, the "digital divide" or differences that may arise between different population groups or among different companies with regard to access to electronic communications networks and services. In that sense, the analysis of the regulatory principles dictated by the CNMC and of application in the telecommunications market from December 2014 onwards are vital [4–22].

For this reason, regulation is based on the definition of specific markets within the telecommunications sector. It will also depend on how much control is exercised on which aspects, which may or may not be counterproductive, as discussed in Choi et al. [3]. Regulators focus on the scope of wholesale and retail services. In addition to the study of relevant markets, the CNMC creates reports, resolves conflicts and participates in the development of the telecommunications sector in Spain. It also reports on the situation of the telecommunications market in Spain by publishing all data relating to development and degree of competition in the sector.

The regulatory regime is dynamic and adapts to the evolution of the market in all its aspects: infrastructure development, service catalogue, operating conditions, market shares of operators and opportunities provided by technology. In addition, studies and obligations in different markets have a starting point and are updated, when required by the situation, as the regulator sees fit. The new regulation has a significant impact on the deployment of NGN–FTTH networks [24]. The latest milestones in relation to the regulatory framework of NGNs in Spain are explained below.

On November 17, 2016, the CNMC published a Resolution in which it was agreed to notify the European Commission, Body of European Regulators for Electronic Communications (BEREC), the Ministry of Energy, Tourism and Digital Agenda and the Ministry of Economy, Industry and Competition about the project. This pertains to measures concerning definition and analysis of the retail market for access to the public telephone network in a fixed location—market 1/2007—and the wholesale market for access and calls originating on fixed networks—market 2/2007 [17].

This publication especially benefits Spanish homes that subscribe to unbundled fixed telephony service. In this proposal, on the one hand, the CNMC analyses the relationships between users and their operators when contracting fixed telephone lines (retail market). On the other hand, the con-

sultation focuses on the relationships among the different operators with regard to fixed telephony service in the wholesale market.

On January 17, 2017, the CNMC published a Resolution on the definition and analysis of the retail market for access to the public telephone network in a fixed location—market 1/2007—and the wholesale market for access and calls originating on fixed networks—Market 2/2007. It was agreed to notify the European Commission and the Body of European Regulators of Electronic Communications of this [18].

On February 23, 2017, the CNMC published a Resolution on the modification of management systems of the Leased Lines Reference Offer (LLRO) by Telefónica de España, S.A.U. [19].

Subsequently, on March 23, 2017, the CNMC published a Resolution approving the price revision of the leased line offer from Telefónica de España, S.A.U. It was agreed to notify the European Commission and the Agency of European Regulators for Electronic Communications (BEREC) [20].

On June 1, 2017, the US Federal Telecommunications Commission took the first step towards changing the principles of network neutrality, by proposing tighter regulation of operators by classifying the Internet as a basic service. This may affect Europe and lead to a new update of the guidelines to further strengthen net neutrality in Spain. Network neutrality and enforcement are enforced by the Ministry of Energy, Tourism and Digital Agenda [33].

García-Paramio et al. [26] showed the effects of the regulation of NGNs in Spain during the key period 2007–2015. This article will analyse the implications of the existing regulation on the implantation of NGNs in rural and urban areas in Spain, taking into account previous work up until today. The main contribution is to show how the existing regulation has influenced the implementation of broadband access in Spanish municipalities and cities depending on their population size. It will reflect that in municipalities with fewer inhabitants coverage rates are significantly disadvantageous compared to municipalities of more than 5000 inhabitants and cities. In addition, the case of a specific region where population density is among the lowest in Spain will be shown.

The next issues to be discussed in this article are the methodology used to carry out this research project, and results obtained (NGNs in Spain, a case study in a rural region of Spain and a comparison between rural and urban areas). The article will conclude with a broad discussion of the research, and conclusions of interest.

To summarize, the main contribution of this paper is to have demonstrated that:

- It is necessary to reform procedures to facilitate achievement of results in a shorter time span.
- Constant conflicts among operators generate great delays in the work of the regulator, given the slowness with which these conflicts are settled.
- The new regulation allows greater competitiveness in market shares.
- There is a significant digital divide within Spain regarding NGN–FTTH networks, although it is gradually decreasing as infrastructure is deployed and CNMC regulation is applied.
- The evolution of market shares per operator for broadband access in service is highly influenced by the speed at which incoming operators deploy, availability of wholesale reference offers and socio-economic and geographical conditions.
- There are large geographical differences among areas in which there are several operators with networks and infrastructures and those in which there is only the network of the incumbent.

2 Methodology

Initially, the scientific databases Web of Science, Google Scholar and Science Direct were used. The searches were conducted until May 2017. The combination of words used to search for publications were as follows: "impact of broadband on growth", "broadband policy in the economy", "NGN" AND "telecommunication" AND "Spain" OR "Spanish" and "FTTH" AND "Spain" OR "Spanish". The results were limited to the last 4 years.

Next, the search for information was reoriented and an exhaustive search was made for all aspects related to the deployment in Spain of the NGN networks of the different technologies that are currently active in the telecommunications networks of the different operators. For this, a search for material from official websites of government agencies was done [23,34]. These results were also limited to the last 4 years. The information was mainly culled from the following three links: www.minetad.gob.es/, www.cnmc.es/, www.ec.europa.eu/digital-single-market/en/news/digital-economy-and-society-index-desi-2017/. Then, the regulatory information contained in the CNMC databases on NGN–FTTH networks was extracted. The main sources were www.cnmc.es and www.blog.cnmc.es [4–22]. The results of these three steps can be seen in Fig. 1.

The fourth step was to interview current Spanish operator technicians regarding the deployment of technologies in Spain. Two interviews were conducted with two technicians, who presented their point of view. The process of writing and analyzing different points followed. For this purpose, all the material presented in the bibliography, installation manuals of different operators and a multitude of technical forums

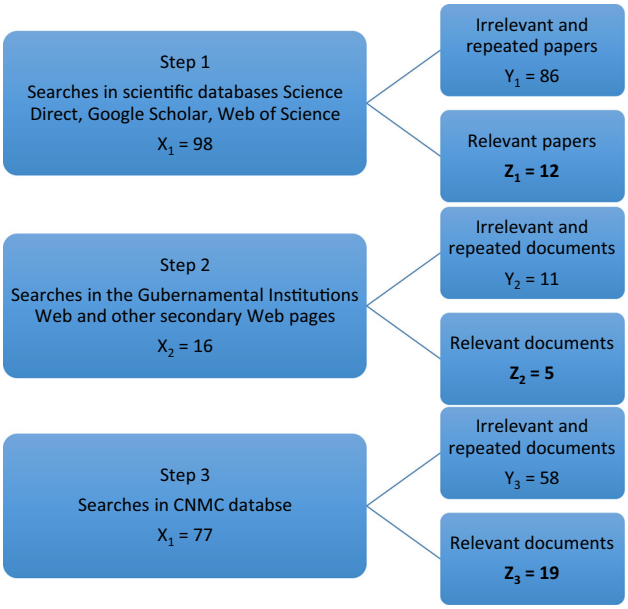

Fig. 1 Search strategy for the analysis

dealing with issues related to network technology installed in Spain were incorporated.

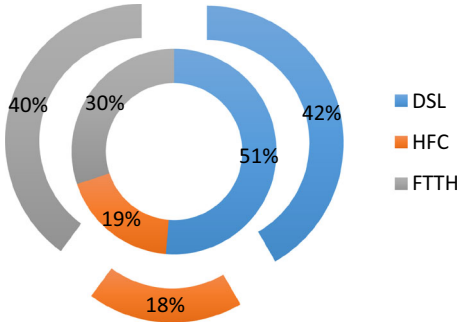

Fig. 2 Technology deployment quota. Source CNMC, 2017. See [22]

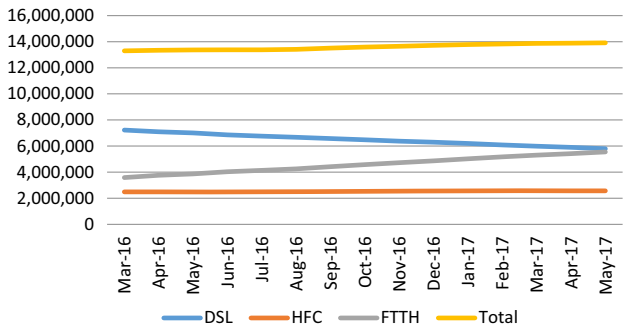

Fig. 3 Evolution of fixed broadband lines for each technology. Source CNMC, 2017. See [22]

3 Results

This section deals with the evolution of NGNs in Spain, with updated data from the article published by García-Paramio et al. [26].

3.1 Evolution of NGNs in Spain

Coverage by means of Next Generation Access Networks (NGANs) has continued to grow in 2017 and has reached 81% of households. NGANs are spreading in rural areas, covering 27% of households.

In Spain, most of the coverage for broadband Internet access is provided by DSL technology, although in recent years there has been a massive advance in the deployment of FTTH. However, in rural areas access is mainly provided by DSL technology since the deployment of FTTH technology is still very low in areas with towns of fewer than 10,000 inhabitants.

As shown in Fig. 2, subscriptions in June 2016 were 51% DSL, 19% hybrid fiber-coaxial (HFC) and 30% FTTH-based technologies. But due to the deployment of the latter, this distribution changed as of May 2017 and household subscriptions were distributed as follows: 42% DSL solutions, 18% HFC technologies and 40% FTTH technology.

The important progress of the FTTH access solutions in Spain has overridden gradually other wired access technologies. Accordingly, the number of subscribers (increased in the last year) generate a favorable ratio for the FTTH solution versus the other wired options. In Spain all the telecomm operators are taking a chance on the FTTH technology, and the other wired solutions are decreasing their market share.

The graph below is an evolution of fixed broadband lines for each technology until May 2017, which shows that there are currently 13,916,040 lines of all types of technologies. DSL technology covers 5,800,128 lines, followed by FTTH technology with 5,551,859 and HFC cable technology with 2,564,053 lines (see Fig. 3).

Figure 3 shows the loss of 1.2 million DSL lines in the last 12 months due to the closure of power plants using this technology. FTTH technology, on the other hand, increased by 48% over the same period of time.

In Spain, fixed coverage (Fiber to the Premises-FTTP) rose overall to 62.8% in 2016, while it remains below 10% in rural areas, meaning that these services are mainly available in urban areas.

Fixed broadband is available for 98% of households in Spain, but only 71% were subscribed to fixed broadband in 2016. Growth has been slowing in recent years due in part to the switch from fixed to mobile telephony. Furthermore, fixed broadband subscriptions vary, depending on the area in Spain: In 2016, 72% of all households had a fixed subscrip-

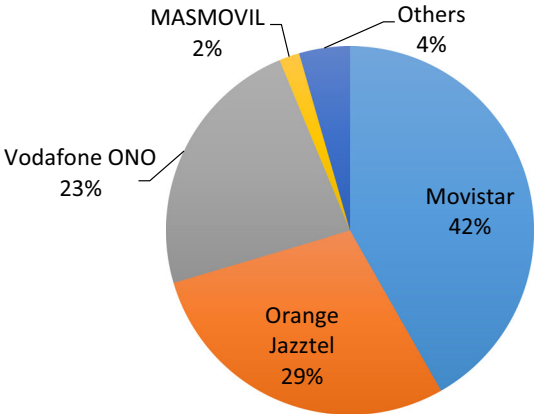

Fig. 4 Market share by operators. Source CNMC, 2017. See [22]

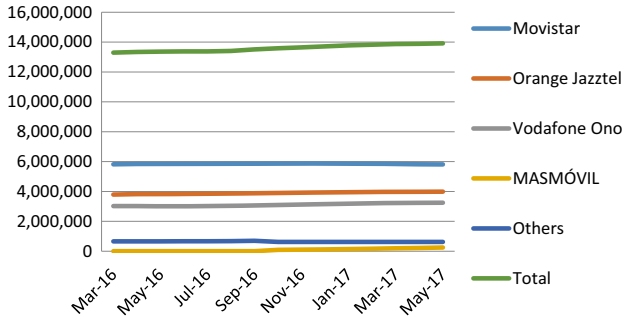

Fig. 5 Evolution of fixed broadband lines per operator. Source CNMC, 2017. See [22]

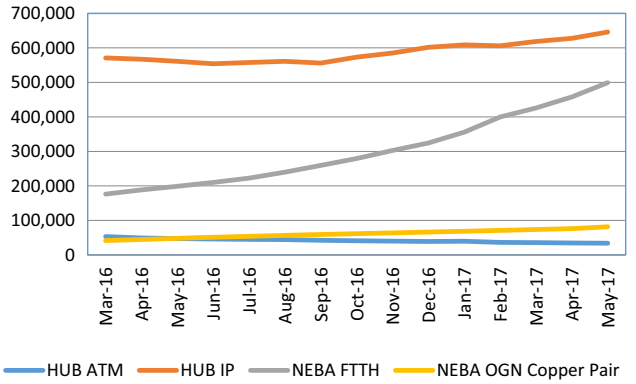

Fig. 6 Evolution of fixed broadband lines for each wholesaler. Source CNMC, 2017. See [22]

tion, whereas 62% of rural households had a fixed broadband subscription.

Due to improvements in technologies with regard to their infrastructure deployment, there has been a significant increase in the number of subscriptions to fast broadband access of at least 30 Mbps. Nowadays 35% of all households in Spain have fast broadband access.

15% of Spanish households currently use ultrafast broadband (speed greater than or equal to 100 Mbps).

The average connection speed in Spanish households is 14.5 Mbps, which is slightly above the European average. This average speed is due to the expansion of FTTH technology and the decrease of DSL-based access.

Currently, new operators are gradually gaining a market share in fixed broadband Internet access, although the incumbent operator (Telefónica and its Movistar brand) still controls 41.75% of fixed broadband lines.

Figure 4 shows the market share of each fixed broadband operator. The exact market shares are: Movistar with 41,75%, Orange–Jazztel 28,65%, Vodafone-ONO 23,32%, MASMÓVIL (last entrant) 1,78%. The remaining small operators have a market share of 4.45%.

All these data have been retrieved using the information provided by the CNMC (institution affiliated to the Ministerio de Economía y Competitividad). CNMC has its own legal entity and public and private full ability. This commission is the guarantor of the telecomm operators data collection, and ensure the effective competition in the telecomm market. In our investigation we can access to this information as the most trusted.

By May 2017, approximately 14 million fixed network lines had been deployed in Spain taking into account all types of technologies, as seen in the evolution of fixed broadband lines per operator (Fig. 5). In first place, Movistar had 5,811,045 lines, followed by Orange–Jazztel with 3,987,360, Vodafone-ONO with 3,245,566, MASMÓVIL with 249,820 and the remaining smaller operators with 622,249 lines.

For the provision of wholesale fixed broadband service, the number of lines using indirect access (bitstream) increased by 63,418 in May 2017. The wholesale NEBA service, which the incumbent operator lends to entrants in places where they do not have their own network, added 46,159 new lines, bringing it to 580,560 lines in total. The rest of the indirect access services (ATM HUB and IP HUB) added 17,259 new lines (see Fig. 6).

3.2 Case study in rural Spain

The framework is used to draw comparisons between urban and rural environments and in so doing allowing the appreciation of differences in the development and expectations for the future of telecommunications markets in the rural region of Soria (Spain).

Soria is a province of northern Spain, located in the eastern part of the autonomous community of Castile–León. It is the least populated Spanish province, with a density of 8.95 inhabitants/km^2, which is also one of the lowest in the European Union. The population of the province is 90,040 inhabitants (INE-Spanish National Statistics Institute-2016), of which 43.8% (39,171) live in the capital, Soria [28].

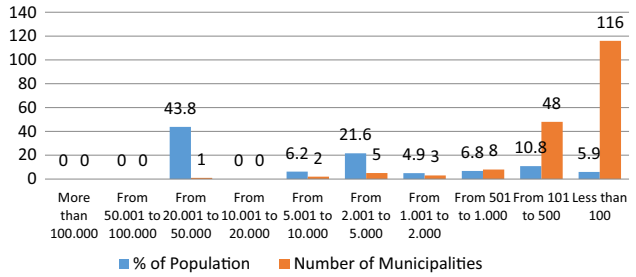

Fig. 7 Percentage of population and number of municipalities by population size. Source INE, 2016. See [28]

Figure 7 shows the percentage of population living in each type of municipality by size. In other words, it shows how the inhabitants are distributed throughout the municipalities of the province and, in addition, the number of municipalities by size.

It is noticeable that there is a great concentration of inhabitants in the capital of the province. The province contains more than 500 towns, grouped into 183 municipalities, of which about half are villages with less than 100 inhabitants. Only eleven have more than 1000 inhabitants and only Almazán, El Burgo de Osma-Ciudad de Osma, and Soria exceed 5000 inhabitants.

The current problem in many towns is not inadequate quality of mobile telephony, fixed lines and access to the Internet, but a lack of these services. The current state of telecommunications in the province of Soria is as follows: in 28 towns there is no coverage by any operator (representing 5.6% of all towns); in 16 there is 'poor coverage' by one operator; 25 with 'poor coverage' by two operators; 30 with 'poor coverage' by three operators; 31 with 'average coverage' by one operator; 75 with 'average coverage' by two operators; 132 with 'average coverage' by three operators; 50 with 'good coverage' by one operator; 49 with 'good coverage' by two operators; and 52 with 'good coverage' by three operators [36].

This indicates that a high percentage of the population, but not the territory, is covered. The problem is that the province of Soria is largely made up of rural areas with low population, and agricultural and livestock farms where there is no Internet. And when considering Mack's study [32], in which he estimates econometric models to examine the links between broadband speed and businesses, it can be observed that his models indicate that broadband speed is more important for agricultural and rural businesses. This should serve as a spur to the development of policies that reduce the time to improve broadband infrastructure in rural areas.

Next, a specific locality is analysed: San Esteban de Gormaz, a municipality made up of 19 towns, with approximately 3000 inhabitants.

The main town is also called San Esteban de Gormaz. The services offered in homes are DSL up to 20 Mbps, VDSL up to 30 Mbps, and 3G and 4G services with good coverage that can reach up to 10 Mbps in speed.

Towns near the main town only benefit from DSL technology if they are relatively close to the main hub. Even then, these homes can only be supplied with access at a speed of 3 Mbps.

In summary, the main town of San Esteban de Gormaz, with around 2500 inhabitants, has access to ADSL and VDSL technologies up to 30 Mbps, and 3G and 4G mobile networks coverage of 80%. In contrast, in villages close to the main town, inhabitants only have access to ADSL technology up to 3 Mbps and mobile network technologies up to 10 Mbps. The latter is only true if network coverage is good.

3.3 Comparison of rural versus urban Spain

This section includes a comparative analysis of broadband coverage in rural and urban areas by technology and speed. For this study the criterion of population density will used. The term *rural municipality* means one whose population density is less than 100 inhabitants/km^2. The INE in 2016, lists a total of 8117 municipalities, of which 6682 are rural.

Figure 8 provides a comparison of total coverage (%) at country level and coverage (%) relative to rural areas for different NGN technologies in Spain.

Coverage based on HFC networks reaches a total average of 48.8% in Spain, but in rural areas it is only 10.6%. This technology offers major expansion possibilities in urban or semi-urban municipalities of up to 20,000 inhabitants. In rural areas, coverage is very low or zero. FTTH coverage reaches a total average of 62.8% at country level, but in rural areas it stagnates at 9.7%. This technology, until now, has been built up in urban areas with large numbers of inhabitants. In rural areas, however, there has been no effective push towards deployment except in a few specific areas.

Networks based on HFC and FTTH technologies are very poorly developed in rural areas due to their high expansion costs, leading to a very large digital divide, which is still present nowadays. This magnifies the economic and social

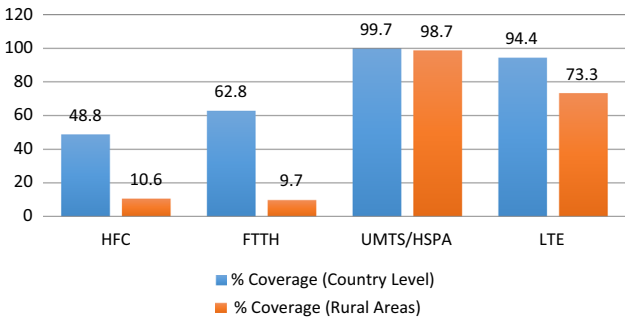

Fig. 8 Average coverage for different technologies in Spain. Source Ministry of Energy, Tourism and Digital Agenda, 2016. See [34]

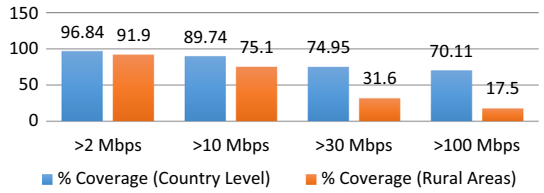

Fig. 9 Comparison of coverage by speed in different areas. Source Ministry of Energy, Tourism and Digital Agenda, 2016. See [34]

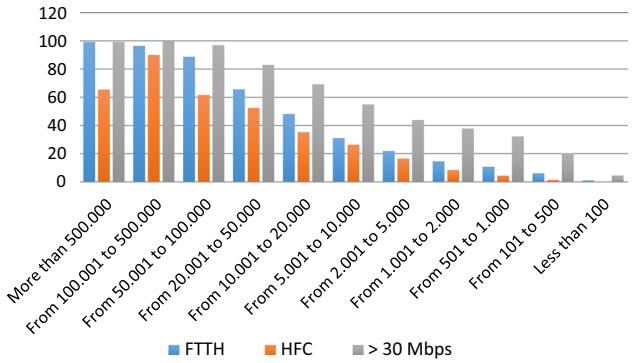

Fig. 10 Coverage of services by municipality size for HFC and FTTH technologies. Source Ministry of Energy, Tourism and Digital Agenda, 2016. See [34]

impact on towns that the absence or limited expansion of networks supporting broadband access has. There is a significant positive causal link especially when a critical mass of infrastructure is present [25,29,31].

In order to combat this problem, a massive expansion of mobile network coverage has been carried out by Spanish operators in the last two years, which can be clearly seen in Fig. 8 (UMTS / HSPA technology and LTE technology). In this way, it is possible to offer broadband Internet access services in rural areas, in which there was previously no network. Noticeable is that the coverage of LTE technology already reaches 73.3% of rural municipalities.

Figure 9 provides a comparison between total coverage at country level and of rural areas for different connection speeds.

For speeds greater than 30 Mbps, there is a large digital divide between urban and rural areas. The reason clearly lies in the limited expansion of HFC and FTTH networks, due to their high cost.

Next, coverage of different NGN technologies in Spain will be illustrated, with respect to size of municipalities and average Internet access speed offered for each of the municipality sizes.

Figure 10 shows a comparison of coverage (%) of HFC and FTTH based services, as well as fixed broadband Internet access service with a speed higher than 30 Mbps, by municipality size.

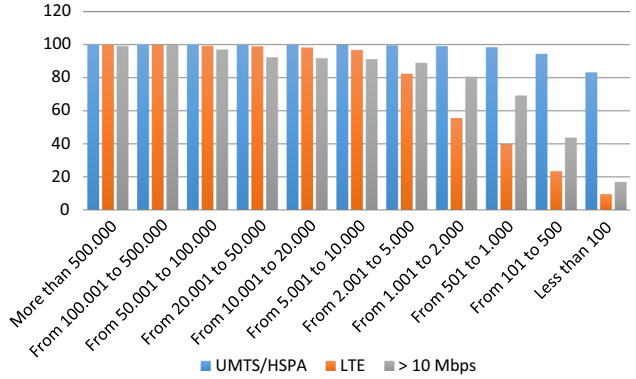

Fig. 11 Service coverage by town size for UMTS with HSPA and LTE. Fuente Ministry of Energy, Tourism and Digital Agenda, 2016. See [34]

FTTH technology in NGNs is implemented in large and very large populations. This is common in the vast majority of developed countries [1]. In Spain, the two largest cities, Madrid and Barcelona, have implemented this technology 100%. Operators are currently implementing FTTH technology in smaller towns. Figure 10 shows that the smaller the town, the smaller the coverage is. Operators have made a commitment to the government to implement FTTH based networks in all municipalities with more than 1000 inhabitants. Thus the trend will be towards greater coverage, in technologies and speeds, in all sizes of municipalities except those smaller than 1000 inhabitants.

The performance for a speed greater than 30 Mbps is similar to that of the NGNs, although it will always be equal or superior since this speed can be offered over networks of copper twisted pair OGN using VDSL solutions.

Figure 11 shows a comparison of coverage (%) of mobile network services by municipality size and coverage (%) of mobile broadband access services (speed greater than 10 Mbps) using UMTS / HSPA and/or LTE technologies.

In general terms, Fig. 11 shows that UMTS/HSPA technology is implemented almost 100% in municipalities with 1000 or more inhabitants. For smaller municipalities it decreases, though not substantially.

The coverage of mobile networks with LTE technology is practically 100% for municipalities with 5000 inhabitants or more. But as a municipality ranking grows lower, coverage decreases significantly.

For this type of technology, the most common mobile broadband Internet access speed is approximately 10 Mbps. It is observed that speed coverage is very high when it is offered by UMTS/HSPA and LTE solutions, but decreases drastically for LTE coverage. UMTS technology does not have the same features. Deployment of LTE technology in towns with a low number of inhabitants (less than 5000) will arrive relatively quickly, which will reduce the digital divide in mobile broadband Internet access currently existing among municipalities based on their size (urban vs. rural).

4 Discussion

Following the analysis carried out, and considering the positive evolution of the digital divide, some aspects can potentially be improved in the regulatory model applied in Spain. The Resolution of these aspects would have a very positive impact on the development of the telecommunications market in Spain. They are as follows:

The administrative and legal system for the protection of rights is too complex and protective. This makes the regulatory processes too slow for combining European legislation, Spanish law and administrative procedures in both areas of competence.

The complexity of the administrative and competency structure in Spain is another important barrier to speedily achieving the objectives set by the Spanish regulator and the EU. It is necessary to reform procedures and assign competencies aligned within this field to facilitate achievement of results in a shorter time span.

Constant conflicts among operators, mainly between the incumbent and the others, generate great delays in the work of the regulator, given the slowness with which these conflicts are settled.

Within the regulatory process cited in this paper (October 2015–June 2017), the effects of regulation caused a number of changes in the NGN–FTTH access networks.

The Resolution adopted on 24 February 2016 relating to wholesale and retail broadband regulation in EU-defined markets 3a, 3b and 4 has had a very positive influence on deployment momentum and general activity of incoming operators with respect to the implementation of new NGNs and their associated fixed network services.

However, the incumbent operator is slowing the deployment of new NGNs in sparsely-populated areas, as a result of the obligations set out in the Resolution, which force it to grant incoming operators access to its NGN–FTTH infrastructure in certain non-competitive areas, among other things. The new Resolutions adopted during this period, such as revisions to the reference offers MARCO, OBA, OIR, NEBA and the launch of the NEBA local reference offer, encourage greater deployment of NGN–FTTH networks by incoming operators as they create a situation in which using incumbent infrastructures may be less enticing than deploying their own NGN–FTTH network. This is especially true when competitive zones are to be extended and the regulator releases the incumbent operator from obligations related to them. Even so, this does not demonstrate that the incentives are sufficient. They might be in intermediate-sized areas and municipalities, but may not be so in small towns.

The new regulation, under the aforementioned Resolution, allows greater competitiveness in market shares, where little by little the incumbent operator is losing ground to incoming operators. But there are two other aspects that should not be forgotten: competition in infrastructure, and prices. Regulation regarding retail (end users) of this Resolution is greatly favoured because incoming operators can offer their broadband services at a competitive price in all areas (competitive and non-competitive) and to almost all municipalities.

With reference to NGN coverage (fixed and mobile), HFC networks make up 48.8%, FTTH based networks 62.8%, UMTS networks 99.7% and 4G-LTE networks 94.4%. NGN–FTTH network coverage is concentrated in large municipalities (more than 20,000 inhabitants). The speed offered to homes and users is closely linked to the type of technology deployed. Therefore, there is always greater access speed in areas with large municipalities.

As already mentioned, FTTH networks in Spain reach 62.8% of the country/national territory, but only 9.7% of rural areas. Access speeds greater than or equal to 30 Mbps amount to 74.95% coverage in urban areas and 31.6% in rural areas. For a rate of 100 Mbps, coverage is provided to 70.11% of households in urban areas, while in rural areas coverage reaches only 17.5%.

There is a significant digital divide within Spain regarding NGN–FTTH networks, although it is gradually decreasing as infrastructure is deployed and CNMC regulation is applied.

Spain has set itself the goal of reaching 50% of households with subscription and access to ultrafast broadband (speed over 100 Mbps) by 2020. Currently, 70.11% of all households already enjoy such services (in rural areas only 17.5%). With regard to access to fast broadband (speed over 30 Mbps), 75% of Spanish households already have coverage.

Penetration of broadband Internet access, number of NGN access points installed and coverage are all in line with the objectives initially set by the regulator. In December 2016 there were 42,181,269 NGN access points installed, with an annual growth rate of 25.9%. The NGN access points at which some type of service is provided (connections that are already active) reached 8,184,359, 31.2% more than a year ago [26].

NGN access points installed by operators are distributed as follows: incumbent operator 42.67% (17,980,888 access points), Vodafone-ONO 25.9% (10,935,914 access points), Orange–Jazztel 22.7% % (9,610,043 access points), MASMOVIL 2% (867,938 access points) and the rest of the operators (Euskaltel and other regional and niche operators) 6.53% (2,786,486 access points) [26]. In May 2017, five months later, these installed access quotas were 41.75% for the incumbent operator, 28.65% for Orange–Jazztel, 23.32% for Vodafone-ONO, 1.78% for MASMOVIL and the remaining operators 4.45%.

The objective in terms of number of houses/housing units with NGN access coverage has been met. Massive deployment planned until 2017 is taking place in towns of more than 10,000 inhabitants.

A different question is which operators are deploying and what is happening in towns of less than 10,000 inhabitants. It is clear that there is a need to strengthen regulation for these geographical locations by boosting investment and involving public authorities. Given the growth rate of coverage, the objective of having three NGN infrastructures in Madrid and Barcelona, two in cities between 10,000 and 1,000,000 inhabitants and one or two for the smaller cities will have been reached before 2023.

The approval of the regulation of wholesale broadband markets has caused the incumbent operator to slow down the deployment of its NGN–FTTH networks in towns of fewer than 5000 inhabitants, the justification sometimes being that they are suffering a severe intrusive regulatory intervention [2].

The evolution of market shares per operator for broadband access in service is highly influenced by the speed at which incoming operators deploy, availability of wholesale reference offers and socio-economic and geographical conditions. Global market shares for Spain have evolved corresponding to objectives. Thus, the redistribution of market shares is being achieved with respect to marked objectives. The next objective will be to achieve those same market shares in locations with the lowest population and in environments with a lower socio-cultural or economic level.

The distribution of new broadband Internet access subscriptions based on NGN–FTTH networks is 40% for the incumbent operator and 60% for the remaining operators. With the passing of time along with the current regulatory framework, Spain's monopolistic market philosophy is fading. There is a need for investment by operators in all geographic areas and support from the government.

5 Conclusion

There is a clear need in Spain to promote a competitive telecommunications market with regard to the deployment of NGNs, and more specifically, FTTH technology, as well as the promotion of broadband Internet access. This fact becomes evident after considering the importance the development of an information society has as a fundamental pillar for the socio-economic take off of our country. In short, while the deployment of new NGNs and their associated services is taking place, and as long as there are areas where the incumbent's network is the only one available, the regulator seeks to encourage competitiveness among operators at service and price level since competitiveness in infrastructures is not yet a reality.

Finally, in order to characterize services in the retail market it should be mentioned that there are large geographical differences among areas in which there are several operators with networks and infrastructures and those in which there is only the network of the incumbent. In the former the competitive situation is better among the different groups generated by socio-economic and cultural factors.

Thus, the contribution of this paper is to have demonstrated that the digital divide exists. It depends on the economic interest of the operators in developing infrastructures according to the size of the town. If we want the economy to improve in rural environments as well as the quality of people's lives, appropriate policies and funding initiatives designed to improve the quality of broadband infrastructure in rural areas must be implemented.

In the near future we are planning to get in touch with the appropriate public institutions and telecomm operators from a significant UE country. Using this way we will be able to collect information about this matter in order to make a deep comparison between its situation and the Spanish environment.

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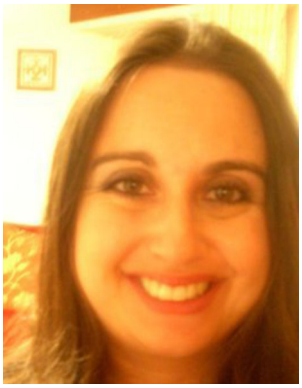

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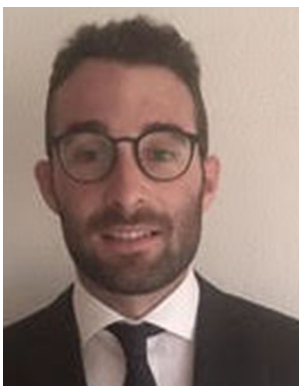

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