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Geographic regulation of next generation broadband networks: A review of practical cases and recent literature

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**Geographic regulation of next generation broadband networks:
A review of practical cases and recent literature**

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Abstract

Alternative telecommunications operators have continuously invested in their own infrastructure in recent years. After more than a decade since liberalization, competitive conditions have substantially changed, especially in urban areas. European regulatory authorities have acknowledged this development by starting regional deregulation. Additionally, different forms of cooperative investments in next generation broadband have appeared on the market. This article reviews the theoretical and empirical literature on geographic regulation as well as practical cases. Based on this review it is suggested that regulators consider geographically segmented access prices to set optimal incentives for the investment in next generation broadband infrastructure.

Keywords: next generation access, co-investment, geographic regulation

Geographic regulation of next generation broadband networks:

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The continuous investment of alternative operators in telecommunications infrastructure in the years after liberalization has led to increasingly differing competitive conditions across geographic areas. This is particularly the case in those network segments where alternative operators have invested; in national and regional backbone segments and also increasingly in local access directly connecting households in urban areas with next generation broadband. The latter investment may be seen as particularly valuable as high-speed broadband has substantial positive spill-overs for the whole economy. Bourreau, Cambini and Hoernig (2012a) review relevant literature and estimates. Given that the regulators' main objective is to ensure competition, uncertainty arises about whether a nationally uniform regulatory approach remains valid or whether some form of regional deregulation would be warranted. Positive spill-overs from investment for the economy may reinforce this uncertainty. In Europe deregulation in dense, more competitive areas has accordingly increasingly been undertaken. The regulatory options a regulator has to implement regional deregulation may range from regional full deregulation to access only obligations or different forms of price regulation. The different instruments will be reviewed in chapter 2 as well as their effects on competition, investment and welfare.

Both, geographic regulation as well as co-investments, take place in a context of migration from legacy to next generation access (NGA) networks. It is useful to analyse this context in this introduction as it affects all subsequent analysis.

Traditional copper networks will be only progressively substituted by next generation infrastructure, and the regulation of both legacy and next generation infrastructure may affect this process and, in particular, investment incentives. Bourreau et al. (2012a) review the literature on migration. Most importantly, Bourreau, Cambini and Doğan (2012) find that regulated legacy access charges may affect investment in NGA in different ways. While an increase in the regulated access price to the new network in all cases increases investments, the effects of access prices associated with the legacy network are less clear. The authors show that with a high legacy network access charge

- the entrants' opportunity cost of investment is low, increasing its investment incentives (replacement effect);
- the incumbent risks to lose important wholesale profits from an investment (wholesale revenue effect)¹; and
- pressure on retail prices for legacy network based services is low. When the access price is low instead, as long as next generation services are seen as substitutes, the overall profitability of the investment is reduced (business migration effect).

Overall, it is therefore unclear whether a relatively high legacy network access charge can increase investments in next generation broadband or not. A high legacy access charge increases investment incentives of the entrant and sometimes those of the incumbent, potentially increasing dynamic efficiency, while negatively affecting static efficiency. The welfare maximising access prices a regulator should set in case of regulation of the legacy network are then shown to depend on the market environment and in particular on the amount of investment spill-overs (with high spill-overs the regulator would set a high access charge to counterbalance the negative effect it has on investments of the incumbent). Finally, when setting both copper and fibre access prices, these effects interact. Whenever a legacy network is present in the models reviewed, such migration issues are considered in some way. Most papers that will be analysed in this survey assume, however, given regulated marginal cost access to the copper network for all operators, implying absence of rent from this infrastructure, minimizing distortions.

Chapter 2 describes geographic regulation approaches, reviews regulatory principles and practices in Europe as well as the theoretical and empirical literature on the subject. Chapter 3 concludes discussing the major issues raised in the paper and open questions.

2. Geographical segmentation of regulation

The cost of rolling-out fixed access infrastructure is typically related to population density which in turn varies strongly across areas. Such geographic differences in investment

¹ it is also assumed that an entrant can more easily roll-out its own network infrastructure once the incumbent has deployed it (investment spill-over).

costs may lead to geographically different market structures such as a higher number of entrants in urban areas. Increasingly competitive conditions in different geographic areas start to differ within European countries. As effective competition is the main objective of telecoms regulation, there is an ongoing debate about whether full or partial deregulation of geographic areas under increased competition is socially optimal. Since the liberalization of the telecommunications market alternative operators are investing in their own network infrastructure. This is especially the case with the roll-out of next generation access infrastructure, as explained in the European Commission Recommendation on regulated access to next generation access networks (European Commission, 2010a)². Consequently, the coverage of regional alternative networks as well as their number has increased over time. Authors such as Cave (2008) argue that this must trigger a geographically differentiated regulation³.

While it is always difficult to draw direct inferences on the effects of regulation from the market outcome, it is useful to describe some fundamental market characteristics at this stage.

Download speeds via the legacy network (xDSL⁴) vary significantly across Europe (Figure 1). While the average legacy network speed in Europe in 2012 was 7.23 megabit per second (around 35 megabit per second (mbps) for Cable and 37 megabit per second for fibre to the home (FTTH)), speeds in Denmark were on average 11 megabit per second while those in the Slovak Republic were only 3 megabit per second⁵. The major cause of slow DSL speeds is insufficiently upgraded backhaul networks and long access lines. While on aggregate Europe scores well when compared to the US⁶, other sources show that comparisons with countries such as South Korea or Japan are less favourable (Akamai, 2012). While this may also be a consequence of different population densities or customer preferences it can also be the result of

² The 2010 NGA recommendation states for these cases that “where the incumbent deploys fibre to the home (FTTH), NRAs should in principle mandate unbundled access to the fibre loop. Any exception could be justified only in geographic areas where the presence of several alternative infrastructures, such as FTTH networks and/or cable, in combination with competitive access offers is likely to result in effective competition on the downstream level”.

³ In particular Cave proposes to distinguish three areas (“potentially competitive”, “probably monopolistic but where NGA investment can be commercially justified” and “noncommercial”) regulated by principles of forbearance, mandatory access to dominant NGA and mandatory access to one or more collectively dominant NGAs respectively.

⁴ xDSL describes all digital subscriber line based technologies such as ISDN, ADSL or VDSL. These are copper-based.

⁵ Industry average speeds are not calculated for Europe

⁶ Actual download speeds in the U.S. are 5.3 Mbps for xDSL, 17 Mbps for Cable and 30 Mbps for fibre to the home

lacking investment incentives in high-speed access networks generated by access regulation and in particular geographic regulation (and co-investments) or its absence.

It will be shown that pioneering regulatory authorities regarding geographic regulation include Austria, Portugal and the UK. From the aggregate data these countries do not seem to have a particularly high or low performing broadband infrastructure when compared to other European countries. It should, however, be noted that such geographic deregulation efforts are relatively recent and concern only strongly limited areas. Any impact on infrastructure investment at national level may therefore still be limited.

It may be interesting to point out that overall broadband access prices do not seem to be higher in countries with higher xDSL performance on the market. Van Dijk (2012) shows for instance that at speeds between 12 and 30 megabits per second prices in Italy and Ireland, where few infrastructure investments in xDSL seem to have taken place are also higher (around 43€ and 45€ per month⁷) than in Denmark and Finland (29 and 35€ per month) for the median offer. This also holds when comparing the least expensive offers in Italy in Ireland (around 26€ and 29€ per month) with Denmark and Finland (around 24€ and 25€ per month). The same is true for lower speeds at 2-4 Mbps⁸. When comparing national population densities the picture is not coherent. For instance Finland has a very low national population density (44 inhabitants per square mile) and Italy a very high density (512), while Denmark and Ireland have an intermediate density (333 and 153). This suggests that it may be insufficient to compare nationally aggregate market outcomes. For instance population density in Helsinki is not lower than in other capitals.

Until recently only few disaggregated data was available. The increasing adaption of regulation to geographic market conditions and the will to support investments locally has, however, led to a recent increase of monitoring. For instance, Point Topic is now mapping progress with next generation investments in EU members states and regions (30 mbps or above) for the European Commission. Figure 2 shows corresponding next generation access coverage in urban and rural areas. Overall coverage seems to be highest in relatively dense countries such as the Netherlands, Switzerland and Belgium. At the same time these countries have historically strong cable competitors. In addition, next generation network coverage in rural areas is in all

⁷ In €/PPP (VAT incl.), see p.116 and p.84

⁸ There is no data in this category for Italy though.

(large) countries significantly lower. This digital divide seems, however, still to be stronger in countries without a historical cable competitor.

The following sections will describe the regulatory principles at EU level guiding regulatory action in this field and regulatory practices implementing geographical segmentation of regulation. In a subsequent section the academic literature is reviewed.

2.1. Regulatory principles in the European Union

Geographical market analysis has always been a part of the European regulatory framework. It states that even if demand and supply-side substitution patterns may suggest a national market, sub-national markets can be defined when competitive conditions differ to a sufficient extent (e.g. urban and rural)⁹. This approach will be referred to as *geographical segmentation of markets*. In this case it is possible that the absence of significant market power of a firm or firms in a geographic sub-market can be demonstrated. In such cases, the regional market would then not be subject to any kind of asymmetric regulation anymore (full deregulation). Moreover, lighter remedies can be imposed in sub-areas with stronger competitive constraints, even though significant market power is found. This approach will be referred to generically as *geographical segmentation of remedies*. While it will be shown that the high flexibility with remedies implies that regarding the regulatory outcome this difference may not be of fundamental importance, the regulatory processes which lead to one or the other are – in Europe – fundamentally different. Finally, the aggregate of both approaches will be referred to as geographical segmentation of regulation or *geographic regulation*.

A series of national regulatory interventions regarding geographical segmentation of markets and remedies have been notified to the European Commission since 2008. While the European Commission currently has veto power on member states decisions on market analysis issues (i.e. in this context the definition of geographic markets), this is to date not the case with remedies (i.e. in this context the geographical differentiation of remedies).

⁹ European Commission (2002), recital 56: “*the relevant geographic market comprises an area in which the undertakings concerned are involved in the supply and demand of the relevant products or services, in which area the conditions of competition are similar or sufficiently homogeneous and which can be distinguished from neighboring areas in which the prevailing conditions of competition are appreciably different. The definition of the geographic market does not require the conditions of competition between traders or providers of services to be perfectly homogeneous. It is sufficient that they are similar or sufficiently homogeneous, and accordingly, only those areas in which the conditions of competition are ‘heterogeneous’ may not be considered to constitute a uniform market.*”

The Body of European Regulators for Electronic Communications Common Position on Geographic Aspects of Market Analysis (BEREC, 2014) acknowledges the described market developments and sees an increasing importance of geographically differentiated regulation in Europe. The document aims at giving European NRAs guidance on geographic regulation¹⁰ and follows an earlier Common Position of 2008. The 2008 Common Position document states that NRAs should consider making a detailed geographical market analyses when some key indicators are present:

- One or several alternative operators have significant but less than national coverage and exert a significant competitive constraint at the retail level in the areas where they are present.
- The incumbent operator differentiates retail prices geographically or is setting a national uniform retail price but there are significant price differences between the incumbent operator and alternative operators, where the latter is present.
- There are significant geographic differences in product characteristics.

The telecommunications sector consists of complex markets and technical products. For a detailed description of the markets and next generation access products analysed in the upcoming sections the reader may refer to BEREC (2010a). In recent years operators have been increasingly climbing the ladder of investment, able to replicate for instance wholesale broadband access (wholesale broadband access) products based on local loop unbundling (LLU). Also, in several countries independent alternative operator technologies (cable, fibre to the node (FTTx), mobile broadband) are expanding rapidly, allowing for the provision of similar services. Provided that the described technologies are found to be retail product substitutes, indicators have to be analysed hinting to regionally different competitive wholesale conditions. The Common Position states that the most likely candidates for segmentation are the wholesale broadband access and

¹⁰ A similar document has been produced at OECD level (OECD, 2012).

leased line markets. Another likely candidate would be the market for physical access to the end customer¹¹ (essentially LLU).

BEREC (2013) distinguishes two types of countries. Firstly, countries - especially in Western Europe - where competition is mainly driven by LLU-based market entry and only partially by alternative infrastructures such as cable (*scenario 1*). Secondly, countries - especially in Eastern Europe - where competition is mainly driven by alternative infrastructures such as cable (*scenario 2*). Romania is an interesting example, as in the broadband retail market intense competition of the incumbent with cable operators is taking place. In 2013, cable operators hold a higher retail market share than the incumbent. In addition, there are regions where even two cable operators are present. The reason for this situation may be that the incumbent was slow to enter the broadband market, and when it did, it did not enter aggressively (i.a. because it has to offer uniform national retail prices while cable operators are only present in urban areas). An additional reason may be that regulation on the incumbent was introduced only recently meaning that LLU-based competition was less aggressive than in other countries¹².

In case a geographical segmentation of the market is indicated the Common Position suggests choosing adequate geographic units. Generally, there are two approaches: political/administrative boundaries or a network approach based on the topology of the incumbent operator. In any case, the Common Position states that the units should satisfy the following four conditions:¹³

- Geographical units should be mutually exclusive and less than national.
- The network structure of all relevant operators and the services sold on the market can be mapped onto the geographical units.
- Geographic units have clear and stable boundaries.

¹¹ Under the so called “modified Greenfield approach” regulation on the market under examination is disregarded, but regulation on other (upstream) markets is treated as exogenous. I.e. an analysis of the competitiveness of the wholesale broadband access market will consider LLU regulation to remain in place.

¹² Informa (2011)

¹³ BEREC Common Position, p. 21.

- Geographic units are small enough for competitive conditions to be unlikely to vary significantly within the unit but at the same time large enough that the burden on operators and NRAs with regard to data delivery and analysis is reasonable¹⁴.

Homogeneously competitive areas should then be aggregated from the chosen geographic units.

Homogeneity is judged essentially using the following criteria:¹⁵

- the barriers to entry in the market,
- the number of operators that exert a relevant competitive constraint on the SMP operator,
- the market shares of the SMP operator and the alternative operators, and
- price differences
- other aspects that may derive from relevant competitive differences between the geographical areas (e.g. marketing strategies, commercial offers and functionalities of the offers, nature of demand, etc.).

Typically geographic areas in scenario 1 could be defined as the areas covered by unbundled main distribution frames (e.g. wholesale broadband access regulation in the UK; UK/2010/1123 in Table 1a)¹⁶. Depending on the extent of alternative parallel networks the segmentation could also be made based on the alternative networks' topology or administrative geographic areas. In scenario 2, such areas could be based on administrative geographic areas, for example communes (e.g. Polish wholesale broadband access regulation case; PL/2011/1184 in Table 1a) or municipalities (e.g. Czech wholesale broadband access regulation case; CZ/2012/1322 in Table 1b). In addition, where a vertically-integrated cable operator is present, the competitive effects on the wholesale market need to be considered only to the extent that they are relevant¹⁷.

¹⁴ As noted in the Common Position, if the choice of a geographic unit that is too small may lead to a very significant number of units (even in the thousands). While the aggregation of geographic areas may contribute to solve part of the administrative burden derived from this fact, it is nevertheless a factor that may have to be weighted carefully by the NRA before deciding on the appropriate geographic unit.

¹⁵ BEREC Common Position, p. 25.

¹⁶ in practice at the local exchange facility

¹⁷ Whether technologies are retail substitutes and whether they can indirectly constrain the wholesale market under consideration in case no wholesale product is offered (e.g. Cable) needs to be analysed in detail. See also BEREC report on self-supply, BEREC (2010b).

In practical cases, regulators have often analysed whether the incumbent operator in a given area would have a market share below a certain threshold (e.g. 40-50%) and whether sufficient alternative infrastructures existed (number of players). More concretely, the BEREC report on co-investment and significant market power (SMP) in NGA networks notes that *“a market characterised by two operators implies automatically that one of the players disposes of a market share of 50% or more and that it is therefore to be expected that a market with high entry barriers with one or two operators in the market raises concerns about dominance and more generally the competitive situation of the market.”* Conversely, it is concluded that only markets with three or more independent operators can lead to effective competition in the physical access market. An access market consisting of two infrastructures (e.g. incumbent and cable) is therefore generally not being considered to be sufficiently competitive. There are, however, various cases in Switzerland and France (usually as a consequence of co-investment) where three or more independent infrastructures currently co-exist (e.g. Basel, Paris and Zurich). In a full market analysis assessing the level of competition, however, several other important factors next to the number of players, such as entry barriers, market shares, downstream competition, indirect effects and commercial or regulated wholesale products (often not available on Cable infrastructure) would need to be assessed.

As has been shown, sub-national geographical markets are defined in case they are indicated by demand and supply side substitutability analysis or in case of sufficiently heterogeneous competitive conditions. The defined sub-national markets must in turn be sufficiently homogeneous and have stable borders. Typically, the Common Position states, geographic market segmentation is applied when a national regulatory authority (NRA) believes that some areas are competitive enough to fully withdraw regulation (no significant market power). Finally, it should be noted that possible closings of redundant traditional local exchanges (including MDFs) during the migration to a next generation access network may have consequences on the geographical market definitions.

In the case that the heterogeneity of economic conditions is not sufficiently strong to justify geographic markets or where the borders of the market are not sufficiently stable or sustainable, the Common Position suggests the definition of a national market with the imposition of – more flexible - geographically differentiated remedies. In these cases typically no fully deregulated areas are defined. Interestingly, the full or partial deregulation of an area may according to the

Common Position also have an economic impact in the remaining areas in case of cost-based regulation. In case of a segmentation of markets, it is likely that deregulation could take place in dense, low-cost areas leaving only the higher cost areas subject to regulation, featuring a network with a higher cost-base per user and higher regulated average prices than before the deregulation of urban areas.

2.2. Regulatory practices in Europe

Since the first decisions imposing geographical segmentation of regulation (UK and Austria in 2008) a number of European national regulatory decisions in this field have been added (Table 1a and 1b). For a more detailed review of wholesale broadband access geographical segmentation of regulation in Europe the reader can refer to Houppis, Santamaria and Lucena Betriu (2011). For a review of the approach to geographical segmentation of regulation in the U.S. instead the reader can refer to Stockdale (2011). Finally, for a review of worldwide cases covering also countries such as Australia the reader may refer to Xavier and Ypsilanti (2011).

This section will review recent decisions and summarize the current situation of geographic regulation in Europe across all electronic communications markets. In particular, proposed and implemented geographic access regulations in European states in the following markets will be analysed: i) wholesale (physical) network infrastructure access, ii) wholesale broadband access and iii) wholesale leased lines.¹⁸ Detailed references to the regulatory decisions summarized below are given in Table 1a and 1b.

In a first decision proposal the Austrian regulator RTR originally wanted to introduce geographically segmented markets as the first national regulatory authority (NRA) in 2008 (wholesale broadband access market). The European Commission had, however, signalled to veto this decision as it judged the boundaries of this market to be unstable. The authority had then adapted the proposal to define a national wholesale broadband access market and to withdraw most remedies in the more competitive segments of the market. Lighter remedies were proposed

¹⁸ These markets are numbered respectively as market 3a, market 3b and market 4 according to the Commission Recommendation on relevant product and service markets (See Commission Recommendation of 9.10.2014 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services C(2014) 7174 final Brussels, 9.10.2014.

in (MDF) areas with two or more alternative operators present, incumbent market share below 50% and serving more than 2'500 households. The European Commission had finally accepted this proposal¹⁹. Regarding remedies it stated that *“the geographic differentiation of remedies may be appropriate in those situations where, for example, the boundary between areas where there are different competitive pressures is variable and likely to change over time, or where significant differences in competitive conditions are observed but the evidence may not be such as to justify the definition of sub-national markets”*. The imposition of geographical remedies was then, however, rejected by the Austrian Administrative Court on 12 August 2008 leading to an implementation of the regulation without geographical differentiation (i.e. without lighter remedies in more competitive areas). In the recent fourth round of market analysis in 2013 RTR again proposes a national market, this time with uniform remedies (retail minus price control; products are restricted to only business-grade products).

On the market for leased lines instead, the Austrian NRA proposed in 2008 a geographical segmentation of markets of high speed (>2 mbps) terminating segments of leased lines in two geographic markets: 12 competitive cities and the rest of the country. The cities would be those communes having i) population of more than 15'000, ii) more than three operators offering terminating leased line segments based on own infrastructure and iii) a market share of the incumbent below 50%. The European Commission stated, however, that it would have doubts about the homogeneity of competitive conditions within these markets and that the incumbent could well not have significant market power also in the rest of the country for high-speed leased lines. In particular, more information about the geographical distribution of market shares and pricing structures as well as their evolution over time has been requested. The European Commission also reminded that a defined market should have stable boundaries over time. The decision has then been withdrawn implying that high-speed wholesale leased lines have been deregulated in 12 cities but not (yet) in the rest of the country. In its more recent fourth round market analysis in 2013, the Austrian NRA reverted back to a national market and uniform remedies. The European Commission vetoed this decision as there seems to be a lack of evidence for homogeneous competitive conditions across all regions in the country. BEREC has shared this view. Especially in the mentioned 12 cities the incumbent's market shares are low (between 23

¹⁹ *“Based on the general principle that remedies should be tailored and proportionate to the identified competition problem, it can be appropriate for NRAs to impose remedies which take account of locally/regionally differentiated competitive conditions while retaining a national geographic market definition.”*

and 34% in the relevant urban market), while the incumbent would not face significant competition in more rural markets. The European Commission has asked for an updated and a detailed analysis. Also the European Commission argues that any reregulation should be carefully evaluated.

The Czech regulatory authority in 2012 proposed for the wholesale broadband access market two geographic submarkets: districts where at least three infrastructures are present and the incumbent has less than 40% market share and other districts. Consequently, it proposed to fully deregulate the area under infrastructure competition while continuing to regulate the rest of the country with relatively light remedies excluding cost-orientation. The European Commission stated that this proposal is mainly based on the number of independent networks and insufficient. It stated that for instance the incumbent's wholesale offer would be national with national prices. Also, the homogeneity of competitive conditions would seem not to be given within the defined urban areas as they seem to include also some small cities (with lower economies of scale). Moreover, the European Commission had doubts about the competitiveness of such areas. In particular it doubted whether Wi-Fi networks may be retail substitutes to DSL, as Wi-Fi coverage would be limited and offer only lower speeds. It also stated that indirect constraints on the wholesale market would be unlikely to be sufficient for Wi-Fi as well as for Cable. While BEREC had supported the NRAs proposal, it was vetoed by the EC.

In 2009 the Dutch regulatory authority has notified a national market including copper and fibre local loops to the European Commission and national remedies were set. Binding price caps for fibre, however, were in practice set per cost area (NL/2009/0868, NL/2013/1439). For unbundled optical distribution frame access to fibre to the home lines and ancillary services such as backhaul and collocation, the authority proposed to take as a starting point the concrete fibre business case of *Reggefiber*, the joint venture formed by the incumbent and an alternative utility operator, to roll out the next generation access network (including an effective and not hypothetically efficient capital expenditure as in LRIC). The authority has decided to allow the joint venture to generate a reasonable rate of return including a risk premium. The fundamental idea is to set a first year access price such to make the investment viable (profitable) in a discounted cash flow (DCF) model estimating cash inflows (the revenues of an FTTH model over the assumed lifetime) and cash outflows (capital expenditure and operational expenditure). Assuming that (real) access prices remain constant over the lifetime of the investment, the initial

regulated price cap for access products is calculated such that the net present value of future cash flows is equal to the initial capital investment, when applying an initial (reasonable) rate of return (between 7-10%, the exact initial amount is not disclosed). Over time the market environment may then change, e.g. demand, costs and competition may develop positively or negatively for the operator and the internal rate of return (IRR) may then vary over the years. However, such profits are not to exceed the standard risk cost of capital (WACC), increased by a risk premium for fibre, by more than 3.5% (representing regulatory risk). As long as this is not the case (verification every three years) maximum access prices are allowed to remain constant in real terms, i.e. to increase over time along with the consumer price index (1.5% per year). If instead the IRR is too high the prices are adjusted downwards by the authority²⁰.

The main inputs into this cost model include the expected economic lifetime (25 years), the expected penetration rate (60% after 2 years), capital expenditure per area, the operating costs (12-18€ per line per year), revenues and an initial reasonable rate of return (7-10%). In case of too pessimistic expectations (of demand for instance) the price would be set such (high) that too high profits could be generated. In the converse - too optimistic - case instead profits would expect to be too low and investment incentives would be adversely affected. Using the DCF model the authority can adjust its prices over time when expectations turn out to be wrong. While this is a highly flexible setting, targeting essentially regulatory, cost and demand uncertainty of investment over time and flexibility regarding the offering of different price schemes (e.g. volume discounts), it was also decided to set geographically different price caps for 14 areas with differing average capital expenditure requirements. Across these cost clusters fibre unbundling prices in 2013 vary substantially from 15.52€ to 25.99€ per line per month (Autoriteit Consument en Markt, 2013²¹). In addition to these tariffs, however, there is a national tariff scheme (18.84€ per line per month), which is calculated as the weighted average of all areas. Wholesale customers can choose between the national tariff scheme and the local tariff scheme, but the choice cannot vary from area to area. However, in the longer term this may imply that firms are active either in urban areas where they choose the local tariff (as it is lower than the national tariff) or in rural areas, where they choose the national tariff (as it is lower than the local tariff). Interestingly, in the long term the binding prices in rural areas could then be lower than the price

²⁰ The approach is broadly described in OPTA (2008)

²¹ See Bijlage B

necessary to cover the area costs as calculated by the business case. In line with what will be shown in the next chapter prices are reduced in urban areas (while remaining higher than local costs) while they are increased (remaining stable) in rural areas.

It should be noted here that the DCF results could also be largely achieved with traditional LRIC pricing as long as identical information is used²². Both approaches consider initial capital expenditure, forecast demand developments and use a WACC to calculate the revenues/prices for the first year. The European Commission has in any case accepted the Dutch regulation proposal. To date the Dutch regulatory authority is the only authority applying geographically differentiated regulated prices according to cost clusters. Interestingly, up to now the incumbent had consistently priced about 2.50€ below the price cap, which seems to indicate the presence of relevant infrastructure competition with cable and regulated copper products (Middleton & Van Gorp, 2010).

The Finnish regulatory authority faced a particular market with a large number of regional incumbents. Initially, geographic markets were defined along traditional operating areas, where 27 regional incumbents have a market share of more than 90% in their wholesale physical network infrastructure access markets. After the regulatory authority had identified that the regional incumbents started to invest in fibre networks outside of their traditional operating areas, a more refined concept of regional markets was defined. The regulatory authority has started by analysing the competitive conditions in 336 municipalities. It has then aggregated these municipalities based on the following criteria: i) the municipalities compose a physically contiguous geographic market area; ii) in terms of the number of local loops, the market share of the area's market leader in the municipalities belonging to one area is more or less equal (variation of $\pm 10\%$); and iii) the number of competing telecommunications operators owning their own local loops in municipalities belonging to the area is more or less equal (± 1 telecommunications operator). The result was the definition of 111 sub-national markets for both the wholesale broadband access market and the wholesale (physical) network infrastructure access market. In 2012 the regulatory authority in a corresponding full market analysis found seven of these wholesale broadband access markets to be effectively competitive and full deregulation in these areas was proposed (including Helsinki). In the remaining 104 areas light regulation excluding cost-orientation for wholesale broadband access of the regional 27

²² See Neu, Neumann and Vogelsang (2012), p. 69

incumbents was proposed. The European Commission did not comment on these issues and the decision has been adopted.

In the market for wholesale (physical) network infrastructure access instead the Finnish regulatory authority has defined 111 sub-national markets as in the analysis of the wholesale broadband access market. None of these markets was, however, deemed to be sufficiently competitive and regional incumbents (at least larger ones) are subject to cost-based regulation. The European Commission did not comment on these issues and the decision has been adopted.

The German regulatory authority in 2010 has analysed the wholesale broadband access market and had identified 771 (MDF) areas (covering about a quarter of all households) where i) the incumbent has less than <50% retail market share, ii) there are at least four operators offering DSL and iii) the local exchange has more than 4'000 subscribers (i.e. sufficiently large to allow unbundling for efficient entrants). However, while the UK and Portugal had proceeded with full deregulation in similar areas, the German authority did not follow this approach and propose a national market. The reasons include that the incumbent pursued a national pricing and product strategy. While the regulatory authority did not propose geographically segmented remedies it proposed a uniform light set of remedies at national scale, i.e. excluding cost-orientation. The European Commission agreed that there is no conclusive evidence for a geographically differentiated regulation. The decision has been adopted.

The Italian regulatory authority has analysed the competitive conditions in the wholesale broadband access market in 2011 and concluded that these are not sufficiently heterogeneous to warrant the definition of sub-national markets. The regulatory authority has, however, proposed to differentiate remedies between areas with infrastructure competition and areas without (details to be defined in a later decision). The Commission advised the authority to follow the criteria for next generation access remedies in the Commission's *NGA recommendation*. It reminded the authority that for a definition of geographic markets the number of operators in a given exchange area, the size of the area to ensure possible entry at the given scale, the distribution of market shares and geographic pricing would need to be analysed. A separate proceeding on geographically differentiated remedies will be opened. With regards to remedies the regulatory authority plans to impose a lighter form of price control in more competitive areas leading to higher prices.

The Polish regulatory authority in 2012 has proposed a national wholesale broadband access market with a lighter set of regulatory remedies for the four largest cities (where there is retail competition from cable and other operators) and one for the rest of the country. In the first segment of the market, mostly urban areas, the regulatory authority proposed to remove the remedies of cost-orientation, accounting separation and transparency, leaving only access and non-discrimination obligations. The European Commission has recommended that the regulatory authority should withdraw the proposal and strengthen its analysis of competitive conditions. While the European Commission has no veto on remedies, the regulatory authority still has withdrawn its decision proposal. Still on the wholesale broadband access market but in an earlier round of analysis the Polish authority proposed geographically segmented markets with a fully deregulated area of 11 cities under competition. The European Commission had at that time, however, vetoed this proposal as differentiated prices and market shares as well as indirect constraints and potential competition would not have been sufficiently demonstrated and the market data had been judged to be outdated.

The Portuguese regulatory authority suggested in 2010 a wholesale broadband access geographic market definition with competitive (MDF) areas where there is at least one unbundling based alternative operator and a cable operator (taken into consideration when the percentage of connected cable households is at least 60% in the area) and non-competitive MDF areas on the other side. The competitive area was proposed to be fully deregulated. The non-competitive areas would still feature a form of light price regulation (retail-minus approach). The European Commission had raised concerns that in some competitive MDF areas the market share of the incumbent is still above 50%. It has therefore invited the regulatory authority to carefully monitor the evolution of competitive conditions in the future, but the decision was not vetoed and has been adopted.

In the leased line market, instead, the Portuguese regulatory authority proposed in 2010 a geographical segmentation of the trunk segments of leased lines market (which usually connect the exchanges of the country) in a competitive trunk market connecting 110 local exchanges where at least two alternative operators are present with own infrastructure and one *non-competitive* trunk market connecting the rest of the exchanges. It was then proposed to fully deregulate the competitive leased lines routes (as also done by the Swiss regulatory authority) and to impose regulation including cost-orientation on the remaining lines. The European

Commission has, however, stated that the geographical market segmentation is primarily based on the number of operators, which it considers to be insufficient, and that further evidence is necessary, such as markets shares over time and regionally differentiated wholesale and retail pricing. Given the important differences in market shares and network duplication the Commission did however not contest the decision and it was adopted. It invited the regulatory authority, however, to base its next market analysis on more detailed data.

The Spanish regulatory authority had identified in 2008 differing competitive conditions in the wholesale broadband access market, but these were not deemed sufficient for a definition of regional markets. It argued that the incumbent's retail pricing was still national. It was also argued that the current next generation access network roll-out would affect the boundaries of possible geographic markets, meaning that sub-national market boundaries would be unstable. However, unlike the German regulatory authority, the Spanish regulatory authority proposed geographically differentiated remedies. In areas where the incumbent faces infrastructure-based competition (at least cable and at least two unbundling-based competitors) and where the incumbent's market share is below 50%, the regulatory authority proposed the withdrawal of the cost-orientation obligation. The European Commission had asked the Spanish regulatory authority to detail its geographic analysis further by analysing different geographic commercial strategies, average retail prices, functionalities provided and market shares (retail and wholesale) in both areas. In addition, the Spanish authority was suggested to analyse in detail the stability of boundaries and a possible trend to competition in the urban areas. BEREC supported the Spanish authority's view of a national market, in particular because of the unstable character of geographic borders and the fact that different retail prices could reflect different technologies rather than market pressure²³. It also agreed that competitive differences could warrant geographic differentiation of remedies. Finally, however, the Spanish authority has withdrawn the proposal imposing the remedies formerly proposed only in more rural regions at national scale. No further round of market analysis has then been notified.

In the leased line market the Swiss regulatory authority in 2010 had defined the market for trunk segments of leased lines as the market of lines between Communes where two or more alternative operators to the incumbent are present with own infrastructure (e.g. 25 Communes in 2009 and 41 Communes in 2010). The trunk market defined in this way has in a second step been

²³ IRG (09) 01 Phase II Case Spain 090116

deemed to be competitive and fully deregulated. Not being part of the EU framework, the Swiss regulatory authority did not need to notify the European Commission. If it would have had to, in light of the Portuguese case, the decision might have been vetoed for unstable market borders. It should be noted, however, that geographical segmentation of markets is currently the only legal tool for geographical segmentation of regulation available to the Swiss regulator as the regulatory framework foresees no flexibility of remedies.

The UK regulatory authority has been the pioneering regulatory authority regarding geographical segmentation of markets in Europe. Its current wholesale broadband access regulation foresees three geographic markets: 1) MDF areas where BT is the only operator present, 2) MDF areas where in addition two or more alternative operators with own infrastructure or via unbundling are present²⁴ (or three when the incumbent's market share is greater than 50%) and 3) areas where in addition four or more alternative operators are present (or three when the incumbent's market share is lower than 50%). While market 3 is fully deregulated as it ensures competition, in market 1 full regulation including cost-orientation and price-control (RPI-X) is imposed. Finally, in market 2 the price-control remedy is withdrawn. Combining full deregulation with a segmentation of remedies between different markets, this proposal corresponds to date to the most flexible regulatory approach adopted in the EU. The European Commission reminded the regulatory authority, however, that the sole criterion of the number of operators is not sufficient for geographic market segmentation, but that homogeneity has to be ensured checking for possible geographic variations in market shares and pricing. It invited the regulatory authority in particular to provide additional structural and behavioural evidence, such as data on barriers to entry, marketing and sales strategies and service characteristics, which could further sustain the geographic market delineation. The European Commission did, however, not veto this decision and it was subsequently adopted.

In the leased line market, the UK regulatory authority, in a detailed analysis in 2013, has defined geographic markets for high performance traditional interface terminating segments of leased lines (>8 mpbs). Effective competition has mainly been found in the Western, Eastern and Central London area (WECLA). The WECLA has been slightly extended in the recent market analysis and includes 421 post-code areas where competition is assumed, with two or more competitors with own infrastructure and relatively low market shares of the incumbent. In

²⁴ presence means here coverage of at least 65% of the MDF area.

practice the regulatory authority estimates the number of potential competitors in a postal sector with a flexibility point within 200m of business sites. It is supposed that 200m can be reasonably bridged by any new installation of fibre to provide high-performance leased lines services to a client. Then, the average number of potential operators per business site in the postcode sector was calculated and contingent postal codes with at least two alternative operators were grouped together. Market shares of the incumbent in this area were shown to be considerably lower and some geographic differences in prices have been detected. The only area with significant differences in economic conditions when compared to the rest of the country was given was then shown to be the WECLA. Finally, very high speed leased lines (622 mbps) were defined separately (as a joint national market) as both submarkets seemed to be equally competitive. Regarding regulation, the regulatory authority proposed to fully deregulate competitive markets (this is automatic) and to impose price-control on the remaining markets. The European Commission has cleared this proposal and it was subsequently adopted.

It should further be noted that in some countries the low performance copper-based wholesale broadband access market has been fully deregulated at national level (Malta, Romania). In Malta, in the retail market, two equally large competitors were found (incumbent and cable) and joint dominance could not be demonstrated in 2008. The assessment could possibly be different in light of next generation access network deployment today. In Romania, strong infrastructure competition seems to take place at national level with the incumbent having relatively low market shares when compared to cable competitors. Also, competitive conditions were not judged sufficiently heterogeneous to warrant sub-national markets. The European Commission has accepted full national deregulation of the wholesale broadband access market in 2010, but cautions the regulatory authority to follow the market development especially of competitive conditions across areas closely.

To sum up, even though the European Commission works towards a homogenous approach to regulation across Europe, current regulatory policy on geographical segmentation of regulation is highly fragmented. Various different approaches and criteria still co-exist. This may also be a result of the current absence of a veto of the European Commission on remedies.

As the review of relevant regulatory cases shows, in several cases a geographical segmentation of markets has not implied full regional deregulation. On the other hand depending

on the concrete details of regulation a light remedy can also nearly correspond to no regulation. The Austrian regulatory authority in its wholesale broadband access decision, for instance, had imposed only accounting separation in competitive areas²⁵. Therefore, both the segmentation of markets as well as the segmentation of remedies may in practice imply near equivalent market regulation. The amount of fine-tuning then also depends on the preference of the regulator and the instruments it is ready to impose. The simplest form of segmentation would be cost-orientation and full deregulation. But different regulators have proposed different solutions than that including access-only obligations to prevent foreclosure²⁶.

To conclude this overview, the approach of lighter regulation where competition is more intense is in line with theory when looking at static welfare – as increasing competition decreases the necessity of safeguarding competition. What is scarcely discussed are the detailed effects on investment incentives and the detailed implementation of the remedies. For instance, unbundling prices are usually based on uniform cost-oriented LRIC prices. As costs in many cases significantly differ across areas²⁷, uniform prices in regional markets may not set the correct investment incentives in all areas as will be seen in the next sections.

Of the reviewed cases there is one exception to national regulated prices: The Dutch regulator has – under formally national regulation - imposed geographically segmented prices according to local capital expenditure requirements.

2.3. Review of Literature

As described above the subject of geographical segmentation of regulation is receiving increasing attention of regulators as the mass market roll-out of next generation access infrastructures by the incumbent, as well as new entrants at local scale, signifying an increasing demand by the public. A popular example described in the regulatory practice section is the UK wholesale broadband access market, where the regulator has first introduced geographic differentiation of regulation by essentially adopting full deregulation in areas where four or more alternative infrastructures are present and has imposed differentiated regulatory remedies in areas

²⁵ This decision was only rejected by a national court, not by the European Commission.

²⁶ Generally, it can be noted that remedies in service-based markets are also be lighter as entry barriers are lower than for instance in the market for wholesale (physical) network infrastructure access.

²⁷ Ilic, Neumann and Plückebaum (2009) show that in Switzerland costs can differ by a factor 6 across geographic cost clusters.

where only the incumbent is present and in areas where two or more alternative infrastructures are present.

Some academic articles analyse the geographical impact of geographically uniform access prices (Lestage & Flacher, 2010; Flacher & Jennequin, 2012). Some others examined the appropriateness of geographic segmentation of regulation for broadband networks and to what extent the economics of NGAs allows this (Tselekounis, Xylogianni & Varoutas, 2013; Soria & Herhández-Gil 2010; Amendola & Pupillo, 2008). To date, however, a comprehensive theoretical analysis of geographically segmented access regulation has been undertaken only by Bourreau, Cambini and Hoernig (2012b)²⁸. In addition, De Matos & Ferreira (2011) analyse similar effects. In this section this literature will be summarized. An overview is presented in Table 3. The detailed effects of the different regulatory options according to the literature are described in the next section.

Amendola & Pupillo (2008), examining architectures and cost drivers (infrastructures, electronics and customer premises equipment) related to NGA deployment, elaborate on the relevant flaws of continuing to advocate national patterns of regulation. Taking into account Italy as an exemplary country they propose a taxonomy of local areas that may be adopted in geographic regulation of NGA networks. In so doing, the authors underline the importance of defining the appropriate geographic units for a possible geographic segmentation of markets 3a and 3b (formerly market 4 and 5)²⁹. Then the authors point out that conditions of competition differ significantly among local areas, regulation should promote both incumbents' and other licensed operators' investments in NGA networks by limiting ex ante interventions to those enduring economic bottlenecks found at a specific geographic market level.

Similarly, Soria & Herhández-Gil (2010) investigate the economics of NGA networks with a focus on sustainability of infrastructure competition for different geographic areas and service

²⁸ Pereira and Ferreira (2011) also consider geographic access prices. As the detailed functions of their algorithm is, however, not disclosed it is difficult to compare their model.

²⁹ Commission Recommendation of 9.10.2014 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services C(2014) 7174 final Brussels, 9.10.2014, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014H0710&from=EN>. According to findings of the paper, conditions to be followed for the market 3a (ex-4) consist of the presence of inter-platform competition, availability of a fibre open access network (such as the Metroweb network in Milano), availability of a legacy infrastructure as well as utilities or municipalities, whereas concerning the market 3b (ex-5) the authors refer to local exchange areas marked by LLU competition as the main criteria to be taken into consideration.

features. Using COSTA model, an engineering model developed by Universidad Politecnica de Madrid with support from Telefónica, five different geographic settings were defined by their population density, including ‘dense urban’, ‘urban’, ‘suburban’, ‘rural’ and ‘sparse rural’ in the study. One of the main results derived by the authors is that the economics of NGA networks are very different in different geographic areas, to the extent that the expected industry structures are very different³⁰. The accompanying conclusion the authors infer is that every kind of geographic area has to be analysed in a separate way, signifying differential regulatory treatment per each area. Notwithstanding, the authors’ analysis does not elaborate on to what extent and under which criteria differentiated remedies could be appropriate and what kind of regulatory treatment would be preferable. This last issue, particularly with an emphasis on access pricing, is analysed by Bourreau et al. (2012b) detailed below.

In Bourreau et al. (2012b), in a Greenfield setting two potential vertically integrated incumbent firms locally roll out own equivalent infrastructure with increasing fixed costs in more rural areas and with identical cost functions. Both operators can choose in which areas they will deploy own infrastructure and decide on the level of their investments, but they are supposed to start to roll-out in the densest areas first and subsequently in ever less dense areas. While one operator can roll out in more areas than the other, the possibility that operators deploy alone in different areas is not given. In a static game in the first stage a regulator is setting the regulated wholesale access charges in all areas. In a second stage the two firms simultaneously and non-cooperatively set their investment levels. Then, a possible downstream entrant (and an incumbent in areas where only the other incumbent is present) decides whether to enter or not considering the access charge (service based competition). The entrant chooses randomly an operator for access in case two incumbents are present. Finally, in a fourth stage all retail operators compete with horizontally differentiated broadband products for final broadband customers by setting possibly also geographically differentiated retail prices. The model uses quasi-linear preferences following Shubik and Levitan (1980) and an exponential investment cost function for the market model. Using this framework the effects of a variety of possible geographic regulation

³⁰ According to the authors’ findings, industry structure is expected to vary greatly with population density, ARPU, service take-up, user demand requirements and the availability of civil infrastructure.

instruments are analysed. In particular the authors describe the effects of geographically differentiated access price regulation in areas with different cost levels and/or competitive conditions and geographically differentiated remedies.

Similarly, in the absence of legacy networks and assuming a fibre Greenfield market, in an endogenous entry setting, De Matos and Ferreira (2011) perform a market simulation with differentiated goods retail competition (Cournot). It is assumed that two areas exist, one with low deployment cost and one with high deployment cost such to temporarily exclude the possibility of infrastructure competition. In the first stage integrated and downstream operators decide in which markets to enter and in the second stage they compete on the retail market for end-customers. The paper simulates the resulting geographic market structure and welfare.

One recent modelling supporting the findings of Bourreau et al. (2012b) is the study of Tselekounis, Xylogianni & Varoutas (2013). They research the incentives of an unregulated monopolist to undertake the socially optimal investment in NGA networks when it takes into account the fact that the NGA deployment is a two-dimensional investment decision concerning both the *quality* (or equivalently, technology) and the *geographic coverage*. Assuming that the investor is not obliged to provide access to its improved access infrastructures to its competitors, and the need for copper (e.g. ADSL) services is eliminated through NGA deployment, the study findings provide useful results. Based on a game setting, the findings of the models show that in the third stage, the investment cost is sunk and the monopolist sets the geographically differentiated retail prices of the different ultra-fast broadband services provided in each area given the level of NGA deployment chosen in the first stage and the quality of the NGA network chosen in the second stage. Accordingly the authors reach the conclusion that implementation of geographically differentiated access remedies is reasonable, whereby they point out that modelling of Bourreau et al. (2012b) should be combined with their modeling in order to conclude about the optimal pricing scheme that leads to the socially optimal geographically differentiated NGA deployment.

While no other articles have taken geographic regulation explicitly into account, some look at the converse problem: the impact of uniform regulation on geographic coverage considering geographic differences in respect of cost levels. Lestage and Flacher (2010) in a similar static stage game as Bourreau et al. (2012b) assume Bertrand retail competition with vertically differentiated goods. In most of the paper the source of quality is assumed to be

generated by the service provided on the infrastructure, i.e. duplication of access infrastructure is not socially valuable³¹. They analyse the impact of uniform access price regulation on the geographic market structure and welfare.

In a setting with a legacy technology and geographically uniform prices Flacher and Jennequin (2012) show that maximum coverage is reached without regulation, but that this is not optimal. With one potentially vertically integrated fibre incumbent and a potential downstream entrant as well as Cournot retail competition with vertically and horizontally differentiated goods it is shown that the social optimum is achieved in case the regulator sets not only access prices but also a coverage requirement³².

Regarding the effects of regulation, the details of the imposed regulatory instruments matter. In European regulatory practice the debate on options to geographically fully deregulate or impose lighter sets of remedies is intense as the review of regulatory cases shows. On the other hand in academic research the analysis of welfare effects of geographically segmented regulated access prices or the problems implied by uniform pricing have not yet received much attention. In the next section the detailed findings of the existing papers with respect to the different regulatory options will be reviewed and put into perspective. The literature is summarized in Table 3 in the annex.

2.4. Review of regulatory options and effects

The different regulatory options to approach geographic access regulation identified by the literature include geographically uniform access regulation as well as competition and/or cost-based geographical segmentation of remedies and prices. Uniform access regulation is a regulation which does not foresee any geographical segmentation of regulation. Such a regulation may include any of the regulatory access remedies (access, non-discrimination, transparency, cost-orientation, price control) or none (full deregulation). In case price control is imposed, prices under uniform access regulation do not vary across areas. On the other hand geographical segmentation of regulation is a type of regulation whereby the detailed regulatory instruments may imply geographically different regulatory conditions. This includes the imposition of

³¹ The authors provide, however, an alternative specification where the source of quality is supposed to be driven by the underlying infrastructure. In this case, firm B accessing a high quality infrastructure A is able to replicate its high quality services. With a possible own lower quality infrastructure this is not possible.

³² Technically this would correspond to a beauty contest including minimum coverage requirements.

different regulatory access remedies in different areas, the imposition of access prices which vary geographically, based on the level of competition and/or the required investment cost in a given area as well as the full deregulation of particular areas. The effects of these different geographic regulatory policy options in light of the literature under consideration are analysed in this section.

2.4.1. Uniform access regulation. Uniform access regulation describes settings where there is no geographical segmentation of regulation of any kind. Herein regulators do not see any reasons or driving factors to differentiate the remedies per geographic areas or model regulatory measures based on average values pertaining to both urban and rural areas. Nevertheless, uniform regulation can have geographic effects on the market. Uniform regulation analysed in the reviewed literature include: full national deregulation (free market), cost-based access prices and (any other) uniform access price regulation (e.g. maximising static and dynamic welfare). A particular form of uniform conditions in the access market is given by the case where no access products are available.

2.4.1.1. Uniform access prices. Under uniform above-cost access pricing an access charge above marginal cost is set at the same level in all areas, independently of the level of competition or investment cost in these areas. This is a common case as current regulatory practice in Europe implies that remedies do not necessarily need to be differentiated geographically even in case of competitive and cost differences. Although the 2010 NGA Recommendation gives guidance on geographic segmentation, no requirement exists to implement as EU law mainly looks at the absence of effective competition and accompanying tools (SMP remedies) in general. From this perspective, the EU regulatory system targets building up ‘level playing field’ essentially by driving the competitors first to have a market penetration. To ensure this, long run incremental cost (LRIC) prices are encouraged by the Commission to be adopted by regulators so as to give a message of “build or buy” for emerging NGA platforms (Recommendation on Non-Discrimination and Costing Methodologies, Recital 27).

It should be noted that LRIC price regulation is considered to be an above cost access price regulation as it applies a positive rent. Bourreau et al.(2012b) show that setting a high uniform access charge means that investment incentives increase both the extent of single

infrastructure areas (SIAs) and of duplicate infrastructure areas (DIAs). The typical trade-off between maximising per area welfare of connected areas by applying low access prices and increasing coverage to generate additional area welfare in marginal areas applying high access prices arises. It should be noted that this analysis assumes Greenfield investments and therefore the absence of a legacy network. This allows abstracting from migration effects which would in the context of this model likely lead to an excessive level of complexity.

Independently of how investment cost is specified the authors show with their market model that the social benefits from investing in duplication in a marginal area in case of uniform prices are negative. A regulator would therefore in this setting wish to decrease the investment incentives for duplication and therefore the extent of the duplicate infrastructure areas with respect to the extent of single infrastructure areas, the reason being essentially the duplication of fixed costs in case of duopoly³³. This can only be done by decreasing the access prices in duplicate infrastructure areas relatively to single infrastructure areas. Any uniform pricing (including cost-based pricing described below) is therefore not likely to be optimal and higher welfare might be achieved with geographically segmented regulation according to competitive conditions. In deciding this issue of geographic segmentation, the industry structure, consumer willingness to pay and demand requirements as well as the cross-effects between copper and fibre markets might need to be taken into account as explained by Tselekounis, Xylogianni & Varoutas (2013).

Lestage and Flacher (2010) show in a substantially similar game-theoretic setting as in Bourreau et al. (2012b) that, when investment costs increase towards rural areas and two potential fibre-based incumbents - having an outside option with traditional low-quality technology - decide on investment, imposing uniform regulated access prices limits the area of total coverage and retail prices are reduced when compared to the free market. On the other hand, high differentiation of retail services can increase coverage. In addition, the authors show that access regulation limits the area where both operators roll out as in Bourreau et al. (2012b). Subsequently it is shown that there are areas between duplicate infrastructure areas and where no operator rolls out, where one operator rolls out in equilibrium (single infrastructure areas); but that for a subset of these areas there are two equilibria³⁴, where it is not clear which operator

³³ In case of high access charges and a high level of service differentiation further incentives for duplication would be necessary.

³⁴ Such areas are only present when the (exogenous) quality advantage of firm A over B is insufficient

would invest and it is then uncertain whether there will be investment at all or not. This zone of uncertainty would only disappear in case the quality advantage between the firms is small. In addition, this zone is supposed to be moving towards more dense areas when the access price falls.

Finally, Avenali, Matteucci and Reverberi (2010), while not directly modelling geographic effects, expect that geographically de-averaged access prices (above-cost in urban areas and at cost in rural areas) would raise welfare as this would induce more efficient investment in high density areas and low-density areas.

So-called cost-based access regulation is a particular case of uniform pricing implying the uniform setting of prices at nationally averaged marginal costs. Fixed investment costs in the industry are typically very high and varying across regions, but marginal costs are typically relatively low and do not differ substantially across regions. It can therefore be expected that a geographically differentiated marginal cost-based access pricing would be nearly equivalent to a uniform implementation. In Bourreau et al. (2012b), uniform cost-based access charges would reduce total coverage when compared to an unregulated setting. The trade-off between static and dynamic welfare does not arise here as single infrastructure and duplicate infrastructure area prices are set at the same level, implying that no additional profits can possibly be generated by an operator by investing in duplication. The duplicated infrastructure would have to be resold at marginal cost at wholesale level generating no additional potential wholesale profits while the potentially investing operator would already have access to the infrastructure at this minimal possible cost from its rival to generate the same retail profits as without investment. Such regulation would be optimal only in cases where duplication is not feasible (i.e. investment cost in a marginal area is very high). When duplication is feasible instead and cost-based regulation prevents it from taking place, this would correspond to a loss of welfare. Uniform cost-based access regulation is therefore not optimal. While duplication is not possible in this setting, it would be preferable to adopt uniform prices above-costs as this starts to create wholesale profits for a duplicate infrastructure and lower opportunity costs for a second incumbent to invest. For this reason welfare would tend to be lower with cost-based uniform access prices than with some form of above-cost prices.

Lestage and Flacher (2010) also show that uniform cost-based pricing is not optimal as it does not take into account the correct investment incentives and reduces total and duplicate

coverage even more than uniform above cost access pricing does. They also show that, when tastes are sufficiently heterogeneous, an optimal regulated access charge would depend on the lowest investment cost across areas (or in other words the maximum population density), the lowest and highest quality valuations of consumers and the quality of the network (where the quality of the traditional copper network is assumed to be zero and the quality of new infrastructures strictly positive). Moreover, it is shown that the optimal access charge increases in the lowest investment cost across areas (and decreases in the areas with highest population density).

2.4.1.2. Other forms of uniform regulation. There exist also other forms of uniform regulation, namely national full deregulation and the case where wholesale access at national level is not available (for example for technical reasons).

In the case when access is not available the firms can make retail offers only where they have own infrastructure. Firms then roll out both up to a point where per area duopoly profits become lower than the per area investment cost. Then one of the firms may roll out up to a point where per area monopoly profits become lower than the per area investment cost. While firms are symmetric ex-ante this leads to differences ex-post, as in some regions only monopoly profits can ensure coverage and hence only one provider can be present in equilibrium.

The case of national full deregulation (when commercial access is available) is another type of geographically uniform regulation. However, differently from the above cases it may imply geographically segmented commercial wholesale access prices. The market model of Bourreau et al. (2012b) shows that when services are sufficiently differentiated, downstream entry is beneficial to the industry due to a demand expansion effect, even though the retail profits of incumbents decline to some extent when giving access. In particular they show that in this case foreclosure (prices set to exclude the entrant) can never occur in single infrastructure areas as giving access can increase overall industry profits with differentiated goods and as the incumbent is able to extract such profit. In duplicate infrastructure areas, instead, foreclosure is possible only when there is low differentiation at the retail level. In such a case the regulator could impose an access-only obligation preventing foreclosure, which might be welfare enhancing as will be also shown later in this chapter. Finally, a regulator would in such cases set regulated prices only below the potential commercial wholesale prices.

Lestage and Flacher (2010) show with their model in a fully deregulated market, when considering two firms A and B, of which A always provides the higher quality service³⁵, that where firm A has rolled out infrastructure as a monopoly, it will not provide wholesale access to B. Where instead B has rolled out as a monopoly, B would set a wholesale price such as to allow the provision of (higher quality) services by A on its infrastructure. This, as excluding product A from the market would reduce the total profits possibly extracted from the market. Regulatory intervention is therefore necessary (at least in some) single infrastructure areas to avoid foreclosure. A different case would exist when the quality is driven by infrastructure instead of services. Then there is no more reason for foreclosure, as B can also provide high quality services when accessing infrastructure A. In this case, however, duplication is not desirable as infrastructure investment by B would only lead to a provision of the lower quality goods.

From a practical point of view it might be interesting to consider company statements during the consultation of the BEREC Common Position on Geographic Aspects of Market analysis in 2008. Some local alternative infrastructure providers seemed to have a critical view on geographic deregulation leading to a de-averaging of wholesale prices³⁶. In the current situation the incumbent needs to charge a uniform wholesale access price (at a national regulated price cap). It cannot offer lower prices regionally as this would imply charging lower prices in rural areas as well. Therefore the price cap in urban area in practice is also a price floor enhancing profitability of operators active in these submarkets. The indicated prices are usually regulated on a national cost base and could therefore potentially be very high when compared to local urban investment costs. Deregulation in presence of any form of local competition may however potentially lower these prices regionally decreasing the value of all infrastructures in the market and especially of alternative investors³⁷.

³⁵ both quality A and B are considered to be preferred to a traditional outside quality which is provided in case of no investment.

³⁶ As an example, consider the statement of Fastweb, retrieved from http://berec.europa.eu/doc/publications/consult_erg_geo_markets_2008/fastweb.pdf; last accessed in December 2013.

³⁷ In addition, some regulators have imposed some form of uniformity of retail prices. Valletti, Hoernig, and Barros (2002) show that in the context of universal service a uniform retail pricing obligation is creating strategic links between areas that would otherwise remain unrelated. The paper shows that uniform retail pricing leads to lower equilibrium coverage of both the incumbent and entrants. The effect depends also on the regulatory context of other universal service policies such as price caps or coverage constraints. For instance, in presence of a minimum coverage obligation the effect may be compensated, but the measure would lead to an increase of (uniform) prices. Anton, Van der Weide and Vettas (1999), Choné, Flochel and Perrot (2000, 2002) and Foros and Kind (2003) find similar effects. Hoernig (2006) arrives at similar results by stating that a uniform price imposed on the incumbent

2.4.2. Geographical segmentation of regulation. Geographical segmentation of regulation describes general settings where regulated conditions vary across areas. Regulatory instruments that can be segmented include regulated access prices according to competitive conditions and/or investment cost, as well as geographical segmentation of remedies in general - as for instance cost-based regulation in rural areas and softer forms of regulation, such as an access-only obligation, in urban areas.

2.4.2.1. Geographical segmentation of access prices according to competitive conditions and investment costs. Bourreau et al. (2012b) describe *pure geographical segmentation* as optimal regulated access charges which are set separately in areas of different population density and therefore investment costs and which are differing, in addition, according to the competitive conditions in the area (single or duplicate infrastructure area). Likewise Soria & Hernández-Gil (2010) reaches to the conclusion that industry structure is expected to vary greatly not only with population density but also ARPU, service take-up, user demand requirements and the availability of civil infrastructures³⁸.

No European regulatory authority has to date chosen such a complex regulatory model differentiating regulatory measures both according to local investment costs as well as competition, and there has recently been no significant public debate on it. In addition, no European regulatory authority has to date implemented a pure single and duplicate infrastructure area distinction (rule of thumb) as it is assumed that the number of operators is not the only driver of competition (section 2.2.). Furthermore, no regulatory authority has to date proposed differing levels of regulated access prices according to competition based on a single methodology. As has been shown the Dutch regulatory authority offers, however, regionally segmented regulated fibre loop access prices.

While Bourreau et al. (2012b) indicate that such a type of regulation would offer maximum flexibility to the regulator and therefore lead to maximal welfare they also assume that

would reduce its coverage as it seeks to avoid duopoly entry. If imposed on entrants it reduces the incentive for duopoly entry and may lead to independent regional monopolies.

³⁸ According to the authors, population density and user requirements will drive which technologies have the best cost position, thus allowing very different industry structures. Furthermore, according to their findings the higher the ARPU, the service take-up and the availability of civil infrastructure, the more potentially competitive a market becomes.

it would be complicated to implement in practice as in-depth knowledge about local retail demand and cost structures as well as the competitive retail market interaction would be necessary. Optimal regulated per area access prices would maximize per area welfare while ensuring that investment in the areas remains viable (both for single or duplicate infrastructure areas, defining separate prices). As welfare in SIAs decreases with the access charge, the access charge in these areas should be set just high enough to make an incumbent operator break even when investing in the area. If the operator's retail profits (i.e. excluding wholesale revenues) would be already higher than the investment cost, the optimal access charge would be zero. The socially optimal extent or coverage of the whole SIA is shown to correspond to the same coverage which would also develop when the operator could set monopoly access charges freely, as it would extend its network, as long as this is profitably possible too (i.e. the last covered and most expensive single infrastructure area would optimally have regulated access prices at monopoly level).

In DIAs on the other hand for a firm duplicative investment incentives exist as long as the investment cost in duplication is lower than the difference between expected profits in duplicate and single infrastructure areas. In the latter case the firm's retail products would be based on a wholesale product. Given the expected demand and cost functions as well as the SIA access charge, the socially optimal wholesale price can be calculated. If DIA retail profits with respect to SIA profits (when not being the access provider) are sufficiently high, the DIA access price can be set to zero. In this way static welfare is maximised, while investment incentives (in duplication) are safeguarded. A particular case is given when the single infrastructure area access charges are set at marginal cost. In this case investment in duplication would incur high opportunity costs in addition to the investment costs which could not be compensated by any benefit as with an own infrastructure marginal cost is still incurred. Duplication in this case brings no social benefits. In this case, the corresponding socially optimal DIA access charge³⁹ would be zero. Investments in duplication would in this case always be unprofitable as no additional wholesale profits or additional retail profits could be generated. Importantly, in the market model used by Bourreau et al. (2012b) it is shown that duplication is optimal in no area when SIA access prices have been chosen optimally for each area. Finally, it is shown that

³⁹ Note that regulation here is strictly tied to the number of competitors in an area. When the number is one, single infrastructure area access charges are automatically applied. If the number is two, duplicate infrastructure area access charges are applied to the operators in this area.

standard cost-based access prices (LRIC prices) *per area* are higher than the described optimal SIA access prices as they include by design a positive rent (which is incompatible with a zero profit condition) and does not take into account retail profits of vertically integrated operators. Long run incremental cost regulation is therefore a problematic approach even if applied per area.

De Matos and Ferreira (2011) show in an endogenous entry market simulation with Cournot differentiated goods competition that geographically differentiated wholesale prices (areas are differentiated according to cost and competition) are socially optimal. At the same time, the authors state that in case of regional markets, which are not independent, implementation of geographic regulation becomes a highly complex task. Interdependencies may be justified for instance by economies of scale and scope and network effects, or as will be shown later, by nationally uniform (retail) pricing obligations. In particular, deregulation of more competitive areas may trigger unexpected consequences such as a change to a monopoly situation in an adjacent market. The authors also show that a deregulation of a subset of regions based on an “N-plus” rule of thumb (Xavier, 2010)⁴⁰ is therefore not sufficient to guarantee that the introduction of geographic remedies is welfare enhancing. The problem of interdependencies raised by De Matos and Ferreira (2011) is largely avoided by Bourreau et al. (2012b) by setting independent per area cost structures and by not considering network effects. It should also be noted that it is shown by many (Soria & Hernández-Gil, 2010; Amendola & Pupillo, 2008) that the economics of NGA networks leads to different industry structures in different geographic areas incorporating distinctive retail demand and cost structures, largely obviating the problem of interdependencies.

In Bourreau et al. (2012b) with *duplication-based regulated access prices* instead, the access charges are not allowed to vary between areas with different investment cost requirements (or between providers) but continue to be different in single and duplicate infrastructure areas. As described before, also in this case no European regulatory authority has to date implemented such an approach purely (rule of thumb) as it is assumed that the number of operators is not the only driver of competition. Furthermore, no regulatory authority has proposed differentiating directly regulated access prices based on a coherent methodology according to competition. Such an

⁴⁰ Such a rule would foresee a threshold number of firms below which regulatory remedies remain in place. Above regulatory remedies would be lifted.

approach is less flexible than the described *pure geographic remedies*, enabling differentiation according to both investment cost and competition. It therefore implies lower social surplus, given that optimally charges vary also across cost clusters as shown above. Duplication-based regulated access prices have the advantage, however, to be more transparent and easier to implement for regulatory authorities.

As with pure geographic remedies Bourreau et al. (2012b) show that the effect of an increase of both single and duplicate infrastructure area access charges on welfare is ambiguous. An increase in a nationally uniform single infrastructure area access charge leads to a loss of static efficiency in the concerned areas, an increase in coverage and possible welfare gains from transforming single in DIAs through the creation of opportunity costs. However, this last effect is positive only if increased competition outweighs the costs of additional investment. On the other hand, an increase in a nationally uniform DIA charge would decrease static efficiency in such areas while also having an effect on the transformation of single in DIAs via potential wholesale revenues. This last effect again is positive only if increased competition outweighs the costs of additional investment. If this is not the case, then the regulator should set the DIA access charge as zero in order to limit duplication.

One feature of this analytical framework is that optimality conditions are such that there is a positive correlation between the socially optimal single and duplicate infrastructure area access charges. Setting a very low SIA access charge (increasing opportunity cost, therefore lowering DIA investment incentives) would optimally imply also lowering DIA access charges. This is the case as low SIA access prices imply an already high per area welfare, meaning that the net benefit of extending the DIA decreases substantially and that the regulator should reduce its incentives to invest in duplication by lowering also DIA access prices.

Finally, in equilibrium Bourreau et al. (2012b) find that optimally regulated SIA access charges are set above cost. DIA access charges, however, should be set above cost only in case of significant differentiation. Otherwise, the social benefit of duplication is insufficient to cover the additional investment costs. In addition, the market model predicts that optimal national access charges in SIAs are to be set higher than in DIAs in order to provide investment incentives but keeping static welfare losses in DIAs as low as possible. It is also shown that in this case SIA long run incremental cost regulation would not be optimal representing too low access charges reducing welfare.

2.4.2.2. Geographical segmentation of remedies. The European regulatory framework provides for the possibility to impose a lighter set of access remedies in more competitive areas. From a legal point of view, this can be the consequence of a national market definition (with regional remedies) but theoretically also of geographical segmentation of markets. Popular examples of geographic differentiation of remedies may be the cited cases of the Spanish and Polish wholesale broadband access markets where the regulatory authorities proposed to lift cost-orientation in more competitive areas, imposing essentially only an access obligation to prevent foreclosure in all other areas.

Bourreau et al. (2012b) assume that the regulator could maintain welfare-maximising price regulation in SIAs while imposing only an access obligation in DIAs. In this case wholesale access prices in DIAs would be freely negotiated. If an entrant feels, however, that the access price in such an area exceeds a level which allows it to enter the market sustainably, he may under the access obligation be able to ask the regulator to impose a price based on a dispute resolution procedure. The regulator would then impose a DIA access charge which is lower than the foreclosing price (and also set the corresponding optimal single infrastructure area access charge). With this procedure two incumbents would compete freely on the access price, provided it falls below the dispute settlement price.

Adjusting slightly the game-setting used in the preceding sections to Bertrand competition with homogenous goods at wholesale level, where the entrant chooses the most convenient offer, Bourreau, Hombert, Pouyet and Schutz (2011) show that in an unregulated environment the retail softening effect makes the rival not provide wholesale access to a more aggressive retail competitor (i.e. setting lower retail prices), which may lead to multiple equilibria. The potential wholesale profits have to be traded-off against possible losses of retail profits due to increased retail competition and demand expansion effects due to differentiation. This means that it is not always optimal to provide access, that undercutting at wholesale level is not always optimal and that the usual Bertrand result at wholesale level does generally not hold. It should be noted, however, that the softening effect disappears in case of full differentiation (i.e. independent goods) as then softening competition with relatively higher retail prices would not lead to higher wholesale revenues.

When this softening effect is present though, Bourreau et al. (2012b) show that a low access charge implies higher profits for an access provider than for the second firm which is not providing access. When the access charge is high enough, in turn, the contrary holds. This means that in a DIA setting there may be an access price below which giving access is more profitable than not giving access. Undercutting prices at wholesale level is then always an individual best response triggering a race to the bottom for providing wholesale services between the two incumbents leading to marginal cost prices for both operators. In the market model used by the authors this equilibrium is unique when services are sufficiently differentiated and the expected dispute settlement prices are sufficiently low. If instead services are sufficiently homogeneous, the access prices of both operators will be set at the second equilibrium, such that the profits of providing or not providing access are equalised (and the access charge is above marginal costs). In this case no operator would again have an incentive to deviate from its choice. Finally, instead, if the dispute settlement price is set sufficiently high, both incumbents may prefer not to make feasible offers (third equilibrium) but expect the regulator to set access prices hoping that it will subsequently not be chosen for access provision. This is in particular the case when the expected dispute settlement price is higher than the access price that equalises anticipated duopoly profits with the profits generated ex-post when providing access in the DIA at the profit-maximising access prices (subject to the condition that the entrant is not foreclosed).

Finally, with both sufficient product homogeneity and a low enough potential dispute settlement price one firm offers a monopoly access price, while the other makes no feasible offer. An anticipated low dispute settlement price can therefore unexpectedly lead to monopoly prices. Using their market model the authors then show how socially optimal prices could be enforced. If the socially optimal DIA access charge is below the access price that equalises the profits of providing and not providing access, the race to the bottom of DIA access prices must be stopped as strong competition has a too negative effect on investment incentives lowering welfare overall. The race to the bottom can only be stopped by setting a price floor at the socially optimal access price. If instead the socially optimal price is higher, it can in many cases be enforced by setting the dispute settlement price at the socially optimal price. In case, however, that the socially optimal access price is lower than the access price that equalises anticipated ex-ante duopoly profits with the profits generated ex-post when providing access in the DIA at profit-maximising

access prices (subject to the condition that the entrant is not foreclosed), this price cannot be achieved in equilibrium without further instruments.

Geographically segmented remedies can therefore lead to a socially optimal outcome under certain conditions. Whether this outcome is achieved or not depend on the details of how such regulation is implemented (especially for instance whether price floors and caps are imposed). Overall this type of regulation seems to have similar informational requirements to the other approaches proposed to maximise local welfare.

2.5. Discussion

In the preceding sections the effects of geographically segmented regulation have been analysed in detail. The simplified typical welfare effects of geographic regulation options that can be inferred from the existing literature are represented in Table 2. In light of the reviewed literature and the practical cases considered it is possible to draw conclusions for the identified regulatory options.

Geographic full deregulation. As has been shown, different regulatory authorities have proceeded to full deregulation of some areas of the country (Austria, Finland, Portugal, Switzerland and UK). Different authors have argued that geographic (full) deregulation may lead to foreclosure. While Lestage & Flacher (2010) argue that this is possible even in SIAs in case there is substantial quality advantage on the potential second incumbent, Bourreau et al. (2012b) argue that this possibility may be given, but only in duplicate infrastructure areas and only in case of low (horizontal) differentiation. Regulators should therefore use this tool with caution.

Geographical segmentation of access prices. In regulatory practice in Europe uniform above-cost access price regulation (e.g. LRIC) is still the commonly applied remedy (e.g. wholesale broadband access in Sweden). The theoretical literature shows, however, that uniform access price regulation is no longer optimal, in particular in case of a local roll-out of new infrastructures under geographically varying costs leading to geographically differentiated market structures. In particular local investment incentives are then not sufficiently taken into account. Bourreau et al. (2012b) show that instead welfare optimizing prices would vary according to investment cost levels and competition and should be largely set by the regulator. No European

regulatory authority has to date, however, used a coherent geographically differentiated access price model according to the level of investment cost and competition. A first step towards such an optimal solution has been made by the Dutch regulator. Geographically segmented fibre access prices according to investment cost (but not according to competition) were defined, resulting in access prices ranging from 16 to 26€ per month per unbundled fibre line depending on the cost cluster. Surprisingly, the decision has to date received few attention regarding this particular aspect by other regulators in Europe, BEREC or the European Commission. It should be noted that such a type of regulation can be close to a solution which also differentiates prices according to competitive conditions as it is likely that in the urban areas where Reggefiber deploys its network, such conditions may be rather homogeneous (cable competition). The question is then mainly whether the price imposed by the authority is also welfare optimal.

Regarding the segmentation of regulation according to competitive conditions no pure single infrastructure area/duplicate infrastructure area distinction has been adopted, as the European Commission judges such “rules of thumb” to be insufficiently represent the level of competition. In light of the above regulators and researchers should consider increasing their efforts to evaluate possibilities to approach current access price regulation to a feasible form of socially optimal geographically segmented access price regulation. The benefits in case of success could be important. Today, for instance, higher uniform access charges would lead to both higher total coverage as well as more duplication. Regulators are therefore currently facing a trade-off on whether to increase such access charges to incentivise investment (e.g. with risk premia on top of cost-based regulated prices) or not. In such a situation regulatory action may well depend on the subjective preferences of regulators, or in other words on how much competition they are ready to sacrifice in order to induce investments in more rural areas.

A regulator could for example decide to only target static welfare (competition), by imposing marginal cost access prices. These preferences may be an additional driver of the state of broadband networks in European countries today, representing the result of past investments decisions (as shown in Figure 1). When adopting an optimal regulatory regime setting welfare-maximising single and duplicate infrastructure area charges in all areas (such that single and duplicate infrastructure area investment is viable and static welfare maximised), regulators would need to take into account the degree of product differentiation at retail level, investment costs and retail competition. Imposing optimal prices would lead to a total coverage which is maximal and

to maximum static welfare per area (even lower prices in an area would mean that entry would not be viable in the first place and welfare could not have been generated at all). When a geographically segmented access pricing approach could be adopted the regulators dilemma of trading-off static and dynamic efficiency would therefore be solved.

Reaching this objective however seems a complex task and it may require a long time for the development of appropriate regulatory instruments. It should be considered whether current regulation would not have simpler options to make small steps in this direction.

In the framework of Bourreau et al. (2012b) it is shown that a local SIA long run incremental cost price is not optimal as it includes a positive rent (in addition the incumbents retail profits are not considered) and therefore it is higher than the price necessary to make local investment viable. Regulators to date, however, essentially use nationally uniform long run incremental cost prices. While Bourreau et al. (2012b) do not explicitly show this, their results can be interpreted such that local long run incremental cost prices are leading to higher welfare than a uniform long run incremental cost price. This conclusion could also be reached by the studies of Tselekounis, Xylogianni & Varoutas (2013), Soria & Herhández-Gil (2010) and Amendola & Pupillo (2008), which all demonstrate that differential regulatory pricing is in line with the underlying economics of NGA as to different geographic areas. This (geographically segmented prices) is the case as in urban areas a local long run incremental cost price would exceed both marginal cost as well as a price that would make the investment viable (as it includes a positive rent). In case of a uniform SIA long run incremental cost price, the price applied in urban areas will then be much higher than local long run incremental cost prices as a national cost base is considered. Therefore, in urban areas, a uniform SIA long run incremental cost price would be such that welfare could be increased by decreasing the SIA access price towards the local long run incremental cost price as the investment would continue to be viable and static efficiency could be enhanced. Conversely, in rural areas a uniform SIA long run incremental cost price would likely exceed marginal costs but may in many cases be lower than the price that would make a SIA investment viable. In such areas an increase in the price could trigger investment and lead to higher welfare. In other rural areas, especially where investments have already taken place, an increase of the charge towards local LRIC price might, instead, have the only consequence to reduce static efficiency. Overall, however, a scheme, which for instance

would approach regulated prices in urban areas to LRIC prices while leaving the access charges in rural areas unchanged would be invariably welfare enhancing.

Interestingly this is largely corresponding to the practical implementation of the Dutch regulation, which foresees local tariffs in parallel to national tariffs. Regarding implementation the circumstance that in the Netherlands an operator can only choose one of the two tariff models may, however, distort the result and potentially lead nevertheless to welfare losses in rural areas. When compared to the outlined theory the regulator would still need to develop a regulatory strategy to address competition, that is prices in duplicate infrastructure areas. Overall, however, the Dutch approach seems to be largely supported by the literature.

Geographical segmentation of remedies. Recently introduced risk premia shows that there is an increasing awareness at the political level that investment incentives may be currently insufficient. However, a clear link of the extent of the premia to the dynamics of optimal local investment incentives is to date lacking and a significant debate on (partial) de-averaging of regulated wholesale access prices according to cost clusters seems still not to take place. Since 2008, however, several regulation proposals and decisions of member states not only based on geographic full deregulation (as described above) but also on geographical segmentation of remedies have been observed leading in their result to (to some extent) geographically differentiated wholesale prices. The latter approach consists in practice mostly in imposing access-only obligations in urban areas implying some form of retail-minus regulation avoiding foreclosure of the entrant and standard cost-based regulation in rural areas (e.g. Spain, Poland).

Given the informational requirements on setting welfare-optimized geographically segmented access prices, Bourreau et al. (2012b) analysed whether a set of geographically segmented remedies can also achieve maximal welfare. In practice they proposed to largely deregulate DIA prices by defining a dispute settlement procedure, which would prevent foreclosure of access seekers in case no viable access price results on the free market (corresponding to an access-only obligation). Foreseeing the market outcome the regulator would then need to set a corresponding welfare-maximising SIA charge as well.

This type of deregulation may, however, have unwanted consequences. For instance, for sufficiently heterogeneous products, in DIAs a race to the bottom for wholesale access prices may result in equilibrium. But too strong competition on the wholesale level may not be socially

optimal, as at some point investment incentives are reduced sufficiently to reduce overall welfare. Hence, there may be cases where a DIA access price of zero may not be socially optimal and the regulator should step in to prevent too strong wholesale competition by setting a price floor at the socially optimal duplicate infrastructure area price. As currently regulators still focus on competition, this proposal is in contrast with current regulation.

On the other hand, when the socially optimal access price is high (and above the duplicate infrastructure area equilibrium price) it can be achieved in some cases by setting the dispute settlement price equal to the socially optimal price. In other cases further instruments would be necessary. Overall it seems that there would be only a few cases when the socially optimal charge would be reached spontaneously on the market. While the regulator could add safeguards to ensure socially optimal prices (such as a price floor and cap) this would imply similar informational requirements as with geographical segmentation of regulated access prices. Regarding price floors it should be noted that to date only few practical cases have received attention where access prices have been set by a regulated firm below the regulated (dispute settlement) prices. Even though this example of geographic regulation seems complex and not encouraging, regulators and researchers should try to further evaluate feasible dispute settlement procedures able to lead to socially optimal prices. In the below figure are presented the main drawbacks as well as promising effects of each regulatory policy approach based upon the literature and theoretical considerations.

NGA regulatory approaches

Uniform regulation

Conventional (full) regulation

- Conventional (full) regulation
- Uniform access rules and prices
- Trade-off problem (e.g. between static/dynamic efficiency)
- Migration effects not considered in general
- Limits the area of total coverage
- Optimal when duplication is not feasible
- SIA LRIC prices higher than optimum because of positive rents included

Full deregulation

- Duplication and accompanying risks of welfare losses.
- Foreclosure is possible (e.g. in case of low horizontal differentiation)
- Access only obligation might be applied.
- Unintended consequences might occur (e.g. exclusion and provision of lower quality goods)

Geographic regulation

Geographically segmented remedies

- Lighter set of remedies in more competitive areas (e.g. only-access obligation in DIAs)
- Free negotiation & dispute resolution could be applied (e.g. in DIAs)
- Multiple equilibria (e.g. in cases of low differentiation)
- Possibility of demand expansion and retail profit losses
- Price floor might be applied.

Geographically segmented prices

- "Pure segmentation prices set simply according to different population densities"
- Local demand and structures are needed for a coherent segmentation
- SIA and DIA access charges interrelated
- Optimal DIA charges positively correlated with product differentiation
- Interdependency problem (De Matos & Ferreira, 2011)

Across this picture, it is clear that emphasis should be paid to investment inducing mechanisms and regulatory tools, given the need for NGA investments underlined by EU policy makers. This paper sets forth alternative paths to achieve this.

In terms of methodology, many issues still remain to be explored. Methods to approximate socially optimal SIA and DIA access charges and to implement them should be the focus of future research. Other subjects of interest may include the structural assumptions of the models explaining the effects of geographic regulation. For instance, only static settings are currently analysed and regulatory commitment could be a problem. Also, possible strategic links between areas due to scale and scope economies, network effects or uniform retail price obligations are not sufficiently considered. Moreover, legacy infrastructure and investment sharing options could be integrating the migration debate described in the introduction in more detail. Also, alternative competition models could be considered as well as endogenous entry in an extended theoretical model. Finally, horizontal and vertical differentiations play a key role. The two alternative hypotheses of the source of vertical differentiation (service or infrastructure) in Lestage and Flacher (2010) indicate also that researchers and regulators may still need to uncover the driving forces of innovation in the broadband market.

3. Concluding remarks

This chapter integrates themes which have appeared throughout the text.

The review of practical cases has shown that by the end of 2013, European regulators continued to lack clarity on how to handle NGA-based geographic regulation. At the time of writing, a wide variety of regulations were being applied. Their ultimate success will not be evident until several years after their implementation. To cite only the most extreme cases which have been reviewed:

- While nearly all regulatory authorities continue to apply nationally uniform access prices, the Dutch regulator imposes also regional access prices varying with the extent of investment cost.

To date, there do not appear to be strong initiatives to address these issues at the European level. It is possible that this is the case as regulators, BEREC and the European Commission do not yet have a clear vision on these issues. Nevertheless, it seems that regulators are now in a position to start to reflect on how to introduce and implement regional access prices and how to better promote investment incentives in general.

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Tables

Table 1a
Geographical segmentation of markets

Country	EC Case No.	SMP operator	Product market	Geographic market	Type of regulation imposed	Status	Comment on status
Austria	AT/2013/1442-1443 AT/2009/0932	Telekom Austria	Terminating segments of leased lines > 2 Mbps and < 155 Mbps	1) 12 competitive communes having population >15'000, more than three infrastructure-based competitors and a market share of the incumbent <50% 2) The rest of the country	1) None 2) Access, non-discrimination, price control, accounting separation and transparency	Withdrawn (partially)	A first market definition of 12 cities and the rest of the country has been contested by the EC. The partial decision of regulating high-speed lines in the rest of the country had been withdrawn. In its more recent fourth round market analysis (2013), the Austrian NRA reverted back to no geographic markets and uniform remedies. The EC vetoed this decision as there seems to be a lack of evidence for homogeneous competitive conditions across all regions in the country. BEREC has shared this view.
Czech Republic	CZ/2012/1322	Telefonica CR (incumbent)	Wholesale broadband access	1) Districts with at least three infrastructures 2) Rest of the country	1) None 2) Access, non-discrimination, cost-orientation, accounting separation and transparency	Withdrawn	BEREC supported the NRAs proposal. However, the proposal was vetoed by the European Commission and it has not entered into force.
Finland	FI/2013/1328-1329	27 regional incumbents	Wholesale broadband access	111 regional submarkets aggregating contingent municipalities with similar competitive conditions (number of competitors and market share of incumbent), 104 of which are non-competitive and 7 competitive	7/111 markets: None 104/111 markets: Access, non-discrimination, and transparency	Adopted	The EC did not comment on geographic issues and the decision has been adopted.

Finland	FI/2013/ 1328- 1329	27 regional incumbents	Wholesale (physical) network infrastructure access	111 regional submarkets aggregating contingent municipalities with similar competitive conditions (number of competitors and market share of incumbent) all of which are non-competitive	111 markets: Access, non-discrimination, cost-orientation, accounting separation and transparency (particularly small regional incumbents are subject to lighter regulation)	Adopted	The EC did not comment on geographic issues and the decision has been adopted.
Portugal	PT/2008/ 0850-851	PT	Wholesale broadband access	1) MDF areas where cable (at least 60% coverage) and one LLU operators are present 2) Other MDF areas	1) None 2) Access, non-discrimination, price control (retail minus), accounting separation and transparency	Adopted	The EC had raised concerns that in some competitive MDF areas the market share of the incumbent is still above 50%. It has therefore invited the NRA to carefully monitor the future evolution of competitive conditions, but the decision was adopted.
Portugal	PT/2010/ 1121	PT	Leased lines (trunk)	1) Competitive trunk segments (between 110 local exchanges where two or more alternative operators are present) 2) Other, non-competitive trunk segments	1) None 2) Access, non-discrimination, cost orientation, accounting separation and transparency	Adopted	The EC has states that the geographical segmentation is primarily based on the number of operators and was insufficient. Given the important differences in market shares and network duplication the European Commission did, however, not contest the decision.
Switzerland	-	Swisscom	Leased lines	1) Lines between communes where more than 3 operators are present (25 Communes in 2009 and 41 Communes in 2010) (trunk segments) 2) Other leased lines ("terminating" segments)	1) No regulation 2) Access, non-discrimination, cost-orientation and transparency	Adopted	This decision is in force. Not being part of the EU framework, the Swiss NRA did not need to notify the EC. If it would have had to, in light of the other cases, the decision would probably have been vetoed for unstable market borders.
UK	UK/2010/ /1123 UK/2007/ /0733	BT	Wholesale broadband access	1) MDF areas where the incumbent is the only operator present , 2) MDF areas where two or more alternative operators are present	1) Access, non-discrimination, cost orientation, accounting separation and transparency as well as an additional	Adopted	The EC reminded the NRA that the sole criterion of the number of operators is not sufficient for geographic market segmentation, but that homogeneity has to be ensured checking for possible geographic variations in market shares

				(or three when BTs market share is greater than 50%) and 3) areas where in addition four or more alternative operators are present (or three when BTs market share is lower than 50%)	strict form of price control (RPI-X). 2) Access, non-discrimination, cost orientation, cost orientation, accounting separation and transparency 3) None		and pricing. The EC invited the NRA in particular to provide additional structural and behavioural evidence. It did, however, not veto this decision.
UK	UK/2013/1428 UK/2008/0747-0749	BT	Terminating segments of leased lines > 8 Mbps with traditional interface	1) WECLA: Areas with two or more alternative competitors with own infrastructure and low market shares of the incumbent 2) Rest of the country	1) None 2) Access, non-discrimination, price control (RPI+X), accounting separation and transparency (for bandwidth at 622 Mbps no remedies are imposed)	Adopted	The EC has cleared this proposal and it was subsequently adopted.

Table 1b
Geographical segmentation of remedies

Country	EC Case No.	SMP operator	Product market	Geographic market	Geographic Segmentation of Remedies	Type of regulation imposed	Status	Comment on status
Austria	AT/2013 /1475 AT/2007 /0757	Telekom Austria	Wholesale broadband access	1) MDF areas with two or more alternative operators present, incumbent market share below 50% and serving more than 2'500 households 2) other areas	-	1) Accounting separation 2) Access, non-discrimination, price control (retail minus), accounting separation and transparency	Adopted but rejected by national court	The EC had signalled to veto a first proposal of the NRA to introduce geographic markets in 2008. The NRA had then adapted its proposal to define a national wholesale broadband access market and proposed to withdraw most remedies in more competitive segments of the market. The EC had accepted this proposal. It was, however, rejected by the Austrian Administrative Court 2008 leading to an implementation of regulation without geographical differentiation. In the recent fourth round of market analysis (2013) the NRA again proposes a national market, this time with nationally uniform light remedies (retail minus price control). But no geographical differentiation of remedies is proposed.
Germany	DE/2010 /1116	Deutsche Telekom	Wholesale broadband access	National	-	Access, non-discrimination, accounting separation and transparency	Adopted	While the NRA had analysed a possible submarket, national pricing strategies of the incumbent indicated a national market. The Commission agreed that there is no conclusive evidence for a geographically differentiated regulation. The decision was then adopted.

Italy	IT/2011/1230	Telecom Italia	Wholesale broadband access	National	1) Infrastructure competition 2) No infrastructure competition (the definition of areas under infrastructure competition is still pending)	1) Access, non-discrimination, cost-orientation (a particular methodology leading to higher prices), accounting separation and transparency 2) access, non-discrimination, cost-orientation, accounting separation and transparency	Adopted (partially)	The market has been defined nationally. A concrete proposal on the geographical extent of the segmentation of remedies is pending.
Netherlands	NL/2009/0868	KPN/Reggefiber	Wholesale (physical) network infrastructure access	National	National, but fibre LLU access prices are geographically segmented according to capital requirements (14 areas in 2013).	Access, non-discrimination, transparency and price control. For fibre: Max. internal rate of return (IRR) allowed up to risk adjusted WACC + risk premium 3.5%. If exceeded price caps are reduced. Local fibre LLU access price caps currently range from 16-26€/month. There is also a cap for a national tariff of 18€	Adopted	The EC has accepted the Dutch regulation proposal.
Poland	PL/2011/1184	TPSA	Wholesale broadband access	National (earlier proposal : 11 cities, rest of the country)	1) Four largest cities 2) Rest of the country	1) Access and non-discrimination 2) Access, non-discrimination, cost-orientation, accounting separation and transparency (earlier proposal in 2011: no regulation in	Withdrawn	Both decisions have been withdrawn, meaning that currently national cost-based regulation is still in place.

						11 cities, cost regulation in the rest of the country)		
Spain	ES/2008/0805	Telefonica	Wholesale broadband access	National	1) MDF areas where cable and two LLU operators are present and the incumbent has less than 50% market share 2) Other MDF areas	1) Access and non-discrimination 2) Access, non-discrimination, cost-orientation, accounting separation and transparency	Withdrawn	While BEREC had supported the NRAs view on both a national market and the possibility of geographic remedies in this case, the EC had asked the Spanish NRA to withdraw the proposal for insufficient evidence.

Table 2
Welfare effects of different geographic regulation tools

Geographic regulatory policy approach	Static welfare (competition)	Dynamic efficiency (investment incentives in SIA and DIA)	Total welfare
Geographically segmented regulated access prices according to investment cost and competition	Optimal	Optimal	Optimal (even if in the market model this implies no duplication)
Geographically segmented LRIC prices according to investment cost and competition (SIA)	Suboptimal	Suboptimal	Suboptimal (but better than uniform LRIC ⁴¹)
Geographically segmented remedies	Can be optimal	Can be optimal	Can be optimal (depends on mechanism)
Uniform or geographically segmented cost-oriented access price regulation (at marginal cost)	Suboptimal (but optimal in already covered areas)	Suboptimal	Suboptimal
Uniform above cost access price regulation (e.g. LRIC)	Suboptimal	Suboptimal	Suboptimal (but better than marginal cost-oriented)
Uniform full deregulation	Suboptimal	Suboptimal	Suboptimal
Geographically segmented full deregulation	Suboptimal	Suboptimal	Suboptimal
Geographically segmented prices according to competition only	Suboptimal	Suboptimal	Suboptimal
Geographically segmented LRIC prices according to competition only	Suboptimal	Suboptimal	Suboptimal

⁴¹ This is an interpretation and not demonstrated in the relevant article.

Table 3

Theoretical analysis – geographical segmentation of remedies and geographic aspects of regulation

Main Assumptions										Main results
Article	Geographic difference in cost and competition considered	Geographically differentiated retail prices allowed	Allow for geographically differentiated access prices (cost)	Allow for geographically differentiated access prices (competition)	Type of retail competition	Entry	Old technology	Remedies considered	Case of free wholesale market considered	
Bourreau, Cambini, & Hoernig (2012b)	Yes	Yes	Yes	Yes, number of firms	Bertrand, horizontally differentiated goods	Two potential incumbents and potential downstream entrants	No	- Access obligation - Access price regulation	Yes. Bertrand, no differentiation (at same prices access providing firm is chosen randomly)	Marginal cost-based geographic access prices lead to suboptimal roll-out and duplication and uniform pricing to too much duplication. The paper analyses geographic regulatory instruments able to achieve the social optimum, i.e. geographically differentiated prices or remedies.
De Matos & Ferreira (2011)	Yes	Yes	Yes	No (assumed to be competitive when investment costs are such to allow infrastructure competition)	Cournot, horizontally differentiated good	Endogenous (simulation)	No	Access price regulation	No	Different market outcomes with different access rates are simulated. Low access prices erode the profitability of infrastructure providers. When regional markets

										interact, deregulation of more competitive areas may trigger a monopoly situation in an adjacent market.
Flacher & Jennequin (2012)	Yes	No	No	No	Cournot, vertically and horizontally differentiated goods	One potential infrastructure entrant, one potential downstream entrant (no duplication)	Yes	-Access price regulation -Coverage obligation	Yes	Show that regulation to maximize total coverage (full deregulation) is not optimal, as well as cost-based regulation to maximize static efficiency. Suggests that setting access prices and coverage obligations is optimal.
Lestage & Flacher (2010)	Yes	Yes	No	No	Bertrand, vertically differentiated goods	Two potential incumbents	Yes	- Access price regulation	Yes	A low access price may lead to areas having two equilibria, where it is not clear which operator would invest. It is then uncertain whether there will be investment at all. If the quality advantage of firm A is sufficient this problem disappears.

Figures

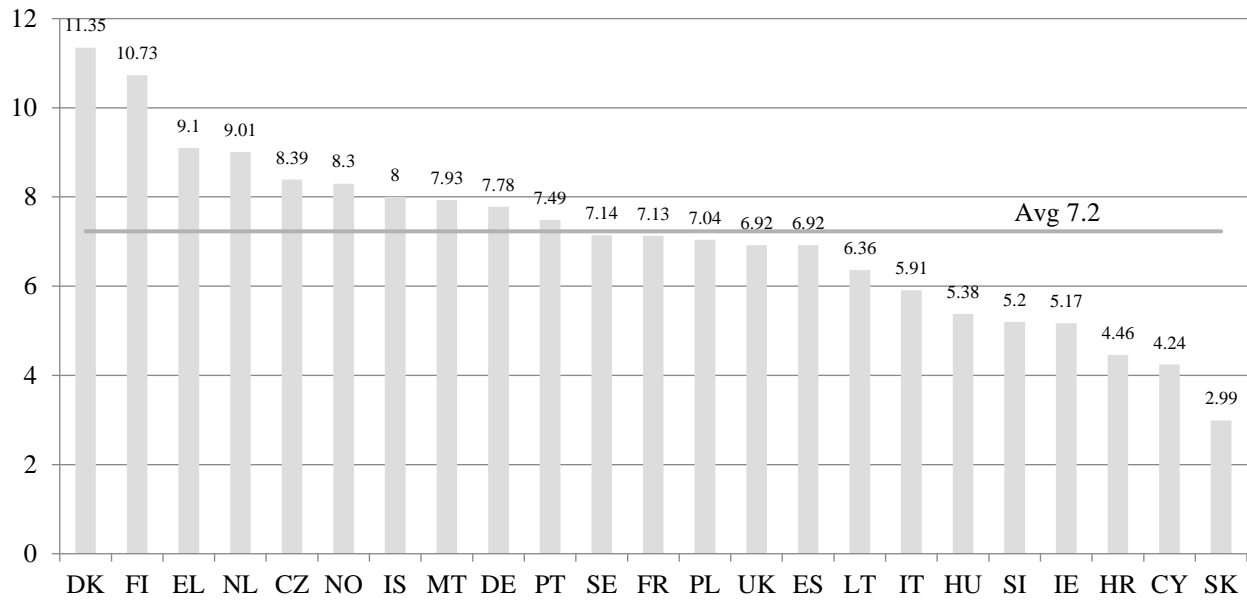


Figure 1. Actual xDSL Speeds in Europe (Source: Samknows, March 2012)

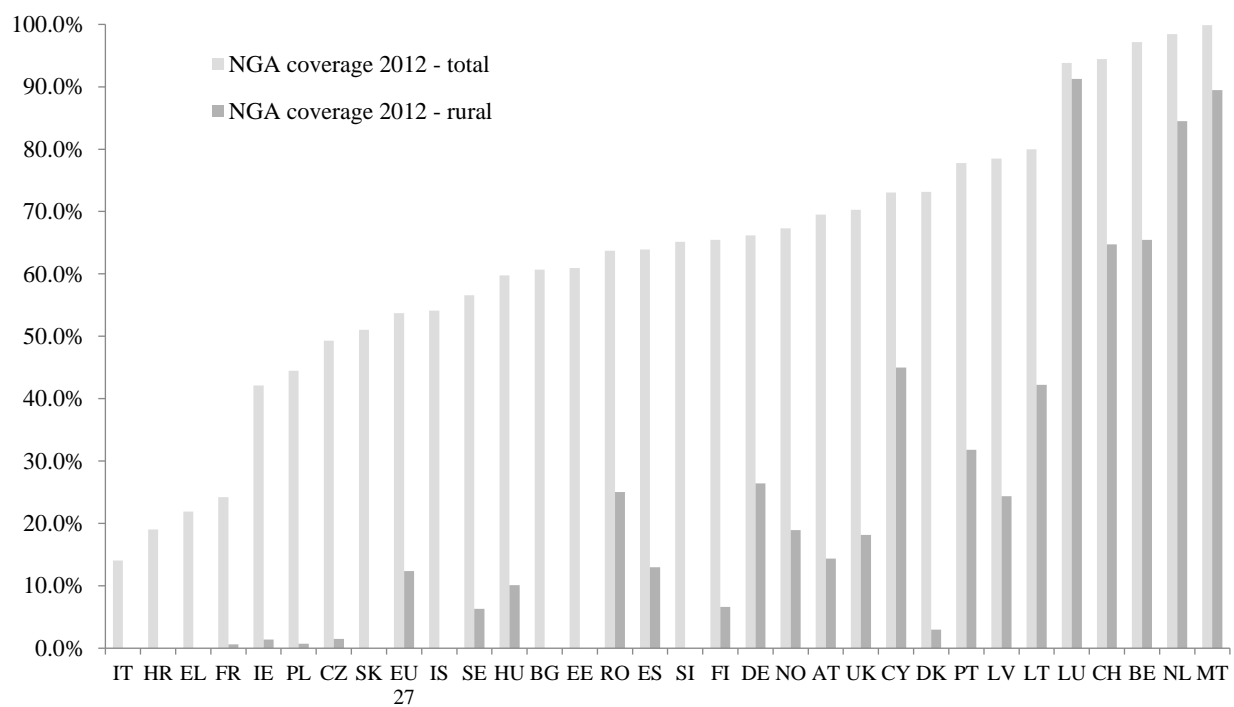


Figure 2. NGA coverage in Europe 2012, total and rural areas (Source: Point Topic)