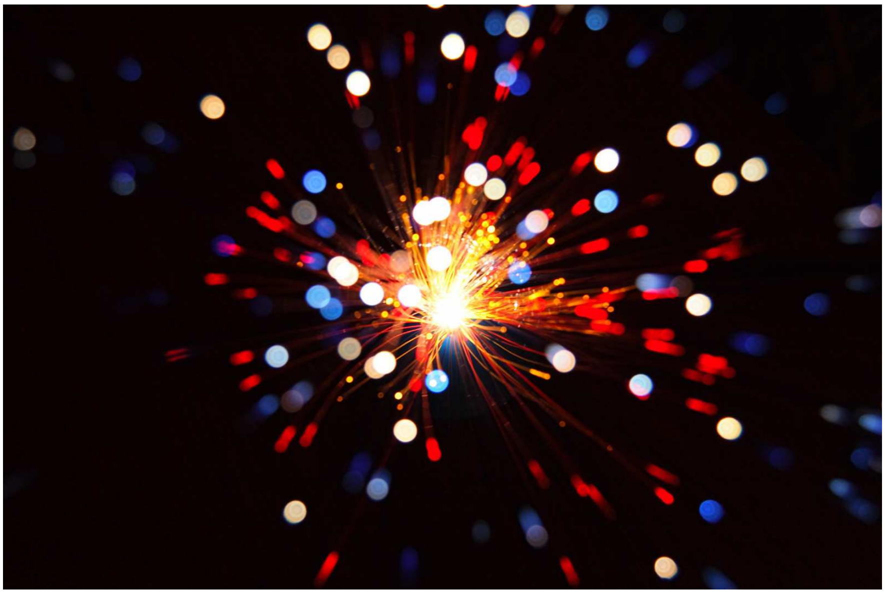
THE FUTURE OF BROADBAND POLICY: PUBLIC TARGETS AND PRIVATE INVESTMENT



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A REPORT BY THE FLORENCE SCHOOL OF REGULATION – COMMUNICATIONS AND MEDIA FOR THE PUBLIC CONSULTATION ON THE NEEDS FOR INTERNET SPEED AND QUALITY BEYOND 2020

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The future of broadband policy: public targets and private investment

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EXECUTIVE SUMMARY

Internet and its connected innovative technologies are fostering the digital economy and society, one of the main objectives of the European Union (EU) and by consequence of the new European Commission. In fact, the deployment of New Generation Networks to ensure specific targets in terms of availability and adoption of fast and high quality Internet connections for European households is one of the main pillars of the Digital Agenda for Europe (DAE) 2020. In spite of the relatively wide set of policy tools put in place at the European and national level, profound differences in terms of broadband coverage and adoption do however persist across member States. These disparities have largely contributed to a feeling of dissatisfaction for the level of investment in broadband networks in Europe. Partly as a response to this view, the European Commission opened a public consultation to assess the need for broadband speed and quality beyond 2020.

Following the questions posed by the consultation, this Report intends to focus on targets, i.e. the meta-instrument that precedes the implementation of more traditional policy instruments, such as national plans, sector-specific regulation, competition policy and direct public intervention. In particular, the Report aims at exploring the impact of setting future targets for ultra-fast broadband, also considering the opportunity, and the risks, of formulating targets that specifically favour higher performing technological solutions, i.e. FTTH, which enables connection speeds well above 100 Mbps, over others, i.e. cable, copper, wireless technologies or a mix of them.

The reason why broadband targets of the kind that have so far been set at the EU level deserve a special attention is that, being voluntary and non-binding, they may appear relatively innocuous. Yet, they are susceptible of driving the direction of future policies and consequently investment to a significant extent. Targets influence each of the policy tools that have so far played a role in broadband promotion, particularly national broadband plans, regulation and public investment. These policy levers, in turn, exert material effects on competitive dynamics and incentives to invest of private operators.

The first question the Report deals with is the rationale for uniform targets to promote broadband in the EU and the rationale for targets specified in terms of extended coverage of ultra-fast broadband technologies. In this regard, the analysis suggests that the setting of uniform targets does not appear to rest on a solid economic rationale either within countries or across countries. Data show that, in general, broadband penetration and adoption do produce sizeable externalities, which may justify the introduction of public policies to support broadband rollout and adoption. However, broadband impact on the economy tends to be very heterogeneous. Broadband has effects, e.g. on growth and/or employment, when used by firms or individuals with particular characteristics in particular areas, and therefore it is difficult to extrapolate broadband impact when used by firms or individuals without those characteristics or in different areas. Thus, even within countries, the rationale for uniform targets does not appear to be economically robust.

As for targets specified in terms of extended coverage of ultra-fast broadband technologies, we can conclude that the existing evidence is not sufficient to make a case for expressing a preference across the board for FTTH solutions. To clearly support the view that an extension of ultra-fast broadband targets would be justified, it would be necessary to find evidence either of the fact that significant positive externalities are not reflected in the current level of demand for ultra-fast broadband, so that there is a wedge between social goals and individual choices, or that a sufficient willingness to pay exists that is not met by private demand. The available empirical evidence does not confirm either of these elements.

These conclusions are corroborated also by the analysis of fast and ultra-fast broadband demand. The Report highlights the extreme heterogeneity existing as regards adoption and take-up of broadband technologies as well as adoption and take-up of fast vs. ultra-fast technologies. A specific gap between adoption and coverage is evident between EU founding members and Eastern European countries. Thus, also from this perspective, it can be safely concluded that one size does not fit all. In particular, attention should be paid to the fact that the economic rationale for investing in FTTH solutions is different for countries where substantial investment in copper upgrades has already been sunk as opposed to countries where the choice of technology may be less influenced by past investment.

Also, the available evidence on Next Generation Networks (NGN) demand is scant and unable to clearly provide empirical support to the proposition that more ambitious ultra-fast broadband targets than those currently embedded in the DAE would be justified on solid economic grounds. Most of the (weak) economic evidence suggests that customers are likely to have high incremental willingness to pay for a high speed service, but a low incremental willingness to pay for a very high speed service.

An additional issue that has been considered in the Report is whether there may be other market failures, additional to externalities, that may suggest to promote specific technologies – FTTP vs. FTTC or FTTH P2P vs. PMP. In particular, the possibility that departures from the technology neutrality (TN) principle may be justified on the grounds that they could allow to address problems deriving from the persistent relevance of bottlenecks owned by incumbent operators was explored. In this regard the Report concludes that the original rationale for TN remains in principle valid as any overly specific approach brings its own dangers. Prescribing specific technological solutions does not allow to exploit firms' comparative information advantage as regards the costs and benefits of different technologies. All in all, even though TN should always be considered an instrumental principle, which may be abandoned if a solid economic supports the notion that it may conflict with other fundamental objectives, any departure from it should be grounded on solid analysis and be undertaken with caution.

Finally, the Report provides insights as to the consequences and desirability of the voluntary and non-binding nature of the targets. This soft 'industrial policy' approach has some advantages. The first is that it appears more compatible with the overarching principle in policy design that indicates that policy makers should adopt the measures that make the best use of private information. From this perspective, a mere indication of the preferred broadband deployment outcomes in terms of coverage and speed fares comparatively better than one that prescribes specific network designs or inputs. Moreover, the fact that targets are uniform on paper, but not necessarily in practice, may be conceived to leave room for differences at the implementation stage that can take into account heterogeneities as well as different starting points at the country level.

However, targets inspired by political desiderata shape both private and public operators' expectations in ways that are not necessarily compatible with the very objectives that those targets are meant to pursue, even if they do not involve strict enforcement or commitment of public resources. First, private operators' expectation that public resources will be found, sooner or later, to back the EU-level targets may result in a waiting game, whereby private investment may be delayed even in areas where a business case would otherwise exist, because to wait promises to deliver benefits in terms of a public subsidy that substitutes in part for private investment. This may give rise to sub optimal results from the perspective of the DAE objectives from two, equally troubling, perspectives: either investment does not happen at all, or it follow too late, in case of scarce public funds; or investment occurs, but simply with public money crowding out private investment.

The effects of targets on public decision-makers' expectations and policy choices in the heterogeneous EU member States may be equally problematic. To bring concrete results, ambitious targets should find support in significant amounts of public investment. An outcome where public investment increases substantially is, however, not only relatively unlikely, but also by and large undesirable, since public investment, as is well known, carries a concrete risk of crowding out or else distorting private investment.

Moreover, higher targets would induce public decision-makers to make possibly misguided choices as regard the trade-off between coverage and performance. In particular, uniform targets focusing public investment on ultra-fast broadband technologies almost automatically reduce coverage, because more resources are required to meet the targets in any given area. Finally, there is a risk that far-reaching targets induce public investment to be biased towards supply-side policies, at the expenses of demand-side policies, so that coverage would be promoted at the expenses of adoption. Since, however, it is actual use of technologies rather than availability of networks per se that generates social welfare, it is doubtful that this outcome can be considered truly desirable.

In conclusion, a soft industrial policy in favour of the development of the NGNs throughout Europe can be certainly considered a worthy policy objective, but its concrete declination and application must pass all the necessary examinations of economic rationality and industrial realism.

INTRODUCTION

In the Affair of so much Importance to you, wherein you ask my Advice, I cannot for want of sufficient Premises, advise you what to determine, but if you please I will tell you how. …To get over this, my Way is, to divide half a Sheet of Paper by a Line into two Columns, writing over the one Pro, and over the other Con. …And tho' the Weight of Reasons cannot be taken with the Precision of Algebraic Quantities, yet when each is thus considered separately and comparatively, and the whole lies before me, I think I can judge better, and am less likely to take a rash Step; and in fact I have found great Advantage from this kind of Equation, in what may be called Moral or Prudential Algebra.

Benjamin Franklin (1772), *Letter to Joseph Priestley*.

The deployment of the New Generation Networks that ensure the availability of an Internet connection at a minimum speed of 30 Mbps for all European citizens, and above 100 Mbps for at least 50% of European households, is one of the main pillars of the DAE 2020.

The European Commission has recently opened a public consultation to look into the needs for broadband speed and quality beyond 2020. The purpose of the new consultation was to understand and assess the needs relating to Internet speed by taking into account all of the stakeholders' views - households, businesses, public institutions – in order to develop an adequate and possibly future-proof public policy.

In the past, to promote the development of the digital economy and society, and, specifically, to pursue the targets of the DAE, the European Commission and member States have intervened using several different policy approaches. In principle, they have adopted a threefold strategy: to organize the plans that are finalized, so as to reach the targets for coverage; to adopt regulations that are favourable to investment; and to finance direct interventions in building networks, all joined to some form of demand side policy.

First, EU policy has involved the translation, by the member States, of the above-mentioned European voluntary targets for the coverage, adoption and speed of Internet connections, into national broadband plans. The plans, as well as the results, however, have varied widely throughout Europe. Second, some regulatory provisions have been re-examined with the intent to favour network investment and to foster the development of facilities-based competition in the European electronic communications markets. This process, however, has been, and still is, the subject of intense debate. Third, public direct investment in networks, at the central or local levels, have been explicitly endorsed as a means to stimulate the broadband rollout, not only in rural or poor geographical areas, where it would have been otherwise commercially unprofitable, but also, to some extent, in areas where existing broadband infrastructures were not perceived to be adequate, in light of the targets set at the European and national levels. Even this activity has not given the expected results.

Together with these supply-side policies, there have been scattered attempts of policies aimed to promote the adoption of broadband through incentives to the demand-side of the market.

In spite of the relatively wide set of policy tools put in place at the European and national levels, profound differences, in terms of broadband coverage and adoption, thus persist across the member States.[1] These disparities have largely contributed to the recent dissatisfaction at the level of investment in broadband networks. This is a feeling that has contributed to worsening the common perception of the result achieved in Europe so far, even when objective data suggest that the present situation, on average, is no worse than in competing areas of the world, for instance, in the USA.[2]

By partially interpreting this discontent, the consultation called for a new set of policies for the future Digital Agenda.

Following the questions posed by the consultation, this Report intends to focus on targets, i.e., the meta-instruments preceding the implementation of more traditional policy instruments, such as national plans, sector-specific regulation, competition policy, and direct public intervention (in the form of substitute or gap investment). The coverage and/or the speed broadband targets are usually introduced by defining the percentage of the population that needs to be served by broadband with the specific service level that is chosen for the referenced territory. Similar measures are used for the adoption targets. Once targets are defined, they have to be translated into actual policy plans by comparing them against the actual situation.

In particular, the Report aims to explore the impact of setting future targets for ultra-fast broadband, also considering the opportunity, and the risks, of formulating targets that specifically favour higher performing technological solutions, i.e., FTTH, which enables connection speeds well above 100 Mbps, over others, i.e., cable or copper.[3] Indeed, given the present widespread (though, to some extent, misguided) perception of the relatively scarce performance of the EU, in terms of the uniformity of broadband indicators across member States, as well as in terms of international benchmarking, it might be tempting to set more challenging targets than those currently embodied in the DAE.

The reason why broadband targets deserve specific attention is that, being voluntary and non-binding, they may appear relatively innocuous. Yet, they are susceptible to drive the direction of future policies and, consequently, of investment, to a significant extent. Targets influence each of the policy tools that have so far played a role in broadband promotion, particularly national broadband plans, regulation and public investment. These policy levers, in turn, exert material effects on the competitive dynamics and incentives to invest for private operators.

While speed and adoption quantitative targets apparently respect the principle of technological neutrality, this is true only to the extent that the targets that are actually set do not fall out of the characteristics of certain industrially and economically alive technologies. For instance, setting a target that is very high in terms of speed, may foreclose on certain technologies that are available in the market at lower costs.

In particular, setting ultra-fast broadband targets that are too ambitious may impose constraints on the choice between different types of FTTx technologies, between wireline and wireless solutions, and may foreclose in some of the most innovative hybrid solutions. The main focus of this Report will

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[1] European Commission (2015b).

[2] SamKnows Report (2013).

[3] In this Report 'ultra-fast broadband' refers to the fastest FTTx architectures available, i.e., ‚Fiber-to-the-home and Fiber-to-the building (FTTH/B). FTTH and FTTB technologies are jointly referred to as Fiber-to-the-Premises (FTTP). 'Fast broadband', in turn, also includes hybrid-fiber copper and coax technologies (FTTC/VDSL Vectoring and FTTLA/DOCSIS 3.0). This distinction between fiber technologies into the fast (over 30 Mbps) and the ultra-fast (over 100 Mbps) categories, is somewhat blurred. However, we will define as ultra-fast those technologies that can guarantee 100 Mbps symmetrical speed for every subscriber at all times.

be on wireline technologies, in light of the fact that they have so far posed the greatest challenges in terms of investment incentives and regulation. However, the wireless solutions so far considered are mostly complementary to wireline technologies, and they may show increasing degrees of substitutability with wireline alternatives in the future.

The pace of technological change in this domain is extremely fast, so uncertainty over the appropriate technological choices makes most medium- to long-term forecasts unreliable. Consider, for instance, two recent developments that illustrate the fast speed of technological evolution. One is hybrid broadband access, which combines fixed and mobile access, in a search for maximum quality of service and coverage at minimum costs. In the same line one might mention the Google Project Fi, a concept and technology with a very disruptive potential, combining different mobile networks into a hybrid that automatically uses the best mobile signal available, while also incorporating WiFi calling ("voice over WiFi").

Departing from technological neutrality to pursue the 'future proof' technologies of today may incautiously exclude the future technologies of tomorrow. Our analysis moves from the premise that there is an essential need for targets to be set, not according to political imperatives, but, rather, after a careful technological and economic analysis. Such an analysis must be rooted in a comparison between the social costs and benefits of the investment to be made, including also the prospective policies that are needed to achieve that objective. There therefore needs to be an overall awareness of the current situation of broadband deployment and of its future developments, both in terms of demand, supply (e.g., the type of applications, the level of competition) and in terms of technological advances, in order to be able to set sensible, useful and, above all, realistic targets. The effect of unique targets in the presence of a differentiated starting situation also calls for a thorough analysis of the possible implications and consequences.

The role of broadband targets as policy instruments will be examined in regard to their rationale and their interaction with several different dimensions of the industry. To this purpose, the authors review the relevant economic literature on the impact that the connection targets of national and supra-national broadband plans may have on telecommunications markets in terms of their structure, competition and regulation.

The structure of the Report is as follows. Chapter 1 introduces the role of broadband targets and discusses their economic implications and consequences. In particular, it considers the issue of the various forms of externalities that are associated with broadband availability and that motivate the setting of digital targets. Chapter 2 proposes an analysis of the demand for ultra-fast broadband. This is done by considering the demand perspectives from the point of view of technology (theoretical band requirements) and economics (willingness to pay). A key issue that is addressed in this chapter concerns the existence of the network effects that are associated with NGNs, a point that is already widely recognized, and the issue of whether these effects are linked to some specific level of speed or adoption. Network effects are a special type of externality that is related to the broadband adoption process: increases in the adoption rates lead to increases in the usage intensity of the respective services, but it remains unclear whether this depends on a specific (minimum) quality of service. Chapter 3 is centred on supply-related issues, and, specifically, on the relationship between targets, technological neutrality and regulation. Whether TN constitutes a value in itself, and which are the consequences for public choices of the alternative responses to these questions is discussed. Chapter 4 moves from the present markets' configurations of the European electronic communications industry and the limited role played, so far, by public intervention. In particular, it analyses and discusses how public intervention, by deciding to force TN in order to reach coverage and/or adoption targets, may reshape market structures and, consequently, may influence competition dynamics in the future. The chapter also considers the impact of higher targets on the various trade-offs involved through the different objectives of the DAE. Chapter 5 summarizes and concludes the work, with an eye to usefully contributing to the consultation of the European Commission on the future digital agenda. This final chapter starts from the methodology and content of the Commission's consultation, and builds on the previous chapters, underlining the major open questions, and it then advances some tentative conclusions and a few policy suggestions.

CHAPTER 1 | The role of broadband targets

1 INTRODUCTION

Broadband Internet has probably been the fastest developing industry in the last two decades. From its early development as an experimental network that linked a limited number of computers, it has now become one of the key priorities for policy makers around the world, as it is seen as an engine for economic growth. Nonetheless, at least in Europe, it is normally left to the market to supply Internet connections, via Internet Service Providers (ISPs), such as telecom and cable providers. Policy makers have traditionally limited their direct interventions to a few targeted rural areas, on top of ensuring a level-playing field among ISPs.

Perhaps as a way to escape the economic crisis, this discreet approach has changed recently. Predictions about the impact of the Internet and broadband infrastructure have been optimistic, and sometimes even outlandish. Policy makers expect broadband to lead to job creation and economic growth. In the USA, the Federal Communications Commission (FCC) launched the National Broadband Plan in 2010 in order to improve Internet access. One goal is to provide 100 million American households with access to 100 Mbit/s connections by 2020.[4] In Europe, broadband is one of the pillars of Europe 2020, a ten-year strategy that has been proposed by the European Commission. Its Digital Agenda identifies targets that are even more aspirational than the US's: for instance, also by 2020, every European citizen will need access to at least 30 Mbit/s, and at least 50% of European households should have Internet connections above 100 Mbit/s.[5] In the UK, the government would like universal coverage of ADSL by 2015, and it is focusing its 'superfast broadband' efforts on 'fiber to the node' technologies.[6] Even though 'superfast' in the UK is rather slower than in countries like Korea, the government hopes that the economic impacts of faster broadband speeds will be substantial. Research commissioned by DCMS projects that fast broadband could add £17bn to the UK's *annual* Gross Value Added by 2024.[7]

This chapter looks at the rationale for adopting broadband targets. Clearly, these targets are not a goal in themselves but, insofar as they ensure the achievement of some other meaningful goals. The major question that needs to be answered relates to the economic impacts of broadband. To get a sense of where these economic benefits might come from, we start by looking at the wider role of the Internet, and at information and communication technologies (ICTs) in general. Broadband Internet, like many other ICTs, is generally considered to be a 'general purpose technology', in that it functions across many areas of economic and social life, and is an enabler of further innovation in those fields.[8] The economic analysis of ICTs looks at both direct effects (such as the growth of the digital economy and online industries) and indirect effects (on GDP, employment and wages, industry structure and the organization of work).[9]

2 THE ECONOMIC IMPACT OF BROADBAND

There are differing views on how ICTs and the Internet shape economic progress. Enthusiasts argue that ICT adoption helps to explain the growth in productivity (particularly of labour) in developed

4 http://www.broadband.gov/plan/
5 http://ec.europa.eu/digital-agenda/our-goals/pillar-iv-fast-and-ultra-fast-Internet-access
6 https://www.gov.uk/broadband-delivery-uk
7 SQW (2013).
8 Bresnahan and Tratjenberg (1995).
9 OECD (2013).

countries. They point to the US experience with computerisation in the 1980s as an illustration of what ICT can deliver.[10] By contrast, sceptics suggest that these economic effects are overstated, and that the Internet, in particular, is far less significant than is often assumed. These critics also emphasize the potential for ICTs to increase inequality, and the economic costs of technological disruption.[11] There is a middle camp between these groups, which assumes that the Internet and ICTs contribute to economic change, but that the extent of this change depends on how people and firms adapt to, and innovate around, technology. For example, a number of studies suggest that ICT investment only delivers productivity gains for firms who also introduce training for staff and new ways of working.[12] In turn, this perspective suggests that take-up and use of broadband may be more important than simply the availability of the technology. It also suggests that the firms most likely to gain from broadband may be the most likely to adopt the technology, which creates a challenge to assessing the causal impact of broadband (technically, this constitutes an endogeneity problem; see further discussion below).

For firms and their workers, broadband should allow for efficiencies in production, both by lowering costs (for data storage, advertising, or working with suppliers), and by enabling innovation (reaching new customers online, for instance, or employing big data analytics).[13] Those productivity gains may translate into higher wages, and possibly into higher levels of employment (although firms may well shed staff in response to technological change). At the same time, broadband may allow for more flexible patterns of work, including working at home, or on the move. For some groups of people, such as those with caring responsibilities, and more flexibility may increase labour force participation, which could, in turn, raise employment levels. More widely, broadband may lower the barriers to starting a business, particularly in sectors like retail.[14]

It is also important to recognize that there may be winners and losers from all these changes. If broadband makes industries more competitive, some firms will lose staff, or will go out of business altogether.[15] ICTs, like broadband, are complementary to human capital, so we might also expect skilled workers to gain more (in terms of wages). Broadband may also help to accelerate automation, which penalises the less skilled workers and those doing routine tasks.[16] Increased labour force participation may raise overall employment levels, but that increase in the labour supply may depress wages – or leave the *rates* of employment unchanged (if changes in participation outweigh the numbers of people moving into work).[17]

We should also expect to see broadband having different economic impacts in different types of places. Specifically, the academic literature suggests that the absolute economic effects of broadband (and of ICTs, in general) may be greater in urban areas. This is because, as discussed above, broadband and ICTs enable production complementarities, especially for skilled workers and knowledge-intensive firms. Both of these groups are urban-orientated.[18] However, for sparser, rural areas, broadband provision may still have *some* economic impact, and could deliver *some* social gains.

As we said at the beginning, in most countries, broadband infrastructure and service provision are market-led: the state's role is to ensure a competitive market, and to regulate service levels.

[10] Jorgenson et al. (2008), Oliner et al. (2007).
[11] Gordon (2012 and 2014).
[12] Brynjoloffson and Hitt (2000 and 2003), Bloom et al. (2012).
[13] Bakhshi and Mateos-Garcia (2012).
[14] http://www.retailresearch.org/onlineretailing.php.
[15] Aghion et al. (2009), Moretti (2012).
[16] Bresnahan et al. (2002), Autor et al. (2003), Brynjolffson and McAfee (2014).
[17] Kolko (2012).
[18] Beaudry et al. (2010).

Critically, this means that we have relatively few examples of explicit broadband delivery programmes, and thus relatively few policy evaluations to draw on. In the EU, State aid rules have further limited national governments' freedom for manoeuvre. This also makes evaluation of broadband networks' economic impacts more challenging than the evaluation of many other areas of economic development policy.

3 EVIDENCE OF BROADBAND IMPACT

In this chapter, we refer to the findings from the academic literature on the economic effects of broadband. As broadband has a very wide set of impacts, we cluster these together, and focus on: GDP per capita, productivity, firm entry and the number of businesses, employment, income, and wages[19].

We also discuss studies that compare impacts in different places, typically, in urban and rural locations. These are the effects that we think are most likely to be of interest to policy makers when they are thinking about the potential impact of broadband on local economic performance.

Unfortunately, we are not able to say as much as we would like about policy design issues, such as the relative effects of indirect versus direct provision of broadband; 'superfast' versus 'ultrafast' technologies[20]; policies that target SMEs, or other types of firms; or scheme costs. This is because not many explicit policy evaluations exist, and not all those that do exist are robust enough to pass standard academic quality filters.

Governments around the world increasingly have strong systems to monitor policy input (such as spending on subsidized broadband provision) and output (such as the total number of houses or business connected to broadband). However, they are less good at identifying policy outcomes (such as the wider effect of broadband on local employment). In particular, many government-sponsored evaluations that look at outcomes do not use credible strategies to assess the causal impact of broadband policies.

By causal impact, the evaluative economics literature means an estimate of the difference that can be expected between the outcome for areas undertaking a project (in this case, improving broadband provision) and the average outcome they would have experienced without the project. Pinning down causality is a crucially important part of impact evaluation. Estimates of the benefits of a project are of limited use to policy makers unless those benefits can be attributed, with a reasonable degree of certainty, to that project.

3.1 Evidence of findings by outcome

GDP per capita. There is one study that looks at the link between GDP per capita and broadband. Czernich et al.[21] examine the wider effects of broadband on GDP per capita across the OECD countries, finding that a 10-percentage point increase in broadband penetration raises national annual per capita growth by 0.9-1.5 percentage points. This provides some evidence to back the focus of national governments on broadband provision, but it also uses highly aggregated data that cannot capture within-country heterogeneity.

[19] We borrow this distinction from the extensive review of Overman et al. (2015).
[20] A point further dealt with in Chapter 4.
[21] Czernich et al. (2011).

Productivity.[22] Broadband can positively impact on a firm's productivity. However, these effects are not always positive, they are not necessarily large, and they may depend on complementary investment. Productivity effects can vary across different types of workers, with skilled workers possibly benefiting more than the unskilled.

Firm entry and number of businesses.[23] Broadband can increase the number of businesses – either because it increases firm entry, or because it helps with firms' survival.

Employment.[24] Broadband can positively impact on local employment. However, the effects are not always positive, they are not necessarily large, and they may be offset by population increases (leaving unemployment unchanged). Employment effects can vary across different types of areas, industries, and workers, with urban areas, service industries and skilled workers possibly benefiting more than rural areas, manufacturing industries and unskilled workers.

Income and wages.[25] Broadband can positively impact on local incomes and wages. However, effects are not always positive, and they can vary across different types of workers, with the highly skilled possibly benefiting more than the low skilled. There are a number of channels through which broadband can affect wages and income. Wage effects will depend on the overall effects on labour demand and supply (which may, in turn, depend on productivity and other effects). Income effects will depend on what happens to wages and employment, as well as on what happens to the non-labour market component of incomes. In contrast to employment, we have more limited evidence about these effects. Of the five studies that consider either wages or income, two find positive effects, one no effect, one finds negative effects, and one reports mixed results.

Urban versus rural.[26] The economic effects of broadband tend to be larger in urban areas, or places close to urban areas.

We emphasise that many of these findings depend on a small number of studies. They are, however, consistent with other research on the broader impact of ICTs.

3.2 Lack of robust evidence.

Instead, there is a lack of robust evidence in the following areas:

- Most studies look at the effect of broadband adoption. Very few studies compare broadband adoption with coverage/availability. The effects of adoption and simple availability may differ considerably.
- There is surprisingly little evaluation evidence of broadband's impact on working patterns.
- Policy evaluations – there is a lack of high quality evaluations of specific broadband policies (voucher schemes, direct public provision, or public/private partnerships). This is due to few countries having experimented with policies of this kind, which makes their evaluation highly conjectural.
- Firm/sector targeting – there are no studies that evaluate, for instance, SME-targeted voucher programmes.

[22] Akerman et al. (2015), Colombo et al. (2013), Haller and Lyons (2015).
[23] De Stefano et al. (2014), Kandilov et al. (2011), Kim and Orazem (2012), Whitacre et al. (2014a).
[24] Akerman et al. (2015), Dettling (2013), Kolko (2012), Whitacre et al (2014b).
[25] Akerman et al. (2015), Kolko (2012), Whitacre (2014a, b).
[26] Fabritz (2015), Haller and Lyons (2012), Kim and Orazem (2012), Whitacre et al. (2014b).

- Direct vs. indirect provision – it would be very useful to know more about the relative effects of (say) voucher schemes for broadband services, against direct investment in infrastructure.
- Other Internet technologies – there is a lack of systematic evidence in other areas of Internet technology, such as the effect of Wi-Fi networks and fast mobile Internet. Future evaluations in this area would greatly improve the evidence base.

In conclusion, many interesting points remains unanswered, and more studies are needed to assess the optimal, or at least the reasonable, approximations to inform policy choices.

4 THE IMPACT OF DIGITAL TARGETS

Digital targets are meaningful, in practice, when they are set over and above what the market would achieve in the absence of any intervention. They are meaningful economically if they solve for a market failure, that is, that there are reasons to believe the market would not supply 'enough' broadband, yet there are some unexploited welfare gains that society could earn by reaching the targets. Unfortunately, there are very few academic papers that manage to assess directly whether or not a market failure exists in respect of broadband supply.

There is one study that explicitly conducts a cost-benefit analysis of the EU Digital Targets, using microdata for the UK. Ahlfeldt et al.[27] show that some urban areas pass the cost-benefit test of current EU policy proposals, while the case for these policy interventions is not very strong in rural areas, where, actually, the case is very weak. It is simply too costly to bring fast broadband to rural areas, compared to the private benefits it generates. Since, according to the study, it is largely the urban areas that pass a cost-benefit test, the question arises: Why do Internet Service Providers (ISPs) supply sub-optimal speed in those areas where there seems to be a willingness to pay that is in excess of costs? The authors' finding is that the broadband rent goes to the "wrong" economic agent. They estimate that there is a meaningful willingness-to-pay for broadband speed, and that a faster connection even implies (in a casual way) an increase in the value of a property. They show how the broadband speed rent is, in fact, appropriated by the property owners, as broadband increases the value of their houses, but not by the ISPs. The ISPs supply broadband according to supply and demand conditions in the broadband market, which is largely a competitive one. However, these conditions do not necessarily reflect the scarcity of the rents that exist in the property market. To upgrade their local networks, ISPs need to recover substantial fixed costs (especially for fiber) throughout the relevant catchment area. ISPs can recover these fixed costs only in part via the premium prices charged to subscribers, since they are still restrained by the competitive landscape. From this perspective, there is a market failure since, despite the willingness-to-pay, (some) urban areas end up being undersupplied.

An implication of these results is that there may be a co-ordination problem among homeowners in the undersupplied areas that pass the cost-benefit tests, perhaps because they are unaware or, most likely, because of their fragmentation. As with other infrastructures, the co-ordination problem therefore rationalizes the public delivery of broadband to undersupplied areas in combination with the levies charged to sellers and landlords to recover part of the costs. The political economy of the housing-markets' literature suggests that homeowners and landlords will support such initiatives as long as the anticipated capitalization gain exceeds the infrastructure levy.[28]

[27] Ahlfeldt at al. (2015)
[28] Fischel (2011), Oates (1969)

We note that the study of Ahlfeldt et al.[29] only calculates the private benefits from broadband supply in residential markets. There may be some externalities that the authors cannot capture with their data. Still, as considerable costs exist in the delivery of high-speed networks to rural areas, one cannot simply assume that such externalities exist to justify the ubiquitous delivery of broadband. Rather, one should try to estimate at least a realistic order of magnitude for such externalities, and then see if these externalities can cover the gap between costs and private benefits.

5 SUMMARY AND CONCLUSIONS

Do targets have a robust economic rationale? We have provided some evidence of broadband's impacts in several directions, but our first assessment has to be cautious. Additional instruments have to be used, or else the impact is likely to be ineffective. Broadband has an impact when employed by firms or individuals that have particular characteristics in particular areas, and therefore it is difficult to extrapolate broadband's impact when it is employed by firms or individuals without those characteristics, or in different areas. Definitely, there is ample evidence of the heterogeneous effects alongside many dimensions. **All in all, targets do not therefore seem to have a strong economic rationale, especially when applied uniformly across countries that start from very different realities.**

We additionally note that, so far, European digital targets have been set uniformly across the board, while current levels of adoption and take-up of broadband technologies are very different in the various member States. Furthermore, it is evident that countries without a copper legacy network have migrated faster towards fiber, if compared with countries where, instead, an existing copper-based network was available and could therefore be upgraded in various, and possibly cheaper, ways. **From this perspective, one would also expect that several economic and regulatory approaches would be needed, instead of a single regulatory framework, as has often been advocated at the EU level**.

It is much more likely that identical targets across the EU therefore have a political meaning, not an economic one. We note that, insofar as the implementation of the targets and how to reach them, are not prescriptive, different countries will adopt different degrees of intervention. There is also no explicit sanction if a target is not met. While a target may thus look strict on paper, *de facto,* the interpretation and interventions are left to member States. It is possible that this is conceived to give a different kind of leverage at the implementation stage, which can take into account the heterogeneities as well as the different starting points at the country level.

An important and possibly dangerous aspect of current EU digital targets that must be mentioned in our conclusions, is the regulatory game that they have generated. If targets have a political meaning and are set, one way or another, by politicians, the expectation is created that politicians will find the resources to meet those targets. This results in **a waiting game where ISPs do not invest, maybe not even in otherwise profitable areas, since waiting may come with the added benefit of receiving public subsidies**. There is double risk here: either investment does not happen at all, or they follow too late, in the case of scarce public funds; or investment occurs, but simply with public money crowding out private investment. In both cases, sub-optimal results for a policy that aims to speed broadband coverage and its adoption in Europe.

[29] Ahlfeldt at al. (2015)

CHAPTER 2 | Determinants of fast and ultra-fast broadband adoption

1 INTRODUCTION

The debate on the evolution of fast- and ultra-fast broadband infrastructure has been largely focused on the role of the supply side incentives, mainly the regulatory ones, to boost the investment in NGNs. However, the adoption of fast and ultra-fast broadband connections has a primary role in regard to the economic outcomes, in general, as well as in the EU scenario.

Indeed, the Digital Agenda for Europe specifies goals in terms of *both* network coverage and service adoption: The DAE "*seeks to ensure that, by 2020, (i) all Europeans have access to much higher internet speeds of above 30 Mbps, and (ii) 50% or more of European households subscribe to internet connections above 100 Mbps*".[30]Both these policy goals are strongly interrelated, since investment in next generation communications networks (NGN),[31] i.e., network coverage, will also depend on (expected) adoption, i.e., (future) demand, which, in turn, will be determined by the attractiveness of NGN specific services and applications. Only if consumers consider NGN services attractive enough, in terms of innovations or quality improvements, when compared with old broadband services, will consumers migrate to NGN.

The so-called "take-up rate", which relates NGN adoption to NGN coverage, is thus a useful indicator of the willingness of consumers to migrate to the new infrastructure. The more consumers are satisfied with conventional broadband services, or the more consumers are reluctant to adopt new technologies, the greater will be the gap with the newly installed network's capacity. Clearly, a high take-up rate, with adoption being close to capacity in terms of NGN coverage, avoids social costs due to over-capacities.

In Section 2, we first review the existing literature on NGN adoption and its determinants in order to provide possible insights into sound policy interventions. In Section 3, we present some graphic evidence across EU member States on NGN adoption, coverage and take-up rates highlighting the structural differences between EU15 and the Eastern European countries. Next, we present, in Section 4, evidence on the existence of network effects on NGN adoption, and on the willingness to pay for ultra-fast connections.

2 LITERATURE REVIEW

Although various cost and demand side factors exert an impact on the deployment and adoption of NGN, academic research shows that *inter alia* competition and regulation in the broadband markets play a role. It thus makes sense to examine these factors more closely, paying particular attention to the demand side issues, i.e., NGN adoption.

[30] European Commission (2010a)

[31] In this chapter, we consider all available (wireline) FTTx architectures (including fibre-to-the-home and fibre-to-the-building (FTTP) as well as hybrid-fibre based on copper and coax infrastructure) as relevant NGN scenarios.

Existing empirical literature presents (i) several contributions related to broadband markets, but only (ii) a few NGN-related publications. We briefly review both streams of literature in this order, below.[32]

Regarding point (i), there exist several, but relatively old, papers that study the determinants of broadband adoption in both the USA and European countries.[33] We summarize, below, their main findings.

Using US data from 2001 to 2004, Denni and Gruber[34]find that infrastructure-based competition has a positive impact on broadband adoption in the longer term, whereas regulatory-induced service-based competition has a positive impact only if the number of service-based entrants is not too large.

Non-US-based work mainly refers to OECD country-level data. Bouckaert et al.[35] examine the determinants of broadband adoption in the years from 2003 to 2008. They find that infrastructure-based competition has a positive impact on broadband adoption, whereas service-based competition is an impediment to adoption. Lee et al.[36] analyse the determinants of broadband adoption for the years from 2000 to 2008. The authors also show that the presence of unbundling obligations has a positive and significant effect on adoption, but they may have a negative impact on long-term investment and the broadband saturation level.

The first paper using EU data is Distaso et al.[37], who find that infrastructure-based competition is the main driver of broadband adoption, and it plays a more important role than service-based competition, especially in the longer term. Höffler[38] also examines data for sixteen Western European countries for the years from 2000 to 2004. He concludes that broadband deployment was predominantly triggered by infrastructure-based competition, with service-based competition playing a secondary role. More recently, Nardotto et al.[39] employ disaggregated broadband data that is related to the old infrastructure for the UK for the quarters from December, 2005, to December, 2009. The authors show that unbundling, in the UK, resulted in no increase in broadband adoption, but positively affected service quality.

The above mentioned papers shed some light on the impact of infrastructure-based competition and access regulation on standard broadband adoption. Though interesting, they are of limited interest, however, for a better understanding of NGN adoption, where the presence of a relatively good "legacy" infrastructure may represent a new and relevant constraint on the development of NGN's adoption.

The papers looking at NGN demand adoption are still very scant. Wallsten and Hausladen[40] estimate the effects of broadband regulations on NGN adoption with data from EU27 countries for the years from 2002 to 2007, thus covering the very early market phase. They find that in the countries where unbundling is more effective, leading to higher quality broadband and a significant penetration experience lower NGN adoption. In this paper, the authors only examine

[32] For related reviews, the reader is referred to the presentations in in Briglauer, Gugler, Haxhimusa (2015) and Briglauer (2014).
[33] Most of this literature is summarized in the report published by the Florence School of Regulation – Communications and Media (2011) for the Independent Regulators' Group.
[34] Denni and Gruber (2007).
[35] Bouckaert et al (2010).
[36] Lee et al. (2011).
[37] Distaso et al. (2006).
[38] Höffler (2007)
[39] Nardotto et al. (2015).
[40] Wallsten and Hausladen (2009).

the presence of unbundling regulations, but they do not provide any evidence for the possible impact of the unbundling access price on NGN adoption. Samanta et al.[41] examine the demand-side determinants of high-speed broadband deployment using International Telecommunication Union (ITU) and OECD data for 25 countries, for the years from 1999 to 2009. The authors employ a dummy variable to capture the extent of unbundling regulation, and they find that this variable has no significant impact. Jeanjean[42] investigates the impact of unbundling access charges and the share of wholesale access lines to the total number of retail DSL lines, using quarterly data covering 15 European countries for the years from 2007 to 2012. The author finds that tight copper access regulation diminishes migration to FTTx-based broadband services. More recently, Briglauer[43] investigates the determinants of NGN adoption for EU27 member States for the years from 2004 to 2013. Competitive pressure from mobile networks affects adoption in a non-linear manner implying the presence of substantial substitution between fixed and mobile connections. Finally, the author also finds evidence for substantial network effects underlying the adoption process.

To summarize, the empirical literature indicates a positive impact of infrastructure-based competition on broadband adoption. As regards the impact of infrastructure based and service-based competition on NGN adoption, the findings are more ambiguous although presenting initial evidence on the existence of a relation between the availability of high quality legacy networks and the willingness to switch to new NGN services.

3 EVIDENCE FROM THE EU MEMBER STATES

Although the main focus of this Section is on NGN adoption ("homes connected"), we also report NGN coverage ("homes passed"), i.e., investment related data, since installed capacity represents a pre-condition for adoption. The European Commission's DAE, as well as most national broadband plans in member States, simultaneously refer to both targets: adoption and coverage.[44]

3.1 NGN Coverage, Adoption and Take-up Rates

Figure 1 and Figure 2 show NGN coverage and NGN adoption for 25 EU ,ember States for the years from 2004/2005 to 2014.[45] NGN coverage is measured by the total number of lines, enabling fast broadband Internet access, which are available to homes or businesses. Network coverage thus refers to the number of consumers that, in principle, have access to fast broadband. NGN adoption refers to the actual number of NGN subscribers. Figure 1 captures almost the entire period of NGN deployment in member States, and it shows that the coverage and the adoption follow a more or less dynamic adoption process, which is more pronounced for the former. In Figures 1 and 2, the horizontal lines at adoption and coverage values equal to 0.5 (50%) and 1 (100%), mark the DAE goals. The mean value of fast broadband coverage already equalled

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[41] Samanta et al. (2012).

[42] Jeanjean (2013).

[43] Briglauer (2014).

[44] To clarify the data in this Section we use the following definitions: *NGN coverage* measures the total number of lines deployed, normalized to the total number of households ("homes passed"). Network coverage thus represents the installed capacity in physical units, where the term 'homes passed' refers to the number of consumers with potential access to NGN infrastructure. *NGN adoption* measures the total number of consumers (normalized to households) who subscribe to at least one service offered via the NGN connection on a commercial basis ("homes connected"). *NGN take-up rate* is the ratio between NGN adoption and NGN coverage and thus ranges continuously in the interval [0;1] as adoption cannot be higher than installed capacity.

[45] Source: FTTH Council Europe/Briglauer, Cambini, Grajek (2015). Data for Malta, Cyprus and Croatia are excluded. The FTTx coverage for Luxembourg was 2.31 in 2014, which was not reported, because we have restricted the presentation to an upper-boundary of 2 for illustrative purposes.

approximately 100% in 2014, which, on average, fulfils goal (i) for the 25 member States in our analysis. Ultra-fast broadband coverage, however, is much lower, with an average mean value of only about 35 % (Figure 2).

Nevertheless, there appears to be a substantial gap in adoption rates. The average NGN adoption rates for fast broadband and ultra-fast broadband are only 25% and 10%, respectively.

Overall, when comparing fast broadband deployment, in terms of coverage and adoption, with ultra-fast broadband, one finds similar growth patterns, but notably lower levels for the latter in most of the EU States. In some countries, what is referred by the European Commission as ultra-fast broadband deployment has started on very small scale or not at all. Instead, operators focus on hybrid technologies to upgrade traditional copper and coaxial cable technologies. In general, according to available data, it can be concluded that present DAE targets are not yet reached.[46]

Furthermore, the gap between adoption and coverage is still huge and differentiated among the EU's founding members and Eastern European countries. In Figure 3 we also report the evolution of NGN adoption, coverage and take-up rate in EU27 as an average across countries.

[46] Briglauer, Cambini, Grajek, (2015). As regards the coverage goal (i), reported NGN coverage data overestimates the actual coverage and adoption because of double counting in many Member States. In particular, in urban areas, there is double counting of homes passed by cable television operators and traditional telecommunications operators. In addition, business establishments, which promise high returns, may passed by in parallel with NGN infrastructures. This explains why the coverage levels in Figures 1 and 2 sometimes exceed 100 percent.

FIGURE 1: FTTX BROADBAND COVERAGE AND ADOPTION RATES PER HOUSEHOLD IN EU25

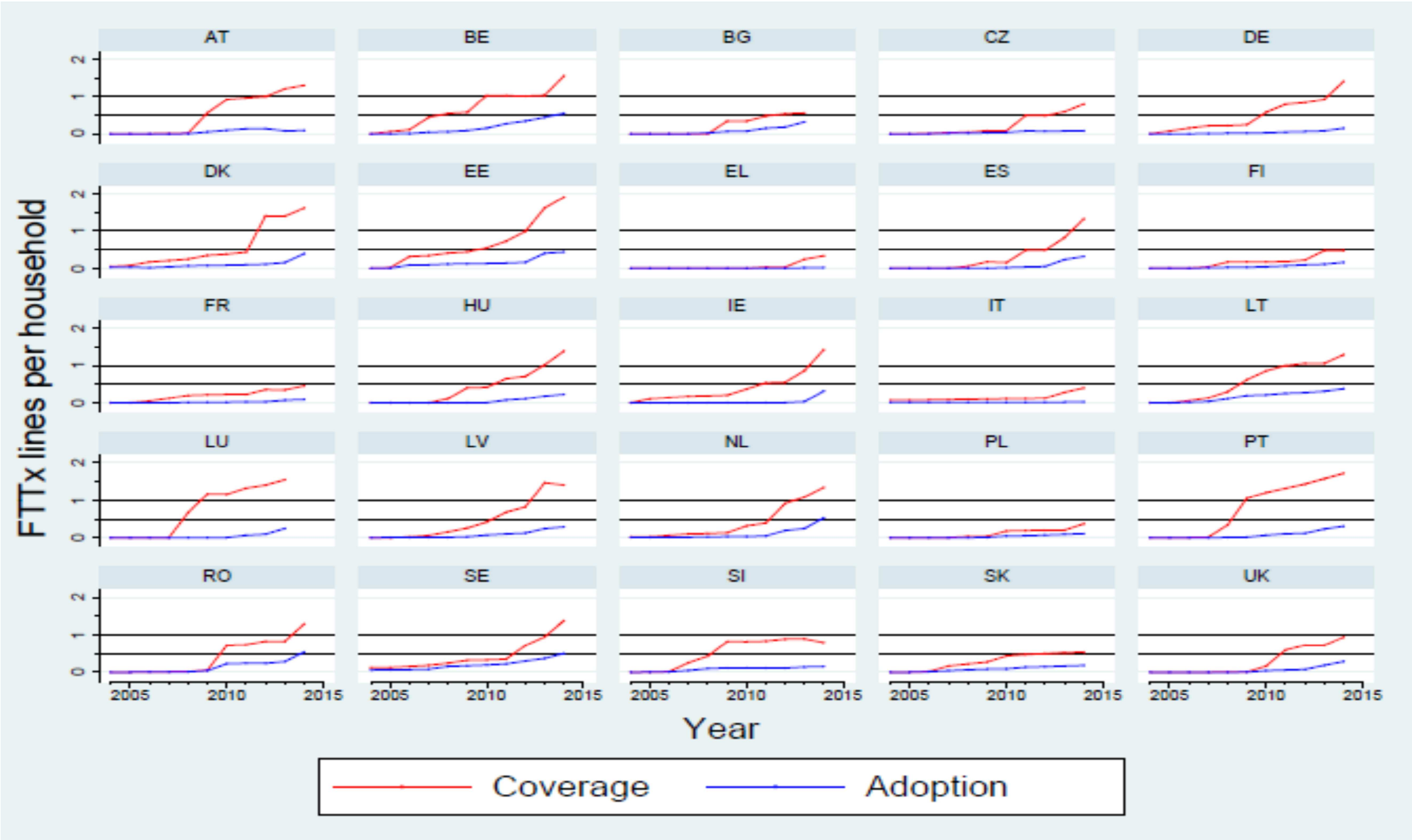
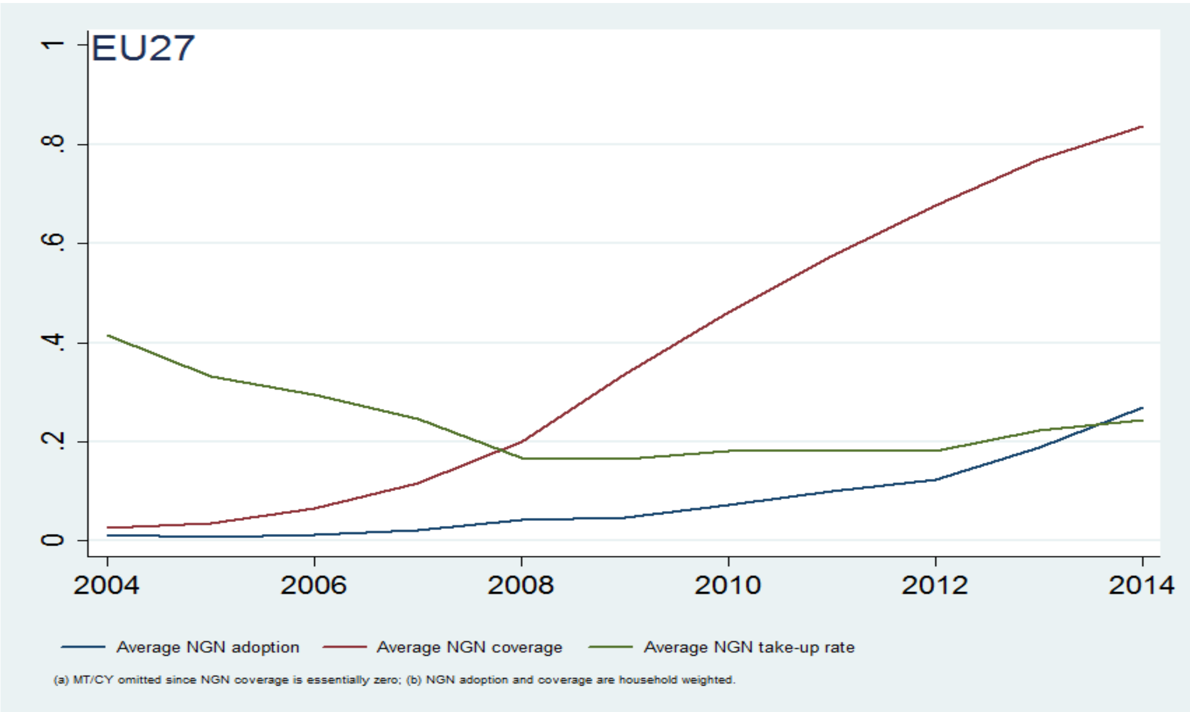


FIGURE 2: FTTP BROADBAND COVERAGE AND ADOPTION RATES PER HOUSEHOLD IN EU25

The evidence suggests that while coverage seems to present a similar trend across the EU countries (although EU15 countries mostly deploy hybrid FTTC connections, while Eastern countries use mostly high-end FTTB/H connections), the adoption and the take-up rates of NGN services are greater in Eastern European countries, where the presence of the "old" legacy (copper based) infrastructure is limited, or even absent. In turn, conventional broadband services enjoy broad consumer acceptance in terms of their quality characteristics and the high market saturation in the EU15 countries. As a consequence, consumer demand may also be subject to substantial switching costs which is not, or is only to a limited extent, the case in Eastern European countries with much lower levels of basic broadband penetration (see the discussion in Section 3.2). The higher market saturation, in terms of per household or per capita adoption of broadband services is, the lower the remaining segment of consumers who can be directly migrate to NGN services without having to overcome switching costs[47].

FIGURE 3: NGN COVERAGE, ADOPTION AND TAKE-UP RATE IN EU27 (SOURCE: BRIGLAUER, CAMBINI AND MELANI, 2015)



3.2 Broadband adoption

Although the related empirical literature suggests that EU broadband access regulations have been only partly successful in facilitating infrastructure investment and infrastructure-based competition,[48] the EU regulatory framework should not be judged as being ineffective, especially in international comparisons and in respect of the adoption of basic broadband technologies. Table 1 shows that all of the OECD countries have experienced a similar pattern of growth in basic wireline broadband subscriptions between 2009 and 2014. Countries are ranked, according to their broadband adoption in 2014, in descending order. The major western European economies,

[47] Briglauer (2014).

[48] The reader is referred to Cambini and Jiang (2009), who review the older and first-generation broadband related literature on investment and regulation, and to Briglauer, Frübing and Vogelsang (2015, section 3.2) who review the NGN related literature. See also the recent analysis on migration from copper to fibre networks (Bourreau, Cambini and Dogan, 2012, 2014).

including France, Germany, the Netherlands and the United Kingdom, which are comparable to the USA in their levels of economic development, do much better in terms of basic broadband adoption. The Scandinavian countries, which have a long tradition of public subsidies for broadband and a high level of consumer ICT-affinity[49], also beat the USA and Japan in the rankings.

Overall, the EU access regulations seem to have worked relatively well in facilitating broadband adoption by consumers on the basis of the old (copper and coaxial-based) broadband infrastructure.

Moreover, on the demand side, there is still significant uncertainty about the willingness of consumers to pay for new broadband services[50]. Since the regulatory approach to legacy networks has been, by and large, extended to the NGN, we expect underinvestment in NGN in the EU, especially in relation to ultra-fast broadband, which then also carries over to FTTH/B adoption.[51]

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[49] Briglauer and Gugler (2013).
[50] Dot.Econ (2012); see also below in Section 3.2.
[51] Briglauer, Cambini, Grajek (2015).

TABLE 1: TOTAL WIRELINE BASIC BROADBAND SUBSCRIPTIONS PER 100 INHABITANTS[52] (IN BOLD THE EU MEMBER STATES)

OECD country	2009	2010	2011	2012	2013	2014
Switzerland	35.60	38.19	40.25	42.58	45.24	48.89
Denmark	36.17	37.23	37.62	38.83	40.21	41.32
Netherlands	37.09	38.10	38.93	39.72	40.44	40.62
France	30.65	32.78	34.68	36.40	37.65	39.23
Norway	33.87	34.53	35.22	36.22	36.95	38.65
Korea	33.24	34.80	35.88	36.50	37.47	38.03
Iceland	32.82	33.65	34.48	34.81	35.77	36.82
United Kingdom	29.67	31.47	33.01	34.26	35.56	36.78
Belgium	28.87	30.84	32.14	33.28	34.39	35.95
Germany	30.46	31.91	33.24	34.06	34.84	35.90
Canada	29.59	30.70	31.70	32.42	33.47	35.37
Sweden	31.63	31.92	31.97	32.22	32.74	33.84
Luxembourg	29.18	30.72	31.50	32.11	32.52	33.68
Finland	28.73	28.58	30.08	30.97	31.54	32.19
New Zealand	22.83	24.85	26.61	28.78	30.20	31.62
United States	25.50	26.72	27.70	28.72	29.69	31.43
Greece	17.12	20.18	22.14	24.21	26.23	28.71
Japan	24.71	26.56	27.27	27.67	28.04	28.52
Czech Republic	12.91	14.55	15.78	16.63	17.38	28.34
OECD - Total	22.96	24.39	25.36	26.11	26.96	28.20
Estonia	22.46	23.28	24.76	24.54	25.49	28.20
Australia	22.99	24.00	24.15	24.83	25.99	27.66
Spain	21.31	23.36	24.48	24.65	26.31	27.62
Austria	21.10	22.90	24.22	25.00	26.15	27.55
Ireland	19.18	20.64	21.71	22.65	24.43	27.28
Portugal	17.75	19.78	21.11	22.59	24.12	27.24
Slovenia	21.53	22.81	23.75	24.40	25.11	26.73
Hungary	17.81	19.56	20.92	21.88	23.07	26.16
Israel	23.47	23.86	24.20	24.70	25.12	25.33
Italy	20.02	21.58	22.11	22.13	22.27	23.64
Slovakia	11.58	12.79	13.83	14.77	15.63	21.98
Poland	12.83	13.82	14.90	15.71	15.64	17.99
Chile	9.71	10.40	11.58	12.38	13.00	13.96
Turkey	8.85	9.73	10.25	10.49	11.19	11.56
Mexico	8.39	9.81	10.33	10.62	11.28	10.72

[52] Source: OECD (oecd.org/sti/ict/broadband). Note: based on total population; subscriptions with ≥ 256 kbit/s download speed.

4 ECONOMICS EFFECTS UNDERLYING NGN ADOPTION

Understanding the key drivers of NGN adoption is extremely important from a policy perspective so as to boost fiber connections among EU citizens and to increase the take-up rates throughout the EU. In this section, we provide quantitative evidence on two issues that appear to be of particular interest, in our opinion:

- the value of network externalities in fiber adoption. We want to answer the question: Is NGN adoption subject to path dependency? Does early adoption of fiber connections motivate other consumers to adopt the same technology, facilitating migration?
- Consumers' willingness to pay for very high speed connections. While it is clear that all fiber connections with ultra-fast speeds can offer a higher quality than the copper-based services, would this automatically imply that, on average, the demand side of the market has a willingness to pay for these products?

4.1 Network effects in ultra-fast broadband connection

Network effects represent a special type of externality that underlies the adoption of broadband/NGN services, in the case where the number of subscribers (and/or producers) has an impact on the consumers' utility (firms' profit). In general, increases in the adoption rates also lead to increases in the usage intensity of the respective services[53].

Consumers' utility can be related to the possibility of communicating with one another at the consumer level, either directly, *e.g.*, via different online platforms, or indirectly, in the case of network effects occurring at different producer levels. For instance, the more users subscribe to (high-speed) Internet services, the more specific content and related applications will be programmed, which increases the consumers' utility and willingness to adopt such (NGN) services. The same is true for the development of related hardware and electronic equipment. Furthermore, it is likely that the NGN adoption process is subject to learning spill overs, inasmuch as the value added to NGN services appears to be *a priori* unknown to potential consumers, whose valuation, *inter alia,* depends on the information gathered by the already-existing subscriber base[54]. Operators simply benefit from the network size, since an increase in the total number of subscribers lowers the average costs significantly, in view of the NGN topology, and this thus increases the profits. Network effects give rise to a self-propelling endogenous growth process, which suggests that the contemporaneous and previous NGN adoption rates are positively related: the higher the existing subscriber base, the higher the potential network benefits.

Few papers address the existence of network externalities in broadband adoption. A first set of papers deals with standard broadband service adoption; the second one specifically accounts for broadband take up in fiber infrastructures.

In the first set of papers, we can mention Bouckaert et al.[55], Lee and Lee[56], and Lin and Wu[57]. Although not directly related to fiber adoption, they may provide interesting evidence on the existence of network externalities and on their values.

[53] Grajek and Kretschmer (2009).
[54] Grajek (2010).
[55] Bouckaert et al. (2010).
[56] Lee and Lee (2010).

Bouckaert et al.[58] and Lee and Lee[59], using data from the OECD countries, found that the penetration in the previous time period significantly and positively affects current broadband penetration. The former study suggested that the result verifies the positive persistence of penetration over time, while the latter suggested that it is a positive network effect, indicating that a higher current subscriber number attracts more subscribers in the future. In Bouckaert et al.[60] the estimated coefficient for lagged penetration is 0.96. No matter what the explanation is, these studies confirm the positive significant effect of previous broadband penetration, and this result reveals that a higher penetration in the current year results in a higher penetration in the following year.

Lin and Wu[61] study the determinants of broadband diffusion for a longer period, from 1997 to 2009. In this analysis, the dependent variable is broadband penetration, measured as the total of fixed broadband subscribers per 100 inhabitants (in log), and the broadband technologies adopted by the subscribers include DSL, cable, fiber, satellite, and fixed wireless. The analysis shows that the estimated parameters of lagged broadband penetration ranges between 0.25-0.54. This implies that a 1% increases in previous broadband subscribers generates, everything being equal, a positive effect on future subscribers that is equal to ~0.2-0.5%.

The only paper that analyses the presence of a network externality effect on fiber adoption is one by Briglauer[62]. Based on an unbalanced panel of the EU27 member States for the years from 2004 to 2012, the paper identifies the most important determinants of the adoption of fiber-based broadband services. In this paper, the author determines what is called the 'speed of diffusion of fiber adoption'. This index is expressed as the percentage of the gap between the long-run (desired or target) stock of fiber subscribers, and the subscribers in the previous period, which is closed in each period. In some sense, considering the dynamic nature of the analysis, the author determines a sort of long-term trend of adoption that is relevant to evaluating network externalities. Briglauer's results[63]show that the estimated coefficient for the previous period's fiber users lies in the range between 0.56-0.78 with a median value of 0.70. This result implies that the speed of diffusion of fiber is equal to $1 - 0.70 = 0.30$. This result has the following interpretation: the gap between the average number of fiber connections per household and the DAE target value (0.5) is covered with an increase of 30% per year.

In sum, we can conclude that the existing evidence confirms the presence of considerable network externalities. From a policy perspective, this also implies that, whenever possible, it will be important to incentivize migration to NGN services in order to generate some positive feedback to further increase adoption and, in turn, the take-up rates.

4.2 Willingness to pay for ultra-fast connections: some evidence

It is rather difficult to predict and estimate the willingness to pay (WTP) of consumers for very high-speed connections. Clearly, high-speed connections deliver better performances than traditional basic broadband services and this in turn would imply that on average the willingness to pay for this product differentiation should be larger.

57 Lin and Wu (2013).
58 Bouckaert et al. (2010).
59 Lee and Lee (2010).
60 Bouckaert et al. (2010).
61 Lin and Wu (2013).
62 Briglauer (2014).
63 Briglauer (2014).

Unfortunately, there exist only a few economic documents that present robust analysis of the willingness to pay for migrating from copper to fiber connections, *i.e.*, in estimating the so called "fiber premium". Most of this evidence suggests that customers are likely to have a high incremental WTP for a high-speed service, but a low incremental WTP for a very high-speed service.

Using data from a nationwide US survey that was administered during late 2009/early 2010, Rosston et al.[64] estimate a random utility model of household preferences for broadband Internet services, offering different grades of speed (slow, fast and very fast). Results showed that the representative household has a high marginal WTP for a high-speed Internet service, but a low marginal WTP for a very high speed service. Quoting the authors, "*the representative household is willing to pay $20 per month for more reliable service, $45 for an improvement in speed from 'slow' to 'fast', and $48 for an improvement in speed from 'slow' to 'very fast'*." This implies that a representative household is willing to pay a relatively higher premium for an upgrade in broadband speed from a "slow" service to a "fast" broadband service, but only a small additional premium of US$3 per month for an upgrading from a fast to a 'very fast' service.

A study[65] based on data from a web-based survey of 3600 respondents in the Netherlands, in 2010, showed that having a fiber connection that leads to symmetrical upload and download speeds appears to have limited appeal, given current bandwidth demand, and enjoys only a limited price premium of around 8%-15%, or around €5 in absolute terms.

Similarly, a 2011 document from the German regulator (Bundesnetzagentur)[66] reports that customers are prepared to spend around €5/month for greater bandwidth.

This premium for fibre is considered to be relatively modest – at least in the EU scenario – with respect to what is needed to spur consumers' migration from copper to fibre infrastructure. A document by WIK-Consult[67], prepared for ECTA i.e. the association of entrant telecoms operators in Europe, shows that the fiber premium, *i.e.* consumers' willingness to pay, appears insufficient to sustain wide-spread fiber investment.

Evidence from New Zealand provides further insights. In the Colmar Brunton report[68], prepared on behalf of the infrastructure operator, Chorus, the WTP for ultra-fast connections for 23% of consumers is above NZ$20/month higher than for DSL, but for 26% of consumers, it is lower than NZ$20/month. On average, the estimated WTP is NZ$20.70/month, around 12.3€/month. These values slightly increase for small businesses, whose WTP ranges between NZ$22.10/month and NZ$25.10/month (i.e., €14-15.5/month).

The Commerce Commission also conducted its own demand side study[69] on WTP for fiber services. The Commission found that only 4% of respondents were willing to pay more than NZ$20/month and that most respondents were willing to pay between NZ$5-10/month (i.e., 3-6€/month). However, the study also revealed that the speed requirements for services are increasing rapidly, so that higher WTP differences can be expected in the next few years.

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[64] Rosston et al. (2010).
[65] Van Camp (2012).
[66] Bundesnetzagentur (2011).
[67] WIK (2011).
[68] Colmar Brunton report(2012)See:
https://www.google.co.nz/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&ved=0CCEQFjAA&url=https%3A%2F%2Fwww.chorus.co.nz%2Ffile%2F50475%2FIntegrated-Fibre-Research-Chorus-Connections---Final-5th-Dec.pptx&ei=LDz2VMOpJqTcmAW3toC4BA&usg=AFQjCNE5GjYZ1xCvUc7V02PfSnbRcJW_cA&bvm=bv.87269000,d.dGY
[69] http://www.comcom.govt.nz/regulated-industries/telecommunications/monitoring-reports-and-studies/studies/

Overall, the literature above indicates that WTP is low, in particular for very-high speed broadband services. This is in line with the evidence in Figure 2, which indicates the low adoption of ultra-fast broadband services in most EU countries. The main exceptions relate to the Eastern European economies, which are subject to a less pronounced replacement effect on the supply side, as well as substantially lower switching costs on the demand side, due to the absence of a well-established high-quality fast broadband infrastructure.

5 SUMMARY AND CONCLUSIONS

Major EU member States do not fare badly compared to other OECD countries, especially US and Japan, considering present broadband adoption. Moreover, DAE targets in terms of fast broadband coverage have been reached on average. However adoption rates, after a first surge, are now lagging behind coverage in terms of fast broadband and, even more, in terms of ultra-fast broadband.

The literature has begun to uncover the theoretical and empirical aspects and trade-offs of the relationship between the regulation of the legacy network and NGN adoption. Evidence also exists that infrastructure-based competition stemming from wireline or wireless operators, has a positive effect on the latter. Furthermore, the adoption of fiber connections appears to be characterized by path dependency, and this implies that policies aimed at fostering retail migration will be important in sustaining demand expansion.

In view of the dynamic interaction of supply and demand, a proverbial chicken-and-egg situation gives rise to a co-ordination problem: it is not clear *a priori* whether there has to be demand for new, attractive, and bandwidth hungry services in advance, in order to promote the deployment of new communications infrastructure, or whether those services and applications will automatically evolve after the necessary infrastructure has been put in place. The Internet history indicates that the development of content and applications usually follows infrastructure deployment, *e.g.* there would be none of the Web 2.0 services and social platforms available in a world with narrowband dial-up Internet infrastructure. This view may suggest that the goals of the DAE can be best reached if NGN deployment is concentrated primarily on the supply side, either by means of State-aid policies targeted to supply unprofitable ("white") areas or via favourable competitive market conditions as in case of Eastern European countries which did not exhibit the presence of a ubiquitous basic broadband legacy network.

A key issue, however, is the permanence of a relevant gap in willingness to pay between fast and ultra-fast broadband connections, since current evidence suggests an extremely low customers' interest to pay, presently evaluated in around 4-6€/month. Moreover, it is also likely that without increased adoption a supply side policy risks to increase over-capacity and underutilization of networks.

CHAPTER 3 | Technological neutrality, targets, and competition objectives

1 INTRODUCTION

One of the often repeated principles of the European Regulatory Framework (ERF) is that it embodies technological neutrality.[70] It was introduced explicitly in the 2002 Framework, as a desirable rather than as an essential feature. This can be seen as a continuation of the European Commission's previous approach, which in essence was that it was best to leave technology choice to industry and not to try to choose a technology winner. In the past there were exceptions to this approach, which allowed the promotion of specific services where it was warranted. In practice this might be read as allowing it only where industry has already reached a conclusion on that technology which is the best or where other exceptional circumstances might arise.[71]

A more recent innovation is the use of quantitative targets, such as those embedded in the digital single market objectives. Such targets have the potential to impinge on all aspects of sector to which they apply. This phenomenon is most evident in the case of activities, which are non-marketed, where output targets play the key role in determining what is produced. The two classic examples of this are centrally planned economies such as that operating in the Soviet Union before about 1990, and the non-marketed public sector of almost any economy. In both cases, targets and performance indicators drive production decisions, leading to a skewing of effort towards activities covered by and rewarded by the incentive system.

In the case of broadband – the subject matter of this chapter – targets play an exhortatory rather than a decisive role; failure to meet them is not expressly associated with punishment or loss of benefit. They are also superimposed upon the operation of a market in which firms pursue their own commercial incentives. However, this does not preclude the use of regulation to influence the attainment of targets. Thus, as noted below, different varieties of fiber network are suited in different ways to promote 'fast' broadband (conventionally with speeds of 30 Mbits per second), and 'ultrafast' broadband (with speeds of 100 Mbits per second and above). We can assume that the underlying reasoning for distinguishing broadband as a suitable activity for targeting is that, as a general purpose technology itself, or as a component of the general purpose technology consisting of information and communications technology, broadband has a wide and general positive effect on the EU's economic development (on this refer to chapter 1). Moreover the scale of that effect may depend on the nature of the service provided, especially its speed.

However, other objectives than target attainment can be influenced by the form of broadband regulation. In particular, it seems that the nature and extent of infrastructure competition among providers is significantly affected by the form of access regulation adopted. Accordingly, the purpose of this chapter is to raise some fundamental questions about the desirability of TN in the specific context of the current review of the European regulatory framework and the technological and other choices presently facing policy makers. Although mobile broadband is of increasing importance, the focus here is fixed broadband, which is usually regarded as being the more problematic mode of supplying connectivity because it requires more intrusive regulation than does

[70] In a way this is slightly surprising, since an earlier much acclaimed triumph of the European telecommunications model was the worldwide domination of GSM, the mobile standard adopted in 1987, which imposed a single and therefore non-neutral technology for 2G mobile, which was compulsory in Europe and which later conquered the world.

[71] It should be noted that the significance of technological neutrality and its interpretation in Europe is evolving over time. Numerical observations show that mentions of TN have been declining in speeches by all EU Commissioners in charge of Electronic Communications in the past 15 years. In the case of Commissioner Oettinger the trend appears confirmed, even if may be too soon to tell.

its mobile complement and rival. Thus section 2 examines what TN means in this context and asks whether it is subject to being over-ridden on market failure or other grounds.

The subsequent sections 3-4 examine two issues in the application of TN to fixed broadband: the issue of whether fiber should be provided by fiber to the premises (FTTP), or by fiber to the cabinet (FTTC or vDSL), a technology which continues to rely on the incumbent's copper and which may limit certain forms of competition; and the choice of technology within FTTP between the so-called point to point (P2P) or point to multi-point (PMP) variants.[72]

Section 5 contains conclusions, which can be summarised as saying that policy makers and regulators should consider technological neutrality as a means to the end of consumer welfare not an end in itself, but they should also be wary to blithely or carelessly overrule firms' technological choices.

2 WHAT IS TN AND WHEN SHOULD IT BE PURSUED?

Maxwell and Bourreau[73] helpfully distinguish three meanings of TN. First, technology neutrality means that technology standards are designed to limit negative externalities, such as radio interference or pollution, in a minimally intrusive way. As so often happens, this is normally best achieved by regulating outputs rather than inputs – i.e., policy makers should describe the result to be achieved, but they should leave companies free to adopt whatever technology they find most appropriate in order to achieve the desired result.

A second interpretation of TN is simply that the same regulatory principles should apply, regardless of the technology used. Regulations should thus acknowledge convergence and avoid treating similar services in different ways. This is well exemplified in approaches to spectrum management, which prohibit the inclusion in spectrum licensing of terms which mandate the use of particular technologies. The same idea was included in the provisions of the 2009 Better Regulation Directive[74], which offered mobile operators more freedom in their choice of technology – clearly a complete reversal of the rigid approach that had been adopted in the GSM Directive.[75] All of this must be distinguished from the much stronger notion of service neutrality, which will allow a licensee to switch the service produced, for example, from broadcasting to mobile communications, which is far more likely to lead to interference problems.

The third and final interpretation is that TN is a protection against seeking to nudge the market in a direction which is considered desirable by policy makers or regulators. In essence, policy makers should not try to pick technology winners and leave this to market forces.

The specific reference to TN in the ERF deserves to be reported in full, as it describes technology neutrality as being 'desirable', but it suggests that, sometimes, promoting a specific technology can be justified: "*The requirement for Member States to ensure that national regulatory authorities take the utmost account of the desirability of making regulation technologically neutral, that is to say that it neither imposes nor discriminates in favour of the use of a particular type of technology, does not preclude the taking of proportionate steps to promote certain specific services where this is justified, for example, digital television as a means for increasing spectrum efficiency.*"[76]

Most statements on the merits of competition - and of limiting public opportunities to intervene in well-functioning, or effectively competitive, markets - emphasise the importance of decentralising the choice of technology for those organisations which (i) are likely to have the best information

[72] A longer version of this paper discusses the history, since 2003, of neutrality in the regulation of cable and telecommunications companies.
[73] Maxwell and Bourreau (2015).
[74] European Parliament and the Council (2009a).
[75] For an optimistic review of the consequences of this Directive, see Pelkmans (2001).
[76] European Parliament and Council (2009b), Recital 18.

about it at their disposal, and (ii) have, by virtue of carrying the can for any poor choice, the strongest incentive to make the right choice. These are, of course, the firms in the marketplace and their financiers, rather than government officials or regulators.

However, there is a corollary to this reasoning. If there is any reason to suppose (1) that TN itself will lead to market failure (due, for instance, to the externalities or the abridgement of competition), or (2) that overwhelming non-standard policy objectives apply in relation to the activities in question, then the general presumption in favour of TN may be rebutted. Examples of this second kind may involve, in some jurisdictions, industrial or protectionist policies that are pursued by favouring, whether openly or covertly, national or regional technologies. This occurred in relation to GSM for Europe; it has been observed in the nuclear power industry, for example, where successful demonstration projects can be seen to provide a springboard for subsequent overseas sales. The justification, if any, for such interventions often hinges upon highly specific circumstances, and they are not considered further here.

More pertinently, the pursuit of broadband targets may influence technological choice, via the means of regulation. The current European targets relate both to 'fast' and to 'ultrafast' broadband. They thus avoid, at least to some degree, the well-known phenomenon associated with partial targeting - that the targeted objectives dominate those that are not covered by targets. In this sense, the present targets do not appear to violate TN, even indirectly. However, we note that, by construction, the same broadband targets presently apply to all member States, whatever their starting points. These uniform targets, applied to different conditions, may, in themselves, locally violate TN, but isolating their impact is probably an insoluble problem, as what we have observed is the combined effect of too many factors.

Further, we want to focus below on possible ways in which departures from TN could relate to hypothetical market failures in the context of fixed broadband deployment. The two major sources of market failure that may be relevant here are the positive externalities and the consequences of the abridgement of competition.

(1) Externalities[77]

We have noted above that, in the case of spectrum use, producer- to- producer negative externalities can occur, mainly through interference. In the case of fixed broadband, the more plausible externalities that 'explain' the existence of targets, however, are likely to be indirect "positive" effects of the following kinds:

- Enhanced speed and quality of information flows: it is sometimes suggested that the combination of more information processing and faster communications are necessary to deliver the benefits, with one alone producing less spectacular results.
- Better access to markets: due to lower barriers to entry, an increase in the geographical scope of markets (the "death of distance"), better job matching, better access to customers via the Web, etc..
- New business processes and organizational structures: better stock control, quicker contracting, just-in-time production, etc..
- More innovation, in general: this is made possible by the availability of new communications services; examples can be multiplied – social networks being a particularly significant one.

However, in a discussion of TN, the key question is not the existence or relevance of general broadband externalities, which by now are quite well established, but it is whether these benefits are available in different degrees from different technologies. One needs to ascertain if, and how

[77] The general theme of broadband externalities was discussed in Chapter 1.

much, of such benefits depend, for example, on the speed and other characteristics of the broadband service produced by each technology, and the speed and cost with which the technologies can be applied. This is not an easy task.

(2) *Market power*

The second form of market failure may arise via a chain of reasoning which links different fixed broadband technologies, the potential which they carry for either competition or, alternatively, the abuse of market power, and the remedies adopted by the regulator to counteract the expected detriments.

It is worth noting that European regulators have a clear history of deliberately seeking to influence the competitive outcomes in broadband markets by regulatory interventions, mainly through the design of access products and their pricing: this is shown by the preference for outcomes which favour infrastructure competition and 'ladder of investment' strategies.[78]

However, what is unusual in the current decision process is that, according to some versions of the story, regulators are not so much choosing as, often, being forced to accept technological evolutions, which increasingly run the risk of restricting their ability to effectively influence access choices.79 In conclusion, regulation and competition law are normally called o apply their consolidated instruments to control such problems, nonetheless, this may create a potential for distorted technological choices. Here, we are not interested in the motives of the parties. Our concern is whether the 'competition effect' of technological choice is reasonably foreseeable. If it is, then it may pose a TN dilemma.

3 FIBRE TO THE PREMISES VS. COPPER UPGRADES

In the next two sections, we discuss the possibilities and risks for particular technological choices in the field of fixed broadband through two case studies. Fiber to the premises vs. copper upgrades

The first case study considered here combines both importance and topicality. The debate in many member States concerns the major question about whether the dominant form of fiber in the near future should be fiber to the premises (FTTP), or fiber to the cabinet (FTTC). The latter can be characterised as a 'cheap and cheerful' version of the former – it is considerably less expensive and more rapid to install, but is not capable of the same speeds or other quality parameters as those of FTTP. There are interesting intermediate stages between the two: one of which is the technology known as G.fast, which takes the fiber closer to, but not right up to, the premises – for example, to a telephone pole close to the house.

One feature of FTTC and G.fast that has been the object of considerable debate is that, differently from FTTP, in the former, the incumbent continues to provide access to the last elements of copper, remaining the owner of an essential facility bottleneck indispensable to its competitors. Here however, we do not want to ask which mode of FTTx is better in which parts of which country. Instead, we ask the much more limited question: is it reasonably foreseeable that FTTC generates a different market structure from FTTP.

In one version, the contrasting strategic choices made by NRAs illustrate how regulation can override technological neutrality. Figure 1 (below) shows the powerful position which FTTC has

[78] Cave (2014).

[79] An important background consideration here is that, in the presence of dominance/SMP, the best technological choice for a firm maybe at odds with that which would emerge in a competitive market, since the incentives faced by a dominant firm differ from those of a competitive firm. European regulators, in market reviews since 2002, have uniformly found that SMP exists in [each, and] the European physical access market, and they have adopted remedies to curb it.

achieved in some European countries. Within this overall picture, it is possible to make a comparison between Belgium, Germany and the UK, on one hand, where FTTC has predominated, and France, Portugal and Spain, on the other, where FTTP may have predominated.[80] It must also be acknowledged that there may be features peculiar to the individual countries that may have slanted the operators' choice in particular directions. However, we are not interested in why the operators did what they did, but only in whether their different approaches have generated different competition outcomes and their eventual consequences for TN.

The FTTC approach is a relatively straightforward extension of the existing regulatory copper regime, by now well known to the EU and the NRAs - subject to the major difference that the key access product switched from unbundled loops to sub-loops for copper, and to bitstream or VULA for fiber.

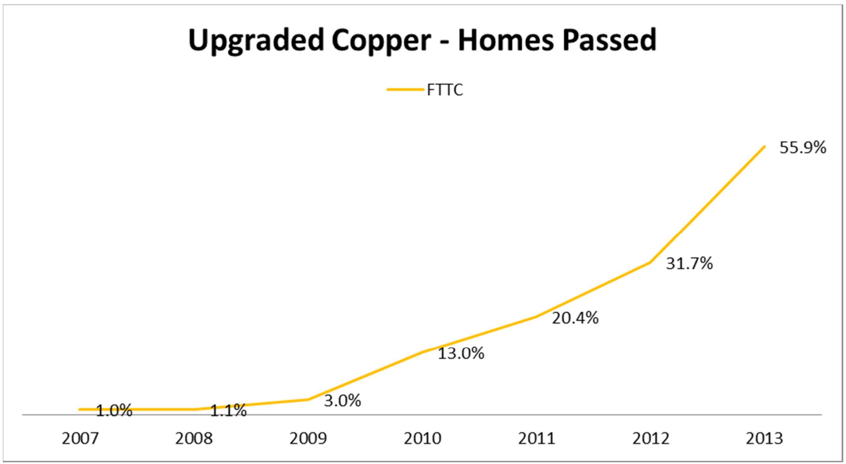
The FTTP approach was much more distinct:

1. Virtual access was signalled to be unavailable on FTTP infrastructure into the future, at least in urban areas. In practice, this meant that once copper network capacity was overtaken by fiber, entrants would not survive on unbundled loops. Spain was the exception, because it did grant access to the fiber network, but capped that capacity at copper performance. France indicated that it was too early, and Portugal also proposed to deal with it 'later'.
2. Significant emphasis was placed on ensuring that access to passive network elements (ducts, trenching, etc.) was best in class, and that a symmetrical regime existed to deal with in-building access to cabling, etc..
3. An urban–rural divide was central to the approach; and thus, while urban areas were subject to the 'build your own' approach, indicated above, rural areas had a much easier access regime. While Portugal went for a straight urban/rural geographic segmentation, France opted for a division based on building density, but the net impact was essentially the same.

As noted earlier, in the absence of a strong policy preference in relation to technology parameters, the strategic choice, established with the 2009 NGA Recommendation, giving FTTC 'NGA' status on an equal footing to FTTP, coincided with network operators in several countries preferring to invest in upgrading copper i.e., in FTTC. This can be observed in Figure 1 below.

[80] Cave and Shortall (2011) argue that this divergence may have been due, in part, to the somewhat troublesome and lengthy gestation period of the European Commission's 2010 NGA Recommendation. While the final version has essentially endorsed the FTTC approach, the 2008 first draft proposed that NGA regulation should rely on good access to passive infrastructure, in order to facilitate competitive network build-out; this would be accomplished by discouraging copper upgrades relative to FTTP, and limiting virtual access products for third parties to rural areas ,where competitive networks were unlikely. See also Shortall and Cave (2015).

FIGURE 1: FTTC DEPLOYMENT AS A PERCENTAGE OF ALL ACCESS LINES



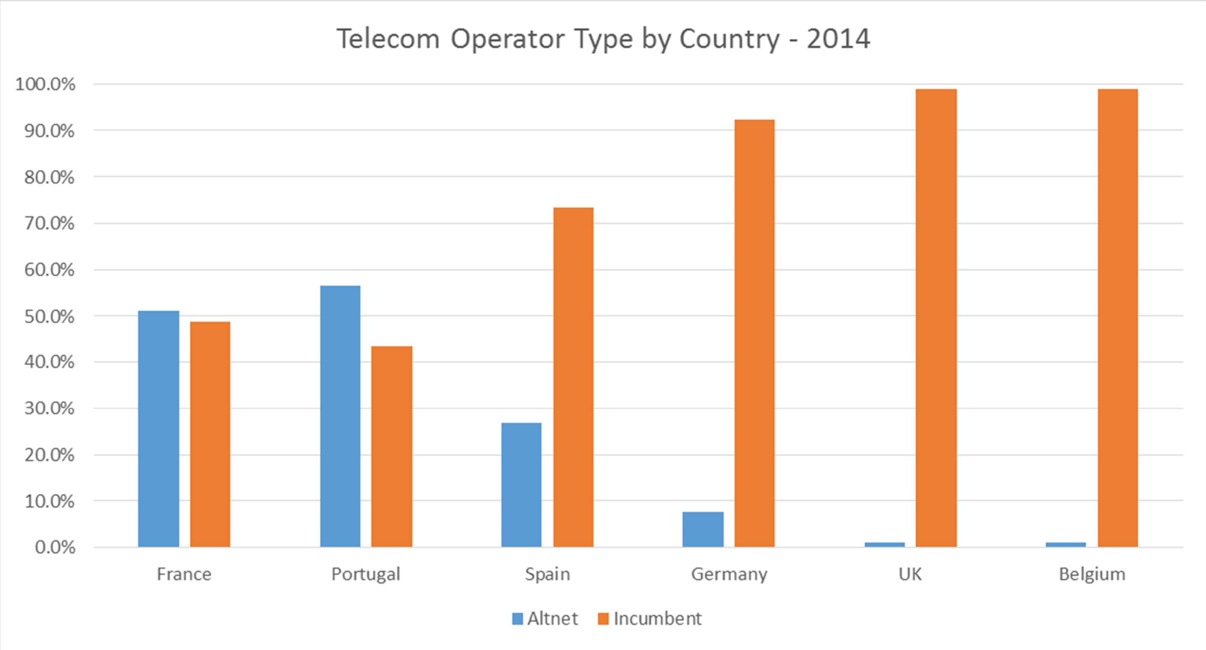
By 2014, the proportion of homes passed by FTTC in Belgium, Germany and the UK, and by FTTP in Portugal and Spain, had reached 60-90%, the figure for France was much lower at 20%. [81] A significant difference between the two cases can be seen in Figure 2, which shows that the regulatory strategy employed in the FTTP countries (a strong version of the conventional 'ladder of investment', combined with symmetric regulation of in-building wiring), is associated with an appreciably more equal split of homes supplied between the incumbent, on one hand, and competitive providers, on the other, than is the case in FTTC countries.[82] Not surprisingly, this makes this approach very palatable to competitive providers with deep pockets.[83]On the other hand, FTTC countries have shown a more rapid deployment of NGN resulting among the ones with a higher percentage of households served by fast broadband services.

In those countries that have adopted FTTH, policy makers put in place extensive sharing regimes for passive outside-plant infrastructures, such as ducts or cabling, and very extensive in-building wiring sharing regimes. These were co-ordinated by the regulator, and extensive industry co-ordination took place. This was further backed by measures to ensure FTTH extended to rural areas, normally with public finance to support the measures - either now, or with a clear path in the future.[84]

[81] Note that the data on Germany in Figure 2 may overestimate the 'altnet' element, since the vDSL is essentially only deployed on those lines where SLU is also LLU.
[82] However, it should be considered, that the competitive picture represented in figure 2 would appear quite different if one would have also taken into consideration the presence and technological choices of cable companies. A topic not dealt with in this Report.

[83] Thus the responses of Sky and Vodafone to Ofcom's UK telecommunications strategy review strongly favour this approach.
[84] For instance France permits public investments in vDSL only if the investing Authority has identified its path to FTTH, including finance http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000024473100&dateTexte=&categorieLien=id

FIGURE 2: TELECOM NETWORK OPERATOR - TYPE ACROSS COUNTRIES IN 2014



It should be noted that, in general, there is little or no overlap in these FTTP networks. The typical pattern is of independent deployment, followed by the striking by network owners of deals which were commercial or not conventionally regulated, once a critical mass is achieved. In Portugal, this took the form of a barter deal between Portugal Telecom and Vodafone. Agreements in Spain are a combination of co-investment and indefensible rights of use (IRU),[85] while the French operators are likely to operate in a more tightly controlled IRU model, at least outside the denser areas.[86] Without subsequent overbuild, this creates the scope for symmetrical, as opposed to asymmetrical regulation, but it may also lead to overbuild and the option to deregulate access entirely.

The hypothesis is thus that the technological choice made by the incumbent, or by the regulators, can mold the market structure. FTTP leads to a more even balance between the incumbent and competitive access seekers, creating opportunities either for more symmetrical regulation, or even for deregulation. On the other hand, FTTC deployment, while maintaining more control for the historical incumbent, and very likely requiring the permanence of asymmetric regulation, has shown that it can lead to a cheaper and more rapid deployment of NGN, probably also in a more geographically homogeneous fashion across countries.

In conclusion, with the example of FTTC vs. FTTH, we have asked and discussed the question about whether there is a potential 'market failure' case for intervening in technology choice on the basis of regulatory or competition considerations. We stress that we are not, on this occasion, taking a position on whether this consideration should guide regulatory policy, but pointing to the possible existence of theoretical grounds from which to depart from TN and to the existence of regulatory trade-offs that may, or may not, lead to bending TN.

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[85] http://inversores.bolsa.jazztel.com/documents/10156/219926/JAZZTEL+signs+a+Vertical+Infrastructure+Access+Agreement+with+Telef%C3%B3nica

[86] http://www.arcep.fr/uploads/tx_gspublication/consult-modele-tarifs-FttH-160514.pdf

4 THE FORM OF FTTP: P2P VS. PMP

It is well known that fiber to the premises can take two distinct topological forms: point to point (P2P), in which each customer is provided with an individual unshared fiber from the point of presence; or point to multipoint (PMP) - in which each user has his/her own fiber access line up to a distribution point, in the same way that copper networks are deployed today. Over these topologies, different technologies can be layered, such as GPON or Ethernet, and although GPON is often associated with PMP, it can equally be deployed on a P2P network. However, fiber PMP can only be physically unbundled at the splitter locations, which are normally very close to the end customers. As these serve a limited number of customers, unbundling at these locations is commercially harder to justify. Further dimensions of choice can be identified, the most important of which concerns the form of PMP that is deployed.[87]
The issue discussed here is whether the choice between P2P and PMP should be left to the firms concerned, or whether (and if so, how) the regulator might depart from technological neutrality in order to influence the extent and form of the access technology which the alternatives can support – essentially, to counteract the abridgement of the competition effect which an operator installing a fiber network may be exercising88.

The limitations on the physical unbundling of a PMP network have already been noted. There is, however, another possibility, wavelength division multiplexing (WDM), in which multiple signals, on laser beams, are combined at various infrared wavelengths, and then separated. This turns a PMP network into a virtual P2P, with the difference that (unlike bitstream and VULA virtual access products) the virtual access path is unfettered; an access seeker controlling the light wave would enjoy technical independence, in the same way as if s/he held a physical access path. Considering WDM deployment introduces further technical refinements: the difference between splicing and 'pre-connectorising' the fibers in the network – a distinction which influences the deployment cost of WDM, or rather, of a 'WDM-ready' network-[89].

The question of the unbundling of fiber networks is expressly addressed in an Analysys Mason consultancy report for Ofcom, covering case studies in seven countries of interest.[90] This notes that in the six countries where fiber to the premises is utilised, one used P2P, and five solely or primarily GPON. In terms of passive access remedies, there is a mixed picture: in Singapore, most access seekers purchase passive PON network access for their customers, including the splitter, which is managed by the (separated) network operator; it provides access back to one of the nine central offices which serve the country[91]. Spain and Portugal have concluded that it is not (or not yet) possible to unbundle a GPON network. In New Zealand, the availability of passive access products for the residential market has been deferred to 2020. Finally, in France, the network is either PON or P2P, that is, it is point to point from the mutualisation point to the end customer, allowing splitters to be used at, or above, the mutualisation point. In summary, the report concludes that '*while several regulators have commented that it is not feasible to unbundle a GPON network, others have simply implemented this, proving that it can be done (at least for certain deployments)*.'[92]

[87] See, for example, Shortall (2011) and Jay et al. (2014).
[88] We are not asserting here that it has been proven that any operator has done this deliberately, thus far.
[89] The key change to move from a current generation PMP to WDM PMP would be to upgrade the splitters in the network. In a spliced deployment, this is difficult and expensive, in a pre-connectorised network it is not.
[90] Analysys Mason (2015). The countries appear to have been chosen for their intrinsic interest, rather than as being representative. They are Belgium, France, Netherlands, New Zealand, Portugal, Singapore and Spain.
[91] This small number limits the investments required by access seekers in order to provide a ubiquitous service.
[92] Ibid. Pp. 20-21, 24-25.

It is worth noting that the choices that are made today will influence greatly what the future upgrade path looks like. Operators that wish to deploy WDM would be likely to build it with that upgrade in mind (as in the USA, Portugal, Spain, where short term pressure from cable and/or competing FTTH networks makes much higher bandwidth desirable in the foreseeable future), than in areas where access competition is weaker or more limited (as in France and the UK). It could be argued that being WDM-ready - i.e., adopting a pre-connectorised solution - may change the perspective over 5 years, in terms of whether light wave unbundling is a proportionate remedy, or not. If the network is WDM-ready, then its use may be proportionate, but if the network is spliced then it may not be. However, as in the FTTP/FTTC evolution described above, policy decisions made today may push future regulation either one way or the other.

On the bright side, the technology does seem to suggest that while operators facing the design choice between P2P, PMP and the type of PMP, may also be influenced by competitive considerations, no foreclosure motive probably may be achieved on a durable basis. An operator may gain time, and may also be able to momentarily raise rivals' costs (see the above discussion about pre-connectorisation), but technical developments seem destined to mitigate the worst outcomes, particularly where the investment decision happens in the face of strong infrastructure based competition.

5 SUMMARY AND CONCLUSIONS

Broadband targets are probably a response to the perception that broadband carries the potential to exercise a positive influence on the European economy. We have noted that the existence of such targets can have an impact on technological choice, and have observed, at the same time, that regulators' concerns to promote infrastructure competition can also influence such choices.

It is suggested, in the two case studies above, that in certain circumstances, giving operators an untrammelled power to make technological choices could, in principle, have an impact on market outcomes. The FTTC vs. FTTP issue is an illustration where, in theory, a departure from TN in favour of FTTP might be argued to have some beneficial effect on the market structure, even if probably at the expenses of a slower deployment of NGN. Paradoxically, however, the major advantages may be available in urban areas, where a policy intervention would face other impediments (State aid policies), or would have dis-advantages (crowding out of private investment) which overcome those benefits.[93] Similar issues may arise for today's policy makers in the specific design of FTTP networks. At present, there may be some benefit in terms of the promotion of competition in the P2P variant that uses WDM over PMP, since it is a minor variation on the dominant technology choice that opens up future access possibilities, but without a deep analysis of the effective trade-offs, this also remains, essentially, a theoretical consideration.

In synthesis, the original rationale for TN remains valid, and an overly specific approach brings its own serious dangers. Maxwell and Bourreau's conception of TN captures this best. From this viewpoint, policy makers may set the desirable characteristics which they want to reach, and then reward them or punish them for their absence.

In all cases, a **policy maker would be better advised to indicate its preferred technology, in terms of the characteristics to be delivered or outputs, rather than in terms of network design or inputs.** It might thus say that it wants to see speeds in excess of some level (as happens already), which can also go to some other limit in the future. The regulator might say it has targets, in terms of latency, since it sees real-time virtual services as being important, and so on. However, in order

[93] These would have to be examined on a case-by-case basis, which would not be easy.

to make use of firms' knowledge of comparative costs, such type targets are better realised via price-based incentives than through instruction or prohibition.

Moreover, other factors also make such decisions more difficult. One is the optimal scale of fiber deployment. The discussion above essentially applies only to more densely populated areas, the only ones where the more expensive technology is economically feasible. In choosing between FTTC and FTTP, or among alternative FTTP technologies, such private cost differences must be traded off against the importance of a possibly more competitive market.

Second, path dependence may be important: that is, a country's decision to sink investment into one technology model, rather than going straight to the technology preferred by the policy maker, may concretely affect the desirability of the preferred technology as the ultimate goal.

Finally, even if one can identify a case where all the risks to abandon TN can be overlooked, implementation by direct *fiat* or command, and control methods, would remain hazardous in the light of the asymmetry of information between the regulator and a firm, while a price guided method, which left the final say with the operator, might be much safer.

So, where does this leave TN? It was noted at the outset that, within the range of objectives currently set for regulators, and specifically within the current European regulatory framework, at least in theory, **there may sometimes be grounds for departing from an instrumental principle, such as TN, but our analysis confirms that any such departure should be carefully appraised, and that the numerous and complex trade-offs of this choice may be very difficult to ascertain.**

CHAPTER 4 | Implications of target-oriented broadband public investment

1 INTRODUCTION

Mostly driven by a belief in the growth-enhancing effects of broadband technologies, as recalled in Chapter 1, many governments around the world have decided to set targets in terms of ultra-fast broadband coverage. These broadband targets have generally been translated into at least some public investment. The size of this investment, and the choices made as regards its provision, vary greatly across countries. Korea, Japan and Australia, for instance, are often cited for the relevance of the public funds that are committed to reaching ambitious broadband targets. The Australian government, in particular, has decided to finance the construction of a nation-wide network through a government-owned company that has also envisaged the 'buy out' of the existing major fixed line cable and copper infrastructures, thus willingly leading to a publicly-owned fiber network (natural) monopoly. Other countries, including in the European Union, have adopted less intrusive approaches.

The extent of public involvement in broadband rollout usually depends on the nature of the broadband targets set by the decision-makers. The more ambitious the targets, the greater the perceived "market failure" identified as a rationale for public intervention, and the greater the extent of public resources required to address it. In particular, targets formulated in terms of wide Fiber-to-the-home (FTTH) coverage entail the strongest need for public investment to make up for a weak private investment business case.

Public investment affects the nature of competitive interaction and market structure in multiple ways. In the case of fiber deployments, these effects are likely to be particularly significant, considering that the economics of NGA networks often implies that only one or two fiber networks may be viable in any given area. Given the strict relationship between public investment and broadband targets, the latter should thus be carefully selected.

In this chapter, we consider how the relationship between broadband targets, public investment in broadband deployment, and the competitive dynamics plays out in Europe. The chapter is exploratory in nature, as very little economic literature tackles this question directly, to our knowledge. The aim of the chapter is twofold: on the one hand, we hope to stimulate reflection on the impact that the current approach to target-oriented public investment in ultra-fast broadband is likely to have on competitive interaction in the EU; on the other hand, we put forward some thoughts on the effect that raising speed targets beyond the current level, so that deployment of certain technologies will be explicitly discouraged in favour of FTTH solutions, may be expected to have on market structure, and whether, from an economic standpoint, this would be a desirable policy to adopt.

2 THE CURRENT EU APPROACH TO PUBLIC INVESTMENT IN ULTRA-FAST BROADBAND

Target-oriented public investment may be made from the basis of a range of different motives[94]. Acknowledgement of the existence of an instance of market failure features prominently among the economic motives. As highlighted in Chapter 1, numerous positive externalities are associated with broadband deployment that benefit the citizens of the country where the infrastructure is built, but they are not directly appropriated by the operators undertaking the investment. A motive that is more political in nature, although generally cast in economic terms, is given by the pursuit of industrial policy objectives, such as the competitiveness of the ICT industry, or of the economy generally. Finally, the main non-economic motive for public investment is given by the equity considerations that lead to the adoption of 'universalization' policies that are meant to reduce, or eliminate, the 'digital divide', and to promote social inclusion.

All of these public policy objectives feature in the EU Digital Agenda for Europe, together with the additional objective of European integration. As one of the flagship initiatives of the Europe 2020 Communication[95], the Digital Agenda, as mentioned in previous chapters, sets specific targets in terms of broadband coverage and speed. To enable the achievement of these targets, it encourages member States to devise national plans to stimulate broadband roll-out through public funding that is drawn from national resources, or from EU-level sources, such as the European Structural and Investment Funds (ESIF, for all types of regions), the Rural Development Fund (EAFRD, in rural areas) and the Connecting Europe Facility.

The 2012 update to the Digital Agenda[96] makes this so explicit, that it can be conceived of as a tool of industrial policy, and that public investment in broadband infrastructures is not only accepted, but encouraged. Indeed, one of the main priorities is described as follows:

"Regaining world leadership for network services, by stimulating private investment in high-speed fixed and mobile broadband networks, enabled by legal predictability improved planning and targeted private and public EU and national funding."

While considered legitimate, public investment in broadband infrastructures is subject to the limitations imposed by the EU State aid policy. A guiding principle of the European Union is, indeed, the acknowledgement that public intervention may affect – and distort – the competitive dynamics of the market, and therefore that any State aid should be devised in a way that avoids, as much as possible, distortionary effects, particularly in terms of crowding out private investment and unduly favouring specific firms at the expense of their competitors. EU State aid regulation, thus, acts as a brake on arbitrary public investment by, in principle, directing public resources towards areas where a market failure can be identified.

The main document enshrining the EU State aid policy in this domain are the Broadband State Aid Guidelines[97]. The Guidelines translate the fundamental notion that public investment in broadband should be limited to addressing market failures and relevant equity concerns into the well-known distinction between "white", "grey" and "black" areas. For both basic broadband and NGA

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[94] Cave and Martin (2010).
[95] European Commission (2010c); Council of the European Union (2010).
[96] European Commission (2012).
[97] Other relevant documents are the General Block Exemption Regulation (GBER), i.e., Commission Regulation (EU) N°651/2014 of 17th June, 2014, declaring certain categories of aid compatible with the internal market through the application of Articles 107 and 108 of the Treaty, and the Regional Aid Guidelines for 2014-2020 (Official Journal C209, 23.07.2013).

networks, State aid is likely to be compatible with the internal market in white areas, where neither a provider is operating, nor are there plans to operate in the next three years; the aid is to be subject to a full compatibility assessment in grey areas, where only one provider is operating, and no other provider is likely to operate in the next three years. It is, in general, excluded in black areas, where there are or there will be in the next three years, two or more operators providing basic broadband.

When a public funding measure qualifies as State aid[98], in order to be authorized by the European Commission it has to comply with specific and cumulative 'compatibility conditions'. In addition to addressing a market failure, or important inequalities, the measure has to achieve an objective of common interest, be appropriate as a policy instrument, have an incentive effect, be limited to the minimum that is necessary, entail limited negative effects, and be "transparent". Moreover, the design of the measure should be aimed at limiting the distortions of competition. One of the key design features indicated in the Guidelines in this regard is the principle of technological neutrality (on which see above, Chapter 3).

Regardless the "colour of the area", public sponsors need also to demonstrate that the State aid involves a "step change", in terms of broadband availability. A step change would result if public intervention spurred: (a) significant new investment; and (b) enhanced capabilities, in terms of broadband service availability, capacity, speed and competition (e.g., effective wholesale access and/or unbundling). The extent of the step change to be substantiated, however, depends on the technological characteristics of the networks in the different areas[99].

The design of the State aid measure should also include rules on effective third party wholesale access, which is imposed on the network regardless of whether the operator is found to have Significant Market Power (SMP) under the broader EU telecommunications regulatory framework. According to the Broadband Guidelines, "*subsidized companies should provide a wider range of access products than those mandated by NRAs under sectoral regulation to the operators that have significant market power*", and wholesale access should be granted as early as possible before starting the network operation, and for a period of at least 7 years.

The pursuit of the efficiency, equity, industrial policy and integration objectives of the DAE thus occurs within the framework of the principles of competition incorporated into the State aid policy. However, the DAE's targets and industrial policy objectives have, to a non-negligible extent, explicitly permeated the State aid rules[100]. The 2013 revised version of the Broadband State Aid Guidelines, in line with the more general process of State Aid Modernization, explicitly mentions, among its aims, a desire to "*achieve the coverage objectives set at European level to spur economic growth and development*" and to "*facilitate well-designed aid targeting market failures or providing a more desirable, equitable market outcome from a cohesion policy point of view*".

In practice, this approach translates into a rather flexible interpretation of the market failure principle while applying State aid rules in the broadband domain, one that, to some extent, bends

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[98] The existence of state aid is excluded if the broadband network is deployed for a non-commercial use (e.g., NN24/2007 Public sector network, Prague), if the so-called "Market economy investor principle" (MEIP) applies (e.g., C53/06 Citynet Amsterdam), and when the broadband deployment fulfils the criteria of the Altmark test and can thus be considered to be a service of general economic interest (e.g., N331/2008 Hauts de Seine).

99 For instance, in white broadband areas, deployment of basic broadband thus qualifies as a step change, while in white NGA areas, where the existing infrastructure is given by ADSL/VDSL at the MDF, another basic broadband infrastructure would not satisfy the step change requirement, while a FTTC/VDSL in the cabinet solution would. Similarly, deployment of an FTTB/FTTH solution, where only an FTTC/VDSL at the cabinet network is available, would be sufficient to indicate that a step change is present.

[100] Sauter(2013).

the principle to industrial policy objectives. This is particularly apparent in relation to the 2013 provisions concerning the compatibility of direct public funding in black NGA areas. In these areas, where at least two NGA networks from different operators exist, the public funding of the rollout of a new network may still be considered as compatible State aid if the publicly financed new NGA network constitutes a "step change", and it is able to provide ultra-fast speeds that are well above 100 Mbps[101]. It is at least dubious that these market features can indicate an instance of market failure. Many economists would disagree, or, in any event, conclude that the empirical evidence is at present insufficient to support such a view of market failure (see Chapter 1 and, below, Section 4).

Finally, it is worth pointing out that the Broadband Guidelines incorporate a specific view of the form that competitive interaction should take in areas financed by public resources. By requiring subsidized firms to offer a wide range of access products, both passive (access to civil engineering infrastructures, particularly ducts) and active (including wholesale bitstream products), these "open access" rules reflect the view that competition needs to be ensured, when public funds are involved, at both the passive and active levels.

This approach may be considered, in practice, if not in principle, to be in line with the broader EU regulatory framework for NGA infrastructures. Indeed, the European Commission recommendation on "*regulated access to next generation access networks*"[102], basically extends the existing regulatory model in place for the first-generation copper infrastructures to the emerging NGA networks, advising NRAs to impose the entire range of access remedies to operators who are found to have significant market power (SMP operators). In particular, as regards active remedies, the recommendation foresees immediate bitstream access and the unbundling of any type of technology.

3 PUBLIC INVESTMENT, PRIVATE INVESTMENT AND MARKET STRUCTURE UNDER THE CURRENT EU APPROACH

Public investment to promote broadband rollout can take many forms. Supply-side policies are, of course, the most intrusive forms of intervention, those most likely to directly affect operators' choices and market structure. Particularly in the case of nascent NGA networks, for which it could be possible that only one or two operators may viably invest in network deployment, supply-side interventions may ultimately influence who gets to participate in the market.

The actual effect on competition in supply-side interventions depends on a range of policy variables being in the hands of public sponsors:

- *Level of investment in the broadband infrastructure* – public investment may occur at the backbone (e.g., the Korean KII-Public network and the publicly-funded Swedish public backbone), at the backhaul (especially in France) and/or at the access level (e.g., the creation of Metropolitan Area Networks (MANs) or subsidy schemes, as, for instance, in

[101] In black NGA areas, the following cumulative criteria apply in order to substantiate the existence of a step change:
- The existing NGA networks, and those planned for the next 3 years, do not reach the end-users premises with fiber networks;
- The market situation is not evolving towards the achievement of a competitive provision of ultra-fast services above 100 Mbps in the near future, by the investment plans of commercial operators.
- A demand for such qualitative improvements is expected.

[102] European Commission (2010b)

Germany)[103];

- *Choice of geographical location of investment* – public financing should be directed predominantly to areas where no existing broadband provider operates (white areas), the main aim being to address the digital divide. They may only exceptionally be directed towards areas where operators are already active, with the purpose of promoting competition and/or network upgrades;
- *Level of involvement of the public entity* – publicly funded projects can be distinguished into: direct investment, where the NGA is deployed and run directly by the public authority, or by the new entity that was born from the PPP agreement; indirect investment or concession models, where the public authority keeps the ownership of the passive infrastructure, but outsources the active infrastructure; gap investments, where the public authority simply subsidizes one operator (or more operators if they are co-investing parties), funding the gap between what is commercially viable and the public target;
- *Number of public funds' recipients* – different outcomes in terms of market structure are associated with the choice to select a single subsidized provider in a given area, or to favour co-investment by multiple operators;
- *Choice of technology* – in particular, the choice between FTTP and copper upgrades, and the choice among different FTTP technologies;
- *Wholesale access rules* – the specific open access rules that are defined by the NRAs influence the incentives and competition.

The impact on market structure of some of these levers is more straightforward. For instance, direct investment at the backhaul/backbone level aims to lower entry barriers for local operators through the development of backbone infrastructures connecting remote and isolated areas, and/or to open backhaul hubs that are closer to customers. Significant public investment in the backbone infrastructure has already been made in the past (e.g., in Sweden) and has perhaps only a residual role to play. Public investment in backhaul, by contrast, may significantly lower the entry barriers for mobile operators.

A fully-fledged analysis of the impact on market structure of all of these features of public investment is outside the scope of this chapter. In what follows, we will focus on the effect of the policy levers that are most clearly related to digital targets: the choice of the geographical location of the investment, and the choice of technology.

The key driver of the impact of public investment on market structure and competition under the current EU approach is, of course, the distinction between white, grey and black areas. The rationale for directing public funds towards white areas finds both theoretical and empirical support. Theoretically, there are reasons to conclude that the risk of crowding out is minimized in white areas, while a ban on public intervention may be welfare-enhancing in grey (and, *a fortiori* black) areas[104]. From the empirical standpoint, the only evidence that we are aware of refers to the specific context of the USA municipal electronic communications networks, which are managed by electricity utilities (and are therefore of somewhat limited use in assisting European policymaking), and this suggests that one can be fairly confident that crowding out will not occur when public intervention (municipal broadband networks) chooses areas that are demographically and economically different than those served by private operators (CLECs)[105].

[103] Another option is to intervene at the level of international connectivity (e.g., Kelvin Project of Northern Ireland and UK).
[104] Jullien et al (2010).
[105] Hauge et al (2008).

In white areas, public funding-induced distortions of competition are not at stake if there is an enduring lack of commercial incentives to invest in NGA by any operator. The subsidized infrastructure is likely to remain the only one available, at least on the reasonably long time-horizon, and therefore the only viable form of competition is likely to be services-based competition.

In these areas, the main competitive issue is whether services-based competition is actually going to develop. IDATE[106]reports that the open access model, which has been adopted by public network deployment initiatives in several American cities, has failed to attract private Internet service providers (ISPs) interested in the public wholesale offer, so that, in many instances, the public deploy of infrastructures has had to integrate into service provision. Troulos and Maglaris[107] report this to be an issue in Europe also, where, in spite of favouring a “wholesaler” or “common carrier” model, a lack of interest by commercial operators has led to the adoption of a service-provider model for the publicly-funded infrastructure.

Public intervention in both grey and black NGA areas involves substantially higher risks of crowding out and of distortions of competition, as public intervention ‘forcefully’ introduces competition in a context where private investment has already occurred, and an infrastructure already exists that provides similar services, and where competitive interaction has already developed. The “step change” requirement entails that public financing in these areas can be understood to ‘promote competition with a stronger (more technologically advanced) competitor’ which is, in turn, subject to the mentioned comprehensive third-party access obligations.

In these areas, the actual impact of public funding on competition is heavily influenced by the sponsor’s choice of technology. In grey areas, sponsors have two main possibilities within the context of fixed broadband, depending on local conditions. In particular, they may choose between FTTC/VDSL (copper upgrades) and FTTB/FTTH solutions.

The choice of funding copper upgrades in grey areas may ensure the availability of connections with speeds currently being up to 100 Mbps, and prospectively up to 1 Gb (with G.fast and similar technologies), at a relatively low cost and within a shorter timeframe than full-fiber solutions. In terms of market structure, this choice preserves the pre-existing model of services-based competition which is based on wholesale access to the incumbent’s infrastructure. This, in turn, may have the effect of delaying or displacing fiber investment, because it may make it harder for fiber investors to aggregate sufficient demand when a relatively well performing alternative is already in place. On the brighter side, of course, this solution ensures more rapid deployment. Moreover, given that some technologies are relatively less amenable to unbundling (e.g., vectoring) an issue emerges as to the most appropriate regulatory solutions to allow the implementation of the “open access” model that is foreseen by the Broadband Guidelines.

When FTTH is the chosen technology in grey areas, the market outcome depends on the identity of the selected operator. If the recipient of the public funds is the legacy network incumbent, the main effect of public investment is to accelerate the substitution of copper with fiber. In this case, again, the pre-existing model of services-based competition, which is based on wholesale access to the incumbent’s infrastructure, carries on to the fiber environment. If an alternative operator is the recipient of public funds, the latter will introduce infrastructure competition with the copper operator in a context where competition, previous to the introduction of the State aid measures, is entirely services-based, as there is a *de facto* monopoly in first generation broadband, or in NGA.

[106] IDATE (2011).
[107] Troulos and Maglaris (2011).

In black areas, the requirement for a “step change” entails that public sponsors can only fund FTTH deployments. Public funding thus introduces infrastructure-based competition between an all-fiber network and the pre-existing networks, in a context where both infrastructure-based and services-based competition is in play before public funding is introduced. This accelerates copper substitution, but may imply that multiple networks operate on a less than efficient scale for a longer period than would have spontaneously occurred.

In these areas, in addition to the standard risk of crowding out, or to the replacement of private investment, public intervention may also interfere with operators’ capacity to benefit from the investment they have already made, and, therefore, undermine their ability to undertake further investment. To address this risk, Article 84(c) of the Broadband Guidelines foresees that, in black NGA areas, the aid granting authority must demonstrate that *“the aid does not lead to an excessive distortion of competition with other NGA technologies that have recently been the subject of significant new infrastructure investments by market operators in the same target areas”*. However, given the long payback periods of most network infrastructures, there seems to be still ample scope for public investment to jeopardize past private investments, unless this provision is interpreted extensively.

Finally, in both grey and black areas, a question emerges with regard to the strength of the ‘multiplier effect’ that public investment is able to generate. On the one hand, private operators’ overall incentives to invest in NGA may, on balance, be not as high as was intended in the presence of a public investment, because of the rules on third party access and of the claw back provisions that are associated with State aid. While on the other hand the open access model seems, indeed, to be a reasonable tool to prevent public funding from “picking winners” in a given local market, and to avoid costly duplications of investment. Nonetheless, it does raise an important question as to the extent of private investment that public investment will be able to spur.. Moreover, the claw-back provisions included in the Broadband Guidelines, which foresee that any unexpected upside from the network investment should be shared with the public sponsor, also cap the incentives of the recipient of public funds. This may entail that the extent of public funds that are needed to trigger private investment may be substantial and, again, it suggests caution in deploying public investment in areas where alternative networks already exist, albeit with a lower performance. On the other side, the perspective of the availability of public funds may affect the timing of deployment, giving rise to a sort of ‘dynamic crowding out’. Private investors may, indeed, postpone investment until uncertainty about the availability of public subsidies is resolved, even in areas where, in principle, there may have been a profitable business case.

Finally, it is worth pointing out that the extent to which public intervention involves co-investment by multiple operators, also affects the market structure. Co-investment agreements have increasingly received attention in the policy debate, due to their mix of avoiding inefficient infrastructure duplication and reducing investment risks for each of the operators involved, thereby ensuring a fair level of investment incentives and competition. In order for co-operative investment agreements to deploy all of these potential benefits, contract provisions must be such that contracting parties can access the NGA at cost-based or zero charges, to avoid high side-payments creating a similar effect to that of the high termination rates. The theoretical economic literature on co-investing agreements[108] finds that they seem to have a positive effect on investment incentives, but the resulting level of competition in the market will depend on the number of insiders to the agreement, and on the existence of NGA access regulation to guarantee fair conditions to access seeking outsiders to the agreement. A strict supervision by competition authorities is strongly advisable in order to control potential collusion between co-investing operators, which might undermine most of the societal benefits from the co-investment.

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108 See, e.g., Cambini and Silvestri (2012) and Cambini and Silvestri (2013).

To sum up, public investment in broadband deployment, under the current European policy framework, does maintain an element of potential distortion of competitive dynamics. This element is primarily linked to the fact that the very definition of market failure, as per the Broadband Guidelines, depends on the DAE targets, and on the assumption that higher-speed NGA infrastructures bring substantial additional positive externalities if compared to lower speed ones. It is to a discussion of this assumption, and of whether it would be worth further extending its policy implications, that we now turn.

4 PUBLIC INVESTMENT, PRIVATE INVESTMENT AND MARKET STRUCTURE IN THE PRESENCE OF HIGHER PUBLIC TARGETS

The discussion so far has highlighted that the setting of broadband targets, in terms of coverage and speed, has been an important part of the policy mix adopted at the European level. It is a (meta-) policy tool, which is susceptible to significantly influence market structure when public financing is involved, through the role it plays in the Broadband Guidelines. One important issue that is worth addressing, especially in view of the current EU Commission's public consultation on the needs for broadband speed and quality beyond 2020, is therefore whether the implementation of EU policy in this domain would benefit from an update and a modification of these targets. In particular, it is worth considering whether setting higher targets in terms of the adoption of NGA connections well beyond 100 Mbps, and thus expressing a specific favouring of FTTH (the only technology that, together with DOCSIS.3 cable, guarantees speeds well over 100 Mbps), would be justified. In this section, we thus explore the consequences of setting higher targets, with a view to identifying their likely effects on public investment, private investment and competitive dynamics. The analysis also proposes some insights into the implications of higher targets in the pursuit of the different policy objectives that are set in the DAE (efficiency, equity and industrial policy objectives).

Private operators currently make their investment choices on the basis of a cost-benefit analysis of different technological solutions where, as is well known, FTTH solutions allow for greater performance, but involve a significantly higher cost of deployment, while FTTN solutions guarantee lower speeds at much lower costs. It is at least doubtful that higher EU-level targets would change significantly the private operators' cost-benefit assessment of the different technological solutions. However, higher targets certainly signal to national and local public authorities the priorities that they are expected to have in choosing how, and where, to direct public funding, as well as the desirable scope of their intervention.

A first effect of setting higher targets is thus likely to be an increase in the scope for public investment. To translate into effective deployment, the policy choice of technological solutions, that guarantee speeds well over 100 Mbps for a higher percentage of the population, is likely to imply a need for more public investment to make up for private investment in areas where operators have already invested, or who would have invested in NGA networks with lower performance, even if they were more than adequate to meet consumer needs. Moreover, it is also likely to require investment in a greater proportion of the national territory, as more areas would qualify as being either 'white' or 'grey' if measured against a benchmark of the availability of very high speed NGA.

This would amount to a significant change in the European approach towards investment in NGA, which has so far been predominantly based on reliance on private investment. The size of the investment at stake, and the track record of EU public investment in broadband, so far suggests that a concrete implementation of this policy change is not particularly likely. According to the Commission's own estimates, the achievement of the current DAE targets requires investment of about €330 billion (of which about €60 billion for 100% coverage of the population at 30 Mbps, and €270 billion for 50% coverage of the population subscribing to 100 Mbps connections by 2020). As of 2012, a total amount of less than €12 billion of multiannual State aid budgets for broadband deployment had been approved (of which possibly only a fraction has been translated into effective public investment)[109]. Even considering the very significant "multiplier effect" of public investment, the pursuit of the DAE targets has so far been largely dependent on private operators' investment choices. Nevertheless, it is worth considering whether the rationale for a substantial increase in public funding, triggered by higher broadband targets, would be strong. The key justification for this change in approach is that very high speed NGA deployment will bring substantial additional positive externalities, if compared to lower performing NGAs, and/or that substantial public intervention is warranted by a meaningful industrial policy motive (e.g., the promotion of the ICT industry).

As explained in Chapter 1, currently there is no robust evidence, nor is there enough empirical research, about the different extent of the positive externalities associated with NGA technologies, which are characterized by different speeds. While the empirical literature on the positive effects of broadband rollout is relatively solid, the extent to which accelerating deployment of a 'future-proof' technology, such as FTTH, is justified on the basis of a cost-benefit analysis that includes social benefits in the assessment, is much more controversial[110].

The only study that, to the best of our knowledge, clearly supports the view that a cost-benefit analysis including externalities would fully justify the investment to build a national FTTH P2P network, is one by the OECD[111]. The study concludes that this investment would be justified if it induces a cost reduction of between 0.5% and 1.5% in each of four sectors – the electricity, health, education and transport sectors – and over a period of 10 years. The other currently available studies supporting the view that increased speed adds to GDP and GDP growth[112] and household income[113] are not actually concerned with differences in speed between FTTx technologies, but rather they are concerned with differences among lower-performing technologies. For instance, in the analysis by Rohman and Bohlin[114], the sample mean bandwidth is 8 Mbps, while Gruber et al.[115] find that *"there seems to be a growth impact in moving away from basic broadband, but the incremental speed impact on growth appears to level off"*, where 'basic broadband' in the study is understood to be given by connections at 0.75 Mbps.

The lack of empirical evidence may, of course, be linked to the scarce availability of data on NGN technologies. However, it may as well depend on the fact that most of the externality-generating applications one may think of (e-health, e-government, smart grids, etc.) do not actually require ultra-fast broadband to bring about social benefits. This is the conclusion reached, for instance, by Kenny and Kenny[116], on the basis of a review of the available literature.

The available empirical evidence is thus not sufficiently robust to conclude that abandoning the standard view that technological choices should be left to the market, and using public investment to push private operators in a specific technological direction, would amount to a wise and 'future-proof' approach. Indeed, given the considerable uncertainties as to future users' demand, technological evolution, and deployment costs, the standard of proof that is adopted in the assessment of whether the extent of incremental externalities from a specific technology is sufficient

[109] Henkel (2014), p.5.
[110] ITU (2012).
[111] OECD (2009).
[112] Gruber, Hätänen and Koutroumpis (2014), Rohman and Bohlin (2012).
[113] Ericsson, Arthur D. Little and Chalmers University of Technology (2013).
[114] Rohman and Bohlin (2012).
[115] Gruber et al. (2013).
[116] Kenny and Kenny (2011).

to justify heavy-handed public interventions that distort technological choices, should be particularly high. The risk is, of course, the usual one, that of picking apparently 'future-proof' technologies that turn out not to deliver the expected benefits.

The second effect of setting higher targets is that it makes the usual trade-off between coverage and performance that is involved with public investment, more stringent. Given limited public funds, and the large cost difference between copper upgrades and very high speed broadband solutions, increasing the performance requirement for publicly-funded networks necessarily entails reducing coverage, i.e., concentrating public resources in more limited areas. This, in turn, may reduce the extent to which it is possible to pursue the equity and cohesion objectives set in the DAE. The effect of this choice on efficiency is less clear since, as recalled in Chapter 1, since the empirical literature comparing the effects of broadband adoption with those of broadband coverage/availability is too scant to allow a meaningful assessment. However, preliminary results indicate that regulatory solutions (ULL price), that are meant to promote fiber, influence coverage more than adoption, so that excessive emphasis on fiber deployment may actually reduce the take up rate, thus making take up targets actually harder to achieve[117].

More generally, focusing public investment on very high speed broadband technologies may lead to two equally problematic outcomes in terms of coverage/performance trade-off. On the one side, public funds may be directed towards areas where the social cost-benefit calculus is less ambiguous, and investment in ultra-fast broadband technologies is more likely to be justifiable by substantial externalities. These are the more densely populated areas, where ICT externalities have empirically been found to be more sizeable. Such investment may be considered compatible with State aid, as per the Broadband Guidelines, even in black areas, as it would, in principle, qualify as a 'step change'. This choice would, however, carry the most potential for market distortion and crowding out, as explained above in Section 3.

Alternatively, public funds for ultra-fast broadband deployment may be directed towards less densely populated areas. This would give rise to a highly counter-intuitive situation: the accelerated deployment of very high speed broadband would occur in some areas where there are less consumers to benefit from very high speed networks, and where the extent of externalities is lower; while deployment in high density urban areas would occur at the (slower) pace that private operators would reckon to be compatible with their (private) cost-benefit calculus. The final result may be at odds with a meaningful interpretation of both the efficiency and the equity objectives of the DAE.

An additional relevant trade-off, associated with the use of public funds in the presence of higher targets, may emerge between coverage and adoption. If far-reaching targets, in terms of performance, were set, a bias of public investment towards supply-side policies, at the expense of demand-side policies, would be likely to arise. Although the empirical evidence on the appropriate sequence of supply-side and demand-side policies is scant, and is limited to first-generation broadband, it nonetheless indicates that 'one-size-doesn't-fit-all', as different forms of intervention are appropriate for different stages of broadband development[118]. This suggests that if EU-level very high speed targets were to encourage countries into a uniform policy response focusing predominantly on supply-side interventions, this may have negative effects in terms of adoption. Since what creates social welfare is the usage of services available through the networks, and not the availability of the network *per se*, this would not be a desirable policy outcome.

[117]Briglauer, Cambini, Melani (2015).
[118]Belloc, Nicita and Rossi, (2012).

5 SUMMARY AND CONCLUSIONS

Targets play an important role in the overall EU-level approach to NGA network development. They do so both directly and indirectly, by setting the stage for national broadband plans, and by shaping what can be considered compatible State aid, as per the Broadband State Aid Guidelines. In this chapter we have questioned whether the implementation of EU policy in this domain would benefit from an updating and the modification of these targets, and particularly from the setting of higher targets in terms of the adoption of NGA connections well beyond 100 Mbps.

Our conclusion is in the negative. **We expect higher targets to translate into a greater scope for public investment that, as is well known, carries a concrete risk of crowding out, or else of distorting private investment in areas where an infrastructure (albeit a lower-performing one) is already active.** Moreover, higher targets would induce public decision-makers to make choices with regard to the trade-off between coverage and performance, and between coverage and adoption, that are not necessarily in line with a meaningful interpretation of the objectives of the Digital Agenda for Europe.

For these reasons, we think that the standard of proof in the assessment of whether to adopt heavy-handed forms of public intervention, thus forcing the market towards particular solutions, should be particularly high. Setting higher targets should, in other words, require a high degree of confidence that this is an appropriate policy choice, and therefore that there is reliance on the fact that externalities are strong enough to warrant public intervention and/or that an explicit industrial policy motive is meaningful. Based on the empirical evidence available so far, as well as of the considerable uncertainties as to users' demands and technological evolution, either of these conclusions is far from being warranted.

Of course, these effects depend on there being a significant commitment of public resources. If substantial public resources are absent, the risks highlighted here would be greatly limited, but higher targets would also be likely to remain confined to paper.

CHAPTER 5 | Policy suggestions on fast and ultra-fast broadband targets

1 INTRODUCTION

The European Commission's public consultation is centred on understanding the necessity and developments of broadband deployment in Europe in the coming decades, for the eventual purposes of developing appropriate policies.

The Commission re-examines and questions the adequacy of the instruments used in the past to promote the development of the digital economy: plans finalized to reach targets for coverage and adoption, regulations in favour of investment, and direct interventions in networks. In the same consultation, the Commission intends to explore the demand side of the market through a series of questions about the perceived needs for broadband in the future.

In its inquiry, the Commission is clearly moved by the perception of a retardation in the creation of a European digital single market, but also by a preoccupation with the status of the European networks *via à vis* other areas of the world, especially in terms of adequacy of the level of investment in NGN networks and of adoption of the new technologies. The ultimate goal of the Commission appears to be to ensure that the EU fully benefits from the digital revolution, in terms of increases in industrial productivity and consumer welfare.

The major instrument used by the Commission to foster broadband – the fixing of uniform targets for coverage, adoption and the speed of Internet connection in Europe – has essentially been suggestion. National broadband plans to subsidize the deployment of NGN networks have not so far translated into amounts of public investment that are comparable with those of other countries that have set ambitious broadband targets. To some extent, they have also been held back, even in rural or poor geographical areas that are unlikely to ever be serviced by private initiatives, by worries about competition distortion, especially under the consolidated State Aid Guidelines, that can only partially be adjusted to the industrial policy desiderata for the sector. Not surprisingly, results throughout the member States, at least for the moment, appear truly variegated.

The fact that targets are intrinsically voluntary and non-binding, however, should not lead to and underestimation of their potential impact on the development of the European electronic communications sector. While their impact is obviously most pervasive when they are backed by substantial amounts of public funding, they may nonetheless crucially affect operators' choices and incentives, as well as the overall competitive dynamics through regulation, and by shaping the direction of the limited public investment available.

This would particularly be the case if a modification of the current targets was sought with the purpose of providing an additional stimulus to ultra-fast broadband deployment and, more specifically, if more demanding targets were set that extended the coverage requirements for ultra-fast broadband technologies (notably, FTTH) beyond the current level.

Moving from the awareness of the relevance of the role that targets play in shaping the overall policy approach to broadband development, the present Report did not seek to answer the many complex questions that this consultation has raised, but has instead concentrated on two central issues. First, are connection and adoption targets in national and supra-national broadband plans a realistic and useful tool? And, second, would an upgrade to the current set of targets be justified on the basis of solid economic reasoning?

In this chapter, we draw some (tentative) policy conclusions, based on the articulated analysis conducted in the previous chapters (see Section 2). Overall, we express a strongly sceptical view about both the general usefulness of targets, and the rationale for adopting more demanding targets than those currently in place. We also propose some reflections on the methodological approach that we think would be appropriate for the evaluation of any changes to the current targets (Section 3). Finally, we advocate caution with regard to the possibility of a target-induced muddling of industrial policy and regulation (Section 4).

2 THE RATIONALE AND IMPACT OF DIGITAL TARGETS IN EU POLICY MAKING

The analysis in the previous chapters has provided a number of insights that are useful in addressing the main questions at the core of this Report.

The first set of considerations relates to the rationale for uniform targets, in general, and to the rationale for targets that are specified in terms of the extended coverage of ultra-fast broadband technologies, specifically. In this regard, the analysis concludes that the setting of uniform targets does not appear to rest on a solid economic rationale, either within or across countries. Data show that, in general, broadband penetration and adoption do produce sizeable externalities, which, in general, justify the adoption of public policies to support broadband rollout and adoption.

However, broadband impact tends to be very heterogeneous. In fact, it varies when employed by firms, or individuals, depending on their particular characteristics in particular areas, and therefore it is difficult to extrapolate an overall impact. Even within countries, the rationale for uniform targets does not thus appear to be solid.

The analysis in the previous chapters has also highlighted the extreme heterogeneity that exists with regard to the adoption and take-up of broadband technologies, as well as of fast vs. ultra-fast technologies. Countries without a high-quality copper legacy network have migrated towards fiber faster compared to countries where, instead, an existing copper-based network was available and could therefore be rapidly upgraded in various effective and less expensive ways.

Moreover, the gap between adoption and coverage is still large, and is different in EU founding member States and the Eastern European countries. From this perspective, also, it can be safely concluded that *one size does not fit all*. In particular, attention should be paid to the fact that the economic rationale for investing in FTTH solutions is different for countries where substantial investment in copper upgrades have already been sunk as opposed to countries where the choice of technology may not be influenced by past investment.

As for targets that are specified in terms of the extended coverage of ultra-fast broadband technologies, we can conclude that the existing evidence is not sufficient to make a case for expressing a preference across the board for FTTH solutions. To clearly support the view that an extension of ultra-fast broadband targets would be justified, it would be necessary to find evidence, either of the fact that significant positive externalities are not reflected in the current level of demand for ultra-fast broadband, so that there is a wedge between social goals and individual choices, or that a sufficient willingness to pay exists that is not met by private demand due, for instance, to co-ordination problems. The available empirical evidence does not allow us to reach either of these conclusions.

While there are many studies that find robust evidence of direct and indirect benefits for society that stem from broadband deployment, few of them concentrate on the relative benefits of ultra-fast broadband, and those that do, compare it with relatively low speeds levels, not allowing meaningful conclusions for the comparison between FTTH and copper upgrades to be drawn.

The literature on NGN demand is also scant and is unable to clearly provide empirical support for the proposition that broader FTTH targets than those currently embedded in the DAE would be justified on solid economic grounds. There exist only a few economic studies that present robust analysis on the end-users' willingness to pay for migrating from copper to fiber connections, i.e., in estimating the so called "fiber premium". Most of this evidence suggests that customers are likely to have a high incremental willingness to pay for a high speed service, but a low incremental willingness to pay for a very high speed services. This is confirmed by the low adoption of ultra-fast broadband services in most EU countries. Moreover, it is unclear whether the network effects that may be considered to justify policies that encourage migration towards NGNs, are linked to some specific level of speed or adoption, and would therefore also justify the selective approach of these policies towards FTTH.

Data show that heterogeneity across member States also exists in this regard, again suggesting that uniform and far-reaching targets may not be an appropriate policy choice. Indeed, Eastern European economies that lack an established basic broadband legacy network are subject to a less pronounced replacement effect on the supply side, as well as substantially lower switching costs on the demand side. The social cost-benefit calculus concerning the deployment of FTTP solutions is therefore necessarily different in these countries from this perspective also.

All in all, there is thus no consensus, either in the specialized economic literature, or in the industry, regarding the incremental benefits that are brought about by immediately rolling-out an all fiber network, while its elevated rollout costs are undisputed. Other, less costly, technologies, which partly continue to exploit the surprising resilience of the copper network, such as G.fast, may soon offer speeds from 700MB up to 1Gb, which could satisfy the levels of demand in the near/medium term future.[119] However, this technology, but also certain versions of all fiber technologies, may propose new regulatory problems in terms of wholesale access to the network, challenging what is probably the last fundamental tenet of European regulation.

An additional issue that has been considered in the Report is whether there may be other market failures, different from externalities, that suggest the promotion of specific technologies, FTTP vs. FTTC and FTTH P2P vs. PMP. In particular, the possibility that departures from the technology neutrality principle meant to explicitly favour FTTP and FTTH P2P may be justified on the grounds that they could allow to address problems due to the dominance of the incumbent operators was explored. In this regard, the overall conclusion is cautious, both with regard to substance and with regard to the methods.

A very rigorous version of TN, which gives no guidance at all in terms of outcomes, can allow choices by dominant firms, which may totally or partially foreclose competition. FTTP, especially FTTH P2P solutions, may ensure more competitive outcomes in exchange for greater development

[119] WIK (2013) and Kenny (2015).

costs. However, this option appears to be sustainable only in the most densely populated urban areas, where the more expensive technology is economically feasible. Elsewhere, it is clear that the desired benefits, in terms of increased competition from an explicit technology choice, would not materialize, given the lack of compatibility of this choice with private operators' incentives. Within urban areas, where operators have expressed a preference for FTTH investment, there may be some benefits, in terms of the promotion of competition in the P2P variant using WDM over PMP, since it is a minor variation on the dominant technology choice that opens up superior future access possibilities.

Thus, the original rationale for TN in principle remains valid, and an overly specific approach brings its own dangers. Prescribing specific technological solutions does not allow the exploitation of firms' comparative information advantage, as regards the costs and benefits of different technologies. Even though TN should always be considered as an instrumental principle, which may be abandoned if a solid economy supports the notion that it may conflict with other fundamental objectives, any departure from it should be grounded on solid analysis and be undertaken with caution.

Finally, the Report provides insights on the consequences and desirability of the voluntary and non-binding nature of the targets. Targets, in their present form, are a kind of soft-law instrument that can broadly be re-conducted into the so-called Open Method of Co-ordination (OMC), a method that was probably codified for the first time by the European Council of Lisbon in 2000. They are not only voluntary and non-binding, but they are also fully respectful of the principle of subsidiarity, as long as their application is explicitly and entirely left to the concrete choices of member States. Whether they are 'armed' through the commitment of public resources, or through the adoption of specific prescriptions and sanctions, will in the end depend fully on member States.

This approach has some advantages. First, it is an approach that appears more compatible with the overarching principle in policy design, which indicates that policy makers should adopt the measures that make the best use of private information. From this perspective, a mere indication of the preferred broadband deployment outcomes, in terms of coverage and speed, fares better, comparatively, than one that prescribes specific network designs or inputs. Moreover, the fact that targets are uniform on paper, but not necessarily in practice, may be conceived to leave room for differences at the implementation stage that can take into account heterogeneities, as well as the different starting points at the country level.

However, uniform targets may affect national policies and overall market outcomes, even if they do not result in a homogeneous application, nor are they backed by uniform and substantial commitment of public funds. Targets drew by political desiderata shape both private and public operators' expectations in ways that are not necessarily compatible with the very objectives that those targets are meant to pursue.

Private operators' expectation that public resources will sooner or later be found to back the EU-level targets, may result in a waiting game, whereby private investment may be delayed, even in areas where a business case would otherwise exist, because of waiting promises to deliver benefits in terms of a public subsidy that substitutes, in part, private investment. This may give rise to sub optimal results from the perspective of the DAE objectives from two, equally troubling, perspectives: either the investment does not happen at all, or it follows too late, in the case of scarce public funds; or investment does occur, but simply with public money that crowds out private investment.

The effect of targets on public decision-makers' expectations and policy choices in the heterogeneous EU member States may be equally problematic. To bring concrete results, ambitious targets should find support in significant amounts of public investment. Indeed, since far-reaching targets do not change the cost-benefit comparison of different technological solutions by private operators directly, more public resources would be needed to effectively meet these more ambitious targets. An outcome where public investment increases substantially is, however, not only relatively unlikely, but also, by and large, undesirable, since public investment, as is well known, carries a concrete risk of crowding out, or else of distorting private investment in areas where a broadband infrastructure (albeit lower-performing) is already active.

Moreover, higher targets would induce public decision-makers to make choices with regard to the trade-off between coverage and performance, and between coverage and adoption, that are not necessarily in line with a meaningful interpretation of the objectives of the Digital Agenda for Europe.

In particular, uniform targets that focus public investment on ultra-fast broadband technologies, almost automatically reduce coverage, because more resources are required to meet the targets in any given area. This may lead to two equally problematic outcomes. If public funds are directed towards areas where the social cost-benefit calculus is less ambiguous (urban areas), this is done at the expense of the equity and cohesion objectives of the DAE, and it carries the most potential for market distortions. If public investment in ultra-fast broadband occurs in less densely populated areas, a highly counter-intuitive situation ensues: the accelerated deployment of very high speed broadband will occur in some areas where there are consumers to benefit from very high speed networks, and positive externalities are clearly lower.

Moreover, there is a risk that far-reaching targets induce public investment to be biased towards supply-side policies, at the expense of demand-side policies, so that coverage will be promoted at the expense of adoption. Since, however, it is the actual use of technologies, rather than the availability of networks *per se* that generates social welfare, it is doubtful that this outcome can be considered desirable in light of the DAE objectives. In this regard, it should also be noted that empirical evidence exists to suggest that the appropriate sequence of supply and demand side policies for the promotion of broadband penetration depends on the stage of infrastructure development. Thus, also from this perspective, uniform targets do not appear to be well grounded.

For these reasons, we think the standard of proof that is necessary for the assessment of whether to adopt heavy-handed forms of public intervention, forcing the market towards particular solutions, should be particularly high. Setting higher targets should, in other words, require a high degree of confidence that this is an appropriate policy choice, and therefore confidence in the fact that market failure motivations are strong enough to warrant public intervention, and/or that an explicit industrial policy motive is meaningful. On the basis of the empirical evidence available so far, as well as of the considerable uncertainties as to users' demands and technological evolution, either of these conclusions is far from being warranted.

3 ON THE METHOD OF TARGET SETTING

The soft law nature of voluntary targets entails that their decision making process is often extremely simplified, at least if compared to the lengthy process of legislation. Sometimes, to take a decision, it is considered sufficient to undertake a rapid, even relatively informal, consultation of the stakeholders and some minimal information gathering.[120] Clearly, however, such an informal process is exposed to risks, if the analysis is rapid but superficial, that the targets may easily turn out to be unreliable or unrealistic. Furthermore, in this instance, the very fact that whoever is setting the targets does not have to carefully plan their practical realization, may backfire by worsening the credibility of all the process. Moreover, also in cases where concrete indicators of achievement, i.e. the ultimate benchmarking, are left to the final actors, the member States, setting unrealistic targets, may introduce a bias that is difficult to overcome at a later stage.

A further difficulty with this type of targets is that they tend to be established mainly on the basis of supply side considerations. The EU and member States, like any Government, when in "industrial policy" mode, tend to consider what they can do directly, or can possibly impose on the industry, but they normally eschew the much more complex task of affecting the more elusive demand side of the market.[121]

For all these reasons, before going to our conclusion about the merits of the issue, it is important to reflect on the method that is presently being followed by the Commission and on its adequacy. In its consultation, the European Commission purports to understand broadband needs for the future by directly asking households, businesses and public institutions. Considering the potential influence of targets on investment and future public policy, this popular consultation may be insufficient. Opinions and analysis play a different role, and they are different instruments. It is possible that EU targets are popularly invoked, but it remains true that they should be set if, and only if, this is really useful, and only after a careful technological and economic analysis.

As we discussed in the introduction, soft-law has many advantages and many risks. In general, political imperatives appear to be a very poor guide to complex industrial choices. Moreover, we are in the presence of very different starting points among the member States. In the likely case that, in this industry as in most of the other sectors, path dependency is important, the effect of unique targets can lead them to irrelevance or, worse, to unexpected implications and consequences.[122]

All this calls for a complete and detailed analysis of the impact of the eventual new targets that the Commission proposes to adopt for Europe. Social costs and benefits of the investment to be made, also including the precise policies that are needed to achieve the objectives, should be part of a necessary second phase of the discussion.

In any case, a public consultation, collecting feedbacks from citizens and stakeholders, is only a necessary first step to a better regulation approach, which should then be followed up with an accurate analysis of the impact of uniform targets. A full appraisal of the foreseen effects of uniform targets on demand, supply and technological advances, appears indispensable. Any option to adopt new targets should be compared with the two other natural options: no targets at all (the zero option), or differentiated targets that are to be based on the specific starting points of each member State. A complete impact assessment, based on alternative solutions, can constitute the legitimate basis from which to reach a sound decision and, in the end, to offer the potential to, eventually, define realistic and relevant targets for broadband in Europe.

In the context of the Better Regulation approach, impact assessments do indeed constitute a crucial support enabling policy and decision makers to take wise regulatory decisions, which are, by consequence, strongly related to the overall market dynamics. In particular, in providing empirical

[120] Héritier (2002).
[121] Sisson et al (2003).
[122] On the importance of path dependency in the liberalization of electronic communications in Europe see Belloc, Nicita, Parcu, (2012).

evidence of the market situation, and in analysing the impacts of the potential different policy and regulatory interventions, they represent a fundamental instrument, which is at the base of any efficient decision. Impact assessments do, in fact, guarantee transparency and accountability, as well as true compliance with the proportionality and subsidiarity principles.

This is in line with the Better Regulation agenda of the European Commission itself and it has been recalled by the recent Communication of May 2015, affirming that "*applying the principles of better regulation will ensure that measures are evidence-based, well designed and deliver tangible and sustainable benefits for citizens, business and society as a whole*".[123]

Indeed, according to the updated Better Regulation strategy, the European Commission shall provide an impact assessment any time its initiatives are likely to have significant economic, environmental or social impacts. Setting new broadband targets for the EU, even if they remain only voluntary and are embodied in soft law instruments, certainly has those characteristics of significant economic and societal impact, which require a careful and complete assessment process.

4 REGULATION VS. INDUSTRIAL POLICY: A NECESSARY DISTINCTION

In the discussion about broadband targets for Europe it is important to avoid, as much as possible, to confuse regulatory policies, and their instruments and goals, with industrial policies. Actually, some authors maintain that the decline of traditional industrial policy, particularly in the form of planning, has been only apparently substituted by a true reliance on market forces, and, in fact, government and regulatory agencies have continued to pursue their plans to influence markets and companies through regulatory orders and agenda setting objectives.[124] This view, however, cannot easily be accepted.

In the words of the European Commission: *"Industrial policy is horizontal in nature and aims at securing framework conditions favourable to industrial competitiveness. Its instruments, which are those of enterprise policy, aim to provide the framework conditions in which entrepreneurs and business can take initiatives, exploit their ideas and build on their opportunities."*[125] If this is industrial policy, it should appear and remain clearly distinguished from regulation. In fact, the most noble and modern view of industrial policy, in Europe, has been primarily based on four pillar "framework" policies: competition, internal market, trade, and European Monetary Union. On the contrary, typical sectorial industrial policies in energy, telecommunications, transport, have essentially remained in the hands of national governments.[126]

European regulation typically represents an important middle ground, and , for several decades, it has had the legal standing to play a major role in shaping the regulatory framework of member States, in view also of the digital single market goal, but it seeks to maintain a high degree of independence from national governmental policies.[127] Furthermore, the EU legal framework requires this independence from national governments and politics, to be guaranteed also for national regulatory authorities (NRAs) that implement EU rules. A confusion of EU regulation and national industrial policy, facilitated by a blurred pursuit of "common" EU broadband targets, may offer space for nationalistic old style industrial policies and weaken the NRAs independence. In the end, all this could probably contribute to further fragmentation of markets, taking the EU even more away from the digital single market goal.

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123 European Commission (2015a)
124 Thatcher (2014).
125 European Commission (2002).
126 Vanden Bosch (2014).
127 Parcu and Silvestri (2014).

Nonetheless, we have to recognize that industrial policy is an elusive concept and that there are alternative, and much wider, definitions. To quote Chang[128]: ""*One interesting thing that has emerged from the debate on industrial policy of the last two decades or so is the recognition that industrial policy is more about broad 'vision' and co-ordination than about doling out subsidies or providing trade protections.*"[129] In a recent study for OECD, Warwick states that a representative definition is that "*Industrial Policy is any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity toward sectors, technologies or tasks that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of such intervention.*" [130]

Clearly, if the definition is so large, the broadband targets discussed in this Report probably are a legitimate proposal of industrial policy, as they may represent an example of the new wave of "soft" industrial policy. Yet, it is even more important than that they are not confused with EU regulation. In Europe, regulation is mandatory and economically principled: to be precise, it is inspired by those principles of competition that give the framework to European industries and that do not allow even governments to distort it. To lose this characteristic of EU regulation would be a price too high to pay for the sake of indicating common targets to member States.

Finally, in full coherence with the discussion in the previous section, we underline that new forms of "soft" industrial policies also need a careful *ex-ante* impact assessment, as they are certainly not immune to the historical criticism of a lack of a rigorous evaluation of effectiveness, which always accompanies the selective political interventions of public powers in the economy.

5 CONCLUSIONS

The consultation of the European Commission on the needs for Internet speed and quality beyond 2020 is an important occasion to reflect on the status of the European industry and the status of European regulation. A too negative approach to both elements may neither be warranted, nor may it be the best guide to assuming wise decisions.

Europe has been, and is still today, an essential part of the Internet revolution. Its companies and its citizens are benefiting from the changes and are coping with them in a fashion that is encouraging.

In this Report, we underline the importance of a deep understanding of the role and consequences of imposing EU targets, even when they are voluntary and non-binding, as in the present case.

It is clear to us that the debate about NGNs' deployment in Europe beyond 2020 is complex and fundamental. It involves a series of relevant trade-offs: we have discussed some of the most important, including the best way to ensure positive externalities, the control of market power, and the optimal equilibrium between public intervention and private investment. Unfortunately, there are no easy answers to any of these trade-offs, only careful economic analysis and flexibility in policy responses may eventually suggest solutions that are truly able to improve on autonomous market outcomes.

Further, in this Report, we underline the necessity to carefully examine the sequencing of supply and demand policies, paying due attention to path dependency, in order to avoid undesirable

[128] Chang (1997).
[129] Chang (1997).
[130] Warwick (2013).

consequences in member States, and to consumer willingness to pay, in order to employ public resources in the most productive way.

To take into correct account all of these difficult issues, we suggest to continue the discussion, and to reach decisions by making full use of the methods of better regulation, especially through a full impact assessment of any chosen broadband target.

Finally, the Report suggests framing the analysis with the vision that it is necessary to always maintain and pursue the clearest distinction between industrial policies and economically principled regulation. The confusion between regulation and policy decisions can only blur the issues and bring back the debate.

The digital single market for Europe remains an important aspiration, but there has been no concrete identification of the right accelerator.

A soft industrial policy that is in the favour of the development of the NGNs throughout Europe can certainly be considered a worthy policy objective, but its concrete declination and application must pass all the necessary examinations of economic rationality and industrial realism.

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Contributing Team

Wolfgang Briglauer

ZEW

Wolfgang Briglauer studied economics at the Johannes Kepler University (JKU), Linz. From 2000 to 2009, he worked for the economics department of the Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR-GmbH) in Vienna. He conducted quantitative and qualitative research, as well as offering major direct testimonies for the Telekom-Control Commission (TKK) as a senior regulatory expert. Wolfgang Briglauer joined the research institute for regulatory economics at the Vienna University of Economics and Business (WU) in 2009. His empirical work is focused on the role of regulating new communications infrastructure (such as fiber-based broadband networks) and its impact on infrastructure investment and penetration rates. He joined ZEW's Research Group "Competition and Regulation" in November, 2013. His research focuses on telecommunications and regulatory economics as well as competition policy. His work has been published in the field's leading journals, such as the Journal of Regulatory Economics, Review of Network Economics, Information Economics and Policy or Telecommunications Policy.

Carlo Cambini

Politecnico di Torino

Carlo Cambini is Professor of Industrial Organization and Regulation at the Politecnico di Torino. He has an extensive background in research focusing on industrial economics, regulatory economics and competition policy with a strong focus on telecommunications, energy markets and transportation. His work has been published in leading scientific journals such as the RAND Journal of Economics, Journal of Industrial Economics, Journal of Economics & Management Strategy, and International Journal of Industrial Organization. He presented research or delivered speeches at more than 100 international academic and institutional venues, and he was invited to present as a keynote speaker on Telecom issues in conferences organized by the Australian Competition and Consumer Commission (2012), by the New Zealand Commerce Commission (2013) and IRG (2014).

Martin Cave

Imperial College Business School

Martin Cave is a visiting Professor at Imperial College Business School, and is an Inquiry Chair at the UK Competition & Markets Authority. He has been a BP Centennial Professor at the London School of Economics, and a Professor at Warwick Business School. He is an economist, specializing in the regulation of the communications sector, and spectrum policy. He has written articles and books on these matters and has advised governments, regulators and firms in Asia, Australia, Europe and North and South America. He was awarded an OBE for public service in 2009

Pier Luigi Parcu

European University Institute

Pier Luigi Parcu is a Professor at RSCAS - European University Institute, where he directs the Communications and Media Area of the Florence School of Regulation, the Centre for Media Pluralism and Media Freedom and the ENTraNCE project in competition law and economics. Since 2004, he has chaired a consultancy company that specializes in antitrust and regulatory issues. Previously, he was the CEO of ISO, running the Italian Electricity Grid (GRTN), Director of Investigation at the Italian Antitrust Authority, Chief Economist at the Italian Security and Exchange Commission (CONSOB) and an economist at the International Monetary Fund. Pier Luigi holds a Ph.D. from UCLA, writes on regulatory and competition themes, and was the invited keynote speaker on electronic communication at the first BEREC stakeholders' meeting in Riga in 2013.

Maria Alessandra Rossi

Università di Siena

Maria Alessandra Rossi is Assistant Professor of Economic Policy at the University of Siena, where she is an Associate Professor. Her research interests include: the law and economics analysis of innovation, telecommunications & media economics, and digital economics, with specific regard to open source software. She has been a visiting researcher at the University of Oxford, the Council of Europe, the Department of Economics at UC Berkeley, the Santa Fe Institute, at the University of Paris X, and at the Florence School of Regulation. She carried out research and wrote reports for OECD, the Italian Telecommunications' NRA (AGCOM), the Italian Ministry of Finance, and the Independent Regulatory Group (IRG). She has written numerous articles in national and international journals, such as: Journal of Economics and Management Strategy, Cambridge Journal of Economics; Telecommunications Policy; Economics of Innovation and New Technologies; Communications & Strategies; European Journal of Law and Economics. Maria Alessandra holds a Ph.D. in Law and Economics from the University of Siena.

Tony Shortall

Independent Consultant, Telage

Tony Shortall is Director of Telage, an economic consultancy based in Brussels. He has almost 20 years' experience working in the telecoms sector, moving from the Irish Competition Authority into the industry (both fixed and mobile) before eventually joining the European Commission (DG Connect) as an economist in 2001. He left the Commission in 2008 to set up Telage which advises firms, regulators, public bodies and Governments on all things relating to telecoms.

Virginia Silvestri

European University Institute

Virginia Silvestri has been a Research Associate at the Florence School of Regulation, Communications & Media Area, since 2009. She is also a lecturer in economics at John Cabot University in Rome. Her research interests are in Industrial Economics, Regulatory Economics and Competition Policy, particularly when applied to Telecommunications, Internet and Media. She has published in peer-reviewed journals, such as Telecommunications Policy, Utilities Policy and Information Economics and Policy. She was a visiting researcher at University College, London. Virginia holds a Ph.D. in Economics from the IMT Institute for Advanced Studies, Lucca.

Tommaso Valletti

Imperial College, London

Tommaso Valletti is Professor of Economics at Imperial College Business School, and at the University of Rome “Tor Vergata”. Tommaso’s main research interests are in Industrial Economics, Regulation, and Telecommunications Economics. Tommaso has held several editorial positions and has published numerous articles. He is Academic Director of the Centre for Regulation in Europe in Brussels and a fellow of CEPR and of ENCORE. He is a member of the panel of academic advisors to Ofcom. He was also a member of the panel of academic advisors of the UK Competition Commission. He was a board director of Consip, the Italian Public Procurement Agency, and has advised numerous bodies, including the European Commission, OECD, and the World Bank, on topics such as network interconnection, mobile telephony markets, and spectrum auctions. Tommaso has a magna cum laude Degree in Engineering from Turin, and holds an MSc and a Ph.D. in Economics from the London School of Economics.