Centre on Regulation in Europe

Improving network and digital industries regulation

Demand-Side Policies to Accelerate the Transition to Ultrafast Broadband

Project Report

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Introduction

At a time when economic activity is becoming increasingly digital, the universal availability of fast access to the Internet and other digital services is ever more important for our economies and societies. Policymakers in Europe therefore consider investments in next generation access networks to be a top priority.

In its 'Digital Agenda' (2010), the European Commission set as a target that all European households should have access to the Internet with a speed of at least 30 Mbps by 2020, and half of all households in Europe should have adopted broadband services with a speed of at least 100 Mbps. In its Communication of September 2016, the Commission added a further target that all European households should have access to networks offering a download speed of at least 100 Mbps by 2025.

To foster the diffusion of broadband services, the emphasis has historically been on supply-side policies to promote the deployment of broadband networks by operators. For example, a decade ago, local loop unbundling regulations were introduced to stimulate entry and competition in broadband markets, with the expectation that this would then accelerate the adoption of broadband services through lower prices and higher quality of service. For next-generation networks and ultrafast broadband, the Commission also focusses on supply-side policies. For example, in its proposed European Electronic Communications Code, announced in September 2016,[1] the Commission promotes access to ducts and poles and co-investment agreements as a way to stimulate investment in new ultrafast infrastructures.

Demand-side policies to encourage the adoption of broadband connections by households represent another approach to increase the diffusion of broadband. This can be achieved with demand-side policies that either aim at reducing the adoption costs or that aim at increasing the expected benefits of broadband.

Cost-reducing policies are mainly price policies. They include, for example, subsidies and tax reductions for broadband access services or for complementary goods such as computers, smartphones or tablets. Policies aiming at increasing the expected benefits from a broadband connection are non-price policies. Examples include policies to increase digital literacy (via education, training programs, etc.), policies to create valuable content for consumers (e.g., e-government or e-health services), policies to increase consumers' 'awareness' of the value of broadband access, etc. At the recent Tallinn digital summit of September 2017, the Commission announced various initiatives of this sort, in particular to increase digital literacy or develop e-government applications.[2]

[1] See the Proposal for a Directive of the European Parliament and of the Council, establishing the European Electronic Communications Code, Brussels, 12.10.2016.
[2] https://ec.europa.eu/digital-single-market/en/news/tallinn-digital-summit

Prieger and Hauge (2010), FSR (2011) and Kongaut and Bohlin (2015), among others, provide comprehensive reviews of demand-side policies for basic broadband. These studies investigate the extent to which demand-side policies can help to increase broadband diffusion, in environments where broadband penetration is initially low.

The problem Europe is facing today with next-generation networks and ultrafast broadband is of a different nature. Almost all European households now have access to basic broadband. The question is how to encourage them to migrate to ultrafast broadband. This report therefore seeks to consider the role demand-side policies might play in the transition to next-generation access networks and ultrafast broadband.

This is an important and timely issue. A report by BEREC (2016) claims that a majority of member states "*report on a lack of demand and willingness to pay for very high speed capacity broadband products*." This undermines the business case for deploying ultrafast fibre networks and jeopardises the achievement of the Digital Agenda targets.

The rest of the report is organised as follows: in the first section, we discuss the objectives and main assumptions of our study. In the second section, we provide definitions for the different types of broadband access services, which we will use in the report, and describe how coverage and uptake of the different types of broadband have developed in Europe. In the third section, we discuss the main properties of the demand for ultrafast broadband. Lastly, in the fourth section, based on this demand analysis, we discuss the demand-side policies that could be operative to stimulate the migration to ultrafast broadband (UFB).

Our main recommendations are summarised as follows. Policymakers should:

a. Set adoption as well as coverage targets for UFB at both European and national level.

b. Explore the use of collective purchasing programmes, with a public subsidy of connections as an incentive for participation, in order to promote collective adoption of UFB in areas where appropriate infrastructure has already been deployed (as well as to promote deployment in areas where it has not).

c. Revisit the State Aid guidelines on the deployment of broadband networks in order to ensure that recipients of public funds are appropriately incentivised to meet demanding UFB adoption targets as well as demanding deployment targets.

d. Anticipate the future need to develop, and for Government to fund, UFB 'social tariffs' to support those households who are unable to fund the ongoing costs of a UFB connection.

e. Consider whether having a timetable for the decommissioning of the existing copper network would serve to reduce uncertainty and so promote UFB adoption, as well as whether the decommissioning of the copper network should be regarded as promoting UFB adoption or being the consequence of it. If a timetable were required, then careful consideration would need to be given to arrangements which would be necessary to achieve this and the implications for other policy objectives.

f. Require all providers of broadband services to adhere to standard terminology and measures when describing the characteristics of their network infrastructure and the services they provide over them, and to comply with approved codes in relation to the advertising of broadband speeds.

g. Require national regulators to assemble data on the actual performance characteristics of broadband networks at the most granular level possible, and preferably at each individual address. Make this data set available to third parties under a free licence.

h. Require national regulators to assemble data on the percentage of UFB installations that are completed without customer complaint and in accordance with industry standards (if such standards exist). Publicise the results, identify best practice, and engage with operators who are failing to meet expectations.

i. Remove any existing regulatory restrictions which might prevent UFB network providers from allowing households to amortise the costs of their UFB connection over an extended period of at least 10 years.

j. Ensure that tenants in rented properties are not denied access to UFB connections by allowing network operators to assume consent from landlords unless objections are received with a specified timeframe.

k. Support further research into the factors which drive broadband take-up, whether and why willingness to pay for broadband might differ between households in rural and urban areas, and whether uncertainty about the future of copper networks influences migration to new networks.

1. Objectives and assumptions

In this section, we present the general objectives of the study as well as our main assumptions.

1.1. Objectives

As discussed in the introduction, the migration from basic to ultrafast broadband is a top priority for policymakers in Europe. Different policies have been considered to influence and possibly accelerate this migration, and most of them can be defined as supply-side policies: their role is typically to facilitate entry in the ultrafast broadband market (e.g., by providing regulated access to ducts and poles) and/or to reduce deployment costs (e.g., by encouraging co-investment between operators).

The objective of this report is to consider another type of policy, the so-called "demand-side policies," whose aim is to stimulate the demand side rather than the supply side. In particular, we want to understand how demand-side policies might influence and accelerate the migration from basic to ultrafast broadband.

We start by discussing the demand for ultrafast broadband for those consumers who already have basic broadband access. What are their incentives to switch to ultrafast broadband or the barriers to migration that they face? Then, we consider the demand-side policies that were considered for basic broadband, and study which among these policies could be effective for the migration to ultrafast broadband.

1.2. Assumptions

We position the study in the context of the European Commission's targets for ultrafast broadband. In its communication of September 2016, the Commission adopted the new target that by 2025, all European households, rural or urban, should have access to networks offering a download speed of at least 100 Mbps. In addition, schools, transport hubs, providers of public services and firms should have access to connections with download and upload speeds of 1 Gbps.

These targets are defined in terms of coverage. However, reaching these goals will deliver no social benefits without uptake. Our focus in this report is both in terms of coverage and uptake: uptake is a necessary condition for broadband to deliver its benefits, but operators also need the proper incentives to invest into next-generation infrastructures and achieve coverage.

Since the Commission's targets provide the context, in this report we define 'basic', 'fast' and 'ultrafast' broadband as the Commission does:

- *Basic broadband*: download bandwidth of up to 30 Mbps.
- *Fast broadband*: download bandwidth of at least 30 Mbps.

- *Ultrafast broadband*: download bandwidth of at least 100 Mbps.

"Broadband" contains all three categories and fast broadband contains the ultrafast connections as a subset.

The Commission's most recent targets are defined in terms of diffusion of ultrafast broadband (not fast broadband). Accordingly, our focus in this report is on the migration from basic to ultrafast broadband, and the measures that policymakers might take to promote it.

We note that other terms are sometimes used in documents of the European Commission and others, including:

- 'Gigabit connectivity': symmetric up- and download speeds of at least 1 Gbps.
- 'NGA infrastructure': technologies that outperform copper ADSL (VDSL, FTTP, Cable DOCSIS 3.0).
- 'VHC (very high capacity)': the meaning of this term varies, sometimes even within the same document. For instance, in EC (2016b),
  - on p.4, it is defined as essentially equivalent to fibre, i.e., linked to technology;
  - on p.13, it is interpreted as speeds of at least 100 Mbps;
  - on p.21, it is equated to Gigabit connectivity (i.e., bandwidth).

We note that most of the above definitions are couched in terms of bandwidth, rather than in terms of a specific technology. Ultrafast broadband (at least 100 Mbps for downloads) can be implemented using a fibre or cable DOCSIS 3.0 solution, and LTE and G.Fast copper technologies may be able to achieve these speeds in the future. Fast broadband can also be achieved using VDSL technologies over copper lines.

We are agnostic in terms of technology and do not specify which technology should be used to deliver basic, fast, or ultrafast broadband. However, we focus on fixed technologies, and ignore mobile technologies.[3] We also highlight that different technologies can present different challenges for the transition (e.g., in terms of switching costs for consumers).

We recognise that the migration from basic to ultrafast broadband may involve intermediate steps in achieving the delivered speed. One technology can be deployed to reach an intermediary step, and another to reach the final step. Note also that, though we frame our propositions in the context of the migration to *ultrafast* broadband, much of our analysis (and many of our policy proposals) would also apply for the migration to *fast* broadband.

A last, but important, assumption of our study is that we take as given the Commission's assessment that the transition to ultrafast broadband is necessary. In other words, our focus is not on evaluating the desirability of this transition, but rather on how policymakers can influence it on the demand side. Though it is out of scope for this report, the question of

[3] The empirical evidence suggests that mobile and fixed broadband are substitutes (see, for example, Macher et al. (2015) and Grzybowski and Verboven (2016)). Therefore, the development of mobile broadband might slow down the migration to UFB.

whether the expected social benefits of a full migration to ultrafast broadband (for example) outweigh the costs is an important question. Box 1 below proposes a brief summary of the literature on the impact of broadband infrastructures on growth, and the more specific impact of speed on growth.

Box 1: The impact of the migration to ultrafast broadband on economic growth.

Broadband can contribute to growth through different channels. First, broadband allows firms to adopt more efficient business processes (e.g., for marketing, inventory optimisation, etc.), thereby increasing their productivity. Second, broadband makes it easier for companies to launch new applications and services, which can generate new revenue sources. Third, and finally, outsourcing is facilitated, leading to lower costs and larger output. For these different reasons, we can expect that the diffusion of broadband will lead to higher growth.

In addition to its impact on the private sector, note that broadband can improve efficiency in the public sector as well (e.g., for public service delivery, education, etc.), and there might also be non-economic benefits to broadband diffusion (e.g., in terms of participation in democracy, civil engagements, etc.).

A number of empirical studies have tested and confirmed the prediction of a positive impact of broadband on growth, mostly for OECD countries. The challenge in these studies is the presence of a strong endogeneity problem, due to a possible reverse causality: if we observe a positive correlation between broadband penetration and growth, is it because broadband diffusion causes growth, or simply because in countries with fast-growing GDP, broadband diffusion is also faster?

The empirical studies in the literature adopt various strategies to solve this endogeneity problem. Most of them then find a positive and causal impact of broadband penetration on GDP growth (see Bertschek, Briglauer, Hüschelrath, Kauf and Niebel (2015) for a comprehensive survey of the literature). For example, Czernich, Falck, Kretschmer and Woessmann (2011) evaluate the impact of broadband on economic growth in 25 OECD countries over the period 1996-2007, using instrumental variables for broadband penetration to control for endogeneity. They find that a 10 percentage points increase in broadband penetration raises annual per capita growth by 0.9 to 1.5 percentage points.

The literature also suggests the existence of a critical mass with respect to broadband diffusion: the benefits of broadband materialise only (or more strongly) when this critical mass is reached. For example, Koutroumpis (2009) finds that for 22 OECD countries over the period 2002-2007, when broadband penetration reaches 50% (in percentage of population served), the impact of broadband on growth doubles compared to lower levels of penetration. The interpretation of this critical mass is that when the broadband network becomes more widely used, network effects kick in, leading to higher growth.

There are only very few studies that analyse the effect of broadband speed itself on growth, and therefore that can inform us about the gains from the migration from basic to ultrafast broadband. However, the possible effects of broadband listed above are probably of a larger magnitude with higher broadband speeds.

One notable exception is the study by Rohman and Bohlin (2014). They analyse the impact of broadband speeds on growth for 33 OECD countries over the period 2008-2010. In particular, they find that doubling broadband speed from 8 Mbps to 16 Mbps adds an additional 0.3% to GDP growth between 2008 and 2010.

The question is then whether the benefits that can be expected from the migration to ultrafast broadband (e.g., in terms of additional growth) cover the costs of migration. Gruber et al. (2014) propose such a cost-benefit analysis for the Digital Agenda goals set by the European Union. Although there is some heterogeneity between member states, they find that at the EU level, the gains from achieving the Digital Agenda goals for broadband outweigh the costs.

2. Setting the stage

2.1. EC Broadband targets 2020 / 2025

The European Commission's targets for broadband coverage and uptake evolved over time. The first set of targets was formulated in 2010, which were subsequently updated in 2016.

In its Communication on the Digital Agenda of 2010 (EC 2010), the European Commission set out three "broadband targets" (Appendix 2 to the Communication):

> "• Basic broadband for all by 2013: basic broadband coverage for 100% of EU citizens. (Baseline: Total DSL coverage (as % of the total EU population) was at 93% in December 2008.)
>
> • Fast broadband by 2020: broadband coverage at 30 Mbps or more for 100% of EU citizens. (Baseline: 23% of broadband subscriptions were with at least 10 Mbps in January 2010.)
>
> • Ultrafast broadband by 2020: 50% of European households should have subscriptions above 100Mbps. (No baseline)"

One easily overlooked issue is that, while the lower bandwidth targets are framed in terms of *coverage* (i.e. roll-out), 100% coverage of basic broadband by 2013, and 100% coverage of fast broadband (at least 30 Mbps) by 2020, the target of ultrafast broadband was framed in terms of *uptake*. This implies roll-out to significantly more than 50% of households, since uptake tends to lag significantly behind roll-out, as we demonstrate below.

In the Staff Working Document of 2015, p. 37, it is explained that the broadband target is meant to ensure territorial cohesion, while the ultrafast broadband target "*sought to anticipate future competitiveness needs in line with the most likely global developments.*" The latter, even though formulated in terms of *household* uptake, was also meant to increase total factor productivity due to firms' use of these technologies.

The same document reports that fixed-line access of at least 30 Mbps was available to only 62% of households at the end of 2013. Due to the high roll-out costs, the Commission expresses the hope that wireless solutions (terrestrial, mobile, satellite) would soon be able to provide the necessary speed and coverage to get close to the coverage target. As concerns the ultrafast uptake target, the actual uptake by 2015 was still very low at about 3% of households. An estimate by the Commission is mentioned (but without detail on how it was derived) that in order to reach the 2010 Digital Agenda target of 50% uptake,[4] at least 75%-80% of the population would have to be covered. The report points to mobile services and the

[4] There is an interesting mismatch here between the target in the Digital Agenda (subscriptions by 50% of households) and the Staff Working Document (50% of the population, which corresponds to the much less ambitious target of about 25% of households). Clearly, care needs to be taken in defining the unit of coverage.

"*achievements of the DSM [Digital Single Market]*" as demand drivers, but warns that "*the uncertainty of adoption dynamics remains a key constraint to investment.*"

The Staff Working Document (p. 41) further points out that the 2010 Digital Agenda targets, initially considered as very ambitious, were already falling short of real needs for many applications. One example given is that, usually, many devices are connected simultaneously to the same connection, while the demand for videos and latency-sensitive services has been growing strongly. Both factors imply that actual bandwidth needs are many times higher than earlier estimates.

In its Communication of September 2016 (EC 2016a), the Commission formulated a new "Gigabit connectivity" target, defined as symmetric up- and download speeds of at least 1 Gbps:

> "Strategic objective for 2025: Gigabit connectivity for all main socio-economic drivers such as schools, transport hubs and main providers of public services as well as digitally intensive enterprises."

In the same Communication, the Commission also revised its 2010 target for ultrafast broadband:

> "Strategic objective for 2025: All European households, rural or urban, will have access to Internet connectivity offering a downlink of at least 100 Mbps, upgradable to Gigabit speed."

We note that now both targets are formulated in terms of coverage ("access") rather than uptake, with 100% coverage as the target for ultrafast broadband. There is no target to indicate the proportion of European households that is expected to have ultrafast broadband connections by 2025, although we assume it is significantly more than the 50% who are expected to do so by 2020.

It is interesting to speculate as to why the Commission has not adopted a target for ultrafast broadband uptake in 2025. It may be that European policymakers are more focussed on promoting the deployment of broadband infrastructure at this time, and believe that uptake will follow automatically ('build it and they will come'), or that measures to promote demand should follow later. It may also be that the Commission considers that it has less ability to influence uptake, and fewer policy tools to do so, so is reluctant to adopt a target over which it may have little influence. Or it may be that it now considers the 2020 target was too ambitious and is likely to be missed, and so is reluctant to introduce further demand-side targets beyond 2020 at this stage.

Whatever the reason, experience suggests that targets tend to drive behaviour, at least to some degree, and so we might expect the Commission and other policymakers to remain more focussed on supply-side measures to promote coverage than on demand-side policies for the foreseeable future. This creates the risk that a gap emerges, and that supply-side and demand-side policymaking become disconnected or disjointed in relation to the development of ultrafast broadband. One of the aims of this study is to assist the Commission and other policymakers in addressing this gap.

The Communication also clarifies that both fixed and wireless technologies are included as means to achieve this target and the accompanying Staff Working Document (EC 2016b) states that in Japan and South Korea Gigabit connectivity is already a reality, and that China and Russia are "*pursuing network rollout at a similar level of ambition.*"

National targets on coverage and take-up may differ from the EC broadband targets. After the Digital Agenda targets of 2010 (100% coverage at 30 Mbps, and 50% uptake of 100 Mbps), most countries adopted them as national targets (EC 2014, Table 1). Some countries did not follow suit, however, and adopted significantly more ambitious targets. Almost all of these (with the exception of Belgium) are supply-side coverage targets, rather than adoption targets:

- *Austria*: 99 % coverage with 100 Mbps by 2020 / 70 % until 2018.
- *Belgium*: 50 % household penetration with 1 Gbps service by 2020.
- *Denmark*: 100 % coverage with 100 Mbps download and 30 Mbps upload by 2020.
- *Finland*: 99 % of all permanent residences and offices should be located within 2 km of an optic fibre network or cable network that enables connections of 100 Mbps by 2019.
- *Luxemburg*: 100 % coverage with 1 Gbps downstream and 500 Mbps upstream by 2020.
- *Slovenia*: 96 % coverage with 100 Mbps, 4% coverage 30 Mbps by 2020.
- *Sweden*: 90 % coverage with 100 Mbps by 2020.
- *UK*: 95 % coverage with 24 Mbps by 2017. At least 100 Mbps for nearly all UK premises (no date).

It is clear, therefore, that European policymakers at both European and national level remain focussed on supply-side coverage targets when it comes to ultrafast broadband. The Commission's 2010 Digital Agenda target that 50% of households have 100 Mbps+ by 2020 was a notable exception, but was not followed up by the Commission in 2016 and was not generally copied by national policymakers, most of whom adopted more ambitious coverage targets rather than more ambitious adoption targets. If adoption does not feature in the high-level targets that are set by policymakers, then we should perhaps not be surprised that it also receives less attention in other contexts as well.

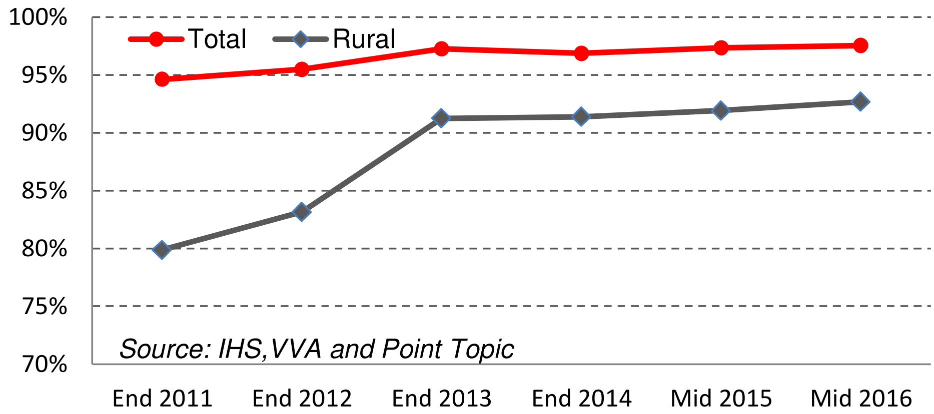
In the next section, we examine how far the Commission's various targets have been met, or how far we still are from achieving them.

2.2. Broadband coverage and uptake

The European Commission provides information about the evolution of broadband coverage and uptake for basic, fast, and ultrafast broadband at the EU level. These numbers are significant on their own, but mask a large variety of different outcomes. It also singles out information about rural regions. The latter is important, because coverage costs are higher, and uptake likely lower, than in urban areas.

For all or any type of broadband at the EU level, in 2012 total coverage reached 95% of households, and has slightly increased since then to 98% (Figure 1). Coverage in rural areas increased strongly until 2013, then remained flat at about 93%.

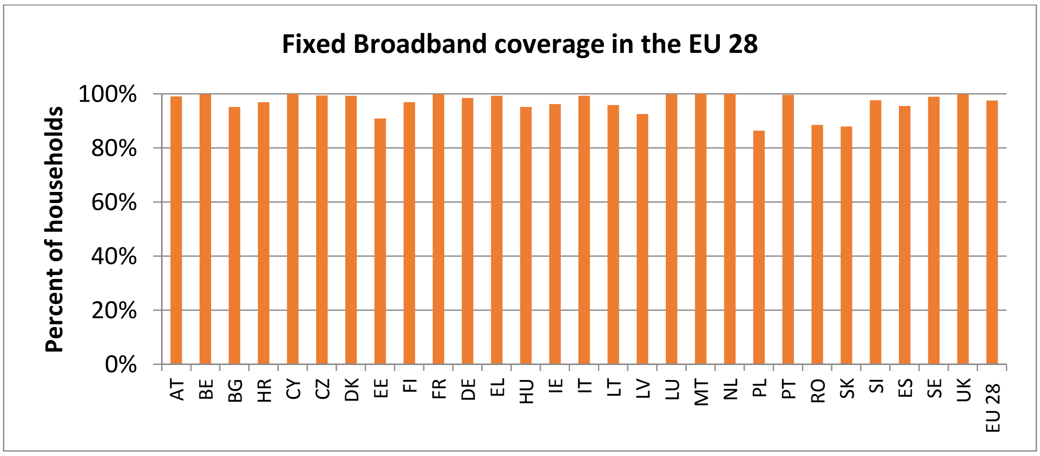
Figure 1: Fixed broadband coverage at EU level (% of households), 2011-2016.



Source: EC (2017a).

At the country level, total coverage with at least basic broadband is uniformly high, ranging from 100% in Malta to 87% in Poland (Figure 2). Rural coverage is lowest in Estonia at 82%. Apart from a few specific cases, the EU is now mostly covered with at least basic broadband.

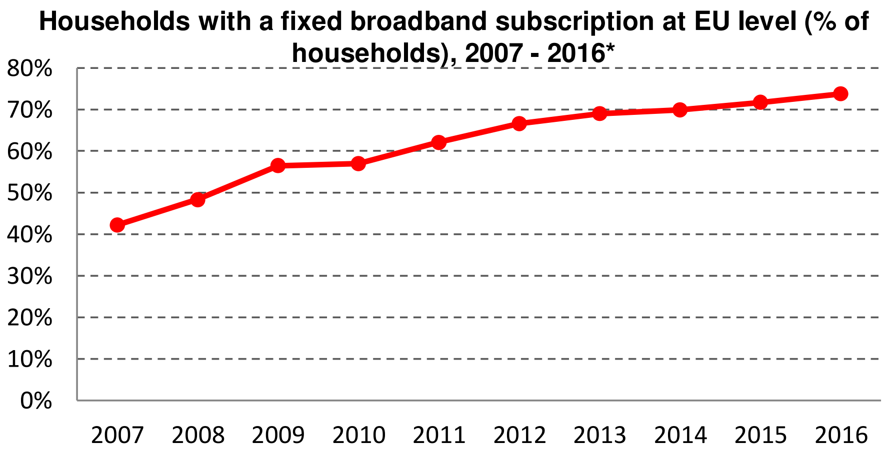
Figure 2: Fixed broadband coverage in the EU (% of households), June 2016.



Source: EU 2017c, Broadband Coverage in Europe 2016, own calculations.

Uptake of fixed broadband has increased from about 40% of households in 2007 to about 73% in 2016 (Figure 3). Uptake lags significantly behind coverage. In the case of all fixed broadband, in 2011 about a third of households were covered but did not take out a subscription; this number reduced to a still sizable quarter of households in 2016.

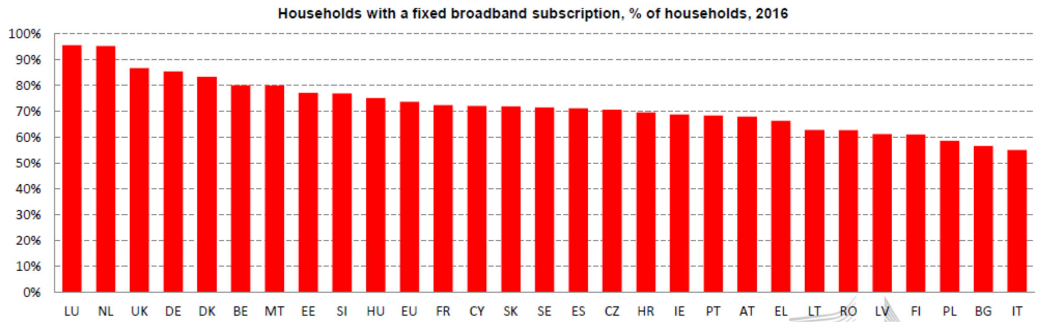
Figure 3: Fixed broadband uptake at EU level (% of households), 2007-2016.



Source: EC (2017a).

The heterogeneity in uptake is significantly larger than that in coverage: while uptake is at 95% in Luxembourg and the Netherlands, in Poland, Bulgaria and Italy it is below 60% (Figure 4).

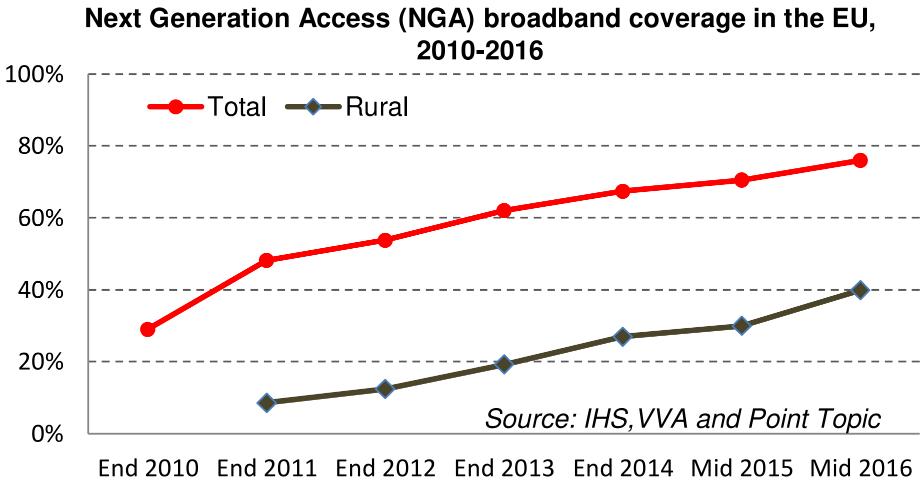
Figure 4: Fixed broadband uptake in the EU (% of households), 2016.



Source: EC (2017a).

Fast broadband (at least 30 Mbps) can be delivered with different NGA technologies (VDSL, DOCSIS 3.0, FTTP). Coverage of fast broadband increased from less than 30% in 2010 to 76% in 2016 (Figure 5). Cable was upgraded first, mostly before 2011, and VDSL roll-out happened later, while some FTTP roll-out had also started. Over the same period, rural coverage reached 40%.

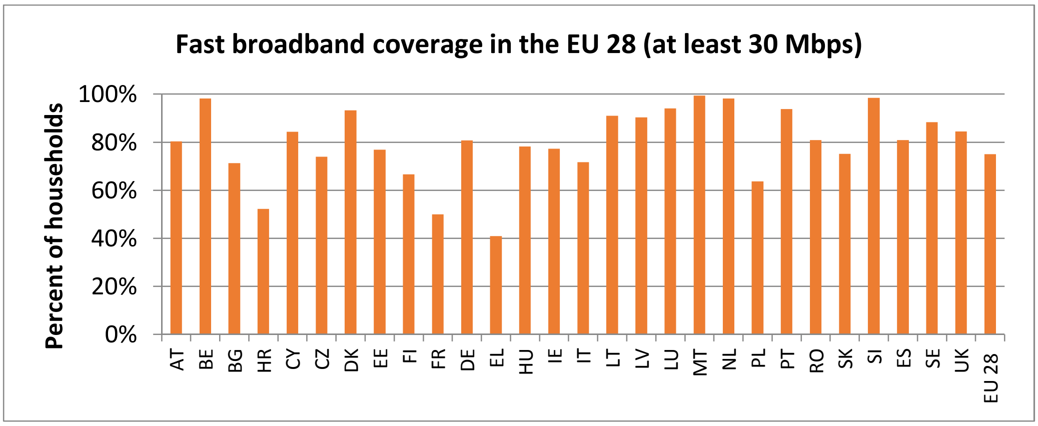
Figure 5: NGA (VDSL, DOCSIS 3.0, FTTP) coverage at EU level (% of households), 2010-2016.



Source: EC (2017a).

Figure 6 shows national coverage of fast broadband. The heterogeneity between countries is high (and higher than with all broadband), with close to 100% reported coverage in Belgium, Malta, the Netherlands and Slovenia, down to less than 50% in France and Greece (Figure 6).

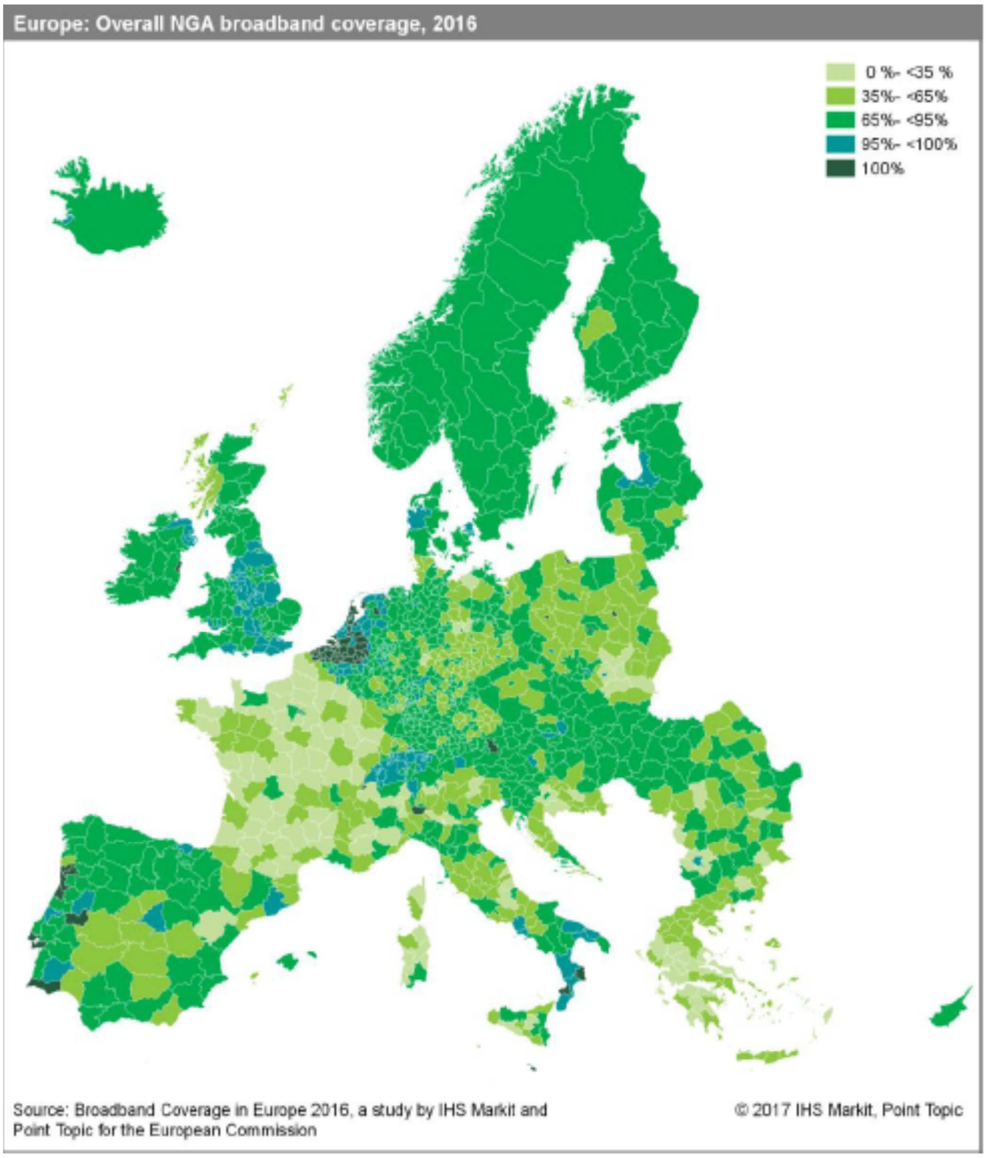
Figure 6: Fast broadband coverage (% of households), June 2016.



Source: EU 2017c, Broadband Coverage in Europe 2016, own calculations.

Further interesting insights are provided by considering NGA coverage not at the country level, but by region (Figure 7). Areas of Belgium, Netherlands and Portugal achieve 100% of coverage, while it is particularly startling to see how thinly covered most of France is. Italy, on the other hand, increased VDSL coverage very strongly in a short period of time. This difference has likely arisen because France has been focused on FTTH roll-out, while Italy opted for higher coverage at lower bandwidth and lower cost.

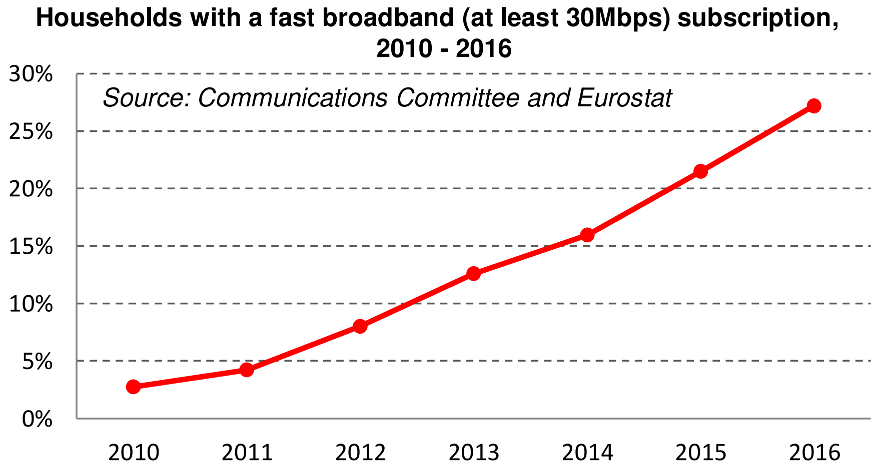
Figure 7: NGA (VDSL, DOCSIS 3.0, FTTP) coverage by region (% of households), 2016.



Source: EC (2017a).

Uptake of fast broadband increased, from 3% in 2010 to 27% in 2016, at about 4% of households per year (Figure 8). At this rate, it would take another 6 years to achieve 50% household adoption of fast broadband – missing the Commission's 2020 Digital Agenda target, both in relation to the date (since 50% uptake would be achieved by 2021-22) and in relation to the speed (since fast broadband is at least 30 Mbps, not at least 100 Mbps).

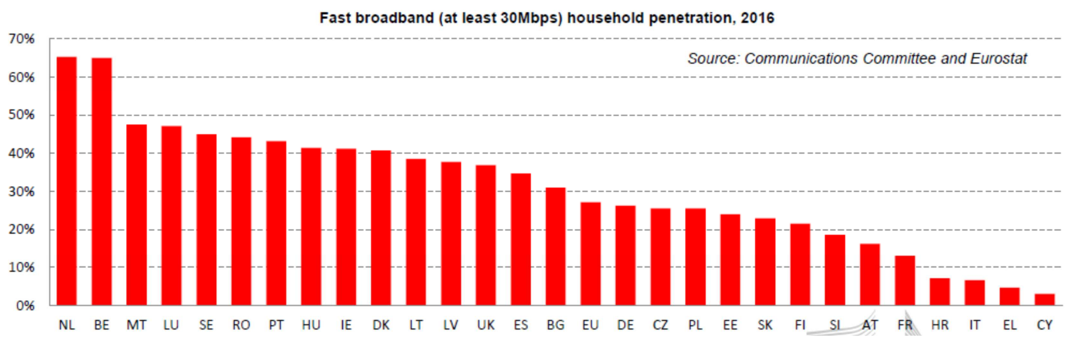
Figure 8: Fast broadband uptake at EU level (% of households), 2010-2016.



Source: EC (2017a).

Again, uptake varies more than coverage, and some countries with high coverage of fast broadband nonetheless have comparatively low uptake (Figure 9). Uptake ranges from 65% in the Netherlands and Belgium (probably due to almost universal cable coverage) to less than 10% in Croatia, Italy, Greece and Cyprus. Even Finland, Austria and France have uptake of fast broadband today of 20% or less of households.

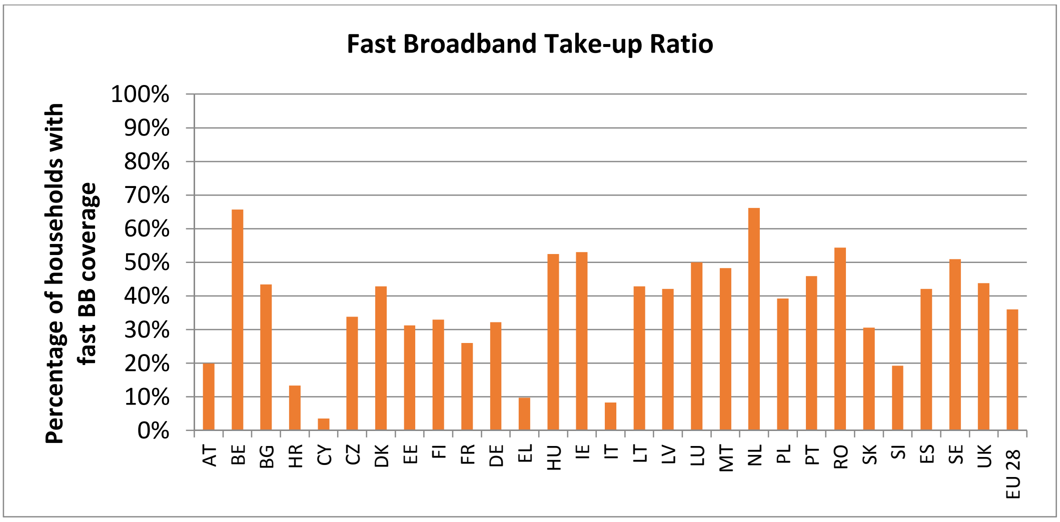
Figure 9: Fast broadband uptake in the EU (% of households), 2016.



Source: EU (2017a).

A useful measure of the "real" adoption rate for broadband is the 'adoption ratio', i.e., the ratio between take-up and coverage. This tells us the percentage of households that have access to fast broadband services who have exercised the option and taken out a subscription. These values vary between close to zero (Cyprus) to 65% (Belgium and Netherlands), with the EU average at 36% (Figure 10). On average, only about one in three European households have so far been willing to adopt fast broadband when it is available to them.

Figure 10: Fast broadband take-up ratio (take-up/coverage), 2016.



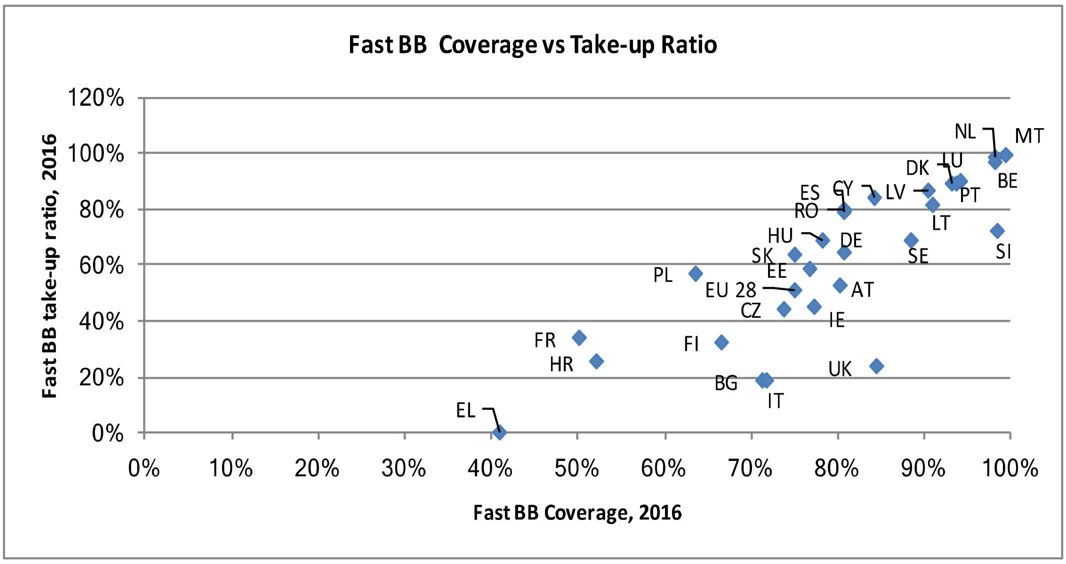
Source: EU 2017c, Broadband Coverage in Europe 2016, own calculations.

Is there an explanation for these differences? Figure 11 plots the take-up ratio against fast broadband coverage, and a clear relationship emerges: the adoption ratio is higher in countries with larger fast broadband coverage. However, there are also some interesting and important outliers – the UK and Italy appear to have fast broadband adoption levels that are much lower than we might expect, but it is harder to identify countries that outperform.

We can only speculate at this point about causal relationships: it could be that larger coverage is the result of more years of rollout, and there was simply more time for take-up to occur; alternatively, a higher latent demand for fast broadband drove coverage, and is then reflected in higher take-up. Or there may be other factors, such as a correlation between the size of the country or its population density, and the rate at which both fast broadband networks are deployed and fast broadband services are taken up. Technology and intensive infrastructure competition might be significant factors – those countries with high adoption levels tend to have significant HFC cable networks, whereas Italy (and to a lesser degree the UK) has been more reliant on VDSL coverage. Alternatively, once operators have achieved high levels of coverage, they may invest more effort in promoting uptake in order to achieve further revenue grow.

We noted in the previous chapter that Koutroumpis (2009) had found that the impact of broadband adoption on growth rates accelerates once broadband penetration rates rise above 50%, and suggested that this may be due to network effects. It is possible that similar factors are present here, but it requires further research to understand them.

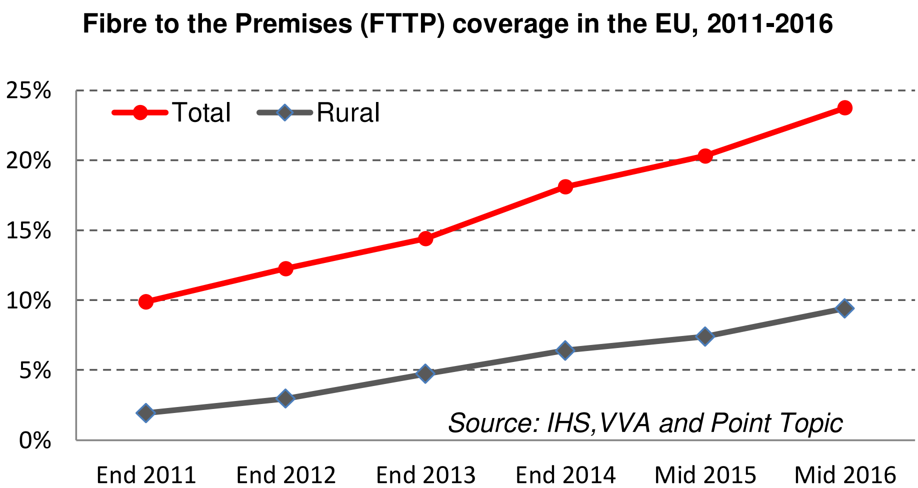
Figure 11: Fast broadband coverage and take-up ratio.



Source: EU (2017a, 2017c), own calculations.

Ultrafast broadband (at least 100 Mbps) can be provided via FTTP, Cable DOCSIS and upgraded forms of VDSL. The European Commission (2017a) only publishes details of FTTP coverage (Figure 12), which understates the actual coverage with ultrafast broadband, since it excludes HFC cable and VDSL/G.Fast. FTTP coverage increased from 10% in 2011 to 24% in 2016. Rural coverage increased from 2% to 9% over the same period.

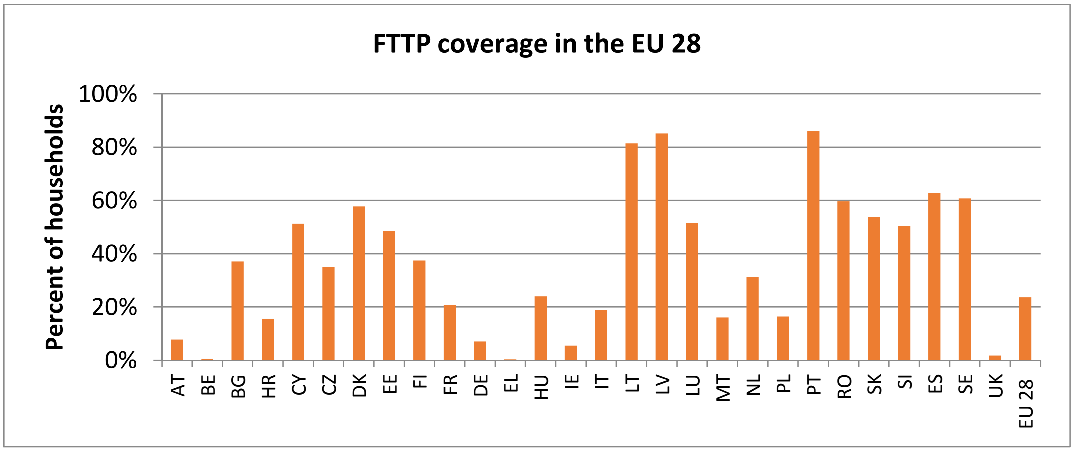
Figure 12: FTTP coverage at EU level (% of households), 2011-2016.



Source: EC (2017a).

At the country level, the disparity is even larger than for fast broadband (Figure 13). In mid-2016, Portugal and Latvia's FTTP coverage exceeded 80%, while in the UK, Belgium and Greece it was close to zero. Average coverage in the EU was just above 20%.

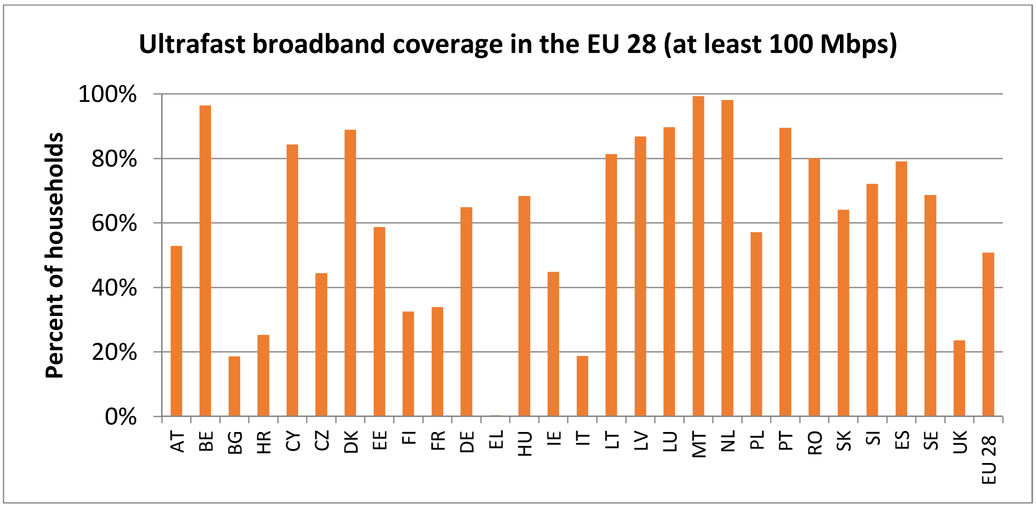
Figure 13: FTTP coverage in the EU (% of households), June 2016.



Source: EU 2017c, Broadband Coverage in Europe 2016, own calculations.

FTTP is only one technology to provide ultrafast broadband, and neglecting alternatives can produce a biased picture of coverage. When we consider all technologies that provide ultrafast broadband (FTTP, DOCSIS, VDSL), a different picture emerges (Figure 14).

Figure 14: Ultrafast broadband coverage in the EU (% of households), June 2016.



Source: EU 2017c, Broadband Coverage in Europe 2016, own calculations.

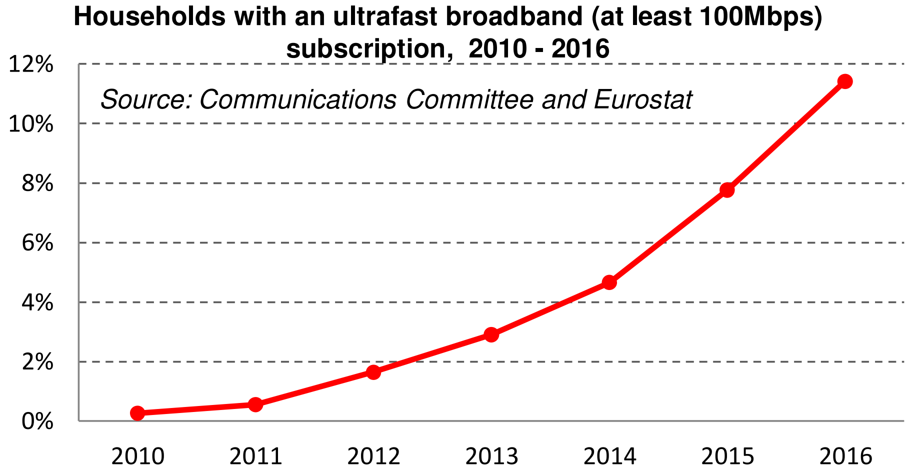
Average ultrafast broadband coverage in the EU reaches 50%, more than double the FTTP coverage. The highest coverage with ultrafast broadband can be found in Belgium, Malta and the Netherlands, at close to 100%. Half a dozen other countries are above the 80% mark. On the other hand, the bottom tier, with around 20%, is formed by Bulgaria, Hungary, Italy, the UK, and finally Greece at 0.4%. Heterogeneity in ultrafast coverage is extremely large in Europe today.

New subscriptions to ultrafast broadband are picking up speed, albeit from a very low base: in 2010, less than 1% of households had subscriptions, while in 2016 close to 12% did (Figure 15).

In other words, fewer than 1 in 4 households with access to ultrafast broadband took up the offer, compared to 1 in 3 for fast broadband. This may be due to the higher quality or price differential between fast and ultrafast broadband as compared to between basic and fast broadband. It may also be because, as discussed above in relation to fast broadband, ultrafast networks have been deployed more recently, and adoption rates take time to build. Unfortunately, data at this level of aggregation does not allow us to determine what the causes are.

Another observation is that there are some countries, such as Portugal and Latvia, where FTTP coverage largely outstrips even the uptake of any kind of fixed broadband. The fact that uptake is so low could be due to socio-economic factors (income and computer literacy in particular), or the pervasive availability of mobile broadband. According to a press release of 6 September 2017, Portugal Telecom already covered 4 million (two thirds) of Portuguese households with FTTP, and plans to cover 5.3 million (almost 90%) by 2020. On the other hand, the company reported that it had 640,000 fibre subscriptions, i.e. 16%, or 1 in 6, of covered households. Of course, the latter number is lower than the aggregate adoption ratio because many covered households are customers of competitors, in particular cable networks (the national average of uptake is 25%, see Figure 16 below). It shows the adoption ratios individual operators can expect to obtain.

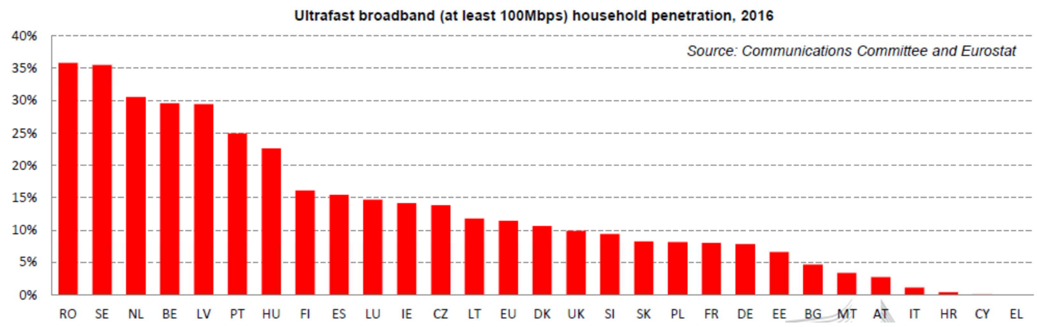
Figure 15: Ultrafast broadband uptake at EU level (% of households), 2010-2016.



Source: EU (2017a).

Uptake of ultrafast broadband is quite high in some countries: close to 35% in Romania and Sweden; close to 30% in the Netherlands, Belgium and Latvia, 25% in Portugal and 22% in Hungary (Figure 16). Uptake is close to zero in Italy, Croatia, Cyprus and Greece.

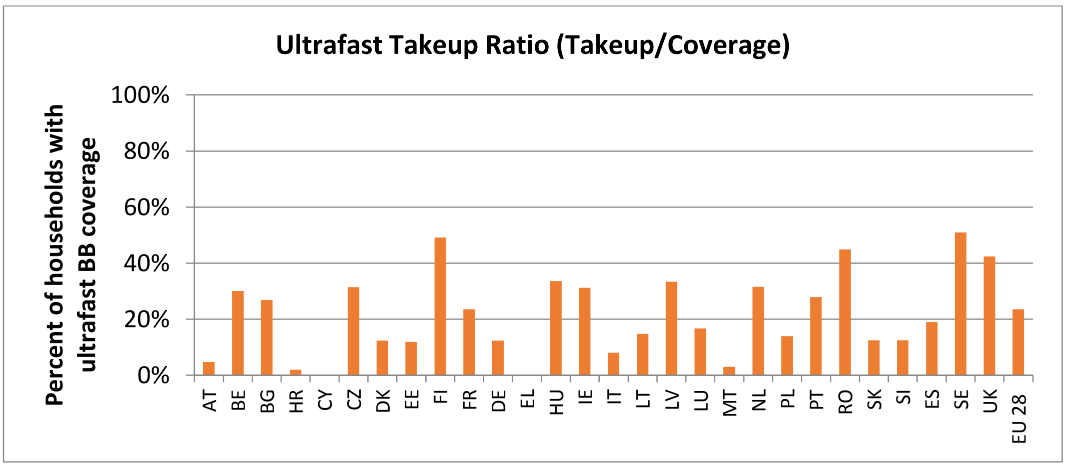
Figure 16: Ultrafast broadband uptake in the EU (% of households), 2016.



Source: EC (2017a).

Figure 17 shows the adoption ratio (take-up relative to coverage) for ultrafast broadband. Some interesting results emerge. On average, only 24% of European households with ultrafast broadband coverage have actually exercised the option to connection to the network. The highest adoption ratios – around 50% – can be found in Finland and Sweden, and in excess of 40% in Romania and the UK. These may have different reasons: in Finland and the UK, the overall coverage is low, so that take-up may reflect very targeted rollout in areas that are most responsive (but see Figure 18 below). In Romania, the copper infrastructure was not upgraded extensively, but there is also significant ultrafast network competition between private FTTP and cable operators. In Sweden, both rollout and take-up are high, and a significant role has been played by local housing associations and other local authorities in the deployment of the technology.

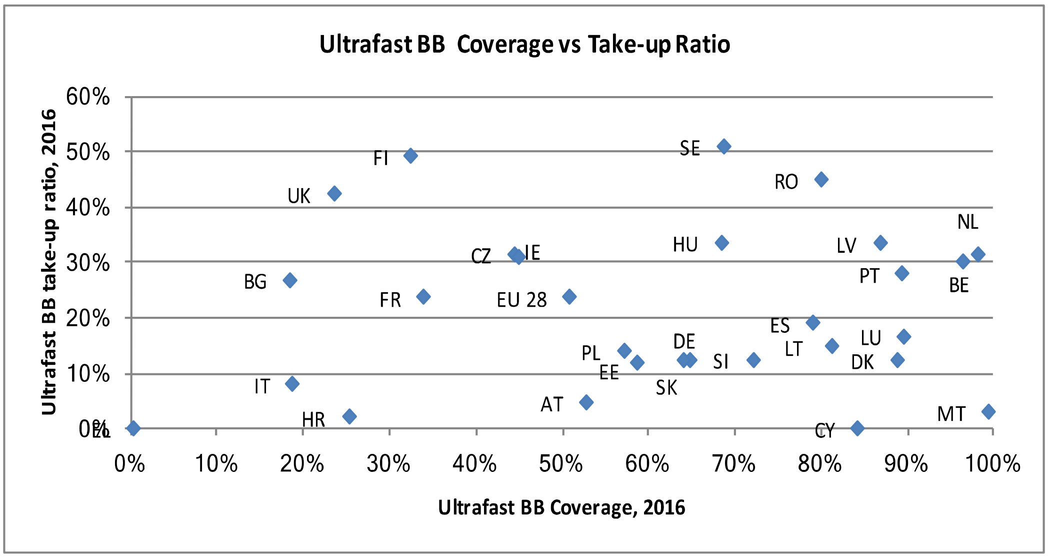
Figure 17: Ultrafast broadband take-up ratio (take-up / coverage), 2016.



Source: EU 2017a, EU 2017c, own calculations.

Figure 18 shows that there is no statistical relationship between coverage and the take-up ratio for ultrafast broadband, i.e. coverage does not determine the level of take-up. Referring back to the hypotheses mentioned for fast broadband, it could be that take-up does not depend on time after roll-out, or that latent demand for ultrafast broadband varies greatly between countries. It may be that ultrafast broadband deployment is simply too recent for underlying trends to emerge at this stage.

Figure 18: Ultrafast broadband coverage and take-up ratio, 2016.



Source: EU (2017a, 2017c), own calculations.

Box 2 below gives a brief overview of the academic literature that analyses the determinants of the diffusion of broadband and ultrafast broadband. More research is clearly needed to better understand the migration to ultrafast broadband.

Box 2: The determinants of the diffusion of ultrafast broadband

Different studies in the literature have investigated the demand-side and supply-side factors that can explain the differences in the diffusion of *basic* broadband across countries. For example, Bouckaert, van Dijk and Verboven (2010) analyse the diffusion of basic broadband (defined as the ratio of the number of broadband subscriptions to the number of households) in 20 OECD countries over the period 2003-2008. They find that more intense "inter-platform" competition (i.e. competition between DSL and cable) is associated with larger broadband diffusion, whereas more intense "intra-platform" competition, through bitstream access or resale, is associated with lower broadband diffusion. Moreover, larger population density leads to larger diffusion (due to lower network costs), and this is also true of larger income and PC penetration. In the same vein, Dauvin and Grzybowski (2014) use data at the regional (NUTS-1) level for the EU-27 countries, over the period 2003-2010. They find a positive effect of inter-platform competition on broadband penetration, and also a positive effect of intra-platform competition, in contrast to Bouckaert et al. (2010).

By comparison, very few studies have analysed the diffusion of UFB. One exception is the paper by Briglauer and Cambini (2017). The authors analyse NGA adoption in 27 EU member States between 2003 and 2014. They use as dependent variables both the NGA take-up (i.e. the total number of subscribers of NGA networks, where NGA is defined as the set of FTTx technologies) and the NGA take-up rate (defined as the ratio between NGA take-up and NGN coverage). They find that an increase of the LLU price (hence, less intense inter-platform competition) increases NGA adoption, but decreases the take-up ratio.

Bourreau, Hasbi and Grzybowski (2017) study the deployment of fibre in French municipalities. Using panel data on 36,000 municipalities over the period 2010-2014, they study the impact of competition in local broadband markets on fibre deployment by the incumbent operator and two alternative operators. They find that the stronger the competition through LLU, the more likely it is that fibre is rolled out in a municipality. One interpretation is that operators try to escape competition by investing in the new fibre technology. They also find that the presence of cable has a positive effect on fibre deployment, which can be explained by the fact that the telecoms operators fear being pre-empted in the UFB market.

More research is clearly needed to better understand the differences in the migration to UFB between European countries, but also to understand the migration to UFB at a more local level within specific countries.

2.3. Conclusions

We draw four main conclusions from the above analysis:

a) European policymakers do not attach sufficient emphasis to adoption targets. The Digital Agenda's 2020 target of 50% household adoption of ultrafast broadband was an exception which was not repeated by the Commission in 2016, nor copied by national policymakers. But if policymakers think adoption is important, attention should be focussed on the issue, even if there is some risk that policymakers will be unable to influence whether or not these adoption targets are met.

b) Europe's performance in broadband is today some way behind the EC targets: coverage of fast broadband in mid-2016 was about 80%, compared to a target of 100% coverage by 2020. Uptake of ultrafast broadband was just above 10%, compared to a target of 50% by 2020. Coverage with ultrafast broadband was just above 20%, compared to a target of 100% by 2025. Of these three targets, the adoption target is the one that appears most likely to be missed.

c) Heterogeneity between countries is very large, in terms of technologies, coverage and uptake. Countries such as Sweden are performing well, by European and international standards, in terms of ultrafast adoption. Others seem to be performing very poorly. Policies to promote ultrafast take-up are likely to need to be informed by these differences in performance (which we do not understand well at this stage), but will then need to be tailored to national needs.

d) Uptake of both fast and ultrafast broadband lags significantly behind coverage or rollout, although again there are differences between countries and between fast and ultrafast broadband. There is a clear correlation between take-up and coverage in the case of fast broadband, but not in the case of ultrafast broadband. But we do not know why the correlation exists in the case of fast broadband, nor what it might mean for policies which might promote the adoption of ultrafast broadband. There are a large number of hypotheses here which require further research and testing. In the next sections, we consider some of the factors which might account for this lag, and then consider policies that may address them.

3. Demand for ultrafast broadband

As we have seen in Section 2, broadband networks cover close to 100% of Europe, in terms of percentage of households who have access to broadband. Uptake is also very high: in 2016, three quarters of households had subscribed to a broadband offer of any kind. The diffusion of ultrafast broadband (UFB) in Europe should therefore be analysed as a migration of consumers, from the old, basic, broadband technology to the new, ultrafast, broadband technologies.

This migration is taking place at a slow pace: as we have seen in the previous section, in 2016, the adoption ratio for UFB (i.e. uptake relative to coverage) was only 24% on average in the European Union.

In other words, in a covered area, one in four households subscribes to UFB, while the others do not. This raises two related questions. First, what motivates adopters to switch from basic or fast broadband to ultrafast broadband when they have the possibility to do so? Is it to benefit from higher broadband speeds? Because there are specific applications that work only with an UFB connection? For some other reason? Second, from a different perspective, how can we explain that some consumers decide to stick to the legacy, basic or fast broadband technology, when they have the possibility to migrate to UFB? Is it because they do not view any extra benefit from UFB, compared to their existing broadband connection? Is it due to switching costs, etc.?

In this section, we try to answer these two related questions to understand better the factors that can influence, positively or negatively, the demand for ultrafast broadband. This preliminary step will be useful in the next section when we discuss demand-side policies aiming at influencing the migration to UFB.

For our demand analysis, we assume that consumers make subscription decisions based on their perceived benefits and costs. That is, they will upgrade to UFB if and only if the perceived benefits from doing so, relative to a basic or fast broadband connection, exceed the perceived costs. The benefits from UFB, relative to basic or fast broadband, include in particular a higher speed and usage of bandwidth-intensive applications (although they may also include other things for some consumers, such as greater reliability). The costs correspond to the price differential of a UFB subscription relative to basic or fast broadband, installation fees, and other switching costs.

Based on a comprehensive review of the academic literature, we identify five main insights about the demand for UFB:

1. There is no evident need for ultrafast speeds.
2. Consumers have a willingness-to-pay for high speeds, but it is characterised by decreasing returns.
3. Some specific applications may motivate the migration to UFB.
4. Consumers face significant switching costs when migrating to UFB.

5. UFB has experience good characteristics.

We discuss below in more detail these different insights and their implications.

3.1. Need for speed

Do users of basic or fast broadband really *need* higher speeds? There are two possible approaches to answer this question: (i) an *engineering approach*, which consists in determining consumers' need for speed, based on actual online usage profiles; and (ii) an *economic approach*, which asks the question of whether consumers are willing to pay for higher speed (whether or not they actually need it). In this subsection, we discuss the results obtained using the engineering approach.

In many policy reports, the question of whether there is a *demand* for UFB is formulated as whether there is a *need* for speed. Otherwise stated, do consumers that have basic or fast broadband really need to switch to UFB given their current or anticipated usage profile?

As an example of this approach, a recent note of Barclays on "Assessing upside from fibre demand" (2017) [5] analyses the demand for ultrafast broadband as follows:

> "When considering what speeds consumers really need, it is easy to look at current trends and simply extrapolate. For example, Netflix recommends a download speed of 5Mbps for HD quality, whereas this was ca3Mbps just 3 years ago (…). Most Telcos typically recommend c5-7Mbps for HD TV. A simplistic extrapolation of this to a slightly larger TV plus maybe streaming to more than one room, then add on some online streaming could lead to a conclusion that 40Mbps is enough for most households. However we note that Netflix recommends 25Mbps for Ultra HD alone (Huawei also confirm this figure for 4K)."

In a report for the Broadband Stakeholder Group, Kenny and Broughton (2013) adopt this type of approach in a more systematic and elaborate way to estimate the need for speed of UK households by 2023 (for downstream traffic). For this purpose, they construct individual usage profiles (e.g. surfing the web, having a video call, watching a HD video stream, etc.), taking into account anticipated bandwidth needs and volume of usage of each application in 2023. In particular, they take into account the fact that the speed requirements of applications could rise for some of them in the coming years, but could also fall due to progress made in compression techniques. They then combine these individual profiles into household profiles, using typical household composition types (e.g. single adults, two adults, two adults with one kid, etc.). They end up with 156 different usage profiles, with their bandwidth needs in 2023.

Their model predicts that by 2023, the median UK household will require a bandwidth of 19 Mbps, and the top 1% of high-usage households a bandwidth of 35-39 Mbps. These results

[5] "Assessing upside from fibre demand," Barclays, Equity Research, 8 June 2017.

suggest a need of some households for fast broadband, but no clear need for ultrafast broadband.

The engineering approach is interesting, but it can be criticised on several grounds. First, keeping a technological viewpoint, it ignores other potential benefits for consumers of ultrafast broadband. For example, the Commission Staff Working Document on "Connectivity for a Competitive Digital Single Market" of September 2016[6] highlights such benefits as low latency, security, low jitter, no radio frequency interference, etc. Or, as Stocker and Whalley (2017) write, "*speed isn't everything*." Along with speed, other technological characteristics of an UFB connection can affect a consumer's "quality-of-experience", and hence, utility.

Second, the engineering approach does not account for the fact that consumers can value lower time to download, for example because they face an opportunity cost of time. For example, the Staff Working Document cited above indicates that a 5 Gb game can be downloaded in 34 minutes with a basic broadband connection, but that it takes only 1.7 minutes with UFB. Even though they don't *need* an ultrafast connection to download such a file, consumers can value the fact that it will be available in 2 minutes rather than half-an-hour. If they do, they will have a willingness-to-pay for speed, as we will discuss below.

Third, and finally, the engineering approach is myopic. As we will argue later in this section, ultrafast broadband has experience good characteristics, and therefore the demand for speed can be expected to evolve over time. As a large number of users have UFB, applications that *require* such high speeds may appear, which will then create an actual *need* for speed.

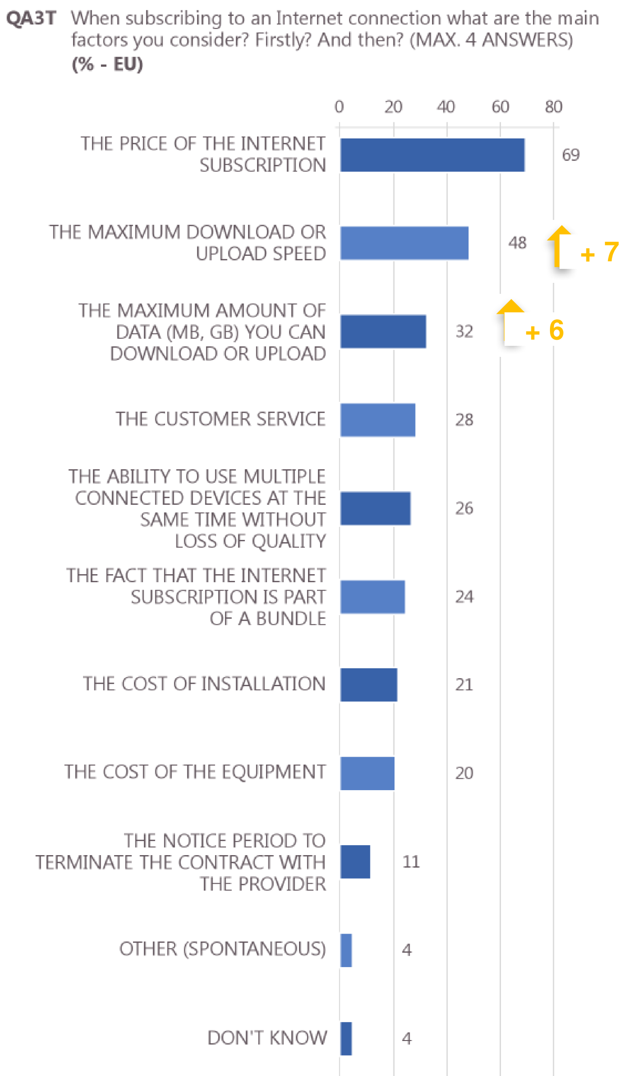
As a final note, though there is no clear need today for high speeds for residential consumers, the opposite conclusion is probably true for business consumers. With digitalisation, firms need higher and higher transmission speeds to develop big data or cloud computing applications, e-commerce platforms or customer relationship management (CRM) systems.[7]

3.2. Willingness-to-pay for speed

Even if consumers do not need high speeds, maybe they care about it when they decide on subscribing to a broadband network. Figure 19 shows that 48% of European consumers cite the maximum download or upload speed as one of the main factors they consider when subscribing to an operator. Therefore, it provides some empirical evidence that consumers do care about speed.

[6] Commission Staff Working Document, Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society, COM(2016) 587 final, Brussels, 14.9.2016.
[7] On this aspect, see, for example, the WIK report for the German Ministry of Economics and Energy, "WIK Gigabitnetze für Deutschland," December 2016.

Figure 19: Factors considered when subscribing to the Internet.



Source: Special Eurobarometer 438.[8]

Another (more economic) approach to the question of whether there is a demand for UFB is thus to ask whether there is a *willingness-to-pay* for it. If we consider that the only difference between basic or fast broadband and ultrafast broadband is the bandwidth or speed,[9] the question is then whether there is a willingness-to-pay for speed.

A first approach to estimate the willingness-to-pay for speed consists in estimating a demand model for broadband services, which takes into account speed as one the quality attributes. We describe below a few academic studies that have taken this route.

[8] Special Barometer 438, "E-Communications and the Digital Single Market," May 2016.
[9] As argued above, there might other benefits of ultrafast broadband over basic broadband (such as a lower latency).

Rosston, Savage and Waldman (2010) use discrete choice experiments conducted in late 2009 and early 2010 in the US to estimate the marginal willingness-to-pay (WTP) for quality improvement of broadband services.[10] In particular, they estimate the WTP for higher speeds, by defining three hypothetical levels of speed: SLOW, FAST, and VERY FAST.[11] These three levels are defined with respect to the types of usage they allow, with SLOW being defined as dial-up speed.[12]

They find that consumers' incremental WTP for VERY FAST speeds is rather low. Whereas a household is willing to pay $45 for an improvement in speed from SLOW to FAST, it is ready to pay only $48 for an improvement in speed from SLOW to VERY FAST. In other words, according to their study the premium that a US household is willing to pay for superfast broadband was only $3 in 2009/2010.

Rosston et al. (2010) use data from experiments rather than real subscriber data, and their study was conducted at an early stage for ultrafast broadband. The question is then whether their low estimate for the WTP for speed is still valid today.

Grzybowski, Hasbi and Liang (2017) provide an answer for Europe, using a unique and very detailed dataset. The authors use data on about 100,000 subscribers of a European telecommunications operator, who are eligible to fibre, for the period January to December 2014. They estimate a mixed logit model of demand for broadband, and using this model, evaluate consumers' WTP for different levels of speed. They find that at the beginning of their observation period, the consumers' valuation for speed was very low: in February 2014, the valuation of an FTTH connection with a speed of 100 Mbps was only 2.9% higher than the valuation of a DSL connection with a speed of 8 Mbps and 7% higher than the valuation of a DSL connection with a speed of 1 Mbps. However, the premium attached to an FTTH connection in comparison to a DSL connection increases over the observation period: in December 2014, the valuation of an FTTH connection is 59% higher than the valuation of a DSL connection with a speed of 8 Mbps and 66% higher than the valuation of a DSL connection with a speed of 1 Mbps. This corresponds in their model to a speed premium of FTTH over DSL of about €103.

Grzybowski et al. (2017)'s study brings forth two additional insights about the WTP for speed. First, the WTP for speed seems to increase over time, and at a fast pace. This may be due to learning effects: consumers realise progressively what benefits an ultrafast connection can deliver, which increases their WTP for higher speeds. Network effects could also be at play: for example, a consumer with a fast connection may exert a negative externality on contacts with

[10] Earlier studies have been conducted on the WTP for bandwidth or speed. For example, Varian (2002) documents a series of bandwidth experiments done during 1998-1999. The conclusion was that consumers were not willing to pay much for bandwidth (which was probably due to the limited set of applications available at that time).
[11] They consider RELIABILITY as another quality attribute, and show that consumers are willing to pay $20 for a more reliable service.
[12] A FAST connection allows sharing photos and watching videos. A VERY FAST connection allows watching HD movies, and transferring large files very fast.

slow connections (e.g. by sending them mail attachments of large size, etc.) and force them to migrate.

A second insight from Grzybowski et al. (2017)'s study is that there are *decreasing returns* for the WTP for speed: in their estimations for February 2014, they find an increase in WTP of 7% when switching from 1 to 100 Mbps and an increase of 2.9% when switching from 8 to 100 Mbps, and therefore larger gains when switching from 1 to 8 Mbps than from 8 to 100 Mbps.

Grzybowski et al. (2017) use a discrete-choice model, as Rosston et al. (2010), and attribute a preference for fast and superfast broadband services over basic broadband as a WTP for higher speed. However, they do not explain *why* consumers have a WTP for speed.

Some papers of the literature offer the following theory to explain this willingness-to-pay: the WTP for speed derives from the time savings that a consumer can obtain by using the Internet with a faster connection. For example, consider that when using the Internet, consumers obtain utility from consuming a given amount of content, with decreasing returns, but at the expense of an opportunity cost of time. The consumers decide on an optimal amount of content, which equates their marginal revenue from content and their marginal opportunity cost from consumption. As a higher connection speed reduces the opportunity cost of time, it leads to higher usage and higher utility. And, therefore, consumers' WTP (i.e. utility) for a broadband connection increases with speed.

Nevo, Turner and Williams (2016) build a structural model along these lines,[13] which they estimate using data on online usage of 55,000 subscribers of a US Internet Service Provider facing different price schedules, over the period May 2011 to May 2012. They use their model to estimate consumers' WTP for speed. They find an average WTP of $2 for a 1 Mbps increase in speed (the average download speed in their data is 15 Mbps). However, consumers are heterogeneous in their WTP for speed: in their sample, the WTP for a 1 Mbps increase in speed ranges from $0 to $5 per month. In particular, they show that consumers that use the Internet more have a higher WTP (due to larger time savings). In a similar vein, they show that the volume of usage depends substantially on the available bandwidth: for a usage price of zero, usage is 60% lower for a 2 Mbps connection than for a 15 Mbps connection.[14]

Therefore, Nevo et al. (2016) find large welfare gains from higher speed, stemming both from lower opportunity costs and larger usage.

Ahlfeldt, Koutroumpis and Valletti (2017) propose a quite different, but equally interesting, method to evaluate the value that consumers attach to broadband speed. Their idea is the following: to the extent that consumers value speed, it should be reflected in housing prices. In other words, the price of a property should be higher with a better broadband connection (i.e. a

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[13] Another example of this approach is provided by Goolsbee and Klenow (2006), who use a consumer's time spent on the Internet and wages to estimate the benefit from residential broadband, with the idea that an hour spent on the Internet is an hour of forgone wages.

[14] They also find a strong increase of data usage over their observation period: the median user increases usage from 9Gb in May 2011 to 20Gb in May 2012.

higher speed), everything else equal. Using data for the UK and for the period 1995-2010, they show that the availability of an Internet broadband connection is indeed an important determinant of the price of property. Ahlfeldt et al. also estimate the contribution of different levels of speed on the price of houses. They show that a basic broadband connection (with a speed up to 8 Mbps) increases the value of a house by 2.8%. However, similar to Grzybowski et al., they also find decreasing returns to speed: upgrading the connection to fast broadband (i.e. to speeds up to 24 Mbps) increases the value of the house by less than 1%. However, note that in terms of magnitude, a 1% incremental value on home prices would be enough to finance the FTTH rollout in urban areas!

To sum up, though it would seem from the outset that there is no need for speed, consumers do exhibit a WTP for speed, which seems to increase over time. However, there is also strong consumer heterogeneity in the valuation for ultrafast broadband: some consumers have a strong interest for an upgrade to higher speed, but others only a small interest (or none at all).

We now discuss two related questions:

- What are the factors that affect consumers' WTP for speed? That is, what factors explain consumer heterogeneity in the WTP for speed?
- To what extent can firms extract the consumers' WTP for speed?

3.2.1. What affects the WTP for speed?

Savage and Waldman (2009) estimate US demand for Internet access using a discrete choice experiment done on 400 consumers in 2002. In their model, consumers maximise a utility function of consumption and leisure, subject to monetary and time constraints. Users with higher technical capabilities can derive higher time savings for a high-bandwidth connection, and are therefore expected to have a larger demand for bandwidth. Their empirical results are consistent with this theoretical prediction: they find that an increase in ability, measured by a one-standard deviation increase in both experience and education, leads to a $3.61 increase in WTP for bandwidth per month. Similar to Savage and Waldman (2009), Rosston et al. (2010) find that inexperienced consumers have a lower WTP for speed, compared to consumers with online experience, and Grzybowski et al. (2017) also find that lower levels of education are associated with a lower WTP for speed.

Savage and Waldman (2009) also find that *urban* consumers are willing to pay more for bandwidth than *rural* consumers. This conclusion is at odds with the idea that there is an extra willingness to pay in rural areas (e.g. because there is less competition or the quality of basic broadband is lower).[15] Note that Savage and Waldman's result is obtained while controlling for consumers' education and ability, so it is not a priori driven by a composition effect (e.g. the fact that urban households are more educated or richer on average).

[15] See, for example, the report "WIK Erfolgsfaktoren beim FTTB/H-Ausbau", May 2016, which reaches this conclusion.

To sum up, households with high WTP for speed seem to be educated, urban households, with good digital skills. If firms first serve the consumers with the highest WTP, urban areas are thus more likely to be served first, aside from any supply-side (e.g. cost) considerations, leading to a digital divide. However, if the digital divide is the result of a lower WTP in rural areas, one could argue that it matters less.

3.2.2. Can firms capture the WTP for speed?

Nevo et al. (2016) argue that the private value of an ultrafast network is much lower than the social value, and therefore firms can only extract a small share of the WTP for speed. As an example, they estimate that from a social welfare point of view it would take 12 months to recover the fixed cost of a 1 Gbps network, but more than 120 months for a private operator. For this reason, private firms' investments in UFB are likely to be too low compared to what would be socially optimal.

Another possibility to evaluate to what extent firms can extract the WTP for speed is to study how firms price speed. The hedonic approach is a methodology that allows us to quantify the relation between broadband prices and speed. The general idea is that the price of a good is the sum of the implicit prices of the different components of the good. When applied to broadband services, it means that to the extent that consumers value speed, it should be reflected through an implicit price of speed.

Calzada and Martínez-Santos (2014) use this approach to analyse the factors that influence the fixed broadband Internet prices charged by incumbent and entrant operators in 15 EU Member States over the period 2008-2011. They find a positive and significant effect of download speed on prices, but no significant effect of upstream speed. More specifically, according to their estimations, a 10% increase in speed raises broadband prices by 1.3%.

Wallsten and Riso (2014) propose a similar study for all OECD countries, for the period 2007 to 2009. Using data on more than 25,000 broadband plans, they find that broadband speed has a positive effect on prices, but the marginal effect of speed on prices decreases with speed (i.e. there are decreasing returns). Interestingly enough, their data contains plans for both residential consumers and business consumers (the latter account for one third of the sample). They find the same (positive) effect of speed on prices for both sub-samples.

Lyons and Coyne (2017) analyse broadband plans in Ireland from 2007 and 2013 using the same methodology. They find that the elasticity of prices to download speed is positive, but it decreases over the observation period – at the end of the period, the elasticity is actually very low.

To sum up, though there is no clear need for speed, consumers have a WTP for speed (perhaps with decreasing returns), and firms are able to extract part of this WTP through higher prices.

3.3. Application-driven demand

Another factor that may influence positively the migration of consumers from basic or fast broadband to ultrafast broadband is the existence of specific applications that can only work well with an ultrafast connection (the so-called "killer applications").[16]

There is some empirical evidence that specific bandwidth-demanding applications may play a role in the migration to UFB. For example, Ida and Sakahira (2008) analyse the migration from DSL to FTTH in Japan in the mid 2000's. In 2002, 74% of households in Japan had ADSL, 22% broadband cable and only 4% FTTH (for a total of 9.5 million broadband subscribers). Four years later, in 2006, the share of FTTH subscribers had increased to 33% (with 53% and 14% for ADSL and cable modem, respectively), for a total of 26.4 million broadband subscribers. Ida and Sakahira identify different factors that influenced positively or negatively this fast migration. In particular, they find that "viewing movies" is a significant determinant for a consumer's migration from ADSL to FTTH.

In the European context of migration for basic or fast broadband to ultrafast broadband, one question is whether TV could pull through UFB. IP-TV alone is unlikely to drive UFB adoption, since it requires bandwidth that basic or fast broadband can deliver. However, TV is changing. Streaming video services offered by OTT players like Netflix are more and more popular among consumers. To the extent that they require larger bandwidth, these services could push consumers to adopt UFB. A limitation is that due to the presence of economies of scale, a global firm like Netflix probably designs its product to reach the largest audience, and hence, the product is optimised for the worst network, not the best.

Baranes (2014) develops a theoretical model where a network operator's incentives to invest in an upgrade are influenced by the availability of high quality content. In his model, a monopoly network operator decides whether to upgrade its network from an old technology (e.g. basic or fast broadband) to a new technology (e.g. UFB). He shows that the availability of high quality content increases the operator's incentives to upgrade its network. This is because high quality content and UFB are complements in this model: a consumer enjoys more the high-quality content with an UFB connection than with a basic broadband connection. An empirical question is whether this effect is of significant magnitude.

To the extent that premium content is a complement to an ultrafast broadband subscription, a concern may be that exclusivity deals for premium content restrict competition in the broadband market, and then possibly the migration to UFB. Ganuza and Viecens (2013) investigate this question in a theoretical model. They show that when the premium is highly valued by consumers, the content provider has incentives to distribute its content to all network operators, without exclusivity.

[16] To have a significant impact on adoption, these applications should be of general interest. Bandwidth-intensive applications designed for very specific market segments (e.g. hard-core gamers) can stimulate adoption in these segments, without having any significant influence on the average consumer.

Another perspective to see if some specific applications can motivate consumers to adopt UFB is to look at how online usage changes when users migrate from basic to ultrafast broadband. In the absence of any asymmetric information or learning effects (something that we will discuss at the end of the section), it may well be that users find some applications too "costly" to use with a basic broadband connection (in terms of opportunity cost of time, for example), and thus that they decide to migrate to UFB to reduce the usage costs for these applications.

Hitt and Tambe (2007) test this idea using data from a panel of users surveyed in 2002 and 2004. They show that the adoption of broadband increases Internet usage by 1,300 minutes per month on average. In addition, the impact is stronger for consumers who were in the lowest usage quintile before adoption: their usage increases by 1,800 minutes per month. Hitt and Tambe's proposed interpretation is that these users had a strong preference for high-bandwidth applications, whose usage costs were too high with narrowband. These results were obtained in a pre-FTTH context, and should therefore be treated with caution in relation to UFB. An interesting avenue for future research would be to replicate this type of study in the context of the migration to UFB: how do the volume and variety of usage change when a household switches from basic or fast broadband to UFB?

The empirical evidence surveyed in this subsection suggests that there are dynamics at play between users, network operators and content providers. When they benefit from higher speeds from their network operator, consumers can change their usage substantially, both in terms of volume and variety. In turn, it affects content providers that can then adjust their services to the increased speed of broadband connections, but also to the changing patterns of consumer usage.

Such dynamics mean that there can be a critical mass of UFB adopters within a large market (e.g. the European market), such that when it is reached, content providers adjust their services to the faster speeds, incentivising then other consumers to migrate.[17] A demand-side policy for the migration to UFB may aim at reaching this critical mass.

So far, we have considered the factors that can explain why some consumers migrate to UFB – i.e. to benefit from higher speeds and bandwidth-intensive applications. We now analyse the potential barriers to migration.[18]

3.4. Switching costs

When considering whether to migrate from basic to ultrafast broadband, a consumer is going to compare the difference in (expected) benefits from both types of connection to the price premium charged for UFB, but the consumer will also take into account the switching costs of

[17] Content providers think globally, therefore they are unlikely to adjust their services to a change of average bandwidth in a small market.

[18] We assume here the availability of an ultrafast broadband offer. Of course, no ultrafast broadband coverage would represent an impassable barrier to migration.

adopting the new broadband technology. Even though the consumer can anticipate a higher net utility from UFB, if these switching costs are too high, the consumer will stick to the legacy network.

The switching costs associated to the migration to UFB can be of different types. It can be financial switching costs, for example if the consumer has to pay an installation fee for UFB. Changing tariff plan can also generate switching costs for consumers. Most importantly, some UFB technologies can imply specific, and possibly high, technical switching costs. In particular, the installation of FTTH or FFTP at a consumer's home requires a technician appointment and some building works, which can be both time-consuming and a nuisance for the consumer.

How large are these switching costs? Do they really matter for the adoption of UFB? The existing empirical evidence suggests that it is indeed the case. Based on data about a European operator, Grzybowski et al. (2017) show that the switching costs associated to a change of technology (e.g. from DSL to FTTH or back from FTTH to DSL) are of significant magnitude, and much larger than the switching costs due to a change of plan. More precisely, they estimate that the adoption of FTTH would be 25 percentage points higher in the absence of switching costs for the consumers eligible to FTTH (i.e. covered by this technology).

Households who wish to migrate to ultrafast broadband are most likely to do so in Europe by switching from a copper to an FTTH or cable network, or by changing the service they obtain from their existing cable provider. In contrast, most households who migrated from basic to fast broadband were able to do so without migrating to a new network (even if they change provider when migrating to fast (VDSL) broadband, households generally do not require a new installation or a visit from a technician). Thus, technical switching costs are likely to be a much more significant consideration for many households when migrating from basic or fast broadband to ultrafast broadband, than they were when migrating from basic to fast broadband (although there will also be some switching costs, largely in the form of time, in this process as well).

In Grzybowski et al. (2017)'s study, consumers change offer, but not provider. Switching costs can be higher if the consumers also switch provider. For example, in their study about the migration to UFB in Japan, Ida and Sakahira (2008) find large additional switching costs (of $35) when consumers also change provider when switching from ADSL to FTTH. Note however that the costs of switching provider are likely to be much lower than the cost of switching technology.

To the extent that switching costs represent a significant barrier to the migration to UFB, a relevant question is if and how they can be reduced.

To begin with, note that the technical and other switching costs due to a change of provider (identified by Ida and Sakahira) can be internalised by the broadband providers. For example, a firm can poach customers from a competitor by offering them inducements to switch, for example via a reduction of the installation fee.

Now, concerning the specific technical switching costs for UFB, one solution would be to design offers that reduce these costs for consumers. For example, in Italy, providers propose self-installing FTTH routers to consumers, which reduce switching costs for tech-savvy users (e.g. young people). Of course, it cannot work for all consumers: for example, older people may still need the help from a technician.

Another solution would be to subsidise consumers, to compensate them for their technical switching costs. Operators could for example reduce installation fees, as we already mentioned. To the extent that the migration to ultrafast broadband is deemed socially desirable, public policy could also play a role, for example through tax breaks. If tax benefits are offered for a limited time only, consumers face an opportunity cost for not migrating fast. Such tax vouchers have been offered in other markets to encourage consumers to upgrade to a new technology. For example, in many countries consumers have been offered (or are still offered) vouchers for upgrading their cars (e.g. to upgrade to a low-emission car, such as an electric car). In France, such vouchers are also offered to households that switch to energy-saving appliances.

In the next subsection, we will argue that UFB is an experience good: consumers realise its benefits only by experiencing it. The same might be true as well of the costs of switching to UFB. Consumers may have expectations about these switching costs, but they can actually underestimate or overestimate them. In the latter case, consumers are going to be unduly reluctant to migrate to UFB. It could be the case if, for example, switching costs are high at some initial stage of migration and then decrease, but consumers are not aware that switching to UFB has become less costly. It might also be the case if stories in the media emphasise the problems that a small number of households have encountered, leading other households to overestimate the probability that will face the same difficulties (this is a problem in Australia, for example).

In sum, it seems important not only to reduce the costs of switching to UFB, but also to inform consumers precisely about the process of migration to UFB, to avoid any overestimation of these costs.

3.5. Ultrafast broadband as an experience good

We have seen that the WTP for speed increases over time (Grzybowski et al., 2017) and that it also increases with online experience (Rosston et al., 2010).

These stylised facts suggest that UFB has an experience good nature: consumers do not anticipate well the benefits of UFB before actually experiencing it. In theory, these benefits could be either higher or lower than anticipated by a consumer. In the latter case, we would expect to observe that some consumers switch back to basic broadband. Grzybowski et al. (2017) provide evidence that it indeed happens: in their sample, a small number of DSL consumers switch to FTTH and then back to DSL.[19]

The experience good nature of UFB can be due to consumers' incomplete information about the potential benefits of high speeds. It can also be due to learning effects: when they upgrade to higher speed, consumers experiment and increase their usage as we have seen. In their study about the migration from narrowband to broadband, Hitt and Tambe (2007) also show that usage diversifies: broadband adopters visit a larger variety of websites (but the distribution of their visits across these sites is less evenly spread).

If learning or experience matter, the diffusion of ultrafast broadband at the office, at school, or in public libraries, could also stimulate consumer demand for ultrafast broadband. For example, consumers would experience the benefits of UFB at the office, and soon be willing to have the same quality of experience at home. In this perspective, the European Commission's 1 Gbps targets for hubs can be seen as a way to encourage indirectly households' migration to UFB.

A few studies have investigated whether these spillovers are significant or not.

Whitacre and Rhinesmith (2015) test whether the availability of computers with broadband access in public libraries has an impact on the residential demand for broadband in the neighbourhood, using county-level data for the US between 2008 and 2012. They find a positive correlation between the number of libraries with broadband access and broadband adoption by households, but only for rural counties. Using propensity score matching techniques, they then test for the existence of a causal link (since correlation does not imply causation). Their conclusion is that there is no evidence of a causal link.

Belo, Ferreira and Telang (2016) study the effect of Internet use by children at school on Internet adoption at home. Their question is whether deploying broadband in schools can stimulate adoption of broadband by nearby households.

Their underlying idea is that deriving the full benefits of a broadband connection requires some skills or knowledge that some households may lack.[20] When children have the opportunity to use the Internet at school, they may learn these specific skills and transmit them to the adults at home. Belo et al. (2016) also consider the possibility of knowledge spillovers from neighbouring households equipped with a broadband connection.

Their empirical results support these hypotheses. Their study concerns Portugal, where all schools were connected to broadband in early 2006. Using data on Internet use at school and household Internet penetration, they show that households with children are more likely to adopt broadband, everything else equal, and even more so when their children use the Internet intensively at school. They also find evidence of spillovers from neighbouring households. Their identification strategy allows them to conclude that these links are causal.

[19] More precisely, they observe about 1,500 switches from a FTTH offer to a DSL offer over a period of one year, for their sample of about 100,000 consumers.
[20] This is also a finding from the literature on broadband adoption by households.

To sum up, there is empirical evidence that UFB has an experience good nature: households realise the benefits they can derive from UFB by experiencing it. There is also evidence of knowledge spillovers, from schools to households, or among households. Therefore, policies that consist in deploying UFB in "hubs", such as schools, businesses, etc. could be an effective means of stimulating households’ migration to UFB.

3.6. Behavioural biases and migration to UFB

So far, we have considered that households act as rational economic agents (in a neo-classical sense). In other words, households compute correctly the expected benefits and costs from adopting UFB, and make their adoption decision accordingly.

The literature on psychology and economics (or "behavioural economics") suggests that in many real-life contexts, individuals make poor decisions, based on biased estimates of a product’s benefits and costs.[21] The literature identifies various types of bias or deviation from the standard model, with respect to preferences (e.g. inconsistent preferences), beliefs (e.g. overconfidence or projection bias) and decision making (e.g. due to limited attention).

Overconfidence is an example of non-standard beliefs. It can take two forms:

(i) *overoptimism*, when individuals overestimate their abilities or prospects;
(ii) *overprecision*, when they underestimate uncertainty.[22]

With overprecision, consumers overestimate or underestimate their usage of a product. In the latter case, it implies that a consumer underestimates the expected benefits from the product. In the context of UFB, this would lead to excessive consumer inertia.

There is a debate in the literature about the extent to which consumers can learn from their mistakes. For example, an often-cited study is the paper by Miravete and Palacios-Huerta (2014), who study the effect of a tariff experiment done in the US in 1986 by a telecommunications operator, and show that consumers adjust their plan choices correctly after the tariff change. However, households that face a more complex tariff problem adjust more slowly. A more recent contribution along the same lines is the paper by Nicolle (2017). She studies the impact of the introduction of a new type of mobile contract (sim-only plans) in a European market on consumers’ choice of plans. Using consumer-level data for the period 2011-2014, she estimates the evolution of consumer myopia over time and shows that consumers adjust rapidly to the new set of available contracts. At the end of her observation period, she finds that consumers’ miscalculations are of small magnitude.

Behavioural economics can help anticipating consumer reactions to new policies. It can also help design more effective policies.[23] In particular, it suggests that simple "nudges", aimed at

[21] See, for example, DellaVigna (2009) for a recent survey of this literature.
[22] See Grubb (2015).
[23] See Chetty (2015) for a discussion of behavioural economics applied to public policy.

influencing behaviour, can be more effective than more standard policies (Thaler and Sunstein, 2008). This general idea could be applied in the context of the migration to UFB, to the extent that one finds the appropriate "nudges".

3.7. Conclusion

The main findings of this section can be summarised as follows (see also Table 1 below):

1. Consumers have a WTP for higher speeds, which can drive the migration to UFB to some extent. However, the WTP for speed is heterogeneous across consumers, and some consumers have a low WTP for speed (if any). Based on WTP for speed alone, the migration to UFB is thus unlikely to be complete. In addition, it may be that demand-side differences in WTP for ultrafast broadband exacerbate the supply-side 'digital divide' between rural and urban areas, which arises because the costs of building broadband networks are typically higher in rural areas. In other words, the demand-side and supply-side factors may compound each other, rather than offset each other.
2. There is an interplay between speed improvements of broadband networks and the quality of online content applications. As the number of UFB users increases, more bandwidth-intensive applications may appear, leading to further adoption. Entertainment content, or TV, and more specifically the simultaneous usage of multiple devices, especially in younger families with a larger number of family members, may have a role to play, although we note that the TV market and viewer habits are also changing with the growth of 'OTT' TV applications like Netflix, and that this may have uncertain consequences for the future relationship between broadband performance and content development.
3. Switching costs represent a significant barrier to migration to UFB, and in particular technical switching costs. They are likely to be much more significant in migrating from basic or fast broadband to ultrafast broadband than they were in the migration from basic to fast broadband.
4. Another barrier to migration may be due to the fact that consumers perceive too little benefit from UFB. One reason is that UFB has experience good characteristics: households realise the benefits of UFB by experiencing it. Learning effects may also play a role. Finally, behavioural biases (e.g. overconfidence) may also lead to excessive consumer inertia.

Table 1: Summary of drivers and barriers for the migration to UFB.

Drivers of migration	Barriers to migration
Utility from higher speed due to: • Less time spent for some Internet uses; • Increase in volume and variety of usage.	Switching costs: • Financial switching costs (installation fees); • Technical switching costs.
Utility from bandwidth-intensive applications.	Too low perceived benefits due to: • Incomplete information about the benefits of UFB (UFB as an experience good); • Learning effects; • Behavioural biases.

A priori, the demand-side policies for the migration to UFB can be of two kinds. First, they could aim at influencing the drivers to migration, if possible. Second, they could try to lower the barriers to migration. We discuss more specifically these demand-side policies in the next section.

4. Policies to accelerate the adoption of ultrafast broadband

This section considers policy measures that Governments might adopt to promote the adoption of ultrafast broadband (UFB). It does so by first discussing policies which have been employed in the past in efforts to promote the adoption of basic and fast broadband by households, and the evidence of their effectiveness. We then consider which of these may be relevant to the adoption of UFB. We then discuss other barriers to the adoption of UFB which may not have arisen or have been encountered for either basic or fast broadband, and which new measures may be required to overcome them. Finally, we summarise our recommendations for policymakers.

4.1. Demand-side measures to promote basic broadband

There is now a substantial literature considering the factors which influence broadband demand and adoption. Rates of broadband adoption or market 'penetration' - generally defined in terms of the percentage of broadband connections taken by households to whom such services are available - have been found to be correlated to a wide range of demographic and other social and economic endowments, including income levels, education, age, the presence of children in the household, rural/urban location, as well as other factors, many of which also appear closely correlated with each other.[24] As we would expect, there are far fewer studies which specifically consider the factors which influence adoption of UFB, but those that do suggest that similar factors, particularly income levels and the presence of children in the households, are also likely to apply.[25]

Many of these factors help us understand why broadband adoption rates might differ between countries and between groups within countries, but most of these are unlikely to be influenced either in the short term or by interventions that might be specifically intended to promote broadband adoption. For example, improvements in adult education levels (which is one factor that appears to strongly influence broadband adoption rates) would likely require sustained Government action over many decades before the results were reflected in broadband adoption levels. Many of these policies are likely to be undertaken for other reasons and to yield other benefits, even if one consequence were likely to be an increase in broadband adoption.

We ignore these kinds of policies, since the focus of this study is confined to short term actions which might be taken by European policymakers before 2025 in support of the Digital Agenda and Gigabit Society targets for UFB adoption, which are discussed in Section 2 of the report. These measures are likely to be targeted specifically at UFB adoption and, as such, to contrast

[24] See Katz and Berry, Nanson et al (2013), Lewin (2010). Particularly relevant to this study is the work of Shapiro (2010) who studies Eurostat data, and the Florence School of Regulation (FSR) (2012).
[25] Ida and Sakahira.

with many of the measures to promote broadband adoption that were taken by Asian Governments after the financial crisis in that region in the late 1990s and which formed a part of a more ambitious and extensive national vision devoted to reskilling their population and transforming their economy. Forge and Bohlin write of Korea:

> *"We may draw the lesson that only an economic discontinuity can precipitate a fundamental change of direction in society, culture and outlook – in this case towards the 'Information Society'. Only in the presence of a catastrophe was the need for strong change realised – specifically enormous efforts in adult education. The policy lesson is that adult training in high technology can be a valid response to mass unemployment, as shown by the Korean Government organising courses to give the unemployed real IT training that could lead to employment. Adult ICT education on a mass scale, roughly a quarter of the Korean population, catalysed Korea's new growth after 1998. Moving the population to new level of IT sophistication strongly increases participation in the information economy. However the question remains – is it only in Korea, with its early culture of a planned command economy and social experience of striving for growth, where such a fundamental retraining would be practical to implement?"* [p. 306]

This reminds us that we have to be aware of the institutional, political and cultural constraints which European policymakers are likely to face when making recommendations to them. The differences in the capacity of European policymakers to intervene or to influence the rate at which any form of broadband services is adopted might be illustrated by reactions to the financial crisis after 2007.

In light of the Korean experience, it might be thought that this crisis would provide Europe with a similar impetus and opportunity to re-orientate its economy and society towards the Commission's 'Digital Agenda' or 'Gigabit society' vision. States such as Italy, Spain and Greece had the same low levels of adult education and digital literacy, and high levels of unemployment that Korea had experienced in the late 1990s. However, it is important to recall that many Scandinavian countries (as well as others such as the Netherlands, Ireland, UK and Germany) already had much higher levels of education, income and digital literacy, as well as levels of fast (and even ultrafast) broadband adoption which already ranked them amongst the best in the world on many measures.

This seems to have meant that whilst individual Member States have adopted a variety of initiatives since the late 1990s which have been intended to promote broadband adoption, policymakers in Brussels have not sought or been able to replicate the kind of programmes to promote adoption which Korean policymakers were able to pursue in the 1990s. Likewise, they have not sought or been able to promote and subsidise the deployment of UFB infrastructure as Korea and Japan did in the 2000s or as Australia and New Zealand decided to do following the 2007 financial crisis. Europe's more incremental approach to policymaking in this area, despite the ambitious targets the Commission has set, might be said to have much more in common with the approach adopted in the United States, where greater emphasis and reliance is placed upon actions by individual consumers and firms operating in the market, and rather less on direct Government intervention, particularly at the national level.[26]

What measures have been adopted?

Since the 1990s, Governments and public authorities around the world have undertaken a wide range of activities which have been intended to increase broadband adoption, either amongst the population in general or amongst particular groups of consumers or citizens. In this study we focus on policies which are intended to promote the connection of households to broadband networks, rather than measures which are intended to promote the increased utilisation of existing connections (which may also be the result of measures that promote adoption) or measures which are primarily focussed on promoting adoption by businesses, public or other institutions. Any list of interventions to promote household adoption of broadband would be likely to include the following:

a. **Policies that are intended to promote the use of devices**, normally PCs, in households which might not otherwise own a device to connect to a broadband connection.[27] Although devices such as PCs may deliver benefits to households without being connected to the internet, it is assumed that demand for broadband derives from PC (or other device) ownership. As mentioned in the previous section, policies to achieve this goal include:

    ii. the direct provision of devices to qualifying households (either by Government, by non-profit bodies, through donations by firms or which are recycled following donation by former users),

    iii. the provision of subsidies (often in the form of vouchers) which reduce the costs of the device purchase, and/or

    iv. the provision of tax benefits or other subsidies which encourage employers to provide PCs for their employees to use at home.

    Many of these programmes are budget constrained (in terms of the number of devices they have to distribute or the funds which they can use to support device purchases) and so these programmes are generally restricted in terms of the number or type of households who qualify (e.g., often limited to in a particular geographic area, a particular socio-economic or demographic group or meeting other criteria, such as being recipients of other public benefits), and/or are time limited in nature in order to encourage rapid take-up and distribution of the available resources. Some programmes include the provision of ongoing support, both in terms of maintenance of software and training on the use of the device, but many others do not.

[26] This is inevitably a simplification, as we explain later that US policymakers have in fact been much more willing to subsidise basic broadband connections for low income households (at least until recently) than policymakers in Europe.
[27] Atkinson (2009) p. 3, FSR p. 69, Hauge and Prieger (2010), p. 17.

b. **Policies to promote the development of services and applications**, such as e-Government services or services that are developed in a local language, to foster demand for broadband connections.[28] Again, as discussed in the previous section, it is assumed that demand for broadband connections derives from the availability of services which households value and which they can access by means of a broadband connection, and that households without broadband connections or internet access do not subscribe because they see no particular benefit or relevance in having a broadband connection for their lives.[29] However, it is often not clear whether policies to promote attractive internet content are undertaken specifically in order to promote broadband adoption amongst households who do not have connections, or whether they are primarily intended to provide additional benefits to those households who already have a broadband connection (or to the institutions which provide the services and who may avoid other costs by doing so).

c. **Policies to promote digital literacy and skills**, again on the assumption that households without broadband connections may misjudge and underestimate the benefits which they would obtain from a broadband internet connection, as discussed in the previous section. Such programmes are often targeted at groups in the population who are thought to have the lowest levels of digital literacy, often the elderly and those who are not in employment (such as housewives) or who otherwise have low levels of educational attainment. Training is often delivered in public institutions, including community centres or libraries.

   An important variant of this approach involves the provision of digital education at schools, both at secondary and increasingly at primary level. These policies may rely upon an important insight from the research which we discussed in the previous section and which shows both that children 'act as change agents' and are very effective at transmitting digital skills to adults at home, and that the use of internet for educational purposes at school then provides a strong incentive for parents to acquire broadband connections for use by their children at home (even if the parents expect to obtain little benefit for themselves).[30] Similar 'onboarding' effects might arise from the use of broadband services by employees in the workplace (and the provision of training by employers to allow them do so effectively), and there is some evidence that employees in digital intensive work environments are much more likely to have broadband connections at home.[31]

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[28] Katz and Berry cite the Netherlands as a key example (p. 229) and find a significant correlation between e-Government and broadband adoption in Columbia (p. 231). We remain more sceptical as to causality – it seems to us likely that investments in e-Government services are likely to be made when broadband adoption is already high (so that the return on investments can be realised more quickly), rather than e-Government services themselves driving such adoption. E-Government services consume a small proportion of the time most households spend online.

[29] Lewin p.38, Katz and Berry p. 17.

[30] See Katz and Berry, p. 27 and p. 46, Hauge and Prieger, p. 15, Nanson et al. (2013), Belo et al. (2016).

[31] Lewin, Shapiro.

d. **Policies to reduce the direct cost of broadband connections for those households who do not have one**. It might be expected that Governments would be keen to intervene directly in order to reduce either the non-recurring or the recurring costs of broadband, and overcome the financial barriers faced by budget constrained households. Arrangements to allow this have existed in telecommunications markets, both in Europe and elsewhere, for many years in order to ensure the 'universal' provision of basic telephony services to every household that requires them. In practice, however, most European policymakers have seemed reluctant to extend these arrangements (noting that even Universal Service schemes for basic voice telephony services have only been implemented in some Member States, with many others requiring the SMP operator to meet such obligations without any form of subsidy) to include even basic broadband services (above 144 kbps).

Rather than prescribing an 'affordable broadband tariff' for a broadband service which might be made available to every qualifying household, European policymakers have so far preferred to limit their interventions to supply-side actions aimed at reducing the costs of broadband supply in general. These include direct public subsidies in (generally rural) areas where broadband connections might otherwise not be available at all (which are in Europe subject to the State Aid regime for broadband networks), measures to promote the sharing of existing civil engineering infrastructure,[32] measures to reduce rates and other taxes payable by broadband network owners and measures to promote 'demand aggregation' initiatives, either by public bodies or by suppliers, in order to reduce the risk of new network deployment and thereby extend it.

Since 2010, some European Member States have adopted 'affordable tariffs' for basic broadband products – in Finland the SMP operator must provide 2 Mbps and in Spain it must provide 1 Mbps, but in both cases neither the SMP operator nor the individual household receives additional subsidies to lower the costs and there is no 'social tariff'.[33] More significantly, the FCC voted in 2016 to extend the existing Lifeline subsidy programme to broadband connections up to 10 Mbps.[34] This programme, with a budget of over $2bn p.a., allows qualifying households (who are generally in receipt of other social and welfare benefits) to receive a subsidy or discount of around $10/month towards their broadband connection (with this sum representing about one quarter of the total costs of the monthly rental). However, following the election of the Trump Administration in the US, the programme has been put on hold as a result of concerns that it was prone to abuse and mismanagement.

[32] Promoted further by the Commission's recent Broadband Cost Reduction Directive.
[33] http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/581977/EPRS_BRI(2016)581977_EN.pdf.
[34] https://www.fcc.gov/general/lifeline-program-low-income-consumers.

In the meantime, the UK Government has become the first in Europe to propose an ambitious 'universal broadband' scheme which would require the provision of broadband connections of up to 10 Mbps to every household in the UK.[35] The costs of doing so are likely to be constrained by a requirement that a household would be required to contribute to any initial connection costs exceeding a certain threshold (expected to be £3,400 per household) and it is not currently envisaged that low income or other qualifying households would receive any discount on the recurring charges either (as is the case with the Lifeline programme or with BT's existing 'BT Basic' social tariff which already offers a discounted telephone line and an ADSL connection of up to 17 Mbps with 12 GB data for around £10/month to those qualifying for relevant social benefits[36]). The legislation implementing the scheme anticipates that the scope of the subsidy will expand in future and provides that the 10 Mbps threshold can be reviewed once 75% of households in the UK enjoy broadband connections of speeds of 30 Mbps or more.

4.2. How effective have these demand-side policies been and how might they apply to UFB?

Evidence which would allow us to draw firm conclusions about the impact of specific policies on broadband adoption appears rather limited and many researchers take a rather sceptical view of the claims that are made by those advocating a particular scheme. Even if a particular programme has been demonstrably effective, it is often unclear – as we noted earlier in relation to Korea - whether it could be exported to a different, in this case European, context. Writing in 2010, Hauge and Prieger reported:

> *"the body of evidence regarding evaluation of demand-side efforts to encourage broadband adoption is exceedingly thin. A massive review of hundreds of digital literacy programs throughout the OECD countries puts it succinctly: "…it is striking how little evidence initiatives have gathered on the impact of the activities on the participants"*[37]

The position has improved since then, notably with the publication of a major study by the Florence School of Regulation, commissioned by the IRG in 2011. This study used quantitative methods to assess the impact of different demand-side interventions on broadband subscription levels (with broadband defined as any connection above 254 kbps) in 23 EU markets over a period of 15 years. However, the policy interventions themselves are not very well described and rely upon rather generic categories which appear to have been derived from the

[35] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/634016/USO_consultation_document.pdf.
[36] http://btplc.com/inclusion/ProductsAndServices/BTBasic/BTBasicBroadband/index.htm.
[37] Hilding-Hamann et al. (2009b), p.54.

International Broadband Policies Database developed by I-Com, the Italian research centre, and which recorded policies adopted by a large number of OECD countries during the period 1995-2010.

Despite this, the FSR's findings are important for our purposes, both because of the size of the data set and because it relates specifically to the impact of demand-side interventions on broadband adoption across Europe as a whole, rather than in relation to a particular Member State. The key findings of the study are:

a. All five of the demand-side measures in the analysis (described below) had a statistically significant and positive impact upon broadband adoption levels.[38]

b. 'Demand aggregation' policies (one of the categories adopted in the I-Com database, and which we understand to refer to measures which encourage or require households to commit to purchasing broadband connections in a given area within a given timeframe, thereby reducing the risk of network deployment for the network operator) had the greatest impact on broadband adoption.

   Although the FSR study does not seem to address the point, this may be because without such policies no broadband network is deployed at all, and so adoption levels would be zero. But this is really a supply-side (no network is rolled out) rather than a demand-side effect. It is difficult when assessing 'demand aggregation' policies to distinguish between households who would remain unconnected if the network were available in the absence of the policy, and households who would only be unconnected because the network is not available at all in the absence of the policy!

c. Direct subsidies to reduce the costs of broadband connections for households – likely in the form of subsidies for PCs (given the lack of Universal Broadband schemes noted above) – also appear to have a significant positive impact on adoption, although this category is likely to include a wide and diverse range of measures.

d. Measures to promote demand for services through the provision of e-Government and other digital services (which may include the provision of broadband services in schools and other public institutions) also appear to have some impact on broadband adoption. We also treat this result with caution since it is not clear to us whether it captures the role of Government as a supplier of digital services which leads households to acquire broadband connections in order to use them (the demand-side measure we discussed earlier in this section) or whether it also or otherwise captures the 'demand-side' role of Government and public institutions as being purchasers of broadband connections and performing a form of 'anchor tenant' function. Again, if the latter is included, it may be that the results capture the fact that a lack of such a Government 'anchor tenant' may mean that no broadband network is built at all.

[38] FSR p. 90. This is consistent with the findings of Belloc (2011) who undertakes a similar analysis for 30 OECD countries using the same variables.

e. Measures to promote what the authors refer to as 'private demand' (which may include the kind of measures to promote digital literacy referred to above) appear less effective than the others identified.

f. The authors also find that demand-side policies may become more effective as adoption rates rise and the market matures. This may suggest that demand-side interventions become more targeted at specific groups in the population who remain unconnected, and likely more effective as a result, and/or it may simply reflect the obvious fact that demand-side measures are likely to be more effective if the supply of broadband connections is already available.[39] It may also reflect the 'experience good' characteristics of broadband that were referred to earlier and which are discussed further below.

Finally, and as noted earlier, most of the demand-side programmes are limited in terms of resources available and the period over which those resources are applied. A study of 464 programmes across 32 countries found that only 40% of programmes continue beyond the initial funding period.[40] It is not clear whether the reluctance to allocate new funds arises from disappointment with the results of the initial programmes, or because they have achieved their goals and no further action is required. Many demand-side programmes are relatively small, localised and targeted at specific groups, and are either administered by existing public agencies or charitable/non-profit organisations which serve those particular groups. Most researchers tend to advocate the use of decentralised delivery arrangements, believing that local initiatives are likely to better reflect and meet the needs of local communities.[41] On the other hand, there is very little research to suggest whether funds which are applied to one programme might be better used in another (presumably because mechanisms to reallocate funds between programmes often do not exist).

4.3. Implications for the promotion of UFB adoption

Before we consider the implications of past experience for UFB adoption, it is worth examining the differences between different types of policies. As we explained in the previous section, the lack of broadband connection can be assumed to arise because the household is currently either willing but unable or able but unwilling to pay the market price for the service. Interventions by policymakers can therefore be directed at influencing one or more of the following factors:

a. **They can be intended to lower the market price for all households.** This is normally done by reducing the general costs of broadband deployment and is a measure which will benefit all households, including those who would have been willing to subscribe at the existing market price. In some cases,

[39] Again, Belloc (2011) comes to the same view.
[40] Hilding and Hannan (2009).
[41] FSR p.77, Shapiro p. 17, Hauge and Prieger.

these measures are required for there to be any broadband supply at all – in other words, there would be no market price at which supply would be available to any household in the absence of such measures.[42] Many of the demand aggregation schemes referred to earlier have this characteristic – the assumption is often that without such measures no broadband network would be deployed in the area concerned, since insufficient householders would be willing or able to pay the 'market price' in the absence of such measures.

b. **They can be intended to lower the market price specifically for those households who cannot subscribe at current prices due to budget constraints**. This is normally done by means of a financial subsidy towards the cost of the broadband connection (a 'social tariff'), which is targeted at households who are presumed to face budget constraints which prevent them from obtaining a broadband connection. Note that in many cases these households may require ongoing subsidies if they are to remain connected to network (unless their economic circumstances change so that they no longer face budget constraints).

c. **They can be intended to increase the willingness to pay of those households who choose not to subscribe at current prices (but who could do so).** This is the aim of policies to promote devices in the home, digital literacy, experience of broadband use outside the home, or new digital services, all of which are assumed to contribute towards a higher valuation of a household broadband connection. Some of these policies are targeted specifically at households with assumed low willingness to pay (such as promoting devices in the home), but others, such as the availability of new services, can be expected to influence the willingness to pay of all broadband users.

d. **They can be intended to lower the market price for those households who choose not to subscribe at current prices.** This is a targeted version of (a) above, and involves policies that are targeted at getting households connected to broadband networks without necessarily influencing their willingness to pay and recognising that they do not face a budget constraint at current prices. At first sight, this is an unattractive political option, since it involves subsidies to households who do not face budget constraints and who do not appear to value broadband highly. It therefore challenges the

[42] Whether this is in fact the case depends on various assumptions, of which the most important is whether suppliers are able, or would wish, to price discriminate between different groups of customers, including between different geographic regions. Generally, this is not the case in Europe today, although we are not aware of regulatory restrictions which would prevent broadband service providers from charging different retail prices.

assumption that householders are the best judge of their own economic interests (although we explained in the previous section how behavioural economics might lead us to this conclusion). Most policymakers prefer to use the policies described in (c) to address this group, but we think this type of policy should be considered if the direct subsidy to reduce the price were more efficient (i.e., lower cost) than attempts to raise willingness to pay. This might be the case if the subsidy to get these households connected were time limited (e.g., on the basis that the household's willingness to pay would rise over time), or if it could be otherwise shown that householders were generally misinformed about the value of broadband or different types of broadband, and that the costs of improving information flows were high relative to the costs of a direct subsidy.

The first category of measures to reduce the costs of broadband network deployment appears attractive, not least because all households will be potential beneficiaries. Some households would have been willing and able to subscribe in the absence of such measures, and so will simply extract greater consumer surplus - assuming that the supply side of the market is sufficiently effective to require producers to adjust their prices as costs fall. Implementing these measures generally requires regulatory or legislative action, for example, to promote network sharing or reduce taxes, rather than direct public subsidy (which generally competes with other Government funding requirements).

We summarise the main household categories and corresponding policy options in the table below:

Can't pay and won't pay	**Can pay but won't pay**
• These households present two challenges: they lack the economic resources to subscribe to UFB services and they currently see no reason to do so either. Policymakers may need to increase their willingness to pay before the consider targeting financial subsidies at them (otherwise the subsidy may be diverted to other purposes or otherwise made ineffective), moving them into the box below. • Lowering costs of UFB provision is unlikely to significantly affect adoption rates amongst this group.	• These households likely represent the majority of households in most European Member States today. • Policymakers have generally sought to increase their willingness to pay to promote adoption through digital literacy, device subsidy and other programmes. • Alternatively, policymakers might seek to lower current prices (at least for one-off switching), in order to get households connected and then rely upon user experience of UFB to increase willingness to pay thereafter. This approach may be politically challenging if viewed as subsidising those who can afford to pay, although the costs of overcoming switching may be 'one off'. • Lowering costs of UFB provision may increase adoption rates amongst this group.
Can't pay but will pay	**Can pay and will pay**
• These households will require the provision of an ongoing subsidy or 'social tariff' to allow them to take up UFB services. • Lowering costs of UFB provision may significantly increase adoption rates amongst this group, but these are likely to be a relatively small proportion of the total population.	• These households are currently UFB adopters, or will be so when services become available in their area. • Lowering costs of UFB provision does not affect adoption rates amongst this group, but increases consumer benefits. • No basis for public intervention.

4.4. Specific policies

Demand aggregation

We are not surprised to find that the research suggests that demand aggregation measures which allow network operators to deploy broadband networks in areas where they might not otherwise build at all, or where they might otherwise delay roll out, produces large effects in terms of broadband adoption. In such cases, demand aggregation assists both the demand side and the supply side. It is of course also possible to envisage the use of demand aggregation measures independently of the supply side, that is to use them to promote adoption after the UFB network has already been deployed. We are not aware of this having occurred in relation to the adoption of basic or fast broadband, but we consider this option in relation to UFB adoption in the next section.

It is perhaps surprising that European policymakers have not paid more attention to demand aggregation measures for broadband. Some Governments, notably in the UK and the Netherlands, have encouraged the use of such schemes in the past, [43] but they are not widespread. One of the authors of this study has noted elsewhere that the prospect of a community otherwise being denied access to a broadband network can be a powerful tool in motivating individual households to commit to subscribing, when they might otherwise delay their purchase or 'free ride' on the commitments of other householders in the area. The FSR study also refers to the importance of 'social interaction' (which we take to mean peer pressure or social rivalry) in driving broadband adoption. High levels of initial adoption of UFB services (at around 40% of households) can be obtained through such demand aggregation exercises, whereas subsequent adoption rates once the network has been deployed tend to be much lower.[44]

This also illustrates one of the other conclusions from the existing literature and something we referred to in Section 2 of this report when discussing 'targets', namely the need for policymakers to better co-ordinate the interaction between demand-side and supply-side measures. It may be that 'demand-side aggregation' measures are made ineffective or obsolete by decisions by Governments to publicly subsidise the deployment of UFB networks in higher cost areas. The result of this may be that local communities and individual households know that the UFB network will be built (with public subsidy) in their area, irrespective of whether they commit to subscribe to it in advance. If so, attempts to drive initial adoption rates through demand aggregation schemes are likely to be ineffective, since failure to commit will have no consequences for whether or when the network is built and no costs to the individual householder.

[43] FSR p. 70, Analysys Mason (2008), p. 26.
[44] Feasey 'Include fibre in housing policy', Intermedia, April 2017.

A state subsidy for UFB networks may have other consequences too. For example, the subsidy agreement is likely to require certain levels of adoption of UFB services, but these may not align with the Commission's Digital Agenda targets. Firms may still have some financial incentives under the State Aid arrangements to exceed the adoption targets. However, in many cases the 'claw back' mechanisms in State Aid agreements (as required by the Broadband Guidelines[45]) are likely to mean that a significant proportion of any financial benefit from higher-than-expected adoption levels will flow back to the State rather than being retained by the network operator. In such cases, incentives for the firms to promote UFB adoption on networks which have been subsidised by State Aid funds may be weak. This leads us to suggest that the Broadband Guidelines might be reviewed in order to ensure that equal focus is given both to rapid and cost effective roll out of UFB networks, but also to the strengthening of incentives for the recipients to promote take-up on those networks. The greater use of demand aggregation schemes to determine where the network is subsidised, or built at all, could be part of that.

On the other hand, it may also be that demand aggregation is of less interest to network operators now that they have collected data about the existing basic and fast broadband usage and habits of the households to which they now intend to offer UFB services. The rise of big data analytics capabilities (and the associated data sets) may allow the industry to predict household demand for UFB connections far more accurately than during the initial roll out of basic broadband services. If so, network operators may conclude that demand aggregation and pre-commitment programmes do little to further reduce the risk of the network investment (and may simply add cost and delay to the process in the meantime).

Social tariffs

The second set of measures to address budget constraints has, as noted earlier, not generally been adopted by policymakers to promote broadband connections, although 'social tariffs' have been a feature of voice telephony in many Member States for many years. We have already referred to recent proposals to extend the US Lifeline programme and to implement a 10 Mbps Broadband Universal Service Obligation in the UK, both of which may suggest a greater prospect of 'affordable' broadband tariffs being adopted by policymakers in future. However, the European Commission has generally sought to resist the expansion of 'Universal Service' Schemes into broadband services in the past. This is perhaps because of concerns that such schemes may distort competition and so undermine other important policy objectives, and perhaps because such schemes are not supervised by the Commission itself, as is the case with supply-side initiatives under the State Aid rules. National policymakers may also be concerned that any subsidy programme would likely involve a long term commitment to subsidise the cost of broadband connections for households who would otherwise cancel their subscription if the subsidy were withdrawn. Policymakers may also be concerned about criticism that past subsidy programmes have been open to abuse and fraud, or have otherwise been ineffective or poor value for money.

[45] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2013:025:0001:0026:EN:PDF

Despite this, some proportion of households in most European countries will continue to face budget constraints which prevent them from subscribing to broadband connections, and a similar, if not greater, proportion of households would face the same constraints in relation to UFB services. The Commission is currently proposing to revise the Universal Service arrangements under the new European Electronic Communications Code (EECC). The Code has yet to be agreed, but the Commission's original proposals were that the arrangements should focus on the provision of 'affordable' services, including a 'functional internet access' service equivalent to that used by the majority of households in the country, and that the net costs of doing this should be financed from public funds (and not by other market participants within the telecoms sector).[46] When we refer to 'social tariffs', we similarly propose and assume that the costs of any subsidies would be met from public funds and not from the telecommunications industry itself.

Under the Code's proposals, Member States are not obliged to implement such arrangements, nor are they obliged to implement social tariffs that are targeted at budget constrained households. In the UK case cited earlier, the Government is not proposing to adopt a new broadband social tariff (although one already exists) but simply to require that existing unsubsidised broadband tariffs are offered to all households across the country on a nationally averaged basis (in order to avoid the risk that households in very remote areas would otherwise face very high prices which would exclude them).

It is not clear to us whether or not the Commission's proposed changes to the Universal Service arrangements will lead to their greater use by Member States to overcome affordability barriers to the adoption of either basic broadband or UFB. This is a case where the Commission has set adoption targets for UFB, but important levers which might affect Europe's capacity to meet them are wielded not by the Commission, but by policymakers in individual Member States. Experience so far suggests that these policymakers will be reluctant to extend Universal Service funding to support UFB connections (and that they could not lawfully do so until 'the majority' of households in a Member State already enjoyed such connections). In particular, this may be so if the Commission succeeds in ensuring that any costs are met by general taxation, as we believe they should. Moreover, many European policymakers currently appear more focussed on 'supply-side' subsidies to promote the deployment of UFB networks in rural areas using State Aid mechanisms, but may turn to focus on demand-side issues later.

In the longer term, policymakers will find themselves needing to decide how and whether to support those households who are unable to obtain UFB connections because they face ongoing budgetary constraints. Some argue that the needs of these households can be better met through the provision of mobile broadband services, which can already be provided on commercial terms at prices that are affordable for many of these households. They note that a significant proportion of 'mobile only' households in Europe (and in the US, where fixed broadband connections have begun to fall) are households who might be expected to be unable

[46] EECC proposal, Articles 79-85.

to afford a fixed broadband connection.[47] It is also notable that the new Universal Service arrangements proposed by the Commission apply only to the subsidy of services that are provided to a 'fixed' connection (although we assume this does not exclude wireless provision).

Others suggest that the costs of UFB deployment will fall sufficiently in future (whether as a result of other measures being taken by Government or for other reasons) so as to reduce the number of households that are unable to afford a UFB connection. This view may be implicit in the requirement that subsidy programmes can only be considered once the majority of the population is already subscribed, at which point greater economies of scale on the demand side may allow for some reduction in market prices. That said, broadband prices in Europe have remained relatively stable in many Member States in recent years, whilst disposable incomes amongst the most economically disadvantaged households have remained under significant stress (given cuts to social and other payments in many European countries). We are not aware of any analysis on the issue, but it is not clear to us that the cost of either basic, fast or UFB broadband connections as a proportion of disposal income will have fallen for the most budget constrained households in Europe over the past 5 years.

Increasing WTP

The third set of measures, aimed at increasing willingness to pay, is the most common and appear to be the most popular amongst policymakers. But their effectiveness is also the most difficult to assess, since they rely upon individual households translating their higher valuation of internet services or the use of a PC into a subscription to a household broadband connection. One of the obvious reasons for their popularity is that they typically involve a non-recurring, time-limited investment in a particular programme.

Our view is that, regardless of their effectiveness in promoting the adoption of basic or fast broadband services, most of these policies have much less relevance to the promotion of UFB services. Specifically:

a. **We do not see a particular type of device, akin to the PC for basic or fast broadband,** which households would need to own before subscribing to an UFB connection. If anything, it seems that it will be the use of many different types of devices within the home that is likely to support household demand for UFB over existing broadband connections. Improvements in TV standards and viewer expectations, the rise of multi-player gaming, future virtual reality and telepresence applications will all require new investments in household devices which will, in turn, promote demand for UFB. But we think it would be very difficult for policymakers to make a case for public subsidy of such equipment.

b. **We are sceptical as to whether further 'digital literacy' programmes are necessary** to promote the adoption of UFB connections. Almost all households in Europe are

[47] Katz and Berry, p. 157.

now familiar with the internet and with the services that are available and the benefits that can be obtained from accessing it. Although the previous section showed that there may be additional benefits from the use of UFB connections rather than basic or fast broadband, we think these are much more likely to be understood through exposure to UFB usage (exploiting the 'experience good' properties of UFB) than through formal education or training programmes. The rise of apps and new user interfaces, particularly on mobile devices (which can be connected to fixed connections via Wi-Fi), has made the use of digital services and applications so intuitive and easy that they have already largely replaced formal digital training initiatives.[48]

c. **We are unclear whether e-Government and measures to promote the development of other services (such as cloud computing) will have a significant impact** upon household UFB adoption. As we explained earlier, the Commission's latest Gigabit Society targets include a requirement for deployment (and by implication adoption) of UFB connections in what the Commission calls 'all socioeconomic drivers', by which it means schools, public buildings (e.g., libraries, doctors surgeries), transport hubs such as stations and 'digitally intensive' enterprises.[49] In making this proposal, the Commission explicitly refers to the expectation that exposure to UFB connections in public places will 'foster familiarity with and demand for Gigabit Internet Access', presumably leading to greater levels of adoption at home.

   This is consistent with our view of UFB as an 'experience good', the valuation of which is likely to increase as users gain greater exposure to it, and this would certainly appear to be a sensible measure to promote adoption. Government subscriptions to UFB connections may also perform the 'anchor tenant' role which we discussed earlier.[50] This is, however, very different from attempts that might be made to develop or support specific services which require UFB connections at home in order to be able to access or use them. A review of the Commission's latest 'eGovernment Action Plan' for 2016-2020 does not reveal many applications which seem likely to promote UFB connections, and this is not mentioned as one of the objectives of that plan.[51] Services will of course develop in response to market demand. South Korea remains a world leader in e-Sports and massive multiplayer

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[48] Williamson 'All about that app', March 2015 p. 30.
[49] Gigabit Society Communication to Parliament, p. 6.
[50] This 'anchor tenant' model is already a feature of the business of some UFB network operators. For example, Cityfibre in the UK deploys a UFB network which first connects all public buildings within a particular city or town. It then develops consumer services and connections in accordance with local demand.
[51] https://ec.europa.eu/digital-single-market/en/news/communication-eu-egovernment-action-plan-2016-2020-accelerating-digital-transformation. Many of the services highlighted, such as digital invoicing, procurement, online registration of business activities, do not obviously require UFB connections to undertake them. We recognise, however, that the Commission is also engaged in supporting projects in areas such as High Performance and Quantum Computing, European Cloud Services and other initiatives which are likely to require UFB capabilities.

gaming applications (ncSoft is a global leader in such MMPOGs), many of which require UFB connections to be played effectively. But it is not clear to us that Governments are either required or well placed to promote these or other services (or rather that they should do so solely in order to promote UFB adoption).

Overall, we find little from previous efforts to promote broadband adoption that would assist in the pursuit of Europe's UFB objectives, with two important exceptions. The first relates to the Commission's effort to expose users to UFB experiences (both connections and services) outside of the home in the belief that this will increase their willingness to pay for UFB connections at home. This seems a sensible measure to us, and one that is supported by evidence from similar efforts in the past. We think it particularly important that UFB connections are provided to schools and other educational institutions, since the evidence suggests that children perform a particularly important 'transmission function' in introducing new technologies to their parents and into the home. It has also been suggested that 'homeworking' would be likely to promote UFB adoption (there is certainly some evidence to suggest that UFB adoption is proportionately higher amongst those working from home, although this may also correlate to other factors), again on the basis that exposure to UFB services in the work environment will increase willingness to adopt UFB at home. This could be promoted, for example, through the provision of tax incentives to employers who wish to promote home working and who are willing to subsidise a UFB connection.

The second issue relates to the use of demand aggregation measures. These appear to have been one of the most effective demand-side measures to promote both broadband take-up and broadband network deployment, and we have already asked why they have not been adopted more extensively by policymakers or by the operators themselves.[52] We have recognised that the transition from basic or fast broadband to UFB may not produce the same demand uncertainties as did the initial deployment of broadband, since the industry now has data about past and current household broadband usage which ought to allow it to predict future UFB demand with greater accuracy. Nonetheless, we still think it highly desirable that other supply-side policies do not deter firms from applying demand aggregation or other measures to increase adoption levels. We worry that current State Aid arrangements for UFB may place greater emphasis on the deployment of UFB networks than on adoption rates (and that current 'claw back' arrangements may in fact deter recipients from maximising adoption rates). Approval of State Aid for UFB networks ought, in our view, to be subject to quite demanding targets for adoption levels and strong incentives to achieve them. This might in turn encourage the recipients of the Aid to be more creative in terms of the measures they take to promote it.

[52] Group purchasing or demand aggregation initiatives have been used by policymakers in other industries to secure pricing discounts - for example, in the UK energy market the Government has supported local Government and non-profit initiatives to establish group purchasing and group switching arrangements. They do not appear to have been used in telecoms in recent years, although the FCC did require consumers to participate in mandatory ballots as it sought to introduce competition into long-distance markets in the 1980s. Households who failed to vote were allocated to providers in proportion to those who had voted.

Finally, we find that, as with basic and fast broadband, a proportion of European households will be unable to connect to UFB networks because they cannot afford to. On current trends, we see no reason to suppose that the size of this group will diminish significantly over time, although their needs may be substantially met by other technologies, most notably high speed (but perhaps not UFB) mobile connections. Policymakers appear to have been rather slow and reluctant to address this issue for basic and fast broadband. If they are to be more effective in addressing it for UFB, they will first need to much better understand the likely number of these households, and the likely cost of bridging any affordability gap. The proposed changes to the Universal Service arrangements under the EECC envisage that measures may be taken to provide 'social tariffs' for broadband, including potentially UFB, connections once the needs of the majority of the population have been met by commercial means. This is unlikely to be before 2020 for Europe as a whole, even on the Commission's own targets, although some individual Member States may need to address the issue before then. We explain below that addressing the issue of 'affordability' of UFB is more complex than for basic or fast broadband.

We summarise our conclusions on how existing policy measures might be used in relation to UFB adoption using the same categorisation of households as adopted earlier:

Can't pay and won't pay Exposure to UFB services outside of the home (schools, libraries) to improve willingness to pay. Will require introduction of UFB 'social tariffs' in the longer term.	**Can pay but won't pay** Exposure to UFB services outside of the home (schools, libraries) to improve willingness to pay. Promote demand-side aggregation measures in order to promote adoption and reduce supply-side risks.
Can't pay but will pay Will require introduction of UFB 'social tariffs' in the longer term.	**Can pay and will pay** No basis for public intervention.

4.5. Other potential barriers to the adoption of UFB

In previous sections, we have introduced the various measures which have been adopted by policymakers in the past to promote the adoption of broadband services by households. For these households, the choice was between having no fixed broadband connection at all and having a connection for the first time. In the case of UFB, however, the vast majority of households will already have a broadband connection and will be considering whether and when to upgrade to UFB.

This changes the nature of the subscription decision. Rather than needing to be persuaded of the benefits of connecting to a broadband network at home in order to access the internet or use other types of digital services, householders will be assessing the relative benefits of a UFB connection compared to their existing basic or fast broadband service. This has a number of important implications for policymakers:

a. First, **households will require accurate information about the relative performance of different types of broadband network if they are to make informed decisions**.[53] Instead of facing a choice of broadband/no broadband, householders will be required to make more subtle choices about the relative performance of different networks. In addition, it is increasingly likely that householders will be able to obtain UFB connections from a number of different providers, each of which use different technologies (HFC, G.Fast, FTTH) to provide them. Public authorities in a number of Member States have already expressed concerns about the amount of misinformation and popular confusion that has arisen from competing claims about the performance of different broadband networks and technologies, all of which undermine consumer confidence in the claims made by broadband suppliers and are likely to discourage switching. In the UK, for example, the advertising standards regulator is currently investigating which networks should be described as 'fibre' and how claims about network performance should be presented.[54] The Australian and German regulators have both recently published guidance on the same topic[55] and the UK regulator, Ofcom, is also proposing to make changes to its industry code of practice.[56] Governments and regulators could play an important role in improving what is sometimes referred to as 'truth in advertising' in relation to the performance of broadband networks. Doing so is likely to improve the prospects of UFB adoption.

b. Second, as highlighted in the previous section, **switching from their existing broadband to a UFB connection is often likely to involve the householder incurring additional costs** of both a financial and technical nature which they did not face when first subscribing to basic broadband or in migrating from basic to fast broadband services over DSL. Policies which aim to reduce these costs, either through some element of financial subsidy or through other measures, are therefore likely to have a significant impact on UFB adoption rates.

   This issue becomes even more challenging when the costs and benefits accrue to different parties, as is the case for example if a landlord is required to give consent to a new UFB installation for the benefit of their tenants. Studies from Australia and evidence from New

[53] This point is made by Kelly et al of the World Bank (2010), p. 8.
[54] https://www.asa.org.uk/resource/consultation-on-speed-claims-in-broadband-advertising.html.
[55] https://www.accc.gov.au/publications/broadband-speed-claims-industry-guidance and https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2017/12042017_breitbandmessung.html;jsessionid=EF1A6354C3462BCCA4DD36575A9F3AA8?nn=404530
[56] https://www.ofcom.org.uk/about-ofcom/latest/features-and-news/better-information-buy-broadband

Zealand suggests that obtaining such consents can represent a major barrier to UFB adoption in rented properties.[57] This may be significant issue in those Member States where a significant proportion of the population are tenants.

c. It is obvious that **any householder's assessment of whether to switch to UFB will depend on the relationship between the ongoing charges for a UFB connection and the charges they pay for their existing connection.** If the price premium for a UFB connection is too high, particularly at the outset when the user has little direct experience of the benefits of UFB and may be poorly informed as to the new network's capabilities (and so may have a low willingness to pay), then adoption rates will be low. This is shown by the case study of Australia and New Zealand. In the case of New Zealand, UFB recurring charges are often lower than those for existing broadband connections and the 'inter-technology' costs of switching to the new FTTH network are subsidised by the Government. Differences in the price of ADSL and FTTH connections in Japan are also negligible,[58] as they are in Sweden and a number of other Member States. In such circumstances, it is unsurprising to find that adoption rates for UFB connections are high. In contrast, the structure of underlying wholesale charges for the UFB products provided by nbn in Australia seems to mean that the UFB prices (and services) offered by retailers remain relatively expensive compared to existing DSL broadband prices. Adoption rates of UFB products are much lower in Australia as a result.

Governments, and particularly regulators, will have some influence over the relative pricing of both UFB and basic and fast broadband products, particularly though the regulation of the underlying wholesale products, although of course the firms themselves can also be expected to promote their own services and networks (although the position in both Australia and New Zealand is further complicated by the fact that the UFB network is structurally separated from the downstream retailers, and so each may have different incentives).

The European Commission has been engaged in extensive debate of these issues for at least the past decade. It currently recommends that national regulators allow UFB network owners the freedom to set their own fast and UFB wholesale charges, specifically in order to allow the firms themselves to determine the price differential between products offering different speeds. The Commission also recommended keeping the regulated charges for ULL-based (basic) broadband products stable and increasing them in some Member States. The primary aim of this policy has been to promote investment in UFC networks, but an important consequence of it may be to narrow (or even eliminate) any retail pricing differential between the charges for services offered over those networks and those basic broadband services offered over copper networks. Putting wholesale pricing to one side, the other key question for European policymakers is

[57] Hanson et al., p. 19, author interviews with Chorus.
[58] Ida and Sakahira.

whether any intervention is required to directly influence the retail pricing of UFB services by operators (or to provide subsidies to consumers) to further promote UFB adoption. We explained earlier that European policymakers have so far been reluctant to consider even the development of social tariffs for broadband to aid budget constrained households, so it seems unlikely that they will wish to intervene more generally in setting retail prices in the foreseeable future.

d. Fourth, **policymakers may seek to influence the extent and rate at which the UFB network comes to replace the existing copper-based basic broadband networks, either by removing barriers which prevent this happening, by requiring that operators commit to a timetable, or by intervening more actively in the market to force 'switchover' (such as occurred in many Member States in relation to the transition from analogue to digital terrestrial broadcasting)**.

   In Australia, for example, householders are obliged to connect to the nbn/UFB network (including for services which may not require UFB capabilities, including basic voice telephony) within 18 months of its deployment in a particular neighbourhood. At this point, the existing copper infrastructure will be turned off by nbn, with a compensation payment having been made by nbn to Telstra, the previous owner of the copper assets. UFB capable connections in those regions will be almost 100% of households at that point, although it appears that relatively few of these households then choose to subscribe to services which require UFB capabilities and many retain services which they could also obtain on their existing copper network. As we explain in Annex A, there are many factors to consider when assessing the performance of nbn, but it does suggest that we cannot simply assume that the decommissioning of the copper network would result in high levels of adoption and use of UFB services.

e. Meanwhile, regulators in a number of other countries, including the US (where the FCC adopted a Technology Transitions Order in 2015, again currently subject to review) and New Zealand (where the Government is currently proposing new legislative measures to promote decommissioning after 2020), have also examined the barriers which might currently inhibit the decommissioning of existing broadband networks.

   In Europe, only the French Government has given the issue of copper switch off serious consideration (so far as we are aware), appointing the former head of the French regulator (Paul Champsaur) to study copper decommissioning or switch off in 2015[59] (which he suggested should be undertaken cautiously). BT, in the UK, has recently advocated that British broadband providers jointly commit to a 'cutover' plan[60] and we understand that other European operators may be considering similar plans. In general, European policymakers appear to be relying upon the operators themselves to take the initiative on copper switch off, and the Commission has yet to provide detailed guidance

[59] At http://www.economie.gouv.fr/files/files/PDF/rapport-final-paul-champsaur_2014.pdf.
[60] BT Openreach 'Upgrading the Access Network with FTTP: Consultation Document', 17 July 2017, p.21.

on this topic (although proposed Article 78 of the new EECC seeks to ensure that competition is safeguarded if an SMP firm withdraws existing facilities). We are not aware that any European operator has yet provided a clear timetable for when it will fully decommission its copper network and require all users to migrate to a UFB alternative.

Finally, we should emphasise that even if it were concluded that establishing a timetable for copper decommissioning would facilitate the earlier adoption of UFB, policymakers will need to assess copper decommissioning in light of a range of policy objectives which go far beyond maximising UFB adoption (and so which also fall beyond the scope of this report). For example, one of the challenges may be that actions which are intended to incentivise operators to decommission their copper network may at the same time serve to discourage households from adopting UFB services. This might be the case if it were argued that the wholesale revenues earned by operators from their copper assets would need to be reduced in order to incentivise the owners of those assets to migrate to newer UFB network technologies which would then promise relatively higher returns. Bourreau et al. (2012) refer to this effect as the "wholesale-revenue effect", which involves reducing the wholesale prices charged for copper. However, reducing copper wholesale prices (to promote UFB deployment by operators) would also likely lead to lower retail prices for existing basic and fast broadband services, relative to UFB services, and so would likely encourage households to retain their existing basic and fast broadband connections and so deter UFB adoption! Bourreau et al. (2012) refer to this effect as the "business-migration effect". This is one example of the formidable challenges which policymakers face when considering the use of copper decommissioning as a means of promoting UFB adoption.[61]

4.6. Key policy recommendations

In this section, we aim to draw upon the experience of past demand-side interventions to promote broadband adoption, and our analysis of the new challenges which arise for households seeking to migrate from basic or fast broadband to UFB, to provide some specific recommendations. However, it is important to note that many of our recommendations may also be relevant to migration from basic to fast or 'superfast' broadband as well. Our views are necessarily qualified by the current lack of research about the use of demand-side policies to promote UFB, which reflects the relatively early development of UFB networks, at least in Europe and the US.[62] Nonetheless, Shapiro rightly reminds us that policymakers often find themselves having to act in fast moving and rapidly changing markets with incomplete

[61] Recognising this dilemma, a 'copper wedge' has been proposed as a form of tax which would allow copper wholesale prices to fall (to promote migration by operators to FTTP) whilst retail prices would be sustained at levels close to those for UFB services (to promote migration by households to FTTP. See Eisenach and Soria (2017).

[62] There is now some academic research on UFB adoption in Japan (and to a lesser extent Korea), where UFB infrastructure has been available for almost a decade. Research in Australia and New Zealand is at a very early stage, and there is very little data on UFB in Europe or the US at this point.

information and with evidence about the past which may have little relevance to the future.[63] The interaction between supply-side and demand-side measures certainly means that European policymakers cannot and should not wait until the UFB networks are fully deployed before turning their minds to the question of how to promote adoption (which many currently appear inclined to do).

'Demand aggregation'' measures

One important area for policymaking we have identified might be called 'collective action'. This has both an ex ante and an ex post form. The ex-ante form is what we have referred to earlier as 'demand aggregation'. This involves policies which bring groups of households together to commit to purchasing UFB services, either in return for a discounted price or to persuade a firm to rollout a UFB network in their area or in their building (when they would not otherwise do so).

We have already noted that such collective action may not be required to support the deployment of UFB networks, since the availability of public funds to subsidise UFB network deployment already substantially reduces the risk for private firms (although this does not mean we wish to discourage its use for this purpose). We have already expressed our concern that current State Aid arrangements for UFB network deployment may weaken the incentives of recipients of that Aid to promote adoption over their networks. We suggest that the Commission re-examine the current Broadband Guidelines to ensure that projects are only supported if they include demanding adoption targets which are consistent with the overall Digital Agenda and Gigabit Society targets, and which recipients of State Aid then have appropriate incentives to fulfil.[64]

However, the fact that collective purchasing arrangements may not be required as much in order to persuade firms to build UFB networks does not, in our view, mean that they could not still be employed to promote the adoption of UFB connections. On the contrary, we think European policymakers ought to think much more seriously about using collective buying arrangements to promote the mass switching of households from basic or fast to UFB networks that have already been built, just as such arrangements have been used in energy and other sectors to promote mass switching between suppliers.[65] In those other cases, the aim is to allow households to secure lower tariffs. In this case, the aim should be to encourage households to

[63] Shapiro p. 7.

[64] It is important to be clear: we do not oppose the use of State Aid to promote the deployment of UFB networks (i.e., as a supply-side measure). Our point is rather that State Aid might also be used to promote UFB adoption (i.e., as a demand-side measure). In contrast, we think demand aggregation measures should be considered to promote the adoption of UFB services, but that they may have a more limited role in supporting the deployment of UFB networks (although we would not exclude this). We consider State Aid and demand aggregation measures to be complementary policies, rather than substitutes for each other.

[65] There is now a growing literature on collective switching policies in energy markets, largely in relation to the application of such policies in the US and UK, see for example Waddams et al (2014] 'Who switched at the 'Big Switch' and why'.

switch to UFB networks, with the prospect of lower tariffs perhaps being one of the means of encouraging them do so.

We think collective purchasing policies would work well in the UFB context for many reasons. First, some interviewees told us that households are most likely to switch to UFB networks when they are already considering a switch of supplier and so are already prepared to contemplate the switching costs which often arise when switching to UFB. We were told that sometimes households are prompted to consider switching because their circumstances change – they move house, get a new job and so on – but householders also need to be prompted to consider switching. Forcing householders to decide – as the FCC did in the 1980s to promote switching between long-distance telephony providers – is not likely to be acceptable to European policymakers or consumers. But collective purchasing programmes could be used to prompt or 'nudge' householders to reassess their broadband requirements from time to time. Every year, for example, a 'UFB switching' programme could be run and householders would need to decide whether to participate (since they would not be obliged to). Such 'nudges' will be particularly important if there is otherwise uncertainty about when or whether existing services over the copper network are going to be withdrawn.

Second, the Commission also proposes that UFB connections be provided at public institutions, such as schools. We think this will itself promote UFB adoption amongst some households to some degree, but these community institutions could also provide the institutional and organisational focus around which to manage collective purchasing programmes. For example, once a school is connected to the UFB network, a service provider might be required to offer a collective purchasing arrangement to all parents of pupils at that school. This would reinforce the 'onboarding' properties which educational institutions already provide, and which the evidence suggests can be an important driver of household broadband adoption.

The obvious question arises as to why private providers of UFB services do not already promote such collective purchasing arrangements if they would serve to promote UFB adoption in the way we suggest. One response is that providers often do, but on an ad hoc basis and invariably before the UFB network has been built, rather than to increase adoption at a later stage. We understand, for example, the installation of UFB connections into a multi-dwelling unit will often only be undertaken once a significant proportion of tenants in the building have agreed to subscribe. The co-ordination of demand in these circumstances is done by the tenants themselves. We also know that UFB network operators, such as Virgin Media[66] and Gigaclear[67] in the UK, Reggefibre in the Netherlands, and, recently, Deutsche Telekom[68], have all used various types of demand aggregation programmes to determine where to build their UFB infrastructure and to accelerate adoption. The UFB networks that have been built by housing

[66] https://www.virginmedia.com/postcode-checker/results?postcode=RG47RW&uprn=310019917&addrSrc=2&nex=0
[67] https://www.gigaclear.com/postcode-checker/
[68] https://www.telekom.com/en/media/media-information/archive/fiber-to-the-home-dt-pushes-build-out-509334

associations or local municipalities in many Scandinavian countries seem to involve a significant element of informal demand aggregation by the relevant authorities.

However, the interests of a UFB network operator may not always be to maximise UFB adoption, but to maximise profits across all its assets. These may include returns from existing copper assets which they do not expect to decommission in the near term (see below). Promoting collective switching may produce some efficiency gains for the operator (for example, in the case of an individual multi-dwelling unit, the same installation team can connect several households in the same building in the same day and save costs by doing so), but it may also involve some complexity and costs (for example, demand for installations may be 'lumpy' if large numbers of consumers switch at the same time, making it difficult to meet customer expectations or to manage resources efficiently). Public institutions, such as local Government, may be much better placed to organise collective action in the community than network operators themselves.

Critically, of course, network operators may have little incentive to promote collective action if consumers stand to gain from it and operators stand to lose. Our aim is not to use collective action to increase buyer power, but to use it to promote adoption. Nonetheless, consumers may require and may expect to obtain some benefit by engaging in collective action which they would not obtain if they were to act alone.

Subsidies for those switching to UFB

When thinking about financial incentives for collective (or even individual) switching to UFB, it is important to remember the distinction which we proposed earlier in this section between measures which address budget constraints ('social tariffs') and measures which address willingness to pay. In this case, we are concerned with a large group of households who may otherwise be unwilling (rather than unable) to switch to a UFB connection. We have seen that there is some evidence that the main obstacle to switching is likely to be the costs of UFB installations that householders face (but which they avoid by remaining with the status quo), and that there is a low willingness to pay amongst many households who have yet to experience UFB services. However, we have also seen that there is evidence that UFB is an experience good and that willingness to pay may increase once a household is connected and/or that many households may be poorly informed about the capabilities of UFB networks, or indeed what they are.

We think these insights could inform the design of financial incentives to promote collective switching. One way this might be done is for households who participate in the collective purchasing programme to avoid the 'one off' charges which they would otherwise face. The installation of the UFB connection would be 'free' to the householder, with the costs being subsidised by the Government. This is the arrangement (although it does not rely on collective purchasing to qualify) which has been adopted in New Zealand, with impressive results. Alternatively, those participating in the collective purchasing scheme might be allowed to amortise any ‘one off’ fees over an extended period (perhaps 10 years), with public authorities underwriting the debt for the operators concerned. Such subsidies would be offered each time a collective purchasing programme was implemented, although the size of the subsidy might need to be reduced over time in order to discourage households delaying their decision until the next programme is run.

We recognise that policymakers are often reluctant to subsidise services when the lack of demand reflects a lack of willingness to pay rather than any inability to pay. There are many other details that arise with such schemes and other ways in which it might be structured. We identify three in particular:

I. Policymakers will need to ensure collective switching programmes are compatible with the promotion of retail competition. It may be, for example, that there is only one provider of UFB services in a particular locality at a particular time. A collective switching programme may allow that operator to capture all those households who wish to switch at that point, even if another operator might have been in a position to offer UFB services at some later point in time. This may present an issue, since policymakers may not wish to delay efforts to promote UFB adoption in the expectation that another operator may offer UFB services in the future but acting early may confer ‘first mover advantage’ and jeopardise competition.[69] To address this, collective switching programmes might be accompanied by conditions which require the network operator who benefits from such arrangements to ensure competitive provision of UFB services over its network – just as the existing State Aid broadband guidelines require the use of an ‘open access’ network in order to benefit from the provision of public subsidy.

II. Policymakers will need to consider how any subsidy would be applied between different operators if each imposes different switching costs on the households concerned, and the extent to which subsidies can be targeted (and hence minimised) between operators and/or between households. For example, a household switching from fast broadband over a VDSL network to UFB over FTTP may face costs arising from the installation of a completely new connection from the street, whilst another household switching from fast broadband over HFC to UFB over HFC may require no more than a software upgrade. Different households may also face different costs – for example, those living in MDUs may face different costs to those in individual properties, and there will be differences related to the density of different properties. At first glance, it seems likely that competition rules would require the provision of the same level of subsidy irrespective of the provider concerned, with the operator who faces lower costs then having the opportunity to either retain the difference or to share a portion of it with householders to encourage switching to its network rather than that of rivals. On the other hand, a question arises as to what level of subsidy should be offered. If

[69] Although it may equally promote network roll out by increasing the gains for the first mover.

competition is to be ensured then it will need to be sufficient to offset the switching costs of any available network.

III. As with many subsidies, consideration will need to be given to the incentives and interests of those who either have already switched to UFB services (and who are therefore unable to benefit from the subsidies which are offered under the collective switching programme) or those who do not switch under the current programme. The former may require some form of financial benefit (e.g. a share of the resulting scale economies which the operator obtains from the collective switching programme) if the programme is retain popular support, whilst the latter will need to be incentivised to participate rather than defer their decision in the expectation that further or better subsidies will always be available in the future.

We consider that all of these issues are capable of being resolved through careful design and our key recommendation for policymakers is that there appears to be a good case for adopting a UFB subsidy programme or programmes which is directed at getting as many households as possible connected to the UFB-capable network (by eliminating 'inter-technology switching costs'

We do not recommend that any changes are made to existing arrangements for the setting of wholesale prices for basic, fast or UFB products (at least until serious consideration is given to the issue of accelerating copper switch off – see below). Current arrangements in Europe ought to allow firms to promote UFB adoption. Nor do we think there is a good case for regulators to intervene directly to set the retail prices of either basic, fast or UFB products, except in the case of subsidies to promote collective switching that we have discussed above.

Social tariffs

We explained earlier that a proportion of European households will not subscribe to UFB services, not because they do not wish to or do not recognise the benefits of doing so, but because they cannot afford to. This group differs from those households who might participate in a collective purchasing programme, since they will be unable to afford the ongoing costs of having a UFB connection, even if the collective purchasing arrangements help them to overcome the initial switching costs.

We think it is likely, and desirable, that policymakers will eventually require that these households receive ongoing financial subsidies from Government to allow them to obtain UFC connections. We have noted that the proposed revisions to Universal Service scheme arrangements under the EECC envisage this. At the same time, we do not expect that this will or should be an immediate priority for policymakers seeking to promote UFB, in part because there are many other households who can first be switched to UFB at lower cost, and partly because the needs of these households may be partially met in future by technological developments, particularly in wireless technologies. Research will, however, be required to assess the likely costs of such schemes, and to identify those households who might require assistance.

Clarity on copper decommissioning

The 'ex post' aspect of the 'collective action' issue relates to switching which is required when the existing broadband network is decommissioned and all the remaining households are required to move to the UFB network. Here we think the setting of clear expectations as to when the existing network might be decommissioned and what households would be required to do in those circumstances might serve to influence current consumer behaviour. What appears to us to be the current high level of uncertainty amongst both operators and consumers about the future prospects of many existing broadband networks will, we suspect, discourage early commitment to UFB by householders since uncertainty of this kind generally tends to encourage consumers to delay purchases and avoid risks. The effect of uncertainty about the future of today's broadband networks and services on household adoption of UFB services is therefore another issue where we think further research would be desirable.

In order to obtain greater clarity on these issues, European policymakers will need to engage seriously on the question of whether, and how, copper decommissioning might advance its UFB adoption objectives and, if so, what measures would need to be in place for this to happen.

Other information measures

1. Greater clarity on the prospects of copper decommissioning – once a clear strategy is in place - is one information measure which we think might help households to make better informed decisions (or which might simply encourage them to make decisions, informed or otherwise) about when and whether to subscribe to UFB networks. However, there are many other measures which public authorities might consider. Examples include:
    a. **Better rules and regulations concerning the advertising of broadband network performance by the industry**, as we noted is being proposed in the UK by the Advertising Standards Authority and has been done in Australia. This is a market in which terms like 'broadband', 'superfast', 'ultrafast' 'gigabit', 'fibre' and 'next generation' have no clear or precise meaning today, and in which consumers have little or no understanding of metrics such as 'Gigabits', 'Gigabytes' or whether these refer to theoretical capabilities, actual average performance, or some other measure. Consumers can be forgiven for being reluctant to switch to new broadband services when they are so poorly informed about the relative performance of different network technologies or the capabilities of their existing services. This is an issue on which we think self-regulation by the industry itself is unlikely to be sufficient, and in which the relevant regulatory bodies ought to be much more engaged.
    b. **The disclosure of information about broadband network performance every time householders are making a purchasing or switching decision for which broadband performance is relevant.** The most obvious example concerns the listing and sales of properties – property websites and estate agents might be required (or

encouraged via their trade associations) to disclose data about actual broadband performance at the property (just as they are required to disclose information about energy efficiency, flood risk and other relevant features in many Member States). Similar considerations could arise when consumers are making significant purchases of new household goods which rely upon a broadband connection – for example, those selling TV sets might be required (or encouraged) to inform purchasers of both the recommended broadband capability required for the device (under normal conditions) and the actual broadband capability at their property. In both cases, retailers or agents would require access to an authoritative database which would hold details of broadband performance at individual properties or in postcode areas. Many telecoms regulators are already developing such databases, but Government action will be required to ensure that these resources are fully exploited by retailers across the economy as a whole.

Other regulatory measures

Our research has identified a number of other measures which policymakers might consider and which involve revisiting existing regulations which might present barriers to UFB adoption.

One relates to requirements in many countries that network operators obtain consents from landlords before installing new UFB infrastructure within a multi-dwelling unit (or a single property that is being lent to a tenant). Obtaining such consent is often time consuming and difficult, since the benefits of the UFB connection are enjoyed by the tenant, but the risk of damage to the property and other inconvenience is more likely to be a concern (i.e., cost) to the landlord.[70] A number of studies suggest that, as a result, UFB adoption tends to be higher amongst those owning their own home than amongst those who rent.[71]

The New Zealand Government has recently decided to tackle this issue by introducing legislation which would allow network operators to assume 'deemed consent' from the landlord if no objection is received within 15 days. Limitations are also placed on the grounds on which the landlord can object. Some Governments, including Spain and Korea, also require all new properties to install UFB connections (or the risers and equipment cabinets which would allow their subsequent installation) as a condition for granting planning permission. Both types of measures seem to us obvious ways in which Governments can reduce the costs of UFB network deployment for operators, and the costs of switching for consumers.

Another example where regulation may inhibit UFB adoption relates to the regulation of retail pricing by service providers. Current European telecoms regulation prohibits the conclusion of contracts of terms greater than 24 months, although the Commission proposes that Article 98 of the new EECC will allow longer terms for 'a separate contract to instalment payments for the

[70] Although research in the UK suggests that the landlord ought to be able to capture some of the benefits which their tenants obtain through higher rents and/or a higher property price, see Feasey.
[71] Hanson et al. p. 19.

deployment of a physical installation'). Although many households keep their broadband service with an existing network operator for far longer than this, we agree with the Commission that it may be desirable to minimise upfront switching costs by allowing householders and operators to amortise those costs over a much longer period of time – perhaps 10 or even 20 years. Sweden provides an example of where these arrangements are common because households are able to add the costs of connection to their mortgage (rather than their contract with the network provider).[72] This will need to be undertaken in a way which ensures competition – for example, the householder may be able/have a right to use their UFB connection to access a range of different UFB service providers. Policymakers should ensure that creative arrangements of this kind, to the extent that they might reduce switching costs to UFB, are not being inhibited by existing regulations (including those relating to the provision of debt to households to finance such arrangements).

In a similar vein, the bundling of UFB connections with other products is likely to help promote UFB adoption. We have seen how retailers in New Zealand bundle UFB products with new in-home devices or services, and the bundling of broadband with TV is a common feature of most markets. However, regulators often appear concerned that bundling may also be used to exclude competitors and are occasionally persuaded to impose restrictions on bundling practices. There may be cases where this is justified, but our view is that, in general, bundling of other products (including discounted mobile products) with UFB connections ought to be encouraged rather than deterred.

We summarise how our recommendations apply to the categories of household we have identified as follows:

[72] An important feature of the Swedish model is that whilst the household commits to a network operator for many years, it can readily switch between the providers of services over that connection. The Swedish market is therefore vertically separated in way which is not the case in other Member States (where the household may be required to switch network provider when they switch service provider).

All households	
• Establish EC-wide UFB adoption targets • Lower costs of broadband deployment (duct sharing, business rates, etc.) • Advertising standards for broadband performance • Improve broadband performance information at key trigger points: house purchase, consumer electronics purchases • Landlords presumed to consent to UFB installations in properties unless they object on specified grounds • Revisit State Aid broadband guidelines and include adoption targets	
Can't pay and won't pay	**Can pay but won't pay**
Exposure to UFB services outside of the home (schools, libraries) to improve willingness to pay Require UFB 'social tariffs' in the longer term	Exposure to UFB services outside of the home (schools, libraries) to improve willingness to pay Run a series of collective switching programmes with financial incentives to trigger UFB adoption Facilitate contracts enabling long term financing of new UFB connections Examine whether establishing a clear timetable for copper decommissioning would accelerate adoption Publish data to build confidence around switching (including the new installation process)
Can't pay but will pay	**Can pay and will pay**
Require UFB 'social tariffs' in the longer term	No basis for public intervention

4.7. Summary of recommendations

Policymakers should:

a. Set adoption as well as coverage targets for UFB at both European and national level.

b. Explore the use of collective purchasing programmes, organised and administered by local authorities or non-profit bodies, to promote collective adoption of UFB in areas where UFB infrastructure has already been built (as well as to promote deployment in areas where it has not). Such schemes should:

   i. Be repeated, perhaps on an annual basis, until adoption targets are met;

   ii. Involve the provision of public subsidy (in full, in the form of loan guarantees or in other forms) to reduce (and perhaps eliminate) inter-technology switching costs for those signing up;

   iii. Be aligned, where possible, with the provision of UFB connections to public institutions in the area;

   iv. Be designed to safeguard competition between operators to the extent possible, consistent with the fulfilment of adoption targets;

   v. Be technology neutral, but target subsidies to the maximum extent feasible in order to minimise overall costs.

c. Revisit the State Aid guidelines on broadband networks in order to ensure that recipients of public funds are appropriately incentivised to meet demanding UFB adoption targets as well as demanding roll out targets. Ensure that 'clawback arrangements' for funds do not discourage firms from exceeding adoption targets at all stages of the project.

d. Anticipate the future need to develop, and for Government to fund, UFB 'social tariffs' to support those households who are unable to fund the ongoing costs of a UFB connection. This involves early assessment of the likely costs of implementing such schemes, and the number of households likely to be affected.

e. Consider whether having a timetable for the decommissioning of the existing copper network would serve to reduce uncertainty and so promote UFB adoption as well as whether the decommissioning of the copper network should be regarded as promoting UFB adoption or being the consequence of it. If a timetable were required, then careful consideration would need to be given to arrangements which would be necessary to achieve this and the implications for other policy objectives.

f. Require all providers of broadband services (basic, fast and UFB) to adhere to standard terminology and measures when describing the characteristics of their network infrastructure and the services they provide over them and to comply with approved codes in relation to the advertising of broadband speeds.

g. Require national regulators to assemble data on the actual performance characteristics of broadband networks at the most granular level possible, and preferably at each individual address. Make this data set available to any third party under a free licence. Encourage or oblige those selling houses and household consumers goods which rely upon broadband connections to communicate the relevant performance data as part of the sales process of these (and other) goods for which broadband performance is relevant.

h. Require national regulators to assemble data on the % of UFB installations that are completed without customer complaint and in accordance with industry standards (if such standards exist). Publicise the results, identify best practice, and engage with operators who are failing to meet expectations.

i. Remove any existing regulatory restrictions which might prevent UFB network providers from allowing households to amortise the costs of their UFB connection over an extended period of at least 10 years. Encourage financial institutions, including mortgage lenders, to lend against the provision of UFB connections if the network operators themselves fail to do so, or consider the use of public finance (e.g. allowing non-recurring UFB costs as deductions from property taxes or income taxes) to underwrite the debt.

j. Ensure that tenants in rented properties are not denied access to UFB connections by allowing network operators to assume consent from landlords unless objections are received with a specified timeframe. Consider the introduction of further measures if landlords were to seek to capture an unreasonable share of the benefits of UFB through immediate rent increases.

Researchers should undertake further research on:

i. Econometric analysis of the variables which determine ‘adoption ratios’ in fast broadband and UFB.

ii. Whether (and why) WTP for UFB differs between urban and rural areas.

iii. Whether uncertainty about the future of existing copper networks inhibits adoption of UFB services.

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Annex A: Case study on New Zealand and Australia

New Zealand

Operators in New Zealand began deploying 'ultrafast broadband' networks using FTTH technology in 2012, following a decision by the Government to improve the country's broadband performance (which had previously ranked at around average amongst OECD countries). As a result, a Government entity, Crown Fibre Holdings, became a significant investor (through the provision of both equity and debt) in the four companies that are today responsible for the deployment of the new 'ultrafast broadband' or UFB network. Chorus, the network division of the former integrated incumbent, Telecom New Zealand, is the most significant of these. The initial plan was to pass 75% of all New Zealand households ('UFB1') by 2020, with a further 9% of households subsequently being added to the plan for completion by 2024 (UFB2). As of March 2017, around 75% of the UFB1 households had been passed.

An important condition of Government financing was that the network operator could not participate in the retailing of UFB services to households, with the result that Telecom New Zealand was forced to structurally separate itself (into Chorus and Spark, a separate retail business) in order to participate in the programme. Chorus (and the other Local Fibre Companies) provides wholesale FTTH services to a significant number of independent retail service providers, who in turn retail those services to householders. Sales began in earnest in 2014. The agreement between Chorus and the Government requires Chorus to undertake some promotional activity (for example, when construction is underway) in order to promote FTTH technology to customers, although there is some ambiguity between the scope of Chorus' activities and responsibilities and those of the retailers themselves. Since it does not participate directly in the retail market or engage in sales, Chorus has sought to position itself as an independent objective source of information about UFB services for consumers.

Adoption of FTTH products by New Zealand households has been comparatively high. As of March 2017, average penetration was around 33% of all households passed. In addition, the rate of adoption within a new build area has accelerated over time – deployments in 2013 or 2014 might have required 24 months or more to achieve penetration levels of 40%, whilst deployments in 2016 have achieved penetration levels above 40% within 6 months. There is no requirement for households to commit to purchase prior to deployment of the network (i.e. by means of demand aggregation schemes) since the deployment schedule is predetermined by the agreement with Crown Fibre Holdings. Sales are then made by retailers once the network has been deployed.

Chorus reports that adoption is widespread across all socio-economic groups, although (consistent with other evidence we have seen) higher income households with children tend to be early adopters. An important factor for these households appears to be the avoidance of conflict between members of the household, all of whom wish to use the broadband connection at the same time (and who may degrade each other's experience as a result). Other important triggers for adoption appear to be the initial purchase of Netflix or other TV streaming services (which may appeal to lower income households who do already subscribe to pay TV), a new TV set or a change of job or income. Chorus notes that different householders will have different considerations, each of which must be addressed. A significant proportion of households, for example, value reliability of the connection above headline speeds.

Retail service providers in New Zealand have often sought to promote FTTH, and to differentiate their own offers, by bundling the subscription with devices such as Apple TVs, Xboxes, or subscriptions to streaming services. Chorus reports that retailers initially promoted a 30 Mbps FTTH product – in March 2015 75% of all FTTH connections were at 30 Mbps and only 24% at 200 Mbps (with negligible numbers at speeds above this). However, Chorus found that a 30 Mbps FTTH connection did not offer a significant improvement in customer experience (and could on occasions lead to a worse experience) relative to the existing VDSL products which Chorus offered (and which already supported speeds of 30-50 Mbps). As a result, Chorus reduced the wholesale price differential between 30 Mbps and 100 Mbps products to $2.50, allowing retailers to offer 100 Mbps products at an additional retail cost of only $5-10 (relative to the 30 Mbps product). Today, many retailers do not offer a 30 Mbps product at all and offer a 100 Mbps entry level FTTH product, which is sold at a price at or below the existing VDSL products. For example, Vodafone New Zealand's 30 Mbps UFB product with unlimited data volumes is sold at $90/month, whilst its VDSL and ADSL products (also with unlimited data volumes) both sell at $95/month. Vodafone's 200 Mbps UFB product sells at only $70, but requires a 24 rather than 12 month contract.[73] Spark similarly prices its unlimited ADSL, VDSL (which it describes as up to 70 Mbps) and 100 Mbps UFB products at the same price of $95 per month.

At the same time, adoption of VDSL is also increasing in New Zealand amongst those who are not connecting to the FTTH network (there were 224k VDSL connections as of March 2017, compared to 260k FTTH users), and Chorus continues to operate its copper network alongside the new FTTH network (although its agreement with Crown Fibre Holdings restricts further investments being made in the copper network). There are currently no provisions or plans for the retirement of the copper network, although the Government is proposing to adopt new legislation which will govern the wholesale pricing of both the copper and FTTH networks after 2020 (in the former case, prices will be deregulated, in the latter, the 100 Mbps 'anchor product' will be price capped, as will overall FTTH revenues).

As of March 2017, over 90% of all new FTTH connections were at speeds of 100 Mbps (or more) and 56% of all FTTH users are now subscribing to 100 Mbps products. Adoption of products of 200 Mbps or more is still relatively limited (at around 10% of all connections) and does not

[73] https://www.vodafone.co.nz/broadband/ultrafast-fibre/?data=unlimited&speed=fastestUFB100&phone=yes&tv=skytv&onaccount=no, as of 28/7/17, excludes home phone.

appear to be growing significantly at this stage. Chorus believes this may be because retailers are currently focussed on the acquisition of new FTTH customers and have yet to devote significant efforts to the 'upselling' of existing customers. Chorus' 1 Gbps wholesale product is priced at around 50% above its 100 Mbps product (at $60 and $43/month respectively).

Although the New Zealand Government has played a significant role in promoting the deployment and supply of FTTH, it has done relatively little to promote adoption, leaving this to Chorus, the other LFCs and the retailers. Perhaps the most important intervention has been the requirement, in the agreements with Crown Fibre Holdings (CFH), that households must not pay an initial connection charge in order to connect to the FTTH network. This, alongside the pricing structure of FTTH products (which CFH as a shareholder must also approve), significantly reduces the initial costs of switching to FTTH. Chorus have themselves also decided to install an 'FTTH-ready modem' in every household which takes a VDSL service, thereby reducing the costs of subsequently switching to FTTH.

The Government did require Chorus to deploy FTTH into schools and other public institutions at an early stage of the roll out, but the administration of education in New Zealand is highly decentralised and some schools have embraced new technologies enthusiastically, whilst others have not. Familiar concerns about the costs of new equipment, staff management of IT resources and general digital literacy are all features of New Zealand schools, as they are in many other countries.

The Government has recently agreed to amend legislation so as to allow Chorus to assume 'deemed consent' from the owners of land and property when installing connections. This means that the property owner or owners (often multi-dwelling units are owned in common) is deemed to have granted Chorus (and the other LFCs) all necessary legal consents in the absence of objections to the contrary (which must be made within 15 working days). Objections could only be made on certain grounds, such as disputes as to ownership rights or that the installation would cause a material detriment to the value or enjoyment of the property. Chorus anticipates that this will reduce the delay and costs in obtaining consents from landlords prior to installation, and the number of orders which subsequently have to be cancelled. In the 2015 RIA, it was reported that at least 25% of all orders for properties requiring such consents had, subsequently, to be cancelled.[74]

Australia

The Australian Government established a wholly owned entity in 2009, now known as 'nbn co' (National Broadband Network) to deploy an FTTH network to the vast majority of Australian households. A change of Government since 2009 has meant that the company is now pursuing a 'multi technology strategy' which involves the provision of wholesale broadband services (of at

[74] http://www.mbie.govt.nz/info-services/sectors-industries/technology-communications/communications/broadband-mobile-initiatives/telecommunications-infrastructure-deployment/property-access-telecommunications/land-access-for-telecomms-2015-summary-of-submissions.pdf/at_download/file

least 25 Mbps to all and at least 50 Mbps to 90% of households), using a mixture of FTTH, FTTN, HFC, fixed wireless and satellite technologies. As of March 2017, nbn had connected 2 million households, of whom 1 million were connected to the FTTH network, 675k to FTTN and the remainder to satellite, HFC and fixed wireless networks. The company announced in July 2017 that it had completed half of the network build, passing 5.7 million homes (with 2.24 million active users).

As with Chorus in New Zealand, nbn provides wholesale services only and relies upon retail service providers such as Telstra and Optus to drive adoption. However, the Government has also entered into an agreement with Telstra which requires the transfer of existing copper assets to nbn, in return for payment, so that nbn can then decommission the copper network where it makes sense to do so (or use it to provide FTTN services if that is the preferred option). It is therefore envisaged that in areas where FTTH is available, all households will be obliged to migrate to the FTTH network 18 months after activation of the new network. This process is still in its early stages, but it is reported that around 350k households have been notified to date.

Although about 50% of homes passed have migrated to the nbn network, there is concern that adoption of ultrafast broadband products remains low. In March 2017, 29% of connections were at 12 Mbps and 52% at 25 Mbps. Only 14% were at 100 Mbps (which some retailers do not appear to offer at all to consumers). There are different views as to why this situation arises, but disputes between nbn co and the retail service providers about the wholesale pricing of services are generally considered to be at fault. In addition to a per household connection charge or AVC, nbn co applies a variable 'connectivity virtual circuit charge' or CVC which will determine the speed which a retail service provider can promise to deliver to any particular group of households (who share that circuit). Retail service providers complain that these charges are much too high and discourage sales of higher speed products which would require greater CVC capacity to support them (or which would otherwise fail to provide the service that is promised). In 2016, nbn introduced a series of industry discounts which led to a reduction in prices for all wholesale customers, reducing the effective price per Mbps from $17 to $15. In mid-2017, nbn introduced a further discount scheme under which individual retailers can obtain discounts in relation to their own sales.

It is not clear whether these changes to the wholesale pricing structure will induce retailers to promote higher speed broadband products or will otherwise encourage the greater adoption of such products by Australian households. It is possible that some retailers are holding back in the hope that the low take-up of higher speed products will prompt the Government or the regulator to intervene and require nbn to make further adjustments to its wholesale pricing arrangements. It is difficult to see how adoption levels of ultrafast broadband will improve in Australia until these matters are resolved, although other commentators suggest that the current Government is reluctant to recognise the write down which a significant reduction in CVC pricing at this stage might imply.

It might also be noted that adoption of standard broadband in Australia was generally slower than in comparable countries, with penetration of broadband (and migration from narrowband) consistently behind the UK (and US or Canada)[75] at least until 2003. In that year the Government's Broadband Advisory Group proposed the creation of a national broadband strategy (and implementation group) and some funding was allocated to support demand aggregation programmes, in particular to fund deployment of higher speed broadband in regional areas whilst maintaining prices comparable to those in urban areas.[76] A number of Government enquiries and reports, including 'Broadband Blueprint' in 2006 and successive Regional Telecommunications reviews (which are undertaken every 3 years in Australia), have made similar proposals (including support for e-Learning programmes in schools), but concerns about supply-side availability of broadband in regional and rural Australia has been a consistent feature of the debate for many years, with much of the public funding being directed at regional subsidy programmes such as the $1.1bn 'Connect Australia' programme of 2005. Some have argued that the focus on narrowing regional variations reflects the federated nature of the Australian Government. Others criticise the Federal Government for failing to implement many of the recommendations which have resulted from the various enquiries referred to above.

Middleton and Chang (2007) suggest that adoption of broadband in Australia may also have been constrained by usage caps which have been imposed on users.[77] In the past, this may have reflected the comparatively high costs of trans-Pacific internet connectivity, as Australian users sought to access content that was hosted outside of Australia (although similar considerations applied in New Zealand). Many of these constraints have since been removed, either through the local hosting of content or through large reductions in the unit costs of network capacity, but popular conceptions amongst Australian households about the need to 'ration' their broadband usage may still remain. In this sense, there may be some degree of 'path dependency' as user perceptions and habits from an earlier broadband era persist, even if the barriers themselves have been largely removed in the meantime (although we are not aware of any research which has considered this point).[78] We note that Telstra currently retails nbn products with monthly usage caps in place, although other providers do not. Accan reports that early nbn adopters were much more aware of the usage caps on their existing broadband offers than upon the speed. It attributes this to the way in which broadband services are marketed in Australia, with providers focussing on the level of caps rather than the speed of the connection.

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[75] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.470.5729&rep=rep1&type=pdf.

[76] Lovell and Ryston Pratt, 2004.

[77] Middleton, Catherine and Shanton Chang (2007). The Adoption of Broadband Internet in Australia and Canada. *Handbook of Research on Global Diffusion of Broadband Data Transmission*. Harrisburg, PA: Idea Group.

[78] Similar claims have been made to the authors in the past to explain the large differences in calling patterns between US and European telephony consumers, with the former being accustomed to 'free local calling' (i.e. zero marginal cost pricing) for many years.

Annex B: Case study on Japan

From the start of the century, Japan followed a two-pronged strategy to increase the penetration of fast broadband and the use of IT. First, on the broadband supply side, the government coordinated and supported the roll-out by private actors. It kept the regulatory burden on fibre lower than on the unbundled copper loops, gave incentives for investment, and created a framework for sustainable infrastructure competition. An important factor in the promotion of the latter was the permission for aerial deployment of fibre, resulting in much lower deployment cost (WIK 2008, Gentzoglanis and Henten 2010). The government itself would roll out fibre in areas that private providers would not cover, in order to reduce the digital divide. As a result, the prices of broadband connections were low as compared to other countries. In 2000, 43% of Japan's territory was covered with fibre, and more than 60% of cities chosen by the government and prefecture capitals (Japan 2002), with service starting in 2001.

Second, a series of demand-side measures were introduced to promote the uptake and usage of fast broadband connections, such as IT access at schools and public places, e-government, e-commerce, and education for the many sides of an IT-based economy.

These policies were formulated in a sequence of national IT strategies. The E-Japan strategy (2001-2005) formulated as goals:

- Establishment of an ultra-high-speed network infrastructure and promotion of competition.
- By 2005, 30m households with access to fast BB, 10m with access to ultrafast BB.
- By 2002, facilitation of electronic commerce through legal framework and design of market rules for safe participation.
- By 2003, electronic government, i.e. most processes available in digital form.
- Nurturing of high-quality human resources:
    - Improved information literacy by having broadband in schools and public sites.
    - Education of IT instructors, technical experts, teachers, and content designers.
- Predicted "lifestyle changes" due to public broadband:
    - Electronic government and electronic municipalities (action plan for almost all of central and local government services to be online)
    - Telemedicine and remote nursing care
    - Virtual universities; virtual art galleries and museums
    - Safety and disaster information

In 2006, the next 5-year strategy was formulated, which seems to be referred to by various names: "IT New Reform Strategy", "Next Generation Broadband Strategy 2010", or u-Japan strategy (2006-2010). The focus this time clearly seems to have been on supply-side measures, as the goals were formulated explicitly as:

- "World's most advanced IT nation in 2010"
- Full coverage with broadband
- Coverage of 30Mbit/s+ to 90% of households
- Government promotes provision of fibre to regions without broadband

We have not been able to find any study attempting to measure the size of the effects of the different demand- or supply-side policies adopted by the Japanese government – or which policies had any effect at all. Thus, there is no information about whether any specific policy actually caused the observed outcomes, and which policies worked and which did not. It is certain that for a long time Japan has been one of the world leaders of fibre broadband rollout. The OECD Broadband Statistics of December 2006 already state:

> "Japan leads the OECD in fibre connections directly to the home with **7.9 million fibre-to-the-home subscribers** in December 2006. **Fibre subscribers** alone in Japan **outnumber total broadband subscribers in 23 of the 30 OECD countries**." [boldface in the original]

OECD (2008) reported that in July 2007, Japan had a penetration of FTTH/building of about 16%, while with FTTB Korea had 19% and Hong Kong 21%. Already in 2007, subscriptions with 1Gbit/s were available, ten times the bandwidth in other countries including Korea (though there is no information about pricing uptake of these offers). While for some time the largest share of connections was copper ADSL, in recent years ultrafast fibre connections have taken the lead and the share of ADSL is actually decreasing. EC (2016b) reports that the share of fibre in all broadband subscriptions in Japan exceeded 70%, the highest share in the world (the OECD average was below 20%).

A related issue is whether Japan's high penetration and usage of ultrafast internet had any effect of the country's attempts to get out of the period of economic stagnation that started in the 1990s. While the broadband policies themselves may be a result of this prolonged crisis, there does not seem to be any evidence that they had a marked effect on the economy as a whole.