The drivers of network deployment for the gigabit age

Governments around the world are focusing their efforts on improving digital connectivity, in particular on increasing the availability and take-up of very high-capacity networks, such as fibre and 5G. While public subsidies are made available for remote, hard-to-reach areas, it is the private sector that is expected to meet the bulk of official objectives. Against that background, it is important for policymakers to understand what spurs high-capacity network deployment.

To shed light on this issue, we analyse data on ultrafast broadband (UFBB)[1] and full fibre (FTTP) coverage in the UK at a local authority (LA) level. We find that both cost factors (such as population density and rurality) and demand-side characteristics (such as the share of the working-age population) affect UFBB coverage. While our study is confined to the UK, similar analysis could assess the drivers of fibre deployment in other markets.

The push for deploying full-fibre broadband infrastructure

There has been an increasing push for investment in full fibre (FTTP) broadband across the globe in recent years. This reflects a broad consensus among policymakers that expanding high-speed broadband infrastructure is a driving force of economic growth. Commonly cited benefits include unlocking access to innovative services, economy-wide productivity improvements and enhanced labour force participation.[2]

While the UK compares favourably with other countries in relation to coverage of superfast broadband (defined as offering speeds in excess of 30 Mbit/s), it has long been perceived as a laggard in full fibre. According to Ofcom, only around 3m homes in the UK (around 10% of the total) currently have access to full-fibre infrastructure[3]. By comparison, in July 2018 European countries with the highest levels of full-fibre household coverage were Latvia (88%), Spain (77%), Sweden (72%) and Portugal (70%).[4]

In the UK, BT accounts for the majority of homes covered (around 2m), though a number of alternative fibre network builders have emerged in recent years, including Gigaclear, Hyperoptic and Cityfibre. It is also worth noting that Virgin Media's ultrafast cable TV network is available to around 50% of the country and, while not as future-proof as full fibre, is capable of offering gigabit speeds (i.e. much faster than BT's copper network).

1 Ultrafast broadband (UFBB) networks are defined as those that are capable of delivering speeds of at least 300 Mbit/s. UFBB networks include cable/ DOCSIS and full fibre (FTTP). In the future they might also include 5G mobile networks.

2 https://researchbriefings.files.parliament.uk/documents/CBP-8392/CBP-8392.pdf; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf;

3 Ofcom, Connected Nations 2019, 20 December 2019, data collected in September 2019.

4 European Commission, Broadband Coverage in Europe 2018, 31 October 2019.

Ambitious official targets for high-capacity networks' coverage

In an effort to boost fibre deployment, governments have set ambitious roll-out targets. For example:

- The European Commission's objective for a European Gigabit Society envisages that by 2025 all schools, transport hubs and main providers of public services should have access to internet connections with speeds of 1 Gigabit per second. In addition, all European households, rural or urban, should have access to networks offering a download speed of at least 100 Mbps, which can be upgraded to 1 Gigabit.[5]
- Similarly, the UK government has set a bold target to deliver nationwide gigabit-capable coverage by 2025. Since the gigabit-capable standard encompasses existing cable infrastructure (and potentially also 5G mobile services), it is less stringent than ubiquitous full-fibre coverage. However, this target would still require a roll-out rate of around 2m homes per year between now and 2025, including in the most remote and hard-to-reach areas of the UK.

While some public subsidies are being made available, governments in Europe continue to rely on the private sector to deliver the lion's share of the investment required to reach these ambitious targets. Therefore, it is important to understand what the main drivers of ultrafast and full-fibre deployment are.

The drivers of fibre deployment in the UK

The case for commercial fibre deployment might depend on a range of factors, such as differences in costs, demand conditions and the degree of competition. For example, fibre networks are more likely to be deployed in densely populated urban areas, where roll-out costs tend to be lower. Parts of the country with high demand/ higher willingness to pay are also more likely to benefit from high-speed network coverage, other things being equal. While we do not observe customers' willingness to pay directly, it can be inferred from average income and other socio-demographic characteristics (e.g. the share of working-age population vs. retired population).

The emphasis placed on each of the above factors will vary from operator to operator depending on their business model. For example, Hyperoptic has sought to maximise economies of scale by targeting multiple dwelling units in urban areas. Gigaclear, on the other hand, appears to have focused on underserved but relatively affluent areas where population density is lower but willingness to pay for fibre may be higher.[6] In short, the dynamics of fibre roll-out are complex, so predicting which areas are likely to see investment soonest is not straightforward.

A recent study by Ofcom on the determinants of fixed (and mobile) coverage in the UK provides some insight into the relative importance of various drivers of network investment. The study used statistical analysis to assess the extent to which regional variations in the coverage of BT's fibre-to-the-cabinet (FTTC) network – the copper-fibre hybrid network that BT uses to offer superfast services – can be explained by variations in supply- and demand-side factors. Ofcom found that significant factors explaining FTTC coverage included population density, local demographics (the affluence of an area and the percentage of residents of working age) and the speed of standard broadband (i.e. the alternative product). However, Ofcom did not analyse what drove ultrafast and full-fibre (FTTP) coverage, which are more relevant to the government's latest target of "*delivering nationwide 'gigabit-capable' coverage by 2025*".

To probe further the various determinants of the business case for rolling out fibre, we have conducted our own analysis. Given that fibre deployment is still in its relatively early stages in the UK, and has been pursued not only by BT but by a mix of alternative providers testing divergent models, it is challenging at this point to discern clear trends that can be extrapolated. Therefore, we have also performed a broader analysis which looks at the driving forces of ultrafast coverage – that is, cable as well as full-fibre coverage. Given that the cable network was also deployed on a commercial basis (albeit in the 1980s and 1990s), and was subject to similar supply and demand factors, this analysis

[5] https://ec.europa.eu/digital-single-market/en/policies/improving-connectivity-and-access

[6] https://app.ft.com/cms/s/e4e63bbc-fd4a-11e3-96a9-00144feab7de.html

should provide some insight into what will motivate future fibre roll-out (or new high-capacity network roll-out)[7].

Demographics drive ultrafast broadband coverage

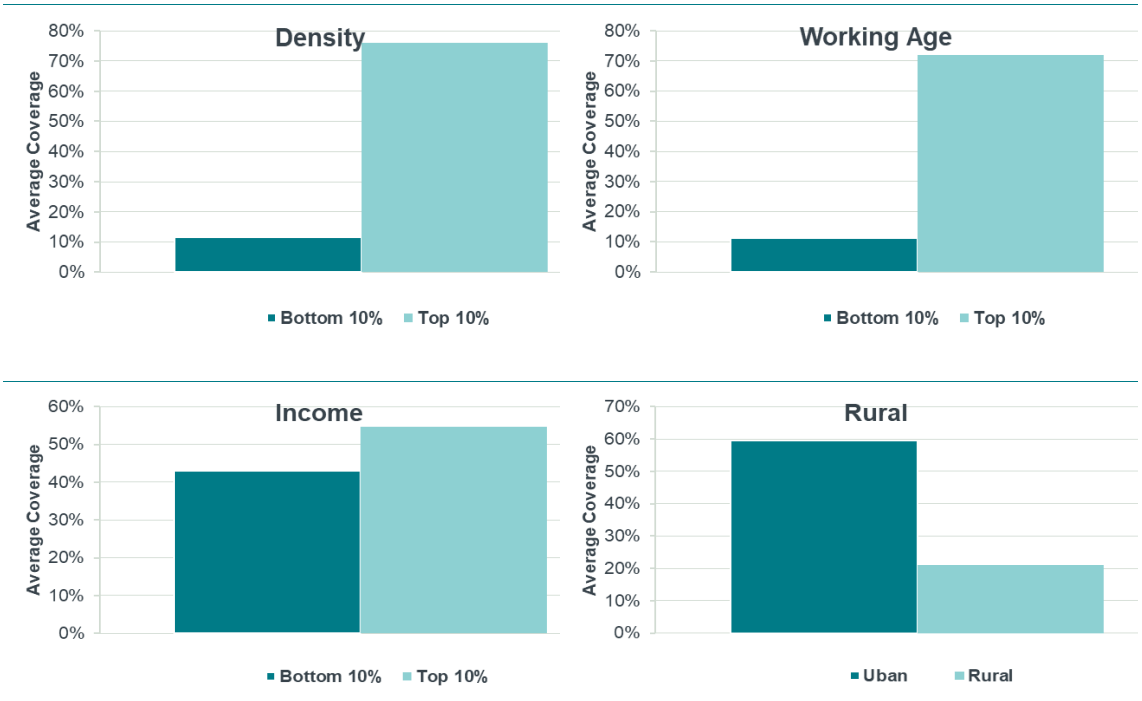
In our analysis, we use publicly available data at a Local Authority (LA) level.[8] UFBB coverage varies greatly. It is nearly universal in some areas, but very low in others.

We expect the same factors highlighted by Ofcom in its FTTC analysis to influence the extent of ultrafast broadband coverage:

- **Population density** – higher population density is likely to lower network roll-out costs since providers can spread their fixed costs across a larger customer base;
- **Working-age proportion** – A higher share of customers of working age could fuel demand for high-speed broadband services;
- **Average income** – higher income could spur demand for ultrafast broadband, as affluent consumers are more likely to be willing to pay a premium for these services;
- **Rurality** – network roll-out costs are likely to be higher in the countryside because of difficult terrain or the need to lay cables over long distances.

These relationships are illustrated in Figure 1 below, which shows a simple graphical analysis of average UFBB availability against the bottom 10% and top 10% of LAs based on population density, working-age population and average income. Figure 1 also shows average UFBB coverage for rural and urban parts of Britain. Urban areas and those with high population density, high average income and a high working-age population share are likely to have better UFBB availability.

Figure 1 Comparison of average UFBB availability between the top and bottom 10% of LAs, by factor



Source: Frontier Economics

[7] We note that our dataset reflects the current drivers of UFBB deployment, whereas the roll-out of cable primarily took place in the 1980s and 1990s. However, we consider it reasonable to use current values as a proxy for deployment of the cable network as demand and cost factors (e.g. the proportionate size of the working-age population) are unlikely to have changed materially in the interim.

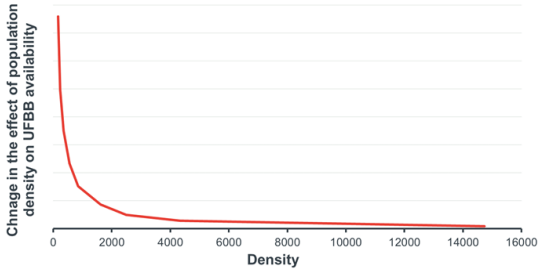
[8] Data on the availability of ultrafast broadband are from Ofcom's Connected Nations 2019 report. Data on local demand and supply factors are from the ONS. Our dataset covers all of Great Britain except Hull but excludes Northern Ireland due to data limitations..

Note: Graph shows average UFBB availability for areas in the top and bottom 10% of population density, mean income and working-age population. Graph also shows the average UFBB availability for urban and rural areas.

However, given that there are several driving forces behind UFBB coverage, it is a challenge to isolate the impact of each demand and cost factor based on a simple graphical analysis. For example, while a densely populated area might enjoy ready access to ultrafast services, this could also be due to its having a larger working-age population. Econometric regression techniques are better suited for this purpose, as they allow us to assess the impact of individual factors while also taking all other factors into account.

The results of the regression analyses are outlined in Figure 2 below. We find that population density, rurality and working-age population share are indeed significant drivers of UFBB availability.

Figure 2 Summary of regression results

Demand / Cost Factor	Regression outcomes
Population Density	A rise in population density is associated with a rise in UFBB availability at the local authority level. This effect is stronger in areas with low population density than in areas with high population density (i.e. there are diminishing returns to population density). For example, an increase in population density by 100 in a low population density area (1000 people per km^2) can be associated with an increase in the number of households that can access UFBB in that area by **1** percentage point. However, a similar increase by 100 in a high population density area (8000 people per km^2) can be associated with a smaller rise of **0.1** percentage points. The graph below shows the change in the expected effect of an increase in population density on UFBB availability – we can observe that the effect diminishes over higher values of population density. 
Income	Mean income does not have a material impact on network availability for the sample as a whole, but has a positive effect if London is excluded.
Working Age Population	A rise in the proportion of working age population is associated with a rise in UFBB availability. On average, a Local Authority that experiences a increase in the proportion of working age by 10 percentage points (e.g. from 60% to 70%) is associated with an increase in UFBB availability by **14.3**% points.
Rural	Network availability in rural areas is lower by **14**% than urban areas on average

Source: *Frontier Economics*

Note: *Regression was run with population density expressed in natural logarithms. Regional effects were included in the regression but these results are not reported for simplicity. Regression was run with heteroscedastic robust standard errors.*

While average income does not have a material impact on UFBB coverage overall, it does become significant if London boroughs are excluded from the analysis. Excluding the capital city, an increase in income is associated with a positive change in UFBB availability. This suggests to us that the relationship between UFBB coverage and income is complex and that further, more granular analysis is needed to understand it fully. Moreover, other factors could

be at play but are not currently taken into account due to data limitations, e.g. the cost of civil engineering works and competition from other networks.

Unlike for UFBB networks (which include both cable and fibre networks), we do not find a statistically significant relationship between fibre (FTTP) coverage and any cost or demand-side characteristics at this stage. This appears to be due to the fact that it is still early days for FTTP deployment. Moreover, fibre networks are being rolled out by multiple providers with different deployment strategies. For example, Hyperoptic and City Fibre are concentrating on densely populated urban areas, while Gigaclear appears to have focused on underserved but relatively well-off parts of the countryside. As a result, it is not possible at this stage to establish a clear relationship between the extent of fibre coverage in a local area and that area's characteristics. However, as operators continue to invest in full fibre, we expect that over time a pattern will emerge that will be similar to the one currently observed for UFBB networks.[9]

Policy implications

While our analysis is specific to the UK, similar techniques could be used to assess what is spurring fibre roll-out in other markets. In particular, it could be used by policymakers to identify areas which are likely to benefit from commercial fibre deployment and those which might need taxpayer subsidies or other forms of public intervention. Being in a position to evaluate the relative importance of different drivers of fibre deployment should help policymakers to develop targeted interventions to facilitate rollout and to stimulate demand.

[9] Our analysis can be further extended by including the impact of competition (e.g. presence of cable) and the quality of alternative broadband products on the extent of full fibre coverage. The analysis can also be carried out at a more granular level

Yulia Kossykh
yulia.kossykh@frontier-economics.com

Jose Maria Rodriguez
jose.maria.rodriguez@frontier-economics.com