Superfast Broadband Programme: Synthesis report

Final report

Contents

Executive summary

Ipsos UK was commissioned by Building Digital UK (BDUK), an Executive Agency of the Department for Science, Innovation and Technology (DSIT)[1] in October 2021 to undertake an evaluation of the Superfast Broadband Programme. The Superfast Broadband Programme was announced in 2010 in response to concerns that the commercial deployment of superfast broadband infrastructure would fail to reach many parts of the UK. In June 2010 almost 3 million homes and businesses did not have access to broadband speeds of at least 2Mbps. In November 2011 (the earliest data that is available), superfast broadband connections were available to 58 percent of premises in the UK. The Government established the Programme to fund network providers to extend provision to areas where deployment was not commercially viable, on the expectation that doing so would result in economic, social and environmental benefits.

This evaluation focuses primarily on contracts awarded under Phase 3 of the Programme, those contracts awarded between 2016 and 2020.

Evaluation objectives

The aims and objectives of the Superfast Broadband Programme evaluation focussed on four main evaluation questions:

- **Question 1:** What are the outcomes of the scheme?
- **Question 2:** How has the behaviour of individuals / organisations changed for these outcomes to come about?
- **Question 3**: How effective and efficient has the delivery of the Programme been?
- **Question 4:** Was the investment cost effective?

Evaluation methodology

The evaluation used a mixed methods approach, which included quasi-experimental evaluation approaches to establish the impact of the Programme, and primary research and thematic analysis to explore how the Programme and broadband connectivity more widely has impacted upon public service provision. The evaluation design was informed by the National Broadband Scheme (NBS) evaluation plan, Superfast Broadband Programme and the previous evaluation of the Superfast Broadband Programme.[2] The evaluation approach used built upon the requirements in the NBS evaluation plan and enhanced the quality, coverage and robustness of the findings from the previous evaluation of the Superfast Broadband Programme. Alongside the approaches detailed in the NBS evaluation plan and in the previous evaluation of the Superfast Broadband Programme, further methodologies were developed by the research team and BDUK, to explore the impacts of the Programme on environmental outcomes, self-reported wellbeing and the impact on public service delivery.

[1] BDUK is formerly an Executive Agency of the Department for Digital, Culture, Media and Sport (DCMS)
[2] https://www.gov.uk/government/publications/superfast-broadband-programme-state-aid-evaluation-report-2020

Programme outcomes

The key outcomes for the changes in broadband coverage because of the Superfast Broadband Programme are:

- **Impacts on superfast coverage:** Subsidised coverage through Phase 3 of the Programme led to a significant positive impact on the availability of superfast and gigabit capable broadband services by the end of September 2021. Subsidised coverage increased the share of premises in the programme area able to access superfast speeds by 41 to 47 percentage points, and the share of premises with gigabit capable coverage by 43 to 56 percentage points. These findings are consistent with prior research into the impacts of the programme on broadband coverage.

- **Take-up:** Subsidised coverage led to a significant increase in the maximum download speeds of connections taken by households and/or businesses by September 2021 (34 to 60 Mbit/s). However, the impacts of the programme on average download speeds were relatively small. This indicates that 'early adopters' have taken advantage of the enhanced broadband connectivity enabled by the Programme. However, the Programme had not led to widespread take-up of faster broadband services by September 2021. Again, this is consistent with prior research into the impacts of the programme on take-up.

- **Additionality:** The level of additionality was estimated to peak in the year after the premises was upgraded (at 81 percent). Additionality was estimated to decay to 49 percent in the fourth-year post-installation (an average rate of decay of 16 percent per annum). This aligns with patterns observed for prior Phases of the programme. However, the estimated level of additionality associated with Phase 3 was notably higher than for prior Phases, indicating that the areas concerned were substantially less likely to benefit from commercial deployments without public sector support.

The key market outcomes nationally and in Superfast Broadband Programme areas were that the market share for Openreach across delivery areas declined between 2016 and 2022, from around 97 to 85 percent of all broadband connections, which aligns with the national trends for Openreach. The market share for all broadband connections for all other network providers awarded contracts through the Superfast Broadband Programme rose faster between 2016 and 2022 in Phase 3 contract areas than nationally. However, the overall market share of these network providers is still relatively low even at the local level, with no network provider having more than five percent of the total broadband market in 2022 in the areas the Programme has delivered connections. This indicates the Programme has not had a large impact on the national broadband market.

The key economic impacts of the Superfast Broadband Programme at the local level were:

- **Local employment impacts**: Subsidised coverage from Phase 3 contracts was estimated to have increased employment in the areas benefitting from the Programme by 0.88 percent, leading to the creation of approximately 6,261 jobs in Phase 3 contract areas, and 23,700 local jobs across the entire programme area by the end 2021.

- **Turnover**: Subsidised coverage also increased the turnover of firms located in the areas benefitting from Phase 3 of the Programme by 1.6 percent, increasing the annual turnover of local businesses in Phase 3 areas by £827m per annum, and for the whole programme by 1.4 percent, approximately£2.6bn per annum by 2021.

- **Turnover per worker**: There was also some evidence of efficiency gains - turnover per worker of firms in the areas benefitting from Phase 3 of the Programme rose by 0.42 percent in response to subsidised coverage. This was not solely driven by more productive businesses moving into areas with improved broadband infrastructure. Firms that did not relocate over the period also saw their turnover per worker rise by 0.17 percent by 2021, indicating that subsidised coverage has also raised the efficiency of firms. It should be noted that while subsidised coverage had a stable effect on turnover, impacts on employment increased with time. This led to the strength of the gains in turnover per worker appearing to decay with time.

- **Wages**: The impacts of the Programme were also visible in wages. Employees working for firms located in the areas benefitting from subsidised coverage saw their hourly earnings increase by between 0.6 and 0.8 percent in real terms in response to the upgrade (which did not vary significantly across occupational groups). This gives greater confidence that the Programme led to an increase in productivity.

- **Unemployment**: Local job creation also appeared to translate into reduced unemployment, with the number of unemployed claimants falling by 34.3 for every 10,000 premises upgraded.

The key findings around public sector service delivery outcomes and impacts were that during the Covid-19 pandemic, public services such as schooling and health appointments were increasingly moved online, which the enhanced broadband connectivity supported. However, in local authorities where connectivity still left gaps, the move to online services presented challenges in that not all households could access the online services, so other provision was required. Local Authorities reported providing dongles and hardware for more deprived households to access key services. However, in social care settings, the provisions of services did not alter significantly in the pandemic, or because of enhanced connectivity. Since the end of Covid-19 restrictions, social care providers have altered some of their services to align with enhanced broadband connectivity, with an increase in the use and linking of online records between different providers and trials of automated services for social care visits.

The longitudinal survey of households collected key information about the effects of enhanced broadband on households. This demonstrated that the provision of the Superfast Broadband Programme has had a positive impact on the internet connection speeds of households in areas that have received subsidised coverage. The reported connection speed had improved at a greater rate in Superfast Broadband Programme areas than in comparator areas, with reported speeds having increased from 20 Mbps in both groups at baseline to 116 Mbps in Superfast Broadband Programme areas (compared to 63 Mbps in the comparator group).

The increase in connection speeds had a positive impact on the following aspects of life:

- Doing things online saves them time (55 percent of those in Superfast Broadband Programme areas that have upgraded strongly agreed with this statement);

- Doing things online makes things easier (58 percent of those in Superfast Broadband Programme areas that have upgraded strongly agreed with this statement);

- Had made keeping in touch with friends and family easier (66 percent of those in Superfast Broadband Programme areas that have upgraded felt a faster connection made it easier to stay in touch); and

- Had made watching entertainment and content easier (82 percent of those in Superfast Broadband Programme areas that have upgraded felt a faster connection made it easier to watch entertainment).

However, nearly a quarter of households that have upgraded their connections in Superfast Broadband Programme areas also reported that they felt they were addicted to going online.

The findings from the survey indicated that working from home frequency in Superfast Broadband Programme areas had remained constant at around 2.7 days per week, whereas working from home frequency had fallen in the comparator areas from 3.3 days per week to 2.9 days per week. A statistical difference in differences analysis was undertaken, which indicated that the provision of the Superfast Broadband Programme is estimated to have led to an increase in the number of days WFH of between 0.7 and 0.8 days per week. Additionally, the household survey found that that although there was an increase in frequency of working from home, there was no associated change in the duration of commuting experienced by individuals living in Superfast Broadband areas. Therefore, the results around associated environmental benefits due to working from home have a large degree of uncertainty, and should be interpreted with caution.

The evaluation also explored subjective wellbeing. Both a statistical analysis of secondary data sources and an analysis of the survey data found limited difference in the self-reported wellbeing for areas upgraded by the Superfast Broadband Programme and comparator areas. This finding is consistent with the previous evaluation results. It is unclear if the lack of statistically significant results were a result of the Programme having no impact on well-being or if the measures used are insufficiently sensitive to small, and potentially temporary changes to well-being. Therefore, alternative approaches to estimating the public benefit of the Superfast Broadband Programme were used.

The findings of econometric analysis suggested that the programme led to an average increase in house prices of between £1,900 and £4,900, suggesting that buyers were willing to pay a premium to obtain houses benefitting from subsidised upgrades.

A range of analyses were completed to explore the potential environmental outcomes of superfast broadband deployment:

- **Traffic levels around business parks:** The analysis failed to find any significant impact between the intervention and the level of traffic on the road around business parks. This suggests that superfast broadband roll-out has not significantly reduced levels of commuting behaviour for those who work in a business park.

- **Change in the number of people that report working from home**: The results from an analysis of census data suggest that the rollout of superfast broadband is associated with a 9.3% increase in work from home behaviour per treated output area, statistically significant at the 99% confidence level. This is broadly in line with the findings from the survey, that the provision of faster broadband connections increases working from home. However, this result should be interpreted with caution.

- **Change in energy consumption:** Positive statistically significant effects were detected for domestic consumption in both electricity and gas, as well as non-domestic electricity and gas consumption – suggesting that receiving superfast broadband led to an increase in energy consumption.

- **Traffic disruption:** Analysis of permit records indicated that the total present value of costs in terms of greenhouse gas emissions resulting from traffic disruption was around £2.3 million (£0.3 million - £4.4 million) over a 17 year-appraisal period (2013 – 2030).

Cost effectiveness

The mechanisms put in place to protect the public purse have substantially improved the value for money obtained from the Programme. At the point of contracting, the expected public sector costs per premises upgraded was £2,636. However, after allowing for clawback, this is expected to fall to £945. Factoring in the likelihood that some of those premises passed to date would otherwise have received coverage through commercial deployments, the public sector cost (after clawback) per additional covered premises over three years was £1,225 to £1,276 per premises passed (depending on whether take-up stabilises at 60 or 85 percent in the long-term).

Even with this being a higher cost than for previous Phases of the Superfast Broadband Programme, Phase 3 of the Programme still appears to be one of the most efficient Programmes supporting broadband deployment in the EU.

The benefits of the Programme are also expected to significantly exceed its costs. The estimated Benefit to Cost Ratio (BCR) was between £1.76 and £4.57 per £1 of net lifetime public sector spending based on its impacts between 2012 and 2021. Allowing for future benefits to 2030, the BCR is estimated to rise to £1.87 to £4.70 per £1 of net public sector spending. However, this is likely to underestimate the total benefits of the Superfast Broadband Programme, as the environmental benefits of the intervention have been omitted from the BCR due to uncertainty about the scale of the impact – with different methodologies leading to different estimates. The environmental benefits range from £0 to £959m for Phase 3, which demonstrates the benefits could drive the BCR to be as high £8.01 for every £1 of public expenditure.

1 Introduction

Ipsos UK was commissioned by the Building Digital UK (BDUK) Executive Agency of the Department for Science, Innovation and Technology (DSIT)[3] in October 2021 to undertake an evaluation of the Superfast Broadband Programme (formerly the UK National Broadband Scheme (NBS) 2016) Superfast Broadband Programme. This document presents the final evaluation report, examining the impacts of the Programme between 2016 and 2022/2023.

1.1 Description of the Programme

The Superfast Broadband Programme was announced in 2010 in response to concerns that the commercial deployment of superfast broadband infrastructure would fail to reach many parts of the UK. In June 2010 almost 3 million homes and businesses did not have access to broadband speeds of at least 2Mbps. In November 2011 (the earliest data that is available), superfast broadband connections were available to 58 percent of premises in the UK. The Government established the Programme to fund network providers to extend provision to areas where deployment was not commercially viable, on the expectation that doing so would result in economic, social and environmental benefits. The scheme was initially backed by £530m of BDUK funding, with the aim of extending superfast coverage to 90 percent of UK premises by December 2016 (Phase 1).

The Programme was expanded in 2015, with a further £250m made available to extend coverage to 95 percent of premises by December 2017 (Phase 2). Phase 1 and Phase 2 of the Programme were funded under the State aid judgement SA.33671 (2012/N).

Phase 3 of the Superfast Broadband Programme began in 2016 and involved over £1bn of public funding It aimed to provide superfast broadband coverage (or faster networks) in areas where availability remained below the 95 percent coverage target and extend superfast coverage beyond 95 percent where possible. This Phase of the Programme covers contracts awarded between 2016 and 2020 and was funded under a new State aid Decision (State aid SA. 40720 (2016/N)).

This evaluation focuses primarily on contracts awarded under Phase 3 of the Programme.

1.2 Evaluation objectives

The aims and objectives of the Superfast Broadband Programme evaluation were set out in the Invitation to Tender (ITT), and focussed on four main evaluation questions. These questions are:

- **Question 1:** What are the outcomes of the scheme?
- **Question 2:** How has the behaviour of individuals / organisations changed for these outcomes to come about?
- **Question 3**: How effective and efficient has the delivery of the Programme been?
- **Question 4:** Was the investment cost effective?

[3] BDUK is formerly an Executive Agency of the Department for Digital, Culture, Media and Sport (DCMS)

1.3 Methodology

The evaluation used a mixed methods approach, which included quasi-experimental evaluation approaches to establish the impact of the Programme, and primary research and thematic analysis to explore how the Programme and broadband connectivity more widely has impacted upon public service provision. The evaluation design was informed by the NBS evaluation plan, Superfast Broadband Programme and the previous evaluation of the Superfast Broadband Programme.[4] The NBS evaluation plan set out the methodological approaches to be used to assess the extent to which the Programme had increased superfast broadband access and take-up, the effects of the Programme on the broadband providers that were awarded contracts (Programme beneficiaries), the effects the Programme had on the broadband market, and how efficient the Programme had been. The proposed methodologies were quasi-experimental approaches where possible.

The evaluation approach used built upon the requirements in the NBS evaluation plan and enhanced the quality, coverage and robustness of the findings from the previous evaluation of the Superfast Broadband Programme. Alongside the approaches detailed in the NBS evaluation plan and in the previous evaluation of the Superfast Broadband Programme, further methodologies were developed by the research team and BDUK to explore the impacts of the Programme on environmental outcomes, self-reported wellbeing and the impact on public service delivery. A summary of the evaluation methodologies is presented below, followed by a description of the ways in which information was collected for the evaluation.

- **Quasi-experimental approaches to robustly identify the outcomes and impacts achieved where possible:** The way in which the Superfast Broadband Programme has been implemented allowed quasi-experimental approaches to be used to identify economic, social and environmental impacts, and some public service provision impacts. The underlying quasi-experimental methodology was as robust as could be achieved within the constraints set by the design of the Programme (achieving Level III on the Maryland Scientific Methods Scale). The quasi-experimental analysis explored the impacts of the Programme on the availability and take-up of superfast broadband services, the performance of businesses located in the Programme area, the labour market (including commuting times and frequency of working from home), house prices, the wellbeing of residents, broadband connection speeds, satisfaction with broadband connections, and the environmental impacts of the programme.

- **Descriptive and Thematic analysis:** Where quasi-experimental approaches were not feasible, the research team undertook thematic analysis using findings from primary research, Programme Management Information (MI) and secondary data sources to identify and form conclusions about the likely impact of the Superfast Broadband Programme. The thematic analysis involved the research team reviewing transcripts of all interviews to identify key themes in the responses, and the responses were entered into a coding framework to be analysed. The research team then explored how frequently each theme occurred in the interviews. A further step in the analysis was to explore whether there were commonalities between the interviewees that had responded in a similar way.

- **Cost-benefit analysis and cost effectiveness analysis:** A cost-benefit and cost effectiveness analysis (the cost per premises passed) of the Programme were completed to explore issues relating to the cost effectiveness of the Superfast Broadband Programme and the degree to which its costs

[4] https://www.gov.uk/government/publications/superfast-broadband-programme-state-aid-evaluation-report-2020

were justified by its benefits. The analysis was completed in line with the guidance set out in the HM Treasury Green Book and the approaches put forward for valuing economic and non-market impacts.

Data sources used

- **Primary research:** The evaluation included multiple strands of primary research to explore how the Superfast Broadband Programme has been delivered and what impact it has had in the areas where enhanced broadband infrastructure has been provided:
  - **Depth research with network providers:** The evaluation was supported by a programme of depth research with 14 telecommunication companies (including direct beneficiaries of the programme, other network providers and internet service providers that could potentially make use of the infrastructure made available through the programme). The focus of the interviews was on understanding the current conditions in the telecommunications market, the progress made in delivering the Superfast Broadband Programme contracts and the impact the programme has had on beneficiaries and the wider market. Interviews were transcribed and analysed, with perspectives offered validated against the objective evidence available from monitoring information where possible. Key findings were also validated by key BDUK officials responsible for the design and delivery of the Programme.
  - **Depth research with public service providers:** The evaluation also involved depth interviews with 14 providers of public services (covering education, health, and social care provided by local authorities). These interviews explored how enhanced broadband connectivity impacted organisations providing public services, how the services they offer are changing, how connectivity supported the delivery of services during the Covid pandemic and what impact this had on public service users.
- **Programme MI:** The Programme MI was used in the descriptive and thematic analysis described above. The MI provided information about the Programme, including the cost of the Programme, premises delivered to and the take-up of connections by contract area. The Programme MI was also linked to secondary datasets to support the quasi-experimental evaluation approaches described above.
- **Longitudinal survey of households:** The evaluation also included a large-scale survey of households, to explore the social impacts of the Superfast Broadband Programme. The survey included a baseline survey of 1,800 households – of which 900 were in areas that were expected to receive superfast broadband coverage in the next year and 900 were in areas with no superfast broadband coverage and that were not expecting to receive an upgrade through the programme. The baseline survey took place in 2021-2022. A follow up survey, with a subset of those individuals surveyed at the baseline stage, was conducted in 2023-24, to explore changes in the key outcome metrics. 840 households completed the follow-up survey.
- **Secondary data sources:** The evaluation design involved multiple strands of research using secondary data sources, including Ofcom Connected Nations data, ThinkBroadband data and Office for National Statistics (ONS) data made available through the Secure Research Service (SRS). These data sources are described in more detail below. The quasi-experimental evaluation designs utilised several datasets in the ONS SRS. These were:

  - **Business Structure Database (BSD):** This dataset includes information about the number of businesses, their turnover and employment by geographic area, and was used to explore the economic impacts of the Programme.

  - **Annual Survey of Hours and Earnings (ASHE):** This dataset includes information about the wages earned by workers at businesses in Superfast Broadband Programme delivery areas and comparator areas, and was used to explore the impact of the Programme on earnings.

  - **Annual Population Survey / Understanding Society:** These datasets include information about the levels of subjective wellbeing reported by individuals, and was used to explore the public value outcomes of the Superfast Broadband Programme.

Other data sources outside of the SRS included:

- **Census:** Data from the census of 2011 and 2021 was used to explore commuting patterns in areas receiving superfast broadband coverage.

- **Other official statistics:** The evaluation team also sourced other official Government statistics to support quasi-experimental evaluation designs. These were:

  - **Department for Education Explore Education Statistics:** This data provides a wealth of information about English school's staffing, financial and demographic profile and academic achievement, and was used to explore the impact of the Superfast Broadband Programme on public service provision.

  - **Department for Health and Social Care General Practice dataset:** This dataset provides details of the size of patient lists, staffing levels and financial information for GP practices in England. Additionally, the GP Patient Survey (GPPS) dataset, which provides information about patient experience of their GP practice was also accessed. These data sources were used to explore the impact of the Programme on public service provision.

  - **ONS house price data:** This information provided data about the value of houses sold in the UK, and has been used to explore the public value outcomes of the Superfast Broadband Programme.

- **Data from Programme beneficiaries Project Financial Model:** This information was used to undertake an assessment of the extent to which subsidises provided by the Programme were needed to make the investments in broadband infrastructure commercially viable.

- **ThinkBroadband market data:** This extensive dataset provided information about Broadband coverage and take-up of services by telecommunications providers. This data was used to undertake a descriptive analysis of the effect of the Programme on the local broadband markets. This involved examining changes in the number of network providers active in the Programme area and their market shares between 2016 and 2022. This was completed using network provider level data compiled independently by ThinkBroadband.

1.4 Limitations

There are some limitations to the evaluation that should be considered when interpreting the findings of the analysis. These are:

- **Progress with programme delivery:** At the time of the evaluation, many Phase 3 contracts were yet to be completed. Much of the data on which the evaluation is based was also only available to September 2021. Just over half (52 percent) of the contracted number of premises to be upgraded were complete at this stage. This creates challenges in assessing the long-term additionality of the infrastructure upgrades for Phase 3 of the Programme, the effect of Phase 3 of the Programme on the market shares of beneficiaries, and the expected rate of return on the contracts awarded.

- **Causality**: The programme was not delivered as a Randomised Control Trial and econometric methods have been used to establish estimates of the causal effects of the programme. These methods are based on comparisons between postcodes that benefitted from coverage subsidised by the programme and other postcodes that were eligible for investment but not chosen by network providers when developing their proposals to deliver the schemes. This creates the possibility that there are systematic differences between those areas benefitting from the programme and the comparison group that could bias findings. The commercial viability of network upgrades in areas benefitting from the programme could be expected to be higher than in eligible areas that did not. While steps have been taken to mitigate this risk, the results may overstate the impact of the programme due to unobserved confounding factors.

- **COVID-19:** The data deployed in this analysis ran to mid-2021 and does not allow for an analysis of the impacts of the programme in relation to COVID-19. It is plausible that the programme enabled benefits such as remote working, the delivery of public services (e.g. General Practitioner consultations) on-line and increased local resilience through supporting social distancing arrangements. However, if COVID-19 has induced greater demand for superfast services amongst residential consumers, the rates of return earned on Superfast contracts will also be higher than when projected based on historic growth in take-up. This could make some upgrades commercially viable that previously were not (implying that additionality in the longer term was overstated). The COVID-19 pandemic may also have had some negative impacts, such as the beneficiaries ability to deliver upgrades (although telecommunications providers did not think this was a substantial issue) and on wider economic performance.

- **Data availability:** The NBS evaluation plan agreed in 2016 identified data sources to be used to undertake the analysis plan set out in the document. However, as noted above, not all this data could be made available to the evaluation team.

1.5 Structure of the report

The remaining sections of this report are structured as follows:

- Section 2 provides an overview of how the Superfast Broadband Programme was expected to generate its intended outcomes and impacts;

- Section 3 discusses the delivery of the Superfast Broadband Programme;

- Section 4 details the outcomes achieved by the Superfast Broadband Programme;

- Section 5 presents an assessment of how effectively and efficiently the Programme has been implemented;

- Section 6 outlines the key conclusions from the evaluation.

2 Superfast Broadband Programme

This section provides an overview of the Superfast Broadband Programme. This includes a description of the aims and objectives of the programme, how it was delivered and an overview of the processes by which it was expected to produce its intended impacts on broadband coverage and take-up and associated economic and social benefits. This serves as an analytical framework guiding the definition of the evaluation questions and the interpretation of results.

2.1 Policy aims

The Superfast Broadband Programme was announced in 2010 to respond to concerns that superfast broadband would fail to reach many parts of the UK. The first Ofcom Infrastructure report in November 2011 demonstrated this concern, showing that 58 percent of UK households had access to Next Generation Access (NGA) broadband services capable of delivering superfast broadband speeds (download speeds exceeding 30Mbps). NGA technologies encompass the installation of fibre-optic networks to connect the telephone exchange to the cabinets serving customers (Fibre-to-the-Cabinet) or to their premises (Fibre-to-the-Premises), improvements to cable networks, and wireless technologies that allow customers to obtain broadband services without a cabled connection to the network.

At the time, private investment in the required infrastructure was expected to be constrained in less densely populated areas of the UK. The costs of investing in the fixed infrastructure needed to provide these services are usually substantial. Where population density is low, this will reduce commercial viability as the consumer base will be smaller and the costs of network build may be higher (e.g. if properties are more distant from the serving telephone exchange).

On the expectation that extending superfast broadband coverage to these areas would produce economic, social and environmental benefits, the Government established the programme to provide £530m of public resources to fund further deployment with the aim of increasing coverage to 90 percent of UK premises by early 2016. The programme was extended in 2015, with a further £250m made available to extend coverage to 95 percent by the end of 2017.

The Superfast Broadband Programme was extended a second time under a new State aid approval covering the 2016 to 2020 period, although the areas targeted were still those that were not expected to be reached by commercial deployment of superfast broadband. Contracts awarded under this State aid scheme (commonly known as Phase 3) are the focus of this evaluation report. These projects had a greater focus on gigabit connectivity (download speeds of 1000Mbps) than those funded in prior Phases, aligning with broader Government objectives to increase FTTP coverage in the UK.

2.2 Theory of Change

This section sets out an overarching theory of change for the programme based on the frameworks developed for prior studies. The Superfast Broadband Programme was expected to produce a variety of downstream benefits for businesses, workers, households, the public sector and the environment.

2.2.1 Digital Divide and Stimulating the Broadband Market

The Superfast Broadband Programme provides subsidies to providers of broadband networks to extend superfast broadband infrastructure to areas that would not otherwise benefit from commercial deployments or would benefit at a significantly later date. Subsidising network providers involves a risk that they seek

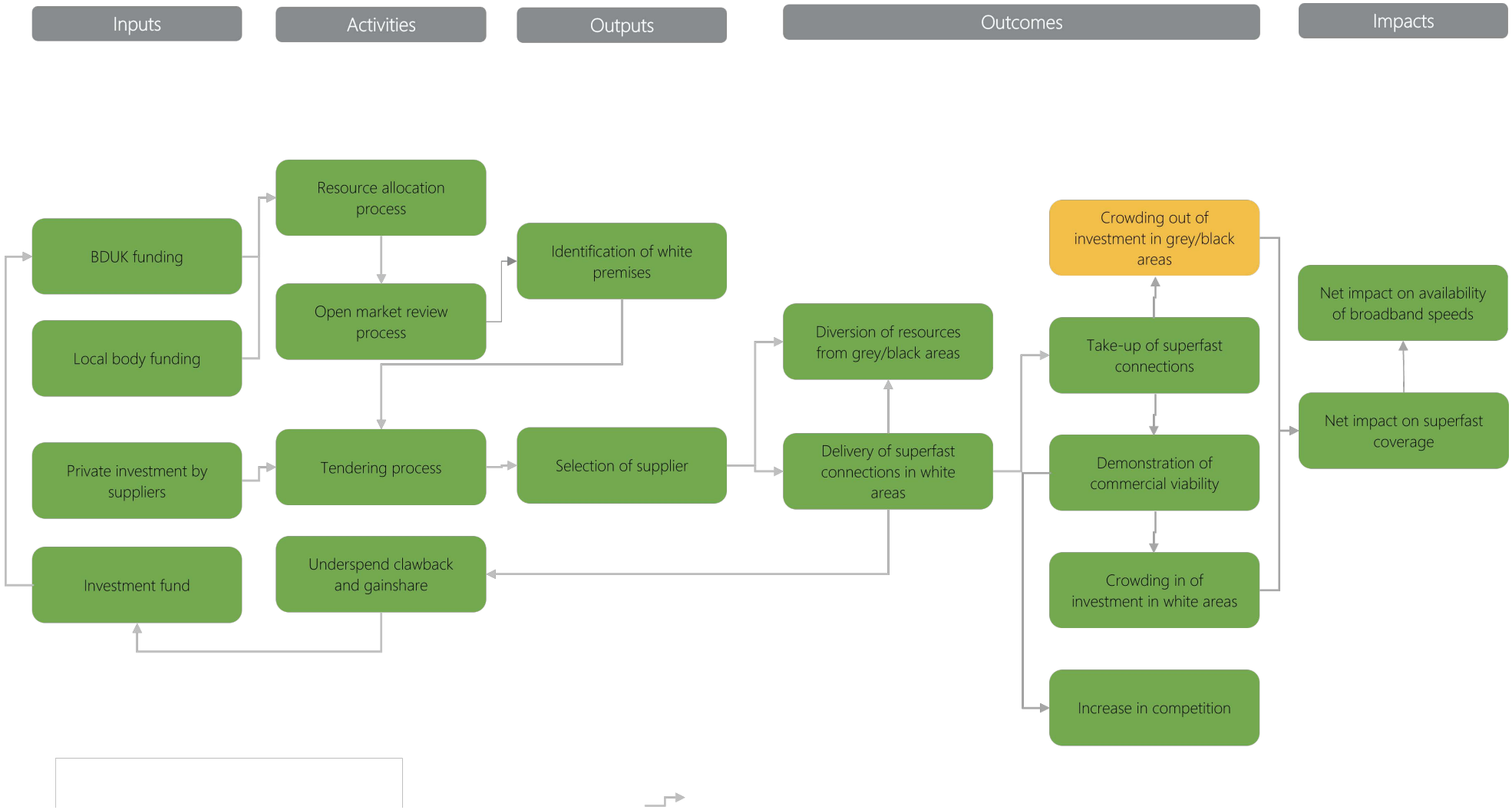
public funds for (deadweight) investments that they would have made anyway, enabling them to earn greater profits. The delivery of the Programme involved several steps to mitigate these risks:

- **Open Market Review (OMR) and public consultation:** Local Bodies were required to manage an OMR and public consultation process before they issued tenders. The first stage of this process involved requesting network providers to provide details of their existing networks and commercial plans to roll-out improved broadband coverage over the next three years – this request was made after the announcement of the funded Superfast Broadband Programme. This allowed BDUK and Local Bodies to identify three types of area:
  - 'White areas' where there were no commercial plans to roll-out superfast broadband within three years. Only these areas were eligible for funding through the Programme;
  - 'Grey areas' where one provider was offering or was expected to offer superfast broadband services within three years; and
  - 'Black areas' where multiple providers were offering or were expected to offer superfast broadband.
- **Tendering process:** Following the OMR and public consultation process, Local Bodies commissioned network providers to deliver superfast coverage in 'white' postcodes. In the first two Phases, contracts were mainly awarded through a framework contract. In Phase 3, Local Bodies used an open procurement process and were free to split the project into multiple lots (allowing different network providers to bid for different lots). Network providers submitting tenders were asked to provide information on the expected costs and revenues associated with the project, to inform an assessment of what level of public subsidy would be needed to make the project sufficiently profitable.
- **Implementation and take-up clawback:** The contracts awarded to successful network providers (Programme beneficiaries) included provisions to allow the public sector to recover unused funds if the beneficiary had overestimated their delivery costs. Additionally, if take-up of the broadband infrastructure proved to be higher than was expected at the tendering stage, beneficiaries were required to return a share of the excess revenues generated to an Investment Fund which could be recycled to fund further coverage. This aimed to limit the amount beneficiaries could earn excess returns on investments subsidised by the public sector.
- **Crowding out and crowding in:** The provision of subsidies for investment in superfast broadband infrastructure could reduce investment in other areas or by other network providers. If network providers faced limits on their overall capacity, this could delay the delivery of other investments in other areas. The plans for subsidised investments were also published, potentially discouraging other network providers from extending their networks to those areas. Conversely, if the Programme helped to demonstrate that investments in superfast broadband infrastructure were profitable in rural areas, then this may have encouraged additional investment.
- **Competition**: Finally, the Programme may have led to changes in the parameters of competition and the market shares of network providers. The Programme required beneficiaries to provide open and non-discriminatory wholesale access to the infrastructure delivered with public subsidy. These requirements could stimulate competition in wholesale or retail markets in the long term. However, the nature of the technologies provided could have resulted in beneficiaries extending their networks

to a small number of premises that were already served by superfast broadband infrastructure, leading to some competitive distortions. The figure below presents a summary of the discussion above.

The discussion above is summarised in the figure below:

Figure 2.1: Connectivity impacts of the Superfast Broadband Programme



Green boxes indicate benefits of the Superfast Broadband Programme, yellow boxes indicate disbenefits.

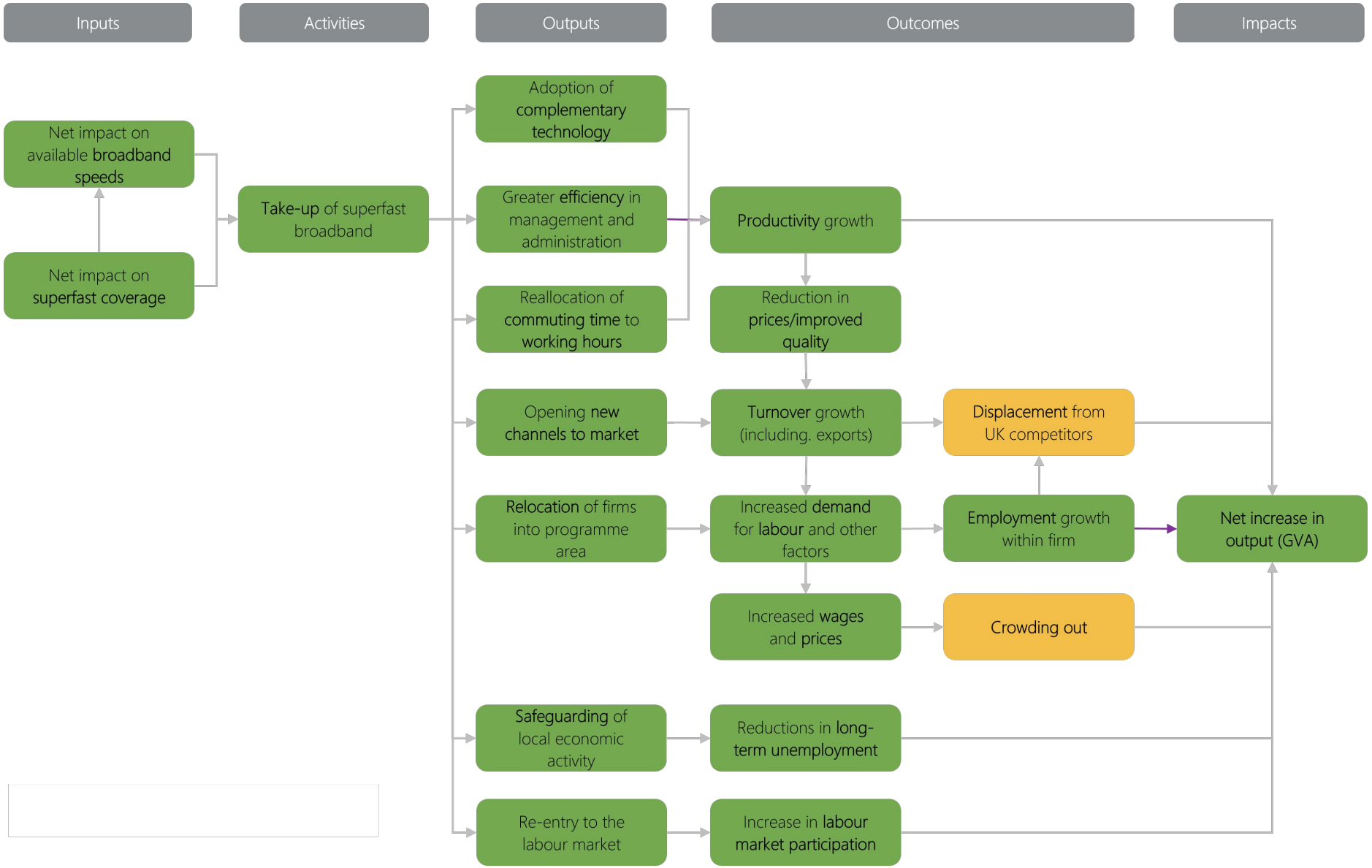
2.2.2 Productivity growth and employment

The impacts of the Programme on businesses are expected to involve the following processes:

- **Take-up**: It is expected that the benefits of the Programme will be driven by firms taking up superfast broadband connections made available through the Programme.
- **Direct impacts on productivity**: Numerous studies have shown that faster broadband stimulates productivity growth. Adoption of superfast broadband could raise the productivity of local firms by allowing them to adopt new technologies or drive product, process, or service innovation. This would allow them to provide their products or services at lower cost or attain higher prices (from the same inputs), resulting in improvements in productivity.
- **Turnover and employment growth:** Adoption of superfast broadband may also aid firm growth by helping them to access new markets or by making them more competitive in their existing markets. This will allow them to increase their sales, turnover and economic output (Gross Value Added). Firms that increase their sales may also need to recruit additional workers to meet the additional demand.
- **Relocation of firms:** The availability of broadband enables important economic activities to take place in less central locations. Providing enhanced broadband infrastructure may create an incentive for firms to relocate to the Programme area, leading to further creation of jobs at the local level. Enhanced broadband may also help retain businesses that would have otherwise been lost to other areas with superior infrastructure.
- **Impacts on workers:** Workers could expect to benefit from these outcomes through greater numbers of employment opportunities and higher wages. These could be particularly large if enhanced broadband coverage helps avoid the emergence of issues associated with long-term unemployment. Faster connectivity also has the potential to transform the nature of work by enabling efficient remote working. This could deliver benefits for workers by reducing their commuting time and altering the time that they work. It could also encourage economically inactive workers to seek employment.
- **Displacement**: However, it should be noted that positive impacts on local economies benefitting from the Programme could be offset by negative effects elsewhere in the economy. Firms that grow as a result of the Programme may take market share from their competitors located in other areas of the UK, causing loss of sales and encouraging them to reduce their employment and GVA. The movement of firms into areas benefitting from the Programme could also result in losses of jobs in those areas from which they relocated.
- **Price effects:** If firms increase their demand for workers (or other inputs) to support their growth, this could also place upward pressure on wages or other prices. The increase in prices could also encourage other firms to reduce their levels of activity.
- **National economic benefits:** As a result of these offsetting effects, the economic benefits of the Programme at the national level will stem from the improvements in productivity enabled by enhanced broadband.

The discussion above is summarised in the figure below:

Figure 2.2: Business, local economic performance and worker impacts of superfast broadband



Green boxes indicate benefits of the Superfast Broadband Programme, yellow boxes indicate disbenefits.

2.2.3 Public sector efficiency

The Programme may also have a range of direct and indirect effects on the delivery of public sector services:

- **Efficiency gains:** Subsidised coverage may allow public sector organisations to benefit from the faster broadband connectivity. This will potentially allow them to generate efficiency gains or realise cost savings by adopting cloud computing and allowing public sector workers to work more flexibly. Cost savings realised could be channelled into improving the quality-of-service delivery.

- **Service transformation:** Improved connectivity may also facilitate the digitalisation of public services that could deliver further cost savings or improve the quality-of-service delivery. The range of possible applications are extensive. These might include enabling simple transactions to be undertaken on-line, such as payment of bills, booking systems for leisure facilities, appointment reminders to reduce missed appointments or renewal of prescriptions. Greater bandwidth could also enable remote delivery of public services. For example, digital health applications can enable remote diagnosis of health conditions through telemedicine platforms (e.g. the GP at Hand service developed by Babylon Health), diagnostic or therapeutic smart-phone applications (e.g. the Changing Health diabetes management application), or using remote sensors to provide real-time information to clinicians to support patient management. The COVID-19 pandemic has also illustrated how other public services – such as education – can be provided online.

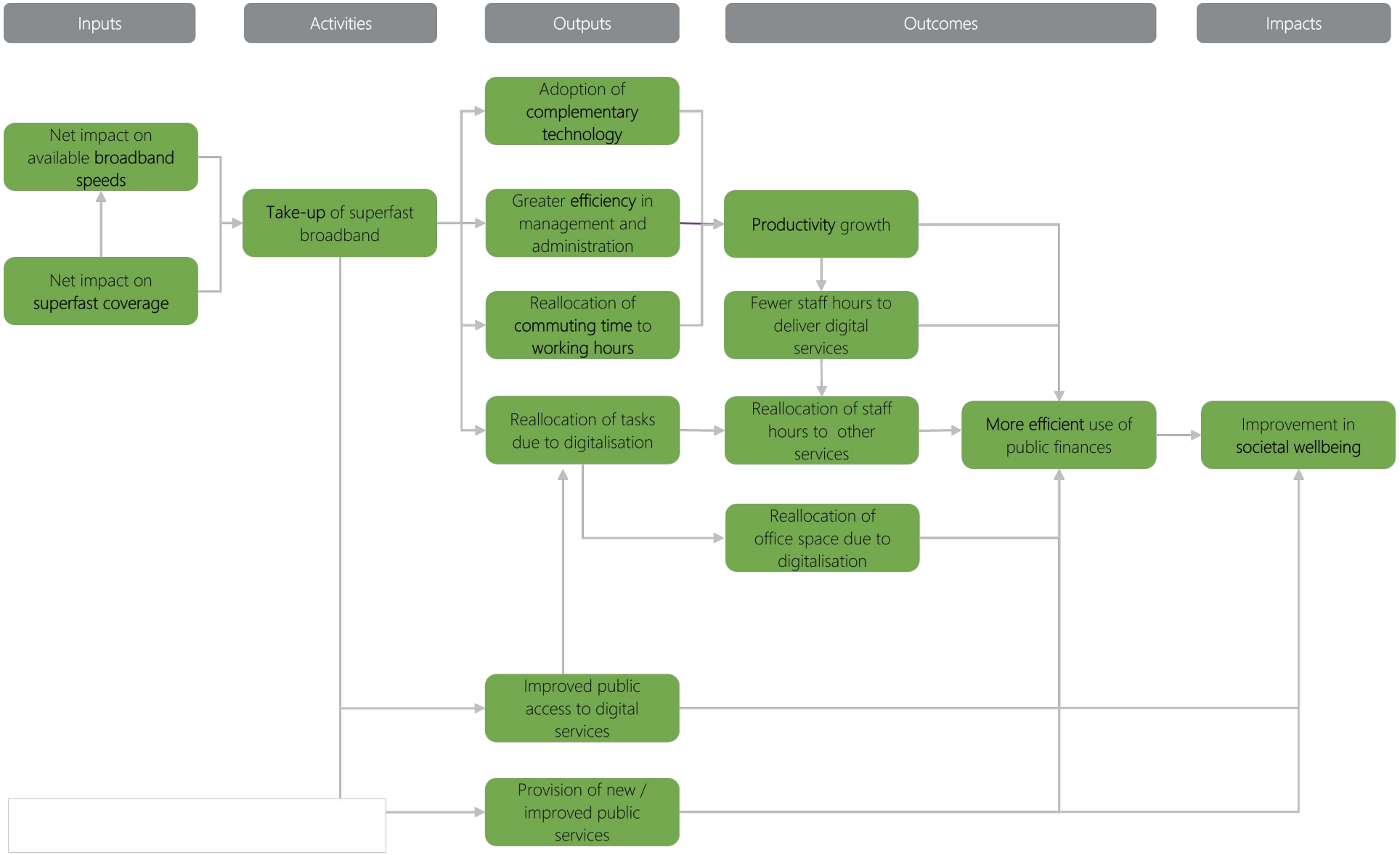
There are two key risks which may prevent the public service efficiency outcomes being achieved. These are:

- **Digital divide issues:** The ability of resident populations to benefit from digitalisation of public services will be partly dependent on how far they can access digital services. If they do not take-up faster broadband services or if they do not have the confidence or skills to use online platforms, then some residents may be locked out of new modes of service delivery. This risks negative social impacts if physical modes of delivery are withdrawn or scaled back.

- **Population growth:** Subsidised coverage may also have indirect effects on public services if it induces the migration of population to rural areas. If the supply of public services does not expand to accommodate the additional demand this may bring, this could place pressure on public services (leading to greater rationing and reduced access, rather than a widening of access).

The discussion above is summarised in the figure below:

Figure 2.3: Public service delivery impacts of superfast broadband



2.2.4 Public value

Households will also benefit through their use of superfast broadband services:

- **Consumption benefits:** Access to faster broadband may benefit households by allowing them to access a wider range of choice and quality of products and services, or alter expenditure patterns (for example due to savings from using smart devices e.g. smart meters). Most obviously, faster broadband speeds will allow consumers to access entertainment and media services that depend on high bandwidths (e.g. streaming services or smart devices). Benefits may also arise from access to more extensive online marketplaces that allow consumers more choice, obtain savings or free up time that would have otherwise been spent travelling to retail or other centres.

- **Teleworking and leisure time:** Households newly able to work remotely may also gain leisure time if commuting times are reduced.

- **Social interaction**: Faster broadband may also open new modes of communication between residents. While email and social media may not be dependent on higher bandwidths (and can be straightforwardly used through mobile phones), the COVID19 pandemic has popularised the use of video conferencing as a mode of interpersonal communication. This technology requires greater bandwidths and subsidised coverage has the potential to improve wellbeing by supporting more extensive social interactions within and beyond the communities in which residents live.

- **Distance learning**: Superfast broadband could also offer a wider range of distance learning options. This could have economic benefits by helping people upskill and find better paid work or wellbeing benefits for those who undertake courses for pleasure.

- **Health benefits:** Households may also see improvements in their physical or mental health. For example, increased leisure time could allow individuals to increase their levels of physical activity, while greater social connectivity could reduce levels of social isolation or loneliness. Further health benefits may also arise if the use of digital health applications enables better access to care or self-management of conditions.

- **Perceptions of inequity:** The Superfast Broadband Programme also has the potential to address perceptions of inequity relating to the locations of major investments in infrastructure. For example, focus groups undertaken by University College London revealed a perception that recent investments in infrastructure have exacerbated disparities in amenities and mainly benefitted those that were already affluent. While the Programme cannot tackle these issues in their entirety, bringing superfast broadband coverage to rural areas has the potential to at least ameliorate these types of public concerns.

- **House prices:** If households place a value on superfast broadband connectivity, changes in the availability of superfast broadband connections in an area could lead to increases in house prices.

However, the impacts of superfast broadband on the wellbeing of residents may not always be positive:

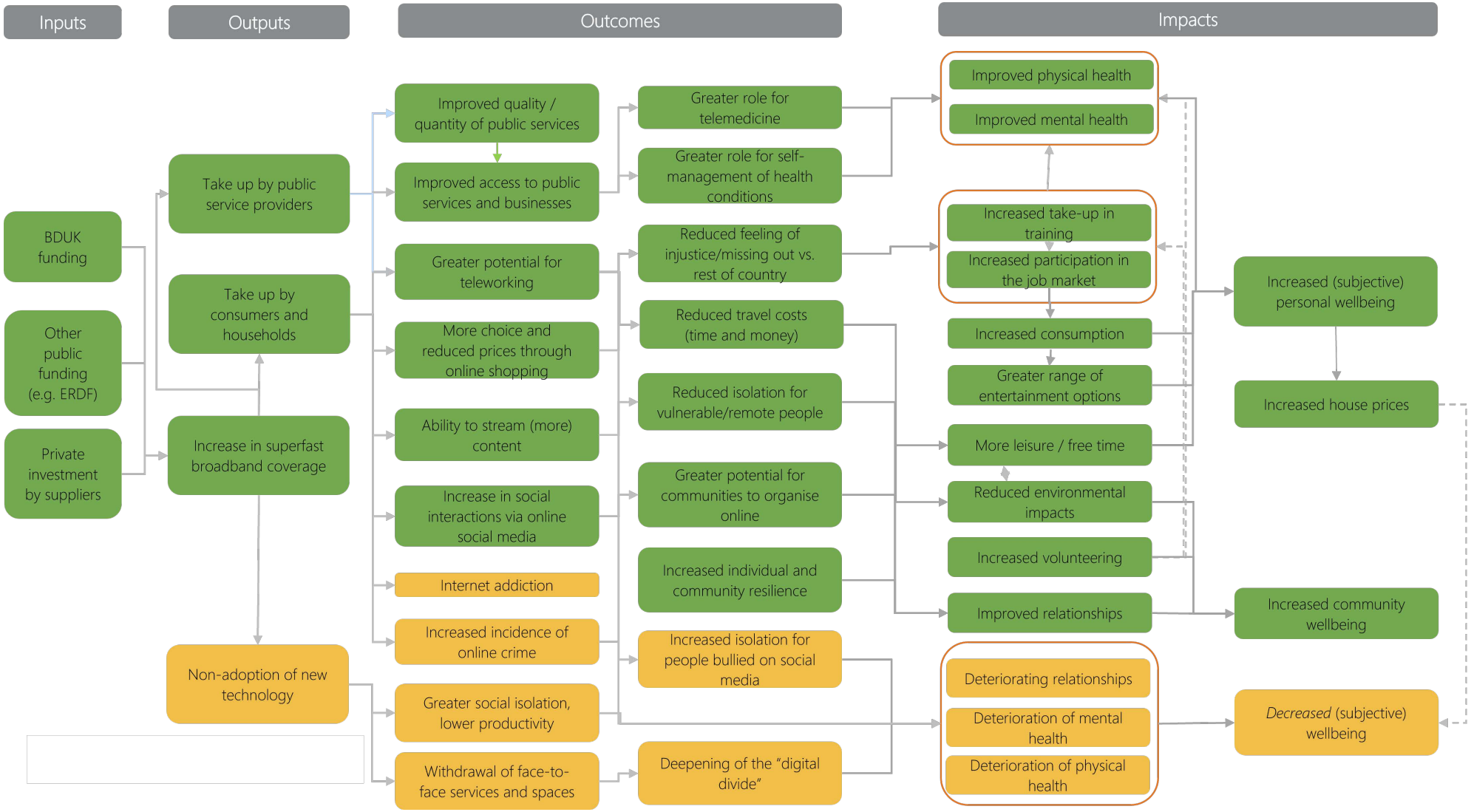
- **Health**: Improved access to superfast broadband could have negative health impacts. For example, increased access to entertainment at home could reduce physical activity or expose individuals to online criminal activity, internet addiction, or cyberbullying. There may also be negative effects on wellbeing if superfast connectivity encourages individuals to work more intensively outside of normal

working hours. These types of issue are being explored by BDUK in on-going work to understand the public value impacts of the Programme.

- **Vibrancy of town centres**: Shifts to online consumption could reduce the commercial viability of in-store retail services. Loss of retail outlets may reduce the vibrancy of town centres (reducing the wellbeing of residents of those communities).
- **Rural population growth:** The availability of superfast broadband services may encourage people to migrate to rural areas. This may have a negative impact on the wellbeing of residents if it increases rent, stimulates housebuilding activity on previously undeveloped land, places additional pressure on public services or leads to greater congestion on rural road networks. Migration could also reduce community cohesion if it disrupts settled patterns of community life.

The discussion above is summarised in the figure below:

Figure 2.4: Household impacts of superfast broadband



Green boxes indicate benefits of the Superfast Broadband Programme, yellow boxes indicate disbenefits, red boxes group related outcomes.

2.2.5 Environmental

A core assumption of this report is that upgrading to faster internet speeds changes social behaviour by increasing the feasibility of working from home (videoconferencing, online events etc.), which consequently results in fewer commutes to the individual's office / workplace leading to reductions in carbon emissions and air pollution, and positive impacts on human health and biodiversity.

In the longer term this may lead to reduced demand for road transport, with an associated impact on net emissions. However, rebound effects may also exist if there is an increase in trip demand or a shift to less frequent but longer distance commuting[5], which would reduce the net impact on transport induced emissions. More working from home may also result in rebound effects in household energy consumption, with higher net energy demands across multiple households working from home, compared to the energy economies of scale in an office setting (noting that offices may not immediately close or downsize in response to working from home, meaning that workers will be contributing to energy demands both at home and in the office during the period where firms adjust to increased levels of remote workers).

In the longer-term, there may also be net emissions impacts from the increased demand for rural/greenfield land away from the cities, as people are able to work from home and base themselves further from geographic clusters of offices in cities. This could have impacts on emissions, as well as habitat loss and biodiversity.

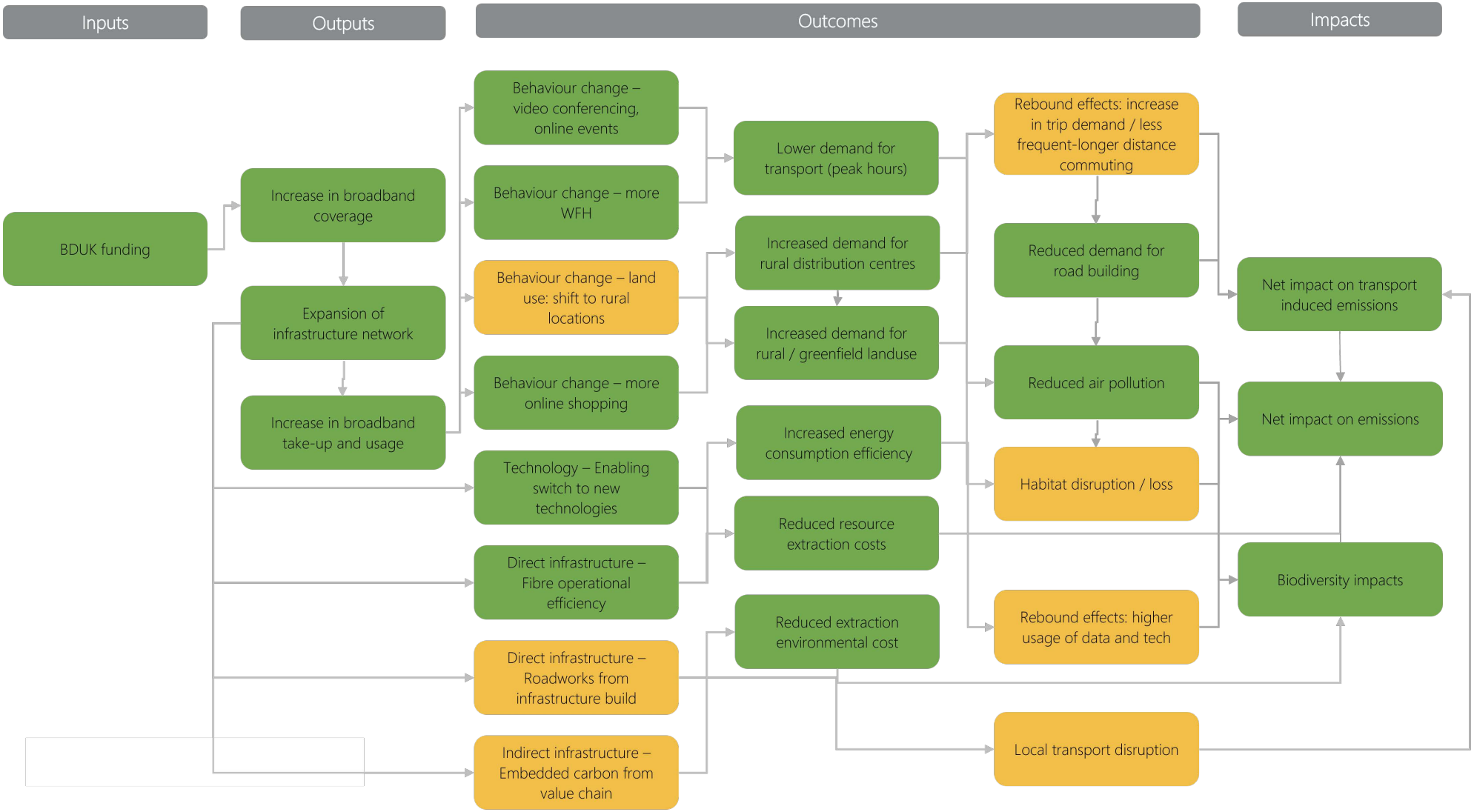
There are also emission impacts from the infrastructure works required for the installation of fibre cables, leading to local transport disruption and a negative impact on transport induced emissions in the short-term.

However, the shift to new infrastructure materials can be expected to reduce the number of repair trips (based on evidence that fibre networks require fewer repair trips than copper cable networks, and a switch to new technology (e.g., cloud computing) which has been found to be more energy efficient). However, this could lead to rebound effects if higher usage of data and technology follows, with implications for the net impacts on emissions. It is also necessary to account for the embedded carbon from the value chain.

The following section explores these three channels of working from home, enabled technology and infrastructure in more detail in the sections below.

[5] As workers are no longer required to live as close to the office as the frequency in which they are physically in the office has reduced. See O'Brien, W. and Aliabadi, F. (2020) Does telecommuting save energy? A critical review of quantitative studies and their research methods, *Energy and Buildings*, 225(15). DOI: https://doi.org/10.1016/j.enbuild.2020.110298.

Figure 2.5: Environmental impacts of superfast broadband



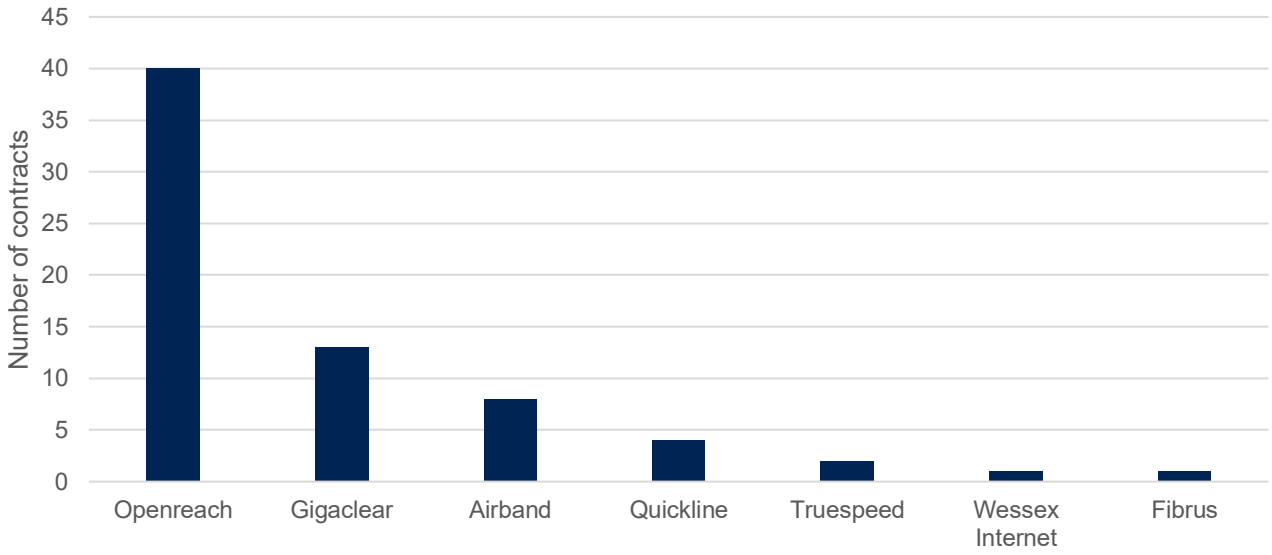
Green boxes indicate benefits of the Superfast Broadband Programme, yellow boxes indicate disbenefits.

3 Phase 3 delivery

3.1 Procurement

The figure below sets out that 69 contracts have been awarded for Phase 3 of the Superfast Broadband Programme, with seven Network Providers holding contracts. Openreach held most contracts with 40 contracts, but Gigaclear held 13 contracts. The remaining five network providers held 16 contracts between them. The contracts awarded in Phase 3 of the Programme had an average size of £20m, and on average passed nearly 7,700 premises (see Table 3.1).

Figure 3.1: Number of contracts awarded by beneficiary



Source: Superfast Status Report, November 2022

Table 3.1: Phase 3 Superfast Broadband Programme budget

	Phase 3 contracts
Average premises	7,696
Average contract value (£m)	£20.2

Source: Superfast Status Report, November 2022. Note: actual spend not available for this iteration of the evaluation.

3.2 Programme delivery

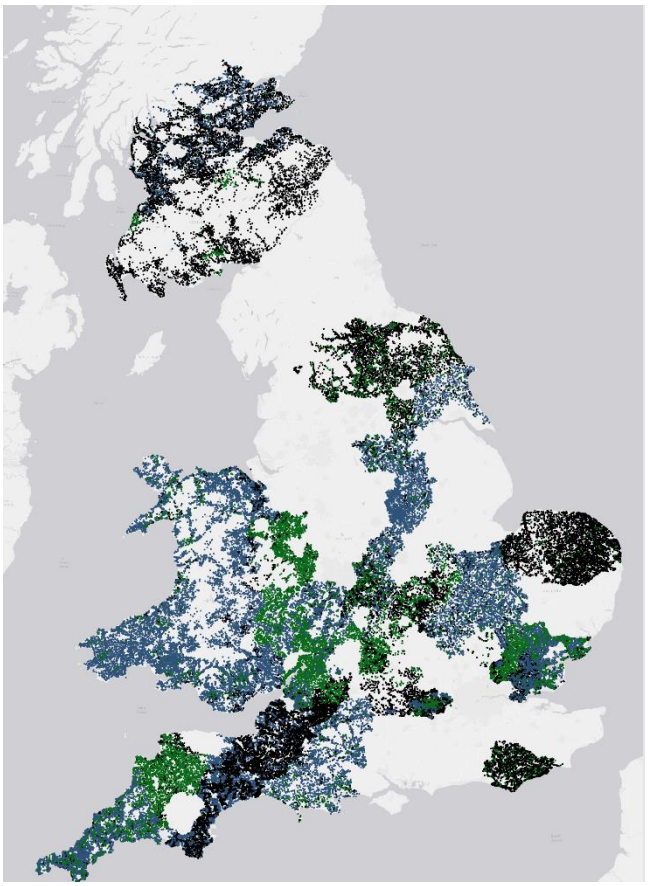
3.2.1 Target areas for Phase 3 contracts

The target areas for the Programme were defined in Speed and Coverage Templates (SCTs) developed by Local Bodies based on the Open Market Review. The template identifies those premises that are not expected to receive superfast coverage under the commercial plans of network providers (white postcodes) and are therefore eligible for subsidised coverage.

These templates are completed by network providers as part of the tendering process, where they set out which premises will be upgraded as part of the proposed network build (the build plan). Premises on 64,000 postcodes were included in the build plans of Phase 3 contracts (four percent of the postcodes in the UK).

Premises on 54,000 postcodes were identified as eligible for the programme but were not included in the build plans of Phase 3 contracts.[6]

Figure 3.2: Eligible postcodes within and excluded from the build plans of Phase 3



Source: SCT templates, C3 Reports, Ipsos analysis; green denotes built to as of September 2022, black are in build plans to be delivered to and blue are other white postcodes

It should be noted that the SCTs do not provide a complete record of white, grey, and black premises across the UK. SCTs were only available for those areas for which contracts were awarded. Additionally, the premises listed in Phase 3 SCTs only provided partial coverage of the territory covered by the relevant Local Body.

[6] Suppliers did not have to cover all eligible premises in their bids for Superfast Broadband contracts.

Table 3.2: Overview of Speed and Coverage Templates, Phase 3 contracts

Status	Phase 3	
	Number of postcodes	% of postcodes in UK
White postcode within build plan defined in SCT	64,473	4.3
White postcode out of build plan defined in SCT	53,729	3.5
Grey or black postcode in SCT	43,602	2.6
Total	**161,804**	**10.5**
Number of SCTs	65[7]	

Source: SCT templates, Ipsos analysis. Note, figures may not sum to total due to rounding.

The postcodes included in the build plans of Phase 3 contracts were linked to other datasets to obtain information on their characteristics before the Programme began. An overview of their key features in relation to other white postcodes that did not benefit from the Programme is provided in the Table 3.3. The table highlights that those postcodes included in the build plans of local schemes differed in several ways from other postcodes eligible for investment through the programme:

- **Availability & coverage:** Superfast broadband penetration was lower in postcodes included in Phase 3 build plans than in other white postcodes that were eligible for investment (in both 2012 and 2016). This is also reflected in measures of take-up, including the average and maximum speeds of connections and the number of superfast connections taken by consumers located in the postcode.

- **Network characteristics:** Areas in the build plans covered by Phase 3 contracts were also more likely to exhibit characteristics that would increase the costs of deployment or reduce commercial viability. Premises included in the build plans of Phase 3 contracts were characterised by longer line lengths to the serving cabinet. These are more expensive to upgrade as copper lines from the serving cabinet are less able to deliver at least superfast speeds, requiring additional investment in fibre. Demand density was also lower – with lower numbers of delivery points per exchange/cabinet and lower population and premises density. This reduces the number of customers that can potentially be served and the potential revenues that can be earned. BDUK modelling completed in 2014 also suggested that the estimated cost of upgrading the serving cabinet would be higher.

- **Area characteristics:** Postcodes included in the build plans of Phase 3 contracts were more likely to be rural in nature (74 percent of postcodes compared to 64 percent of postcodes eligible but not included in build plans). Employment and unemployment rates in the local authorities were similar across groups, though average wages were lower in those areas included in Phase 3 build plans than in areas not included in build plans.

This indicates network providers selected premises that were costlier to upgrade and were characterised by weaker demand side characteristics. This is the reverse of the patterns observed for Phase 1 and Phase 2 of the Programme. This may be related to the comparatively high levels of penetration in white postcodes that were not included in the build plans of Phase 3 contracts. Where existing levels of

[7] A total of two SCTS were excluded as they did not provide the required detail and no alternatives were available.

penetration is high, the remaining unserved premises may be concentrated in relatively small pockets. It may not be cost effective to build out networks to fill these gaps in provision. Network providers may have targeted communities with low levels of existing penetration to maximise the size of the local markets that could be addressed.

Table 3.3: Characteristics of postcodes included in Phase 3 build plans

Characteristics	Postcodes in Phase 3 build plans	Postcodes receiving subsidised coverage by Sep. 2021	White postcodes not included in Phase 3 build plans
Broadband availability and take-up in 2012			
% of postcodes with Next Generation Access	14.9	14.3	39.6
Average maximum download speed (Mbit/s) of connections[8]	9.3	10.0	13.4
Average download speeds (Mbit/s) of connections	6.2	9.7	13.9
Broadband availability and take-up in 2016			
% of postcodes with Next Generation Access	70.4	72.4	79.8
% of postcodes with superfast (30Mbit/s) access	25.2	25.2	55.6
Average number of premises on postcode with superfast connections[9]	1.7	5.1	8.1
Network characteristics in 2013			
Length of line from exchange to premises (m)	3,588	3,050	2,165
Share of premises with exchange only lines (%)	22.3	13.0	4.5
Delivery points at serving exchange	6,231	10,765	17,601
Delivery points at serving cabinet	242.7	300.5	381.0
% of postcodes in Virgin Media footprint	0.7	14.7	48.4
Number of residential delivery points	11.1	14.9	19.6
Number of non-residential delivery points	1.0	1.1	0.7
Estimated cost to upgrade serving cabinet (£)	65,549	63,939	61,834
Estimate upgrade cost per premises upgraded (£)	325.5	307.9	179.3
Area characteristics in 2013			
% of postcodes in rural areas	74	54	64
Working age population (in Output Area)	170	195	200
Population aged 65+ (in Output Area)	62	55	50
Population density in OA (population per square km)	634	1,659	4,412
Premises density in OA (premises per square km)	402	988	2569
Gross weekly earnings in LA (£)	465	537	519
Employment rate in LA (%)	71.8	74.4	71.1
Unemployment rate in LA (%)	6.1	7.1	8.2

Source: Ipsos Analysis

[8] Note that this does not factor in the number of premises on a postcode able to reach a certain maximum download speed

[9] There were around 11.3 premises per postcode on postcodes in the build plans of Phase 3 schemes.

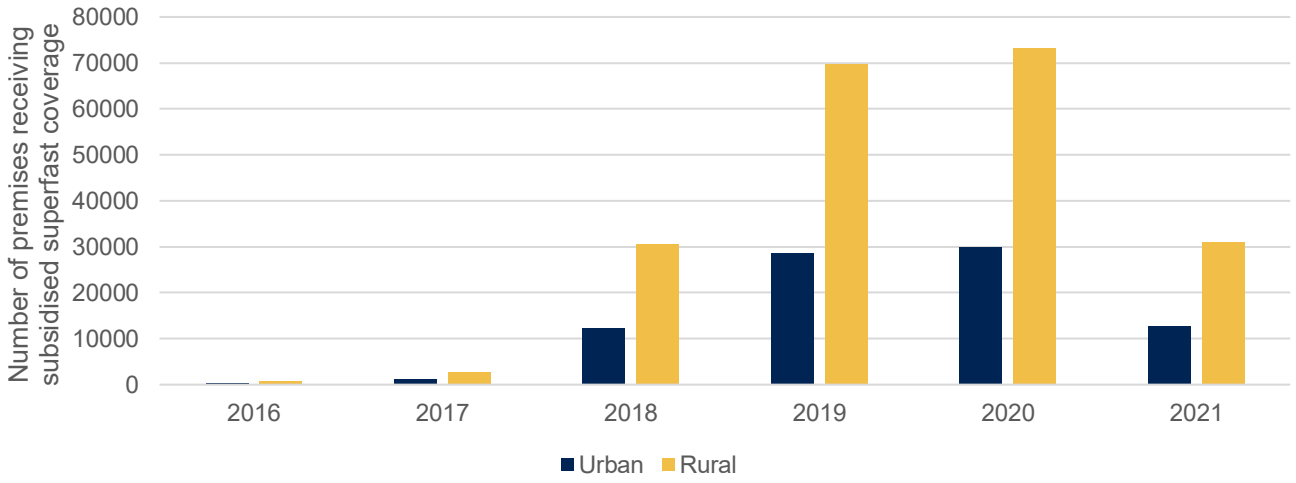
3.2.2 Delivery of Phase 3 contracts

Delivery of the Programme began in 2016 and analysis of C3 reports provided by BDUK indicated that around 292,618 premises received subsidised coverage by September 2021 (over 37,000 postcodes). It should be noted that most coverage was towards the latter stages of the time horizon for this evaluation.

Additionally, unlike prior Phases of the programme, Phase 3 contracts prioritised gigabit capable technologies with most premises passed by FTTP (rather than Fibre-to-the-Cabinet).

As take-up of superfast broadband services will follow deployment, it should be noted that the estimates of the impact of the programme presented in this paper are likely to understate the eventual impact of the programme on take-up.

Figure 3.3: Number of premises receiving superfast (30Mbit/s[10]) coverage subsidised by BDUK, areas for which Phase 3 SCTs are available, 2016 to 2021



Source: C3 reports, Ipsos analysis.

[10] 24MBits for Phase 1 and Phase 2

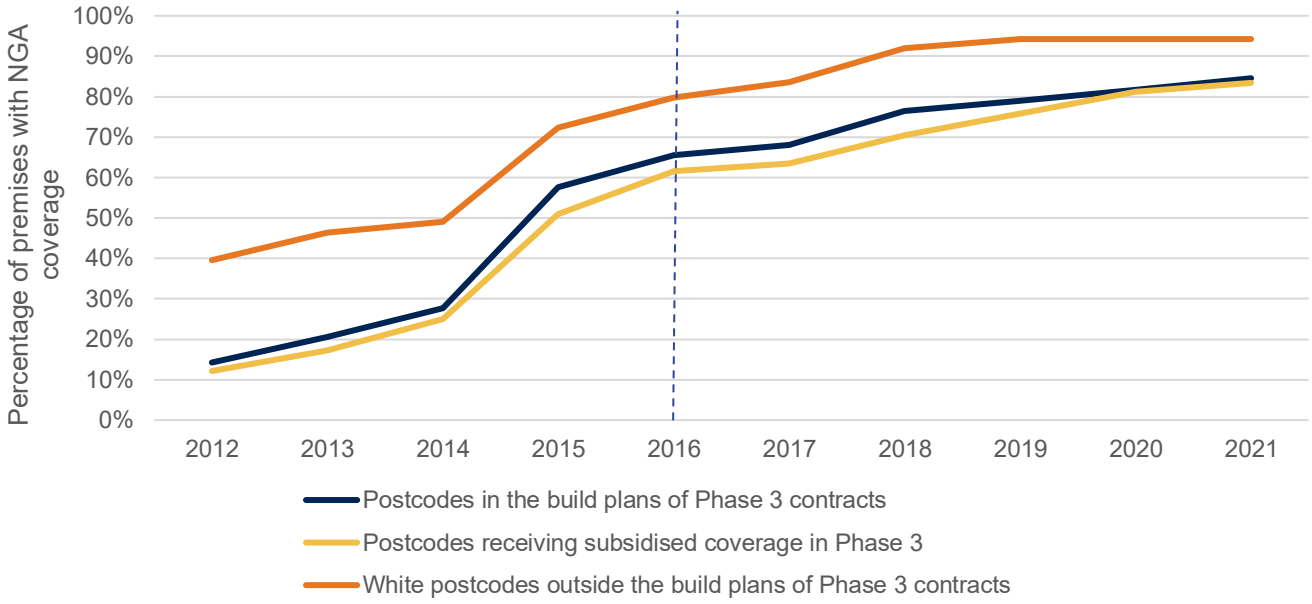
4 Programme outcomes

This section provides an assessment of the key outcomes and impacts achieved by the Superfast Broadband Programme by 2022. The findings here draw on an analysis of management data held by BDUK describing the delivery of the Programme, econometric analyses exploring the net impacts of the Programme on NGA and superfast broadband coverage, a survey of households, and qualitative findings from research undertaken with, telecommunication providers, and public service providers.

4.1 Reducing the digital divide

The following figure shows changes in availability of Next Generation Access (NGA) broadband (FTTC, FTTP/Gigabit capable, Wireless or Cable) between 2012 and 2021 on white postcodes included and excluded from the build plans of Phase 3 contracts. The percentage of postcodes included in the build plans of Phase 3 contracts with NGA coverage rose from 66 percent to 85 percent between June 2016 and September 2021. NGA coverage was persistently higher on white postcodes outside of Phase 3 build plans (rising from 80 percent to 94 percent over the same period).

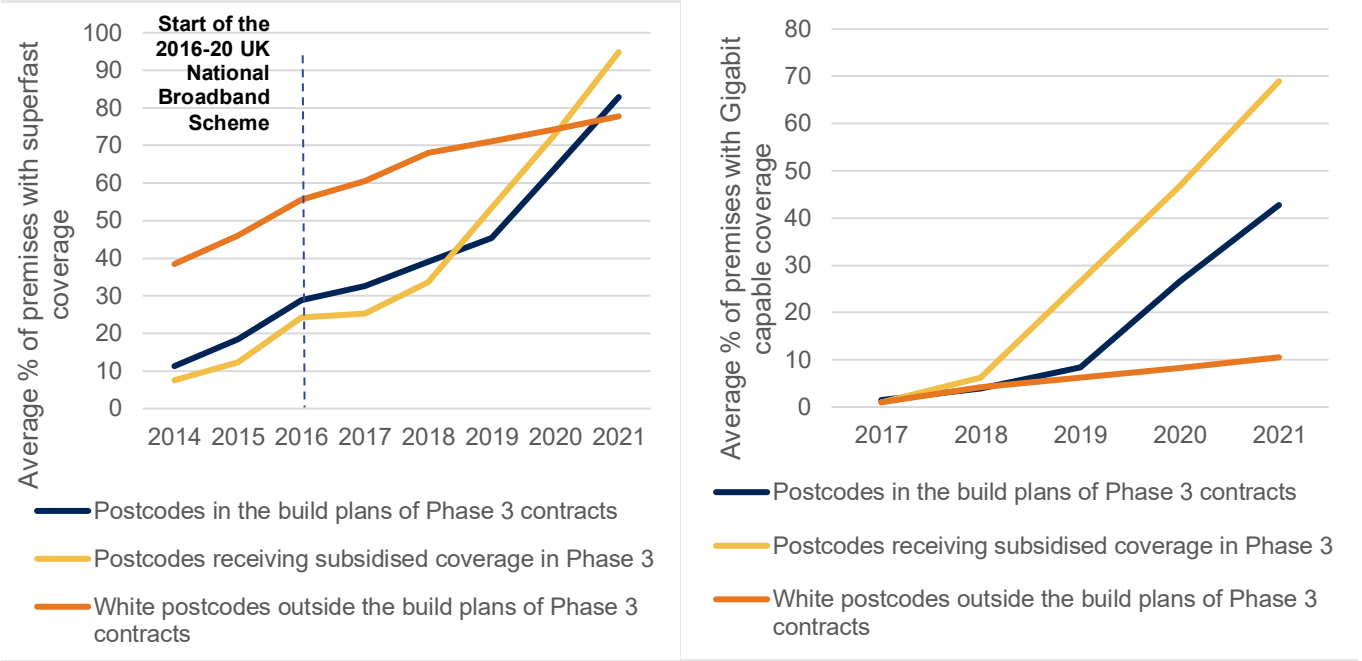
Figure 4.1: Changes in Next Generation Access (NGA) coverage – areas in Phase 3 build plans and other white postcodes, 2012 to 2021



Source: C3 reports, Ofcom Connected Nations, Ipsos analysis.

Superfast broadband coverage rose at similar rates in areas covered by Phase 3 build plans and other white postcodes between 2016 and September 2019 (from 29 to 45 percent and from 55 to 71 percent respectively). However, in line with the delivery profile, areas within Phase 3 build plans saw coverage expand much more rapidly between 2019 and 2021, rising from 45 percent to over 80 percent of premises over the period. FTTP/Gigabit capable coverage also rose more rapidly in the programme area than on other white postcodes.

Figure 4.2: Changes in superfast broadband (at least 30Mbit/s) and gigabit capable coverage (% of premises), areas in Phase 3 build plans and other white postcodes, 2014 to 2021



Source: C3 reports, Ofcom Connected Nations, Ipsos analysis. Note data on FTTP coverage is only available from 2017 onwards.

A range of statistical analyses were completed to estimate the impact of the Programme on both measures of broadband availability and take-up. These analyses showed:

- **Impacts on NGA and superfast coverage:** Subsidised coverage through Phase 3 of the Programme led to a significant positive impact on the availability of superfast and gigabit capable broadband services by the end of September 2021. Subsidised coverage increased the share of premises in the programme area able to access superfast speeds by 41 to 47 percentage points, and the share of premises with gigabit capable coverage by 43 to 56 percentage points. The impact of the programme on NGA availability was relatively small, however, indicating that in its absence most premises would have benefitted from some form of enhanced connectivity (albeit via technologies less able to deliver download speeds of 30Mbit/s or higher). These findings are consistent with prior research into the impacts of the programme on broadband coverage.

- **Take-up:** Subsidised coverage led to a significant increase in the maximum download speeds of connections taken by households and/or businesses by September 2021 (34 to 60 Mbit/s). However, the impacts of the programme on average download speeds were relatively small. This indicates that 'early adopters' have taken advantage of the enhanced broadband connectivity enabled by the Programme. However, the Programme had not led to widespread take-up of faster broadband services by September 2021. It should be noted that most subsidised coverage was delivered in 2019 and 2020. As take-up will lag deployment, it is premature to draw any firm conclusions on the impact of the programme on take-up of faster internet services. Again, this is consistent with prior research into the impacts of the programme on take-up.

Estimates of the additionality of the coverage funded through the programme are taken from Technical Appendix 1 of the Superfast Broadband State aid report[11], which examined the share of the premises involved that would not have been upgraded in the absence of the programme (and how this evolved with time). These findings suggested that:

- **Superfast vs gigabit availability:** The level of additionality associated with gigabit coverage was higher than for superfast availability. This implies that while many households would not have benefitted from gigabit infrastructure in the absence of the programme, some may have benefitted from upgrades that enabled superfast broadband services. Average levels of additionality across the two technological standards were used for the purposes of this analysis (reflecting an assumption of diminishing returns to speeds).

- **Evolution over time:** The level of additionality was estimated to peak in the year after the premises were upgraded (at 81 percent). Additionality was estimated to decay to 49 percent in the fourth-year post-installation (an average rate of decay of 16 percent per annum). This aligns with patterns observed for prior Phases of the programme. However, the estimated level of additionality associated with Phase 3 was notably higher than for prior Phases, indicating that the areas concerned were substantially less likely to benefit from commercial deployments without public sector support. This is reinforced by the findings set out in Technical Appendix 2 of the State aid report, which show that the rates of return associated with Phase 3 contracts are likely to fall below network providers' cost of capital in many cases (even with public subsidies).

- **Projected additionality:** Projections of additionality to 2029/30 were developed on the following basis:

  - **Lower bound estimate:** A lower bound estimate was developed by extrapolating these results over the duration of the appraisal period (i.e. at a rate of 16 percent per annum). This assumption implies that additionality would fall to 12 percent 12 years post-installation, capturing a scenario in which 88 percent of premises upgraded eventually benefit from enhanced broadband coverage.

  - **Upper bound estimate:** The lower bound projection appears potentially pessimistic given parallel findings in relation to the commercial viability of investments in FTTP in areas covered by Phase 3 contracts. While commercial deployments of FTTP have expanded rapidly since 2020, it might be expected that some areas will never be covered by commercial deployments without substantial technical innovations to reduce deployment costs (or if network providers are able to subsidise such deployments with profits earned from investments in commercially viable areas). An upper bound scenario, in which additionality decays at a slower rate to 30 percent in 2029/30 was adopted to capture this possibility.

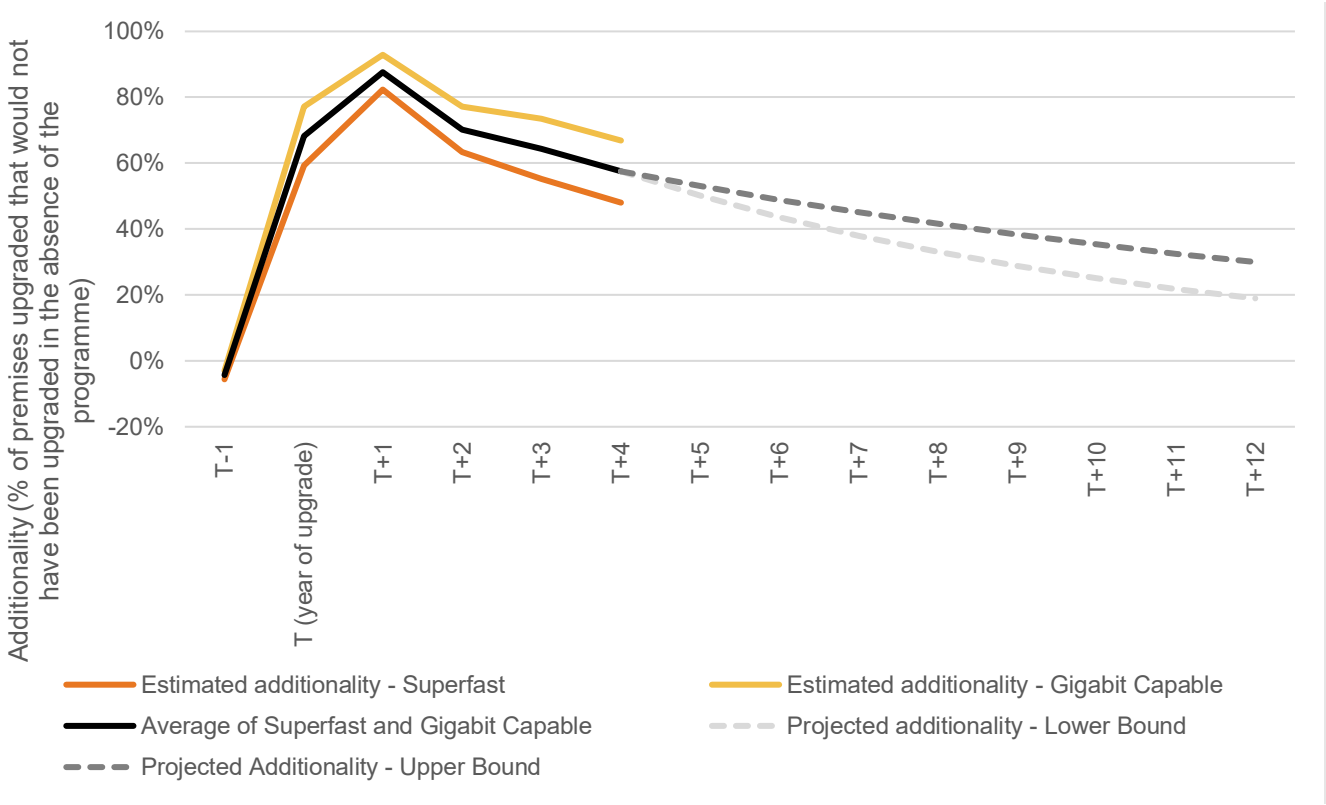
- **Delaying effect:** The evidence also suggested that seven percent of premises upgraded would have otherwise received superfast coverage one year earlier in the absence of the programme. This is consistent with evidence from qualitative research with network providers as part of the 2020 State aid evaluation that suggested that the OMR process could lead to some postcodes being marked as eligible for investment where commercial deployment plans were insufficiently developed or certain.

[11] BDUK (2023) Superfast Broadband Programme - State Aid evaluation report 2023, available at: https://www.gov.uk/government/publications/superfast-broadband-programme-state-aid-evaluation-report-2023#:~:text=The%20evaluation%20aims%20to%20provide,detail%20on%20the%20analysis%20conducted.

The likelihood that a subsidised competitor would emerge would discourage investment in these areas. This delaying effect will have negative economic and social costs in the short-term and this is modelled using a negative value for additionality in the year prior to the upgrade.

The figure below displays the assumed additionality profile over time under the two scenarios.

Figure 4.3: Additionality profile over time



Source: Ipsos UK analysis

4.2 Market outcomes

The Superfast Broadband Programme was expected to stimulate competition in the broadband market. This has been explored using supplier level data on broadband coverage and take-up compiled by ThinkBroadband.

Between 2016 and 2022, the market share of total broadband connections for the beneficiaries decreased, driven by a decrease of the market share for Openreach (via Sky and TalkTalk). However, the market share of the NGA market has increased – due to the increase in NGA services offered through the Openreach network. For the smaller network providers, the market share of total broadband connections has increased from close to zero in 2016 to just under one percent in 2022, and to just over one percent of the NGA market (see Table 4.3 below).

Table 4.1: Market share of the total broadband market for Superfast Broadband Programme beneficiaries (percentage of total number of broadband connections)

Network provider	Total broadband market			NGA market		
	2016	2020	2022	2016	2020	2022
Openreach (including Sky and TalkTalk)	*78.08%*	*75.16%*	*71.03%*	*60.46%*	*67.23%*	*65.99%*
Airband	0.01%	0.09%	0.06%	0.12%	0.12%	0.08%
Gigaclear	0.08%	0.18%	0.35%	0.15%	0.25%	0.43%
Callflow	0.02%	0.02%	0.01%	0.02%	0.02%	0.01%
Relish	0.00%	0.01%	0.01%	0.00%	0.02%	0.02%
Fibrus	0.00%	0.00%	0.09%	0.00%	0.00%	0.11%
Quickline	0.02%	0.04%	0.06%	0.06%	0.07%	0.08%
Wessex	0.05%	0.09%	0.30%	0.16%	0.18%	0.36%
Total programme participants	**78.26%**	**75.59%**	**71.93%**	**60.97%**	**67.89%**	**67.07%**
Virgin Media	*19.86%*	*17.10%*	*20.64%*	*36.90%*	*23.30%*	*24.84%*
Other providers	*1.88%*	*7.31%*	*7.43%*	*2.13%*	*8.81%*	*8.09%*

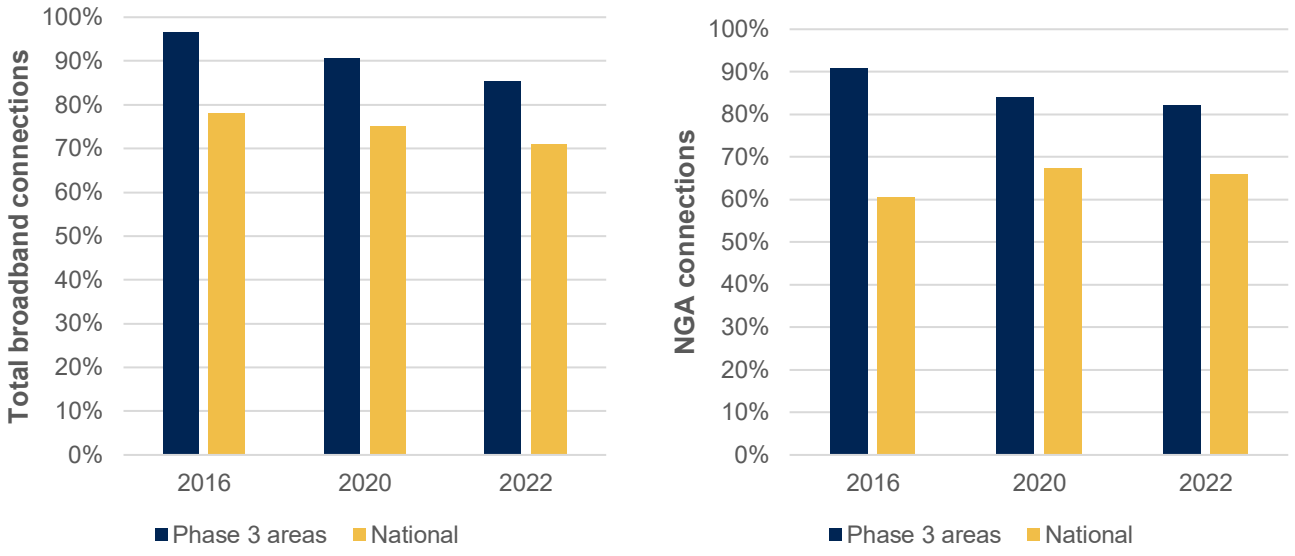
Source: Thinkbroadband data

4.2.2 Effects on Programme beneficiaries

The market share of the broadband market for the network providers across the areas that the Superfast Broadband Programme has or is currently operating in for Phase 3 of the Programme (postcodes which the Superfast Broadband Programme has provided enhanced connectivity to) was analysed using the same approach. This approach was taken instead of examining the impact at a local authority level as at the local authority level it would not be possible to distinguish the impact of contracts awarded in different Phases of the programme.

The market share for Openreach (including Sky and TalkTalk) across these areas declined between 2016 and 2022, from around 97 to 85 percent of all broadband connections. While this is higher than the national average (between 70 and 80 percent), the decline in market share aligns with the national trends for Openreach. In terms of NGA connections, the pattern in Phase 3 areas remains the same, with a decrease in Openreach's market share in the Phase 3 areas (91 to 82 percent of all NGA connections), but this is not matched by the national trends, where there is no clear pattern for Openreach's market share (see Figures below).

Figure 4.4: Openreach market share in Phase 3 contract areas and nationally, for total broadband connections and NGA connections, 2016 - 2022

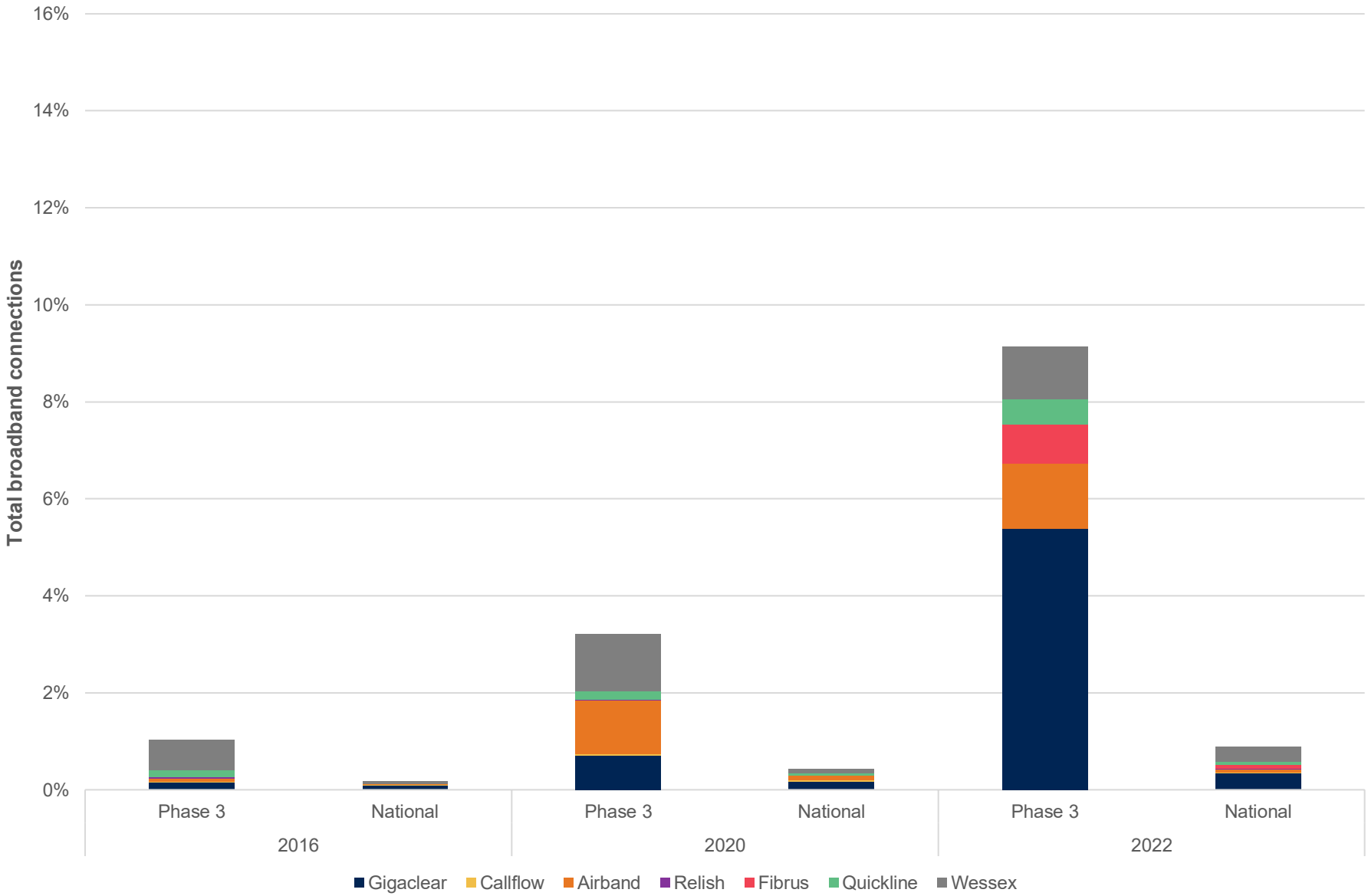


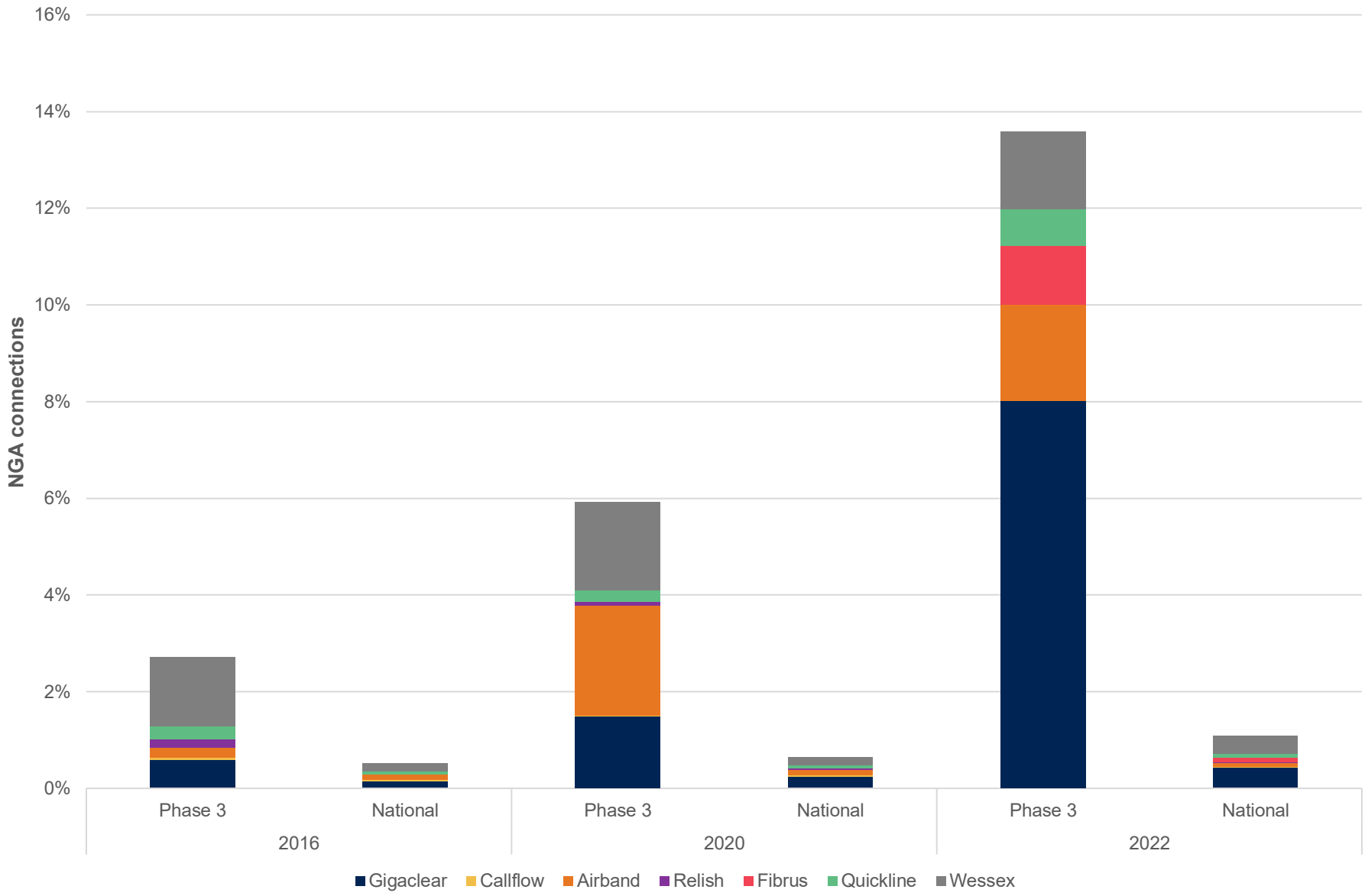
Source: Thinkbroadband speed test data

The market share for all broadband connections and NGA connections for all other network providers awarded contracts through the Superfast Broadband Programme is presented in the figure below. This shows that the market share of these network providers rose faster between 2016 and 2022 in Phase 3 contract areas than nationally.

Airband and Gigaclear – who have been awarded more contracts – saw larger increases in market share in the Superfast Broadband Programme delivery areas. Similar patterns are seen in terms of their share of NGA connections. However, the overall market share of these network providers is still relatively low, even at the local level, with no network provider having more than five percent of the total broadband market in 2022 in the areas where the Programme has delivered connections.

Figure 4.5: Other beneficiaries market share in Phase 3 contract areas and nationally, for total broadband connections and NGA connections, 2016 - 2022





Source: Thinkbroadband speed test data. NOTE: The scale of the market share in the figure is from 0 to 5 percent of the total market – caution when comparing to Figure 4.4

4.3 Economic outcomes

The Superfast Broadband Programme was expected to produce local economic growth by helping firms improve their competitiveness and find new markets. A range of econometric analyses were completed to explore these impacts, using firm and worker level data drawn from a variety of ONS datasets. These analyses explored the effects of improved broadband infrastructure by comparing areas benefitting from the Programme in earlier years to those that benefitted later.

The results suggested that the Programme has produced a variety of important economic impacts at the local level:

- **Local employment impacts**: Subsidised coverage from Phase 3 contracts was estimated to have increased employment in the areas benefitting from the Programme by 0.88 percent, leading to the creation of approximately 6,261 jobs in Phase 3 contract areas, and 23,700 local jobs across the entire programme area by the end 2021.

- **Turnover**: Subsidised coverage also increased the turnover of firms located in the areas benefitting from Phase 3 of the Programme by 1.6 percent, increasing the annual turnover of local businesses in Phase 3 areas by £827 per annum, and for the whole programme by 1.4 percent, approximately £2.6bn per annum by 2021.

- **Turnover per worker**: There was also some evidence of efficiency gains - turnover per worker of firms in the areas benefitting from Phase 3 of the Programme rose by 0.42 percent in response to subsidised coverage. This was not solely driven by more productive businesses moving into areas with improved broadband infrastructure. Firms that did not relocate over the period also saw their turnover per worker rise by 0.17 percent by 2021, indicating that subsidised coverage has also raised the efficiency of firms. It should be noted that while subsidised coverage had a stable effect on turnover, impacts on employment increased with time. This led to the strength of the gains in turnover per worker appearing to decay with time.

- **Wages**: The impacts of the Programme were also visible in wages. Employees working for firms located in the areas benefitting from subsidised coverage saw their hourly earnings increase by between 0.6 and 0.8 percent in real terms in response to the upgrade (which did not vary significantly across occupational groups). This gives greater confidence that the Programme led to an increase in productivity.

- **Unemployment**: Local job creation also appeared to translate into reduced unemployment, with the number of unemployed claimants falling by 34.3 for every 10,000 premises upgraded.

The findings above describe the effect of the Programme on the areas that benefitted from subsidised coverage. However, these results do not account for possible negative effects in areas that did not benefit from the Programme. For example, as the Programme encouraged firms to move to the areas benefitting from enhanced broadband coverage, there will have been offsetting loss of jobs in the areas from which those firms relocated. Allowing for these types of offsetting effects, at the national level, the Programme is estimated to have resulted in £8.4m in productivity gains in total between 2016 and 2021.

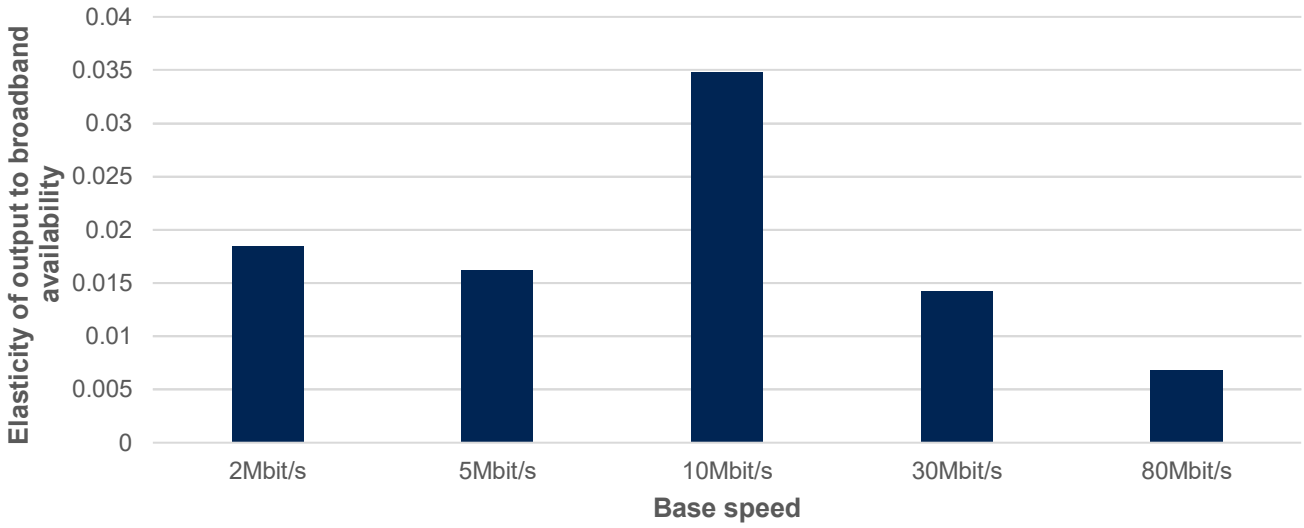
Further analysis was undertaken to explore the economic impacts of the Superfast Broadband Programme for businesses by the speed that was made available by the enhanced coverage. The analysis examined the elasticity of output to broadband speeds and the marginal rate of return to businesses from changes in broadband speeds if labour and capital inputs are held constant. The analysis showed that there is an

estimated elasticity of output to availability of 0.019 percent. This indicates that a 1 percent increase in broadband speed led to a 0.019 percent increase in GVA. For SMEs, the elasticity was slightly higher at 0.026 percent.

The analysis also explored the results depending on the speed of connection that was available to businesses before enhanced connectivity is provided to their area. This showed that:

- Upgrades from basic broadband: Base speeds of below 10 Mbit/s were associated with elasticities of between 0.016 and 0.035 percent. The higher range was obtained where areas had a base speed of under 10Mbit/s but higher than 5 Mbit/s.
- Upgrades from superfast to ultrafast: Estimated elasticities for upgrades above superfast were smaller and imply that improvements from superfast to ultrafast had a lower impact on output than changes from basic broadband.

Figure 4.6: Output elasticities by base speed



Source: Ipsos analysis.

4.4 Public sector outcomes

A mixed methods approach was used to explore the effects that the Superfast Broadband Programme has had on public sector efficiency. Where secondary data was available, econometric analysis was also undertaken to explore the effect of the Programme on objective measures of public sector service performance.

Qualitative research was undertaken in two local authority areas in the UK – Cumbria and Wolverhampton, to explore how public services adapted during the Covid-19 pandemic, and whether any changes in services had continued to be implemented since restrictions were lifted. The research initially aimed to focus on the social care strand of public service provision, due to findings in the previous evaluation of the Superfast Broadband Programme focussing on library services, schools and local authorities working from home. However, due to the complex needs of many people involved in social care, the case studies expanded to cover health service provision, education and access to local government services for individuals in remote areas.

The two selected case study areas provided a good contrast in terms of type of area – with Wolverhampton being a very urban area with very good existing levels of broadband connectivity, whereas Cumbria has a lot of rural areas which have struggled, and continue to struggle with broadband coverage.

The key findings from the research demonstrated that in Wolverhampton, there were no infrastructure challenges associated with switching to digital solutions when the Covid pandemic began. Schools and GP practices switched towards online communication for some GP consultations, (although some remained over the phone and in person), and for school lessons and homework. Staff delivering social care, education and health services were required to work from home a lot more frequently than before the pandemic, but this did not pose any issues. However, in Cumbria, the switch to digital solutions during the pandemic was more problematic. This was because there were still many premises in the area that did not have good broadband connections, therefore could not fully utilise online learning from schools or engage with GP practices online, alongside struggling to engage with other local government departments as a result of offices closing.

In social care, and particularly community care, the approach to care provision in both areas did not alter much during the Covid pandemic as a result of enhanced connectivity. The major changes were around social distancing and the provision and wearing of Personal Protective Equipment. There was more working from home than was the case previously as central offices were closed. However, the experience of those using care services remained largely the same.

However, in Cumbria, since the end of the pandemic, the ways in which social care is being delivered is altering. This is in part due to the increased connectivity being provided through the Superfast Broadband Programme. These are:

- An increased use of online records and linking of records between services. Previously, most social care notes were taken by hand, typed up at a later date and stored on separate systems. However, Councils in Cumbria are now moving towards online records, with social workers typing up notes directly onto connected devices while visits are taking place, between visits or at home, which can then be uploaded directly onto central systems. This requires mobile broadband coverage as well as enhanced fixed broadband infrastructure. However, an important factor is that these records are now starting to be connected to other databases, such as those at GP practices. These other databases were not able to connect to social care databases previously, partially because many GP practices had poor broadband connectivity, and as this has improved, data sharing possibilities have become enhanced.

- Trials of automated social care visits. This includes the provision of tablet based social care visits, where a social worker will check in on a client digitally rather than in person. This is not appropriate for all clients or all the time, but it does help social workers speak to more clients in a day. Additionally, in social care for older individuals, pilots have been trialled using automated and AI solutions for some clients, such as automated reminders for medication or tasks. These are not widespread yet, but if the trials are successful the council will expand them. These interventions need to be supported by enhanced broadband infrastructure, otherwise some individuals will not be able to access these services, even if they are eligible for them.

Although there were no infrastructure issues in Wolverhampton when switching to digital solutions during the pandemic, a significant problem did materialise. This was that although most premises in the local authority could access decent broadband connections, due to the levels of deprivation in the area there were significant numbers of people that either could not access broadband because they could not afford

the connection, or they did not possess the hardware (computers, laptops etc.) to utilise connections. This meant that there were many households that could not access education and health services. To increase access, the local authority, in partnership with neighbouring authorities and the local health board, provided a loan scheme for laptops and dongles to be provided to households for a month loan at a time. Households could be referred to the scheme by health and social care professionals. When the household was approved for a loan, they were provided with some initial training and guidance of how to use the laptop and internet connection.

This scheme proved to be very successful over the pandemic and has been continued and expanded since the end of the pandemic. This is because education and health services in particular are continuing to require access to the internet to facilitate the provision of public services – through means such as portals for sharing homework from schools and online learning materials, to online booking and consultations in the health service.

GP practice outcomes

A statistical analysis undertaken to explore the impact of the Superfast Broadband Programme on GP practices and found that the programme had an impact in both raising awareness and usage of online services amongst patients registered with GP surgeries:

- **Awareness:** Awareness of the availability of on-line services to book appointments, order repeat prescriptions and review medical records online rose by 9, 7 and 7 percentage points respectively in response to the provision of subsidised coverage.
- **Usage:** Usage of these services increased between 2 and 7 percent.

The findings suggest that patients have found new ways to access primary care services as a result of the Superfast Broadband Programme. However, the underlying mechanism is not clear and there are several possible explanations of the underlying result. Enhanced connectivity may have encouraged or enabled GP surgeries to offer more services on-line. However, these results would also be explained if increased take-up of superfast connectivity in the surrounding area made residents more aware of online services already being provided by GPs (or if it attracted new residents to the areas concerned that were more familiar with the on-line delivery of primary care services).

The findings gave mixed results in terms of the impact of enhanced broadband connectivity on these measures:

- **Time with GP:** Subsidised coverage appeared to increase the proportion of patients that were satisfied with the amount of time given to them for their last appointment by one percentage point.
- **Access and continuity of care:** However, subsidised coverage had a negative impact on measures of access and continuity of care. Subsidised coverage led to a reduction in the share of patients satisfied with the availability of appointments (by four percentage points) and the share of patients able to see their preferred GP most or all the time (by five percentage points). These are indicative of capacity pressures on GP surgeries receiving subsidised coverage.
- **Overall satisfaction:** Overall, subsidised coverage appeared to reduce the share of patients that described their experience as fairly or very good by two percentage points.

The data also supported an investigation of the impacts of the Superfast Broadband Programme on the supply and demand for primary care services (over a more extensive period, from 2012 to 2021). This

included the number of patients registered with the GPs concerned (giving a measure of demand), and clinical and non-clinical staff employed by the GP surgery (giving a measure of supply). The findings indicated:

- **Number of patients:** Subsidised coverage increased the number of patients registered with GPs by 3.4 to 8.1 percent on average.
- **Staffing:** However, the number of staff employed by GP surgeries did not rise to the same degree. Subsidised coverage led to an increase in the number of nursing and non-clinical staff of 5.6 to 5.7 and 5.6 to 7.6 percent respectively. The number of GPs also increased by between 3.1 and 4.5 percent unlike in previous analysis.

The findings indicate that subsidised coverage has led to an increase in demand for primary care services (as visible in the positive effects on the number of patients registered with the GP). However, the increase in demand has not been met by an equivalent increase in the supply of primary care services.

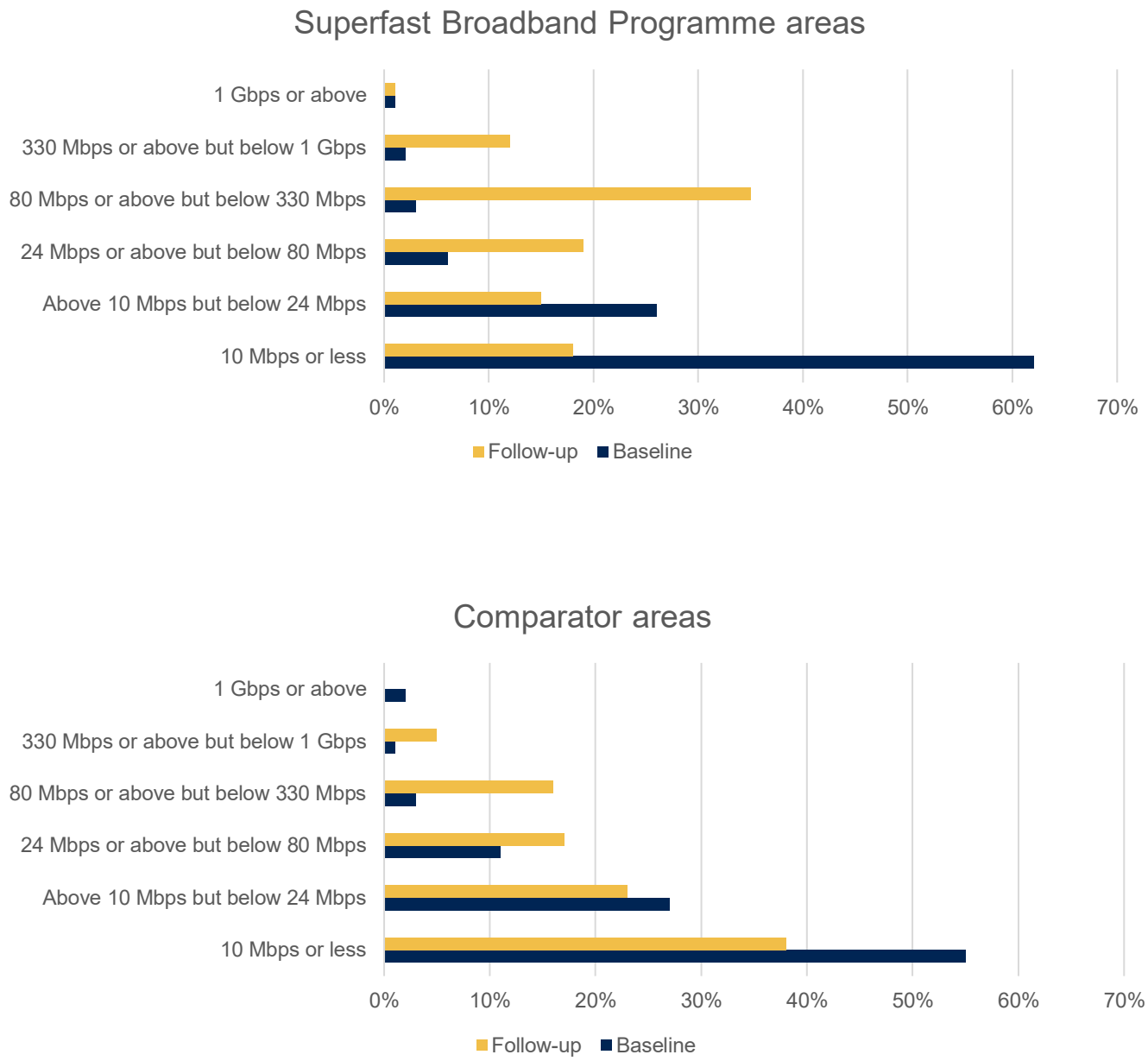
4.5 Public wellbeing

4.5.1 Longitudinal survey analysis

The longitudinal survey of households provided a large degree of insight into the effects of having access to better broadband connections for households. The survey covered internet use, connection speeds and societal outcomes which are expected to flow from the provision of faster broadband connections.

The survey data demonstrates that the provision of the Superfast Broadband Programme has had a positive impact on the internet connection speeds of households in areas that have received subsidised coverage. This information was collected in two ways in the survey – asking respondents what their reported speed was (in categories) and respondents completing a speed test. Using both approaches, the reported connection speed had improved at a greater rate in Superfast Broadband Programme areas than in comparator areas, with reported speeds having increased from 20 Mbps in both groups at baseline to 116 Mbps in Superfast Broadband Programme areas (compared to 63 Mbps in the comparator group). The figure below presents the changes in reported speed category from households, which demonstrates that households in Superfast Broadband Programme areas are more likely to have seen their connection speed increase between the baseline and follow-up survey, with over 60 percent of households in the comparator areas still having sub-superfast speeds, compared to under 40 percent in the Superfast Broadband Programme areas.

Figure 4.7: Self-reported connection speeds in baseline and follow-up surveys



Source: Household survey of adults aged 18+ who go online nowadays when at home through their home internet connection and provided an estimate
Baseline: Not delivered to (661), Delivered to (652), 8/11/2021 – 10/01/2022

Follow-up: Not delivered to (347), Delivered to (303), 20/11/2023 – 17/03/2024

The increase in connections speeds has also led to an increase in the reported levels of satisfaction with broadband connections. Whilst households in Superfast Broadband Programme areas and comparator areas both saw a positive improvement in perceptions, it was residents in the Programme areas who were most positive – 42 percent stated that it was very good in the follow-up survey – an increase of 35 percentage points compared to the baseline. In the comparator areas, 22 percent stated very good - an increase of 14 percentage points.

Both the Superfast Broadband Programme and comparator areas showed an increase in the share of residents who had upgraded their internet connection to one that was faster or better, at the follow-up stage 69 percent of households in the Superfast Broadband Programme area reported having upgraded

their connection and just over half of households in the comparator areas. The speed of internet connection was the most common reason for upgrading.

These findings show that the conditions for the Superfast Broadband Programme to achieve downstream societal impacts are in place as connectivity has improved, as has take-up of faster connections.

Households that had upgraded their internet connection perceived it to have had a positive impact on the following aspects of life:

- Doing things online saves them time (55 percent of those in Superfast Broadband Programme areas that have upgraded strongly agreed with this statement);
- Doing things online makes things easier (58 percent of those in Superfast Broadband Programme areas that have upgraded strongly agreed with this statement);
- Had made keeping in touch with friends and family easier (66 percent of those in Superfast Broadband Programme areas that have upgraded felt a faster connection made it easier to stay in touch); and
- Had made watching entertainment and content easier (82 percent of those in Superfast Broadband Programme areas that have upgraded felt a faster connection made it easier to watch entertainment).

However, nearly a quarter of households that have upgraded their connections in Superfast Broadband Programme areas also reported that they felt they were addicted to going online.

The survey also collected data on the frequency of working from home for residents that are employed. It should be noted that the baseline survey took place during Covid-19 restrictions, and therefore working from home arrangements were necessary for many people to work, which was not the case for the follow-up survey. However, as the Covid-19 pandemic impacted the Superfast Broadband Programme and comparator areas equally, the difference in the change of working from home patterns between the two groups is not estimated to be due to Covid-19 restrictions. The findings from the survey indicated that working from home frequency in Superfast Broadband Programme areas had remained constant at around 2.7 days per week, whereas working from home frequency had fallen in the comparator areas from 3.3 days per week to 2.9 days per week**.** A statistical difference in differences analysis was undertaken, which indicated that the provision of the Superfast Broadband Programme is estimated to have led to an increase in the number of days WFH of between 0.7 and 0.8 days per week – which indicates that the Programme has supported individuals to maintain their WFH patterns whereas in other areas individuals have had to return to their workplace. However, the sample for this analysis is relatively low, as it only includes those that were employed in both waves of the survey.

Despite the increase in working from home frequency, the survey and statistical analysis found that the provision of the Superfast Broadband Programme had no impact on commuting times experienced by residents who were employed – with commuting duration per week increasing in both area types. This, coupled with the WFH findings, suggests individuals in Superfast Broadband Programme areas are commuting for longer when they have to go to their workplace than individuals in non-upgraded areas. This finding contradicts the findings from the environmental analysis (see Section 4.7) that there has been a decrease in commuting as a result of Superfast Broadband connectivity. One reason for these differences could be the time at which the data for the two sets of analysis were collected (the household survey looking at the period 2021 to 2023 and the environmental analysis looking at 2011 to 2021).

However, it could also reflect a rebound effect, in that individuals are still commuting to other destinations (for example school drop off, running administration tasks) that they would otherwise have done on the commute to work even when working from home.

The increase in flexibility available to residents that work, and the faster internet connections and the reported improvements in staying in touch and time savings were expected to contribute to improvements in self-reported wellbeing. When residents who had upgraded their connection were asked if they felt this had an impact on their wellbeing, 48 percent of households in Superfast Broadband Programme areas reported that the improved connectivity had a positive impact on their wellbeing.

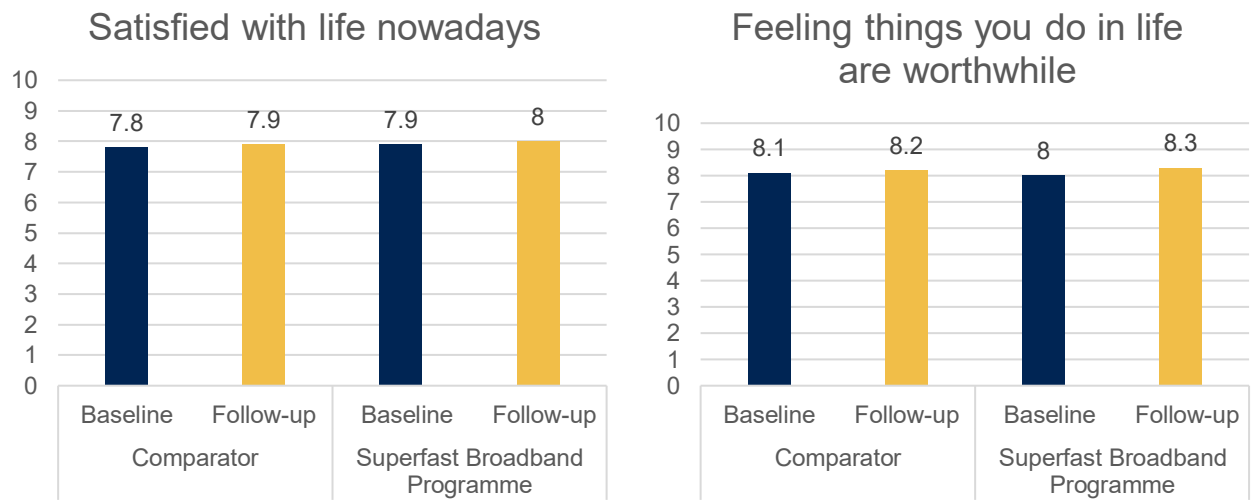
However, the survey also asked residents about their overall wellbeing in both waves, as well as asking them about whether broadband specifically had improved their wellbeing in the follow-up. The findings from these questions demonstrated that there was limited difference in the self-reported wellbeing measures between time periods and between the Superfast Broadband Programme and treatment areas. The only wellbeing questions where there appeared to be any differences were:

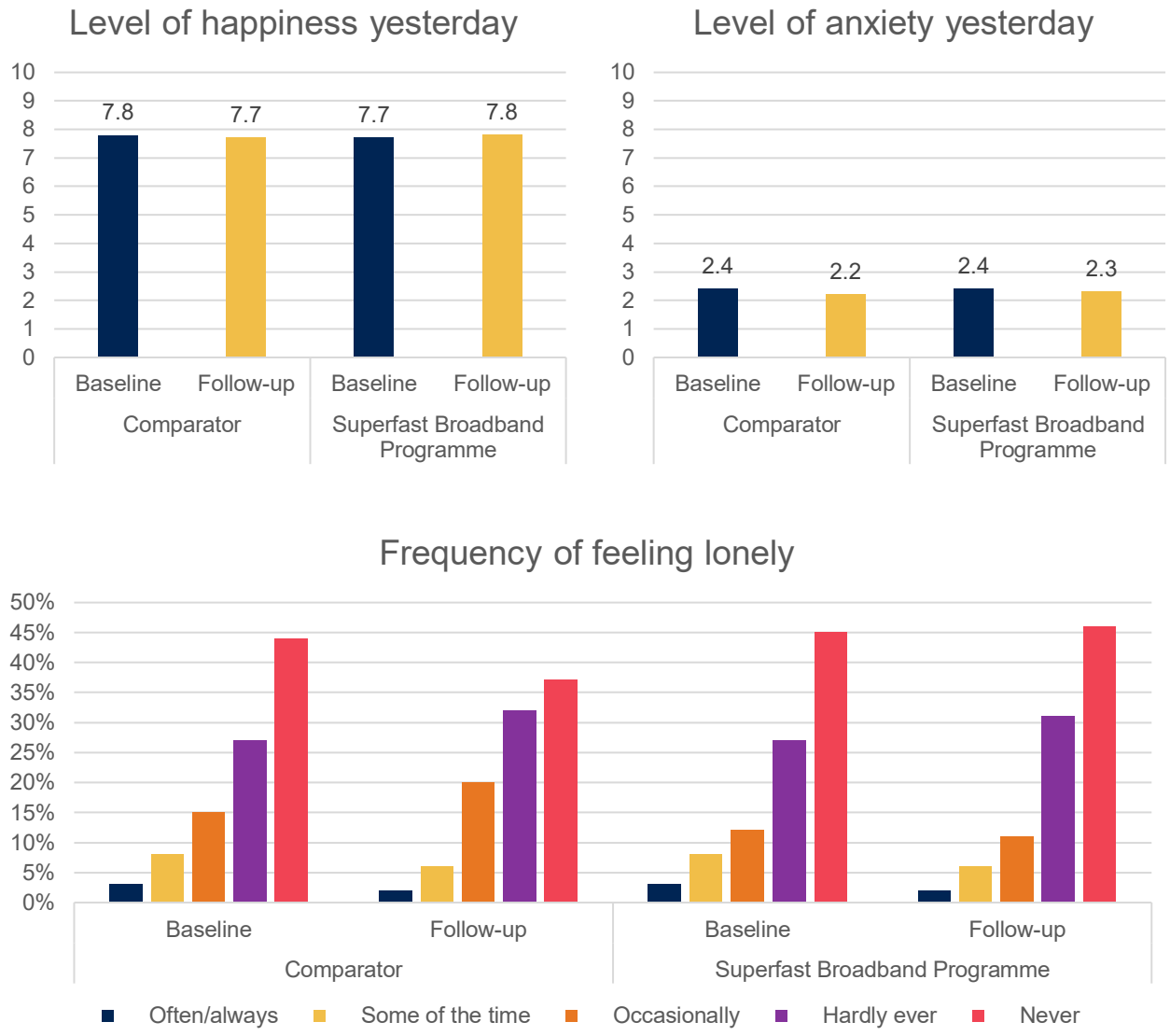
- For the question around whether people felt what they do is worthwhile, where the proportion that felt what they do is worthwhile increased from 42 percent at the baseline to 48 percent in the follow-up survey (this increase was not observed in the comparator areas).
- For the question around whether people feel lonely, the proportion of residents in Superfast Broadband Programme areas were significantly more likely to state that they 'never' feel lonely compared to the comparator areas in the follow-up survey (46 percent vs. 37 percent).

Statistical analysis was also undertaken on the survey results, using a difference in differences methodology to identify if the Superfast Broadband Programme had an impact on self-reported wellbeing. This analysis showed there was no detectable effect of the provision of enhanced connectivity on self-reported wellbeing. It is unclear if the lack of statistically significant results were a result of the Programme having no impact on well-being or if the measures used are insufficiently sensitive to small, and potentially temporary changes to well-being. Therefore, alternative approaches to estimating the public benefit of the Superfast Broadband Programme were used (see Section 4.6 below).

The figures below show the wellbeing scores of the two groups and time periods, which highlights the limited changes observed.

Figure 4.8: ONS self-reported wellbeing measures at baseline and follow-up





Source: Household survey of adults aged 18+ who go online nowadays when at home through their home internet connection and provided an estimate

4.5.2 Analysis of secondary datasets

The evaluation explored the effects of the Programme on the overall wellbeing of residents using secondary datasets (the Annual Population Survey and Understanding Society datasets). The key findings from the analysis found no statistically significant effect on subjective wellbeing (no effect on any measure - life satisfaction, happiness, anxiety or life is worthwhile). Further, there were no significant effects when the analysis was run exploring the impacts by different age band. The only significant result was that there was a small, positive effect on wellbeing for those aged under 35 and living in urban areas. This reinforces the findings from the longitudinal survey that the Superfast Broadband Programme has not had a statistically significant impact on general wellbeing using the self-reported wellbeing measures.

4.6 House price impacts

The findings of the study suggested that the programme led to an average increase in house prices of between £1,900 and £4,900, suggesting that buyers were willing to pay a premium to obtain houses benefitting from subsidised upgrades. Based on hedonic pricing approaches, this can potentially be interpreted as a measure of the average gain in social welfare associated with access to superfast and

gigabit capable broadband networks (i.e. on the basis that the maximum households are willing to pay should reflect the marginal gain in wellbeing derived from access to the technology).

4.7 Environmental impacts

A range of analyses were completed to explore the potential environmental impacts of superfast broadband deployment:

- **Traffic levels around business parks**: Traffic levels around business parks that are located near the Strategic Road Network were targeted to try to reduce noise in the data as business parks are predominately single use, and road traffic data is less likely to be agglomerated with other forms of travel such as retail or leisure parks.

  The analysis failed to find any significant impact between the intervention and the level of traffic on the road around business parks. This suggests that superfast broadband roll-out has not significantly reduced levels of commuting behaviour for those who work in a business park, by allowing residents to work more from home. It is possible that the nature and/or type of work undertaken at business parks may not be conducive to working from home, and focusing the search on traffic levels around business parks has therefore meant we were unable to detect a significant impact on the level of traffic around business parks – as such a second approach to addressing this research question was pursued.

- **Change in the number of people that report working from home**: Data which explores peoples commuting patterns, taken from the Census, was used to explore whether the provision of enhanced connectivity had an impact on individuals working from home and their commuting patterns, and the environmental impact of changes to commuting patterns. It should be noted that the ONS recommend against comparing changes in work from home behaviour between 2011 and 2021 due to the disruption caused by the COVID-19 pandemic (and the lockdowns that were subsequently introduced). As such, estimated impacts should be interpreted with caution.

  The results suggest that the rollout of superfast broadband is associated with a 9.3% increase in work from home behaviour per treated output area, statistically significant at the 99% confidence level. This is broadly in line with the findings from the survey that the provision of faster broadband connections increases working from home. Additionally, the household survey found that that although there was an increase in frequency of working from home, there was no associated change in the duration of commuting experienced by individuals living in Superfast Broadband areas (see Section 4.5). Therefore, the results around associated environmental benefits due to working from home have a large degree of uncertainty, and should be interpreted with caution.

- **Change in energy consumption:** Energy consumption data for areas that have benefitted from the Superfast Broadband Programme (provided by the BEIS sub-national energy consumption statistics), was explored to examine whether enhanced connectivity has led to changes in domestic and non-domestic energy consumption.

  Positive statistically significant effects were detected for domestic consumption in both electricity and gas, as well as non-domestic electricity and gas consumption – suggesting that receiving superfast broadband led to an increase in energy consumption.

  For domestic energy consumption, the results suggest that:

- Each additional connection in a postcode leads to an increase in domestic electricity consumption of 0.1% for an urban property; the equivalent to 0.36kWh per connection per year.
- Each additional connection in a postcode area leads to an increase in domestic electricity consumption of 0.04% for a rural property; equivalent to 1.27kWh per connection per year.
- Each additional connection results in a 0.02% increase in domestic gas consumption, for an urban property, equating to an additional 2.5kWh of gas consumption.
- Each additional connection results in a 0.05% increase in domestic gas consumption, for a rural property, this is equivalent to an additional 7.3kWh.

For non-domestic energy consumption, the results suggest that:

- Each additional connection in a Middle layer Super Output Area (MSOA) area increases non-domestic energy consumption by 0.004% (equivalent to annual increase of 0.29kWh per connection to the superfast broadband network).
- Each additional connection made in an MSOA area is associated with a 0.001% increase in non-domestic gas consumption; this is equivalent to approximately 1.68kWh of additional gas per connection to the superfast broadband network.

For more details of the methodological approach, please see the accompanying environmental analysis technical annex.

- **Land use change and associated habitat disruption:** Analysis suggested that the percentage of areas that are classified as urban in the treatment and comparator areas has increased between 2007 and 2020, with a larger increase in the comparator areas. However, since 2015, the land use change has been lower in the comparison group compared to the treatment group (with the interventions starting in 2016), which suggests that there has been more change in land use in treatment areas than comparator areas over the course of the Programme. However, given the fact that the allocation of the treatment is dependent on the area being built, it does not fully explain the extent to which the roll out of superfast broadband *caused* the land use to change.
- **Traffic disruption:** Analysis of permit records indicated that the total present value of costs in terms of greenhouse gas emissions resulting from traffic disruption was around £2.3 million (£0.3 million - £4.4 million) over a 17 year-appraisal period (2013 – 2030).

5 Value for money

5.1 Assessment of effectiveness

Data on the costs of delivering the Superfast Broadband Programme have been drawn from BDUK monitoring data and the outputs of the modelling exercise described in Section 6 (and used to support the cost-benefit analysis).

Over £1bn of public sector funding appears to have been committed across Phase 3 contracts with a total of 531,029 contracted premises passed. This equates to an ex-ante gross public sector cost per premises covered of £2,636[12].

Table 5.1: Contracted cost per premises passed in Phase 3

Contract Phase	Contracted public sector cost (£m)	Contracted premises passed	Gross public subsidy per gross premises passed (£)
Phase 3	1,400	531,029	2,636

Source: Ipsos UK analysis; Superfast Status Report, November 2022

5.1.1 Current expected (actual) public sector cost per covered premises

The table below provides estimates of the current expected public funding per covered premise by March 2021/22. The expected gross public spend per premises passed is lower overall at £945 (rather than £2,636).

Factoring in the likelihood that some of those premises passed to date (to 2022) would otherwise have received coverage through commercial deployments, the table below also includes the estimated number of additional covered premises. The gross public sector cost (i.e. before clawback) per additional covered premises over three years was £1,418. After allowing for clawback, this will fall to £1,225 to £1,276 per premises passed (depending on whether take-up stabilises at 60 or 85 percent in the long-term).

Table 5.2: Expected gross cost per premises and additional premises passed

Contract Phase	Expected public sector cost (£m)	Premises passed by March 2021/22	Additional covered premises to date (2022)	Expected Gross public subsidy per gross covered premises (£)	Expected Gross public subsidy per additional covered premises (£)
Phase 3 to date (before clawback)	273.3	289,063	192,700	945	1,418
Phase 3 to date (after clawback)	236.0 to 245.8	289,063	192,700	816 to 850	12,255 to 1,276

Source: Ipsos UK analysis; Superfast Status Report, November 2022

[12] This figure is based on the Superfast Status Update (CORA) data

5.1.2 Benchmarking

Whilst an attempt has been made to compare the costs per connection outlined for the programme above, there remains little evidence on comparable interventions. There are very few studies that have sought to examine the cost-effectiveness of broadband programmes in the EU ex-post. This may in part be because of a relative lack of public programmes on the same scale as the Superfast Programme and a consequent lack of published evaluative work. However, there are some examples where the expected unit cost of premises passed has been estimated. It should be noted that these are projected public sector costs per gross premises passed, rather than observed costs. The estimated costs are:

- In Austria, the cost per premises passed was estimated to be approximately £1,900 and £3,600 across two projects.
- In Germany, projects estimated the average of cost per premises passed was between £1,100 and £9,300.
- In Finland, the projected cost per premises passed was estimated to be between £1,300 and £5,800 across three projects.
- In Hungary there are multiple projects, and the average cost per premises passed was estimated to be between £200 and £660.
- In Ireland, the estimated cost per premises passed was £4,900.
- In Italy, several projects estimated that the cost per premises passed was between £230 and £330.
- In Portugal there are several projects and the estimated cost per premises passed was estimated to be between £220 to £810.

It should be noted that the cost per premise passed for the programmes presented above will be dependent on the type of infrastructure investments made to reach premises, and this information was not available. However, the high level analysis shows that in most countries, the average cost per premises upgraded is higher than the cost observed in the Superfast Broadband Programme.

A recent study evaluating parts of the SuperConnected Cities Programme (SCCP) in the UK did include a cost benefit analysis of the Connection Voucher Scheme element of that programme. This made vouchers up to a value of £3,000 available to small to medium sized businesses (SMEs) to put towards upgrading their internet connection. To be granted, the connection would need to provide at least superfast speeds but was technology agnostic. The study found the average cost of subsidised connections through this programme was £1,400, although this also varied substantially by technology type (ranging from £1,100 for FTTC connections to £2,800 for Fixed Wireless / Microwave connections). The cost per installation was estimated at £1,400, though each installation led to a further 4.7 additional connections per postcode. This equated to an estimated cost per additional connection of £290. However, this is not directly comparable to the values listed above as it focuses on the cost of connections rather than the cost of coverage.

5.2 Cost Benefit Analysis

A cost-benefit analysis of the Programme was completed in line with the guidance set out in the HM Treasury Green Book. The findings of the analysis are summarised here, and full details are provided in the State aid evaluation report.

The evaluation produced a variety of evidence to show that the programme has led to important economic impacts at the local level. This was visible in estimates of the impact of the programme on employment, unemployment, and wages. However, in line with the HM Treasury Green Book, it is assumed that the local economic impact of the programme will largely be neutralised by offsetting effects elsewhere in the economy (displacement). While businesses located in areas receiving subsidised coverage have expanded their sales, this will have come at the expense of loss of market share for competing firms (who may be located locally or elsewhere in the UK).

The findings also suggested that relocation of economic activity was an important driver of the effects observed. Assuming these activities would have otherwise been relocated elsewhere in the UK, it is likely that much of the job creation impacts described above would have been realised in other locations. Even if firms expanded without directly displacing the activities of domestic competitors, increased demand for workers and other inputs can be expected to have placed additional pressure on prices, resulting in reductions in output and employment elsewhere.

As such – and in line with the principles of the HM Treasury Green Book - only the effects of the programme in terms of raising productivity are considered to qualify as economic benefits at the national level. The evaluation provided a range of results to indicate that the programme has supported improvements in productivity – including raising the turnover of per worker and wages of employees of firms located in areas benefiting from subsidised coverage under Phase 3 (which rose by 0.6 and 0.8 percent respectively in response to the upgrades).

5.2.1 GVA based measure of economic benefits

An increase in productivity will increase overall economic output (GVA) as resources are used more efficiently. However, it is important to note that turnover per worker may rise at the local level both because firms become more efficient, and because more productive firms relocate to the area (a displacement effect that would not lead to improvements in productivity at the national level). To address this issue, the economic benefits of the programme have been estimated based on its effects on firms that did not relocate (i.e. spatially stable firms) over the period of interest, as follows:

- **Impact on turnover per premises upgraded:** The estimated impact of the programme on the turnover per worker of spatially stable firms was estimated at 0.002 percent per premises upgraded in Output Areas benefitting from Phase 3 contracts. The average turnover per worker of spatially stable firms benefitting from Phase 3 contracts was approximately £95,372. This result implies that turnover per worker in spatially stable firms rose by around £2 per premises upgraded under Phase 3. The average level of employment amongst spatially stable firms in these areas was 32 employees per output area. This gives a total effect on turnover driven by apparent efficiency gains of £63 per premises upgraded.

  The overall effect on turnover per worker per premises upgraded was lower than estimated for prior Phases of the programme (as explored in the 2020 State aid evaluation report[13]), and this decrease in impact is statistically significant. This is likely driven by an increasing share of residential upgrades under Phase 3 of the programme (which has focused addressing gaps in network deployment in largely residential areas, meaning that relatively smaller numbers of commercial enterprises have

[13] BDUK (2021) Superfast Broadband Programme – State aid Evaluation Report 2020, available at: https://www.gov.uk/government/publications/superfast-broadband-programme-state-aid-evaluation-report-2020

benefitted from subsidised coverage). Additionally, businesses located in areas benefitting from Phase 3 of the programme tended to be less productive and employed fewer workers than those benefitting from prior Phases. These features will also have limited the net economic impacts of subsidised coverage. However, as it is not possible to identify individual enterprises that have benefitted from subsidised coverage in the available data, it is also not possible to rule out the possibility that the relevant businesses have been less able to exploit enhanced connectivity to realise efficiency gains.

- **Short term impact on GVA per premises upgraded**: It is assumed that firms did not change the shares of labour and other inputs used in production in response to the subsidised coverage, and the effect on turnover per worker can be interpreted as an improvement in productivity. Applying the average GVA as a percentage of turnover across the UK as whole over the 2016 to 2021 period (32 percent)[14], this gives an effect on GVA per premises upgraded of £20 (per annum).

The assumptions were applied to the profile of additional premises upgraded set out in the preceding section. Summary results covering the 2016/17 to 2021/22 period (benefits to date) and the 2016/17 to 2029/30 period (including projected benefits) are set out in the table below. The present value of GVA benefits (with a baseline of 2012/13) are estimated at £7.2m by 2018/19 and between £20.8m and £23.1m by 2029/30.

This approach may understate the economic benefits of the programme. If spatially stable firms displace sales from less productive firms, then there will also be benefits associated with the transfer of output from less to more productive producers which are not captured in this analysis. The programme is also assumed not to lead to productivity gains for relocating firms (as the quality of their broadband access prior to the relocation is unknown). Additionally, the relocation of firms to the programme area may also produce agglomeration economies (e.g. resulting from knowledge spill-overs arising from greater opportunities for face-to-face interaction and collaboration) that could only be partly captured in the econometric analysis. However, it should be noted that these relocations will be accompanied by disagglomeration elsewhere and these effects may neutralise each other at the national level.

Table 5.3: Additional GVA resulting from productivity gains (£m, 2019 prices, low – high range)

Period	Undiscounted (£m)	Discounted (£m)
Productivity gains 2016/17 to 2021/22 (£m)	8.4	7.2
Productivity gains 2016/17 to 2029/30 (£m)	26.5 – 29.9	20.8 – 23.1

Source: BDUK, Ipsos UK analysis

[14] Source: Annual Business Survey, ONS

5.2.2 Unemployment impacts

The results of the evaluation suggested that for every 10,000 premises upgraded there was a corresponding on-going reduction in the number of unemployed claimants of 34.3 claimants. The extent to which these effects might be understood as net economic benefits will be linked to how far the programme drew individuals out of (or helped them avoid) extended periods of involuntary worklessness in which they were not productively deployed (rather than short-term episodes of unemployment[15]).

The data available did not permit an analysis of the effects of the programme on long-term unemployment directly as claimant counts at the local level do not provide information on the duration of claims. However, a prior evaluation (using different data series[16]) suggested that for every individual taken out of unemployment by the programme, 0.29 individuals were taken out of long-term employment. Assuming this applies to the results obtained in this study, it is estimated that for every 10,000 premises upgraded, the number of long-term claimants fell by 9.8.

Assuming the effects on long-term unemployment represent the effect of the programme on the overall productive capacity of the economy, and valuing the output produced by those individuals at £15,480 per annum (see Technical Annex 2 from the State aid report[17]), it is estimated that these effects could have led to an additional £5.5m in national economic output (GVA) by 2022 (in present value terms). This effect is estimated to rise to between £15.7m to £17.4m in the longer term (though to the extent this is driven by relocation of economic activity, there may have been corresponding increases in long-term unemployment elsewhere).

Table 5.4: Additional GVA resulting from reduction in long-term unemployment (£m, 2019 prices, low – high range)

Period	Undiscounted (£m)	Discounted (£m)
GVA from the reduction in long-term unemployment 2016/17 to 2021/22 (£m)	6.3	5.5
GVA from the reduction in long-term unemployment 2016/17 to 2029/30 (£m)	20.0 – 22.6	15.7 – 17.4

Source: BDUK, Ipsos UK analysis

5.2.3 Social benefits

The findings of the study suggested that the programme led to an average increase in house prices of between £1,900 and £4,900, suggesting that buyers were willing to pay a premium to obtain houses benefitting from subsidised upgrades. Based on hedonic pricing approaches, this can potentially be interpreted as a measure of the average gain in social welfare associated with access to superfast and gigabit capable broadband networks (i.e. on the basis that the maximum households are willing to pay should reflect the marginal gain in wellbeing derived from access to the technology). However, there are several issues of interpretation that create some complexities in this approach:

[15] Though some of these episodes will have otherwise evolved into long-term unemployment.
[16] DCMS (2018) Economic and Public Value Impacts of the Superfast Broadband Programme.
[17] BDUK (2023) Superfast Broadband Programme - State Aid evaluation report 2023, available at: https://www.gov.uk/government/publications/superfast-broadband-programme-state-aid-evaluation-report-2023#:~:text=The%20evaluation%20aims%20to%20provide,detail%20on%20the%20analysis%20conducted.

- **Expectations**: There are questions as to how consumers form expectations regarding the likely future availability of superfast broadband and build this into their willingness to pay. If households have perfect information on the deployment plans of network providers, the estimated effects of the programme show what households are willing to pay for housing with superfast broadband coverage over and above housing that will be upgraded in later years. If this is the case, then the results can be understood as the short-term gain in welfare associated with having access to superfast broadband services as opposed to coverage at some uncertain point in time in the future. As users will continue to derive benefits from the availability of superfast broadband beyond the point where it is available on a close to universal basis, the house price premium is also likely to understate the long-term social benefits of access to superfast networks.

- **Additionality**: Flowing from the above, the gross value of the price uplift was adjusted in light of estimates of short-term additionality (an average of 72 percent up to two years following the upgrade) to reflect the possibility that the premises would have otherwise received subsidised coverage in the absence of the programme at the time of purchase. However, the value of the price uplift was not adjusted further in the long term as it was assumed that the possibility that the property would have received superfast coverage in the future was factored into willingness to pay.

- **Estimated total land value uplift**: BDUK monitoring information indicated that 93 percent of the 289,000 premises upgraded were residential premises (269,000). Assuming the house price premium provides a reasonable measure of the average gain in welfare across the programme, this gives an estimate of the present value of welfare benefits of £370m to £947m.

- **Representativeness of buyers**: The price of homes sold will reflect the value of the property to the marginal buyer. Buyers are likely to have different preferences to the average resident of the programme area and may place a particularly high value on the features of the property such as broadband capability. Existing residents would have moved into the area before superfast connectivity arrived. As such, it may not be possible to assume that the apparent price premium reflects improvements of the welfare of other residents of the areas concerned (who may place a lower value on superfast broadband).

- **Lower bound estimate**: A lower bound estimate was derived by assuming the house price premium only provided a reasonable approximation of the welfare gains associated with the programme in cases where houses were sold after the premises was upgraded (114,162). This gives a lower estimate of the total welfare gains of between £157m to £402m, although this is a highly conservative approach as it assumes that existing residents derive no value from enhanced broadband connectivity.

- **Uncertainty**: To the extent that house prices were driven by migration induced by the programme, these may not represent net benefits as there may be offsetting effects elsewhere. Additionally, there is a possibility that the house price uplift may be linked to the programme's effects in attracting additional economic activity to the area (in which case, there may be an element of double counting with the economic benefits).

The following table provides a summary of the results.

Table 5.5: Land value uplift arising from impacts on house prices (£m, 2019 prices)

	Low house price premium (0. 78%)	High price premium (1.43%)

Welfare impacts confined to households purchasing homes		
Land value uplift (£m, present value)	370.3	946.9
Land value uplift (£m, only sold properties)	157.2	402.1

Source: BDUK, Ipsos UK analysis

5.2.4 Environmental benefits

For the purposes of this analysis, the monetised impact for the entire Superfast Broadband Programme has been estimated over a 17-year evaluation period (2013 – 2030), to remain consistent with the economic impacts estimated for the Programme.

The table below presents the estimate economic value of the estimated impacts of the Superfast Programme, where economic costs and disbenefits have a negative value, as they reduce societal welfare.

Table 5.6: Economic Impacts – Total Present Value (gross impacts)

Economic Impact	2013 – 2022	2023-2030
Reduced greenhouse gas emissions through reduced commuting through increased **working from home**	£1,837m (£918m to £2540m)	£1,668m (£834m to £2,045m)
Increased domestic energy consumption through working from home	-£9.9m (-£4.9m to -£14.8m)	-£8.2m (-£4.1m to -£12.1m)
Increased non-domestic energy consumption associated with superfast broadband rollout	-£4.0m (-£6.0m to -£2.0m)	-£3.6m (-£5.4m to -£1.8m)
Increased greenhouse gas emissions through road works/ closures when installing cables	-£2.3m (-£4.4m to -£0.3m)	NA
Total economic impact	**£1,820m (£903 - £2,523)**	**£1,657m (£825m - £2,031m)**

Source: Ipsos UK analysis

The results above suggest that the Superfast Broadband Programme yielded estimated present value environmental benefits that totalled £3,477m (£1,728m - £4,554m) over the evaluation period. This was primarily driven through reduced greenhouse gas emissions through reduced commuting, enabled by increased working from home (noting the uncertainty in the estimated impacts). It is important to note that key environmental impacts (e.g. land use change and associated biodiversity impacts, embedded carbon in the fibre network, etc.) have not been estimated, nor monetised and so the estimated benefits present a partial view of the economic value of the associated environmental impacts.

When the benefits are limited to Phase 3 of the Programme, and accounting for the additionality profile presented in Figure 4.3, the additional environmental benefits are presented in the table below. This shows an estimated impact of between £149m and £419m between 2016 and 2022, and £102m and £279m between 2023 and 2030.

However, it should be noted that the household survey found no evidence of changes in commuting times experienced by individuals in Superfast Broadband Programme areas. This is despite a significant impact on the frequency of individuals working from home in these areas. These findings would suggest that the low estimate of the impact of the Superfast Broadband Programme on reduced emissions from working from home should be zero.

Table 5.7: Economic Impacts for Phase 3 contracts - additional impacts

Economic Impact	2016 – 2022	2023-2030
Reduced greenhouse gas emissions through reduced commuting through increased **working from home**	£307.7m (£153.8m - £420m)	£229.3m (£114.6m - £282.9m)
Increased domestic energy consumption through working from home	-£1.6m (-£0.8m to -£2.4m)	-£1.1m (-£4.1m to -£12.1m)
Increased non-domestic energy consumption associated with superfast broadband rollout	-£0.7m (-£0.3m to -£1.0m)	-£0.5m (-£0.3m to -£0.8m)
Increased greenhouse gas emissions through road works/ closures when installing cables	-£0.8m (-£1.6m to -£0.1m)	NA
Total economic impact	**£304.6m (£148.8m - £418.8m)**	**£227.7m (£101.7m - £278.5m)**

Source: Ipsos UK analysis

5.3 Benefit to cost ratio

Drawing on the results above, low and high estimates of the Benefit to Cost Ratio (BCR) associated with the programme are developed using the estimates of the net cost of the programme set out in the Section 5.1. However, given the uncertainty around the environmental benefits, these have been omitted from the initial BCR calculations. This gives a range for the BCR as follows:

- **Benefits from 2016 to 2022**: The short term BCR (based on benefits to date) is estimated at between £1.76 and £4.57 per £1 of net lifetime public sector costs. This assumes that the house price premium is a reasonable approximation of the average welfare gain associated with the programme (and the width of the range is driven largely by modelling uncertainty regarding the size of the house price premium associated with subsidised coverage).

- **Benefits from 2016 to 2030**: In the long run (allowing for future economic benefits), the BCR is estimated are £1.87 to £4.70 per £1 of net public sector spending. However, if the higher estimates of environmental benefits are included, this would rise to £8.01 per £1 of net public sector spending (see Section 5.3.2), although these estimates are subject to a greater degree of uncertainty.

- **Lower bound estimates**: As noted above, it is possible that the house premium overstates the average welfare gain associated with enhanced broadband connectivity. Using the lower bound

estimates of the social benefits of the programme outlined above, whereby the house price premium only provided a reasonable approximation of the welfare gains associated with the programme in cases where houses were sold after the premises was upgraded (114,162), the long-term BCR would fall to between £0.89 and £2.04. This will clearly understate the net benefits of the programme, as it assumes that existing residents derive no value from superfast broadband availability.

- **Comparisons with prior findings**: Previous analysis set out in the 2020 State aid evaluation report found that the Benefit Cost Ratio associated with the overall Programme was substantially higher (£3.6 to £5.1 between 2012 and 2030). The average benefit per premises upgraded for Phase 3 was in line with (if not higher than) estimates for prior Phases. However, the unit cost of upgrades to the public sector was markedly higher for Phase 3 than for prior Phases of the Programme. The net cost per additional premises passed was by 2022/23 was estimated at £1,270 for Phase 3, versus £217 for all Phases of the programme. This increase in cost was driven by a change in technical focus to gigabit capable technologies (which are more costly to deploy) and a change in spatial focus to areas that are harder to reach. Contracts awarded under Phase 3 are also expected to generate substantially lower levels of implementation and take-up clawback than contracts awarded under Phase 1 (which were often commercially viable without subsidy).

- **Omitted benefits**: It should be noted that these results also do not factor in the value of some important potential benefits of the programme, particularly in terms of its environmental impact (see Section 5.3.1, which could raise the BCR as high as £8.01 per £1 of net public sector spend) and impact in improving equity in access to broadband infrastructure. These types of benefit are likely to become more significant in the longer term, as new applications dependant on faster broadband speeds are brought to market (leading to greater risks of digital exclusion).

Table 5.8: Benefit to Cost Ratios, 2016 to 2022 and 2016 to 2030

Period	2016 to 2022		2016 to 2030	
	Low additionality / house price effects	High additionality / house price effects	Low additionality / house price effects	High additionality / house price effects
	Benefits			
Productivity gains (£m)	7.3	7.3	20.8	23.1
Long term unemployment (£m)	5.5	5.5	15.7	17.4
House prices (£m)	370.3	946.9	370.3	946.9
Total	**383.1**	**959.8**	**407.0**	**987.7**
	Costs			
Lifetime cost (£m)	210.2 to 217.5	210.2 to 217.5	210.2 to 217.5	210.2 to 217.5
Benefit to cost ratio	**1.76 to 1.82**	**4.41 to 4.57**	**1.87 to 1.94**	**4.54 to 4.70**
Lower bound estimate of total benefits and costs				
Total benefits (£m, house premium applies to sold houses only)	170.0	414.9	237.5	442.1
Lifetime cost (£m)	210.2 to 217.5	210.2 to 217.5	210.2 to 217.5	210.2 to 217.5
Lower bound BCR (£)	**0.78 to 0.81**	**1.91 to 1.97**	**0.89 to 0.92**	**2.04 to 2.11**

Source: BDUK, Ipsos UK analysis

5.3.2 Benefits to cost Ratio including Environmental benefits

The above BCR calculations exclude the environmental benefits of the Superfast Broadband Programme. The reason for this exclusion from the calculations is the degree of uncertainty about the magnitude of the impacts. For example, for the environmental benefits resulting from changes in travelling to work, one set of analysis shows large decreases in carbon emissions, whereas the findings from the household survey indicate that there were no changes in commuting patterns. These two estimates cover different time periods and utilise different methodological approaches, but combined lead to uncertainty about the impact the Superfast Broadband Programme has had on environmental emissions.

However, due to the large scale of the environmental benefits presented in Section 5.2.4, it does suggest that the BCR of £1.87 to £4.70 per £1 of public expenditure underestimates the total value of the benefit of the Superfast Broadband Programme. The estimated carbon saving from commuting using the findings from the household survey are zero, as there was no statistically significant impact on time spent commuting to work (despite the increase in working from home) – however, this impact increases to a maximum estimate of £703m if the higher end estimates of the analysis using the census data are used. This means the long term BCR could increase to £8.01 if the higher end environmental benefits are included.

6 Conclusions

This section presents the key findings from the preceding sections of the report and the answers to the four main evaluation questions.

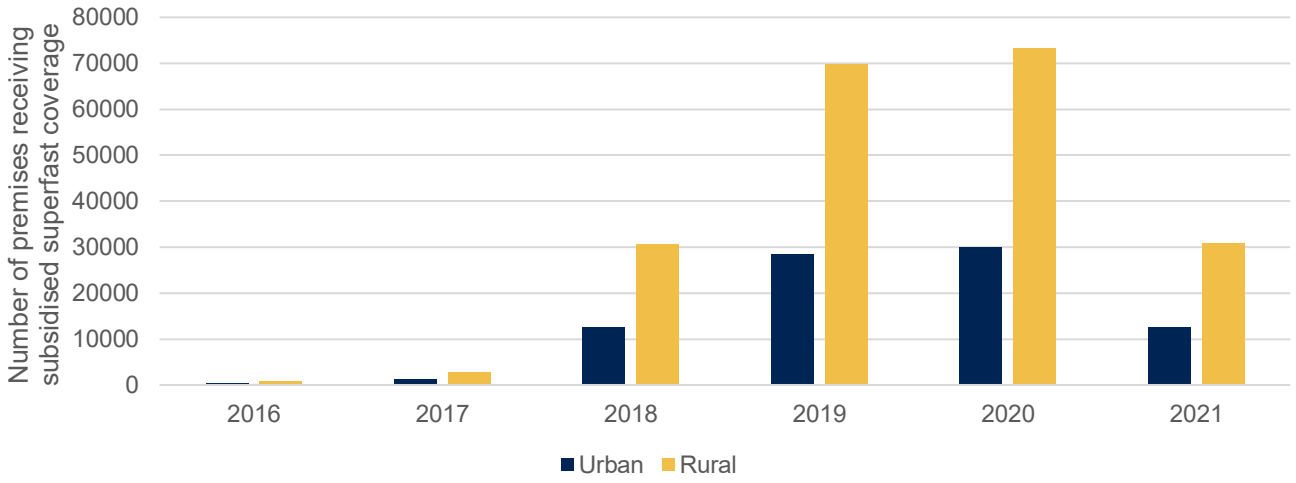
6.1 Delivery of the programme

69 contracts have been awarded for Phase 3 of the Superfast Broadband Programme, with seven Network Providers holding contracts. Openreach held most contracts with 58 percent, but Gigaclear held 13 contracts. The remaining five network providers held 16 contracts between them.

Delivery of the Programme began in 2016 and analysis of C3 reports provided by BDUK indicated that around 292,618 premises received subsidised coverage by September 2021 (over 37,000 postcodes). It should be noted that most coverage was towards the latter stages of the time horizon for this evaluation.

Additionally, unlike prior Phases of the programme, Phase 3 contracts prioritised gigabit capable technologies with most premises passed by FTTP (rather than Fibre-to-the-Cabinet).

Figure 6.1: Number of premises receiving superfast (30Mbit/s[18]) coverage subsidised by BDUK, areas for which Phase 3 SCTs are available, 2016 to 2021



Source: C3 reports, Ipsos analysis.

6.2 What are the outcomes of the scheme and how have these been achieved?

6.2.1 Reducing the Digital Divide

A range of statistical analyses were completed to estimate the impact of the Programme on both measures of broadband availability and take-up. These analyses showed:

- **Impacts on NGA and superfast coverage:** Subsidised coverage through Phase 3 of the Programme led to a significant positive impact on the availability of superfast and gigabit capable broadband services by the end of September 2021. Subsidised coverage increased the share of premises in the programme area able to access superfast speeds by 41 to 47 percentage points,

[18] 24MBits for Phase 1 and Phase 2

and the share of premises with gigabit capable coverage by 43 to 56 percentage points. The impact of the programme on NGA availability was relatively small however, indicating that in its absence, most premises would have benefitted from some form of enhanced connectivity (albeit via technologies less able to deliver download speeds of 30Mbit/s or higher). These findings are consistent with prior research into the impacts of the programme on broadband coverage.

- **Take-up:** Subsidised coverage led to a significant increase in the maximum download speeds of connections taken by households and/or businesses by September 2021 (34 to 60 Mbit/s). However, the impacts of the programme on average download speeds were relatively small. This indicates that 'early adopters' have taken advantage of the enhanced broadband connectivity enabled by the Programme. However, the Programme had not led to widespread take-up of faster broadband services by September 2021. It should be noted that most subsidised coverage was delivered in 2019 and 2020. As take-up will lag deployment, it is premature to draw any firm conclusions on the impact of the programme on take-up of faster internet services. Again, this is consistent with prior research into the impacts of the programme on take-up.

The level of additionality associated with gigabit coverage was higher than for superfast availability. This implies that while many households would not have benefitted from gigabit infrastructure in the absence of the programme, some may have benefitted from upgrades that enabled superfast broadband services. The level of additionality was estimated to peak in the year after the premises was upgraded (at 81 percent). Additionality was estimated to decay to 49 percent in the fourth-year post-installation (an average rate of decay of 16 percent per annum). This aligns with patterns observed for prior Phases of the programme. However, the estimated level of additionality associated with Phase 3 was notably higher than for prior Phases, indicating that the areas concerned were substantially less likely to benefit from commercial deployments without public sector support.

6.2.2 Stimulating the broadband market

The market share for Openreach (including Sky and TalkTalk) across these areas declined between 2016 and 2022, from around 97 to 85 percent of all broadband connections. While this is higher than the national average (between 70 and 80 percent), the decline in market share aligns with the national trends for Openreach. In terms of NGA connections, the pattern in Phase 3 areas remains the same, with a decrease in Openreach's market share in the Phase 3 areas (91 to 82 percent of all NGA connections), but this is not matched by the national trends, where there is no clear pattern for Openreach's market share.

The market share for all broadband connections and NGA connections for all other network providers awarded contracts through the Superfast Broadband Programme rose faster between 2016 and 2022 in Phase 3 contract areas than nationally. However, the overall market share of these network providers is still relatively low even at the local level, with no network provider having more than five percent of the total broadband market in 2022 in the areas the Programme has delivered connections. This indicates the Programme has not had a large impact on the national broadband market.

6.2.3 Employment growth and productivity

The results suggested that the Programme has produced a variety of important economic impacts at the local level:

- **Local employment impacts**: Subsidised coverage from Phase 3 contracts was estimated to have increased employment in the areas benefitting from the Programme by 0.88 percent, leading to the

creation of approximately 6,261 jobs in Phase 3 contract areas, and 23,700 local jobs across the entire programme area by the end 2021.

- **Turnover**: Subsidised coverage also increased the turnover of firms located in the areas benefitting from Phase 3 of the Programme by 1.6 percent, increasing the annual turnover of local businesses in Phase 3 areas by £827 per annum, and for the whole programme by 1.4 percent, approximately £2.6bn per annum by 2021.

- **Turnover per worker**: There was also some evidence of efficiency gains - turnover per worker of firms in the areas benefitting from Phase 3 of the Programme rose by 0.42 percent in response to subsidised coverage. This was not solely driven by more productive businesses moving into areas with improved broadband infrastructure. Firms that did not relocate over the period also saw their turnover per worker rise by 0.17 percent by 2021, indicating that subsidised coverage has also raised the efficiency of firms. It should be noted that while subsidised coverage had a stable effect on turnover, impacts on employment increased with time. This led to the strength of the gains in turnover per worker appearing to decay with time.

- **Wages**: The impacts of the Programme were also visible in wages. Employees working for firms located in the areas benefitting from subsidised coverage saw their hourly earnings increase by between 0.6 and 0.8 percent in real terms in response to the upgrade (which did not vary significantly across occupational groups). This gives greater confidence that the Programme led to an increase in productivity.

- **Unemployment**: Local job creation also appeared to translate into reduced unemployment, with the number of unemployed claimants falling by 34.3 for every 10,000 premises upgraded.

6.2.4 Public sector efficiency

The research explored how enhanced connectivity has supported the delivery of public services during the Covid-19 pandemic and during the post pandemic period. During the pandemic, public services such as schooling and health appointments were increasingly moved online, which the enhanced broadband connectivity supported. However, in local authorities where connectivity still left gaps, the move to online services presented challenges in that not all households could access the online services, so other provision was required.

Additionally, where broadband connectivity was strong, local authorities discovered a further challenge in that many poorer households could not utilise the fast broadband coverage either because they could not afford the connection cost, or they did not have the hardware to access services. To increase access, the local authority, in partnership with neighbouring authorities and the local health board, provided a loan scheme for laptops and dongles to be provided to households for a month loan at a time. Households could be referred to the scheme by health and social care professionals. When the household was approved for a loan, they were provided with some initial training and guidance of how to use the laptop and internet connection.

Since the end of the pandemic, the ways in which social care is being delivered is altering. This is in part due to the increased connectivity being provided through the Superfast Broadband Programme. These are:

- An increased use of online records and linking of records between services. Social care records are now starting to be connected to other databases, such as those at GP practices. These other

databases were not able to connect to social care databases previously, partially because many GP practices had poor broadband connectivity, and as this has improved data sharing possibilities have become enhanced.

- Trials of automated social care visits. This includes the provision of tablet based social care visits, where a social worker will check in on a client digitally rather than in person. Additionally, in social care for older individuals, pilots have been trialled using automated and AI solutions for some clients, such as automated reminders for medication or tasks.

6.2.5 Public value

The survey data demonstrates that the provision of the Superfast Broadband Programme has had a positive impact on the internet connection speeds of households in areas that have received subsidised coverage. The reported connection speed had improved at a greater rate in Superfast Broadband Programme areas than in comparator areas, with reported speeds having increased from 20 Mbps in both groups at baseline to 116 Mbps in Superfast Broadband Programme areas (compared to 63 Mbps in the comparator group).

The increase in connection speeds had a positive impact on the following aspects of life:

- Doing things online saves them time (55 percent of those in Superfast Broadband Programme areas that have upgraded strongly agreed with this statement);
- Doing things online makes things easier (58 percent of those in Superfast Broadband Programme areas that have upgraded strongly agreed with this statement);
- Had mad made keeping in touch with friends and family easier (66 percent of those in Superfast Broadband Programme areas that have upgraded felt a faster connection made it easier to stay in touch); and
- Had mad made watching entertainment and content easier (82 percent of those in Superfast Broadband Programme areas that have upgraded felt a faster connection made it easier to watch entertainment).

However, nearly a quarter of households that have upgraded their connections in Superfast Broadband Programme areas also reported that they felt they were addicted to going online.

The findings from the survey indicated that working from home frequency in Superfast Broadband Programme areas had remained constant at around 2.7 days per week, whereas working from home frequency had fallen in the comparator areas from 3.3 days per week to 2.9 days per week. A statistical difference in differences analysis was undertaken, which indicated that the provision of the Superfast Broadband Programme is estimated to have led to an increase in the number of days WFH of between 0.7 and 0.8 days per week. However, the sample for this analysis is relatively low, as it only includes those that were employed in both waves of the survey.

The survey also asked residents about their wellbeing. The findings from these questions demonstrated that there was limited difference in self-reported wellbeing. Statistical analysis showed there was no detectable effect of the provision of enhanced connectivity on self-reported wellbeing. This finding is consistent with the statistical analysis of secondary datasets, which also showed the Programme had no statistically significant impact on self-reported wellbeing. It is unclear if the lack of statistically significant results were a result of the Programme having no impact on well-being or if the measures used are

insufficiently sensitive to small, and potentially temporary changes to well-being. Therefore, alternative approaches to estimating the public benefit of the Superfast Broadband Programme were used.

The findings of econometric analysis suggested that the programme led to an average increase in house prices of between £1,900 and £4,900, suggesting that buyers were willing to pay a premium to obtain houses benefitting from subsidised upgrades.

6.2.6 Environmental outcomes

A range of analyses were completed to explore the potential environmental impacts of superfast broadband deployment:

- **Traffic levels around business parks:** The analysis failed to find any significant impact between the intervention and the level of traffic on the road around business parks. This suggests that superfast broadband roll-out has not significantly reduced levels of commuting behaviour for those who work in a business park. It is possible that the nature and/or type of work undertaken at business parks may not be conducive to working from home, therefore a second approach to estimate the impact on travel behaviour was utilised.

- **Change in the number of people that report working from home**: The results suggest that the rollout of superfast broadband is associated with a 9.3% increase in work from home behaviour per treated output area, statistically significant at the 99% confidence level. This is broadly in line with the findings from the survey, that the provision of faster broadband connections increases working from home. Additionally, the household survey found that that although there was an increase in frequency of working from home, there was no associated change in the duration of commuting experienced by individuals living in Superfast Broadband areas. Therefore, the results around associated environmental benefits due to working from home have a large degree of uncertainty, and should be interpreted with caution.

- **Change in energy consumption:** Positive statistically significant effects were detected for domestic consumption in both electricity and gas, as well as non-domestic electricity and gas consumption – suggesting that receiving superfast broadband led to an increase in energy consumption.

- **Traffic disruption:** Analysis of permit records indicated that the total present value of costs in terms of greenhouse gas emissions resulting from traffic disruption was around £2.3 million (£0.3 million - £4.4 million) over a 17 year-appraisal period (2013 – 2030).

6.3 How cost-effective and efficient has the delivery of the Programme been?

The mechanisms put in place to protect the public purse have substantially improved the value for money obtained from the Programme. At the point of contracting, the expected public sector costs per premises upgraded was £2,636. However, after allowing for clawback, this is expected to fall to £945.

Factoring in the likelihood that some of those premises passed to date would otherwise have received coverage through commercial deployments, the gross public sector cost (i.e. before clawback) per additional covered premises over three years was £1,418. After allowing for clawback, this will fall to £1,225 to £1,276 per premises passed (depending on whether take-up stabilises at 60 or 85 percent in the long-term).

Even with this being a higher cost than for previous Phases of the Superfast Broadband Programme, Phase 3 of the Programme still appears to be one of the most efficient Programmes supporting broadband deployment in the EU.

The benefits of the Programme are also expected to significantly exceed its costs. The estimated Benefit to Cost Ratio (BCR) was between £1.76 and £4.57 per £1 of net lifetime public sector costs sector spending based on its impacts between 2012 and 2021. Allowing for future benefits to 2030, the BCR is estimated to rise to £1.87 to £4.70 per £1 of net public sector spending. However, this is likely to underestimate the total benefits of the Superfast Broadband Programme, as the environmental benefits of the intervention have been omitted from the BCR due to uncertainty about the scale of the impact – with different methodologies leading to different estimates. The environmental benefits range from £0 to £959m for Phase 3, which demonstrates the benefits could drive the BCR to be as high £8.01 for every £1 of public expenditure.

Our standards and accreditations

Ipsos' standards and accreditations provide our clients with the peace of mind that they can always depend on us to deliver reliable, sustainable findings. Our focus on quality and continuous improvement means we have embedded a "right first time" approach throughout our organisation.

ISO 20252

This is the international specific standard for market, opinion and social research, including insights and data analytics. Ipsos UK was the first company in the world to gain this accreditation.

Market Research Society (MRS) Company Partnership

By being an MRS Company Partner, Ipsos UK endorse and support the core MRS brand values of professionalism, research excellence and business effectiveness, and commit to comply with the MRS Code of Conduct throughout the organisation & we were the first company to sign our organisation up to the requirements & self-regulation of the MRS Code; more than 350 companies have followed our lead.

ISO 9001

International general company standard with a focus on continual improvement through quality management systems. In 1994 we became one of the early adopters of the ISO 9001 business standard.

ISO 27001

International standard for information security designed to ensure the selection of adequate and proportionate security controls. Ipsos UK was the first research company in the UK to be awarded this in August 2008.

The UK General Data Protection Regulation (UK GDPR) and the UK Data Protection Act 2018 (DPA)

Ipsos UK is required to comply with the UK General Data Protection Regulation (GDPR) and the UK Data Protection Act (DPA). These cover the processing of personal data and the protection of privacy.

HMG Cyber Essentials

Cyber Essentials defines a set of controls which, when properly implemented, provide organisations with basic protection from the most prevalent forms of threat coming from the internet. This is a government-backed, key deliverable of the UK's National Cyber Security Programme. Ipsos UK was assessed and validated for certification in 2016.

Fair Data

Ipsos UK is signed up as a "Fair Data" company by agreeing to adhere to twelve core principles. The principles support and complement other standards such as ISOs, and the requirements of data protection legislation. .

For more information

3 Thomas More Square
London
E1W 1YW

t: +44 (0)20 3059 5000

www.ipsos.com/en-uk
http://twitter.com/IpsosUK

About Ipsos Public Affairs

Ipsos Public Affairs works closely with national governments, local public services and the not-for-profit sector. Its c.200 research staff focus on public service and policy issues. Each has expertise in a particular part of the public sector, ensuring we have a detailed understanding of specific sectors and policy challenges. Combined with our methods and communications expertise, this helps ensure that our research makes a difference for decision makers and communities.