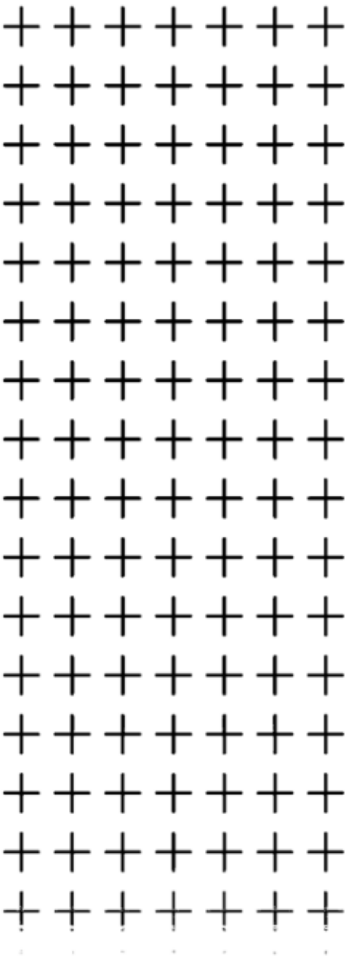

Evaluation of BDUK Gigabit Vouchers: Initial Impacts and Benefits

A Report by Hatch
28 July 2022

Department for Culture Media and Sport

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Glossary of key terms

BDUK	Building Digital UK
CDRC	Consumer Data Research Centre
F20	These are areas identified by BDUK using a DCMS model of coverage and costs, as falling within the "final 20%" (the 20% hardest to reach locations for broadband connectivity).
GBVS	Gigabit Broadband Voucher Scheme; the first voucher scheme for gigabit-capable broadband connectivity launched in 2018. The Scheme used the voucher product to prioritise connections for Small to Medium Enterprises, alongside connections for residential premises. The original scheme closed in May 2020.
Gigabit broadband	Any technology that can deliver 1 gigabit-per-second download speed
IUC	Internet User Classification
LFFN	Local Full Fibre Networks Programme – the BDUK programme which included the initial testing of the voucher product for gigabit broadband connectivity; trialling the Gigabit Broadband Voucher Scheme (GBVS) in 4 areas before it launched as a separate national scheme.
LSOA	Lower Super Output Area: geographical areas for the purpose of local data analysis. LSOAs have an average population of around 1,500.
Project voucher	A voucher which forms part of a group of vouchers focused on a geographical area. Projects have been used by suppliers to aggregate multiple applications and increase the subsidy available.
PSM	Propensity Score Matching – a statistical technique used to estimate the effect of a treatment, policy, or other intervention by accounting for the observable characteristics that can predict treatment.
RGC	Rural Gigabit Connectivity: the second voucher scheme launched in May 2019 and was focused on rural areas.
SME	Small and medium-sized enterprises – business voucher eligibility was restricted to SMEs and referred to in the report as 'small businesses.
Standard voucher	Standalone vouchers where an application was submitted for a single premise.
Superfast broadband	Any technology that can deliver more than 30 megabits-per-second.
Top-up vouchers	Vouchers which have received additional subsidy from a participating local authority which increase the maximum value of voucher support.
Ultra-fast broadband (UFBB)	Any technology that can deliver more than 300 Mbps download speed.

Executive Summary

i. This report provides the findings of two research strands to inform the evaluation of the BDUK vouchers schemes:

- Counterfactual analysis of the impact of vouchers on broadband coverage and performance.
- Business beneficiary survey which has sought to understand the benefits of upgraded connections for businesses, and the changes it has allowed them to implement.

ii. The analysis includes vouchers issued under the original Gigabit Voucher Scheme (GBVS[1]) and the Rural Gigabit Connectivity (RGC) programmes. These voucher schemes had different objectives and eligibility criteria:

- GBVS: Original gigabit broadband voucher scheme aimed to stimulate the rollout of gigabit-capable infrastructure and enable the market to extend its own plans further and quicker by offering a single business connection voucher (standard voucher) or vouchers for mixed premises projects (small businesses and residential premises).
- RGC Programme: Eligibility was increasingly focused on the least viable areas for gigabit broadband (e.g. restricting to rural areas and low connection speeds) and only offered the vouchers for mixed premises projects (small businesses and residential premises).

iii. Vouchers offer subsidies towards the cost of installing gigabit broadband. They are one of a number of demand side interventions used by BDUK to increase coverage of gigabit capable broadband and are available to households and businesses.

Counterfactual analysis findings

iv. The impact of vouchers was assessed by comparing change in broadband coverage and speed in Lower Super Output Areas[2] (LSOAs) that received vouchers with control areas of LSOAs with similar characteristics that did not receive support. This allowed us to estimate how much of the change would have happened anyway (deadweight), and the change that can be attributed to vouchers (additionality).

v. The evaluation assessed the impact of 15,000 vouchers used to connect premises in 4,892 LSOAs[3] over a two-year period between October 2018 and September

[1] GBVS vouchers were first issued as part of a trial of the voucher product in the Local Full Fibre Network Programme, then expanded to a national scheme which ran until May 2020. The Gigabit Broadband Voucher Scheme was re-launched, under Project Gigabit, with new eligibility criteria, in April 2021 and is still in operation (as of August 2022): https://www.gov.uk/government/news/government-launches-new-5bn-project-gigabit.

[2] These are geographical units used for statistical analysis. LSOAS have an average population of around 1,600 people

[3] 9,257 of these were delivered through 788 projects

2020. The analysis does not include vouchers connected[4] before these dates, due to low sample sizes of LSOAs, or after this date as the effects of vouchers will not be reflected in the most recently available datasets.

vi. We constructed nine models for assessing impacts, using different variables and control groups. All of the models were tested and found to be robust. In some models, the sample of treated LSOAs was restricted for various reasons, but in each case the sample of treated LSOAs did not fall below 2,000 in a treatment year. We are therefore confident that the findings are representative and provide a robust assessment of the impact of the voucher schemes as a whole.

vii. This approach enabled this report to test all hypotheses but not confirm all of them. There is evidence that vouchers boost the availability of ultra-fast broadband (UFBB)[5] but not gigabit speeds as yet. There was take up of higher speeds in treated areas, and encouraging findings which suggest the net additional impact of vouchers on availability was greater in rural areas and in areas where vouchers were deployed through projects.

Impacts on availability: Change in broadband coverage levels available

viii. **There is evidence that vouchers had a significant additional effect on the availability of ultra-fast broadband (UFBB), but only for vouchers connected in 2020**. LSOAs that received vouchers in 2019 experienced an increase in the availability of UFBB in the year after support (gross change in Table 1). However, in 7 of the 9 statistical models tested, there was no statistically significant difference in change in UFBB availability between areas treated in 2019 and control areas. In the two models which found a significant difference, availability increased at a faster rate in control areas than treated areas. This means there is currently insufficient evidence that vouchers connected in 2019 had an additional effect on availability of UFBB over and above what would have happened anyway.

ix. For vouchers connected in 2020, all models found that availability of UFBB increased by more in treatment areas[6] than control areas, ranging from 0.27 to 1.57 percentage points (with a median of 0.98 pp). The difference was found to be statistically significant in six out of nine models, indicating an additional effect which can be attributed to vouchers. The reasons for the difference between 2019 and 2020 need to be investigated further. The most likely explanation is that vouchers in 2020 were more focused on rural areas which are less likely to be part of the market's existing rollout plans[7].

[4] Premises that have been upgraded via a BDUK voucher

[5] Any technology that can deliver more than 300 Mbps download speed

[6] An area (LSOA) is assumed to be 'treated' if it has at least one premises connected via a voucher.

[7] This will be investigated in the next phase by restricting the sample to rural areas

Table 1 Impact of vouchers on the availability of UFBB one year after support (percentage points)

Treatment year	Gross change	Models significant	Median additional change	Additional change range
2019	5.2	2 of 9	-0.38	-1.00 to 0.13
2020	5.9	6 of 9	0.98**	0.27 to 1.57

Source: Belmana. Note: Significance levels are 1% (***), 5% (**) and 10% (*).

x. **But there is no evidence that vouchers had an additional effect on the availability of gigabit broadband**. None of the models tested found that availability of gigabit broadband increased at a faster rate than control areas, with some finding the difference was negative. However, this could be due to measurement issues as, despite there being over 100 active suppliers across the voucher schemes, many of them do not report to Ofcom Connected Nations.[8] In addition, changes in the data collected by Ofcom through Connected Nations makes measures of coverage growth less reliable, as any indicator of the availability of gigabit broadband is measured inconsistently over the time period analysed. We will re-run evaluation analysis, as later Ofcom Connected Nations data comes available, bringing more recent vouchers issued and connected in scope of the evaluation.

xi. **Vouchers had a significant additional effect on availability of superfast broadband**. All of the models found that the number of premises that can access speeds of at least 30 Mbps increased by more in treated areas than control areas. This was the case for both treatment years, with all but one models finding a significant effect. For vouchers connected in 2019, between 5 and 10 additional premises can access superfast broadband as a result of those vouchers[9]. The effects are lower but similar for vouchers connected in 2020 (4 to 7 additional premises). This suggests vouchers enabled suppliers to offer higher speed (but sub gigabit) connections to premises which were close to vouchers.

Differences by scheme and voucher type

xii. Preliminary results suggest the RGC scheme was ten times more effective at increasing availability of UFBB than the original GBVS scheme (up to May 2020). All of the models found that the availability of UFBB increased at a significantly faster rate in areas that received vouchers through the RGC scheme than control areas, ranging from 7.09 to 10.97 percentage points. This was only assessed for vouchers connected in 2020 since very few RGC vouchers were issued in 2019. The median effect was 8.29 percentage points; over ten times higher than the median effect for GBVS areas (0.71 percentage points). However, there are a number of caveats to this finding, not least the fact that the sample size

[8] 2019 Ofcom Connected Nations report included data from 24 fixed network operators, in 2020 there were 37 and since 2021 the report has included 48 fixed network and 24 wireless operators - see Annex A for full list of operators in the data.

[9] Based on an average population of 1,600 in an LSOA this represents between 0.3% and 0.6% of premises

is very small for the RGC scheme (93 LSOAs). This should therefore be treated as a preliminary result which will be tested as more data becomes available[10].

xiii. **Preliminary results suggest project vouchers were more effective at increasing the availability of UFBB than standard vouchers**. Six of the nine models found that the availability of UFBB increased at a significantly faster rate in areas that received project vouchers in 2020 than control areas, ranging from 1.13 to 3.35 percentage points. The median effect was 2.34 percentage points, compared to 0.78 percentage points in standard voucher areas. As above, there are a number of caveats to this finding which is based on a sample size of 213 LSOAs. This will be tested further as more data becomes available.

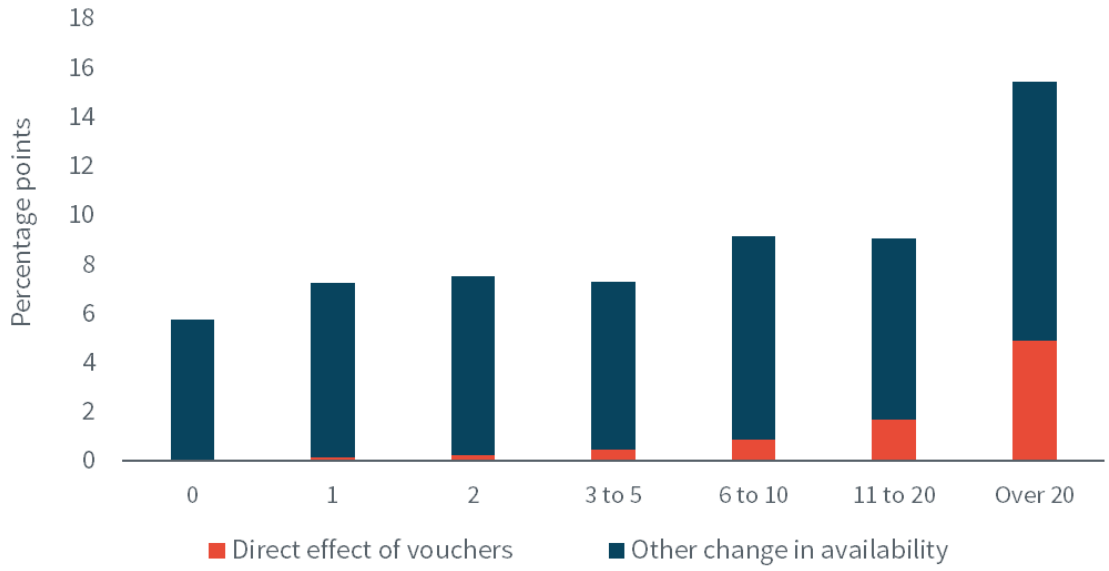
Numbers of vouchers and effects on availability

xiv. The treatment/control group approach was unable to measure the effect of increasing the level of voucher support. To do this, we analysed differences in the gross change in the availability of UFBB in areas that had different levels of support. This found that areas that received larger numbers of vouchers (20+) experienced a larger increase in availability than areas receiving fewer vouchers, but all of the difference could be explained by the direct effect of vouchers (assuming one voucher leads directly to one premise receiving access to UFBB). In other words, there was no evidence of knock-on effects on coverage for premises in the same LSOA that did not receive a voucher (see Figure 1).

xv. When the analysis was restricted to rural areas or areas considered least commercial to the market using a DCMS model; with an F score of at least 0.8 (referred to in this report as F20 premises or the 20% hardest to reach premises), we found much clearer evidence of a relationship between the number of vouchers and increases in availability of UFBB. This includes the direct effect of vouchers but also larger increases in availability among premises that did not receive a voucher.

[10] Later versions of Connected Nations will allow us to assess the impact of RGC vouchers delivered after Sep 2020, which will give larger sample sizes

Figure 1 Gross change in the availability of UFBB in LSOAs with different numbers of vouchers, 2020-2021 (F20>0.8)



Source: BDUK monitoring data and Connected Nations.

xvi. **Conclusions on availability:** The findings on availability can be seen as reflective of the outcomes of early versions of the voucher scheme. Although the findings for 2020 include some of the effects of vouchers issued through the RGC Programme and project vouchers, these only account for a relatively small proportion of the sample, meaning the overall results are naturally skewed towards the effects of GBVS. This is in line with the findings on availability as a result of vouchers issued in 2019. This may reflect the development of the voucher product (either through maturity of use in the market or an effect of the targeting of the voucher through further eligibility restrictions as part of the RGC Programme) but it is not possible to state conclusively from these initial findings. However, the emerging findings of the effect of the voucher on availability through projects, and in rural and the least viable areas for gigabit broadband, are encouraging and will continue to be monitored as later data points come available.

Impacts on broadband speeds (change in speeds taken up by households and businesses)

xvii. **Vouchers had a significant additional effect on download speeds being used by households and businesses**. All of the models found that change in download speeds taken up by premises was significantly higher in treated areas than control areas in both years of support, indicating an additional effect which could be attributed to vouchers. For vouchers connected in 2019, these additional speed changes ranged from 0.78 to 1.36 Mbps. The median from these models[11] was

[11] The median in this case was the model which includes change in download speed prior to treatment as a modelling variable and which used a control group drawn from all LSOAs excluding those with high employment.

1.06 Mbps or 8% of the gross change. The net additional effect of vouchers was similar in those areas where vouchers were issued in 2020. This ranged from 0.81 to 1.21 Mbps, with a median effect of 1.0 Mbps (or 7.2% of the gross change)[12].

Table 2 Additional change in download speed (Mbps) in areas supported with vouchers in 2019 and 2020

Treatment year	Gross change in treated areas	Models significant	Median additional change	Additional change range	Median additionality estimate
2019	12.54	9 of 9	1.06***	0.78 to 1.36	8.4%
2020	13.91	9 of 9	1.00***	0.81 to 1.21	7.2%

Source: Belmana.

Note: Results for the three models considering three different samples. Significance levels are 1% (***), 5% (**) and 10% (*).

xviii. **LSOAs receiving between 16 and 20 vouchers experienced the largest speed changes**. Changes in download speed were, on average, over 5 Mbps higher than areas that received only one voucher, and around 4 Mbps higher than areas that received 30 vouchers. It is unclear why this was the case, since the analysis shows the availability of UFBB is higher in areas receiving larger numbers of vouchers. It suggests take-up of high-speed broadband in areas with between 16 and 20 vouchers was higher than in areas with larger numbers of vouchers.

xix. **The two voucher schemes had similar effects on download speeds**. None of the models found a statistically significant difference between the change in download speeds in areas that received vouchers through the RGC scheme and the GBVS scheme. This suggests the effects of the schemes so far have been similar, although this is based on low sample sizes for the RGC scheme.

xx. **Project vouchers had a greater effect on download speeds than standard vouchers**. All of the models found that areas receiving project vouchers experienced a greater increase in download speeds than areas receiving standard vouchers, with all models finding the difference was statistically significant. On average, the increase in download speeds was 1.59 Mbps higher in project areas than standard areas.

xxi. **Areas in close proximity to treated areas experienced similar improvements in speed, but the reasons for this are unclear**. The modelling shows there was no statistically significant difference in changes in broadband speeds between LSOAs receiving vouchers and LSOAs within 3km. This may be related to the size of the intervention and the size of LSOAs; therefore, the ability for the scale of impact of the voucher scheme to be detected amongst or even across the output area geography for which the data is available. However, beyond 3km, the increase in speed changes are significantly lower. The reasons for these differences need to be investigated further in the next phase of the study. The effect of improved speeds being similar within 3km of the LSOA receiving vouchers could be explained by the spillover effects of vouchers (vouchers making it more viable to connect

[12] Based on the model which includes pre-treatment broadband speed as a modelling variable (but not change) and uses a control group drawn from all untreated LSOAs

neighbouring areas). However, it could also reflect the fact that suppliers used vouchers in areas where they were already expanding their network, in which case the speed improvements in nearby areas may not have been caused by vouchers.

xxii. **Conclusions on speeds in use**: The findings already show an impact in increasing average speeds in use, similar for both voucher schemes, but fully understanding spillover effects needs more data and analysis to establish causes. Whilst the speed available (coverage) is observable at the point at which a voucher is connected, the take up and use of the available services should take longer to realise. This evaluation has established this effect already from the earlier vouchers issued in 2019. Although this change is small it is statistically significant and has capacity to rise still further without further intervention should even higher speeds be taken up on the upgraded infrastructure. Also, a larger effect of projects should be more pronounced in later vouchers from the RGC Programme that could not be evaluated at the data points available at the time of this study.

Business survey findings

xxiii. A total of 1,681 completed responses were received from business voucher recipients, representing a 6% response rate. Based on a 95% confidence level, this means the results in the report have a margin of error of +/- 2.3%.

xxiv. Where possible, the representativeness of the sample was assessed by comparing against the known characteristics of businesses that received vouchers (specifically the sector and date at which they received the voucher[13]). Overall, we found that the sample was broadly representative, although there was an over-representation of businesses from the professional services, ICT and land-based sectors (agriculture, forestry and mining). The sample was also skewed towards more recent vouchers, and had an under-representation of businesses that applied for a voucher in 2017 and 2018.

Key findings

- **High levels of satisfaction with the application process**: Nine out of ten (89%) of respondents said that they were satisfied or very satisfied with the ease / simplicity of the voucher process, and eight out of ten (80%) were satisfied or very satisfied with the length of the application process.
- **High levels of satisfaction with the upgraded connection**: A high proportion of business reported being satisfied with their upgraded connection, including reliability (93%), download speeds (94%), upload speeds (93%). Satisfaction levels were lower for value for money but still high overall (74%). Satisfaction levels were particularly high for RGC voucher recipients and those in rural or F20 areas.
- **Range of business benefits:** A large proportion of respondents (79%) reported their upgraded connection had enabled them to do new things. The most common changes included adoption of more flexible working practices

[13] It has not been possible to compare the sample with the size profile of businesses that have received vouchers as this is not recorded for a large number of businesses in BDUK's database.

for staff (51%), implementation of new business processes (48%) and reducing business travel (46%).

- **Transformational effects for rural, RGC and F20 businesses:** Rural businesses were more likely to identify a wide range of business objectives and benefits from faster and reliable broadband. Although Rural, F20, RGC and project voucher recipients were less likely to be using a range of applications (explained mainly by their size/sector) they were more likely to be using a range of applications for the first time

- **Boosting productivity:** Of those that were doing new things (for instance flexible working practices or new business processes as described above), 82% reported an increase in productivity (34% reported a major increase), 50% saw an increase in profitability and 42% experienced an increase in turnover. These benefits will be assessed and monetised using counterfactual analysis of ONS data in the next phase of the evaluation.

- **Adapting during the pandemic:** 70% of businesses say the upgrade helped them to adapt and continue to do business during the pandemic. There was an even more pronounced effect for RGC (79%), F20 (78%) and rural businesses (81%).

2. Purpose of Report

About the voucher product

2.1 Building Digital UK (BDUK), part of the Department for Digital, Culture, Media and Sport (DCMS) is responsible for delivering digital infrastructure programmes for the government. Its vision is that everyone in the UK can benefit from a better digital connection, including gigabit capable broadband.

2.2 Vouchers are one of a number of demand side interventions used by BDUK to increase coverage of gigabit capable broadband. Vouchers are available to households and businesses to contribute towards the costs of installing gigabit broadband. This enables suppliers to aggregate multiple vouchers until it is commercially attractive enough for them to deliver gigabit broadband to an area.

2.3 Vouchers were used as part of two BDUK programmes:

- In 2018 the Local Full Fibre Networks (LFFN) programme launched a Gigabit Broadband Voucher Scheme (GBVS), which prioritised connections for Small to Medium Enterprises (SMEs). This scheme was closed to new applications in May 2020.
- From May 2019, as part of the Rural Gigabit Connectivity (RGC) programme, BDUK adapted the voucher scheme to support the delivery of full fibre connectivity in rural areas. This rural voucher scheme was closed to new applications on 31 March 2021, with some eligible voucher projects transferring to the new UK Gigabit Voucher Scheme.

2.4 There are two different types of voucher covered by the evaluation:

- Standard vouchers: these are standalone vouchers where an application was submitted for a single premise.
- Project vouchers: these vouchers form part of a group of vouchers focused on a certain geographical area, where a supplier encouraged multiple applications from premises which were then aggregated to increase the subsidy available.

About the evaluation

2.5 DCMS has appointed Hatch, Belmana and Winning Moves to undertake an evaluation of the Building Digital UK (BDUK) vouchers product, including both of the schemes above (hereafter referred to as the GBVS and RGC schemes).

2.6 The evaluation has a number of different elements:

- An **impact evaluation**. This needs to assess the additional coverage and premises passed due to vouchers compared to areas that did not receive support, and the outcomes and impacts generated for businesses and households.
- A **process evaluation** to understand how the impacts were achieved, and to identify any barriers and enablers to achieving objectives.
- A **value for money evaluation** to assess whether the schemes delivered good value for money based on the costs and benefits compared to the original appraisal.

2.7 The key research strands are as follows:

1) Analysis of BDUK monitoring data, focusing on how vouchers were used and in which locations.

2) Interviews with suppliers that used vouchers to gain their perspectives on the impact of the programme and how it influenced their investment decisions.

3) Counterfactual analysis of the additional impact of vouchers on the availability of different download speeds and take-up of services through changing download speeds.

4) Counterfactual analysis of the impact of vouchers on business and local economic performance.

5) A business beneficiary survey to understand the benefits of upgraded connections for businesses, and the changes it allowed them to implement.

6) A resident beneficiary survey to explore how upgraded connections affected various aspects of households' quality of life.

About this report

2.8 This report provides the findings of two of the research strands above:

- Counterfactual analysis of the additional impact of vouchers on coverage and download speeds. This was led by Belmana.
- Analysis of the business beneficiary survey undertaken by Winning Moves in early 2022.

2.9 This will form one of a number of reports, feeding into the final report which will assess the impact and value for money of the intervention.

3. Counterfactual Analysis

Summary of key findings

Impacts on availability of broadband at different speed levels

- There is evidence that vouchers had a significant additional effect on the availability of UFBB, but only for vouchers connected in 2020 (+0.98 percentage points based on the median result from our models).
- There is currently insufficient evidence that vouchers had an additional effect on the availability of gigabit broadband, with no models finding a significant positive effect.
- Vouchers had a significant additional effect on the availability of superfast broadband. This ranged from five to ten additional premises per LSOA for areas treated in 2019 and from four to seven premises per LSOA for areas treated in 2020.
- Preliminary results suggest the RGC scheme has been ten times more effective at increasing the availability of UFBB than the GBVS scheme. The median additional effect for RGC areas was 8.29 percentage points compared to 0.71 percentage points in GBVS areas.
- Preliminary results suggest project vouchers were more effective at increasing the availability of UFBB than standard vouchers. The median additional effect was 2.34 percentage points in areas where project vouchers were used compared to 0.78 percentage points in areas where standard vouchers were used.
- Findings are affected by the availability of Ofcom Connected Nations data for all network operators using vouchers, and inconsistency in the data on 'gigabit-capable' availability. Further analysis will be required as later data points become available. This will bring voucher issued later into scope of the analysis (all project and RGC Programme vouchers); currently the findings are influenced heavily by the outcomes of GBVS vouchers.

Impacts on download speeds taken up by households and businesses

- Vouchers had a significant additional effect on download speeds being used by premises. The median effect from models was 1.06 Mbps in 2019 and 1.00 Mbps in 2020.
- LSOAs receiving between 16 and 20 vouchers experienced the largest speed changes. Changes in download speed were on, average, over 5 Mbps higher than areas that received only one voucher, and around 4 Mbps higher than areas that received 30 vouchers.
- The two voucher schemes had similar effects on download speeds. None of the models found a statistically significant difference between the two schemes.
- Project vouchers had a greater effect on download speeds than standard vouchers. On average, the increase in download speeds was 1.59 Mbps higher in project areas than standard areas.
- Areas in close proximity to treated areas experienced similar improvements in speed, which may indicate vouchers had spill-over effects into neighbouring areas. However, it could also reflect the fact that suppliers used vouchers in areas where they were already expanding their network. This will be investigated further in later phases when more Ofcom Connected Nations data points are available.

Introduction

3.1 This section aims to measure the effect of vouchers on the availability of broadband and its performance in small areas. It does this through counterfactual analysis. That is, it compares change in areas supported by vouchers (treatment areas) with the change in similar areas that did not receive support (control areas). By measuring the difference between treatment and control areas it allows us to estimate the *additional* impact on coverage and performance that can be attributed to vouchers i.e. would not have occurred without intervention.

3.2 The modelling assessed the impact of vouchers on:

- **Availability** (or coverage) of broadband at different speed levels (gigabit, ultra-fast and super-fast broadband). This uses the Connected Nations coverage dataset, which provides postcode level data on whether premises can access broadband at different speed levels, irrespective of whether they choose to do so.
- **Performance**, as measured by the average download speeds which households and businesses actually receive through their broadband service. This uses the Connected Nations performance dataset which provides average download speeds at postcode level.

3.3 The methodology is described in full in the technical annex. In summary, this involved the following:

- All analysis was undertaken for Lower Super Output Areas (LSOAs). These are geographic areas used for statistical analysis, which are broadly similar in population having an average population of 1,600.
- An LSOA was assumed to be 'treated' if it had at least one premise connected via a voucher.
- A technique called Propensity Score Matching (PSM) was used to identify control areas. The aim of using PSM was to identify untreated areas that had a similar probability of receiving vouchers based on a range of characteristics. The most important characteristics for determining whether an area received vouchers were identified through statistical modelling. These included rurality[14], FScore >0.8 (F20 score)[15], income and employment in digital sectors.
- We developed nine different models for comparing treatment and control areas. These differed in terms of:
  - whether broadband performance in the year before treatment was included as a variable in the model. Three different approaches were used; the first did not include pre-treatment broadband performance at all, the second included broadband performance levels (but not

[14] The modelling found that rurality was a statistically significant characteristic explaining whether an area received support in 2020 but not in 2019.

[15] BDUK's FScore model provides an index from 0 to 1 that reflects the estimated relative cost to install fibre to the premise. A value close to 0 reflects premises that can be connected at low cost while values closer to 1 indicate the opposite. Those premises modelled that have an Fscore between 0.8 to 1.0 are assumed to be in the "last 20%" the market would not achieve on its own without further public subsidy. These are referred to as being F20 premises in the report.

change) and the final approach included change in broadband performance.

- the sample of LSOAs from which control areas were drawn for matching. Again, we used three pools of LSOAs. One used all untreated LSOAs in England and Wales, the second included all LSOAs but excluded those with very high levels of employment[16], and the third was limited to LSOAs in the same exchange area as treated LSOAs[17]. We considered one additional pool based on cancelled vouchers, but this was ruled out since a large number of cancelled vouchers were linked to projects which went ahead and therefore had a high probability of receiving access to gigabit broadband anyway.
- By combining these different modelling approaches and sample pools, we developed nine different models for comparing treatment and control areas. All of the models were tested and found to be robust[18].

- Change in coverage and average download speeds in treated and control areas was assessed using the Connected Nations dataset, which provides data down to postcode level. This enabled us to quantify the difference in change between treated and control areas.
- If the difference in treated and control areas proved statistically significant, we can be confident attributing the additional change in coverage or speed to vouchers. If a number of models found significant differences, this would increase our confidence that vouchers led to additional effects.
- The report presents the range of estimates and the median result from the nine models. All of the models were tested and found to be robust[19], so the reporting of the median result does not mean that this model should be considered the most robust. This represents our central estimate but the value could lie anywhere within the range presented.

3.4 The Maryland Scientific Measurement Scale (SMS) can be used to assess the relative robustness of different methods of evaluation based on the extent to which the control group is robust and has dealt with issues of selection bias. The method used for this study, which combines PSM with difference-in-difference techniques,

[16] It was necessary to restrict the sample in this way because high employment levels were such a common characteristic of treated LSOAs that it was difficult to identify comparable untreated LSOAs. Where this sample was used we therefore excluded any treated LSOAs that had high employment levels from the modelling.

[17] The rationale for this pool was based on the hypothesis that exchange areas where at least one LSOA had been treated would have similar infrastructure to untreated LSOAs served by the same exchange.

[18] The technical appendix includes a short summary of strengths and weaknesses of the different control groups used

[19] By this we mean that the effect of vouchers on broadband outcomes is not very sensitive to the exact specifications used. The results are consistent to different covariates and samples. The models do not show conflicting results, they change in a predictable and theoretically consistent manner. The adjusted R squared range of 0.18 to 0.33 is adequate and consistent with the values found in the literature on similar estimations in applied economics.

should attain a score of 3. This is the minimum standard considered to be robust by the What Works Centre for Local Economic Growth.

Vouchers included in the modelling

3.5 The modelling assessed change in coverage/performance in treated LSOAs in the year after they received a voucher. It was therefore necessary to assess impacts separately for each treatment year. The evaluation focused on vouchers connected between October 2018 and September 2020 giving us two treatment years for analysis. We did not include vouchers connected after this date as it is unlikely that any effects on broadband performance or the availability of broadband at different speed levels would be reflected in Connected Nations 2021.

3.6 The analysis also does not include vouchers connected before October 2018. Although there were nearly 2,000 vouchers delivered before this date, the number of treated LSOAs was much smaller than in 2019 and 2020. Therefore, we focused on the two treatment years with a larger sample size, which was sufficient for us to assess the impact of vouchers overall, and analyse how impacts varied in LSOAs which received different levels of support.

3.7 In 2020, there were also a large number of vouchers issued in LSOAs that had already received vouchers in earlier years of support. To avoid the risk of contamination from support in earlier years these were not included in the modelling for 2020. This reduced the number of vouchers in that year from 15,743 to 7,807.

Table 3.1 Number of vouchers and treated LSOAs over time

Treatment year	Period covered	No. vouchers	No. vouchers in modelling	Number of treated LSOAs*
2018	Oct 2017 to Sep 2018	1,969	0	567
2019	Oct 2018 to Sep 2019	7,432	7,432	2,426
2020	Oct 2019 to Sep 2020	15,743	7,807	2,428

Source: BDUK monitoring data. *does not include LSOAs which had been treated in earlier years.

3.8 It was also necessary to remove other vouchers and treated LSOAs from certain models due to the nature of some of the control group samples used. For example:

- One of the control group samples excluded LSOAs which had very high levels of employment. It was therefore necessary to remove those LSOAs which also had high levels of employment[20].
- Another sample was drawn from LSOAs which were served by the same exchange areas as treated LSOAs. It was therefore necessary to remove treated LSOAs that could not be linked to a single exchange.

3.9 The effect of removing these vouchers and treated LSOAs from the sample for each of the relevant models is shown in Table 3.2. All of the models include a sample of at least 2,000 treated LSOAs and at least 6,000 vouchers in each year.

[20] These were identified using the Business Register and Employment Survey (BRES)

Table 3.2 Number of vouchers and treated LSOAs in models with different control group samples

	Vouchers		Treated LSOAs	
Control group sample	2019	2020	2019	2020
All LSOAs	7,432	7,807	2,426	2,428
All LSOAs excluding high employment	6,733	7,719	2,278	2,391
Same exchange LSOAs	6,313	6,365	2,136	2,132

Source: Belmana.

Note: LSOAS with high employment were identified using BRES

3.10 Table 3.3 breaks down the number of vouchers included in each model by voucher scheme and voucher type. It shows the sample to be heavily weighted towards GBVS vouchers, particularly in 2019 when the RGC scheme was in its infancy. The findings in this report therefore largely reflect the outcomes of early versions of the voucher scheme, which aimed to stimulate the rollout of gigabit capable infrastructure and enable the market to extend its own plans further and quicker. There were few restrictions on eligibility for GBVS meaning a high proportion of vouchers were issued in urban and higher density areas.

3.11 In later versions of the scheme (RGC), eligibility was increasingly focused on the least viable areas for gigabit broadband (e.g. rural areas and the 20% hardest to reach). Although the findings for 2020 include some of the effects of the RGC scheme, these only account for a relatively small proportion of the sample.

3.12 The table also shows the split between voucher types (standard and project vouchers). These were evenly split in 2019 but were more heavily weighted towards project vouchers in 2020. In total, there were 9,257 of these vouchers delivered through 788 separate projects.

Table 3.3 Numbers of vouchers and treated LSOAs by voucher scheme

Control group sample	Treatment year	Scheme		Voucher type	
		GBVS	RGC	Standard	Project
All LSOAs	2019	7,362	70	3,496	3,936
	2020	5,861	1,946	2,486	5,321
All LSOAs excluding high employment	2019	6,663	70	3,104	3,629
	2020	5,776	1,943	2,418	5,301
Same exchange LSOAs	2019	6,276	37	3,094	3,219
	2020	4,942	1,423	2,216	4,149

Source: BDUK.

Intensity of support in treated areas

3.13 Table 3.4 shows the number of LSOAs which received a voucher for the first time in 2019 and 2020[21] and the number of vouchers each area received. It shows there was considerable variation in the level of voucher support in treated LSOAs. Around two thirds received only one voucher while 2% received more than 25 vouchers (including a small number of LSOAs that received in excess of 100 vouchers). This means the level of subsidy provided to broadband suppliers was much higher in some treated LSOAs than others, and we might therefore expect impacts on broadband coverage and performance to be greater.

3.14 The treatment/control group approach described above was unable to measure the effect of increasing the level of voucher support because it uses a binary treatment variable; LSOAs were either treated (if they received at least one voucher) or untreated (if they received zero vouchers). We therefore supplemented the counterfactual modelling with the following analysis:

- Dosage modelling: we used regression analysis to model the relationship between the number of vouchers in an LSOA and the change in download speeds or the availability of broadband at different speed levels. This enabled us to control for a number of other explanatory variables (e.g. rurality, F20 score and economic characteristics).
- A comparison of the gross change in availability of broadband and download speeds in LSOAs with similar characteristics, which received different levels of voucher support.

Table 3.4 Number of treated LSOAs by number of vouchers

Number of vouchers in LSOA	2019	2020
1 voucher	1,607	1,696
2	342	298
3-5	244	172
5 to 10	87	112
11 to 15	41	42
16 to 20	27	30
21 to 25	33	15
More than 25 vouchers	45	63
All treated LSOAs	2,426	2,468
Total vouchers	7,432	7,807
Mean vouchers per LSOA	3.1	3.2

Source: BDUK monitoring data.

Availability

3.15 This section presents the key findings from the counterfactual analysis of the impact of vouchers on the availability of broadband at different speed levels (Gigabit, ultra-

[21] LSOAs were only considered to be treated in a particular year if they had not already been treated in earlier years. This was necessary because the counterfactual analysis measured the effect on coverage/performance in the year after treatment and therefore could not include areas which had already been treated.

fast and superfast broadband). The methodology and detailed modelling results are provided in the appendix.

There is evidence that vouchers had a significant additional effect on the availability of UFBB, but only for vouchers connected in 2020

3.16 Figure 3.1 compares the change in the availability of ultra-fast broadband[22] (UFBB) in LSOAs treated in 2019 with a number of control areas. It shows that the availability of UFBB was slightly lower in treated LSOAs than in control areas in 2018. After receiving vouchers in 2019, all areas experienced an increase in the availability of UFBB but the change followed a broadly similar trajectory in each area. The one exception to this was the control group based on LSOAs served by the same exchange as treated LSOAs (the dark orange line). In this control group, the availability of UFBB increased by a slightly larger amount than in treated LSOAs. This means areas that received vouchers fared *worse* than similar untreated LSOAs in the same exchange area.

3.17 This was confirmed by the modelling (see Table 3.5); only two of the nine models found there was a statistically significant difference in the change in the availability of UFBB in treatment and control areas. Both of these models used control groups drawn from LSOAs in the same exchange area as treated LSOAs, and in both cases the difference between treated and control areas was negative. There is therefore currently insufficient evidence that vouchers connected in 2019 had a positive additional effect on the availability of UFBB.

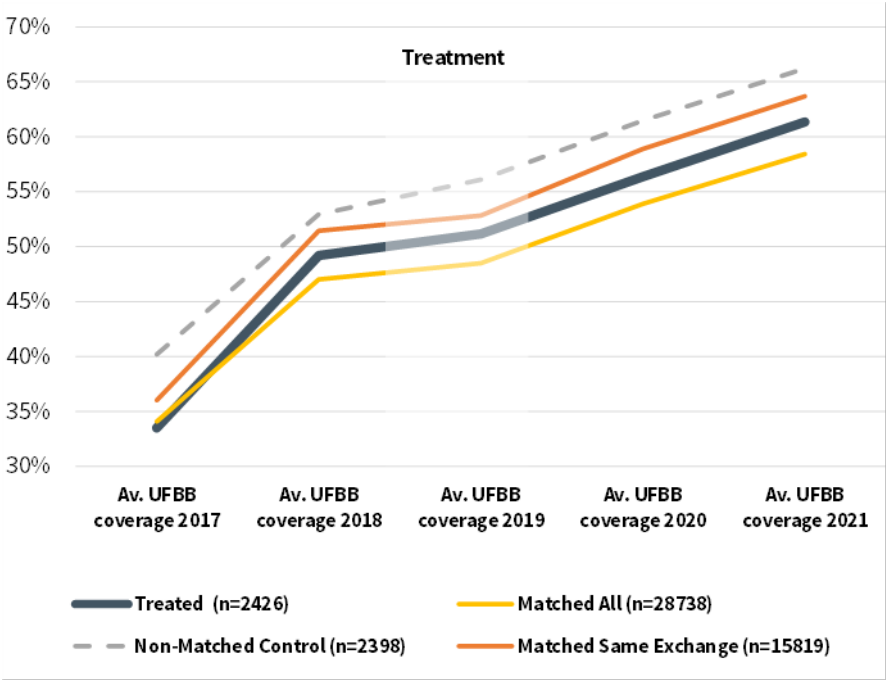
3.18 At this stage, it is not clear why control areas from the same exchange area experienced a larger increase in availability of UFBB than treated areas in two of the models. It is not due to any differences in the observable characteristics that influence the likelihood of receiving vouchers; after matching, this control group is comparable to treated areas across a range of characteristics including rurality and F20 score (see Figure A3 in the appendix). There may be a number of potential explanations, which would need to be investigated further. These include:

- Suppliers may have used vouchers in areas where they were expanding their network anyway. The voucher programme is a demand led scheme and they tend to be used where suppliers have an existing presence. It is therefore plausible that vouchers may have been used to supplement the market rollout in areas where this was already planned. For example, a supplier may already have planned to connect most but not all premises in an exchange area, and vouchers allowed them to address remaining premises.
- Alternatively, the use of vouchers in one LSOA may have allowed a supplier to expand its network into neighbouring LSOAs (which fall within the same exchange area), as the cost of connecting these premises fell. In this interpretation, the increased availability of UFBB in LSOAs in the same exchange area would be the result of spillover effects from vouchers, and therefore would not have occurred without the voucher scheme[23].

[22] Download speeds over 300 Mbps

[23] We provide some preliminary analysis of the spatial effects of vouchers on broadband speeds later in this Chapter

Figure 3.1 Change in the availability of UFBB in LSOAs treated in 2019 and control areas



Source: Belmana.

3.19 The findings for LSOAs treated in 2020 are more positive. All models found that the availability of UFBB increased by more in treatment areas than in control areas, ranging from 0.27 to 1.57 percentage points. The difference was found to be statistically significant in six out of nine models, indicating there was an additional effect which can be attributed to vouchers[24].

3.20 The median additional effect from these models was +0.98 percentage points. Based on gross change of 5.9 percentage points, this means that 13.4% of the change in the availability of UFBB can be attributed to vouchers.

3.21 One possible explanation for why we have found positive significant effects for vouchers in 2020 and not in 2019 is that the vouchers were increasingly used in rural areas over time. 26% of premises connected through vouchers in 2019 were in rural areas but this increased to 50% in 2020[25]. Voucher support was therefore increasingly focused on areas where the market rollout was likely to be less viable. As a result, the number of premises gaining access to UFBB in the year after support was more heavily skewed towards rural areas in 2020 than in 2019 (40% vs 23%). This may explain why we found evidence of additional effects for later vouchers. There are also preliminary findings that vouchers delivered through the RGC scheme (which was only delivered on a large scale from 2020 onwards) had

[24] The models which did *not* find significant effects were those which used control areas drawn from the same exchange area.

[25] The modelling found that rurality was a statistically significant characteristic explaining whether an area received support in 2020 but not in 2019.

a greater impact on availability of UFBB than those delivered through GBVS (see below).

Table 3.5 Additional change in coverage of UFBB

Treatment year	Gross change (percentage points)	Models significant	Median additional change	Additional change range
2019	5.19	2 of 9	-0.38	-1.00 to 0.13
2020	5.90	6 of 9	0.98**	0.27 to 1.57

Source: Belmana.

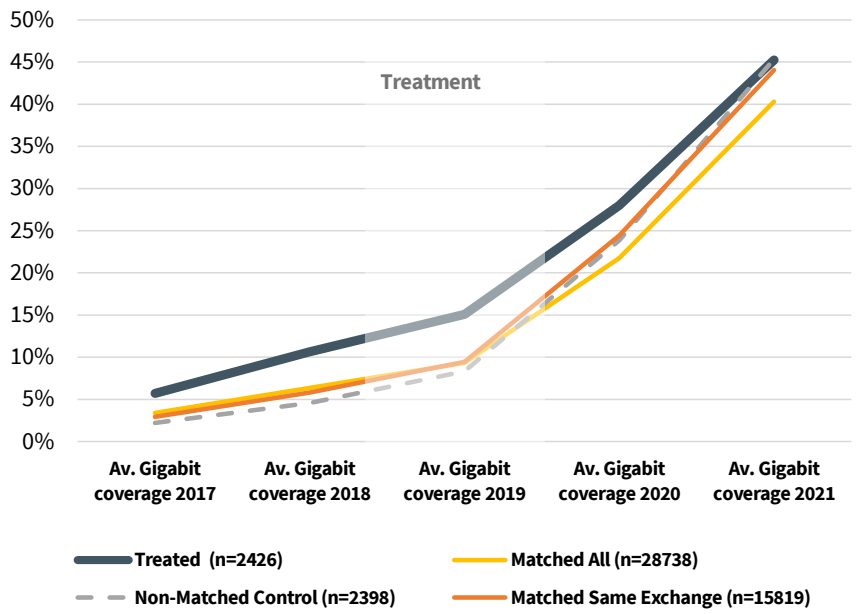
Note: Significance levels are 1% (***), 5% (**) and 10% (*).

There is no evidence that vouchers had an additional effect on the availability of gigabit broadband

3.22 Figure 3.2 shows change in the percentage of premises that can access gigabit broadband. This analysis is more complicated because there is no consistent indicator for measuring this over time in Connected Nations. The chart uses 'full fibre' availability for 2017 to 2019 and 'gigabit capable' availability from 2020 onwards[26]. With this caveat in mind, the chart shows that availability of gigabit capable broadband in LSOAs that received vouchers in 2019 followed a similar trajectory to a number of control areas, and that the control area based on LSOAs from the same exchange area experienced a faster increase in coverage than treated areas. Again, this suggests that areas which received vouchers fared worse than similar LSOAs in the same exchange area.

[26] Gigabit capable coverage has been introduced, which includes all Full Fibre coverage, and all Coaxial coverage using Docsis 3.1 that has been identified as delivering download speeds up to 1 Gbit/s. However, due to commercial confidentiality, Full Fibre coverage has been removed from this data set (CN 2020).

Figure 3.2 Change in the availability of gigabit broadband in LSOAs treated in 2019 and control areas



Source: Belmana.

3.23 Table 3.6 shows a summary of the modelling results. Most of the models found no statistically significant difference in the change in the availability of gigabit broadband in treated and control areas. Those models which found significant differences were those which used a control area drawn from LSOAs in the same exchange area, and in each case the difference was negative. As noted above, there are a number of possible explanations for this, but this would need to be investigated further.

3.24 These findings are surprising because the aim of the vouchers schemes was to improve availability of gigabit capable broadband. We would therefore expect to see a stronger positive effect. This may be due to the measurement challenges described above, or it may be due to the fact that, in most treated LSOAs, only one premise received a voucher meaning only a small number of premises are likely to be able to access a full fibre connection. This would make it difficult to detect a robust effect. We analyse the effects of increasing the number of vouchers below.

Table 3.6 Additional change in the availability of gigabit broadband

Treatment year	Gross change (percentage points)	Models significant	Median additional change	Additional change range
2019	13.09	1 of 9	0.07	-1.66 to 0.70
2020	18.40	3 of 9	-1.32	-2.35 to -0.03

Note: Significance levels are 1% (***), 5% (**) and 10% (*).

There is a significant increase in availability of superfast broadband in treated areas

3.25 The modelling did find that the number of premises that can access download speeds of at least 30 Mbps increased by more in areas receiving voucher support than control areas. This was a consistent finding across most of the nine models[27]. This suggests there is an additional effect which can be attributed to vouchers.

3.26 Table 3.7 shows that the average number of premises that can access these speeds increased by 86 in areas supported by vouchers in 2019. Between 5 and 10 of these can be attributed to vouchers, depending on which model is used. The median from these models was 8 additional premises which would mean 9.5% of the change can be attributed to vouchers. The results were lower but similar for vouchers connected in 2020 (between 4 and 7 additional premises able to access superfast broadband as a result of vouchers).

3.27 This requires some explanation since the purpose of the voucher schemes was to improve access to gigabit capable broadband, not superfast broadband. The most likely explanation is that vouchers enabled suppliers to offer higher speed (but sub gigabit) connections to premises which were close to vouchers.

Table 3.7 Additional change in number of premises that can access download speeds of at least 30 Mbps

Treatment year	Gross Change	Models significant	Median Additional Change	Additional Change Range
2019	86	9 of 9	7.73***	4.59 to 10.09
2020	72	8 of 9	5.51***	4.49 to 7.05

Source: Belmana.

Differences between voucher schemes

3.28 The evaluation investigated whether there was any significant difference between effects on coverage for the two main voucher schemes; GBVS and RGC. This might be expected because the RGC scheme focused on rural areas which were less likely to be connected by the market than urban areas connected through GBVS.

3.29 This was assessed by undertaking a post-estimation analysis, which uses the same models described above but estimates the effects on the change in the availability of UFBB separately for areas which received vouchers through each scheme. The focus was on vouchers issued in 2020 since very few RGC vouchers were issued in 2019 meaning the sample size was not large enough

[27] One of the models for vouchers treated in 2020 did not find a significant difference

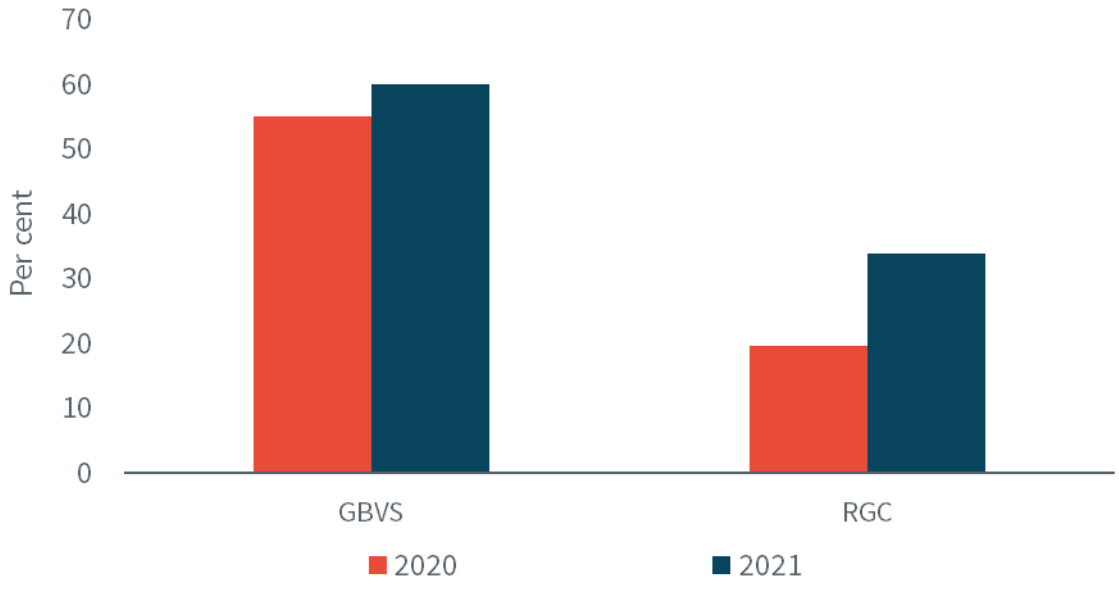
Preliminary results suggest RGC scheme has been ten times more effective at increasing coverage of UFBB than the GBVS scheme

3.30 Figure 3.3 compares the change in availability of UFBB in areas which received vouchers through the GBVS and RGC schemes in 2020. It shows that GBVS vouchers were used in areas that already had good coverage of UFBB in 2020 (over 50%). This suggests GBVS vouchers were being used in areas where suppliers of high-speed broadband already had a significant presence and had been expanding their networks. The availability increased by 5 percentage points in the year after treatment.

3.31 The availability of UFBB was initially much lower in areas that received vouchers through the RGC scheme, which indicates suppliers were less active in these areas prior to the voucher scheme. Availability increased by 14.3 percentage points in the year after treatment (9.3 percentage points higher than the change in GBVS areas).

3.32 Part of this difference is explained by the direct effect of vouchers; RGC areas received more vouchers on average than GBVS areas. However, this only accounts for a small proportion of the change (0.8 percentage points), meaning change in the availability of UFBB was still 8.5 percentage points higher in RGC areas when we take account of this.

Figure 3.3 Change in the availability of UFBB in RGC and GBVS areas treated in 2020



Source: Hatch analysis of BDUK monitoring data and Connected Nations

3.33 Counterfactual modelling appears to confirm that the change in the availability of UFBB that can be attributed to vouchers was significantly higher in RGC areas than GBVS areas. All of the models showed a significant difference with control areas, ranging from 7.09 to 10.97 percentage points. The median effect was 8.29 percentage points; over ten times higher than the median effect for GBVS areas

(0.71 percentage points). This suggests the rural scheme was far more effective than GBVS at increasing the availability of UFBB.

3.34 However, there are some caveats to this finding. Firstly, the sample size is very small for the RGC scheme[28] (93 LSOAs) which presents a risk for these types of estimations that require large samples. A second caveat is that rural LSOAs tend to be larger and therefore may include some spillover effects from neighbouring LSOAs[29]. Finally, there were other policies implemented in rural areas to increase broadband coverage (such as the Hubs Product) which could have contributed to increased availability of high-speed broadband which have not been taken into account here.

3.35 Therefore, we suggest treating this as a preliminary result that needs further research that will be conducted in the next phase of the evaluation when more data about the rural scheme becomes available.

Table 3.8 Impact of vouchers on availability of UFBB by scheme, 2020 to 2021

Scheme	Median effect	Range of effect	Models significant
RGC	8.29***	7.09 to 10.97	9 of 9
GBVS	0.71**	-0.22 to 1.25	6 of 9
All vouchers	0.98***	0.27 to 1.57	6 of 9

Source: Belmana. Note: Results for the three models considering four different samples. Significance levels are 1% (***), 5% (**) and 10% (*).

Differences between voucher types

3.36 The evaluation also explored differences in effects in areas where only project vouchers were compared to areas with only standard vouchers. This tested the hypothesis that additionality was greater for project vouchers because they enabled suppliers to aggregate multiple points of demand and therefore connect a larger number of premises than standard vouchers.

Project vouchers have had a significantly greater effect on coverage than standard vouchers

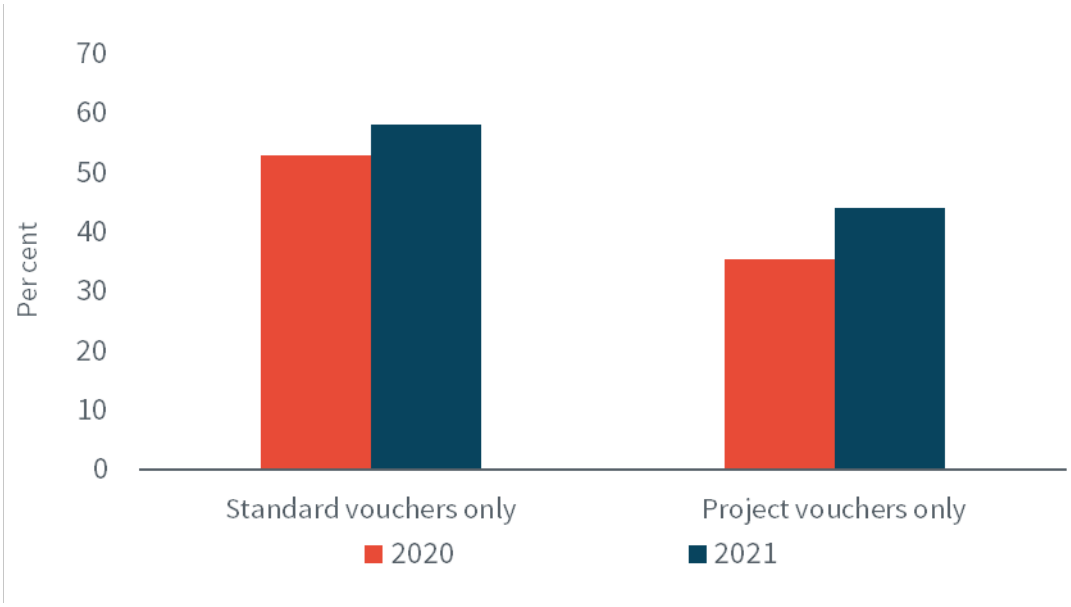
3.37 Figure 3.4 compares change in availability of UFBB in areas that received project and standard vouchers in 2020. Again, it shows that areas with standard vouchers started from a higher base than those with project vouchers, and the availability of UFBB increased by a smaller amount in the year after support (5.2 percentage points compared to 8.7 percentage points in project voucher areas).

[28] This is due to the later rollout of the RGC scheme and the fact that we were only able to analyse vouchers issued in 2020 because the effect of later vouchers would not be captured in Connected Nations 2021. Later evaluations will be able to repeat the analysis using a larger sample size.

[29] See analysis in the final section on this chapter which shows evidence of spillover effects from treated LSOAs to LSOAs in close proximity, which relates particularly to small urban LSOAs. If these are close to rural LSOAs then that could explain some of the effects on coverage.

3.38 Part of the difference is explained by the fact that project areas received larger numbers of vouchers than standard areas, but this only accounts for less than third of the difference. Even if we take account of these direct effects, the change in availability of UFBB was still 2.5 percentage points higher in project areas.

Figure 3.4 Change in the availability of UFBB in areas which received project and standard vouchers in 2020



Source Hatch analysis of BDUK monitoring data and Connected Nations

3.39 The post estimation analysis found that changes in the availability of UFBB that can be attributed to vouchers were significantly higher in areas where only project vouchers were used. Six of the nine models found a significant effect, with a median effect of 2.34 percentage points, compared to 0.78 percentage points in standard voucher areas. This suggests project vouchers were more effective at increasing availability of UFBB than standard vouchers.

3.40 The sample size for project vouchers was larger than for RGC (213 LSOAs), but we would still note that the same caveats in paragraph 3.34 apply to this analysis. For this reason, the findings should be treated as preliminary and will be tested further in the next phase of research.

Table 3.9 Impact of vouchers on availability of UFBB by voucher type, 2020 to 2021

Type	Median effect	Range of effect	Models significant
Project	2.35***	1.13 to 3.35	6 of 9
Standard	0.78**	-0.09 to 1.31	6 of 9
All vouchers	0.98***	0.27 to 1.57	6 of 9

Source: Belmana. Note: Results for the three models considering four different samples. Significance levels are 1% (***), 5% (**) and 10% (*).

Numbers of vouchers and effect on coverage

Although areas which received more vouchers experienced greater increases in availability of UFBB and Gigabit broadband, there is no evidence of any additional coverage beyond the direct effect of vouchers

3.41 In order to analyse the effect of increasing the numbers of vouchers in treated areas we analysed gross change in the availability of UFBB and gigabit broadband in areas which were broadly similar other than their level of voucher support. This initially focused on LSOAs which

- had fewer than 1,500 premises (this excludes the very large LSOAs where it was more difficult to detect an effect from vouchers)
- had less than 10% of premises with availability of UFBB or gigabit broadband in 2018 (this ensured we were comparing areas that were not attractive to the market at the start of the intervention period)

3.42 Table 3.10 compares change in availability of UFBB between 2020 and 2021 in areas with different levels of support in 2020. As well as showing the total change in availability, it shows the change that can be directly attributed to vouchers (assuming each voucher results in a premise being able to access UFBB) and the other change in availability which cannot be directly attributed to vouchers. This other change could include:

- premises which were able to access higher speeds as a result of the market roll-out or other public interventions.
- premises passed – these are premises which did not receive a voucher but are close to premises which did, and are now able to access UFBB because of the enhanced infrastructure in the local area. They are therefore indirect beneficiaries of vouchers. Where vouchers have been delivered through projects, we might expect the number of premises passed to be considerable since they should enable broadband suppliers to offer ultra-fast services to all properties in an area once a threshold has been reached[30].

3.43 The table shows that all areas experienced an increase in the availability of UFBB between 2020 and 2021 ranging from 9 to 14 percentage points. The areas that experienced the largest increase were those that had received more than 20 vouchers. However, a large proportion of this can be attributed to the direct effects of vouchers. In many cases the 'other change' was the same as LSOAs which have not received any voucher support. The treated LSOAs which experienced a notably larger increase were those that had received between 3 and 10 vouchers.

3.44 This suggests that increasing the number of vouchers in an area did not lead to an increase in availability over and above that which was delivered directly by the vouchers. There is limited evidence of indirect effects on availability as a result of premises passed which was a key goal of BDUK's voucher interventions.

[30] In Phase 1 we conducted a large number of consultations with broadband suppliers who reported this was the case; "*suppliers have delivered a large amount of infill ie connected up large numbers of properties passed by the voucher projects without the need for more vouchers*"

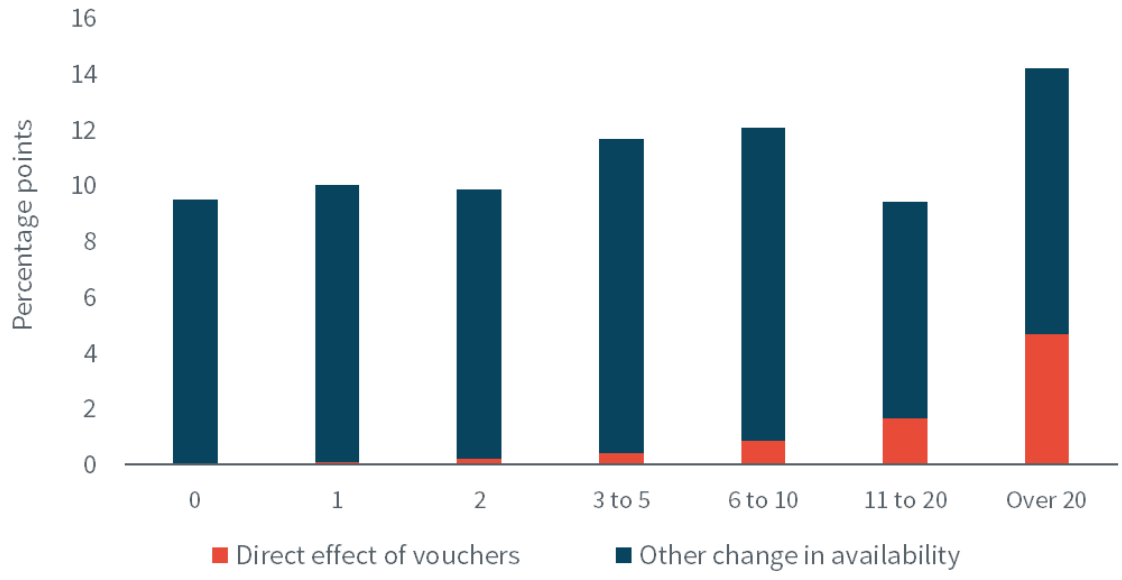
Table 3.10 Change in the availability of UFBB in LSOAs with different levels of voucher support in 2020

No. vouchers in LSOA	No. LSOAs	No. vouchers	Availability 2020	Availability 2021	Direct effect of vouchers (% points)	Other change (% points)	Total change in UFBB availability (% points)
0	9,101	0	19.6%	29.1%	0.0	9.5	9.5
1	536	536	16.6%	26.6%	0.1	9.9	10.0
2	96	192	19.5%	29.4%	0.2	9.6	9.8
3 to 5	64	238	19.5%	31.1%	0.4	11.3	11.7
6 to 10	55	405	12.3%	24.4%	0.9	11.2	12.1
11 to 20	43	632	10.9%	20.3%	1.6	7.8	9.4
Over 20	40	1,611	19.4%	33.6%	4.7	9.5	14.2

Source: Hatch analysis of BDUK monitoring data and Connected Nations.

3.45 Figure 3.5 shows the same data in a chart. It shows no clear relationship between the numbers of vouchers in an LSOA and the gross change in availability of UFBB once we take account of the direct effects of vouchers.

Figure 3.5 Change in availability of UFBB in LSOAs with different numbers of vouchers, 2020-2021



Source: Hatch analysis of BDUK monitoring data and Connected Nations.

Large numbers of vouchers had a greater effect on availability of UFBB in rural areas or those in the final 20%

3.46 The analysis above is focused on those LSOAs with fewer than 1,500 premises and with less than 10% of premises with UFBB availability in 2018. This includes a number of denser urban areas with a lower F20 score which may have had a higher likelihood of receiving coverage through the market roll-out. We therefore repeated the analysis, focusing only on rural areas or areas with a F20 score above 0.8 (the 20% hardest to reach areas in the UK).

3.47 Table 3.11 shows the results for areas with an F20 score of at least 0.8. In this sample[31], the total change in availability is notably higher in LSOAs which received any voucher support compared to those that did not receive vouchers. It also shows that those LSOAs which received over 20 vouchers experienced a much greater increase in the availability of UFBB than those which received smaller numbers of vouchers. This was due to the direct effect of vouchers but also a result of larger 'other change' which may indicate a higher number of premises passed. The modelling found very similar results when we focused only on rural areas.

3.48 This indicates a relationship between the number of vouchers and change in the availability of UFBB, but only in rural areas or those in the final 20% (although the analysis is limited by low sample sizes). If we do not apply this criteria, there does not appear to be any relationship, or at least a weak one based only on the direct effects of vouchers.

Table 3.11 Change in the availability of UFBB in areas with F20 score over 0.8

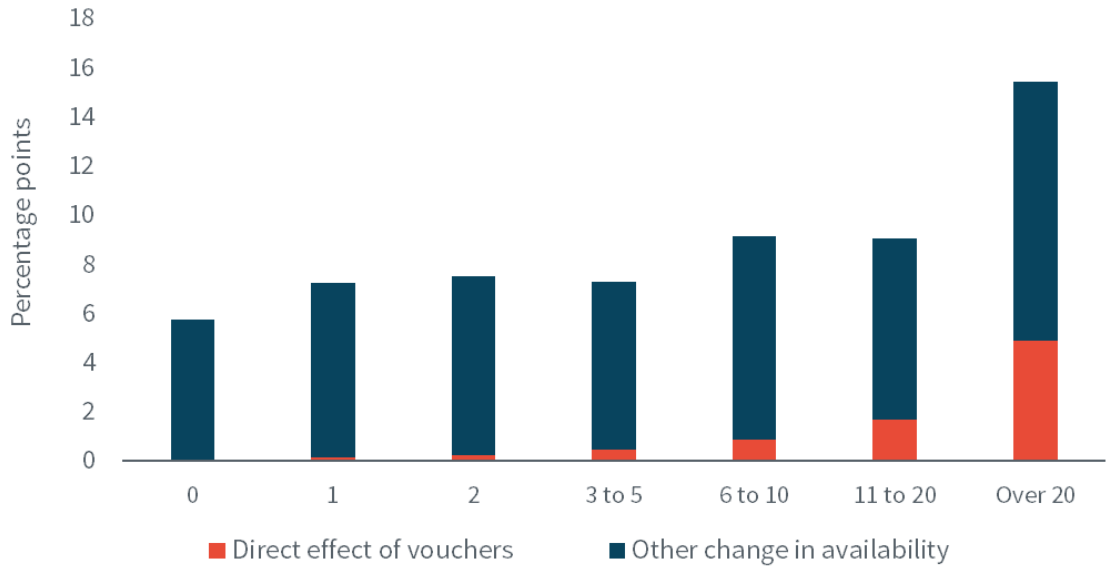
No. vouchers in LSOA	No. LSOAs	No. vouchers	Availability 2020	Availability 2021	Direct effect vouchers (% points)	Other change (% points)	Total change in UFBB availability (% points)
0	1,730	0	10.0%	15.7%	0.0	5.7	5.7
1	180	180	10.6%	17.8%	0.1	7.1	7.2
2	55	110	10.5%	18.0%	0.2	7.3	7.5
3 to 5	33	125	10.3%	17.6%	0.5	6.8	7.3
6 to 10	42	307	12.9%	22.0%	0.9	8.3	9.1
11 to 20	27	395	8.8%	17.9%	1.7	7.4	9.0
Over 20	40	1,611	19.4%	33.6%	4.7	9.5	14.2

Source: Hatch analysis of BDUK monitoring data and Connected Nations.

3.49 The chart shows the large increase in the availability of UFBB in areas which received over 20 vouchers compared to areas which received lower levels of support.

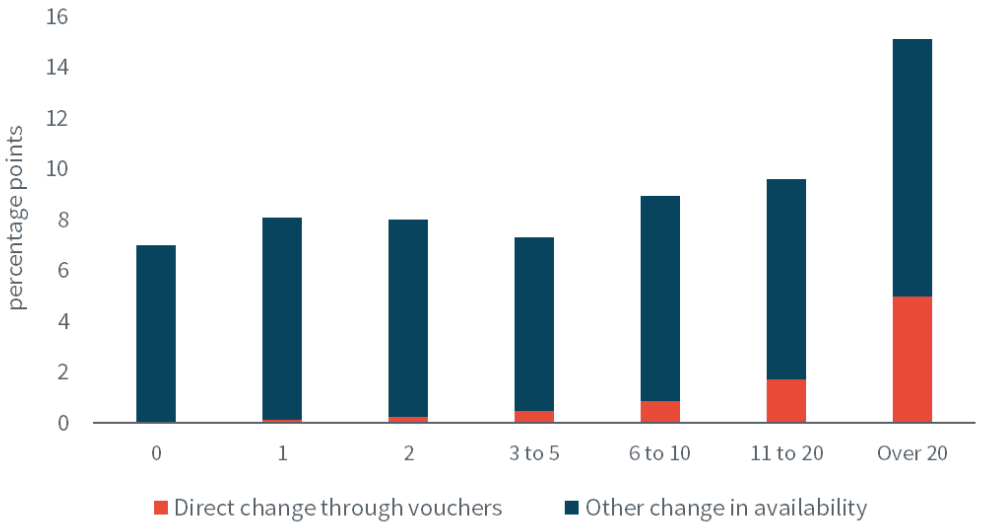
[31] It should be noted that the sample size for some categories of LSOA that received different numbers of vouchers is low which increases the margin of error. The results should therefore be treated as indicative.

Figure 3.6 Change in availability of UFBB in LSOAs with different numbers of vouchers, 2020-2021 (F20>0.8)



Source: Hatch analysis of BDUK monitoring data and Connected Nations.

Figure 3.7 Change in the availability of gigabit broadband in areas with different levels of support, 2020-21 (F20>0.8)



Source: Hatch analysis of BDUK monitoring data and Connected Nations.

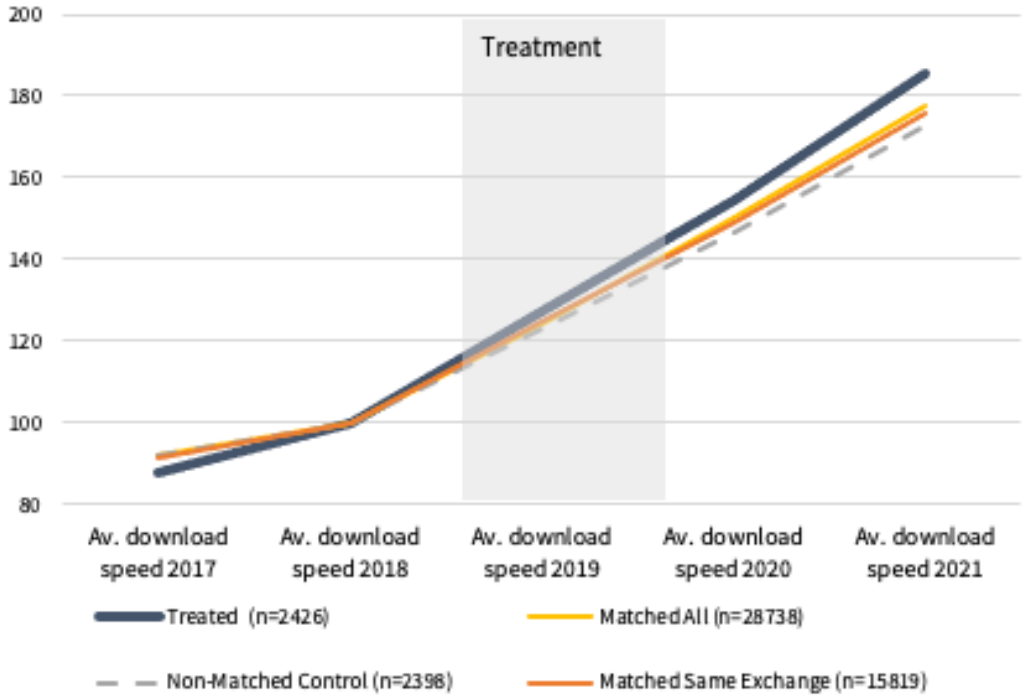
3.50 Figure 3.7 shows similar results when we measure change in the availability of gigabit broadband in areas that received different numbers of vouchers.

Broadband Performance

3.51 The effect of vouchers on broadband performance was assessed by analysing change in average download speeds in the Connected Nations performance dataset. This is a good indicator as it reflects availability of high-speed broadband and the actual speeds accessed by households and businesses.

3.52 Figure 3.8 compares the change in average download speeds for LSOAs supported in 2019 with a number of different control areas. It shows that all areas experienced growth in download speeds, but this growth was stronger in treated areas after receiving vouchers than in control areas. This indicates there was an additional effect on download speeds which can be attributed to vouchers.

Figure 3.8 Average download speed after support for areas receiving vouchers in 2019 (Indexed, 2018=100)



Source: Belmana.

3.53 Table 3.12 quantifies the scale of this effect. All the models found that change in download speeds was significantly higher in treated areas than control areas, indicating an additional effect which can be attributed to vouchers. For vouchers connected in 2019, these additional speed changes ranged from 0.78 to 1.36 Mbps. The median from these models[32] was 1.06 Mbps or 8% of the gross change.

[32] The median in this case was the model which includes change in download speed prior to treatment as a modelling variable and which used a control group drawn from all LSOAs excluding those with high employment.

3.54 The net additional effect of vouchers was similar in those areas where vouchers were issued in 2020. This ranged from 0.81 to 1.21 Mbps, with a median effect of 1.0 Mbps (or 7.2% of the gross change)[33].

3.55 Although the change in speeds due to vouchers appears to be marginal, it is worth noting:

- There were average speed changes in treated LSOAs which, on average, had over 1,000 premises. Two thirds of these LSOAs received only one voucher. It is therefore positive that we were able to detect a statistically significant effect on download speeds despite the relatively modest level of support in many areas.
- It is still early days in terms of demand for gigabit capable services. These changes reflect the speeds that premises access through their broadband service. Many premises that are able to access gigabit capable broadband as a result of vouchers may choose not to do so, either because they are not aware that it is available or because they are satisfied with a lower speed at a more affordable cost. As the need for increased speed and reliability increases over time, the availability of this infrastructure in places where vouchers have been delivered will mean consumers can upgrade when required. This may lead to faster growth in speed change in those places in the future.

Table 3.12 Additional change in download speed (Mbps) in areas supported with vouchers in 2019 and 2020

Treatment year	Gross change in treated areas	Models significant	Median additional change	Additional change range	Median additionality estimate
2019	12.54	9 of 9	1.06***	0.78 to 1.36	8.4%
2020	13.91	9 of 9	1.00***	0.81 to 1.21	7.2%

Note: Results for the three models considering three different samples. Significance levels are 1% (***), 5% (**) and 10% (*).

[33] Based on the model which includes pre-treatment broadband speed as a modelling variable (but not change) and uses a control group drawn from all untreated LSOAs

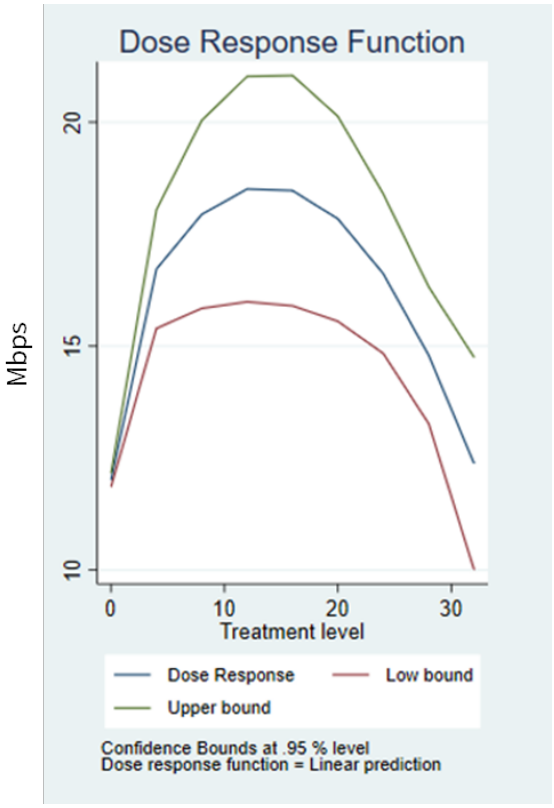
Areas which received between 15 and 20 vouchers experienced the greatest increase in download speeds

3.56 The relationship between the number of vouchers in an LSOA and the change in download speeds was investigated through dosage modelling.

3.57 0 illustrates this relationship. The x axis shows the number of vouchers in an LSOA. The y axis shows the change in average download speed between October 2018 and September 2019. The central line in the chart is the central estimate of the relationship, with upper and lower bounds also shown.

3.58 The chart shows there was a positive impact on average download speed change for all levels of treatment (numbers of vouchers), but the optimal treatment occurs in LSOAs that received between 15 and 20 vouchers. The speed change was c. 5 Mbps higher in these LSOAs than those that received only one voucher and c. 4 Mbps higher than areas that received 30 vouchers.

Change in average download speed by number of vouchers (Mbps)



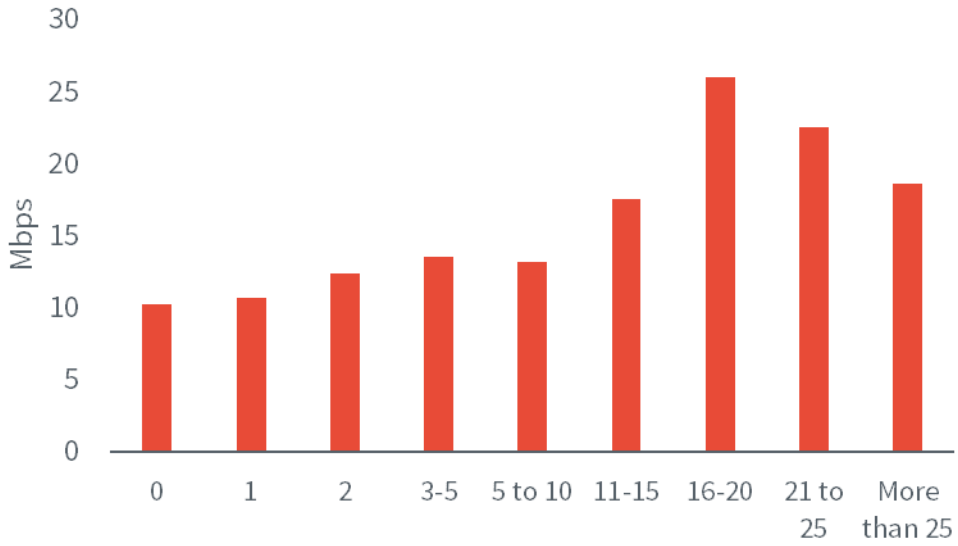
Source: Belmana.

3.59 Analysis of gross change in download speeds in areas with different numbers of vouchers also shows a broadly similar pattern. Here the analysis focused only on LSOAs treated in 2020 which had between 500 and 1,000 premises and an average download speed of less than 40 Mbps in 2018[34]. Figure 3.9 shows that areas that received between 16 and 20 vouchers experienced the greatest increase in average download speeds in the year after support. This is consistent with the dosage modelling, although the scale of the difference between areas is much greater in the chart below (and broadly aligned with the upper bound of the relationship shown in 0).

3.60 It is unclear why LSOAs with between 16 and 20 vouchers experienced a greater speed change than areas that received a larger number of vouchers. The analysis above shows a broadly positive relationship between the number of vouchers in an LSOA and the change in availability of high-speed broadband. We would therefore have expected a similar relationship for broadband performance, however we have not found evidence for this to date. This suggests that take-up of high-speed broadband in areas with large numbers of vouchers was lower than in areas with between 16 and 20 vouchers.

[34] This is to ensure that we are comparing LSOAs with broadly similar characteristics.

Figure 3.9 Gross change in download speeds in LSOAs with different numbers of vouchers



Source: Hatch analysis of BDUK monitoring data and Connected Nations.

Differences between schemes and voucher types

The two voucher schemes had similar effects on download speeds

3.61 Table 3.13 compares the additional effects of vouchers on download speeds in areas which received vouchers through the RGC scheme and the GBS scheme. We found no statistically significant difference between these areas in any of the nine models. This suggests that the RGC and GBVS programmes had similar effects on speeds.

3.62 This is in contrast to the analysis of the availability of broadband at different speed levels, which found that RGC areas experienced a significantly larger increase in availability of UFBB than GBVS areas. This suggests that, as of 2021, a large number of premises that gained access had not taken up high speed connections. This may change if the need for increased speed and improved reliability increases over time.

Table 3.13 Impact of vouchers on broadband speeds by voucher scheme, 2020 to 2021

	Median Additional Effect	Range of effect	Models significant
RGC	0.42	-0.02 to 1.71	0 of 9
GBVS	0.71	0.55 to 1.06	
All	1.00***	0.81 to 1.21	9 of 9

Source: Belmana. Note: Results for the three models considering three different samples. Significance levels are 1% (***), 5% (**) and 10% (*).

3.63 There are a number of important caveats to the findings above. As already noted, the sample size of LSOAs which received only RGC vouchers was small, which presents a risk for these types of estimations. The small sample size also prevented us from constructing a model specifically for RGC vouchers. Rather, the wider model for all vouchers was used. The fact that the model was constructed for all vouchers and not just the RGC scheme may mean that some characteristics particular to RGC areas were not adequately reflected in the control group. This could potentially lead the model to understate or overstate the results for this scheme. This would need to be explored as more data becomes available from Connected Nations.

Project vouchers had a greater effect on download speeds than standard vouchers

3.64 Table 3.14 compares the additional effects of vouchers on download speeds in areas which received project vouchers with those that received standard vouchers in 2020. All the models found that areas receiving project vouchers experienced a greater increase in download speeds than areas which received standard vouchers, with all models finding the difference was statistically significant. On average, the increase in download speeds was 1.59 Mbps higher in project areas than standard areas.

Table 3.14 Impact of vouchers on download speed by voucher type, 2020-2021

Type	Median Additional Effect	Range of effect	Models significant
Project	2.30***	1.89 to 3.05	9 of 9
Standard	0.71	0.55 to 1.06	
All	1.00***	0.81 to 1.21	9 of 9

Source: Belmana. Note: Results for the three models considering four different samples. Significance levels are 1% (***), 5% (**) and 10% (*).

Spillover effects

Areas in close proximity to treated areas experienced similar improvements in speed, but the reasons for this are unclear at this stage

3.65 As well as benefitting the LSOA to which they are issued, vouchers may have had positive spill-over effects on download speeds in nearby areas. This is because vouchers enable providers to extend the fibre network, which in turn reduces the cost of connecting nearby areas.

3.66 This was investigated by comparing download speeds in treated areas with untreated LSOAs which are in close proximity. The analysis found no statistically significant difference in change in download speeds between treated LSOAs and untreated LSOAs within 3km[35]. Beyond this distance, the increase in speed changes were significantly lower. This offers possible evidence of spillover effects for areas in close proximity to those which received vouchers.

[35] Based on the centroid of LSOAs

3.67 However, it is also possible that this was not an effect of vouchers, but a reflection of the fact that some suppliers used vouchers in areas where they were already expanding their network, in which case we would expect to see improvements in nearby LSOAs. Vouchers may have allowed them to go further than they otherwise would, but the increased coverage in neighbouring areas would have occurred anyway and therefore could not be attributed to vouchers.

3.68 Further research would be needed to investigate whether this was due to spillover effects, or the result of the expansion of networks which would have happened anyway.

Table 3.15 Change in download speeds in LSOAs of varying distance from treated LSOAs

	1km	2km	3km	4km	5km	All LSOAs
DID estimate - (Model I)	-0.233	0.126	0.584	0.654*	1.094**	1.445**
Speed change as % of treated areas	100%	91.2%	59.6%	54.7%	24.3%	0%
Number of LSOAs	5750	14,566	19,746	22,377	23,972	28,738

Source: Belmana.

Note: Results are outlined for model I for given counterfactual pools. Significance levels are 1% (***), 5% (**) and 10% (*).

3.69 An additional note of caution is that the analysis used LSOAs as the geographical unit of measurement. As LSOAs are designed to be equally sized in terms of populations, they are much smaller in urban areas than in rural or less densely populated areas. Therefore, this analysis includes far more observations in more densely populated areas, which might be expected to have experienced stronger improvements in broadband performance.

3.70 So far it has not been possible to assess evidence of spillover effects at a more local level for rural areas because most of the datasets used in the modelling are only available for LSOAs. This will be explored in the next phase of the study as more data becomes available (e.g. data on individual businesses). This may allow us to carry out more fine-grained analysis at a more localised level to assess whether there are benefits for neighbouring areas.

Conclusions

3.71 The modelling undertaken to date shows a positive picture about the additional impacts of vouchers on broadband coverage and performance:

- **Additional effects on the availability of broadband at different speed levels**: Vouchers connected in 2020 increased the availability of UFBB by 0.98 percentage points compared to control areas (based on the median effect). We did not find evidence of additionality for vouchers issued in 2019, but this could be due to the fact that these were more focused on urban areas which were more likely to be connected through the market rollout. We also

found strong evidence that vouchers led to higher availability of superfast broadband.

- **Additional effects on speeds**: All the models found that treated areas experienced additional speed improvements which can be attributed to vouchers, of around 1 Mbps in the year after support. This is based on the speed that households and businesses received through their broadband subscription. Many of the premises that received access may not have subscribed to high-speed subscriptions yet, so this could increase in future.

3.72 These findings largely reflect the outcomes of early versions of the voucher scheme, which was to stimulate the rollout of gigabit capable infrastructure and enable the market to extend its own plans further and quicker. In later versions of the scheme, eligibility was increasingly focused on the least viable areas for gigabit broadband (e.g. rural areas and the 20% hardest to reach), and suppliers were encouraged to build bigger and further than they otherwise would through the use of project vouchers. Although the findings for 2020 include some of the effects of the RGC scheme and project vouchers, these only account for a relatively small proportion of the sample, meaning the overall results are heavily skewed towards the effects of GBVS.

3.73 Nevertheless, there is emerging evidence that the RGC scheme and project vouchers had a much larger effect on the availability of UFBB than the GBVS scheme and standard vouchers. This is still a preliminary finding at this stage, which will be tested further as more data becomes available. However, it offers some initial evidence that the changes made to the voucher scheme model led to higher levels of additionality and better value for money.

3.74 There are a number of areas requiring further research and investigation:

- Additional modelling of the differential impacts of vouchers delivered through the RGC and GBVS scheme, and project/standard vouchers. This will be explored for vouchers used to connect premises in 2021 as more data becomes available through Connected Nations, which will provide larger sample sizes.
- Further investigation of the reasons why areas in close proximity to LSOAs that were also close to treated LSOAs experienced comparable speed changes. This could be done through the selection of a number of case study areas and further research undertaken with broadband suppliers. This may also explain why similar untreated LSOAs in the same exchange area as treated LSOAs experienced larger increases in coverage of broadband.
- Further analysis of the relationship between the number of vouchers and coverage of broadband. We will construct a dosage model to assess this relationship and use this to assess the value for money of voucher investments.

4. Business Survey Findings

Summary of key findings

- **Sample**: A total of 1,681 completed responses were received from business voucher recipients, representing a 6% response rate. Based on a 95% confidence level, this means the results in the report have a margin of error of +/- 2.3%.
- **Business characteristics**: 75% of respondents employ fewer than ten employees, and most were single site businesses operating from an office (45%) or a home-based business (28%). Respondents were drawn from a wide range of sectors and were operating in a diverse range of locations, including town/city centres (27%), residential areas (23%) and rural areas (22%).
- **Motivations**: Of those respondents that were involved in the application process, over two thirds were seeking a more reliable connection and faster download speeds. The main business goal of those who applied for a voucher was improved productivity (66%).
- **The voucher process**: Nine out of ten (89%) of respondents said that they were satisfied or very satisfied with the ease / simplicity of the voucher process, and eight out of ten (80%) were satisfied or very satisfied with the length of the application process.
- **Satisfaction with the upgraded connection**: A high proportion of business reported being satisfied with their upgraded connection, including reliability (93%), download speeds (94%), upload speeds (93%). Satisfaction levels were lower for value for money but still high overall (74%). Satisfaction levels were particularly high for RGC voucher recipients and those in rural or F20 areas.
- **Business benefits**: A large proportion of respondents (79%) reported their upgraded connection had enabled them to do new things. The most common changes include adoption of more flexible working practices for staff (51%), implementation of new business processes (48%) and reducing business travel (46%).
- **Impacts on rural and F20 businesses**: Rural businesses were more likely to identify a wide range of business objectives and benefits from faster and reliable broadband. Although Rural, F20, RGC and project voucher recipients are less likely to be using a range of applications (explained mainly by their size/sector) they are more likely to be using a range of applications for the first time
- **Business impacts**: Of those that were doing new things, 82% reported an increase in productivity (34% reported a major increase) 50% saw an increase in profitability and 42% experienced an increase in turnover.
- **COVID-19 pandemic**: 70% of businesses say the upgrade helped them to adapt and continue to do business during the pandemic. There was an even more pronounced effect for RGC (79%), F20 (78%) and rural businesses (81%).

Method

4.1 The survey was undertaken by Winning Moves, a specialist research and survey company which specialises in evaluation of UK public policy interventions. The survey used a mixed-methods approach. An online survey was developed and sent to all business voucher recipients supported via the GBVS and RGC schemes. Online survey responses were monitored, and telephone interviews were used to boost the number of responses in certain groups, in particular:

- Voucher recipients that applied in the early stages of GBVS (i.e. 2017-19) due to a lower response rate among these beneficiaries.
- RGC voucher recipients, as the total number of businesses which have received support through RGC is much lower than for GBVS. DCMS has a particular interest in the responses of RGC beneficiaries because of the similarities between that scheme and the current Project Gigabit.
- Topped-up voucher recipients, as the size of this group was small, but an important area of interest to DCMS.

4.2 Telephone interviews were also used to contact businesses that had only partially completed an online response to the survey, to either complete over the telephone or to encourage them to complete their online response. It was also used more generally to encourage businesses to respond online if a telephone interview was not convenient for them.

4.3 The risk of interviewer bias when conducting telephone interviews was minimised by undertaking all research in line with the MRS Code of Conduct and Winning Moves' quality procedures, which are registered to the ISO20252 standard. Winning Moves' researchers are thoroughly trained for their roles, and quality assured by listening to interviews as part of its procedures to ensure interviews are undertaken in a neutral and appropriate way.

4.4 The online survey asked about a range of topics including the characteristics about their business and premises, their decision to apply for a voucher, views on the application process, their satisfaction with their connection before and after the upgrade to their connection, use of the internet and the impact of the COVID-19 pandemic on their business. A copy of the survey questionnaire is provided in Appendix C.

4.5 In total, 1,681 responses were received from business voucher recipients, with 361 of these being fully completed by telephone. In total a 6% response rate was achieved from the total population of 27,536 vouchers[36]. The low response rate means there is a risk of non-response bias. However, the telephone boost was a deliberate part of the strategy to address this issue, by boosting the overall response rate and improving overall representativeness. The data were also weighted to reflect the differing response rates observed for the subgroups of interest.

4.6 In the sections below, we assess the representativeness of the sample by comparing the characteristics of respondents with those of all businesses that have received vouchers. Due to gaps in BDUK's database it was only possible to do this

[36] In total, contact details for 26,252 vouchers were provided and emailed the survey. Out of those, 3,625 emails bounced back / were unusable.

for the sector profile of respondents and the year in which they applied for a voucher. Overall, we conclude that the sample is representative, although there is an overrepresentation of certain sectors (professional services, ICT and agriculture) and of businesses that applied for vouchers more recently (since 2019).

4.7 The table below summarises the number of completed responses received from different groups of interest to DCMS. As well as the two schemes and the urban/rural split, this includes the number of responses and response rates from businesses in F20 and non F20 areas[37], standard and project vouchers and topped up and non-topped up vouchers. It shows that the survey achieved a large sample of all the different groups of interest, with the exception of topped-up vouchers. This was due to the fact that there were only 643 topped up vouchers in the BDUK database which made it hard to achieve a large sample size. This limited the analysis possible for recipients of topped-up vouchers and how these differed from non-topped-up vouchers.

Table 4.1 Response rates from key groups of interest

	Number of completed responses	Number in the population	Response rate
Scheme			
GBVS	1,157	22,793	5%
RGC	524	4,743	11%
Rural / urban			
Rural	915	8,018	11%
Urban	766	18,233	4%
F20 / Non F20			
F20	1,158	12,748	9%
Non-F20	407	13,468	3%
Not specified within database	116	1,320	9%
Standard / Project			
Standard	639	13,237	5%
Project	1,042	14,298	7%
Topped up voucher / Non-topped up voucher			
Topped up voucher	91	643	14%
Non-topped up voucher	1,590	26,893	6%

Source: Winning Moves.

4.8 Significance testing was conducted to identify any statistical differences in responses from key groups of interest, as follows:

- Scheme (GBVS and RGC recipients)

[37] This is based on a model developed by BDUK which aims to identify the final 20% of hardest to reach locations in the UK (aka F20).

- Business sector
- Business size (number of employees)
- Location (urban or rural, and F20 or non F20 area)
- Project voucher or standard voucher
- Topped up voucher / non-topped up voucher
- Year of application
- Type of premises.

4.9 Where statistically significant differences in responses are evident, to a 95% confidence interval, these are included in the commentary.

4.10 Data presented in the report has been weighted to reflect the size of the population of each voucher type, urban / rural locations and F20 / non F20 locations. This is detailed in Appendix B.

Survey findings

Characteristics of respondents

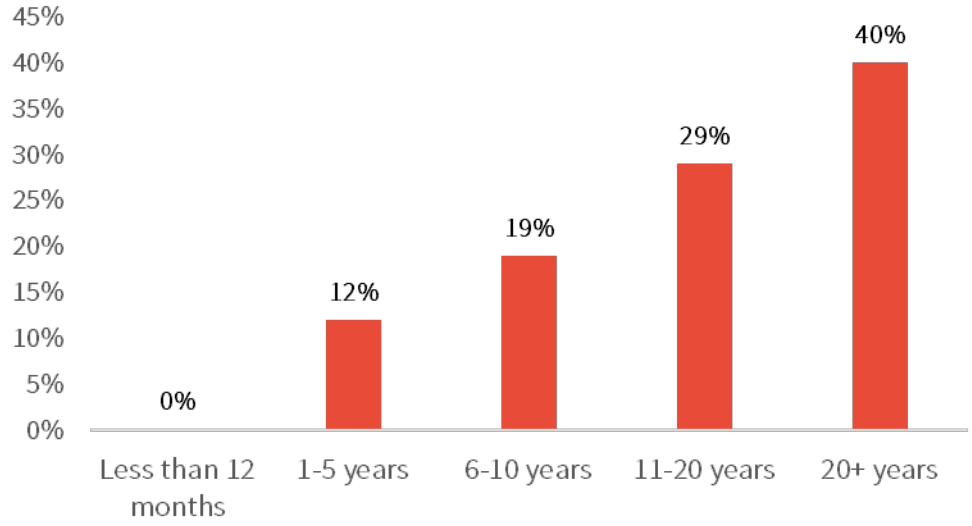
- **Business age**

4.11 The majority of businesses responding to the survey were well-established businesses, with over two thirds having been in operation for at least 10 years. This is substantially higher than the proportion of the overall business population active for this length of time[38] (40%). The remaining third of businesses were established for 10 years or less. A very small proportion (0.2%) were start-up businesses trading for less than 12 months.

4.12 A significantly higher proportion of standard voucher recipients (45%) were established for over 20 years, compared to project voucher recipients (36%). Conversely, the proportion of project voucher recipients established for five years or less, was significantly higher than standard voucher recipients (15% and 8% respectively). This is likely to reflect the fact that suppliers targeted residential areas in order to aggregate demand and in doing so, encouraged applications from a large number of home-based businesses which tended to be newer businesses.

[38] Based on ONS data: SME, age of business by Broad Industry Group - Office for National Statistics (ons.gov.uk)

Figure 4.1 Business age (n=1,681)



Source: Winning Moves.

- **Business size**

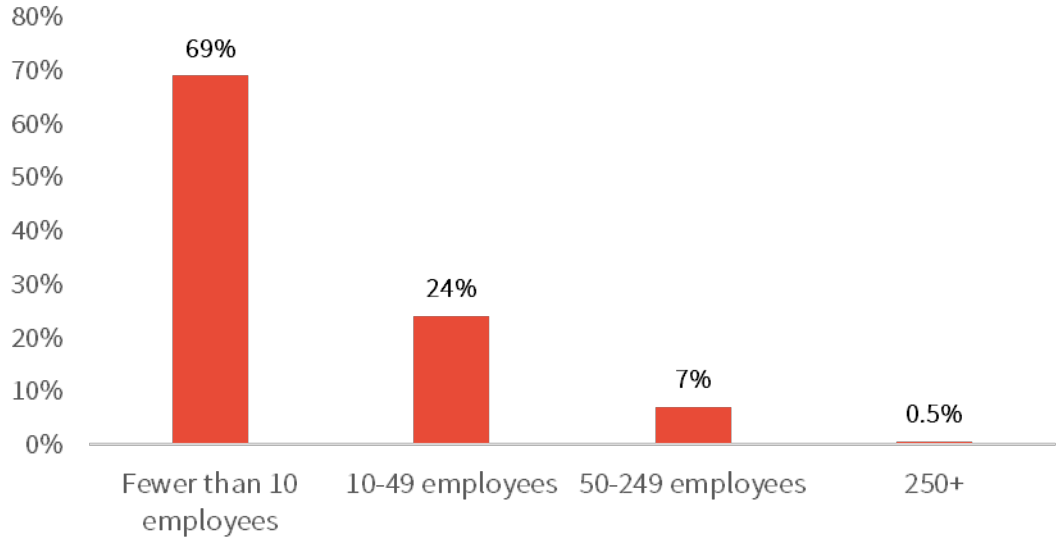
4.13 69% of businesses were micro-businesses, employing fewer than ten employees. This is significantly lower than the share of UK businesses with fewer than ten employees (90%). 31% had between ten and 249 employees, compared to only 10% in the UK business population. A very small proportion of businesses had 250 or more employees (0.5% which is comparable with the UK business population). This suggests vouchers were disproportionately used by small and medium sized businesses.

4.14 A number of groups had a significantly higher share of micro-businesses:

- 88% of RGC recipients, compared to only 65% of GBVS recipients, reflecting the smaller size of businesses in rural areas which have been a major focus of RGC.
- 84% of project voucher recipients, compared to 53% of standard voucher recipients. Again, this is likely to reflect the higher share of home-based businesses served by projects.
- 83% of topped-up vouchers, compared to 69% of non-topped up vouchers.

4.15 The high share of micro-businesses is important for understanding some of the differences in how different types of voucher recipient have used the internet and the outcomes this has generated, described in later sections.

Figure 4.2 Size of business (n=1,681)



Source: Winning Moves.

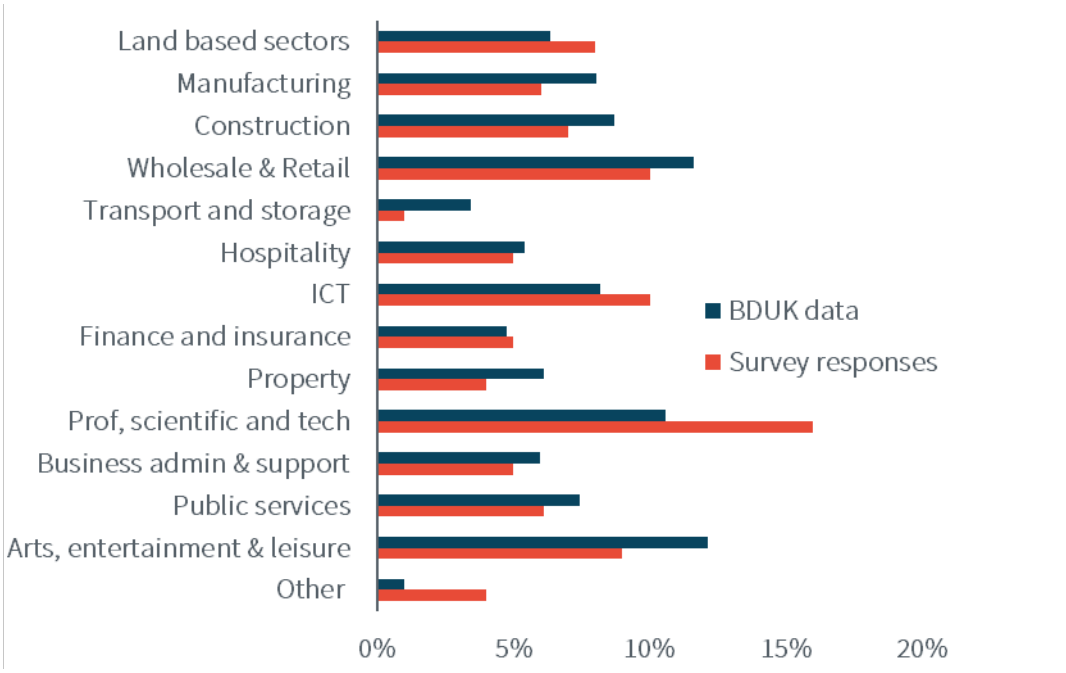
- **Business sector**

4.16 The survey drew responses from a wide range of sectors, with the largest number of responses provided by businesses in the professional, scientific and technical activities sector (16%), followed by ICT and wholesale/retail (both 10%).

4.17 Figure 4.3 compares the sector reported by respondents with the sector breakdown of all business voucher recipients as recorded by BDUK[39]. The chart suggests the sector breakdown of respondents was broadly representative, but that the survey received a disproportionately high share of responses from businesses in professional, scientific and technical activities, ICT and land-based sectors (agriculture, forestry, fishing and mining) and a disproportionately low share of responses from businesses in arts, entertainment and leisure, wholesale and retail, property and manufacturing.

[39] It is not possible to do this for the size of businesses as this is unknown for too many businesses in BDUK records

Figure 4.3 Business sector of respondents compared to sector of voucher recipients in BDUK database



Source: Winning Moves and BDUK records

4.18 Statistically significant differences between groups are as follows:

- a significantly higher proportion of RGC voucher recipients (22%) were in land-based sectors compared to GBVS recipients (4%). Similarly, a higher proportion of recipients in rural areas (19%) were in this sector compared to voucher recipients in urban areas (1%).
- a significantly higher proportion of RGC voucher recipients (10%) were in the accommodation and food services sector compared to 5% of GBVS recipients.
- significantly higher proportions of GBVS recipients were in the ICT sector (11% vs 5% in RGC), retail / wholesale (9% vs 4%) and business administration and support services (6% vs 2%).

4.19 Again, the sectoral profile of the two schemes helps to explain some of the differences in business use and outcomes described in later sections.

- **Year of application**

4.20 The survey captured responses from businesses who applied for the voucher when the scheme first began in late 2017 to early 2021. This is shown in the table below. Analysis was conducted on BDUK's records, but this was not confirmed with respondents in the survey. The table shows that responses received were broadly representative of the population, although there was an underrepresentation of businesses that received their vouchers and upgraded connection in 2017/18.

Table 4.2 Year of voucher application

Year of voucher application	Proportion of responses (n=1,681)	Proportion of voucher in the population (N=26,251)
2017-2018	25%	30%
2019	51%	47%
2020-21	22%	23%
Total	100%	100%

Source: BDUK.

- **Types of premises connected by vouchers**

4.21 Respondents were asked in the survey to indicate the type of premises benefitting from the voucher[40]. Almost half of (45%) of vouchers were used to connect offices, and just over one quarter (28%) supported a home-based business located in a private residence. Much smaller proportions of vouchers supported other types of premises such as shops / retail, factories, warehouses, agricultural buildings, and hospitality and leisure buildings.

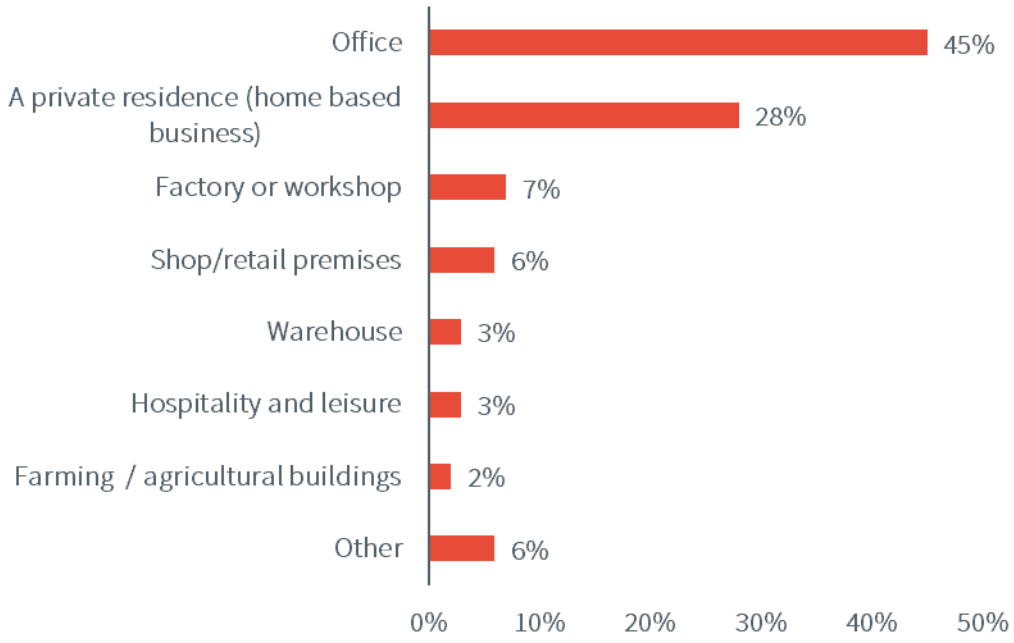
4.22 Vouchers were used to connect a significantly higher proportion of home-based businesses in a number of groups:

- RGC vouchers (64%), compared to 21% of GBVS vouchers
- Project vouchers (43%), compared to 12% of standard vouchers
- Topped up vouchers (41%) compared to 28% of non-topped up vouchers
- Rural (60%) compared to 14% of urban vouchers
- F20 (45%) compared to 12% of non F20 vouchers.

4.23 In contrast a significantly higher proportion of GBVS vouchers were used to connect offices (51% compared to 17% of RGC vouchers), with similar patterns for vouchers in urban areas (57% used to connect offices compared to 18% in rural areas) and for standard vouchers compared to project vouchers.

[40] This was based on a list of options. Respondents that selected 'other' were asked to specify. For those that did specify, these responses were analysed and recoded whether into an existing category or into one of two new categories; Agricultural buildings and Hospitality and Leisure buildings. For those that did not specify, there are reported in the chart as 'other'.

Figure 4.4 Type of premises connected by vouchers (n=1,681)



Source: Winning Moves.

- **Role of premises**

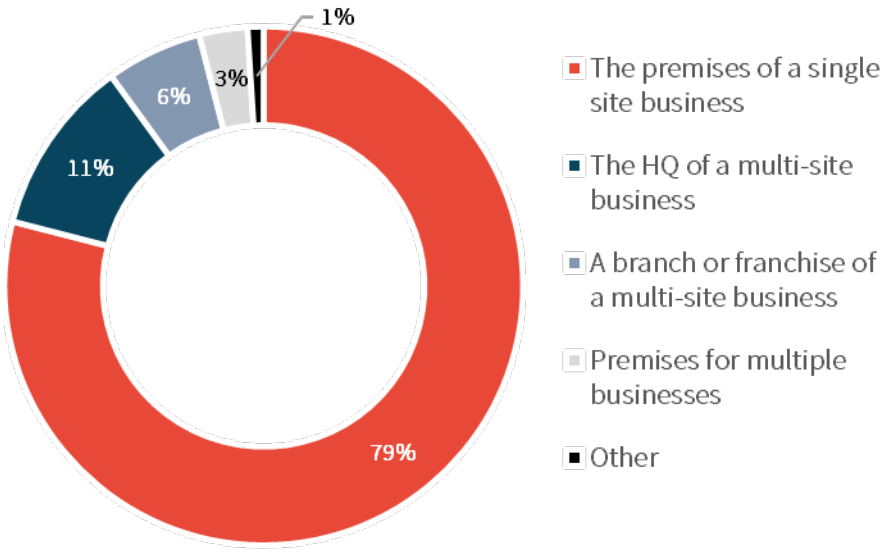
4.24 Respondents were asked to describe the role of the premises in their business from a list of options[41]. A large majority of respondents (79%) said that the premises supported by the voucher were the premises of a single site business. In contrast, 11% indicated that premises were the HQ of a multi-site business. Smaller proportions of respondents said the supported premises were a branch or franchise of a multi-site business or premises which house multiple businesses e.g. a business centre.

4.25 Statistically significant differences were as follows:

- higher proportions of GBVS recipients (12%) and standard voucher recipients (15%) selected 'the HQ of a multi-site businesses' compared to project voucher recipients (7%) and RGC voucher recipients (7%).
- 83% of project vouchers were used to connect the premises of a single site business compared to 75% of standard vouchers. Similarly, 85% of RGC vouchers supported the premises of a single site business compared to 78% of GBVS vouchers.

[41] Respondents that selected 'other' were asked to specify. Those that specified, were recoded either into an existing category or into a new category 'A premises for multiple businesses'. Those that remain as 'other' did not specify.

Figure 4.5 Role of premises in organisation (n=1,681)

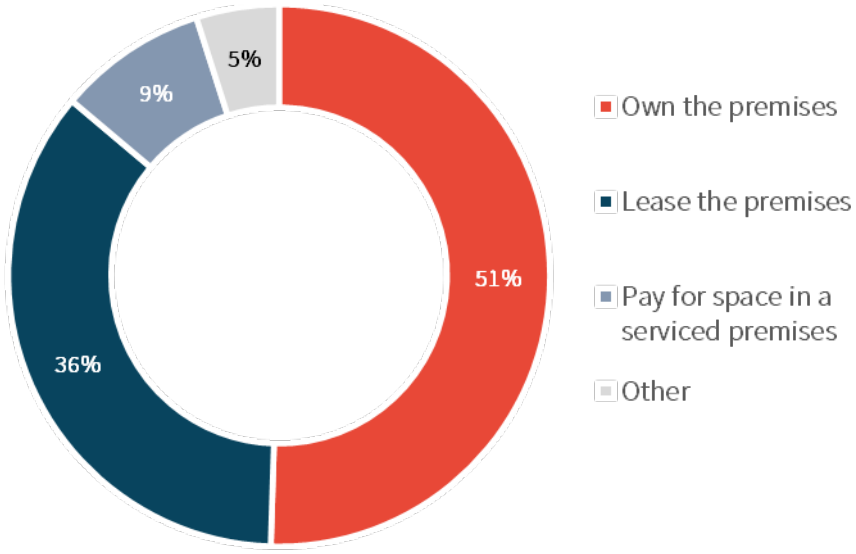


Source: Winning Moves.

Tenure of premises

4.26 Just over half (51%) of businesses said they owned the premises supported by the voucher, and a further third (36%) said they leased the premises. A much smaller proportion (9%) said that they payed for space in serviced premises. For respondents that said 'other', those that specified suggested they rented their premises (in some cases this was their home).

Figure 4.6 Type of premises supported by the voucher



Source: Winning Moves.

4.27 A significantly higher proportion of RGC vouchers recipients (82%) owned their premises compared to 44% of GBVS recipients (reflecting the higher share of home-based businesses in the RGC sample). Conversely a higher proportion (41%) of GBVS recipients leased their premises compared to RGC recipients (12%).

- **Location of premises**

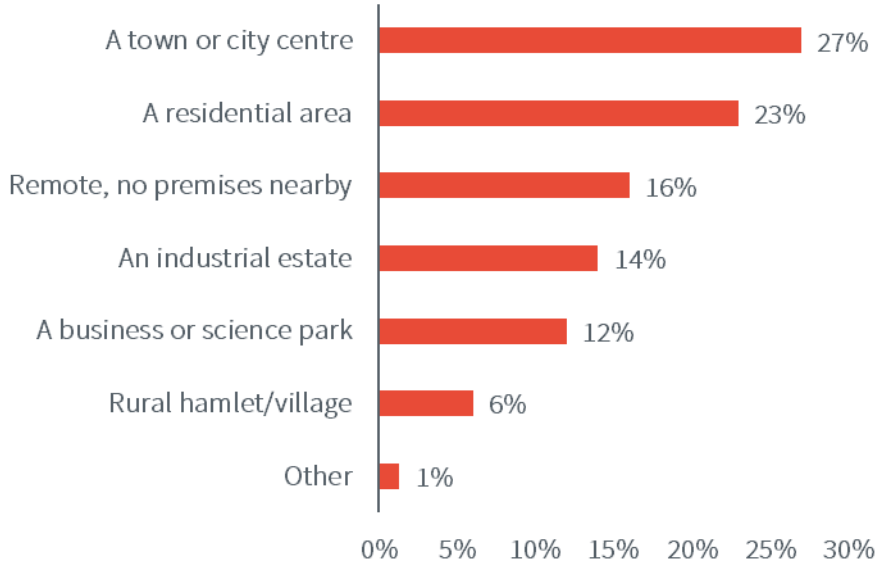
4.28 Respondents were provided with a list of options and were asked which best described the location of the premises which had benefitted from the voucher[42]. One quarter (23%) said the supported premises were in a residential area and a similar proportion (27%) said the supported premises were in a town or city centre. The vouchers also supported remote premises, premises on a business or science park and on industrial estates.

4.29 The key statistical differences were as follows:

- A higher proportion of project vouchers were in residential areas (29% compared to 17% of standard vouchers) or remote/rural locations (32% compared to 11% of standard vouchers). In contrast a larger proportion of standard vouchers were used in town or city centres (38% vs 17% for project vouchers) and in industrial estates (20% vs 9%).

- A higher proportion of RGC vouchers were used in remote or rural locations (60%) compared to GBVS (14%). GBVS vouchers were more likely to be used in town or city centres (32% vs 4%), business or science parks (14% vs 2%) or industrial estates (16% vs 4%).

Figure 4.7 Location of premises supported by vouchers (n=1,681)



Source: Winning Moves.

[42] For respondents that selected 'other' they were asked to specify. Responses were analysed; the majority that specified said that their premises was in a rural area, for example a hamlet or small village where there were some other buildings in the nearby area. Therefore, a new category for 'rural' was set up and responses were recoded.

Motivations and goals

- **Involvement in the application process**

4.30 Respondents were asked whether they were involved in the application process. This was in response to the pilot telephone interviews which indicated that some voucher recipients had not been involved in the process and therefore could not answer questions about their motivation for applying for a voucher. Two thirds (68%) of respondents confirmed that they were involved in the voucher application process. However, the proportion was significantly higher for standard vouchers (75%) than project vouchers (62%). This suggests that overall, project voucher recipients were less motivated than project voucher recipients to seek a broadband upgrade and only chose to do so because they were convinced by a supplier.

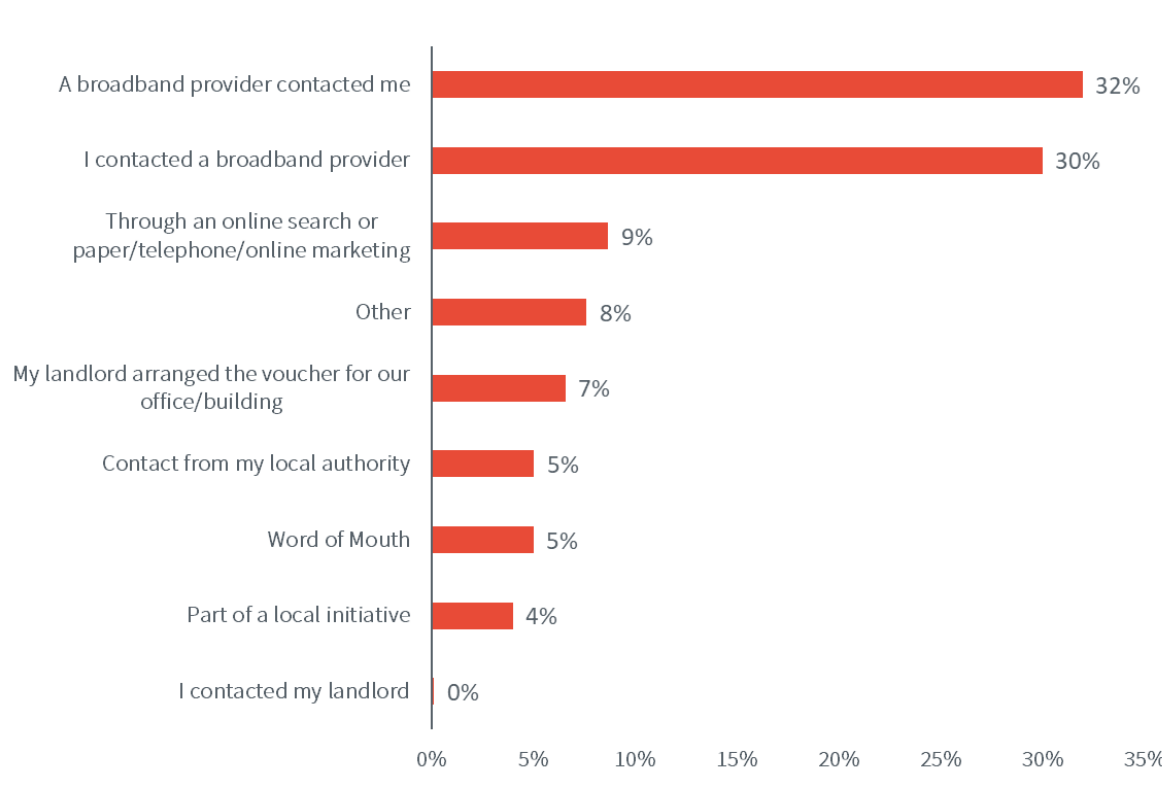
- **How they heard about the voucher**

4.31 Those involved in the application process (n=1,149) were asked how they heard about the voucher scheme. Just under a third (32%) were contacted by a broadband provider, while 30% contacted a provider themselves. Smaller proportions of respondents said that they had heard about the voucher scheme through their local authority, through an online search or marketing, or word of mouth.

4.32 Statistically significant differences were as follows:

- Higher proportions of project voucher recipients heard about the scheme through a local authority, their landlord, word of mouth or through a local initiative (39% in total), compared to 6% of standard voucher recipients.
- A higher proportion of GBVS voucher recipients (32%) contacted their broadband provider compared to 20% of RGV voucher recipients. Higher proportions of RGC recipients heard about the scheme through word of mouth or through a local initiative than GBVS recipients. However, just over one quarter (28%) of RGC voucher recipients that were involved in the application process were contacted by a broadband provider.

Figure 4.8 How recipients heard about the voucher scheme (n=1,149)



Source: Winning Moves.

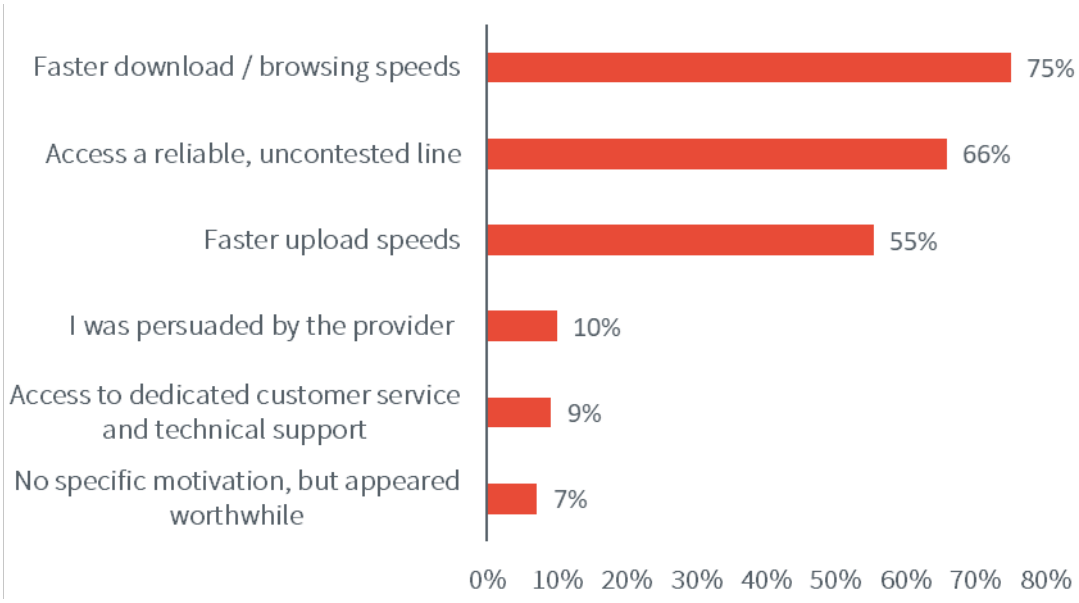
- **Motivation for applying for a voucher**

4.33 Respondents who were involved in the application process (n=1,149) were then asked what their motivations were from a list of options. Accessing faster download speeds or browsing was the most common motivation, cited by 75% of respondents. This was followed by the desire to access a reliable, uncontested line (66%) and accessing faster upload speeds. (55%).

4.34 10% of respondents said that they were persuaded by the broadband provider that contacted them and 8% said they had no specific motivation. It should also be noted that a large proportion of those businesses that were not involved in the application for a voucher did not have specific motivations.

4.35 A statistically significant higher proportion of rural respondents (84%) and RGC recipients (86%) selected 'faster download / browsing speeds' compared to 71% of respondents in urban areas and 73% of GBVS recipients.

Figure 4.9 Motivations for applying for a voucher



Source: Winning Moves.

- **Wider business goals**

4.36 Respondents involved in the application process (n=1,149) were asked what their wider business goals that they hoped to achieve through the new / upgraded broadband connection. The most common goal by a large margin was increasing productivity or reducing costs (66%). Around a third of businesses hoped to adopt more flexible working practices (34%) and implement new business processes (33%).

4.37 Table 4.3 shows that RGC voucher recipients were significantly more likely to state that they hoped to achieve a large number of business goals than GBVS recipients. This included adopting flexible working practices, improving profitability, reduced business travel and accessing new markets. A similar pattern was also clear for rural businesses compared to urban, but not for F20/non F20 businesses where there were no significant differences.

4.38 This suggests that rural businesses saw a much greater range of possibilities from their upgraded connection, and that they saw it as having more of a transformational impact than businesses in urban areas.

Table 4.3 Wider business goals of RGC and GBVS voucher recipients (n=1,149)

	GBVS	RGC	All vouchers
Improved productivity/reduced costs	66%	66%	66%
Adopt more flexible working practices (e.g. home working)	32% ↓	45% ↑	34%
Implement new business processes	32%	34%	33%
Increase business turnover	25%	32%	26%
Improved profitability	21% ↓	31% ↑	22%
Reduce business travel	19% ↓	35% ↑	22%
Foster new/richer relationships with customers/suppliers/collaborators	18% ↓	30% ↑	20%
Develop new products/services	14% ↓	21% ↑	15%
Other (please specify):	14%	16%	14%
Access new markets	10% ↓	23% ↑	12%
Adopt new sales methods	10% ↓	18% ↑	11%
No specific business goals	9%	8%	9%
Reduce energy usage	6% ↓	13% ↑	7%

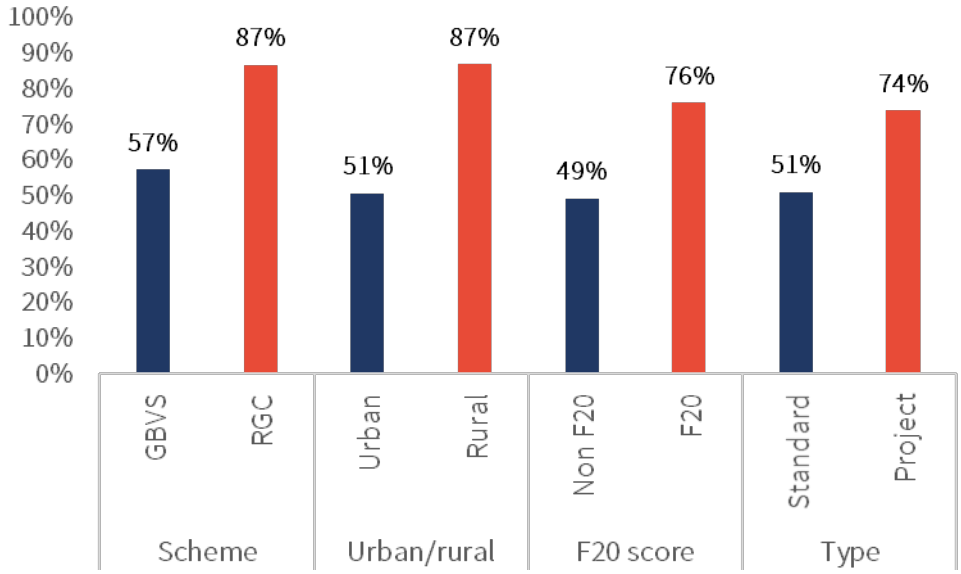
Source: Winning Moves

- **Reasons for not upgrading connection previously**

4.39 Respondents involved in the application process were asked why they had not upgraded their broadband connection previously from a list of options. The most common response was that that level of service was not available where the business was located (62%). Around a third stated that 'it was too expensive' (34%). Much smaller proportions of respondents selected the other options.

4.40 Lack of availability was the most common response given for all voucher types, but particularly for rural, RGC, F20 and project vouchers, where a significantly higher proportion were likely to give this answer than urban, GBVS, non F20 and standard vouchers.

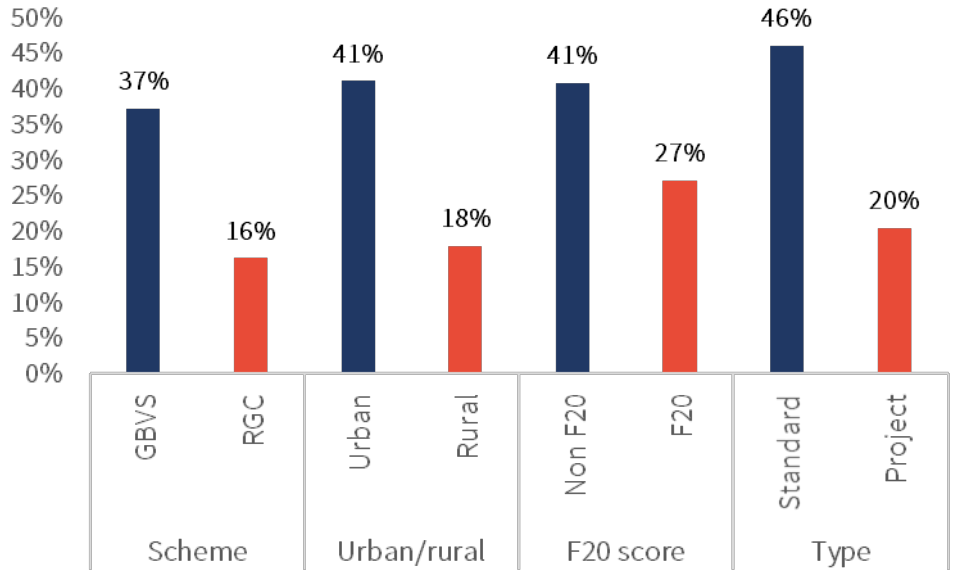
Figure 4.10 Percentage who had not upgraded their connection because it was not available where they are located



Source: Winning Moves.

4.41 In contrast, a significantly higher percentage of urban, non F20, GBVS and standard vouchers recipients stated that it was too expensive. This could be because prices quoted previously to provide access to fibre were expensive due to the work required to get a connection to their specific premises or it could also indicate that the fibre network already existed but businesses may have felt that the benefits of a connection did not outweigh the costs. In these cases, the role of the voucher was to bridge that gap. This is different to the RGC programme and in many of the areas covered by projects where, in the majority of cases, the infrastructure did not exist and the voucher support helped to install this infrastructure *and* bridge the affordability gap.

Figure 4.11 Percentage who had not upgraded their connection because it was too expensive



Source: Winning Moves.

- **What would businesses have done if the voucher had not been available?**

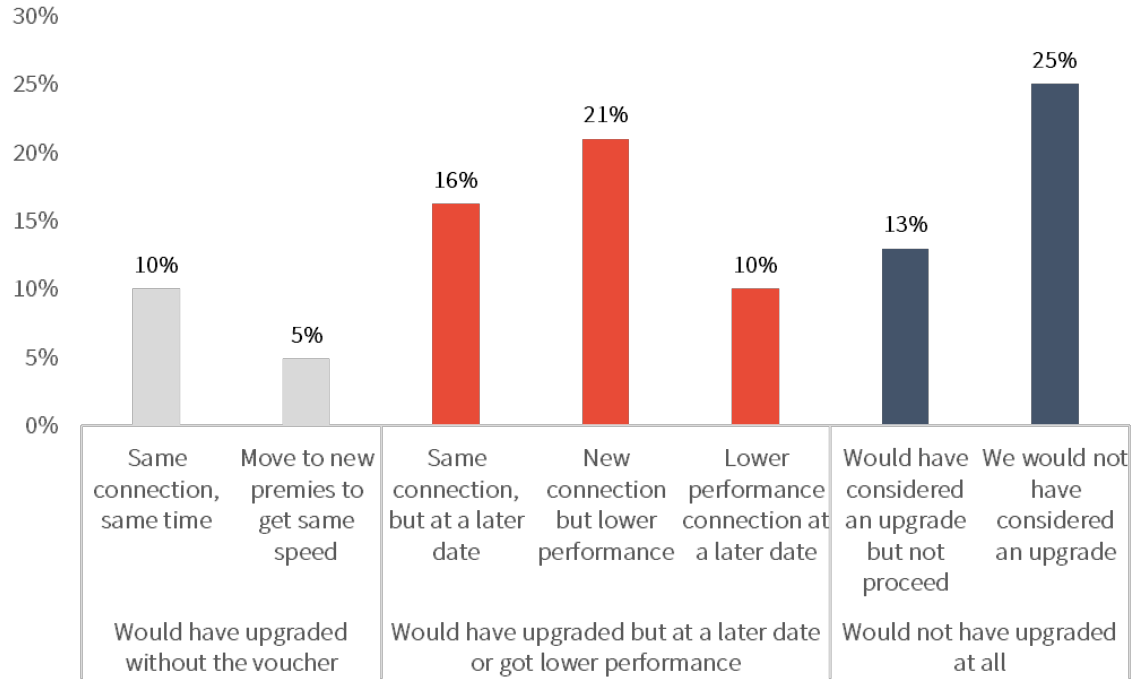
4.42 When asked what they would have done had the voucher not been available, only 10% of businesses stated that they would have secured the same connection at the same time. Any benefits that flow from these connections would have happened anyway (deadweight) and therefore the vouchers did not provide any additional benefits. 5% of respondents reported that they would have moved to new premises to get the same speed, so any benefits for these businesses should also be counted as deadweight.

4.43 Most businesses either:

- would not have upgraded at all (38%), or
- would have upgraded but in a way, which was sub optimal (47%). This includes 16% who would have secured the same connection but at a later date, 21% who would have got a lower performance connection now, and 10% who would have received a lower performance connection at a later date.

4.44 A significantly higher proportion of RGC and project voucher recipients said they would not have upgraded were it not for the voucher (compared to GBVS and standard voucher recipients). However, this difference can be explained by the size profile of RGC and project vouchers which were skewed more towards micro businesses, who were less likely to upgrade in the absence of a voucher.

Figure 4.12 What would businesses have done about their broadband connection if the voucher had not been available? (n=1,149; all those involved in the application process)



Source: Winning Moves.

The Application Process

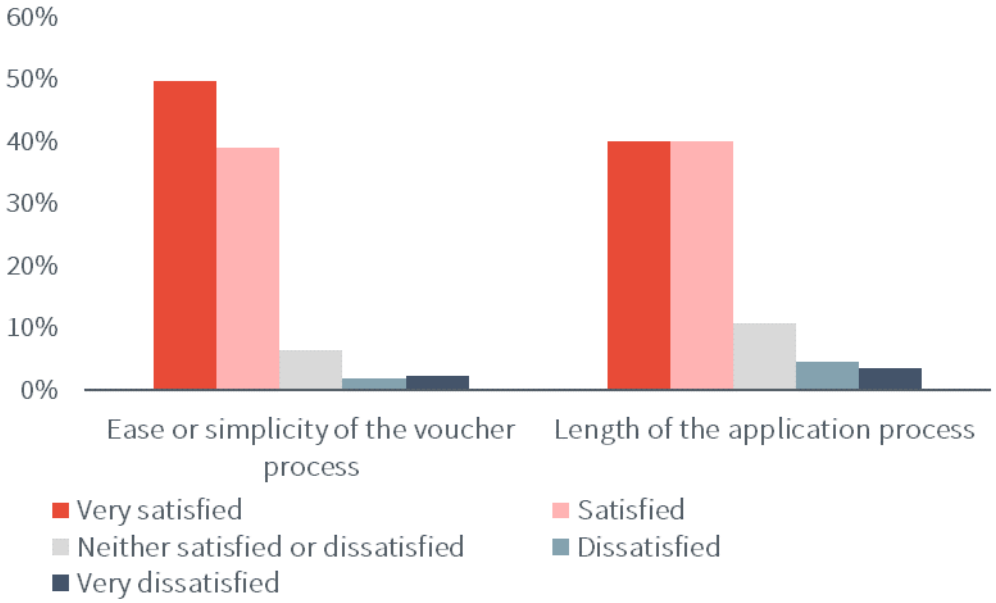
4.45 Of those respondents who were involved in the application process (n=1,149), nine out of ten (89%) said they were satisfied or very satisfied with the ease/simplicity of the voucher process, while eight out of ten (80%) were satisfied with the length of the application process.

4.46 Although satisfaction levels were very high overall, the following reasons for dissatisfaction were identified from open responses:

- Concerns about being tied into multi-year contracts, and this not being clear at the start of / during the voucher application process.
- Concerns about high monthly broadband costs, and this not being clear at the start of /during the voucher application process.
- Delays in the installation process, with several mentioning BT Openreach in particular.
- A view that with hindsight they have been charged for an upgrade which was already in place, and that this was not clear during the application process.

4.47 There were no significant differences found in the levels of satisfaction amongst different voucher types, or when the voucher was applied for.

Figure 4.13 Satisfaction with voucher application process (n=1,149)



Source: Winning Moves.

Satisfaction with connection

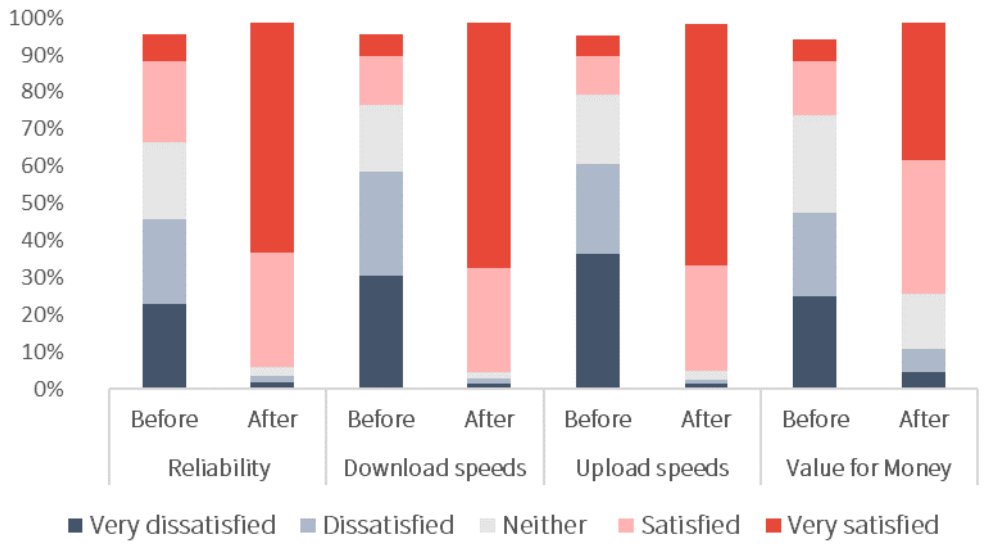
4.48 Figure 4.14 shows that businesses satisfaction with various aspects of their broadband connection increased significantly after the voucher, including reliability, download and upload speeds and value for money. A high proportion of businesses reported being very satisfied with each of the aspects following the voucher upgrade.

4.49 Further analysis shows that significantly higher proportions of RGC voucher recipients (and those in rural / F20 areas) were dissatisfied or very dissatisfied before their upgrade. However, there were no significant differences in satisfaction after the upgrade.

4.50 Overall the analysis shows that:

- 79% were more satisfied with the reliability of their broadband service
- 85% were more satisfied with download / browsing speeds
- 86% were more satisfied with upload speeds
- 69% were more satisfied with value for money

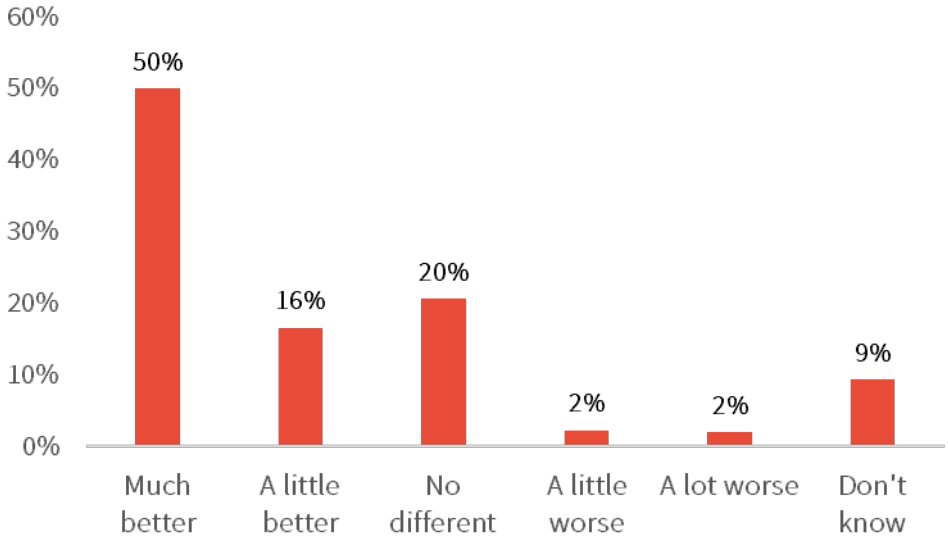
Figure 4.14 Satisfaction ratings before and after voucher (n=1,681)



Source: Winning Moves.

4.51 Respondents who said that their business operated from multiple sites (n=240), were asked how their new / upgraded connection compared to the broadband connection at their other sites. Two thirds of respondents (66%) said that the connection at the premises that was supported through the voucher scheme was better than at their other sites. Responses are shown in the chart below.

Figure 4.15 How does their new connection compare to other premises they operate from? (Multi-site businesses only (n=240)

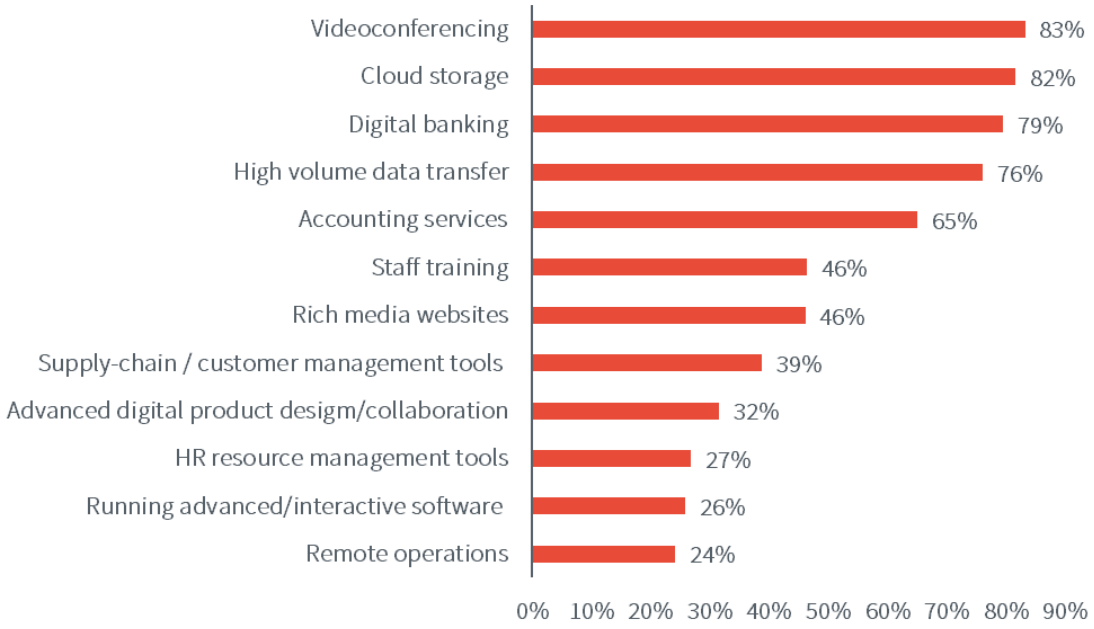


Source: Winning Moves.

Use of the internet

4.52 All respondents were asked whether they were using a range of digital tools for the first time, more often, more effectively, more efficiently or not at all, since their broadband upgrade. Figure 4.16 shows that large proportions of voucher recipients were making greater use of digital tools such as cloud storage, video conferencing, high volume file / data transfer and download, digital banking and accounting services.

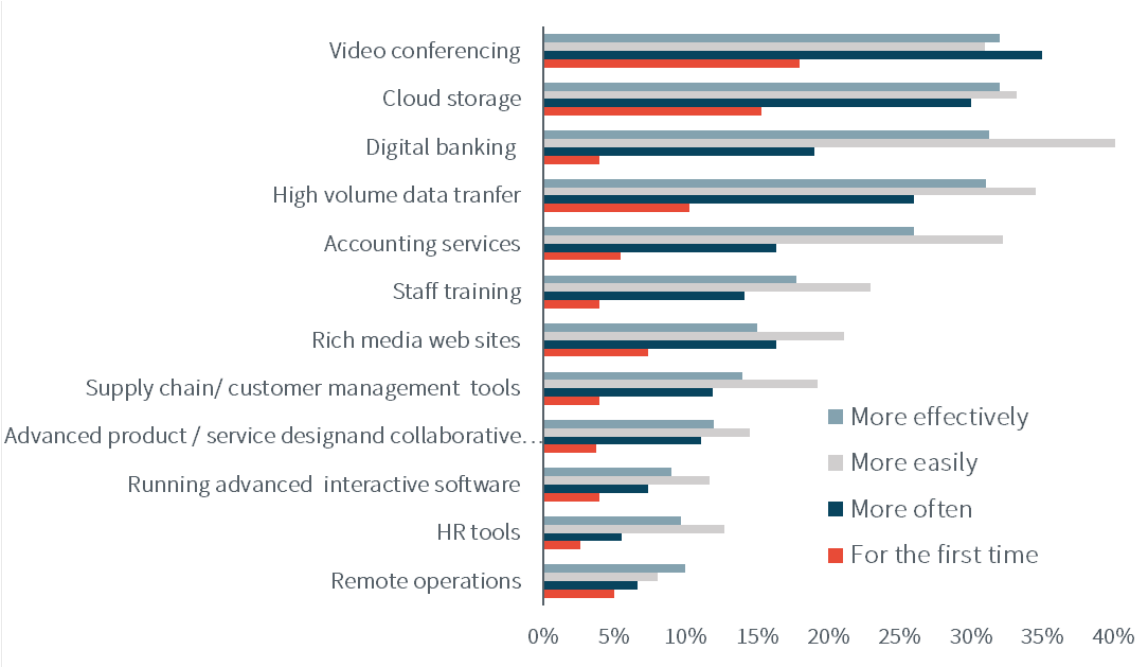
Figure 4.16 Proportion of respondents making greater use of digital applications (for the first time, more often, more efficiently OR more effectively)



Source: Winning Moves.

4.53 Figure 4.17 shows that only a small proportion of businesses were using these digital applications for the first time, a much larger proportion of businesses were using applications more often, more easily or more effectively.

Figure 4.17 Proportion of respondents using digital tools for the first time, more often, more easily and more effectively (n=1,681)



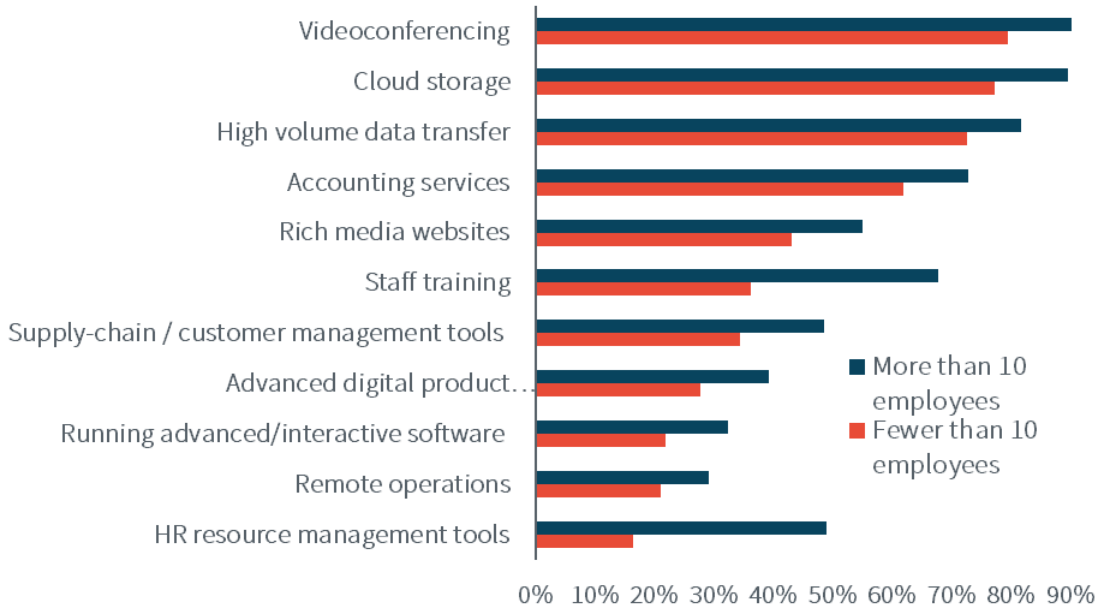
Source: Winning Moves.

4.54 There were a number of significant differences in how different groups are using the internet. These include:

- A higher proportion of GBVS voucher recipients were using a number of different applications than RGC vouchers, including cloud storage, high volume data transfer, staff training and supply chain/customer management tools. Very similar patterns can be observed for urban businesses compared to rural businesses, and businesses in non F20 areas compared to F20.
- A higher proportion of standard vouchers were using a number of applications than project vouchers. This includes videoconferencing, cloud storage, staff training, HR tools, advanced software and remote operations.

4.55 However, in most cases, these differences can be explained by differences in the size profile of businesses. Rural, RGC, F20 and project vouchers supported a significantly higher proportion of micro businesses with fewer than ten employees. These micro businesses were significantly less likely to use a number of applications than larger businesses as shown in Figure 4.18. If we control for business size (for example by only comparing micro businesses in these different voucher types), there was no statistical difference in most cases.

Figure 4.18 Proportion of respondents making greater use of digital applications by business size

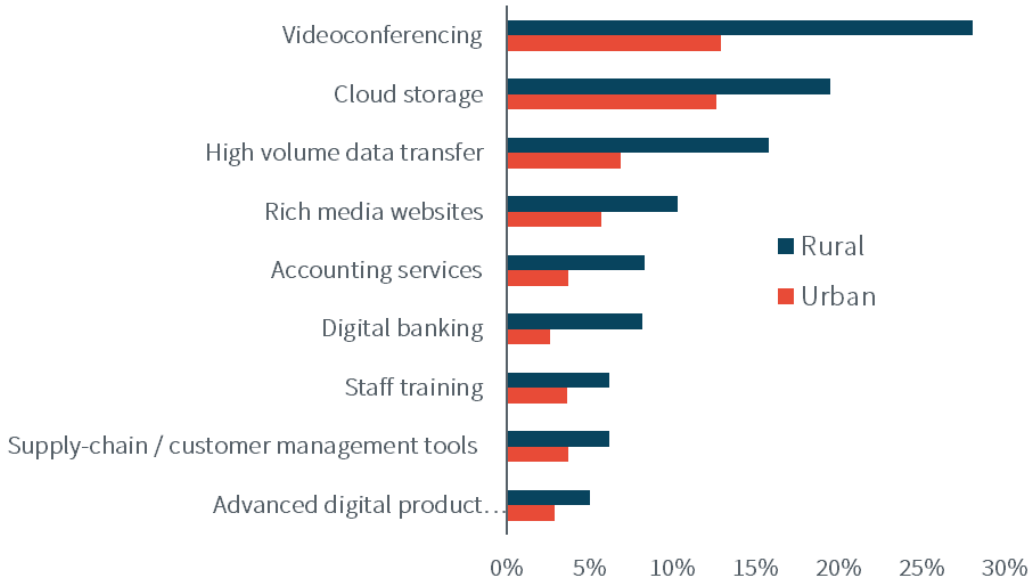


Source: Winning Moves.

4.56 Other significant differences not explained by business size were as follows:

- **Sector**: Larger proportions of businesses in the Information and Communication sector were using a number of applications more effectively including video conferencing (51%), high volume file / data transfer and download (45%), Advanced digital product / service design and collaborative design tools (22%), remote operations (21%), HR tools (21%), and staff training (30%).
- **Urban/Rural**: Rural businesses were more likely to be using a number of applications for the first time than urban businesses, particularly videoconferencing, cloud storage and high-volume data transfer (see Figure 4.19).
- **Types of premises**:
  - Higher proportions of home-based businesses / private residences were using digital banking (51%), cloud storage (39%) and video conferencing (36%) more easily. Higher proportions of home-based businesses were also using high volume data transfer more often (32%).
  - Higher proportions of offices were now using delivering staff training (28%) and using HR tools (17%) more easily, compared to other premises types.
  - A higher proportion of warehouse premises (28%) were using supply chain management tools more easily.

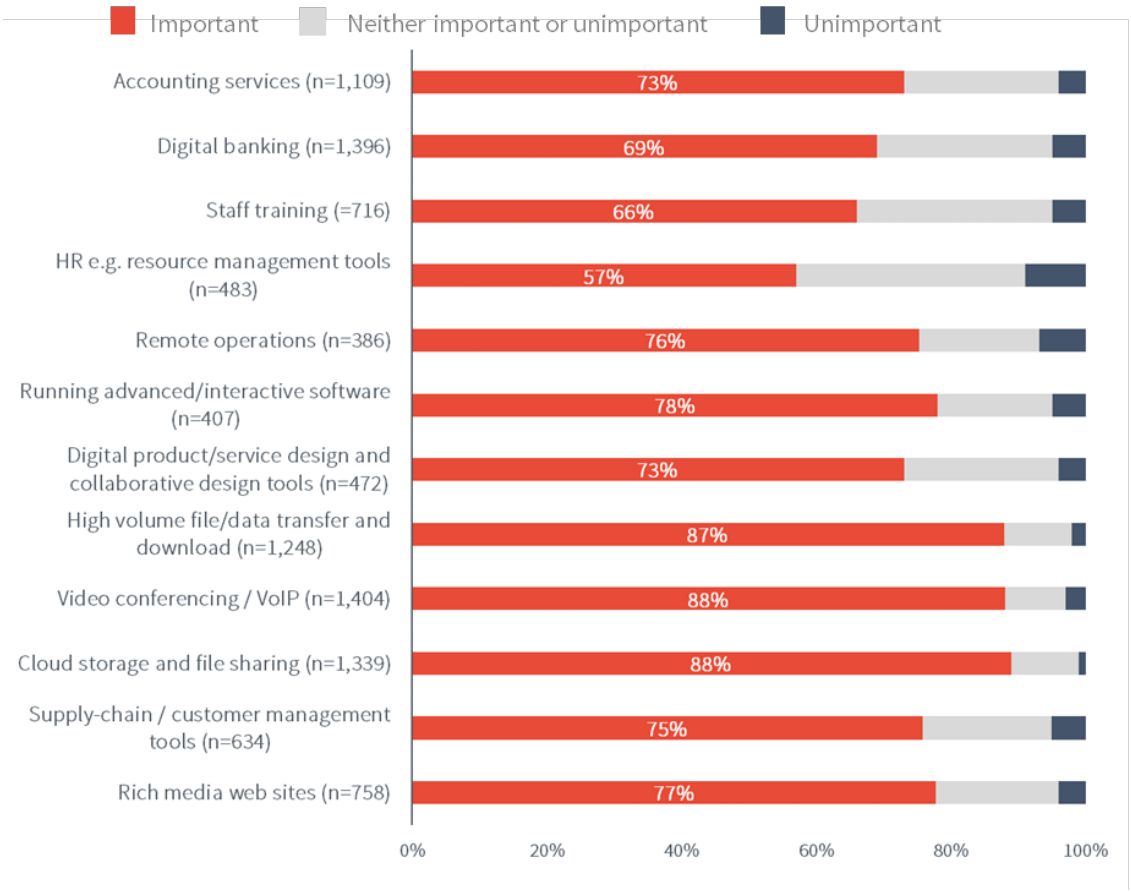
Figure 4.19 Percentage of businesses in rural/urban areas using applications for the first time (n=1,681)



Source: Winning Moves.

4.57 Respondents that said that they were making use of digital applications were asked how important their new broadband upgrade was in helping them to use the tool, on a scale of 1 to 5 where 1 was very unimportant and 5 is very important. Responses are shown in the chart below. Large proportions (around three quarters or more) of digital tool users reported that their upgrade was important in helping them make use of it, including over 85% of businesses that reported their connection was important in making better use of videoconferencing, cloud storage and high-volume data downloads.

Figure 4.20 Importance of the upgraded connection to make better use of digital tools



Source: Winning Moves.

4.58 Further analysis shows that businesses in rural or harder to reach locations (F20) were more likely to say that their upgraded connection was very important in making greater use of a number of digital applications, suggesting it was more transformational for these businesses:

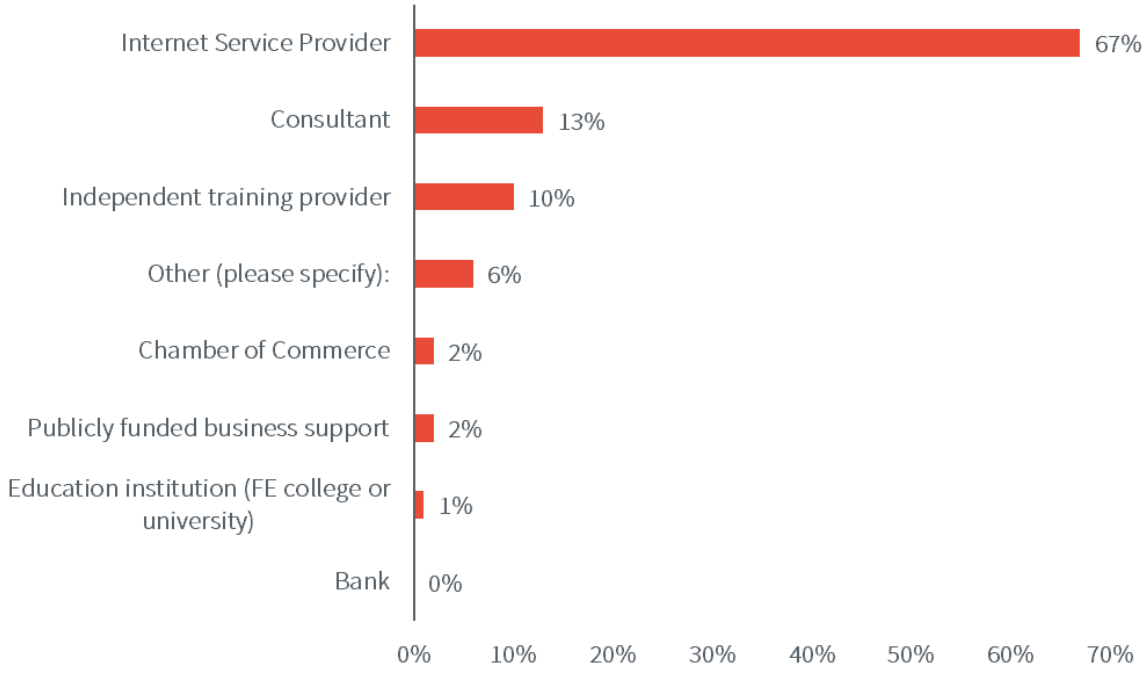
- A higher proportion (38%) of RGC voucher recipients said that their upgraded broadband connection was very important in making greater use of digital banking compared to 25% of GBVS recipients.
- A higher proportion of rural businesses said that their upgraded broadband connection was very important to making greater use of rich media web sites (49%), video conferencing (62%), staff training tools (27%), digital banking (40%) and accounting services (35%).
- Higher proportions of voucher recipients in F20 areas said that their upgraded broadband connection was very important in helping them make greater use of rich media (46%), digital banking (34%) and accounting services (33%), compared to businesses in non F20 areas (31%, 20% and 21% respectively).

Help and support

4.59 13% of businesses reported they had received any help, training or support to make the most of their enhanced connectivity. A higher proportion of standard voucher recipients (16%) said that had received help, training or support compared to 9% of project voucher recipients. Similarly, a slightly higher proportion of GBVS recipients received help (13%) compared to 8% of RGC voucher recipients. This is not explained by differences in business size as there were no significant differences between micro and larger businesses.

4.60 Of those who had received help, training or support, two thirds had received this support from an internet service provider. This was by the far the most common source of support.

Figure 4.21 What type of organisation provided the support? (n=198)



Source: Winning Moves.

Business outcomes

- **Change in business activities and outcomes**

4.61 A large proportion of respondents (79%) reported their upgraded connection had enabled them to carry out new business activities. The most common changes included adoption of more flexible working practices for staff (51%), implementation of new business processes (48%), reducing business travel (46%) and fostering new or richer relationships with customers and suppliers (41%).

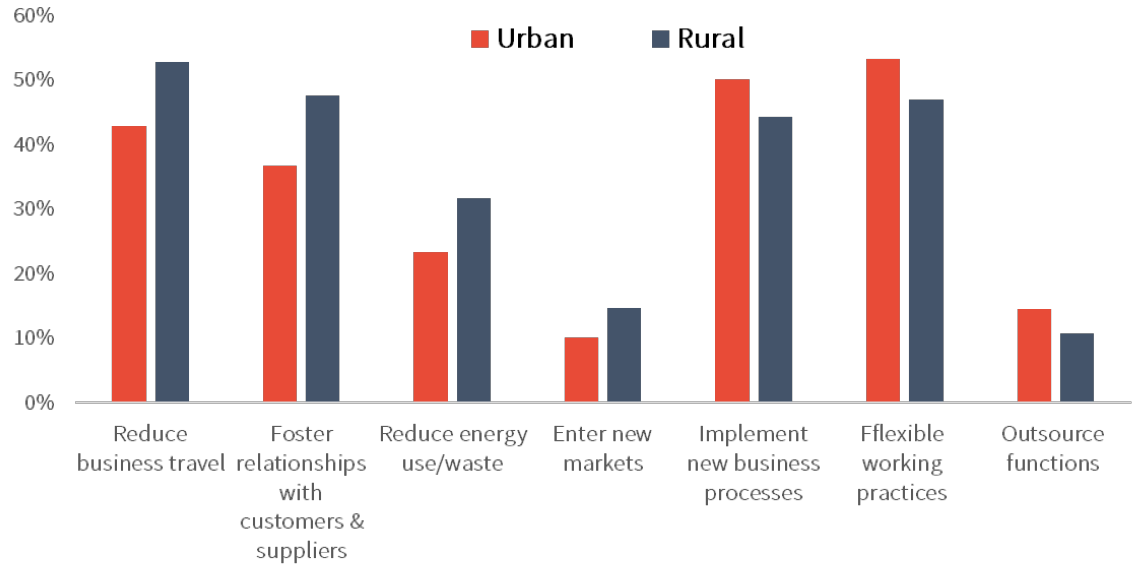
Figure 4.22 Changes in business activities as a result of their upgraded connection (n=1,681)

Source: Winning Moves.

4.62 The main significant differences were as follows:

- Rural businesses were more likely than urban businesses to report a number of positive outcomes, including entering new markets, fostering new or richer relationships with customers/suppliers, reducing business travel and reducing energy use. This was also true for RGC and F20 businesses.
- Urban businesses were more likely than rural businesses to have implemented new business processes, introduced flexible working practices and outsourced functions or activities to other sites. This was also true for standard vouchers compared to project vouchers. However, these differences can be explained by the size profile of each of these groups. Urban and standard vouchers included a much larger share of medium and large businesses who were more likely to have introduced these changes.
- Higher proportions of voucher recipients in the professional, scientific and technical activities sector fostered new / richer relationships with customers / suppliers (41%), adopted more flexible working practices (65%), and reduced business travel (64%) (compared to other sectors).

Figure 4.23 Significant differences in outcomes between urban and rural businesses



Source: Winning Moves.

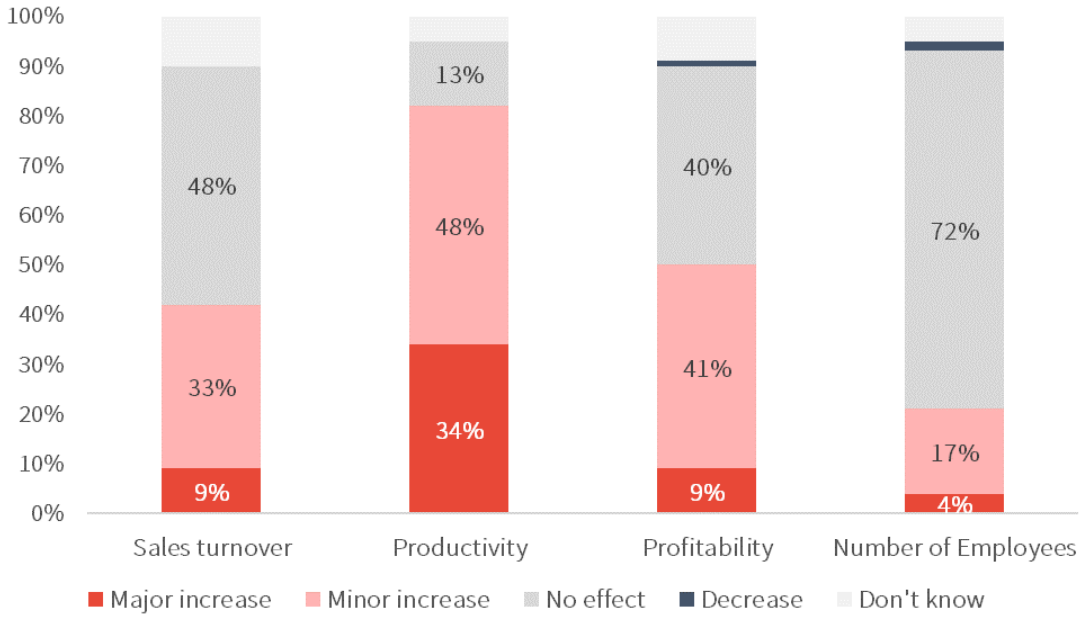
- **Change in business performance**

4.63 Of those who reported that the upgraded broadband connection had enabled them to do new things as a business (n=1,344), 82% reported an increase in productivity (34% reported a major increase) 50% have seen an increase in profitability and 42% have experienced an increase in turnover. Only 21% reported an increase in employment with most stating it had no effect.

4.64 There were very few significant differences between groups, suggesting that the upgraded connection has had broadly similar impacts on businesses regardless of the type of voucher or their location.

4.65 It should be noted that it was difficult for businesses to accurately assess the impact of improved broadband on these business metrics. This would be best assessed through a counterfactual impact assessment using administrative datasets which measure business performance. This will be a key focus of the next stage of work.

Figure 4.24 Change in business metric reported by respondents (n=1,344)

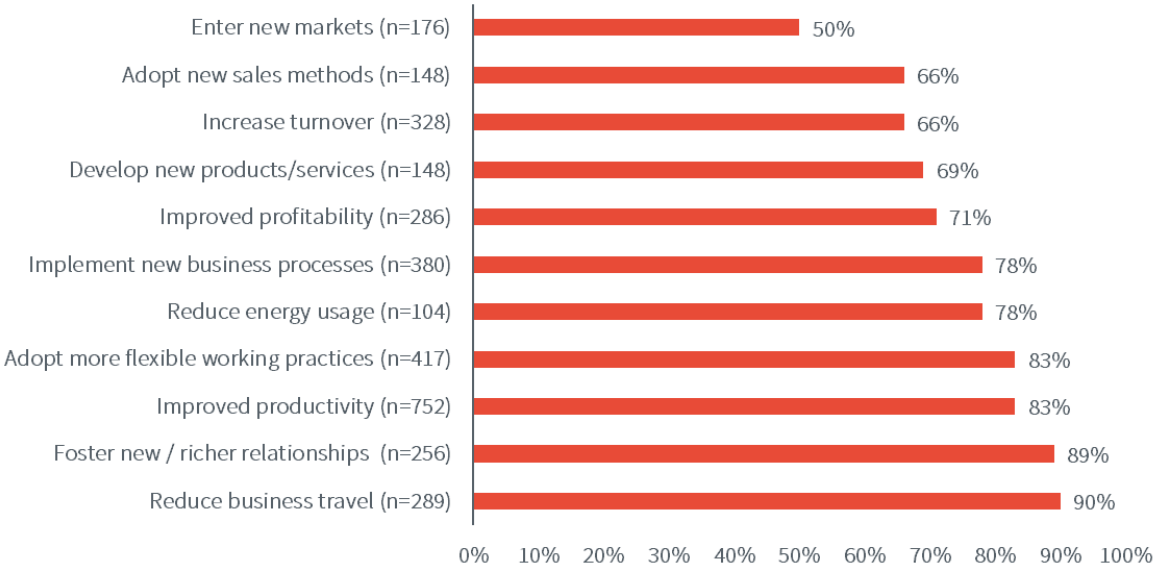


Source: Winning Moves.

- **Achievement of business goals**

4.66 Figure shows the proportion of respondents who successfully achieved the original goals that they hoped for when applying for a voucher (see Table 4.3). It shows that a large proportion of voucher recipients achieved a number of these goals, particularly reduced business travel, fostering new relationships, improved productivity and adoption of flexible working practices.

Figure 4.25 Have respondents achieved their original business goals?

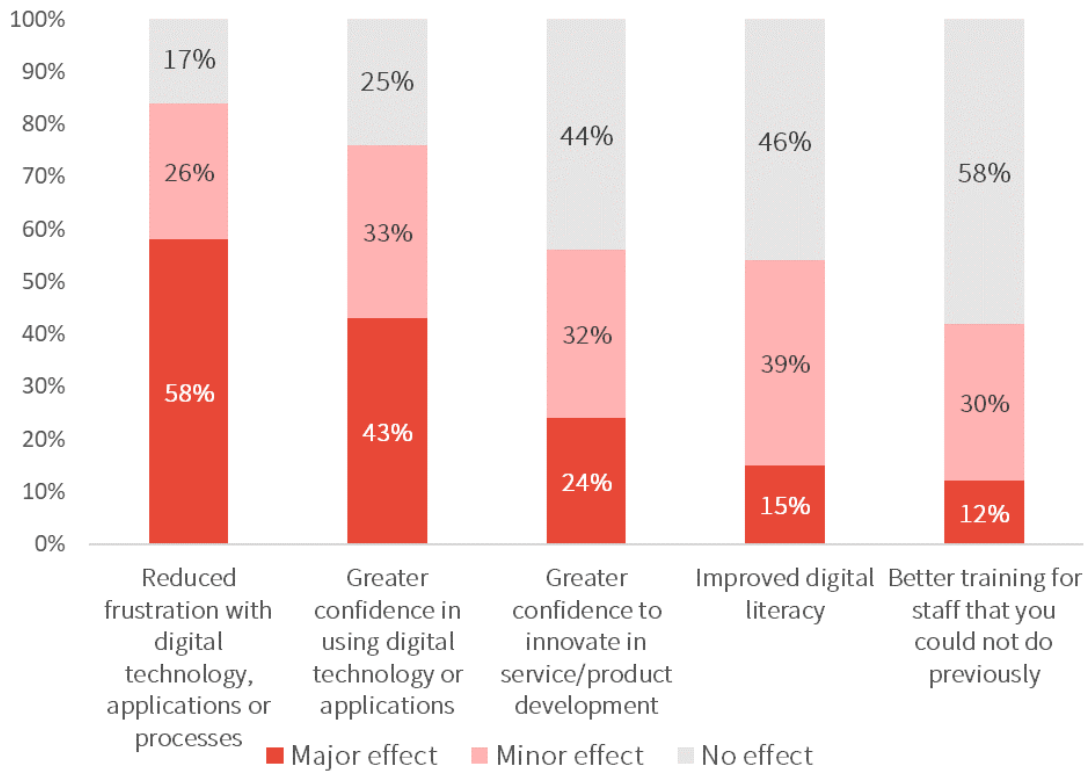


Source: Winning Moves.

- **Effects on staff**

4.67 A large proportion of respondents reported that the upgraded connection has had positive effects on staff. In particular, a large majority of respondents (83%) reported that their upgraded connection helped to reduce their employees' frustration with digital technology, applications or process. Similarly, a large proportion (76%) reported that the improved connection had a positive effect on employees' confidence in using digital technology or applications.

Figure 4.26 Effect of new/upgraded broadband connection on staff (n=1,681)



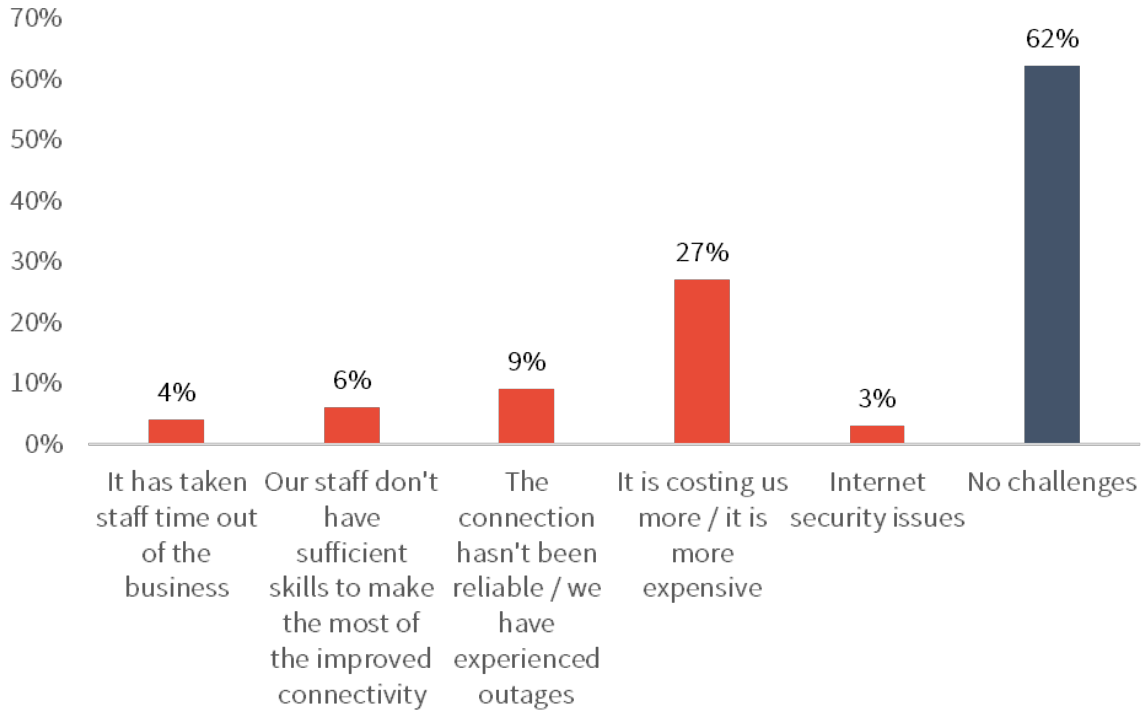
Source: Winning Moves.

- **Challenges**

4.68 38% of businesses reported that they had experienced one or more challenges associated with their upgraded connection. The challenge experienced by the highest proportion of businesses related to the cost of their upgrade (27%). One in ten (9%) reported reliability issues or outages. Much smaller proportions of respondents experienced challenges regarding staff having to take time out of the business, staff not having sufficient skills to make the most of the improved connectivity or internet security issues.

4.69 A higher proportion of standard voucher recipients (44%) experienced one or more challenges compared to the proportion of standard voucher recipients (32%). In particular, a higher proportion of standard voucher recipients (35%) reported the cost of their new connection as a challenge, compared to 19% of project voucher recipients.

Figure 4.27 Challenges experienced by businesses as a result of the upgraded broadband connection (n=1,681)



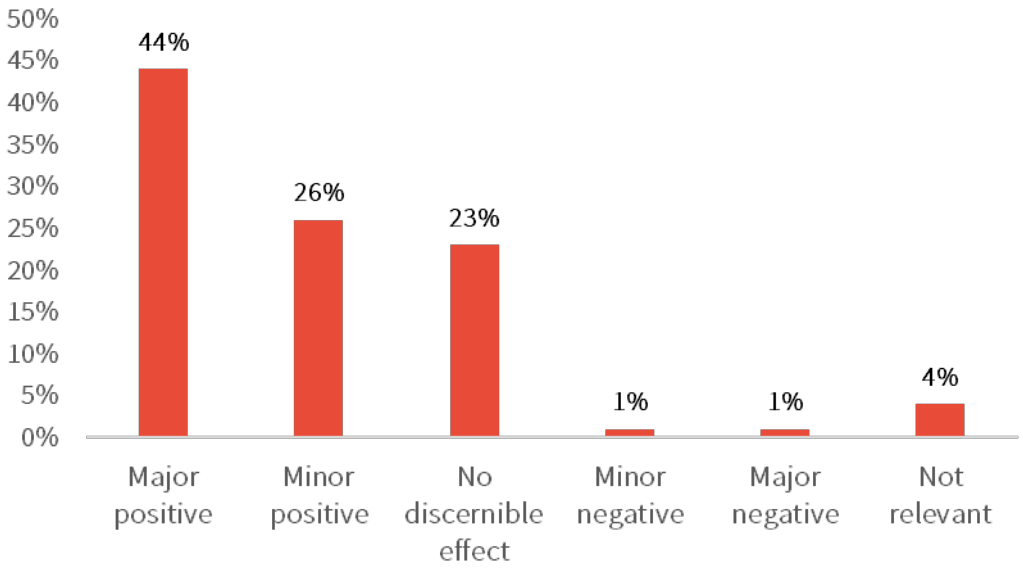
Source: Winning Moves.

- **COVID-19 pandemic**

4.70 Overall, 70% of businesses said that their broadband upgrade had a positive effect on their ability to adapt and continue to do business during the pandemic (see Figure 4.28). A higher proportion of RGC recipients (53%) reported that their broadband upgrade had had a major positive impact on their ability to adapt and continue to do business during the pandemic, compared to 43% of GBVS recipients. The same difference can be seen between rural and urban based businesses and between F20 and non-F20 businesses. There were no significant differences between different sectors.

4.71 Improved broadband appears to have had a more positive effect on businesses that said COVID-19 had had a positive effect on their business – 81% of those that said COVID-19 had a positive effect reported that their upgraded broadband had a positive impact on their ability to adapt and continue to do business. This compares with 40% of businesses who said that COVID-19 had a negative impact on their business.

Figure 4.28 What affect has your new/upgraded broadband connection had on your ability to adapt and continue to do business during the pandemic? (n=1,233[43])



Source: Winning Moves.

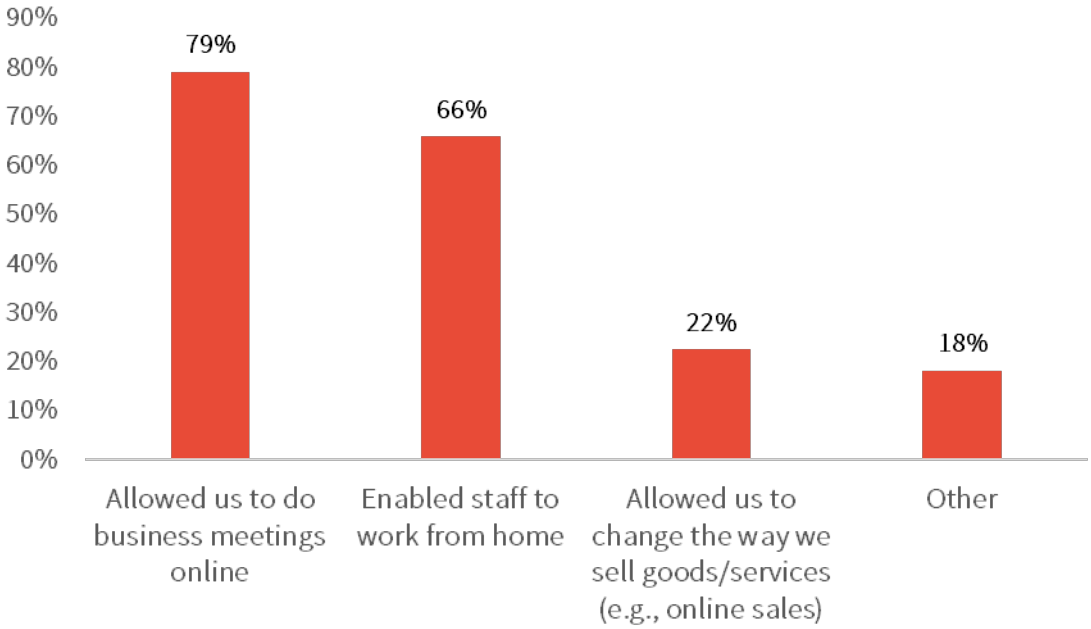
4.72 Businesses that said their broadband upgrade had a positive effect on their ability to adapt and continue to do business (n=917), were asked what were the main ways in which their broadband connection helped their business to adapt. Figure 4.29 shows that the main benefits were the ability to do business meetings online (79% of respondents) and allowing staff to work from home (66%). There were few differences between key groups, but non-micro businesses were more likely than micro businesses to cite staff working from home as a benefit.

4.73 Respondents that selected 'other' were asked to specify. Of those that did specify, a range of responses were given, examples include the ability to:

- Order stock online
- Live-stream events
- Remotely monitor premises or operations
- Transfer large files
- Improve communications
- Deliver training
- Reduce hardware and server costs.

[43] A routing error occurred in the survey which meant that some respondents were not asked this question. Respondents were sent an email with a link with this question to complete, and telephone research resource was used to boost responses and ensure a spread of responses across the different voucher groups to enable comparisons.

Figure 4.29 In what ways did your broadband connection help you to adapt / continue to do business during the pandemic? (n=917)



Source: Winning Moves.

Appendix A - Technical Annex for Counterfactual Analysis

A.1 The evaluation sought to measure the effects on broadband performance of receiving voucher support. A means to estimate the impact of vouchers support is to study non-recipient areas as comparable as possible to the recipient areas. Propensity score matching (PSM) was used to identify comparable unsupported LSOAs.

A.2 Having identified the comparable areas, the supported LSOAs and the controls were tracked in the Connected Nations Report (CN) linked to data from Nomis – Official Labour Market Statistics, the Office of National Statistics (ONS) and more detailed geography (such as the property level data about the vouchers and the F20 model provided by BDUK). Analysis was undertaken at the Lower Super Output Area (LSOA) level.

Counterfactual design

A.3 To undertake the counterfactual impact analysis, various datasets needed to be linked at a lower super output area (LSOA) level. This section presents a description of the datasets used. and describes the approach taken to understand whether impacts can be attributed to the vouchers.

Datasets used in the study

A.4 **Coverage and performance data:** Ofcom publish the Connected Nations reports on the UK's communications infrastructure, focusing on coverage and performance of fixed broadband and mobile networks. The annual reports track progress in fixed and mobile services in the UK, and this is published at a detailed geographical level (postcodes and output areas) which can then be averaged or aggregated at the higher LSOA level used in the analysis. The data enables year-on-year comparisons of the UK's communications infrastructure in terms of both the availability of broadband at different speed levels and performance (data on change in average speeds). This dataset was used to obtain the main outcome variables of the analysis. Connected Nations relies on data provided by suppliers and cannot be guaranteed to provide full coverage of all fixed networks[44]. This report used the annual report data from Ofcom Connected Nations from 2017 up to 2021.

A.5 **Intervention data:** BDUK also provided two datasets for the analysis. The first, the Vouchers Data covers the timing, value and location of the voucher support and whether it was supported under the GBVS or Rural Gigabit Programme vouchers scheme. It also identifies whether the voucher was part of a project (where a supplier has aggregated a number of applications focused on a specific geographical area) or was a standard voucher (a standalone application from a household or business).

A.6 **Commercial viability data:** Secondly, BDUK's F20 Model provides an index from 0 to 1 that reflects the estimated relative cost to install fibre to the premise. A value close to 0 reflects premises that can be connected at low cost, while values closer to 1 indicate the opposite. Those premises modelled that have an F score between

[44] See Connected Nations 2020: Methodology (ofcom.org.uk) Appendix for list of suppliers providing information.

0.8 and 1 are assumed to be in the "last 20%" that the market would reach on its own without further public subsidy[45]. These premises are referred to as being F20 premises in the report.

A.7 **Economic statistics:** The modelling sought to characterise LSOAs in terms of their business population. For this, the ONS Business Register and Employment Survey was used to provide data on employment at LSOA level for England and Wales (via Nomis). As well as total employment by LSOA, a variable measuring employment in digital sectors was constructed.

A.8 **Other area characteristics controls:** ONS population density estimates at LSOAs, the 2011 Rural Urban Classification for LSOAs, Indices of Deprivation, and the Internet User Classification (IUC) from the Consumer Data Research Centre (CDRC), which allocates LSOAs to different categories based on how households interact with the internet.

Selection models

A.9 In order to assess the additional impacts of vouchers on the availability of broadband at different speed levels and broadband performance in local areas, it was necessary to identify supported LSOAs and comparable unsupported LSOAs with similar characteristics to act as a counterfactual.

A.10 Every LSOA that had at least one property with a connected voucher was deemed as supported in the year up to September 2019 and for the year to September 2020. The analysis therefore was able to look at effects over two years using the 2020 and 2021 Connected Nations reports for those supported October 2018 to September 2019 and for a single year for those supported 2019/20. Table A1 presents the numbers of vouchers awarded and LSOAs that had vouchers. The average numbers of connected vouchers in an LSOA was 3.06 in 2019 and 3.22 in 2020.

A.11 We did not include vouchers connected after September 2020 as it is unlikely that any effects on broadband performance or availability of broadband at different speed levels would be reflected in Connected Nations 2021. The analysis also did not include vouchers connected before October 2018. Although there were nearly 2,000 vouchers delivered before this date, the number of treated LSOAs was much smaller than in 2019 and 2020. Therefore, we focused on the two treatment years where we had a larger sample size, which was sufficient for us to assess the impact of vouchers overall and analyse how impacts varied in LSOAs which received different levels of support.

[45] See paragraphs 108 and 109 of the Further Telecoms Infrastructure Review: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf

Table A1 Average number of vouchers by LSOA

	Voucher level	LSOA Level				
		Connected all	Connected final*	Average	Min	Max
Treated 2019	10,787	2,798	2,426	3.06	1	120
Treated 2020	15,744	3,753	2,428	3.22	1	94

*In the final sample for each year of treatment we only consider the first year in which the LSOA was connected.

Source: BDUK vouchers data, own elaboration

A.12 A statistical technique called propensity score matching then estimated a selection model to identify a counterfactual. The selection model was then tested and, if found to be robust, a difference-in-difference approach would be used to understand whether the growth seen in supported areas differs from that in the control group.

A.13 The performance data described above links across LSOAs over time, allowing changes in broadband performance to be tracked, a first difference. Comparing between the supported areas and the counterfactual LSOAs (which is the second difference) would quantify the additional performance change that can be attributed to the vouchers. The Connected Nations annual report compiles data about the fixed coverage (number of premises that are able to connect to broadband at different speed levels) up to September each year and for fixed performance (average download speeds) up to June.

A.14 Matching was done through a statistical model that estimates the selection process to identify places more or less likely to get vouchers. The specification of the model was informed by the policy design and evidence from recent comparable studies. These highlighted what type of LSOAs were likely to receive support, i.e. the drivers into selection. Broadly, data about three dimensions were compiled: the broadband performance, the drivers of demand for connectivity (such as demography, socioeconomic characteristics and businesses in an area) and the rurality of an area. The modelling benefitted from compiling a number of variables available for each, such as rurality indices and population density. Both were available for this dimension of the modelling. This meant some refining of the modelling was possible, converging on estimates that appeared robust.

A.15 The modelling used variables available before support at LSOA level, and were derived from the datasets noted above, such as total employment in an LSOA, population density, high digital employment, rurality, index of multiple deprivation (income), region dummies. A Probit regression was used to estimate what drove an LSOA towards selection.

A.16 The analysis used Stata, a general-purpose statistical software package developed by StataCorp for data manipulation, visualisation, statistics, and automated reporting. Within Stata, estimation used a number of data compilation tools, and the modelling used the psmatch2 suite of programs. This is a standard tool for propensity score matching in Stata, performing the matching, and also common support graphing, and covariate imbalance testing

A.17 Three different models were developed, with each model differing in terms of whether and how broadband performance in the year before support were included:

- Model I: included total employment (ln), population density, high digital employment, rurality, index of multiple deprivation (income), F20 LSOA average and region dummies. Excludes broadband performance.
- Model II: included variables in Model I and broadband performance levels before support (but not change).
- Model III: included variables in Model I and the change in broadband performance before support.

A.18 The analysis also varied the sample from which the counterfactuals were selected. Three different samples were used:

- All LSOAs: this was the largest pool and included all the LSOAs in England and Wales that did not receive the voucher support.
- All LSOAs but excluding those with high levels of employment: the sample was further restricted to correct for the observation that high employment levels (the largest 1% by employment) was such a common characteristic in supported LSOAs that it was difficult to identify comparable unsupported LSOAs. This probably reflects the high chance that at least one business in an LSOA with a very high density of businesses would have received a voucher. The number of treated LSOAs in 2019 fell to 2,278 after this selection and for 2020 it fell to 2,391.
- Same Exchange LSOAs: the study team was provided with a table estimating the exchange serving each UK property. Our hypothesis was that exchange areas where at least one LSOA had been treated (i.e. received a voucher) would have similar infrastructure to untreated LSOAs served by the same exchange. This provided a third match pool.

A.19 One other sample pool was modelled but subsequently removed from the analysis. This related to LSOAs in which there had been applications for vouchers but which were subsequently cancelled. These could have provided a good counterfactual, in that they were areas where residents and businesses had shown an interest in applying for vouchers. However, after further discussions with BDUK, it became clear that a large proportion of these were cancelled because they were part of projects where suppliers already had sufficient numbers of vouchers to provide access to fibre broadband to all premises in an area. In effect, these areas had also been supported by the vouchers scheme, making them unsuitable as a comparator.

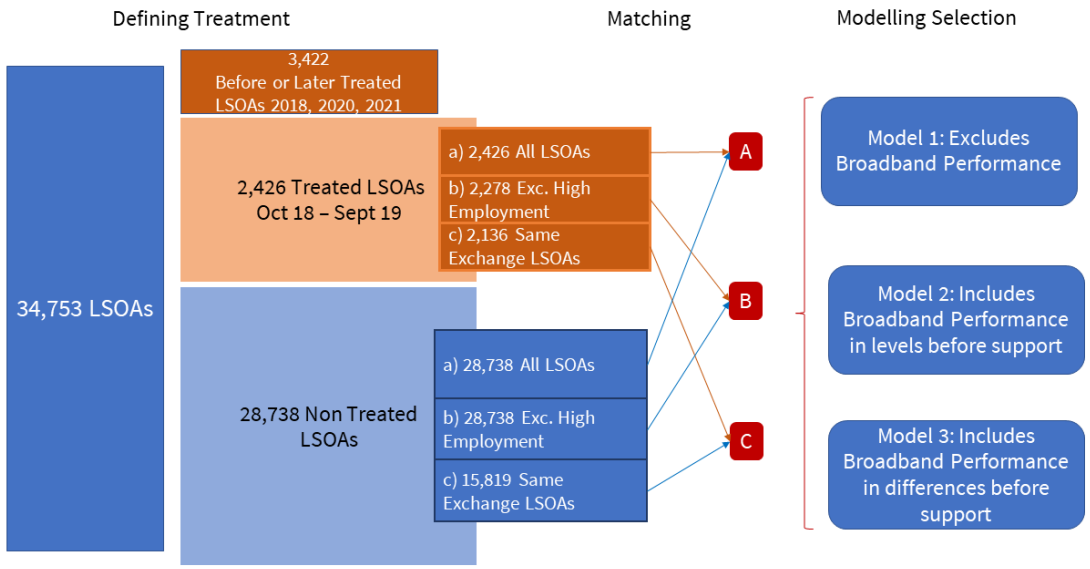
A.20 Table A2 presents a summary of the control group samples and their strengths and weaknesses.

Table A2: Strengths and weaknesses of control group alternatives

Description	Strengths	Weaknesses
Control group: All LSOAs		
The first control group was obtained from the sample of all LSOA in England and Wales that did not receive voucher support. This was the largest control group.	Large sample size with 28,252 LSOAs and detail information on broadband connectivity, vouchers program characteristics, linked to geographic and socio-economic variables at the LSOA level.	High variability in the characteristics of the LSOAs, which led to more difficulty finding an appropriate control for the treated if the distribution of the covariates in both groups was significantly different. The treated LSOA were 2,426 in 2019 and 2,428 in 2020.
Control group: All LSOAs excluding high employment		
The second control group came from all LSOAs as in the first case but excluding from the treated the LSOAs with high employment (the largest 1% by employment).	The intuition behind it is that high employment may be correlated with an increase in the demand for faster broadband connectivity. Thus, it could potentially affect the selection into treatment and the outcomes.	The sample of the control group was the same but the sample of treated was reduced to 2,278 in 2019 and to 2,391 in 2020. This sample maintained the high variability in the characteristics of the control group, being more difficult to find a good control if the distribution of the covariates proved different to the treated LSOAs.
Control group: Same exchange LSOAs		
The third control group corresponded to the LSOAs that use the same exchange as the treated but did not receive voucher support. To create this group the study team was provided with a table estimating the exchange serving each UK property.	The strength of this model resided in comparing areas that have the same telecom infrastructure, which offered the possibility to control for unobservable variables depending on infrastructure, which is very sensitive for the policy. Moreover, when using this control group, we included in the selection model the distance (reported in km) from the centre of the LSOA to the exchange[46].	A weakness of the model was that it was not possible to link all LSOA to a unique exchange therefore the sample size of treated was reduced to 2,136 in 2019 and to 2,132 and to in 2020.

A.21 By combining these different modelling approaches and sample pools, we developed nine different models for comparing treatment and control areas. A summary of the models and different samples is presented in Figure A1. There were 32,844 LSOAs in England and 1,909 in Wales that formed the focus of analysis. Of these, 2,426 were treated in 2018-2019 and a further 2,428 in 2019-20, and these were the focus of analysis.

Figure A1 Summary of selection models and samples for treated in 2018-2019



Source: Belmana.

Profiling the Supported Areas

Identifying supported and non-supported areas

A.22 There were 2,426 treated LSOAs in 2019. This fell to 2,278 when the areas which had very large employment were removed (this corrected for the likely correlation between selection and the number of businesses in the LSOAs). Similarly, there were 2,428 treated LSOAs in 2020 and this number fell to 2,391 excluding the LSOAs with very large employment (above 99 percentile).

A.23 Since one of the samples for the analysis was LSOAs served by the same exchange (see above), it was necessary to construct an additional treatment group for LSOAs which could be linked to a single exchange. Given the overlapping geographies of

[46] To find the coordinates of the exchange we calculated the weighted average of the longitude and latitude by exchange, weighted by the number of premises in the postcode. This assumption was tested in a random sample of 5 exchanges comparing the real location with our approximation obtaining a difference of 487 m., which is a reasonable approximation for the study.

LSOAs and exchange areas, a large number of LSOAs included properties served by two or more exchanges. For the purpose of this analysis, it was considered that an LSOA was linked to a single exchange if at least 60% of the properties in the area were served by that exchange. The LSOAs that did not meet this criterion were dropped in some models to consider the effect of exchange connections. For this analysis, 2,136 treated LSOAs were linked to one exchange in 2019 and 2,132 LSOAs were linked to one exchange in 2020.

A.24 To form the control group and avoid the potential for previously or subsequently supported LSOAs being included in the matching, LSOAs with vouchers connected at any point from 2018 to 2021 were removed from the pool of comparable LSOAs, or untreated. There were then 28,738 LSOAs that could be used as a counterfactual.

Statistical matching

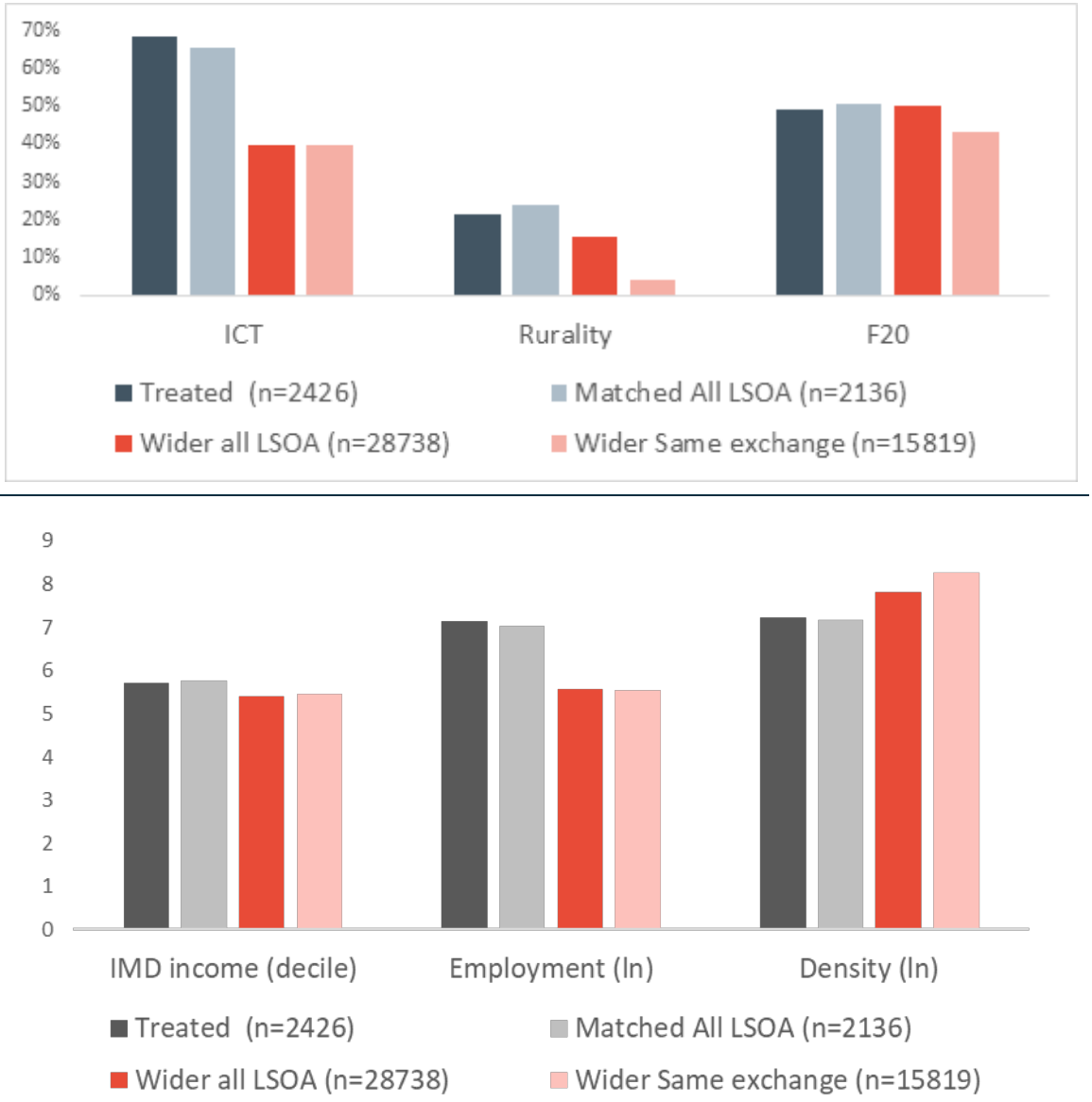
A.25 The characteristics of supported and non-supported areas were then analysed using the data sources described above (including Nomis – Official labour market statistics, ONS demographic data and the Internet User Classification).

A.26 Statistical matching was carried out by identifying unsupported LSOAs with similar characteristics to those which had received a voucher in 2018/19 and 2019/20 on a one-to-one basis. For example, the levels of employment in supported LSOAs were high, with a geometric mean of 1,261. This compared with the England and Wales average of 265, so the matching tends to draw unsupported areas with a high level of employment into the counterfactual.

A.27 This statistical matching can be rationalised in terms of the design of the voucher programmes. Applications for vouchers were encouraged from businesses and so it is unsurprising that LSOAs with high employment levels feature in the treated group. This can also be seen in LSOAs where vouchers were cancelled; the average employment was closer to that seen in supported LSOAs, at 584. Matching then selected from these the LSOAs that were as similar statistically as possible, so that – after matching – the matched control group for areas with cancelled vouchers had an average employment of 596.

A.28 Figure A2 indicates some further characteristics used in matching: the proportion of employment in the ICT sector, whether an LSOA was rural and the average F20 score. The figure shows the effect of statistical matching using propensity score matching on these non-characteristics. The approach is detailed further below, but the figure indicates how the differences between supported areas and the wider LSOAs – while modest in some variables – could then be balanced to achieve a more comparable set of areas. Broadly, the PSM matched on the industrial structure and population differences in the supported LSOAs.

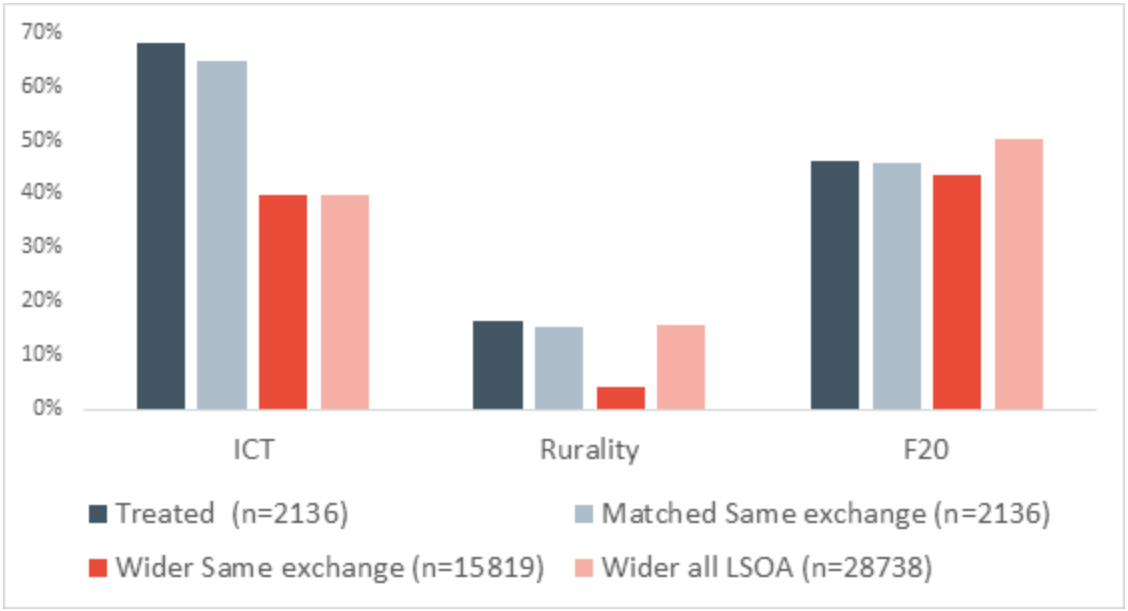
Figure A2 Profiling Supported and Comparator LSOAs for treated 2018/19 – Control group All LSOAs

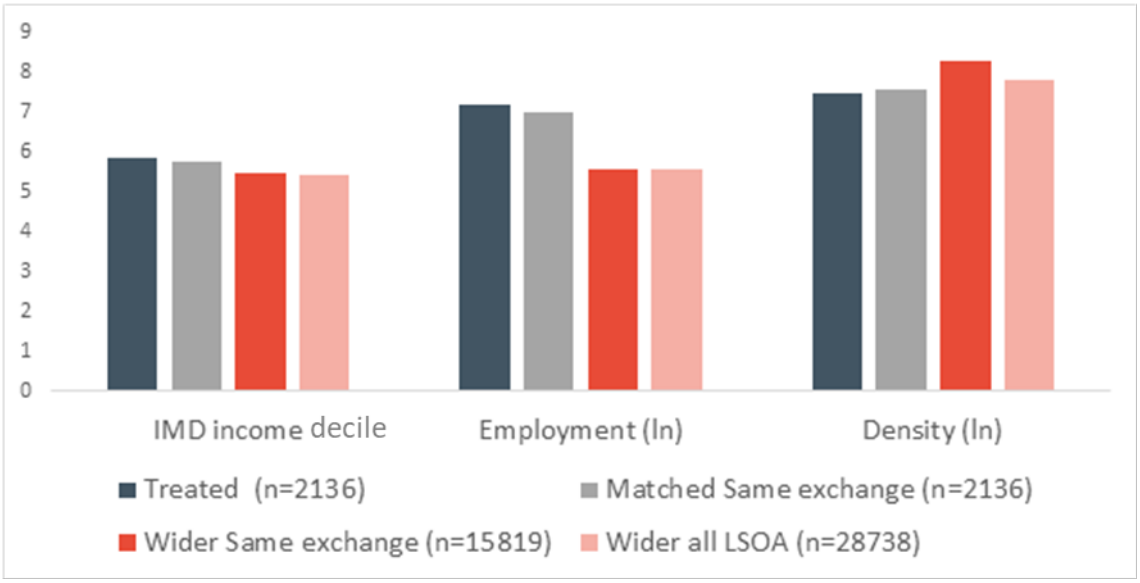


Source: Belmana.

A.29 Figure A3 shows the results from statistical matching using LSOAs in the same exchange area as a control group. The employment in the ICT sector was 68% for the treated and 37% for the control before the matching, after the matching it increased to 65%. The rurality for the treated LSOAs in 2019 was 16%, which was significantly higher than in the control group (3%). After matching it was increased to 15% in the control group. The same logic was applied for the F20 score and the other variables used in the selection model.

Figure A3 Profiling Supported and Comparator LSOAs for treated 2018/19 – Control group Same Exchange LSOAs





Source: Belmana.

Discussion and Robustness of Estimation

A.30 Propensity score matching was used to understand whether the performance changes seen in supported areas were greater than a statistically similar set of areas. In modelling the counterfactual, it is always important to check whether the estimates are robust. Some of the robustness checks undertaken for this study included:

- looking at the performance changes in the year before support to ensure the treated area were not already on very different growth trajectories
- and considering alternative models to ensure results were not unduly sensitive to matching strategies.

A.31 A key consideration was whether, before support, the areas that were supported were not already experiencing a different performance growth rate which distorts the post support analysis. This would mean that, even after matching, the growth in broadband speeds or the other performance measures differed between supported and unsupported areas. While download speeds in the supported areas were growing faster before the support, the changes seen after support were greater. Alternative models matched on past growth performance so that the counterfactual's previous growth was forced to be similar, and the supported LSOAs exhibited significant performance improvements.

A.32 Robustness tests also included whether the matching satisfactorily matched the supported LSOAs to comparable LSOAs, usually in terms of whether the full range of propensity scores exhibited by the supported areas could be found in the unsupported areas. Given the large number of observations for unsupported LSOAs, this proved relatively easy to do. Further, by removing the LSOAs that had very high unemployment in some models, this could be further tested.

A.33 The research has also highlighted some of the potential improvements that could be made to estimation methods as more data is collected. These mainly centre on the Rural Gigabit Connectivity Vouchers and the spillover effects in less densely populated areas. The analysis presented in this report, being focused on the national impacts, may not adequately model the drivers for voucher take up and the effects of distance from broadband investments in rural areas. The potential to cover these in more detail will be explored using the more detailed datasets available in ONS Secure Research Service in the next phase of the study.

Data

A.34 The data driving the analysis was derived from different sources. This section presents a description of the data available and their limitations.

Connected Nations Report

A.35 Ofcom publishes the Connected Nations and infrastructure reports on the UK's communications infrastructure, focusing on the availability and performance of fixed broadband and mobile networks, tracking annually the progress in fixed and mobile services in the UK, taking the coverage data from September each ear. In addition, Ofcom publish two smaller updates a year, in spring (January) and in summer (May) which focus on the key changes in the availability of broadband services at different speed levels since the last report.

A.36 For this study, the data from the annual report was used as it is a final version for the year, filling gaps in the interim updates. The annual report data was used for each year from 2017 to 2021. The data enabled making year-on-year comparisons of the UK's communications infrastructure.

A.37 Ofcom publishes the Connected Nations currently collects and reports coverage from 48 wired and 21 wireless operators (2021 annual report data point). In 2018/2019 this was only 24 wired operators and no wireless operators.

Table A3: Connected Nations Operators

Year	Fixed Wire Operators	Wireless Operators	Operators Included
2017	13		B4RN, BT, BU-UK, CityFibre, Gigaclear, Hyperoptic, ITS, KCOM, Relish, Sky, Talk, Virgin Media, Vodafone
2018	24		B4RN, Bridge Fibre, BT Group, Cablecom Glide, Call Flow, CityFibre, Community Fibre, Gigaclear, Hutchinson 3G UK Limited ("Three"), Hyperoptic, IFNL, ITS, KCOM, Openreach, Sky, Spectrum Internet, TalkTalk, Truespeed, Virgin Media, Vodafone, VX Fibre, Wessex Internet, WightFibre
2019	24		B4RN, Bridge Fibre, BT Group, Cablecom Glide, Call Flow, CityFibre, Community Fibre, Gigaclear, Hutchinson 3G UK Limited ("Three"), Hyperoptic, IFNL, ITS, KCOM, Openreach, Sky, Spectrum Internet, TalkTalk, Truespeed, Virgin Media, Vodafone, VX Fibre, Wessex Internet, WightFibre
2020	37		Ask4, B4RN, Bridge Fibre, BT Group, Cablecom Glide, Call Flow, CityFibre, Community Fibre, Country Broadband, Fibrespeed, Fibrus, Full Fibre, FW Networks, Gigaclear, G.Network, Hampshire Broadband, Hutchinson 3G UK Limited ("Three"), Hyperoptic, IFNL, ITS, KCOM, MiFi Wales, Openreach, Sky, Spectrum Internet, TalkTalk, Technological Services, Telcom Infrastructure, Truespeed, Velocity1, Virgin Media, Vision Fibre, Vodafone, VX Fibre, Wessex Internet, WightFibre, Zzoomm
2021	48	21	FIXED: Ask4, Atlas Communications, Axione, B4RN, Box Broadband, Bridge Fibre, BT Group, CityFibre, Community Fibre, County Broadband, Electronic Communities, F & W Networks, Fibre Nest, Fibrespeed, Fibrus, Full Fibre, G.Network, Gigaclear, Glide, Hampshire Broadband, Hyperoptic, ITS, Jurassic Fibre, KCOM, Lightning Fibre, MyFi Wales, Netomnia, OFNL, Openreach, Orbital Net, Sky, Spectrum Internet, Swish Fibre, TalkTalk, Technological Services, Telcom Infrastructure, Toob, Trooli, Truespeed, Velocity1, Virgin Media, 4th Utility (Vision Fibre), Vodafone, Voneus, VX Fiber, Wessex Internet, WightFibre, Zzoomm WIRELESS: Airband Community Internet, Borderlink Broadband, Boundless Networks Limited, Broadband for Rural Kent, County Broadband Limited, Cromarty Firth Wireless

			Networks, Fram Broadband Limited, Highland Wireless, Juice Broadband/WideFM Ltd, Kencomp Internet Limited, Locheilnet CIC, Loop Scorpion, Lothian Broadband, Orbital Net, Quickline Communications, Secure Web Services Limited, Voneus, Wessex Internet, WiFi Scotland, WiFi X Limited, Wildanet Limited

Source: Ofcom Connected Nations Annex A - Methodology Reports (2017-2021)

A.38 BDUK's voucher schemes have over 100 active suppliers, some of which are resellers of Openreach / Cityfibre, who'll appear in early Connected Nations data, but others who may not. For example, Trooli only appear in the most recent report, Airband are predominantly a fixed wireless supplier and their fibre coverage (via vouchers) won't be included. Some suppliers like Alncom are still missing. Ofcom Connected Nations remains the most reliable, consistent and comprehensive data on broadband availability and use in the UK. However, the gaps in the availability of data from all voucher suppliers using the voucher schemes will impact the extent to which the full effect on availability and use can be detected through evaluation.

Fixed Coverage

A.39 Most of the variables on the fixed coverage focus on the percentage of premises that meet certain speed availability cut-offs. The data was collected in September of each year from 2017 to 2021. Table A4 looks at the variables compiled for different reports about the coverage of fixed broadband. It also looks at the geographical level of detail that is available, with data files generally being by postcode or output area, and – for many variables – available for both levels of geography.

A.40 The table does highlight some data gaps. Perhaps most notable is the availability of data about the availability of full fibre is only for the earlier two years. However, generally, the coverage is good especially for output area level. An issue with postcode level datasets is the limited availability of counts of properties that are consistent with the shares data that is published. For output areas, a completer and more detailed dataset is provided.

Table A4: Variables available for Fixed Coverage by Connected Nation Report Year

Variable	Level	2017/18	2019/20	2020/21
postcode	Postcode	X	X	X
oa11	Output area	X	X	X
All Premises	Both*	X	X	X
All Matched Premises	Both*	X	X	X
Superfast Broadband availability (% premises)	Both	X	X	X
Ultrafast BB (100Mbit/s) availability (% premises)	Both			X
UFBB availability (% premises)	Both	X	X	X
Full Fibre availability (% premises)	Both	X	X	
% of premises unable to receive 2Mbit/s, 5Mbit/s, 10Mbit/s, 30Mbit/s	Both	X	X	X
Gigabit availability (% premises)	Both			X
% of premises below the USO	Both	X	X	X
% of premises with NGA	Both	X	X	X
% of premises able to receive decent broadband from FWA	Both	X	X	X
% of premises able to receive SFBB from FWA	Both	X	X	
% of premises with download speed: 0<2Mbit/s, 2<5Mbit/s, 5<10Mbit/s, 10<30Mbit/s, 30<300Mbit/s, >=300Mbit/s	Both		X	X
Number of premises with SFBB availability	Output area	X	X	X
Number of premises with UFBB (100Mbit/s) availability	Output area			X
Number of premises with UFBB availability	Output area	X	X	X
Number of premises with Full Fibre availability	Output area	X	X	
Number of premises unable to receive 2Mbit/s, 5Mbit/s, 10Mbit/s, 30Mbit/s	Output area	X	X	X
Number of premises with Gigabit availability	Output area			X
Number of premises below the USO	Output area	X	X	X
Number of premises with NGA	Output area	X	X	X
Number of premises able to receive decent broadband from FWA	Output area	X	X	X
Number of premises able to receive SFBB from FWA	Output area	X	X	
Number of premises with download speed: 0<2Mbit/s, 2<5Mbit/s, 5<10Mbit/s, 10<30Mbit/s, 30<300Mbit/s, >=300Mbit s /	Output area		X	X

* For postcodes data only available for 2018.

Fixed Performance

A.41 The variables available for fixed performance are presented in Table A5. Most of them show the minimum, average and maximum download speed for different lines, as well as the data usage, and the number of connections. The data was collected in May of 2018/2019/2021 and in June of 2020.

Table A5 Variables available for Fixed Performance by Connected Nation Report Year

Variable	Level	2017/18	2019	2020/21
oa11	Output area	X	X	X
postcode	Postcode	X	X	X
Median upload speed (Mbit/s)	Both	X	X	X
Median download speed (Mbit/s)	Both	X	X	X
Median data usage (GB)	Both		X	X
Average upload speed (Mbit/s) for lines < 10Mbit/s, 10<30Mbit/s, 30<300Mbit/s	Both	X	X	X
Average upload speed (Mbit/s) for SFBB lines, and for UFBB lines	Both	X	X	X
Average upload speed (Mbit/s)	Both	X	X	X
Average download speed (Mbit/s) for lines < 10Mbit/s, 10<30Mbit/s, 30<300Mbit/s	Both*	X	X	X
Average download speed (Mbit/s) for SFBB lines, and for UFBB lines	Both	X	X	X
Average download speed (Mbit/s)	Both	X	X	X
Average data usage (GB) for lines < 10Mbit/s, 10<30Mbit/s, 30<300Mbit/s	Both**	X	X	X
Average data usage (GB) for SFBB lines, and for UFBB lines	Both	X	X	X
Average data usage (GB)	Both	X	X	X
Maximum upload speed (Mbit/s)	Both	X	X	X
Maximum download speed (Mbit/s)	Both	X	X	X
Number of connections (number of lines) < 2 Mbit/s, 2<5 Mbit/s, 5<10 Mbit/s, 10<30 Mbit/s, 30<300 Mbit/s, >=300 Mbit/s, >=30 Mbit/s	Both	X	X	X
Minimum download speed (Mbit/s)	Both	X		
Minimum upload speed (Mbit/s)	Both	X		
Average data usage (GB) for Basic BB lines	Both	X		

* Data not available for postcodes corresponding to lines 30<300Mbit/s in 2018.
** Data not available for postcodes corresponding to lines 10<30Mbit/s, and 30<300Mbit/s in 2018.

Data supplied by BDUK

A.42 BDUK provided two further internal datasets for the analysis. A key dataset used in the counterfactual impact evaluation was the Vouchers Data, described elsewhere in the report. For the impact analysis, the vouchers data provided the main characteristics of the vouchers, including geographic variables, date of delivery, date of connection, status of the voucher, amount of the voucher, scheme (divided into GBVS and rural), type (divided into project and standard) among others. The date of voucher connection was used, converted to financial year, to define the year of the treatment.

A.43 A second dataset provided was the F20 Model Output. The F20 modelling work undertaken by Broadband Delivery UKs sought to identify the 20% most difficult to connect properties in the UK, in term of the cost of connection. This dataset presents an index from 0 to 1 that reflects the cost to install fibre to a premise. A value close to 0 reflects premises that can be easily connected, being the opposite as it gets closer to 1.

Nomis – Official Labour Market Statistics

A.44 The counterfactual modelling controls for differences in employment characteristics, between supported and non-supported areas, that might affect the selection for voucher support. The data was obtained from the Business Register and Employment Survey, which contains employment information at the LSOA level for England and Wales.

A.45 There were two variables derived using the Nomis dataset. A first was the total employment by LSOA: the model includes the logarithm of the total employment by LSOA before the period of evaluation. It meant that we were using the employment in 2018 for the treated in 2019, and the employment in 2019 for the treated in 2020.

A.46 Secondly, Nomis was used to identify whether an LSOA had high employment in digital business. A dummy variable indicated a high prevalence of employment in digital business. This variable was constructed using the industry percentage of employment by LSOA in the year before the support.

A.47 The data obtained from Nomis is divided into eighteen industrial groups. For the analysis we were considering seven industries defined as intensive in the information and communication technology which were: manufacturing, motor trades, wholesale, information & communication, financial & insurance, professional, scientific & technical, and business administration & support services. Then the percentage of employment was summed in these industries, and if it was greater than the mean in all LSOAs then it took the value of 1 and 0 otherwise.

Other control variables

A.48 A further set of control variables was collected from the Office of National Statistics (ONS). These variables were:

- Population density: The number of people per square kilometre in Lower Layer Super Output (LSOA) areas in England and Wales.

- 2011 Rural Urban Classification for LSOAs: The Rural Urban Classification is produced using Census data, with the 2011 Rural Urban Classification being the latest version of the classification. The next Rural Urban Classification will be produced when the 2021 Census data has been published. We included a dummy identifying rural areas.
- Indices of Deprivation - Income and Employment Domains for England and Wales: These datasets provide a directly measured indicator of income and employment deprivation across all LSOAs in England and Wales, as at 2015-16, enabling comparable analysis across the two countries.
- The Income Deprivation Domain measures the proportion of the population experiencing deprivation relating to low income, and the Employment Deprivation Domain measures the proportion of the working-age population in an area involuntarily excluded from the labour market. In the analysis we included the deciles of the income domain rank.

A.49 One additional control variable was included from the Consumer Data Research Centre (CDRC).

- 2018 Internet User Classification (IUC): The IUC is a bespoke classification that describes how people living in different parts of Great Britain interact with the Internet. It provides coverage for Great Britain at the LSOA (for England and Wales) and Datazone (for Scotland) level.
- The IUC provides 10 unique profiles of neighbourhoods based on a number of characteristics, the mean attributes of which are summarized below. We include the different levels of this variable in the post-estimation regressions. The omitted category is the number 1 e-Cultural Creators.

Group Code	Group Name
1	e-Cultural Creators
2	e-Professionals
3	e-Veterans
4	Youthful Urban Fringe
5	e-Rational Utilitarians
6	e-Mainstream
7	Passive and Uncommitted Users
8	Digital Seniors
9	Settled Offline Communities
10	e-Withdrawn

Profiling the Supported Areas

A.50 For the LSOA level analysis, where vouchers were connected, a list of the supported and non-supported areas was linked to Nomis, ONS demographic data, Internet User Classification, BDUK F20 Model and BDUK vouchers data. Key points are:

- There were 2,426 treated LSOAs in 2019. This fell to 2,278 when the areas which had very large employment were removed (this corrected for the likely correlation between selection and the number of businesses in the LSOAs).

Properties linked through exchanges and as broadband connectivity would also be determined by the exchange connection for each property, a further geography was the broadband coverage of areas in terms of the exchange properties were linked to. A treatment group was constructed for LSOAs that could be linked to one exchange only, defined as the share of properties tied to the single exchange being greater than 60%. The LSOAs that did not meet this criterion were dropped in some modelling to consider the effect of exchange connections. For this analysis, 2,136 treated LSOAs were linked to one exchange in 2019, and 2,132 in 2020.

- LSOAs not selected were used to form the control group. However, to avoid the potential for previously or subsequently supported LSOAs being included in the matching, LSOAs with vouchers connected from 2018 to 2021 were removed. There were 28,738 LSOAs that met these criteria.

A.51 This evaluation focusses on vouchers connected between October 2018 and September 2020. We defined two treatment periods i) treated in 2019 that corresponded to the vouchers connected from October 2018 to September 2019 and ii) treated in 2020 that corresponded to the vouchers connected from October 2019 to September 2020.

- Table A6 presents the summary statistics comparing the treated and all LSOAs. The focus is supported LSOAs in 2018/19. Table A7 shows the summary statistics for the treated LSOAs but excluding those with a very high level of employment. Analysis focused on these because there were few LSOAs with a density of businesses so high that they were unlikely not to have any vouchers and so finding a comparable unsupported LSOA was unlikely. The table also presents summary statistics for the treated LSOAs served by one exchange. It also includes the comparable LSOAs that used the same exchange as treated.

Table A6: Summary Statistics comparing the treated and all LSOAs

	Treated 18/19		All LSOA's	
	Mean	**Sd**	**Mean**	**Sd**
Broadband performance				
Average download speed (Mbit/s) – 2019	58.8	27.7	61.8	21.6
Number of connections >=30Mbit/s – 2019	384.1	152.1	375.0	109.0
% of premises unable to receive 30Mbit/s - 2019	8.8	12.0	3.7	8.0
UFBB availability (% premises) -2019	51.3	34.6	56.1	39.5
Gigabit availability (% premises) - 2019	15.3	25.1	8.3	21.2
Demographics				
Employment (log) -2019	7.2	1.2	5.6	1.1
Population density (log) – 2019	7.2	1.8	7.8	1.4
Income deprivation domain (decile)	5.7	2.8	5.4	2.9
Rurality	0.2	0.4	0.2	0.4
Industry				
High employment in digital business – 2019	0.7	0.5	0.4	0.5
F20 model output	0.5	0.3	0.5	0.2
Internet User Classification - 2018	5.4	2.4	6.1	2.2
Average number of properties in LSOAs	994.5	416.8	757.2	201.1
Observations	**2,426**		**28,738**	

Table A7 Summary Statistics comparing the treated, rejected, and other LSOAs

	Treated 18/19 without high employment		LSOAs with the same exchange as treated			
			Treated 18/19		Control	
	Mean	Sd	Mean	Sd	Mean	Sd
Broadband performance						
Average download speed (Mbit/s) – 2019	59.0	28.2	60.2	24.2	66.6	19.8
Number of connections >=30Mbit/s – 2019	383.0	150.1	390.2	151.4	386.7	104.9
% of premises unable to receive 30Mbit/s -2019	8.5	11.8	7.4	10.5	2.1	5.3
UFBB availability (% premises) -2019	51.0	35.2	53.5	34.3	65.7	35.7
Gigabit availability (% premises) - 2019	14.9	25.3	15.2	25.6	8.7	22.4
Employment (log) -2019	7.0	1.1	7.2	1.2	5.6	1.1
Population density (log) – 2019	7.2	1.8	7.5	1.6	8.3	1.0
Income deprivation domain (decile)	5.7	2.9	5.9	2.8	5.5	2.9
Rurality	0.2	0.4	0.2	0.4	0.0	0.2
High employment in digital business – 2019	0.7	0.5	0.7	0.5	0.4	0.5
F20 model output	0.5	0.3	0.5	0.3	0.4	0.2
Internet User Classification - 2018	5.5	2.3	5.4	2.4	6.0	2.3
Average distance to the exchange (miles)			1.4	1.0	1.4	0.7
Average number of properties in LSOAs	951.2	332.5	937.5	410.4	721.4	205.2
Observations	**2,278**		**2,136**		**15,819**	

Assessing Impact

A.52 A means to estimate impacts is to study non-recipient areas which are as comparable as possible to the recipient areas. In this evaluation propensity score matching (PSM) was used to identify comparable unsupported LSOAs. This generated a score for each of the areas, based on its characteristics. The same selection model was then applied to score the unsupported LSOAs. This section presents firstly results about the selection modelling and then details the estimated performance differences.

Selection models

A.53 Matching was undertaken through estimating a statistical model of the selection process into support. The modelling had to use variables available about LSOAs before support and these were derived from the data above. Variables available included the number of employees, population density, high digital employment, rurality, index of multiple deprivation (income), region dummies.

A.54 The selection modelling for this analysis used a Probit model for the treated in 2019 and the treated in 2020. The dependent variable took a value of one for those in receipt of first support through vouchers in 2018/19 or 2019/20 and zero for the unsupported areas which did not receive any support, including from other treatment cohorts or types.

A.55 Tables A8 and A9 show the estimates for a selection of the estimated models, comparing the results for the treated in 2018 and 2019. The focus was on the models using different sets of unsupported LSOAs from which to select the counterfactual. The pools shown include the pool of all LSOAs and one where the focus was on areas connected to the same exchanges as the supported LSOAs.

A.56 The modelling highlights that the characteristics explaining the selection into treatment were similar in 2019 and 2020 in terms of direction and magnitude. With regards to the fitness of the model the adjusted R-square was higher for the treated in 2018 compared to the treated in 2019 for all the selection models. The model shows that LSOAs with cancelled vouchers were already quite similar to the supported. The overall fit of the model is lower, and the coefficients on the variables used to model selection proved less statistically significant.

A.57 Overall, the models show good performance with coefficients taking the correct sign, such as being positive in employment and the share of employment in ICT industries. These characteristics made selection into support more likely as expected.

A.58 There was a regional dimension to being supported. LSOAs in London, the East of England and the Southeast are less likely to have received voucher support. The regional effects were measured in terms of Wales.

Table A8 Selection models for all the outcome variables – All LSOAs

	Treated 18/19			Treated 19/20		
Variable	**Model I**	**Model II**	**Model III**	**Model I**	**Model II**	**Model III**
SFBB coverage		-0.02 (-13.13***)	0.01 (10.62***)		-0.01 (-10.27***)	0.00 (1.89*)
Average data usage (GB)		0.00 (-2.66***)	0.00 (1.30)		0.00 (-1.19)	0.00 (-1.47)
Average upload speed (Mbit/s)		0.01 (3.60***)	0.00 (1.23)		0.00 (-0.75)	0.00 (-1.53)
IMD income	0.01 (2.54**)	0.01 (1.02)	0.02 (2.84***)	0.01 (2.65***)	0.01 (2.09**)	0.01 (2.55**)
Employment (ln)	0.57 (45.97***)	0.57 (45.51***)	0.56 (45.27***)	0.45 (37.64***)	0.45 (37.28***)	0.45 (37.70***)
ICT	0.39 (15.40***)	0.40 (15.64***)	0.39 (15.21***)	0.28 (11.98***)	0.29 (12.00***)	0.29 (12.01***)
Rurality	-0.02 (-0.49)	-0.10 (-2.23**)	-0.04 (-0.87)	0.14 (3.39***)	0.11 (2.59***)	0.13 (3.26***)
F20	-0.87 (-7.44***)	-0.77 (-6.50***)	-0.84 (-7.22***)	-0.74 (-6.60***)	-0.65 (-5.78***)	-0.74 (-6.58***)
Density (ln)	-0.17 (-10.12***)	-0.10 (-5.10***)	-0.16 (-9.31***)	-0.19 (-11.93***)	-0.12 (-7.20***)	-0.19 (-11.77***)
Region North East	0.34 (3.96***)	0.33 (3.72***)	0.34 (3.94***)	0.15 (1.88*)	0.14 (1.81*)	0.15 (1.88*)
Region North West	0.27 (3.76***)	0.24 (3.33***)	0.29 (3.96***)	0.30 (4.96***)	0.30 (4.89***)	0.30 (4.91***)

Region Yorkshire and the Humber	0.65 (9.11***)	0.58 (8.17***)	0.61 (8.48***)	0.23 (3.52***)	0.23 (3.50***)	0.23 (3.41***)
Region East Midlands	0.23 (2.99***)	0.22 (2.92***)	0.23 (3.09***)	0.08 (1.21)	0.11 (1.62)	0.08 (1.17)
Region West Midlands	0.29 (3.87***)	0.24 (3.28***)	0.28 (3.80***)	0.16 (2.38**)	0.14 (2.12**)	0.15 (2.28**)
Region East of England	0.19 (2.59***)	0.15 (2.10**)	0.18 (2.43**)	0.11 (1.80*)	0.12 (1.84*)	0.11 (1.66*)
Region London	0.38 (5.17***)	0.30 (3.95***)	0.38 (5.10***)	0.41 (6.29***)	0.36 (5.37***)	0.41 (6.23***)
Region South East	0.32 (4.61***)	0.29 (4.17***)	0.33 (4.71***)	0.18 (2.95***)	0.19 (3.02***)	0.18 (2.93***)
Region South West	0.28 (3.81***)	0.20 (2.75***)	0.28 (3.83***)	0.11 (1.64)	0.06 (0.95)	0.10 (1.60)
Omitted region Wales	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Constant	-3.83 (-17.40***)	-2.82 (-11.96***)	-3.96 (-17.85***)	-2.84 (-14.14***)	-1.96 (-8.95***)	-2.84 (-14.10***)
Adjusted R-square	**0.27**	**0.28**	**0.27**	**0.18**	**0.19**	**0.18**
Observations	**31164**	**31164**	**31164**	**31166**	**31166**	**31166**

Table A9 Selection models for all the outcome variables – Same Exchange LSOAs

	Treated 18/19			Treated 19/20		
Variable	**Model I**	**Model II**	**Model III**	**Model I**	**Model II**	**Model III**
Average distance to the exchange	-0.12 (-5.50***)	-0.12 (-5.63***)	-0.12 (-5.41***)	-0.15 (-7.53***)	-0.16 (-7.73***)	-0.16 (-7.55***)
SFBB coverage		-0.02 (-12.85***)	0.02 (9.64***)		-0.02 (-9.60***)	0.00 (1.66*)
Average data usage (GB)		0.00 (-4.35***)	0.00 (0.91)		0.00 (-2.02**)	0.00 (-1.94*)
Average upload speed (Mbit/s)		0.01 (2.74***)	0.00 (0.39)		0.00 (0.18)	0.00 (-0.35)
IMD income	0.00 (0.78)	-0.01 (-1.36)	0.01 (1.14)	0.01 (1.23)	0.00 (0.20)	0.01 (1.05)
Employment (ln)	0.57 (38.91***)	0.56 (37.95***)	0.56 (38.24***)	0.44 (31.32***)	0.43 (30.37***)	0.44 (31.35***)
ICT	0.39 (12.87***)	0.41 (13.25***)	0.39 (12.81***)	0.33 (11.57***)	0.33 (11.46***)	0.33 (11.60***)
Rurality	0.50 (8.36***)	0.38 (6.23***)	0.47 (7.77***)	0.55 (10.70***)	0.49 (9.42***)	0.54 (10.52***)
F20	-0.76 (-5.56***)	-0.63 (-4.50***)	-0.73 (-5.28***)	-0.81 (-6.22***)	-0.70 (-5.33***)	-0.80 (-6.14***)
Density (ln)	-0.30 (-12.24***)	-0.23 (-8.79***)	-0.29 (-11.58***)	-0.35 (-15.61***)	-0.29 (-12.45***)	-0.35 (-15.52***)
Region North East	0.08 (0.70)	0.06 (0.56)	0.06 (0.52)	0.04 (0.39)	0.03 (0.30)	0.04 (0.41)
Region North West	0.01 (0.09)	0.00 (-0.04)	0.01 (0.12)	0.17 (2.11**)	0.16 (2.03**)	0.16 (2.08**)
Region Yorkshire and the Humber	0.41 (4.25***)	0.33 (3.35***)	0.33 (3.44***)	0.18 (2.12**)	0.18 (2.06**)	0.17 (2.05**)
Region East Midlands	-0.04 (-0.44)	-0.04 (-0.38)	-0.05 (-0.45)	0.07 (0.83)	0.09 (1.00)	0.07 (0.79)
Region West Midlands	0.02 (0.20)	0.00 (-0.04)	0.00 (0.04)	0.14 (1.61)	0.13 (1.53)	0.13 (1.55)
Region East of England	-0.08 (-0.81)	-0.08 (-0.78)	-0.09 (-0.94)	0.02 (0.23)	0.01 (0.17)	0.01 (0.15)
Region London	0.12 (1.22)	0.06 (0.64)	0.10 (1.05)	0.29 (3.50***)	0.23 (2.81***)	0.29 (3.48***)
Region South East	0.02 (0.20)	0.02 (0.17)	0.01 (0.13)	0.06 (0.82)	0.07 (0.86)	0.06 (0.80)

Region South West	0.06 (0.56)	-0.02 (-0.23)	0.04 (0.35)	0.07 (0.84)	0.01 (0.13)	0.06 (0.74)
Omitted region Wales	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Constant	-2.18 (-7.16***)	-0.43 (-1.27)	-2.32 (-7.57***)	-0.91 (-3.23***)	0.61 (1.90*)	-0.89 (-3.18***)
Adjusted R-square	**0.31**	**0.33**	**0.32**	**0.24**	**0.25**	**0.24**
Observations	**17955**	**17955**	**17955**	**17852**	**17852**	**17852**

Assessments of impact

A.59 After matching, estimates of the change seen in performance measures in the supported areas were compared to the changes in the counterfactual areas. The range of models used in the study allowed a relatively large number of estimates of the additional performance seen in supported areas. Tables A10 and A11 present results for all models. For the treated in 2019 the first table shows the effects on the outcome variables measured in 2020, and the second table the effects for the outcomes measured in 2021 (latest CN data). With regards to the treated in 2020, the last tables present the results on the outcomes in 2021.

Table A10 Difference-in-Difference Estimates by Models for Key Performance Outcomes

Treatment: Connected vouchers between 01 October 2018 and 30 September 2019. Analysis of the output variables in 2020

	Model I			Model II			Model III		
	Pool All LSOA's	LSOA's exc. high emp.	Same exchange LSOA's	Pool All LSOA's	LSOA's exc. high emp.	Same exchange LSOA's	Pool All LSOA's	LSOA's exc. high emp.	Same exchange LSOA's
Average download speed (Mbit/s)									
Treated	12.65	12.61	12.39	12.61	12.61	12.36	12.62	12.61	12.40
Control	11.87	11.25	11.49	11.49	11.38	11.36	11.47	11.55	11.60
Difference	0.78**	1.36***	0.90***	1.12***	1.23***	1.00***	1.15***	1.06***	0.80***
Number of connections >=30Mbit/s (number of lines)									
Treated	87.03	85.34	85.13	86.87	85.35	84.78	87.01	85.34	84.98
Control	81.26	77.61	75.04	79.05	79.04	75.44	81.86	80.75	76.41
Difference	5.77***	7.73***	10.09***	7.83***	6.30***	9.34***	5.15**	4.59**	8.57***
% of premises unable to receive 30Mbit/s									
Treated	-1.39	-1.36	-1.23	-1.36	-1.36	-1.18	-1.40	-1.36	-1.18
Control	-0.79	-0.99	-0.59	-1.37	-1.52	-0.88	-0.86	-0.90	-0.88
Difference	-0.59***	-0.36***	-0.64***	0.01	0.17	-0.31***	-0.53***	-0.45***	-0.31***
UFBB availability (% premises)									
Treated	5.24	5.25	5.12	5.19	5.26	5.08	5.21	5.25	5.10
Control	5.39	5.12	6.06	5.57	5.80	6.08	5.13	5.29	5.82
Difference	-0.15	0.13	-0.94***	-0.38	-0.54	-1.00***	0.08	-0.04	-0.72
Gigabit availability (% premises)									
Treated	12.96	12.98	13.34	12.94	12.99	13.37	12.92	12.98	13.34
Control	12.43	12.88	15.00	12.24	13.48	14.61	12.57	12.92	14.37
Difference	0.53	0.11	-1.66***	0.70	-0.48	-1.24	0.35	0.07	-1.03

All Observations

Untreated	30436	30436	17703	30436	30436	17703	30436	30436	17703
Treated	2797	2586	2451	2797	2586	2451	2797	2586	2451

Treatment: Connected vouchers between 01 October 2018 and 30 September 2019. Analysis of the output variables in 2021

	Model I			Model II			Model III		
	Pool All LSOA's	LSOA's exc. high emp.	Same exchange LSOA's	Pool All LSOA's	LSOA's exc. high emp.	Same exchange LSOA's	Pool All LSOA's	LSOA's exc. high emp.	Same exchange LSOA's
Average download speed (Mbit/s)									
Treated	14.25	13.98	14.33	14.18	13.97	14.14	14.39	13.98	14.27
Control	12.58	13.01	12.77	13.16	13.00	13.04	13.25	12.91	13.11
Difference	1.67***	0.97***	1.56***	1.02***	0.97***	1.10***	1.14***	1.07***	1.16***
Number of connections >=30Mbit/s (number of lines)									
Treated	75.08	70.76	78.52	75.17	70.75	77.35	75.87	70.76	78.02
Control	70.26	69.03	68.37	70.98	69.84	69.52	71.75	70.50	67.89
Difference	4.82**	1.73	10.14***	4.19	0.91	7.83***	4.12	0.26	10.12***
% of premises unable to receive 30Mbit/s									
Treated	-0.86	-0.92	-0.64	-0.85	-0.91	-0.64	-0.86	-0.92	-0.64
Control	-0.45	-0.42	-0.28	-0.65	-0.68	-0.48	-0.39	-0.41	-0.48
Difference	-0.41***	-0.50***	-0.36***	-0.21**	-0.23**	-0.16	-0.48***	-0.51***	-0.16
UFBB availability (% premises)									
Treated	4.95	5.15	4.57	4.94	5.15	45.94	4.94	5.15	4.58
Control	4.54	4.63	4.80	4.28	5.12	44.46	4.80	4.67	4.85
Difference	0.41	0.52	-0.23	0.65	0.03	1.47	0.14	0.48	-0.27
Gigabit availability (% premises)									
Treated	17.16	17.47	17.40	17.20	17.47	17.52	17.24	17.47	17.45

Control	18.53	18.20	19.59	17.73	17.88	19.65	17.95	17.81	19.24
Difference	-1.37	-0.73	-2.19***	-0.53	-0.41	-2.13***	-0.70	-0.34	-1.80***

All Observations									
Untreated	30436	30436	17703	30436	30436	17703	30436	30436	17703
Treated	2797	2586	2451	2797	2586	2451	2797	2586	2451

Treatment: Connected vouchers between 01 October 2019 and 30 September 2020. Analysis of the output variables in 2021

	Model I			**Model II**			**Model III**		
	Pool All LSOA's	**LSOA's exc. high emp.**	**Same exchange LSOA's**	**Pool All LSOA's**	**LSOA's exc. high emp.**	**Same exchange LSOA's**	**Pool All LSOA's**	**LSOA's exc. high emp.**	**Same exchange LSOA's**
Average download speed (Mbit/s)									
Treated	13.99	13.90	13.84	13.99	13.90	13.83	13.99	13.90	13.84
Control	13.00	12.69	12.95	12.99	12.85	13.02	12.98	12.74	12.89
Difference	0.99***	1.21***	0.89***	1.00***	1.04***	0.81***	1.01***	1.15***	0.95***
Number of connections >=30Mbit/s (number of lines)									
Treated	71.67	71.19	72.79	71.65	71.19	72.95	71.67	71.19	72.79
Control	66.87	66.11	65.73	66.15	64.72	68.46	67.14	64.53	66.99
Difference	4.80**	5.07**	7.05***	5.51***	6.46***	4.49	4.53**	6.65***	5.80***
% of premises unable to receive 30Mbit/s									
Treated	-0.79	-0.79	-0.62	-0.78	-0.79	-0.62	-0.79	-0.79	-0.62
Control	-0.55	-0.51	-0.29	-0.68	-0.74	-0.64	-0.62	-0.52	-0.64
Difference	-0.23***	-0.28***	-0.32	-0.11	-0.05	0.02	-0.17**	-0.28***	0.02
UFBB availability (% premises)									
Treated	5.94	5.95	5.82	5.93	5.95	5.82	5.94	5.95	5.82

Control	4.93	4.39	5.29	4.95	4.85	5.54	4.97	4.67	5.08
Difference	1.01**	1.57***	0.53	0.98**	1.10***	0.27	0.98**	1.28***	0.74
Gigabit availability (% premises)									
Treated	18.10	18.18	18.95	18.09	18.18	18.87	18.10	18.18	18.94
Control	19.05	18.21	21.02	18.13	19.07	21.22	19.47	19.50	21.19
Difference	-0.95	-0.03	-2.07***	-0.04	-0.88	-2.35***	-1.36	-1.32	-2.24***

All Observations									
Untreated	30436	30436	17703	30436	30436	17703	30436	30436	17703
Treated	2797	2586	2451	2797	2586	2451	2797	2586	2451

Table A11 Postestimation regressions for the treated in 2020 including interactions by scheme and type of voucher

Outcome variable: DiD for UFBB availability (% of premises) 2021

	All LSOAs			All LSOA exc. High Emp.		
	Model I	**Model II**	**Model III**	**Model I**	**Model II**	**Model III**
Treatment	0.70 (1.70*)	0.71 (1.72*)	0.72 (1.71*)	1.25 (3.06***)	0.83 (2.01**)	0.94 (2.27**)
SFBB coverage 2019		-0.12 (-5.87***)	-0.02 (-0.47)		-0.14 (-6.92***)	0.01 (0.24)
Average data usage (GB) 2019		0.01 (5.12***)	0.00 (1.10)		0.01 (4.42***)	0.00 (1.58)
Average upload speed (Mbit/s) 2019		0.05 (1.39)	-0.02 (-0.61)		0.04 (1.02)	-0.01 (-0.29)
IMD income	-0.05 (-0.55)	-0.02 (-0.19)	0.03 (0.29)	-0.09 (-1.01)	0.07 (0.78)	-0.05 (-0.53)
Employment 2019 (ln)	0.42 (2.02**)	0.25 (1.21)	0.48 (2.29**)	0.48 (2.32**)	0.23 (1.10)	0.27 (1.27)
ICT 2019	-0.05 (-0.13)	-0.68 (-1.61)	-0.25 (-0.59)	-0.30 (-0.71)	-0.29 (-0.68)	-0.01 (-0.02)
Rurality	0.77 (1.09)	1.17 (1.65*)	2.26 (3.18***)	2.03 (2.94***)	1.20 (1.70*)	1.80 (2.58**)
F20	13.09 (6.69***)	11.75 (6.01***)	13.24 (6.68***)	11.61 (6.05***)	12.46 (6.30***)	13.00 (6.61***)
Density (ln) 2019	1.50 (5.42***)	1.77 (6.05***)	1.89 (6.76***)	1.61 (5.92***)	2.06 (6.92***)	1.72 (6.24***)
Region North East	2.21 (1.52)	1.89 (1.29)	2.58 (1.75*)	1.26 (0.87)	0.00 (0.00)	0.81 (0.55)
Region North West	-0.19 (-0.17)	-0.66 (-0.60)	-0.08 (-0.07)	-1.18 (-1.07)	-2.37 (-1.88*)	-1.59 (-1.45)
Region Yorkshire and the Humber	-1.06 (-0.90)	-0.67 (-0.56)	-1.67 (-1.38)	-1.91 (-1.63)	-3.95 (-2.97***)	-1.20 (-1.02)
Region East Midlands	-1.53 (-1.27)	-1.49 (-1.25)	-1.49 (-1.21)	-1.99 (-1.69*)	-3.84 (-2.81***)	-1.74 (-1.45)
Region West Midlands	-2.95 (-2.50**)	-3.25 (-2.78***)	-2.40 (-1.99**)	-3.31 (-2.85***)	-5.05 (-3.80***)	-2.98 (-2.57**)

Region East of England	-0.76 (-0.66)	-0.27 (-0.24)	-0.32 (-0.27)	-1.81 (-1.60)	-3.14 (-2.42**)	-1.32 (-1.17)
Region London	-0.18 (-0.15)	-1.04 (-0.88)	-0.41 (-0.33)	-1.44 (-1.23)	-2.87 (-2.18**)	-1.22 (-1.03)
Region South East	1.75 (1.58)	1.18 (1.08)	1.63 (1.44)	1.11 (1.02)	-0.49 (-0.39)	1.19 (1.09)
Region South West	0.97 (0.84)	0.98 (0.86)	1.94 (1.64)	-0.14 (-0.12)	-1.12 (-0.85)	0.22 (0.19)
Omitted region Wales	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-1.69 (-1.15)	0.00 (0.00)
Scheme (rural=1)	7.78 (5.03***)	7.57 (4.94***)	7.42 (4.76***)	7.58 (5.02***)	7.50 (4.92***)	7.31 (4.76***)
Constant	-15.14 (-4.24***)	-7.81 (-2.14**)	-19.43 (-5.36***)	-15.28 (-4.33***)	-6.12 (-1.61)	-15.78 (-4.48***)
Adj R-Squared	0.03	0.04	0.03	0.03	0.05	0.03
Obs	4856	4854	4856	4782	4782	4782

Outcome variable: DiD for Average download speed 2021*

Treatment	0.77 (2.01**)	0.96 (2.48**)	1.06 (2.86***)	0.71 (1.89*)	0.55 (1.39)	0.67 (1.77*)
Scheme (rural=1)	-0.23 (-0.16)	-0.53 (-0.37)	-0.46 (-0.33)	-0.29 (-0.21)	-0.57 (-0.39)	-0.33 (-0.23)
Adj R-Squared	0.11	0.11	0.11	0.1	0.11	0.1
Obs	4856	4854	4856	4782	4782	4782

Outcome variable: DiD for UFBB availability (% of premises) 2021

	Same exchange LSOA		
	Model I	**Model II**	**Model III**
Treatment	0.15 (0.32)	-0.22 (-0.48)	0.37 (0.82)
SFBB coverage 2019		-0.31 (-1.02)	-0.09 (-0.29)
Average data usage (GB) 2019		-0.19 (-7.44***)	-0.02 (-0.49)
Average upload speed (Mbit/s) 2019		0.01 (5.48***)	0.00 (1.55)
Average distance to the exchange (km)	0.11 (0.35)	0.05 (1.09)	0.01 (0.15)
IMD income	-0.11 (-1.14)	0.05 (0.48)	-0.05 (-0.47)
Employment 2019 (ln)	0.23 (1.01)	0.02 (0.08)	0.25 (1.10)
ICT 2019	-0.33 (-0.70)	-0.43 (-0.92)	-0.30 (-0.65)
Rurality	0.73 (0.96)	1.01 (1.32)	1.18 (1.58)
F20	12.89 (6.17***)	12.07 (5.77***)	12.13 (5.92***)
Density (ln) 2019	1.40 (4.01***)	1.81 (5.02***)	1.32 (3.84***)
Region North East	2.07 (1.30)	0.00 (0.00)	2.79 (1.78*)
Region North West	-1.33 (-1.08)	-2.66 (-1.97**)	-0.35 (-0.29)
Region Yorkshire and the Humber	-1.09 (-0.84)	-4.30 (-3.00***)	-0.64 (-0.50)
Region East Midlands	-3.03 (-2.26**)	-5.58 (-3.83***)	-2.03 (-1.54)
Region West Midlands	-2.67 (-2.02**)	-5.55 (-3.84***)	-2.76 (-2.14**)

Region East of England	-1.42 (-1.11)	-4.13 (-2.93***)	-1.17 (-0.93)
Region London	-0.35 (-0.27)	-3.96 (-2.85***)	0.35 (0.27)
Region South East	2.84 (2.33**)	-0.49 (-0.37)	3.28 (2.76***)
Region South West	0.90 (0.69)	-2.29 (-1.61)	1.28 (1.01)
Omitted region Wales	0.00 (0.00)	-1.26 (-0.79)	0.00 (0.00)
Scheme (rural=1)	9.73 (5.48***)	9.00 (5.12***)	9.55 (5.44***)
Constant	-12.00 (-2.75***)	3.06 (0.64)	-12.47 (-2.91***)
Adj R-Squared	0.04	0.06	0.04
Obs	4238	4264	4240

Outcome variable: DiD for Average download speed 2021*

Treatment	0.69 (1.67*)	0.67 (1.61)	0.75 (1.78*)
Scheme (rural=1)	0.37 (0.23)	0.23 (0.14)	0.65 (0.39)
Adj R-Squared	0.11	0.13	0.12
Obs	4238	4264	4240

Interaction: Type (project=1)

Outcome variable: DiD for UFBB availability (% of premises) 2021

	All LSOAs			**All LSOA exc. High Emp.**		
	Model I	**Model II**	**Model III**	**Model I**	**Model II**	**Model III**
Treatment	0.77 (1.80*)	0.82 (1.92*)	0.78 (1.82*)	1.31 (3.10***)	0.95 (2.23**)	1.01 (2.35**)

SFBB coverage 2019		-0.11 (-5.74***)	-0.02 (-0.66)		-0.14 (-6.81***)	0.00 (0.04)
Average data usage (GB) 2019		0.01 (5.15***)	0.00 (1.17)		0.01 (4.44***)	0.00 (1.63)
Average upload speed (Mbit/s) 2019		0.05 (1.36)	-0.02 (-0.65)		0.04 (1.00)	-0.01 (-0.33)
IMD income	-0.05 (-0.53)	-0.02 (-0.17)	0.03 (0.30)	-0.09 (-1.00)	0.08 (0.81)	-0.05 (-0.53)
Employment 2019 (ln)	0.41 (1.99**)	0.23 (1.12)	0.47 (2.24**)	0.48 (2.30**)	0.21 (1.01)	0.26 (1.23)
ICT 2019	-0.05 (-0.11)	-0.67 (-1.59)	-0.24 (-0.56)	-0.29 (-0.68)	-0.28 (-0.65)	0.01 (0.01)
Rurality	1.11 (1.58)	1.54 (2.18**)	2.59 (3.67***)	2.36 (3.43***)	1.58 (2.24**)	2.14 (3.07***)
F20	13.14 (6.70***)	11.79 (6.01***)	13.30 (6.69***)	11.68 (6.08***)	12.51 (6.31***)	13.06 (6.63***)
Density (ln) 2019	1.52 (5.48***)	1.78 (6.08***)	1.90 (6.79***)	1.64 (5.99***)	2.07 (6.95***)	1.73 (6.29***)
Region North East	2.17 (1.48)	1.86 (1.26)	2.51 (1.70*)	1.21 (0.83)	0.00 (0.00)	0.76 (0.52)
Region North West	-0.38 (-0.35)	-0.85 (-0.78)	-0.27 (-0.24)	-1.39 (-1.26)	-2.54 (-2.01**)	-1.77 (-1.61)
Region Yorkshire and the Humber	-1.13 (-0.95)	-0.74 (-0.63)	-1.73 (-1.42)	-1.99 (-1.70*)	-4.01 (-3.01***)	-1.24 (-1.05)
Region East Midlands	-1.63 (-1.35)	-1.62 (-1.36)	-1.60 (-1.29)	-2.11 (-1.78*)	-3.95 (-2.88***)	-1.84 (-1.53)
Region West Midlands	-3.09 (-2.61***)	-3.40 (-2.90***)	-2.53 (-2.09**)	-3.45 (-2.97***)	-5.18 (-3.88***)	-3.10 (-2.66***)
Region East of England	-0.90 (-0.78)	-0.42 (-0.37)	-0.44 (-0.38)	-1.96 (-1.73*)	-3.27 (-2.51**)	-1.44 (-1.27)

Region London	-0.25 (-0.21)	-1.11 (-0.95)	-0.47 (-0.39)	-1.51 (-1.29)	-2.94 (-2.23**)	-1.27 (-1.08)
Region South East	1.75 (1.58)	1.17 (1.07)	1.64 (1.44)	1.09 (1.00)	-0.48 (-0.38)	1.21 (1.10)
Region South West	0.84 (0.73)	0.87 (0.76)	1.81 (1.53)	-0.28 (-0.24)	-1.22 (-0.93)	0.12 (0.10)
Omitted region Wales	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-1.66 (-1.13)	0.00 (0.00)
Type (project=1)	1.67 (1.93*)	1.31 (1.53)	1.56 (1.79*)	1.71 (2.01**)	1.22 (1.42)	1.56 (1.81*)
Constant	-15.30 (-4.27***)	-8.04 (-2.20**)	-19.54 (-5.37***)	-15.49 (-4.38***)	-6.36 (-1.66*)	-15.90 (-4.50***)
Adj R-Squared	0.03	0.04	0.03	0.03	0.04	0.03
Obs	4856	4854	4856	4782	4782	4782

Outcome variable: DiD for Average download speed 2021

Treatment	0.49 (1.23)	0.73 (1.83*)	0.82 (2.17**)	0.43 (1.11)	0.34 (0.83)	0.43 (1.11)
Type (project=1)	1.99 (2.47**)	1.49 (1.84*)	1.52 (1.97**)	1.90 (2.46**)	1.34 (1.63)	1.59 (2.03**)
Adj R-Squared	0.11	0.11	0.11	0.1	0.11	0.11
Obs	4856	4854	4856	4782	4782	4782

Outcome variable: DiD for UFBB availability (% of premises) 2021

	Same exchange LSOA		
	Model I	**Model II**	**Model III**
Treatment	0.22 (0.46)	-0.09 (-0.18)	0.42 (0.90)
SFBB coverage 2019		-0.38 (-1.27)	-0.16 (-0.53)
Average data usage (GB) 2019		-0.19 (-7.38***)	-0.03 (-0.72)

	Same exchange LSOA		
	Model I	**Model II**	**Model III**
Average upload speed (Mbit/s) 2019		0.01 (5.54***)	0.00 (1.70*)
Average distance to the exchange (km)	0.03 (0.09)	0.05 (1.12)	0.01 (0.15)
IMD income	-0.11 (-1.13)	0.05 (0.51)	-0.04 (-0.45)
Employment 2019 (ln)	0.22 (0.95)	-0.01 (-0.04)	0.24 (1.05)
ICT 2019	-0.33 (-0.71)	-0.44 (-0.93)	-0.31 (-0.68)
Rurality	1.15 (1.53)	1.44 (1.90*)	1.59 (2.14**)
F20	12.90 (6.16***)	12.08 (5.76***)	12.14 (5.91***)
Density (ln) 2019	1.35 (3.86***)	1.76 (4.86***)	1.27 (3.69***)
Region North East	2.14 (1.34)	0.00 (0.00)	2.87 (1.82*)
Region North West	-1.52 (-1.24)	-2.92 (-2.16**)	-0.52 (-0.43)
Region Yorkshire and the Humber	-1.16 (-0.89)	-4.47 (-3.11***)	-0.68 (-0.53)
Region East Midlands	-3.13 (-2.33**)	-5.80 (-3.96***)	-2.10 (-1.59)
Region West Midlands	-2.81 (-2.13**)	-5.78 (-3.98***)	-2.87 (-2.22**)
Region East of England	-1.59 (-1.23)	-4.39 (-3.10***)	-1.29 (-1.03)
Region London	-0.38 (-0.29)	-4.10 (-2.94***)	0.35 (0.28)
Region South East	2.88 (2.35**)	-0.56 (-0.41)	3.34 (2.79***)
Region South West	0.71 (0.54)	-2.55 (-1.78*)	1.13 (0.88)

	Same exchange LSOA		
	Model I	**Model II**	**Model III**
Omitted region Wales	0.00 (0.00)	-1.38 (-0.86)	0.00 (0.00)
Type (project=1)	1.94 (1.98**)	1.25 (1.28)	2.05 (2.11**)
Constant	-11.46 (-2.62***)	3.70 (0.76)	-12.01 (-2.79***)
Adj R-Squared	0.03	0.05	0.04
Obs	4238	4264	4240

Outcome variable: DiD for Average download speed 2021*

Treatment	0.48 (1.13)	0.49 (1.14)	0.57 (1.30)
Type (project=1)	1.71 (1.94˜)	1.50 (1.67˜)	1.64 (1.80˜)
Adj R-Squared	0.12	0.13	0.13
Obs	4238	4264	4240

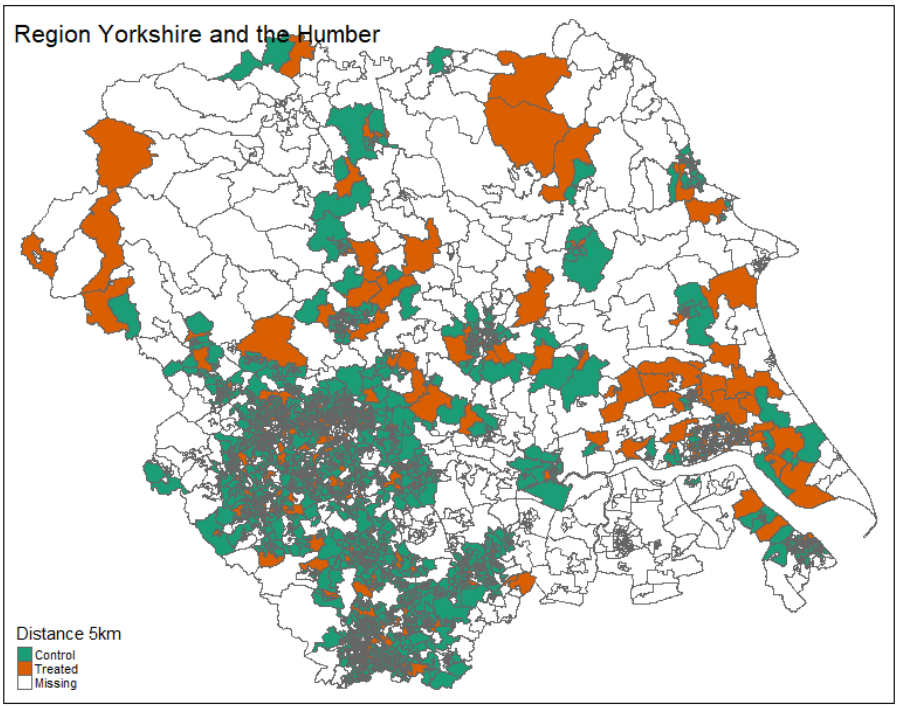
˜ The results presented for the outcome variable DiD Average download speed 2021 correspond to the coefficients for the treatment and the interaction by scheme and project which are the variables of interest in the postestimation. Nevertheless, these models include all the variables of the selection model presented for the outcome variable DiD UFBB availability (% premises) 2021 and have similar results.

Developing a spatial comparator

A.60 Figure A4 maps out the way LSOAs were selected to analyse spatial spillovers using the Yorkshire and Humberside region as an example. The LSOAs that were supported with vouchers – in red – were compared with the nearby LSOAs with the analysis focusing on the areas that are less than 5km from the supported LSOA in green.

A.61 The map highlights a large number of potential comparators, with the initial spatial analysis being based on a large number of LSOAs acting in the counterfactual and a good range of distances from the treated. It also highlights the problem of finding comparable LSOAs that are nearby for the less densely, and so larger, LSOAs. Here there are often no neighbouring LSOAs that are at most 5km away as the LSOA itself is very large.

Figure A4: Supported LSOAs and spatial comparators



Source: Belmana.

Appendix B - Survey Weighting

Table B1: Business Survey Weighting (weighted and unweighted)

		BDUK Population		BDUK voucher scheme survey (unweighted)		BDUK voucher scheme survey (weighted)
		Percent	Frequency	Percent	Frequency	Percent
Project Type	*Project*	52%	14,298	62%	1,042	52%
	Standard	48%	13,237	38%	639	48%
	Total	**100%**	**27,535**	**100%**	**1,681**	**100%**
Scheme Type	*GBVS*	83%	22,793	69%	1,157	83%
	RGC	17%	4,743	31%	524	17%
	Total	**100%**	**27,536**	**100%**	**1,681**	**100%**
Top-up / non-top-up	*Top-up*	2%	643	5%	91	2%
	Non-top-up	98%	26,893	94%	1,590	98%
	Total	**100%**	**27,536**	**100%**	**1,681**	**100%**
Rural vs Urban	*Rural*	31%	8,018	54%	915	31%
	Urban / non-rural	69%	18,233	45%	766	70%
	Total	**100%**	**26,251**	**100%**	**1,681**	**100%**
F20 vs Non-F20	*F20*	46%	12,748	69%	1,158	46%
	Non F20	49%	13,468	24%	407	49%
	Missing	5%	1,320	7%	116	5%
	Total	**100%**	**27,536**	**100%**	**1,681**	**100%**

Appendix C - Survey Questionnaire

Email

Good morning X

I am writing from Winning Moves on behalf of Building Digital UK (BDUK), part of the Department for Digital, Culture, Media & Sport (DCMS). We are contacting businesses who are located in premises that received a government subsidy to upgrade their broadband, through either the **Gigabit Broadband Voucher Scheme (March 2018-May 2020)** or the **Rural Gigabit Connectivity Programme (March 2019-March 2020)**

More information about the schemes can be found here https://gigabitvoucher.culture.gov.uk

Tell us what you think

The application for voucher support for your premises was in [MONTH / YEAR.] We realise that this may feel a long time ago, but your views are still important to us.

You may have applied for the voucher scheme, or your landlord may have applied on your behalf. Either way, as a beneficiary of the voucher support, we would really like to know what you think about the scheme, and how it has affected your business' use of the internet.

The findings will help us inform future service development, and ensure that other businesses are provided with the most up to date and effective support.

How to take part

To take part please click the following link: https://www.smartsurvey.co.uk/s/FO2Q6P/?m=60071016rio8v
It shouldn't take more than 10-15 minutes to complete.

Further information
Winning Moves is conducting the research on behalf of BDUK. All the information you provide will be kept confidential and stored securely in accordance with GDPR. Further details of this can be found in Winning Moves Privacy Notice at www.winningmoves.com/privacy-notice

If you have any queries, please contact us on bduk@winningmovesresearch.com.

Thanks in advance for your time, and sharing your views.

[Insert signature]

Introduction

Many thanks for accessing this brief survey about the BDUK Voucher Scheme. The survey explores your decision to upgrade your connection, the application and set up process, as well as any effects on your business.

By continuing with the survey you are agreeing to your responses being shared with Building Digital UK (BDUK), part of the Department for Digital, Culture, Media & Sport (DCMS) in an attributable format. Data may be linked to other surveys or datasets for analytical purposes and data may be published, but it will not be possible to identify any person, business or address from any published data.

For technical issues with the survey, please contact us by email on ___. If you need to change an answer to a question, use the previous button located at the bottom of each page, rather than your browser's back button.

Thank you for your time.

About your business

1. When was your business established (please provide the calendar year)?

2. How many people does your business employ?

Full-time	Part-time

3. What is your business' specific industry / sector? Please select an option from the following:

- Agriculture, forestry and fishing
- Mining, quarrying and utilities
- Manufacturing
- Construction
- Motor trades
- Wholesale
- Transport and storage
- Accommodation and food services
- Information and communication
- Finance and insurance
- Property
- Professional, scientific and technical activities
- Public administration and defence
- Education
- Health
- Arts, entertainment, recreation and other services
- Other (Please specify)

- Retail
- Business administration and support services

4. Which of the following best describes the type of premises that have benefitted from the voucher:

   - A private residence (home based business)
   - Office
   - Shop/retail premises
   - Warehouse
   - Factory or workshop
   - Other (please specify)

5. Which of the following best describes the role of the premises in your business?

   - The premises of a single site business
   - The HQ of a multi-site business
   - A branch or franchise of a multi-site business
   - Other (please specify)

6. Which of the following best describes the tenure of your premises?

   - We own the premises
   - We lease an office
   - We pay for space in a serviced premises
   - Other (please specify)

7. *[if multi-site only]* How many staff do you have at the site which has been connected using a voucher?

Full-time	Part-time

8. Which of the following best describes the location of the premises which have benefitted from a voucher?

   - A residential area
   - A town or city centre
   - A business or science park
   - An industrial estate
   - Remote, no premises nearby
   - Other (please specify)

Decision to apply for voucher/upgrade connection

9. Were you involved in the application process for the voucher support?

- Yes
- No (If no, skip to Q16 – How satisfied were you with your broadband connection before the voucher)

10. How did you hear about the voucher scheme?

- I contacted a broadband provider (enter name?)
- A broadband provider (enter name?) contacted me
- Contact from my local authority
- I contacted my landlord
- My landlord arranged the voucher for our office/building
- Through an online search or paper/telephone/online marketing
- Other (please specify)

11. What was your motivation for applying for a voucher (tick all that apply)?

- To access a reliable, uncontested line
- To access faster download / browsing speeds
- To access faster upload speeds
- To access dedicated customer service and technical support
- I was persuaded by the provider that contacted me
- No specific motivation, but given the incentives the benefits appeared worth

12. What were your wider business goals that you hoped to achieve through the new/upgraded broadband connection (tick all that apply):

- Increase business turnover
- Improved productivity/reduced costs
- Improved profitability
- Access new markets
- Adopt new sales methods
- Implement new business processes
- Develop new products/services
- Foster new/richer relationships with customers/suppliers/collaborators
- Adopt more flexible working practices (eg home working)
- Reduce energy usage
- Reduce business travel
- No specific business goals
- Other (please specify)

13. Why had you not upgraded broadband connection previously?

- It was too expensive
- It wasn't available where we are located
- We wouldn't have known what to do with it
- We weren't aware of the benefits at the time
- We were happy with the connection we had at the time
- Other (please specify)

14. What would you have done about your broadband connection if the voucher had not been available? Please select the most appropriate statement from the list below

- We would have bought the same connection anyway, at the same time
- We would have bought the same connection, but at a later date
- We would have bought a connection at the same time, but one with lower performance (e.g., a lower speed/a consumer grade connection, contested line)
- We would have bought a lower performance connection at a later date
- We would have moved to new premises to get the connection speeds we require
- We would have considered a connection, but decided not to proceed
- We would not even have considered an upgrade to our connection

The Application Process

15. Please rate each of the following:

	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied	Very dissatisfied	Don't know
The ease or simplicity of the voucher process						
The length of the application process						

If you wish to make any comments, please do so here: *[Optional]*

Your Connection Now

16. How would you rate your satisfaction with your broadband service before the upgrade?

	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied	Very dissatisfied	Don't know
Reliability						

Download / browsing speeds						
Upload speeds						
Value for Money						

If you wish to make any comments about what broadband connection was like before the upgrade, please do so here: *[Optional]*

17. How would you rate your satisfaction with your broadband service after the upgrade?

	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied	Very dissatisfied	Don't know
Reliability						
Download / browsing speeds						
Upload speeds						
Value for Money						

If you wish to make any comments, about what broadband connection is like after the upgrade please do so here: *[Optional]*

18. *[if multi-site only in question 5]* How does your new/upgraded connection compare to the broadband in your business' other sites?

Much better	A little better	No different	A little worse	A lot worse	Don't know

If you wish to make any comments, please do so here: *[Optional]*

How your business' use of the internet has changed

19. Are you now doing any of the following for the first time, more often, more easily or more effectively?

	For the first time?	More often?	More easily?	More effectively?	No – we are not currently doing this
Rich media websites *e.g. embedding videos & interactive customer tools.*					
Supply-chain / customer management tools *e.g., real time tracking and communications*					
Cloud storage and file sharing					
Video conferencing / VoIP					
High volume file/data transfer and download					
Advanced digital product/service design and collaborative design tools					
Running advanced/interactive software *E.g., to assess big data inputs*					
Remote operations *E.g. operating machinery from a separate site*					
HR e.g. resource management tools					
Staff training online					
Digital banking					
Accounting services					
Other (please specify)					

20. *[If answered yes (i.e., 'for the first time', 'more often', 'more easily', 'more effectively')]* How important was your new connection in achieving this?

	Very important	Important	Neither important of unimportant	Unimportant	Very unimportant
Rich media websites *e.g. embedding videos & interactive customer tools.*					
Supply-chain / customer management tools *e.g., real time tracking and communications*					
Cloud storage and file sharing					
Video conferencing / VoIP					

High volume file/data transfer and download
Advanced digital product/service design and collaborative design tools
Running advanced/interactive software *E.g., to assess big data inputs*
Remote operations *E.g. operating machinery from a separate site*
HR e.g. resource management tools
Staff training online
Digital banking
Accounting services
Other (please specify)

21. *[If answered no (i.e. 'have not implemented')]* Are you planning to adopt any of these applications to make greater use of your connectivity in the future? (Respondents will only see those answers they said they are not doing currently)

	We are planning to adopt	We are not planning to adopt
Rich media websites *e.g. embedding videos & interactive customer tools.*		
Supply-chain / customer management tools *e.g., real time tracking and communications*		
Cloud storage and file sharing		
Video conferencing / VoIP		
High volume file/data transfer and download		
Advanced digital product/service design and collaborative design tools		
Running advanced/interactive software *E.g., to assess big data inputs*		
Remote operations E.g. operating machinery from a separate site		
HR e.g. resource management tools		
Staff training online		
Digital banking		
Accounting services		
Other (please specify)		

22. Did you receive any help, training or support to use or make the most of your enhanced connectivity? (Yes/No)

    [If yes] what type of organisation provided this support:

    - Bank

- Internet Service Provider
- Chamber of Commerce
- Publicly funded business support
- Consultants
- Education institution (FE college or university)
- Independent training provider
- Other (please specify)

What is the effect on your business?

23. Which of the following has your business been able to do as a result of getting your new/upgraded connection? (tick all that apply)

- Enter new markets
- Adopt new sales methods and channels
- Foster new/richer relationships with customers/suppliers
- Foster new/richer relationships with collaborators
- Develop new products/services
- Implement new business processes
- Adopt more flexible working practices for staff (e.g. homeworking)
- Outsource functions or activities to other sites or locations
- Recruit more widely and/or diversify your workforce
- Reduce business travel
- Reduce energy use/waste
- None of the above/too early to say

24. And as a result, has there been any measurable changes in any of the following metrics for your business? What has the effect been?

	Major increase	Minor increase	No effect	Minor decrease	Major decrease	Don't know
Sales turnover						
Productivity						
Profitability						
Number of Employees						

25. Has the new/upgraded connection had any of the following effects for you/your staff? If so, how significant has the effect been?

	Major effect	Minor effect	No effect
Improved digital literacy			
Better training for staff that you could not do previously			
Reduced frustration with digital technology, applications or processes			
Greater confidence in using digital technology or applications			
Greater confidence to innovate in service/product development			

26. Have you experienced any of the following challenges as a result of your improved connectivity? (Please tick all that apply):

- It has taken staff time out of the business
- Our staff don't have sufficient skills to make the most of the improved connectivity
- The connection hasn't been reliable / we have experienced outages
- It is costing us more / it is more expensive
- Internet security issues
- Other (please specify)

COVID-19 pandemic

27. How would you describe the impact of the COVID-19 pandemic on your business?

- Major positive effect
- Minor positive effect
- No discernible effect
- Minor negative effect
- Major negative effect
- Not relevant (e.g., only received the new broadband connection at a late stage)

28. Where there has been a positive or negative effect, please provide brief details below:

29. Would you say that your new/upgraded broadband connection contributed to your ability to adapt and continue to do business during the pandemic?
    - Major positive effect
    - Minor positive effect
    - No discernible effect
    - Minor negative effect
    - Major negative effect
    - Not relevant (e.g., only received the new broadband connection at a late stage)

30. If 'major positive effect'/ 'minor positive effect', what were the main ways in which the broadband connection helped your business to adapt:
    - Enabled staff to work from home
    - Allowed you to do business meetings online
    - Allowed you to change the way you sell goods/services (e.g., online sales)
    - Other (please specify)

31. If 'major negative effect'/ 'minor negative effect'. Please provide brief details below

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Callback Permission

That is all the questions we wanted to ask.

32. Would you be happy for us to contact you by telephone if we need to review your answers? This may help us to develop a more accurate understanding of the impact of the voucher scheme.
    - Yes
    - No

Thank you

Thank you for your time.

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