dot·econ

Deployment of FTTP in rural Northern Ireland

A DotEcon report for NI Networks, part of BT

22 May 2018

DotEcon Ltd
17 Welbeck Street
London W1G 9XJ
www.dotecon.com

Contents

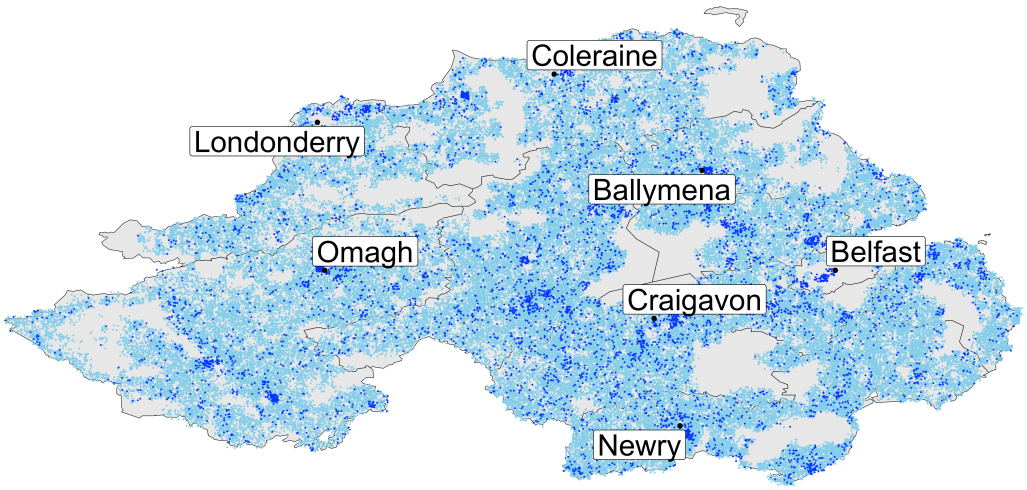
Tables & Figures

Executive Summary

This report estimates the benefits for the Northern Irish economy from extending ultrafast broadband. BT is supportive of the proposed investment, outlined under the DUP and Conservative Confidence & Supply Arrangement, which will see £150m of public funds allocated to a public procurement. For this reason, we have been commissioned by NI Networks, part of BT, to provide an independent assessment of the potential economic and wider social and environmental benefits that might result.

Roll-out plans

BT's roll out plans for the investment (shown below) would see approximately 140,000 additional households and business premises provided with ultrafast broadband with download speeds of at least 30 Mb/s. The roll-out is phased but would be largely complete by 2021. We estimate that roughly 6,900 business premises would benefit. Given the rural focus, we can expect these to mainly be small and micro businesses, plus some agriculture.

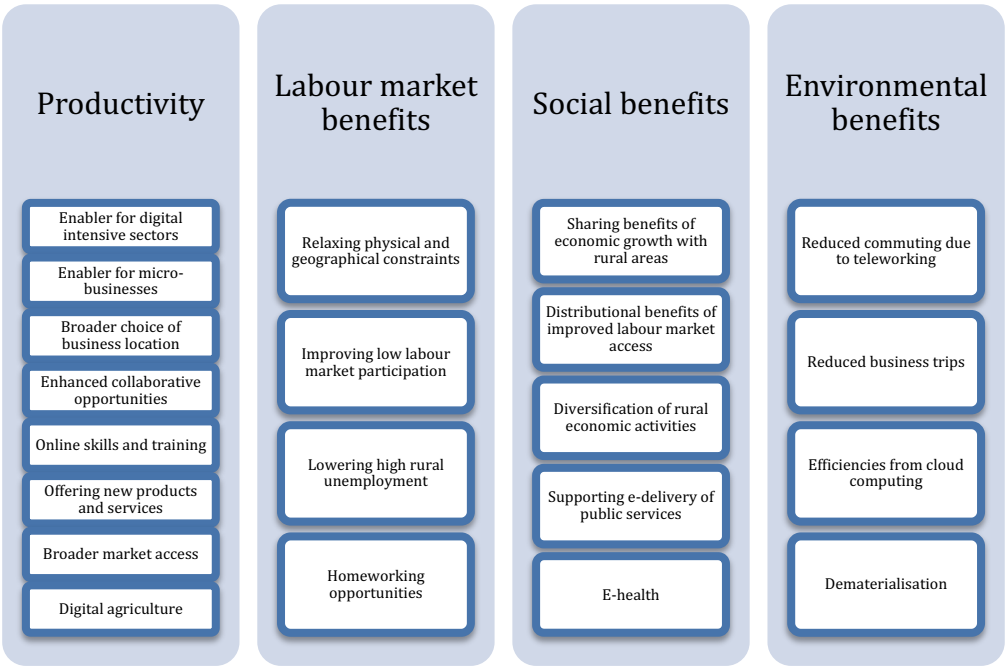


Categorising benefits

The key benefits of ultrafast broadband fall into four categories:

- increases in productivity;
- improvement in labour market participation and employment levels; and
- social benefits, including distributional benefits and greater digital inclusion; and
- environmental benefits.

The main generators of these benefits are summarised in the figure below. Productivity benefits arise when there is an increase in the value of the output produced per hour of work. Such increases can arise from more effective working, time savings, introduction of new products and services, skilling sharing and greater collaborative opportunities and greater market access. Labour market benefits arise both from improved employment opportunities and greater participation in the labour market.



Rural areas are disadvantaged in broadband provision

There are good reasons to expect an intervention raising rural broadband speeds to be particularly effective in Northern Ireland, where geo-demographics and planning regulations provide unique challenges in broadband provision to rural areas. Rural areas in Northern Ireland are relatively disadvantaged in terms of the availability of high-speed broadband both relative to urban areas in Northern Ireland and relative to other rural areas in the UK.

Benefits through enhanced productivity and employment

The proposed fibre investment will help to realise several of the goals set out in the DfE's Industrial Strategy, which include reducing economic inactivity, improving collaboration within Northern Ireland, increasing global competitiveness and supporting digital-intensive sectors. At present, Northern Ireland's economy – and particularly its rural areas – struggles with low productivity, high economic inactivity and high unemployment. Faster and more reliable broadband could play a significant role in helping to address these issues by allowing businesses to work more efficiently, encouraging business relocation and opening up labour market opportunities through remote working.

Environmental and social benefits

High-speed broadband can lead to carbon abatement through teleworking, dematerialisation, eCommerce and use of cloud computing. Better broadband will also facilitate digital inclusion, improving individuals' ability to access public services, such as online Universal Credit applications and e-health.

Using previous evaluations of intervention to forecast benefits

A number of studies have evaluated the impact of previous interventions to improve broadband in the UK, finding significant benefits. In our approach, we focus on a small selection of studies that we consider relevant to the Northern Irish setting. We seek to reapply their findings, taking into account local circumstances. These studies are:

- *The UK Broadband Impact Study*
- *The Broadband Voucher Scheme Impact and Benefits Study*
- *The Superfast Cornwall Final Evaluation Report*

We draw on experiences from previous broadband interventions in the UK, especially in Cornwall, to illustrate the impact channels through which ultrafast broadband might benefit firms, households and the economy as a whole. High-speed broadband should improve the productivity of firms' existing operations. Reviews of Superfast Broadband in Cornwall show that access to high-speed broadband also enables businesses to offer new services, such as opening online shops or using Wi-Fi in the hospitality industry. It may also affect business location decisions. Increased options for teleworking may increase labour participation, improve productivity and bring environmental benefits.

Estimating benefits

To estimate benefits, we have largely reapplied the methodology used in previous *ex post* assessments of broadband interventions. However, we have made certain changes where this leads to more robust results, where there are data limitations or to bring the delineation of benefits into alignment with our four categories. Throughout we have sought to make conservative assumptions.

Benefits are considered over a 15-year horizon and discounted according to HM Treasury Green Book assumptions. A conservative rate of underlying productivity growth across Northern Ireland (1% per annum) is assumed.

Our preferred, central estimate of benefits is based on using:

- the UK Broadband Impact Study to estimate productivity growth;
- the Superfast Cornwall evaluation to estimate employment growth; and
- the methodology of UK Broadband Impact Study combined with own our regression model to estimate increased teleworking.

Around £8 of benefit for every £1 spent

On this basis, total benefits to the NI economy until 2033 are estimated to be £1.2 billion for a subsidy cost of around £150m.

This implies that every £1 of subsidy could create £7.90 of economic benefit.

To assess the robustness of this conclusion, estimated ranges for benefits using different methodologies are summarised below.

Benefit category	Absolute benefit	Benefit multiple (relative to cost)
Productivity growth	£50m - £410m	0.3 - 2.7
Employment benefits	£290m – £890m	1.9 - 5.9
Teleworking	£40m	0.3

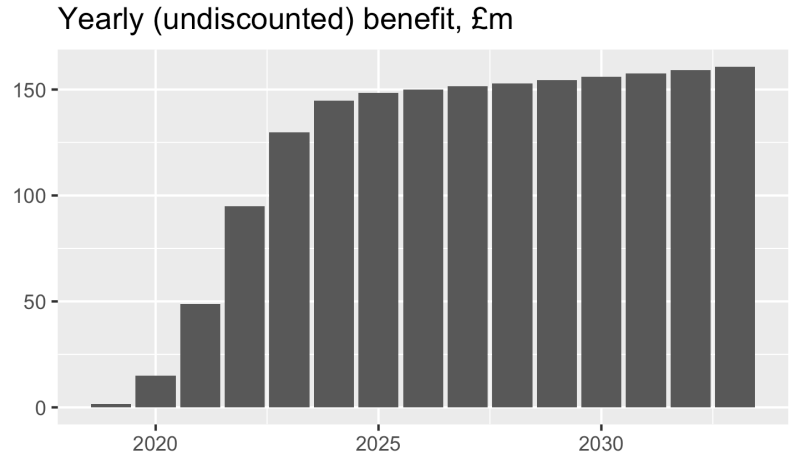
Total benefits are anticipated to be in range of **£380 million** to **£1.33 billion** as compared with a subsidy cost of around £150m. This implies that every £1 of subsidy could create between £2.50 and £8.90 of economic benefit to the Northern Irish economy.

Additional environmental benefits

In addition, we find that, as a lower bound, the investment will lead to at least 230,000 $tC0_2e$ of carbon abatement over the 15-year period.

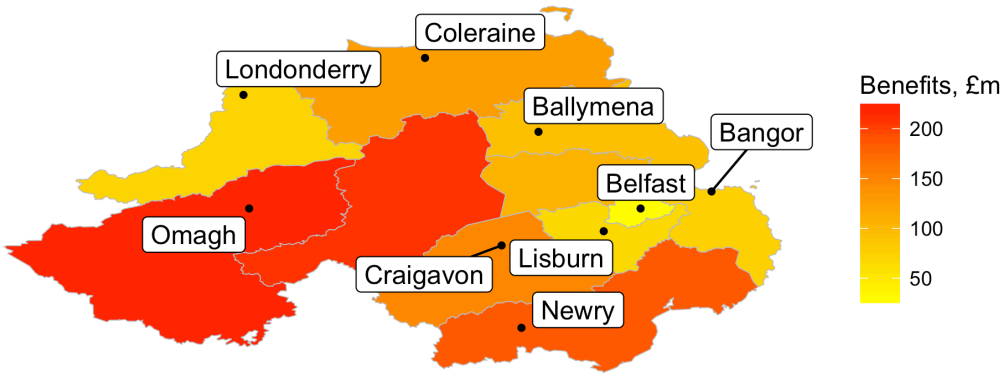
Stable benefit flow achieved by around 2025

The time profile of benefits until 2033 for the central case is shown below. The phasing of benefits arises from our assumptions about roll-out and take-up. By 2024, the annual (undiscounted) benefit is about £150m per annum, with subsequent increases being driven by general economic growth.



Benefits accrue mainly where productivity is currently low

The regional breakdown of the benefits, split by eleven Local Government Districts, is illustrated below.



The largest benefits accrue in Fermanagh and Omagh, and Mid-Ulster districts, where the roll-out plans are focussed. The intervention is thus directed towards the western part of the country, where output per head is currently about half that of Belfast.

1 Introduction

1.1 Terms of reference

BT is supportive of the proposed investment in ultrafast broadband, outlined under the DUP and Conservative Confidence & Supply Arrangement, which will see £150m of public funds allocated to a public procurement. This would extend the availability of ultrafast broadband with at least 30Mb/s download speed to about 140,000 additional households and business premises in rural areas of Northern Ireland.

DotEcon has been commissioned by NI Networks, part of BT, to make an independent economic appraisal of the net benefits that arise from this intervention. This includes estimating the Gross Value Added (GVA) created against the counterfactual of no extra public funding. We also identify potential additional social and environmental benefits.

1.2 Overview of our approach

Speeds in the order of 100Mb/s enabled

The characteristics of the new services enabled by this investment will depend on how communications providers make use of the infrastructure operator's new optical fibre in these areas. The speeds on offer to customers will depend primarily on choices those providers make about their backhaul capacity, rather than any limitation arising from the fibre. We expect speeds in the order of 100Mb/s to be offered, with future upgrade paths to higher speeds being enabled.

NI's particular circumstances enhance potential benefits

Northern Ireland's geo-demographics and planning regulations have led to unique challenges in broadband provision[1] due to the population outside urban areas being less clustered into villages and groups of houses than the UK Mainland and most other EU Member States. However, this also creates opportunities for the intervention to enable new business activity, especially amongst micro-businesses, in the intervention area.

Our approach relies on quantifying the benefits of high-speed broadband by considering how benefits may manifest themselves

[1] Despite a high proportion of VDSL (FTTC) penetration, the proportion of premises with sub-24Mb download speeds is one of the highest in any UK region. This is attributable to the particular difficulty associated with provision in rural Northern Ireland where planning regulations have led to 'a house in every field' (see Connected Nations 2015 - Northern Ireland report, Ofcom).

to businesses and individuals and estimating the benefits under a number of mutually exclusive headings.

Productivity improvements, new services, business formation and increased labour force participation

We can group impacts into four categories, which we quantify separately:

- Increased productivity;
- Increased teleworking;
- Increased employment levels; and
- External benefits, such as environmental benefits.

Our estimates are largely obtained by reapplying estimates of impacts estimated from previous interventions and adjusting them for Northern Ireland's specific circumstances. We focus on three studies that provide *ex post* reviews of interventions:

- the *UK Broadband Impact Study*;
- the *Broadband Connection Voucher Scheme Impact and Benefits Study*; and
- the *Superfast Cornwall Final Evaluation Report*.

The Cornwall study in particular is very relevant to our analysis, as it involves an intervention in a largely rural area.

We have also undertaken some analysis directly from Ofcom and ONS data to estimate the impact of broadband speeds on the propensity to telework.

1.3 Structure of this report

The report is organised in the following way:

- Section 2 provides a brief review of previous evaluations of high-speed broadband provision;
- Section 3 considers the Northern Irish context, and what features of the economic, geographic and social landscape may imply for the magnitude of benefits. We also discuss how a fibre network investment might help achieve the goals set out in the Department for the Economy (DfE)'s Industrial Strategy;
- Section 4 provides an overview of the likely impact channels by which broadband availability may generate benefits;
- Section 5 gives the quantitative benefit assessment itself;
- Section 6 concludes.

2 Previous studies

This section discusses previous studies on the economic impact of interventions to increase broadband availability. We focus primarily on interventions that have occurred in the UK. The relevant studies are given in Table 1 below.

Table 1: Relevant impact studies of broadband availability interventions

Study	Date	Geographical area	Author / sponsor	Methodology
UK Broadband Impact Study	Nov 2013	UK	SQW for DCMS	Cross-sectional study of BB speed on macroeconomic variables
Broadband Connection Voucher Scheme Impact and Benefits Study	Aug 2017	UK	DCMS	Impact study of intervention based on surveys
Superfast Cornwall Final Evaluation Report	June 2015	Cornwall	SERIO and Buckman Associates	Quantitative and qualitative review of the benefits of SFBB in Cornwall, primarily based on surveys.
SME Benefits and Business Opportunities with Superfast Broadband: the Virtuous Circle of Connectivity	Sep 2013	Cornwall	Lacohée and Phippen for Superfast Cornwall project and BT TSO	Primarily qualitative study on impact of Superfast Broadband on business processes.
Delivering Britain's Digital Future	Sept 2015	UK	KPMG	High-level assessment of growth rate impact

To quantify benefits, we focus on the *UK Broadband Impact Study*, the *Broadband Connection Voucher Scheme Impact and Benefits Study*, and the *Superfast Cornwall Final Evaluation report*. Lacohée and Phippen provide a number of interesting case studies showing how superfast broadband has helped businesses in Cornwall, which help in understanding the likely impact channels. The KPMG paper relies primarily on an estimate of the long-run impact of broadband

speed on productivity; this is derived from an earlier academic paper[2], which is also used in the SQW study for DCMS.

We provide brief summaries of the three key studies' focus and methodology below.

2.1 The UK Broadband Impact Study

The UK Broadband Impact Study was published in 2013 by a consortium led by the consultancy SQW. It tries to measure the benefits to the UK economy from the overall increase in fixed broadband speeds in the UK since 2008. The authors separate out the increases attributable to public interventions, of which there have been several in the relevant period.

Productivity gains are by far the most important benefit

The study relies on a top-down approach. It uses macroeconomic data and territorial aggregates to construct models of productivity, propensity to telework and employment in relation to broadband speed in territorial categories grouped into 10 deciles by density of premises. SQW find that productivity gains are the largest contributor to overall benefits (over 80% of the benefits attributable to the intervention). A critical assumption of the study is the estimate of the elasticity of productivity with respect to broadband speed.

Relevance to Northern Ireland

In contrast to survey-based review, this study relies on analysis of various data sets relating broadband speed, economic outcomes and various controlling factors. The responses of businesses and workers to increased broadband speeds are modelled separately for areas with different population densities. This is helpful, as it provides a ready way to correct for Northern Ireland being more rural than England and Wales.

The key parameter for estimation of productivity effects is the elasticity of productivity with respect to broadband speed. This has been estimated using data from all OECD countries and, therefore, should be broadly representative of Northern Ireland.

2.2 The broadband voucher scheme

The Connection Voucher Scheme, which ran from March 2014 to March 2016, provided thousands of small firms with subsidies that they could use to improve the Internet connection. 54,000 firms had their grants approved and the 42,500 of them who utilised the grants found their new connections to be 18 times faster on average.

[2] Rohman, I. and Bohlin, E., 2012. Does broadband speed really matter for driving economic growth. Investigating OECD countries.

Evidence of employment increases

The Voucher Scheme Study provides a simple survey-based framework to quantify the effect of the scheme. It concludes that it delivered £8 of benefit for every £1 invested through increased profit and increased employment (with the latter being significantly more important). Despite analysing a demand-side intervention (i.e. vouchers) rather than a supply-side intervention (i.e. an infrastructure subsidy), the scheme helped small businesses with unsatisfied connection needs and is therefore relevant to our analysis.

Relevance to Northern Ireland

The profile of the businesses connected by the Voucher Scheme is broadly similar to the businesses that will be offered new connections in Northern Ireland, as these are also likely to be SMEs with below-average speeds due to their relatively remote locations.

2.3 Superfast broadband in Cornwall

The Next Generation Broadband Infrastructure project, otherwise known as 'Superfast Cornwall', was developed in 2011 with the intention to provide fibre-based broadband to 80% of premises in Cornwall, but a promising start meant that this was soon extended to 95% coverage by March 2015. The project was jointly funded, at a total cost of £132 million, by BT investment and the European Regional Development Fund (ERDF).

The evaluation, conducted by SERIO and Buckman Associates for BT, attempts to understand the benefits of superfast broadband (SFBB) both in qualitative and quantitative terms, making extensive use of surveys. These compare the behaviour and performance of connected businesses and households to their non-connected counterparts, as well as more high-level counterfactual comparisons of Cornwall with regions that did not receive funding for superfast broadband deployment.

More efficient working, increased employment and digital inclusion

The study reports how the SFBB has impacted businesses' operations by allowing them to work more efficiently and to offer new services. It also discusses cross-cutting themes such as how the programme has improved digital inclusion, and the strategic added value of the programme. Although these benefits are found to be potentially very large, the paper does attempt to quantify them directly. The primary quantitative focus is on benefits achieved through growth in full-term employment (FTE) in terms of gross value added (GVA).

Employment and turnover of connected businesses is compared with non-connected businesses. The authors found that SFBB brought a net additional GVA of £91.8m to the Cornish region by June 2015 and forecast that the benefits were likely to reach £124m by June 2016.

Relevance to Northern Ireland

The Cornish survey respondents (as opposed to Cornish companies in general) are fairly similar to Northern Irish companies. The key difference is that agriculture is more strongly represented in Northern Ireland, and that there are a larger number of microbusinesses in Northern Ireland than in Cornwall.

The sectors likely to benefit most from fast broadband (such as information & technology, professional, scientific & technical activities, financial & insurance activities and education) are less prevalent in Northern Ireland than in Cornwall (with the exception of information & technology, although this could be attributed to the different time periods). Therefore, it is possible that benefits could be somewhat smaller in Northern Ireland than might be suggested by the Cornish study. However, surveys also find that relatively less productive businesses in Cornwall attributed their increased employment to SFBB; given relatively low productivity in Northern Ireland, this suggests the impact of broadband might be enhanced. Therefore, the overall picture is not clear enough to warrant any systematic adjustment for the different sectoral composition of the Cornish and Northern Irish economies.

If we compare Cornwall in 2011 to Northern Ireland today, they are fairly similar in macroeconomic terms. In both cases, there is scope to reduce economic inactivity through measures that increase labour market participation (e.g. flexible working). There are also similar, relatively high levels of unemployment that suggest that there is capacity to meet any increases in labour demand.

Business births and deaths, business density and self-employment are relevant for considering the entrepreneurial landscape of NI. Self-employment is higher in Northern Ireland than Cornwall, although not substantially so. Rates of business births and deaths are relatively similar, with the implication that the identification of 'safeguarded jobs' in the Cornish study should be broadly applicable in Northern Ireland.

2.4 Other relevant macroeconomic studies

General growth and productivity effects

Productivity impact of general ICT investments

The broader macroeconomic literature on the growth effects of IT and computerisation also demonstrate the potential for significant productivity gains. Cardona *et al*[3] comprehensively review different empirical methods from measuring the effect of ICT investments (in general, rather than for broadband specifically). They find a general consensus that ICT investment leads to productivity growth, with

[3] Cardona, M., Kretschmer, T. and Strobel, T., 2013. ICT and productivity: conclusions from the empirical literature. *Information Economics and Policy*, *25*(3), pp.109-125.

the mean output elasticity of ICT investments between 0.05 and 0.06; that is, a 10% increase in ICT investments increases output by 0.5-0.6%.

Significant growth impacts of broadband investments

The impact of broadband investment on productivity, and other economic indicators, is generally found to be positive. Czernich *et al*[4], using data from 1996-2007, find that a 10% increase in broadband penetration increases annual growth of GDP per capita by 0.09-0.15%. Qiang *et al*[5] find that the same level of increase led to a1% increase in growth of GDP per capita. There has also been debate about classifying broadband as a General Purpose Technology, which is considered to have the potential to affect not only subsets of the economy but the entire system, including businesses across all sectors and households.

Regional impacts

Evidence that broadband affects business location decisions

Studies have found that broadband investments can affect both productivity and the location of economic activity at a sub-national level. McCoy *et al*[6] find that the location of business establishments in Ireland is positively correlated with broadband infrastructure, but that pre-existing levels of human capital impact the magnitude of these effects.

Reduction in regional inequality

There has also been some research into the regional impact of superfast broadband. For example, Jung's 2014[7] analysis of broadband in Brazil found that that broadband yielded higher productivity gains in less developed regions, and that higher speeds and network externalities play an important role. Mack and Faggian[8] also conclude that positive impacts are only found if accompanied with high skill levels. Several studies have found that broadband has a greater economic impact in low-income countries. Whilst these are not necessarily directly comparable situations to Northern Ireland, they illustrate the potential for broadband improvements to reduce regional inequalities.

[4] Czernich, N., Falck, O., Kretschmer, T. and Woessmann, L., 2011. Broadband infrastructure and economic growth. The Economic Journal, 121(552), pp.505-532.

[5] Qiang, C.Z.W., Rossotto, C.M. and Kimura, K., 2009. Economic impacts of broadband. Information and communications for development 2009: Extending reach and increasing impact, 3, pp.35-50.

[6] McCoy, D., Lyons, S., Morgenroth, E., Palcic, D. and Allen, L., 2017. The impact of broadband and other infrastructure on the location of new business establishments. Journal of Regional Science.

[7] Jung, J., 2014. Regional inequalities in the impact of broadband on productivity: Evidence from Brazil.

[8] Mack, E. and Faggian, A., 2013. Productivity and broadband: The human factor. International Regional Science Review, 36(3), pp.392-423.

Estimates of the impact of high speed broadband

Table 2 below gives a summary of some recent estimates of the impact that high-speed broadband has on various economic indicators. Many studies rely on old data and are often based on experiences in the US or developing countries, which may differ substantially in economic and social terms. Therefore, we have tried to restrict attention to relatively recent estimates in countries that should be broadly comparable to Northern Ireland.

Table 2: Relevant studies

Study	Date	Geographical area	Author/ sponsor	Findings
Superfast Broadband - Boosting Business and the UK Economy	March 2012	UK	Regeneris for BT Group	SFBB implies an annual increase in GVA of 0.3% pa over 15 years for rural areas, 0.5% for UK towns and 0.4% for UK cities.
The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of US Data	July 2007	USA	Robert Crandall, William Lehr, Robert Litan	Every one percentage point increase in broadband penetration in a state is projected to increase employment by 0.2-0.3% a year.
Economic Impact of Broadband: An Empirical Study	Feb 2009	14 European countries, the USA	LECG Ltd. for Nokia Siemens Networks	One additional broadband line per 100 inhabitants increases productivity by 0.1% in "medium or high ICT countries"
Early effects of FTTH/FTTx on employment and population evolution	2012	Sweden	Forzati, Mattsson and Aal-E-Raza	Weak correlation that suggests a 10% increase in FTTH/B coverage increases employment between 0 and 0.2 percent
Economic value of the take-up of ultra-fast broadband in New Zealand	July 2016	New Zealand	Murray, Davies, Blick and Ryan (Sapere Research Group)	An additional 10% of employees gaining access to UFBB is associated with a 29% increase in firm-level labour productivity, and an overall 1.62% increase in GDP.

3 Northern Irish context

This section highlights how the Northern Irish economy and geo-demographics vary from the rest of the UK. We show that there are good reasons to expect the benefits of broadband improvements to be particularly large for Northern Ireland.

3.1 Population distribution

The default definition of urban and rural areas for statistical purposes differ between Northern Ireland and other areas of the UK.[9] In Northern Ireland, urban areas are largely defined as groupings of at least 5,000 people, whereas for England and Wales a cut-off of 10,000 people is usually used.

Northern Ireland's population is much more rural than the rest of the UK

The NISRA classification scheme estimates that approximately 35% of the Northern Irish population lives in rural areas, which make up about 46.4% of the land area. In comparison, under the ONS system of rural/urban classification, only 17% of the English population is considered to live in rural areas[10], despite the broader definition of what constitutes a rural area. If the ONS default rule of 'population greater than 10,000' were applied to settlements in Northern Ireland to define urban areas, then approximately 51% of the population would considered to live in rural areas.

3.2 Broadband and the urban/rural divide

'A house in every field'

Rural areas in Northern Ireland differ from their counterparts in the rest of the UK in that where homes in the UK are often arranged in

[9] The official classification of a 'rural' community in Northern Ireland is largely defined by the 2015 Review of the Statistical Classification and Delineation of Settlements, which groups settlements into eight bands, A-H, based on population size. The most straightforward classification of settlements into either rural or urban categories is whether their population is of at least 5,000 people. The previous 2005 terminology of defining rural areas as either 'accessible' or 'remote' is replaced with a simple statement of 'within 20 minute (or 30 minute) drive' of these town centres.

The systems used to distinguish urban and rural systems for other regions in the United Kingdom differ substantially: for example, the threshold for the urban/rural split in England and Wales is a population of 10,000 and there are a further four sub-categories for urban and six sub-categories for rural settings, depending on factors such as sparse setting, conurbation and isolation. This difference implies that rural settlements in England and Wales are likely to be larger those in Northern Ireland.

[10] https://www.gov.uk/government/publications/rural-population-and-migration/rural-population-201415

'clusters' of housing, dwellings in Northern Ireland are often isolated from other homes. This feature, sometimes described as 'a house in every field', poses a challenge for the delivery of broadband.

Deploying FTTC to isolated homes may be challenging

High-speed broadband provision is often achieved by deploying 'fibre to the cabinet', FTTC. Data is sent over fibre to a cabinet located ideally near the centre of a cluster of households. Provision to individual homes is then achieved through the use of copper wires, which can be kept short to avoid degradation of service.

The proliferation of isolated single dwellings in the rural areas of Northern Ireland raise the costs of deploying broadband to all premises. It also implies that, because the length of copper drops from the cabinet to an individual home must be substantially longer, broadband speeds are markedly lower for these homes.

Large speed disparities in Northern Ireland

These factors have led to significant disparity in availability of high broadband speeds between rural and urban Northern Ireland, with the percentage of premises unable to achieve 2Mb/s speeds varying from 0% in Belfast, to 12% in Fermanagh and Omagh[11]. Furthermore, rural areas in Northern Ireland are also relatively disadvantaged in comparison to other rural areas in the UK, as demonstrated in Figure 1 below**,** taken from Ofcom's 2017 'Connected Nations – Northern Ireland' report.

Figure 1: UK rural/urban broadband connectivity differences

Figure 3 : Premises unable to receive a download speed greater than 10Mbit/s

	Total	Urban	Rural
UK	3% (↓1pp)	1%	17%
England	3% (↓1pp)	1%	15%
Northern Ireland	7% (↓1pp)	1%	23%
Scotland	5% (↓2pp)	1%	26%
Wales	5% (↓4pp)	1%	19%

Source: Ofcom analysis of operator data

Source: Ofcom Connected Nations Report 2017 – Northern Ireland

[11] https://www.ofcom.org.uk/__data/assets/pdf_file/0021/108813/ni-connected-nations-2017.pdf

(footnote continued)

Disparity of speeds for SMEs

Inequality in access is even greater for SMEs than for households. Although superfast broadband coverage for SMEs in urban parts of Northern Ireland is jointly highest in the UK at 92%, coverage for rural Northern Irish SMEs is second lowest at 47%[12]. This has the potential to put rural entrepreneurs at a competitive disadvantage relative to their urban counterparts and may even be an impediment to starting a business altogether.

Social benefits

There are also social aspects to this rural urban split; rural dwellings tend to be more geographically isolated, and so are more susceptible to social exclusion. Therefore, rural areas stand to benefit more from improvements to telecommunications infrastructure in terms of social inclusion and community involvement, which in turn may have associated economic benefits if labour market participation improves (for example, through home working possibilities).

The 2017 Northern Ireland Multiple Deprivation Measures report found that 95 of the 100 areas considered most deprived of service access were rural; tasks such as visiting a doctor or shopping become more difficult and time consuming when there are less services in near proximity, and online alternatives to access could alleviate these disparities substantially.

3.3 Labour market conditions

High rates of economic inactivity in Northern Ireland

The most recent labour market data[13] shows that the seasonally adjusted employment rate in Northern Ireland was 69% (between September and November 2017), and 75.3% for the entire UK. However, the percentage of individuals considered 'unemployed' is also lower in Northern Ireland (3.8%) than in the whole of the UK (4.3%). This can be explained by differences in economic inactivity, as defined by the percentage of population who are neither employed nor looking for a job. Northern Ireland's economic inactivity rate of 28.2% is the highest in the UK, and significantly above the next highest region, the North East of England, at 23.7%. The UK average is 21.2%. These large inactivity figures are historically typical of Northern Ireland and are considered a top priority for improving the competitiveness and performance of the Northern Irish economy.

[12] Ofcom, Connected Nations Report 2017. This notes that SFBB coverage for SMEs in rural areas is lowest in Scotland, at 45%.

[13] Northern Ireland Statistics and Research Agency, 2017, 'Percentage of total employed (16-64) by industry and NUTSIII area, 2016', nisra.gov.uk.

(footnote continued)

Potential for reducing economic inactivity

As nearly 20% of the economically inactive population in Northern Ireland stated that they would like a job[14], there appears to be considerable room for expansion in employment. Improvements to digital connectivity allow for greater flexibility in working and open up labour markets by relaxing physical and geographic constraints. Individuals whose mobility is restricted, for example because of disability, illness or carer obligations, may particularly benefit. Improvements in productivity or the creation of new businesses due to increased broadband speeds could also lead to more jobs in rural areas.

Youth unemployment is a particular problem in NI

A large proportion of unemployment in Northern Ireland is long-term, with 45.2% of unemployed individuals having had that status for at least 1 year in May 2017, compared to the 25.3% UK average[15]. Long-term youth unemployment is a particular problem, which at 43.3% is markedly higher than the UK average (25.7%)[16]. The most recent labour statistics found inactivity rates amongst 16-24 year olds as high as 48.1%, a marked increase from 2015 levels and the highest of any UK regions. This is relevant to the case for improving broadband, as young people are likely to possess relatively advanced digital skills and are therefore well-placed to take advantage of any increased demand for computer-based skills.

Lower employment and greater economic inactivity in rural areas more than an hour from Belfast

The labour market in Northern Ireland also features a rural-urban divide.[17] At an aggregate level, employment rates in urban areas are in fact lower than in rural areas, at 68.2% and 71.2% respectively. However, this aggregation into 'rural' and 'urban' settlements hides a number of subtleties, and a further disaggregation of the rural settlements reveals an interesting pattern.

Employment levels for rural areas that are more than an hour from Belfast are much lower than not only other rural but also urban areas at 63.1%. This pattern is replicated for economic inactivity rates, where inactivity is 5.6 percentage points higher in rural areas more than an hour from Belfast than in urban areas (and 11.5% higher than rural areas less than an hour from Belfast).

Relative importance of self-employment in NI

The most recent Labour Force Survey in Northern Ireland shows that about 15% of employed persons are self-employed, in line with the UK average. However, a recent review[18] found that self-employment levels in Northern Ireland were much more volatile than elsewhere, although the authors could not find a reason for this. A potential explanation may be that large employers are not as

[14] ONS, HI12 Regional labour market: Headline indicators for Northern Ireland, 21 February 2018

[15] PDFNISRA, May 2017, 'Labour Market Report,' nisra.gov.uk

[16] NISRA, May 2017, 'Labour Market Report,' nisra.gov.uk

[17] DAERA, 30 November 2017, Northern Ireland Labour Force Survey: Urban-Rural Statistics, daera-ni.gov.uk

[18] Eóin Murphy for the Northern Ireland Assembly, 16 January 2015, 'Self-Employment in Northern Ireland'.

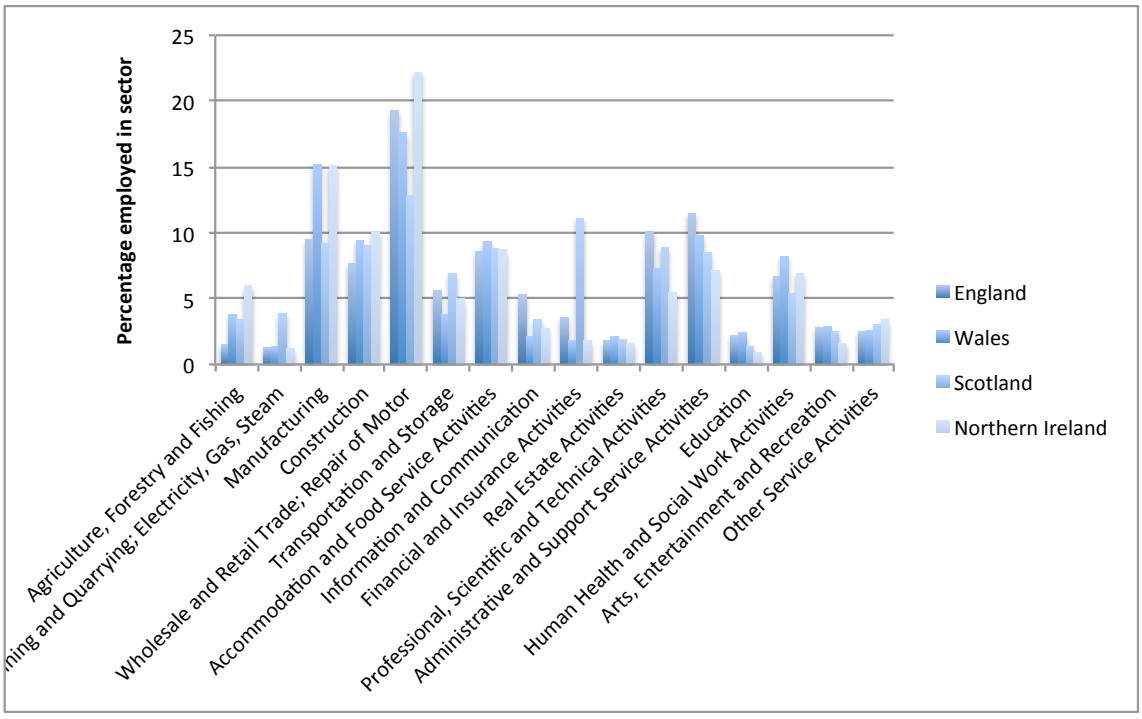
diversified in Northern Ireland, and so self-employment absorbs more of the swings in employment. The relatively large volatility implies that superfast broadband may actually have a greater effect on the number of self-employed than elsewhere in the UK if individuals have a greater propensity to start a business.

3.4 Sectoral composition of the economy

The sectoral composition of the Northern Irish economy is somewhat different to other parts of the UK. Whilst it is difficult to anticipate exactly how this might affect the overall scale of benefits from improving broadband in rural areas, there are good reasons to expect those benefits to be enhanced.

Figure 2 below shows which sectors are comparatively more important in Northern Ireland than the rest of the UK. These are primarily agriculture, fishing and forestry, and to a lesser extent wholesale and retail trade. On the other hand, the number of employees in the Professional, Scientific and Technical activities, as well as Administrative and Support Services, are particularly low.

Figure 2: Percentage employed by sector in each region



Source: ONS data

Agriculture creates need for rural broadband

The Northern Irish economic has a relatively high dependency on agriculture. Although construction is currently the largest overall employer in Northern Ireland, the agricultural sector represents a

much greater share of microbusinesses. With 69% of land devoted to agricultural purposes, this sector is of even greater importance to the rural areas of Northern Ireland than to the economy as a whole.

Digitisation and so-called 'precision agriculture' are widely expected to be important in increasing agricultural productivity and reducing the environmental impact of agricultural activities. Clearly, access to high quality, reliable connectivity in rural areas will be important to support these developments.

Trade sectors

Northern Ireland also has relative large retail and wholesale trade sectors. Again, there are likely to be benefits from digitisation in these sectors that will benefit from wider availability of high-speed broadband in rural areas, both in terms of consumers accessing e-commerce sites and through digitisation of supply chain management for businesses located in those areas.

Opportunities for expansion of skill-based sectors

Skills-based sectors form a smaller share of the Northern Irish economy as compared with the rest of the UK. However, ensuring that – regardless of location - individuals have access to suitable broadband speeds to be able to learn and develop skills, and thus accommodate technological change, is important and a key aspect of the DfE's industrial strategy.

3.5 Productivity

Productivity in NI is low in relative and absolute terms

Northern Ireland's productivity is much lower than the UK average. GVA per head is approximately £20,000, compared with the UK average of £26,000. This is in the context of productivity in the UK as a whole already ranking second to last among the G7 economies. The wider UK's growth rate from 2015 to 2016, at 1.6% in real terms, also exceeded Northern Ireland's 1.1%. A recent study by Ulster University[19] found that productivity is the most significant explanatory factor of the income gap between Northern Ireland and the rest of the UK.

There are two main components to the productivity gap between Northern Ireland and the rest of the UK. First, Northern Ireland's sectoral composition is heavily biased towards relatively low-productivity sectors, such as agriculture. High-speed broadband would allow for more rapid expansion of relatively high-productivity sectors, which usually rely heavily on digital connectivity.

[19] Ulster University Economic Policy Centre, September 2016, 'Understanding productivity in Northern Ireland'

(footnote continued)

Second, Northern Ireland is relatively less productive *within* each sector. Sectoral productivity is lower for 16 of 20 sectors, and on average lags 15% behind UK productivity.[20] In IT, the 2014 differential was 22%. Universal provision of high-speed broadband should address this gap both directly, by streamlining processes and increasing the digital skill base, and indirectly if it leads to greater competition within NI.

3.6 The importance of SMEs

SMEs and microbusinesses are relatively important

SMEs account for over 75% of private sector employment in Northern Ireland, far exceeding the UK's share of 60% and roughly comparable to Wales[21]. Microbusinesses (businesses with less than 10 employees) alone make up 89.2% of businesses by number[22], and account for 39% of employment and nearly 28% of total private turnover; by comparison, UK figures are 32.8% and 22.1% respectively. Only 2% of businesses employ over 50 people.

These very small businesses are the most likely to benefit from the introduction of ultrafast broadband, as they can operate remotely from urban centres where costs are lower and make use of flexibility to work from home. The 2017 Connected Nations Report for Northern Ireland found that only 74% of microbusinesses (excluding sole traders) had superfast broadband available to them, compared to 80% for small businesses (between 10 and 50 employees) and 81% coverage for medium businesses (between 50 and 250 employees). Although there is insufficient information to establish causal links, providing high-speed broadband to these microbusinesses could allow them to compete more effectively with larger businesses – a key goal of the 2017 Industrial Strategy.

Relatively little dynamism

Although Northern Ireland has some of the lowest business death rates in the UK, it also has amongst the lowest business birth rates. A comprehensive introduction of superfast broadband in rural areas could lower barriers to entrepreneurship as individuals would no longer need to relocate to urban centres to easily build networks or to attract talented employees. A larger number of firms should lead to more competition in the Northern Irish market and so improve the competitiveness and dynamism of the Irish economy.

[20] Ulster University Economic Policy Centre, September 2016, 'Understanding productivity in Northern Ireland'

[21] Ulster University SME Centre for Federation of Small Businesses, 'The contribution of Small Businesses to Northern Ireland'.

[22] Department for the Economy, "Economy 2030: A consultation for the Industrial Strategy of Northern Ireland", January 2017.

3.7 Industrial Strategy for Northern Ireland

DfE is consulting on an Industrial Strategy

This section provides an overview of the Department for Economy's (DfE) Industrial Strategy for Northern Ireland, and the role that increased digital connectivity and improved broadband infrastructure across Northern Ireland could have in achieving its aims. As the final version of the strategy has not yet been published, we rely on a 2017 consultation document[23] that sets out the government's central priorities and measures.

Inclusive and balance growth

The overarching aim of the strategy is to increase the global competitiveness of the Northern Irish economy to promote export-led economic growth, keeping it sustainable, inclusive and balanced at a sub-regional level. Improving economic productivity and reducing the historically high levels of economic inactivity in Northern Ireland are identified as stepping-stones to achieving these aims.

The Strategy emphasises inclusive growth, where all sections of society share the benefits. Growth should not only be measured by increases in per capita income, but also by an additional broad set of metrics in areas such as health, education, opportunity, social capital and personal freedom. Promoting digital access in rural areas will help by not only improving the economic opportunities of individuals in the historically disadvantaged rural areas, but also by addressing broader social issues surrounding digital exclusion.

Growth strategy

Based on the success stories from small yet advanced export-led economies like Singapore and Switzerland, the DfE highlights the need for Northern Ireland's economy to specialise in certain key sectors where it can develop and build on expertise and world-class capabilities.

Need for telecoms infrastructure to support the target sectors

The strategy therefore strongly focuses on export growth, particularly in view of the relatively small domestic market. Whilst it acknowledges that there is no simple universal path to success, it has identified six broad sectors of the economy in which Northern Ireland has either already developed world-class expertise or is likely to do so:

- Financial, Business and Professional Services;
- Digital and Creative Technologies;
- Advanced Manufacturing, Materials and Engineering;
- Life and Health Sciences;
- Agri-Food; and
- Construction and Materials Handling.

[23] Department for the Economy, "Economy 2030: A consultation for the Industrial Strategy of Northern Ireland", January 2017. Available at: https://www.economy-ni.gov.uk/sites/default/files/consultations/economy/industrial-strategy-ni-consultation-document.pdf

The exact strategic plans for supporting the development of these sectors is still under review; however, they will likely involve fostering collaboration between different members of the supply chains, and prioritising investment and funding to these areas. For several of the industries, such as digital and creative technologies, the need for a sound telecommunications infrastructure to ensuring competitiveness is immediate.

Emerging sectors requiring digital skills

The strategy notes the potential of emerging ICT areas such as machine learning, and data analytics. A Matrix Digital ICT foresight report published in February 2016[24] identifies four areas – software engineering, advanced networks and sensors, data analytics and cyber security – where it anticipates Northern Ireland could be 'world class'. The DfE notes the *'transformative and disruptive'* potential of digital technologies, to which Northern Ireland should be adaptable. Accordingly, the Strategy stresses the necessity of a skill base applicable to these markets, for which a comprehensive coverage of high-speed broadband will be essential in allowing individuals to develop flexible digital skills that can adapt to continuously evolving technologies.

Role of broadband in achieving growth

The DfE's proposed framework for international competitiveness and export-led growth relies on five *"interdependent and mutually supportive"* 'pillars' for growth:

- Pillar 1 – accelerating innovation and research;
- Pillar 2 – enhancing education, skills and employability;
- Pillar 3 – driving inclusive, sustainable growth;
- Pillar 4 – succeeding in global markets; and
- Pillar 5 – building the best economic infrastructure.

The first pillar builds on the DfE's ambition for Northern Ireland to gain reputation as an excellent place to grow a business, *"underpinned by innovation and creativity"*, achieved by driving cultural change, fostering an 'innovation ecosystem' and supporting research excellence. Extending broadband availability to rural areas will allow individuals and small/micro businesses, as opposed to just the largest firms and firms in physical innovation hotspots, to participate in this knowledge-based ecosystem.

The second pillar focuses on skills, education and employability – the relatively low skill levels in Northern Ireland was identified as a key historic weakness in the 2012 NI Economic Strategy. Addressing economic inactivity, particularly of young people, is considered vital to global competitiveness. Emphasis is given to the growing need for STEM skills (which undoubtedly include digital literacy), and the DfE's plans to support further education through improved flexible learning options. Extending high-speed broadband connections to rural areas may facilitate access to the popular and convenient online learning platforms.

[24] Matrix Digital ICT Report 2016, available here: http://matrixni.org/wp-content/uploads/2016/03/2016-Matrix-Digital-ICT-Report.pdf

The Industrial Strategy aims for economic growth to encompass all sections of society and regions in Northern Ireland, with labour market opportunities extending to towns and rural areas as well as cities. Pillar 3 of the Industrial Strategy sets this priority out in further detail, with emphasis placed on the value of rural development.

Inclusivity

The DfE hopes that the private sector will be a driving force for sustainable growth and plans to improve the historically low rate of business start-ups in Northern Ireland[25] by fostering an entrepreneurial environment, for example through favourable financing and regulatory schemes. The Strategy also aims to encourage young people and women to start businesses, where the ability to work from home (improved by a reliable and high-speed broadband connection) may be particularly relevant.

Need to support collaboration networks

The vast majority of businesses (89.2%) in Northern Ireland have less than nine employees, whereas only 2% of businesses employ more than 50 people. Hence the DfE plans to provide suitable environment for companies to scale their operations. For small economies, larger firms can provide critical mass, scale, specialisation and employment generation. This requires dense collaboration networks to yield a productive, competitive and innovative environment.

Agri-food, one of the largest employment sectors in Northern Ireland, is given priority status for ensuring that the skill base and infrastructure available to NI businesses is adequately equipped to allow for growth and changes in the industry. Greatly increased use of sensors, data analytics and automation in agriculture are expected. Almost by definition these developments will be of greatest relevance to the rural areas, where high-quality digital infrastructure will be necessary.

The fourth pillar is based on succeeding in global markets through trade, investment and tourism. Competitiveness and attracting foreign investment is vital for export-led growth. The DfE hopes to "*unlock the full potential"* of tourism, doubling external revenue to £1 billion by 2025. Similar objectives in Cornwall – to attract businesses and tourism – were partially fulfilled by the universal roll-out of SFBB, which promoted growth in the hospitality sector by enabling online booking services and allowing establishments to offer improved services such as WiFi.

The final pillar of the Strategy, *"building the best economic infrastructure",* cites digital (as well as physical) infrastructure as vital to ensuring a level playing field in terms of market access and the ability to establish businesses across all parts of Northern Ireland, and that any approach taken should encompass both private and public infrastructure. Part of this strategy includes plans to impose a

[25] The Industrial Strategy points out that in 2014, the business birth rate in Northern Ireland was 8.7%, compared to the overall UK average of 13.7%.

Universal Service Obligation (in partnership with the UK Government) for a broadband connection with speeds of 10 Mb/s in all of Northern Ireland and within a reasonable cost threshold by 2020.

Benefits for businesses

The deployment of ultrafast broadband in rural Northern Ireland is important to the success of these initiatives. Businesses based in rural areas will not be able to compete effectively without access to many of the services enabled by superfast broadband, such as video conferencing and cloud storage. It will also allow businesses to accept and place orders electronically and to participate in electronic supply change management.

Promoting digital skills

Northern Ireland's competitiveness will be further disadvantaged if its citizens are not able to adapt to changes in the technological landscape of their sector – a growing number of 'smart' devices and digital applications in sectors that would not have traditionally required a high level of digital literacy, including construction and agriculture, are already beginning to materialise. Access to high-speed broadband does not only enhance skills through greater access to alternative learning resources, but also enables and encourages individuals to familiarise themselves with using computers where slow speeds may have previously frustrated such efforts.

Sharing the benefits of clusters of skills and knowledge

This ability to connect with businesses and individuals across distance is essential for inclusive growth: with the availability of adequate broadband speeds, any group in Northern Ireland, no matter their location, will be able to become fully integrated members of virtual 'clusters' or collaborations. Similarly, this ability to connect means that those who would have previously been excluded from participating in certain labour markets because of their physical location now have access to greater opportunities. Providing equal access to online services is therefore fundamental to ensuring the benefits of growth are not restricted to urban centres, but rather shared with rural areas.

Overall, we can expect the benefits of improving rural broadband to be enhanced in Northern Ireland given the:

- **Low labour market participation in distant rural areas;**
- **Particular problems with low productivity in Northern Ireland;**
- **Relative importance of economic sectors such as agriculture which could particularly benefit from intervention to improve digital infrastructure in rural areas;**
- **Particular importance of small businesses (both SMEs and microbusinesses) and self-employment within NI**
- **Need to develop knowledge-based sectors that are underrepresented in the NI economy and create virtual clusters to share skills;**
- **Government's aim for inclusive growth that is shared with rural areas.**

4 Mechanisms of impact

We have distinguished **four mutually exclusive categories of benefits** from improved rural broadband. For each category of benefit, we provide examples of how benefits might be achieved and discuss what lessons can be drawn from previous studies.

4.1 Categorisations of benefits

4.1.1 Productivity growth

Productivity growth, as defined by growth in value added per hour of work in existing companies, can be affected by faster broadband in a variety of different ways. An ultrafast broadband connection can result in immediate time and cost savings on the activities that require the Internet, but also allows businesses to change their behaviour or business models in a way that improves the quality of their output or allows production to be more efficient. Results from previous studies suggest that this could be by far the single largest source of benefits.

Reduced costs

Costs for businesses may be reduced by better broadband in many ways. Fast connections may allow access to cloud computing which may provide cheaper IT capabilities, especially for small firms. Dematerialisation – such as using downloads rather than sending physical media to transfer data – may reduce costs. There may be associated savings in time and so labour costs.

Improved quality of existing services

Improved connection reliability and speed have benefits beyond pure cost savings. This is likely to be especially relevant for small businesses that take internet orders, such as bookings in the hospitality industry. Even a small percentage of failed orders (e.g. if response time is too slow) can have serious consequences in terms of lost revenue or reputation.

In addition, several respondents to the Cornwall survey from the hospitality industry were able to offer Wi-Fi to guests for the first time as a result of SFBB. In one case, a caravan site owner was able to charge for Wi-Fi services following connection, where initially they felt the connection was too poor to justify charging. As Wi-Fi provision increasingly becomes the norm rather than a bonus, keeping up with technological innovations may be important for offering a satisfactory quality of service in the hospitality sector.

The agricultural sector is becoming increasingly reliant on connectivity and data; the digital agricultural market is expected to triple from 2015 to 2021[26]. As noted earlier, a large proportion of small businesses in Northern Ireland are agriculture-based and ultrafast broadband will be essential for them to be able to compete effectively.

Ability to offer entirely new services

A high-speed connection may allow businesses to offer completely new services and create new revenue streams. For example, a Cornish computer repair business was able to offer a new service of remote log-ins to fix computers and teaching abroad[27]. A business services participant described how SFBB enabled them to develop a new 'desk top surveys' product. Online video applications like Skype could also enable professionals to host webinars or courses, expanding their business models. New services might allow business diversification.

Access to wider skillsets

Improved rural broadband should allow individuals to communicate more effectively, conveniently and with increased reliability through applications such as Skype, or because sending large files becomes easier. This means that small businesses can broaden their collaboration networks and access new skills and expertise[28]. This is particularly important for small businesses that may need to gain skills not through hiring expertise, but through training and knowledge absorption[29].

This benefit may also manifest itself through increased access to online training – for example, one individual working in education reported that they were able to use webinars much more frequently and effectively. Therefore, where travel costs may previously have been prohibitive, online learning can be used to enhance or acquire new skills.

Improved market access

With faster Internet connections, it will be easier for firms to market their products, which is essential for business growth. In the top-down approach, these effects will be still counted as productivity effects, as they increase the revenue per each hour of work – not

[26] Digitising Agriculture, PA Consulting. See: http://www.paconsulting.com/insights/digitising-agriculture/

[27] Page 52, *SME Benefits and Business Opportunities with Superfast Broadband: the Virtuous Circle of Connectivity*

[28] Page 29, *SME Benefits and Business Opportunities with Superfast Broadband: the Virtuous Circle of Connectivity*

[29] Page 31, *SME Benefits and Business Opportunities with Superfast Broadband: the Virtuous Circle of Connectivity*

through improvements in the production process itself, but rather through directing the products to the customers who are most willing to pay for them.

Faster and more reliable connection will allow for better sales opportunities. For example, this may enable small physical shops to open online shops, hospitality businesses to launch websites (e.g. restaurants taking online bookings) or allow for greater online social media presence. Although these are all theoretically possible even with slow Internet connection, the Cornish experience suggests that unreliability and slow speeds can frustrate such efforts. One example is given where a business increased sales by 60% and, as a result, invested £40,000 to develop their online facilities[30]. This is both a benefit to businesses, and to customers who have a greater availability of choice.

4.1.2 Increased teleworking

As employees use faster and more reliable connections to increase the share of work they do from home, they save time (creating either more work or more leisure) and reduce commuting costs and associated environmental externalities.

4.1.3 Increased employment

As previously noted, long-term unemployment and economic inactivity are concerning features of the Northern Irish labour market, especially in rural areas. There are several ways in which improved broadband connection coverage has the potential to increase employment levels, by affecting both demand and supply of labour.

In terms of demand for workers:

- **Business relocation –** Ultrafast broadband gives an incentive to relocate to connected areas. A clear counterargument is that there is no net benefit if businesses simply move from urban to rural areas. However, this is unlikely as rural areas have lower accommodation and labour force costs, which may attract businesses that would not be able to thrive in cities. In addition, work-related migration usually flows from rural areas to cities. Establishing favourable conditions for business in areas where employees have personal ties may incentivise those who do not currently work - as they do not wish to relocate - to do so. Therefore, this benefit should exceed any loss felt elsewhere if businesses move out.

[30] Page 55, *SME Benefits and Business Opportunities with Superfast Broadband: the Virtuous Circle of Connectivity*

- **Business start-ups –** as demonstrated by the Cornwall experience, superfast broadband has enabled some customers to start businesses that might previously not have been possible at all.
- **Growing established businesses –** if productivity gains per worker means that firms become more profitable or grow in size, this could result in the firm hiring more people. Although there is an offsetting effect to consider – that more efficient workflows lead to less employees being required – this does not seem to have an overall negative effect in practice.
- **Safeguarded jobs -** The Cornwall study defines safeguarded jobs as those '*that were at risk but are now no longer at risk of being lost*'. It found that the impact of net jobs safeguarded exceeds the net additional increase in jobs. Although one should note that Cornwall was still recovering from the recession during the time of SFBB roll-out, this will nevertheless be an important potential impact to consider for Northern Ireland.

In addition to these demand considerations, superfast broadband is also likely to have effects that will increase individuals' willingness or ability to participate in the labour force as it provides much greater flexibility, and for example:

- **Increased flexibility** makes working more attractive for those who were voluntarily not part of the labour force (e.g. stay-at-home parents or carers); and
- **Improved opportunities** for those with disabilities or other constraints that prevent them from travelling to interviews or work, or working in an office.

The 2017 Northern Ireland labour market report[31] finds that 31% of economically inactive individuals were either long-term sick or disabled, and 24% were looking after their family and home, suggesting that this effect could be significant in size.

4.1.4 External benefits

Aside from the pure economic benefits to businesses, improved rural broadband may have external effects that are not reflected in the willingness of broadband users to pay for services.

Environmental effects

There are several ways in which increased broadband speed can reduce CO_2 emissions:

- fewer commutes and business trips;

[31] See: https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/J47eb-labour-market-report-september-2017.PDF

- de-materialisation (e.g. downloads rather than physical media);
- reduced shopping trips due to e-commerce; and
- an increased use of cloud computing and storage (which is more energy efficient than in-house solutions).

Although the Cornwall report does not quantify these benefits in monetary terms, the UK Broadband Impact report finds that the value of total environmental effects was considerable.

Economic multiplier effects

Multiplier effects arise from the spending associated with the network construction – this provides revenue to businesses participating in this process. In turn revenue is spent elsewhere, creating a 'virtuous cycle'. We omit the multiplier effect from our analysis, as it is difficult to determine whether the multiplier will be greater or smaller compared to a counterfactual scenario where the money is spent on a different project.

4.1.5 Social effects and digital inclusion

Better broadband in rural areas may bring broader social benefits of digital inclusion above and beyond the economic benefits we have estimated. These include:

- Access to government services that are increasingly being provided over digital platforms;
- Broader distributional benefits from reduced economic inactivity above and beyond the direct economic benefits of job creation;
- Benefits to deep rural areas from agricultural diversification.

Online access to public services

An increasing number of government services are being made available online. In some cases, this is alongside other traditional means of accessing those services (e.g. road tax) but in other cases, online portals may be the primary means of access. In particular, this is the case for Universal Credit, which is currently being rolled with nationwide coverage expected by the start of 2019. There is a strong expectation that claimants for Universal Credit will apply online.[32]

Developments in e-health

Over time, a greater range of public services are likely to come to rely on wide broadband availability. A particular example is e-health, where there is currently considerable interest in the use of

[32] https://www.citizensadvice.org.uk/benefits/universal-credit/apply/apply-for-universal-credit/

(footnote continued)

online consultations, which require sufficiently capable internet connections.[33] Online GP appointment booking and repeat prescription systems are already being promoted by the NI Department of Health as part of its current strategy.[34] This strategy also emphasises the use of online support and care services (such as advice portals) and online medical tracking. These developments are likely to be particularly useful for those living in rural areas where travel times to GP surgeries or clinics are longer.

Distributional aspects of job creation

As we have already discussed in depth, Northern Ireland has particular problems with labour force participation, especially in rural areas. Whilst we have formed estimates of possible job creation, there are also broader social benefits likely to arise from improving options for segments of the population that might be excluded from the labour force at present. Our estimates focus on GVA increases created by employment increases. However, there are also distributional benefits given the nature of the inclusion benefits that rural broadband improvements might bring. In particular, the ability to work from home might particular aid those for whom travel to a workplace might be difficult, such as carers and the disabled, or uneconomic, such as those only working few hours. Access to online job search would also become easier. These groups may also experience a reduction in social isolation.[35]

Agricultural diversification and rural communities

Broadband improvement is likely to bring particular benefits for agriculture, which is relatively more important in Northern Ireland than the rest of the UK. The experience of interventions in Cornwall suggests that superfast broadband can not only directly support farmers' day-to-day activities (e.g. allowing submission of online forms, interacting with suppliers and customers etc.), but also help in diversification strategies, such as tourism. Clearly diversification strategies are important to sustain rural communities.

Beneficial feedbacks

Digital exclusion may have a variety of causes, including lack of digital skills, not taking up broadband services for various reasons and broadband not being available.[36] Direct measures to make good quality broadband available in rural areas may also have indirect effects. For example, take-up might be encouraged by seeing and hearing about how others can use new services. This might also provide an incentive to acquire better digital skills and draw suppliers of training into areas. Therefore, although the

[33] Online consultations are likely to become important in the near future. For example, NHS England has established a fund for GPs to install online consultation systems.

[34] https://www.health-ni.gov.uk/sites/default/files/publications/dhssps/interactive-ehealth-strategy.pdf

[35] For a discussion of these possible benefits, see https://www.btplc.com/Purposefulbusiness/Connectivity/Beingonlineisgoodforsociety/Valuing-Digital-Inclusion.pdf

[36] See for example https://www.citizensonline.org.uk/wp-content/uploads/2017/12/Citizens-Online-Switch-sample-report-v2.0.pdf

question of digital inclusion is broader than simply provision of high-quality broadband, there is a variety of possible positive effects that might follow from improvements in rural areas.

4.2 Time horizons

Some benefits are clearly more certain, and more immediate, than others. For example, time and cost savings arising from the decreased download/upload times, and reduced need for network maintenance are almost indisputable, and will occur without any significant behavioural change on the part of an individual.

On the other hand, there are some benefits that will take some time (i.e. a few years) to manifest. Although our focus is on benefits likely to occur within a 5-year horizon, this is not to say that benefits in the more distant future might not be significant.

Some skills will need to be acquired before businesses can take full advantage of their connection – for example, in cloud technologies or online marketing. Similarly, it may take some time for people to move to the labour market or for firms to hire new employees. These deferred effects are somewhat more speculative as they require assumptions about how people will behave, and are therefore more difficult to quantify. However, the account of such benefits in the Cornwall studies speaks strongly for their likely magnitude.

In particular, there is evidence that prior to experiencing SFBB users may not anticipate how they might use the service and what benefits they might enjoy. It may take time to explore potential new possibilities and gain skills needed to take up new services. Therefore, ex post studies are likely to be much more useful in assessing benefits than ex ante surveys asking how customers might use such services.

5 Benefit Assessment

This section describes our quantitative assessment of each category of benefit defined in Section 4. We begin by setting out key assumptions used throughout, including the nature of likely services to be offered over the new fibre, take-up assumptions and discount rates.

Broadband speeds

The size of the benefits from the new infrastructure will depend on the magnitude of the speed improvement it delivers. Most of our benefit calculations are based on comparison of the speeds available to affected premises with and without the intervention.

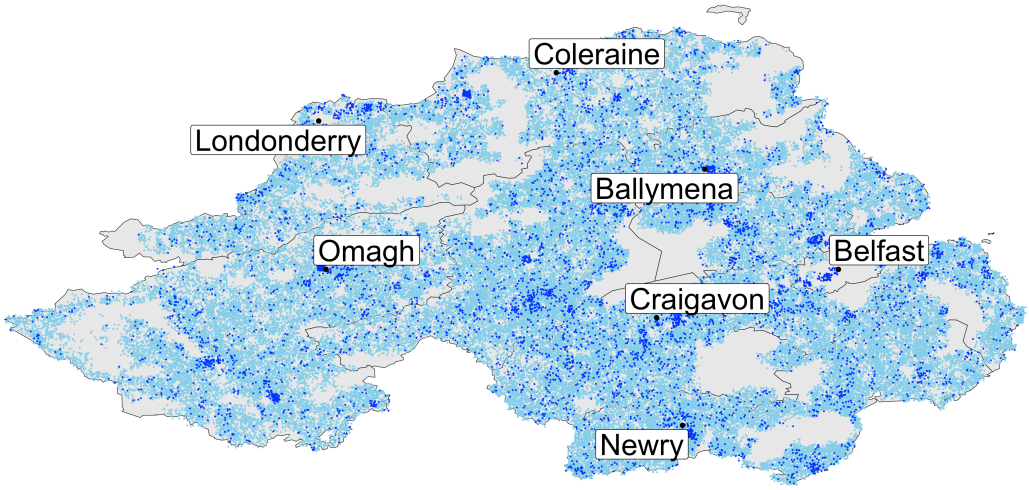
The scenario without the intervention assumes that the speeds will remain constant over time, pegged at their present level because of the limitations of the currently available infrastructure. This initial speed is taken from a dataset provided by BT, showing the average ADSL and VDSL download speed available to each premise included in the deployment plans. For the purpose of our calculations, we take the higher of the two as the currently available highest speed. In some cases, the fastest available connection will not be the one currently used (for example, if a customer has not upgraded from ADSL to VDSL despite speed benefits).

We assume that the target speed for each of the premises will be 100 Mb/s. The actual speed delivered will depend on the services communications providers choose to offer. Speed will be constrained by contention in backhaul, rather than the fibre drop to the customer's premises.

Finally, we assume that the intervention funds will be spent solely on premises that are currently achieving speeds less than 30 Mb/s. The deployment plan given to us by BT included some premises already receiving a service at 30Mb/s or greater. We exclude these premises from our benefit calculations entirely; they amount to 36% of businesses and 16% of households in the roll-out plan.

We have also excluded premises where we suspect there might be service from an alternative provider, Virgin Media, available. The geographical distribution of the premises that are considered eligible for intervention funds after these corrections is illustrated on the map below.

Figure 3: Distribution of eligible premises (businesses are marked with a darker colour)



Take-up modelling

Assumptions about the rate of take-up of new fibre broadband are based on previous studies. The Northern Ireland Broadband Improvement Project (NIBIP), which has achieved a 60% take-up in December 2017, up from 5% in March 2015, is especially relevant.

We assume that, in the long run, the take-up rate will plateau at 60%. For the calculation of benefits in the near future, we assume that from the time the fibre broadband is deployed in the area the proportion of users using the new service in the intervention area rises linearly from 0% to 60% over 30 months.

Discounting of benefits

In line with the HM Treasury's Green Book recommendation, we discount benefits at an annual rate of 3.5%. The reference year for our discounting exercises is 2018. We report benefits over a 15-year horizon.

We also adjust for underlying productivity growth. Although the generally accepted long-term growth rate of the UK economy is 2%, productivity growth rate in Northern Ireland has, in recent years,

been much lower[37]. Therefore, we use a more modest assumption of 1% productivity growth per annum.

5.1 Productivity growth

5.1.1 UK Broadband Impact Study

Methodology

The model developed by SQW relies on estimates of broadband speed increases for businesses grouped by three characteristics: industry group (six categories), band sizes (four categories) and the density of premises (split into deciles).

The model also includes postcode-level speed data, assumptions about the pace of the take-up of new, faster connections and an estimate of the elasticity of productivity with respect to broadband speed (taken to be 0.3%).

Data and adjustments to methodology

We have split up premises in the proposed roll-out plan by NUTS3 regions. In order to estimate what proportion of the economy in each region will be affected by the deployment plan, we calculate the proportion of the region's businesses that will be affected, assuming that a given relative increase in broadband speed in any business in a region produces the same increase in GVA.

That proportion is calculated by extracting from the deployment plan the number of premises flagged as businesses and dividing it by the number of firms in the region reported in ONS data.

It is reasonable to assume that large firms, which we define here as those employing at least 250 persons, are less likely to be targeted by this intervention. Because large firms generally produce more output per premise, our benefit projection may prove to be an overestimate. As we do not know the distribution of firm size among the targeted firms, we are not able to correct for this effect.

It should be noted, however, that the intervention mostly targets areas where there are significantly fewer big firms than in the rest of the UK. In all of Northern Ireland excluding Belfast (which contains only 3.93% of targeted businesses), there are just 130 firms that employ at least 250 employees.

[37] See: https://www.nisra.gov.uk/statistics/economic-output-statistics/ni-composite-economic-index

The point estimate of 0.3% has been used as the elasticity of productivity at all speeds (up to 100 Mb/s).

Results

The benefit is projected to accumulate to £267 million by 2033, or £1.78 per pound spent by the government.

5.1.2 Broadband Connection Voucher Scheme study

Methodology

The study's methodology for estimating the average profit increase across businesses is based on a survey – businesses are asked directly about the size of the increase in their profit attributable to their new subsidised connections. Another question asked is whether they would have bought the connection had they not been given the subsidy. The estimated average of £1293 additional yearly profit is based solely on these answers.

This approach of asking about profit increases is not likely to be an effective means of estimating productivity increases. In particular, it is possible that a firm, through an increase in output, increases competition. It will then increase the productivity of firms in that sector, which will in turn create benefits for consumers that are not reflected in the firm's profits. Therefore, we should expect this approach to provide a gross underestimate of productivity benefits.

Data and adjustments to methodology

We have taken the £1293 additional profit estimate as the starting point for each business of which we are aware in BT's deployment plans. Then, we have applied several adjustments.

First, we have adjusted the benefit for the different take-up profile (rising to 60% in the long term, instead of 71% obtained in the Voucher Scheme study).

Second, for each of the five NUTS3 regions, we have multiplied the number by the ratio of regional GVA per capita to UK GVA per capita in 2016. This adjusts for the fact that Northern Ireland's smaller output per capita will likely reduce the profit increases. Regional GVA will also provide a substantial correction for the geographic distribution of the businesses, which are mostly located outside of Belfast.

Finally, we have taken account of the differential in median speed uplift between the two projects. We have set an uplift of 7 times

(which was the median uplift in the Voucher Scheme study) as the uplift at which no correction is applied. Otherwise, we have assumed constant elasticity of profit to broadband speed.

Results

The discounted value of the benefit is projected to reach £4.48 million per annum by 2024, or approximately £640 per connected business. In total, the additional profit will accumulate to approximately £50 million by 2033, equivalent to £0.33 per pound spent by the government.

5.1.3 Superfast Cornwall evaluation

Methodology

Businesses that were interviewed as part of the study frequently cited improved efficiency as a business benefit of SFBB.

The estimate of productivity increases is based on data from the longitudinal business survey, which collected direct estimates of GVA (based on company accounts data) before they connected, and at two points post-connection Feb/March 2014 and Feb/March 2015. This information, provided by 22 firms, is used to measure productivity changes as measured by GVA per FTE. This is likely to be an effective means of assessing the productivity impact as it is obtained from a direct measure in the businesses surveyed.

Productivity was found to increase on average by 30% per FTE from the pre-connection to Wave 2 responses (Feb/March 2015). However, the authors advise caution when using this figure, as the longitudinal business survey was not based on a random sample and there was no comparative survey for non-connected businesses. Furthermore, the sample size (22) is relatively small.

Data and adjustments to methodology

Due to limited information about longitudinal survey respondents, it is difficult to assess how relevant these results are for Northern Ireland and what adjustments might be needed to reflect the changed context.

However, as Northern Irish labour productivity is much lower than in the rest of the UK, especially in the North[38], there is substantial room for improvement, and increased broadband speeds might be one of the more easily realised drivers of improvements.

We initially take the 30% per FTE per firm increase in GVA at face value, as we do not know exactly how these increases are achieved nor have information that would allow us to further disaggregate this into type of business.

However, we also consider how GVA changed for the rest of Cornwall and key comparator regions identified by the study itself – Devon, Lincolnshire and North Yorkshire – throughout the course of the programme. The percentage increases for GVA/hour are presented below[39].

Table 3: GVA in Cornwall and comparators

Region[40]	2011-2015 increase in GVA
Cornwall & Isles of Scilly	11.6%
Devon	7.47%
Greater Lincolnshire	14.0%
North Yorkshire	3.07%
Average	9.05%

Source: ONS data

On average, GVA/hour increased by 9% across all the regions over the same period. This includes all of Cornwall, and therefore for businesses that were connected to superfast broadband as a result of the scheme as well those that were not. This average includes some firms in Cornwall who might have benefitted from SFBB, so is possibly a slight overestimate of the counterfactual growth rate for Cornwall in the absence of SFBB. However, this is a conservative assumption as it leads to a slight underestimate of the benefits of SFBB.

On the basis of a 9% increase in GVA being the counterfactual, we assume a 21% *attributable* increase of superfast broadband

[38] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/articles/regionalandsubregionalproductivityintheuk/jan2017/pdf

[39] Note that as we only have this data in GVA/hour, it may be an imperfect comparator to the Cornwall study's estimate of GVA/FTE changes.

[40] Note that we could only find this data disaggregated to the level of Local Enterprise Partnerships, so in some cases may include areas that are not strictly in the comparative zone.

connectivity to GVA increases (although this should still be treated with caution due to the various issues with finding perfectly comparable data).

To apply this 21% increase to Northern Ireland, we use the weighted average GVA calculated for our estimate of employment benefits (see section 5.4.3). The attributable increase in GVA would represent **£10.9k per connected firm.**

This is then scaled up to reach an aggregate figure for the scheme based on take-up rates over time.

Results

We find an estimated increase of **£407 million in benefits over 15 years.** We once again note that there are several methodological concerns with this exercise, and that this estimate should be used as an indication rather than as a concrete figure.

5.1.4 Summary of productivity growth results

The differences in results summarised in Table 4 very much reflect the different approaches the previous evaluations take. The approach of the UK Broadband Impact Study and the Superfast Cornwall Evaluation is to measure the increase of output per worker, which is roughly consistent with the definition of productivity typically used in economics. The Superfast Cornwall Evaluation should be a good proxy for the effects that could occur in Northern Ireland, but as discussed above there are significant uncertainties due to the small sample size used in the study's surveys, and lack of a robust counterfactual.

Table 4: Summary of productivity growth benefits

Base study	Absolute benefit	Benefit multiple (relative to cost)
UK Broadband Impact Study (*preferred approach*)	£267m	1.78
Broadband Connection Voucher Scheme study	£50m	0.33
Superfast Cornwall Evaluation	£407m	2.71

The Voucher Scheme study, on the other hand, measures the increase in profit – which may come both from increased

productivity of the already employed workers as well as from output produced by new workers (after subtracting the costs associated with their employment). The Voucher Scheme study adjusts the delineation of its employment benefit so that it fits with the productivity benefit without overlap (see section 5.2.2. below). But although the Voucher Scheme study becomes consistent within itself, its division of benefits is to some extent inconsistent with the other studies replicated in our report. In particular, increased output due to productivity increases may lead to consumer benefits, yet no profit increase for the firm if this is competed away.

We take the estimate obtained using the UK Broadband Impact Study as our central scenario as we consider this the most robust of the three approaches. It uses regressions on macro-level data to obtain necessary parameters and avoids the problem of external validity, present in replications of regional studies such as the Cornwall one.

Conversely, we consider that the estimate of the productivity impact obtained from the Voucher Scheme – which is by far the smallest of the three – is the least reliable. This is because it is based on a survey question whose answers are not checked against a counterfactual for what firms would have done without improved broadband. Although the Cornwall methodology suffered from a similar drawback, we were able to construct a counterfactual based on the comparator regions specified in the Cornwall report to make the estimate more robust.

5.2 Increased employment

5.2.1 UK Broadband Impact Study

Methodology

The study establishes a relative index of broadband speed calculated as the average speed (in a given density decile) divided by the national average. Then, it estimates enterprise and employment growth in each area as a function of this relative speed.

It is found that the areas with below-average speeds have a negative employment growth impact that is greater than the positive employment growth impact in areas that operate above-average speeds. The relation is non-linear in such a way that sustained broadband speed inequalities lead to an overall nationwide loss of employment. In other words, jobs lost due to slow connections in least dense areas are not fully compensated by

employment gains in dense areas. This is due to effects that we have described in section 4.1.3.

Therefore, interventions in the least dense areas have an overall positive effect on the nationwide employment figures. Indeed, the UK Broadband Impact Study finds that the benefits stemming from safeguarded jobs in the four least dense deciles of output areas are several times larger than the corresponding losses in the five most dense deciles.

Another source of employment benefits is an increased number of carers and disabled persons who take up jobs where they can mostly work from home. SQW's calculations show that a substantial portion of carers and disabled persons has or will find jobs thanks to faster broadband at home. We understand that these calculations are based on census data, as this is the only source of figures that we are aware of and which would provide data on teleworking among the aforementioned groups at the level of detail necessary for the analysis.

Replication

We have sought to replicate the approach applied in the SQW study. However, we have not found that the estimates are particularly stable given the available data and using census output areas as our geographical unit. This contrasts with our analysis of homeworking, where we have been able to demonstrate a positive association between broadband speeds and homework, controlling for population density.

As a matter of logic there is some difficulty in using broadband speeds in small, largely residential geographic areas to explain increases in employment levels. Typically, a person's place of work is in a different output area than their home. The problem cannot be solved by grouping output areas by population density into large clusters – workplaces will usually exist in more dense areas than homes.

Given these issues, we consider that survey-based studies are much more likely to identify employment impacts.

5.2.2 Broadband Connection Voucher Scheme study

Methodology

This methodology is similar to the one used for calculating profit increases, outlined in the section 5.1.2. However, instead of a monetary value, businesses are asked how many more persons they have employed as a consequence of the new connection (in full-

time equivalent). The value of average compensation to a UK employee is used for quantification of the benefit. The final value, accounting for deadweight, is £9322 per business.

In employment benefit, in contrast to the productivity benefit, is assumed to materialise only after six months.

Data and adjustments to methodology

We have applied the same adjustments to the £9322 figure as in the case of the productivity benefit. Additionally, we have assumed a displacement benefit.

The Voucher Scheme study does not take account of the fact that some of the benefit may be coming from relocation of employees from elsewhere. We have made some adjustments to take this into account.

The Superfast Cornwall study reports that 19.5% of the employment gains for businesses in Cornwall resulting from the faster broadband were offset by businesses elsewhere losing these employees. We have assumed the same diversion ratio. However, there are three arguments to keep in mind when judging the validity of Cornwall's rate of job relocation in the Northern Irish setting.

First, there are relatively more economically inactive people in Northern Ireland than in Cornwall. This provides for a greater opportunity to employ persons who are not currently employed in other firms.

Second, we are not taking business formation into account. The Voucher Scheme study only allows us to look at benefits for existing businesses. Therefore, we are only including business premises in our benefit calculations. However, in some residential premises that receive better connections, new businesses will be started. This also makes our estimate conservative.

On the other hand, the deployment plans for the new infrastructure in Northern Ireland are more selective. The premises whose connections will be improved are more scattered across the geographic area than the premises whose connections were improved in Cornwall. This means that businesses with improved broadband will rather be competing with other businesses in their area, as opposed to other businesses with improved speeds, which is the case when the improvement is not dispersed geographically. As a consequence, a greater proportion of the employment gains in firms with new infrastructure may be offset by employment losses elsewhere.

The original study investigated benefits over a two-year period, as this was the duration of the voucher contracts. Our much longer 15-years horizon requires assumptions about the long-term behaviour

of the employment increases. A significant proportion of the jobs that are initially created as a result of the faster connections will vanish by 2033. However, it is reasonable to assume these will be replaced by other jobs that are also supported by faster broadband. Therefore, jobs may change over time – being destroyed and created – but the impact of improved broadband should endure in terms of the total number of jobs created.

Results

The discounted value of the benefit is projected to reach £25.4 million per annum by 2024, or £3702 per connected business. The discrepancy between this number and the £9322 benefit found in the original study is partly due to the discount rate between 2018 and 2024, but mostly results from the corrections we have applied in terms of (i) displacement effects and (ii) difference in GVA per capita between affected regions of Northern Ireland and the UK as a whole.

In total, the value of the employment gains will accumulate to £290 million by 2033. That is £1.93 per pound of subsidy.

5.2.3 Superfast Cornwall evaluation

Methodology

The Cornwall evaluation separates employment benefits into three categories: existing businesses increasing number of employees; 'safeguarded jobs' in existing businesses; and employment created by business start-ups.

Business births and deaths, business density and self-employment are relevant for considering the entrepreneurial landscape of NI. Self-employment is higher in Northern Ireland, although not substantially so. Considering business births and deaths is especially important for the validity of 'safeguarded jobs' – a very low business death rate may suggest that jobs are generally not at risk anyway. As Table 5 shows, these figures are broadly similar.

Table 5: Cornwall 2011 and Northern Ireland 2017 comparison

Indicator	Cornwall 2011[41]	Northern Ireland current[42]
Economic inactivity	33.3%	28.2%
Unemployment	3.3%	3.8%
Business birth and death rates	9.6%/9.2%	10.2%/9.6%
Business density (per 10,000 inhabitants)	600[43]	894[44]
Self-employment	13.8%[45]	15%

Source: Cornwall 2011 census, ONS, NISRA

Change in full-term employment for established businesses

This benefit looks at jobs created in established businesses as a result of SFBB connections.

Two surveys are used: the business omnibus (connected businesses) and the counterfactual (non-connected businesses). The study compares gross FTE changes of connected and non-connected businesses over the last two years. It finds that gross FTE increases by an average of 0.63 for connected businesses, compared to 0.45 for non-connected businesses.

Total and average GVA is calculated by multiplying each FTE by the average GVA of the industry in which the job is created. This is then scaled up by the estimated number of businesses of established businesses in Cornwall estimated to be connected to superfast for 12 months or longer, and the number of connected businesses in Cornwall overall. Two results are reported: GVA if only businesses that have been connected for more than a year are considered, and GVA including those connected for less than a year.

The authors also consider an alternative approach of 'attributable jobs', which relies on a question in the survey that asks businesses how many jobs were created as a direct result of SFBB. These

[41] Figures taken from 2011 Cornwall census except where stated

[42] In all cases, most recent data used. This varies between 2015 and 2017.

[43] Cornwall and Isles of Scilly LEP: Strategy and Business Plan April 2012. Available here: https://www.cioslep.com/assets/file/LEP%20Strategy/Evidence%20Base%201.pdf

[44] Department for Business, Energy & Industrial Strategy; Business Population Estimates for UK and the regions 2017

[45] Taken from NOMIS website, available here: https://www.nomisweb.co.uk/reports/lmp/lep/1925185540/subreports/ea_time_series/report.aspx? (March 2010 – April 2011)

subjective assessments are used as a sense-check for the first estimate. This exercise results in estimated increase in employment that is actually 0.05 FTE higher than the first approach. However, GVA increases are lower due to the differing productivity distributions of the firms between the two methods – that is, relatively more low productivity firms attributed their increases in employment to SFBB. This is potentially encouraging for the Northern Irish experience due to the relatively large low-productivity sectors.

The reasons for attributing increased employment to SFBB include increases in speed and efficiency, which allows businesses to deal with larger workloads and respond to more tenders, increases in sales, development of new services that require new staff and that ability to access new markets and increase market share.

The study also finds that where the businesses saw increases in employment, the average FTE amongst non-connected businesses in the same sector decreased by 0.25 FTE over the same period. It is not clear whether connected businesses would have anticipated a reduction in employment in the counterfactual case that they did not take SFBB, so employment effects may have been underreported.

The proportion of micro-businesses is higher in Northern Ireland than in the Cornwall sample, which would imply greater impact as these are the firms least likely to have had access to SFBB already. The proportion of large businesses is similar.

Table 6: Comparison of business size in NI to Cornwall survey groups

	Omnibus Survey (%)	Counterfactual Survey (%)	Northern Ireland (%)
Large Businesses (250+)	0.4	0.2	0.4
Medium-sized Business (50-249)	2.6	2.2	1.7
Micro-business (0-9)	73.9	79.3	88
No employees	1.5	0.5	0.5
Small business (10-49)	14.1	14.6	9.8
Unknown	7.4	3.2	N/A

Source: Cornwall Superfast Broadband Evaluation, NISRA IDBR

Safeguarded jobs

The Superfast Cornwall programme had a target to 'safeguard' – ensuring that at-risk jobs were no longer at risk - 2,000 jobs (and a net additional safeguarded GVA of £70m). The omnibus survey found that 14.3% of the 460 connected businesses attributed safeguarded jobs to SFBB, at an average of 0.42 FTE per business.

This figure is calculated in terms of GVA using the same methodology as for the job creation exercise.

Business start-ups

The study uses the household survey to gauge whether SFBB has encouraged the start-up of new businesses. They find that 9.6% of respondents set up a business, and a further 7.1% reported that another member of the household had done so.

The survey also asks the extent to which SFBB influenced their decision to set up a business. Of the 33 who provided details, 12 considered superfast internet influential at some extent. Using data provided on number of employees, and assuming a similar pattern for businesses established by other household members, the study finds that SFFB created an average of 0.02 FTE per consumer.

Once again finding this in terms of GVA per industry, this result is then scaled up for all estimated connected residents and estimated connected residents who were connected for longer than 12 months.

Scaling up benefits

The results are then scaled up to all estimated connected premises in Cornwall. The evaluation estimates this figure using a MINT database figure on the estimated number of business premises in Cornwall (12%, or 29,000) and therefore approximating the number of connected businesses from the number of lines (61,471). Results only including businesses that have been connected for more than a year (approximately 20.4%) are presented alongside this estimate.

The overall results are then converted from gross to net figures by adjusting the FTE/GVA using a displacement estimate (measuring how much the benefits of SFBB are realised at the expense of other businesses in Cornwall – an estimate of 19.5% is used) and a multiplier effect (measuring the additional economic activity in Cornwall that occurred as a result of the creation of jobs, for example through increased spending power – a 1.25 multiplier is used). The appropriateness of these adjustments is considered in previous section 5.2.2.

Data and adjustments to methodology

We make a number of changes to the Cornwall report's approach.

Number of connected premises and take-up assumptions

The evaluation uses the MINT database to estimate the number of business properties in Cornwall: this suggests that about 12% (29,000) of premises in Cornwall are business premises. As we do not have access to this database for Northern Ireland, we instead use the number of business premises that BT targets (6874 are assumed to be eligible for intervention funds), which is in any case likely to be a more accurate figure. Similarly, we estimate connected households from the BT data.

The Cornwall evaluation estimates that the take-up rate is approximately 26%. We estimate benefits using the linear aggregate take-up rate in order to present annual benefits, plateauing at 60%.

In line with the original methodology, we only include businesses that have been connected for more than a year in our final estimates.

Full-term employment and GVA

The evaluation uses estimates of FTE for each industry. However, we cannot find any sufficiently disaggregated figures for self-employment per industry in Northern Ireland, and therefore instead rely on the Workforce Jobs (WFJ) estimate, which is a compounded measure of employee jobs, self-employment jobs, HM Forces and government-supported trainees. This may result in an overestimate of full-time positions depending on how many of those are part-time roles, but should therefore lead to a conservative approximation relative to the Cornwall estimate.

The evaluation calculates GVA based on what industry the job was created in. As we do not have access to the raw data, we cannot employ a similar methodology. Instead, we use weighted average GVA/FTE of Northern Ireland (weighted by the size of the two-digit SIC code industry in terms of number of businesses) to convert FTE into GVA. The weighted average is approximately £52,900 per WFJ.

We also compare the sectoral distribution of the survey respondents and Northern Ireland, including Belfast (due to data restrictions, our estimates will include all of Northern Ireland, rather than just rural areas). The biggest differences is that agriculture plays a much larger role in Northern Ireland than in either survey (24.9% vs 5.4% for omnibus and 14.1% for counterfactual survey), although interestingly the counterfactual survey's proportion of agriculture is still relatively high. Similarly, construction is more relevant in Northern Ireland than in Cornwall. On the other hand, accommodation and food services play a much smaller role, approximately 12% smaller than in Northern Ireland than the surveys.

Adjustments for longer time horizons

We project and discount our benefits over 15 years, substantially longer than the 6-year term of the Cornwall evaluation. Although one could argue that some of these jobs will be naturally lost over time, this is likely to be offset by a creation effect. Thus, we can assume that a similar number of jobs attributable to the new broadband will be in place at all times.

Results

For their presentation of net GVA created, the SFBB report omits the safeguarded jobs from the final figure. Replicating this, we find that businesses and households connecting to BT's network will create just above 2000 jobs in Northern Ireland, with a further 2900 jobs no longer at risk (*safeguarded jobs*),

Converting this into GVA terms and discounting yields a total estimate of **£890 million over the 15-year period,** equivalent to a benefit of **£5.90 for every £1 of public money spent.**

5.2.4 Summary of employment growth results

Table 7: Summary of employment effects

Base study	Absolute benefit	Benefit multiple (relative to cost)
Broadband Connection Voucher Scheme study	£290m	1.93
Superfast Cornwall Evaluation	£885m	5.9

One reason why the Voucher Scheme study-based projection might be an underestimate is that not all impact channels are covered in its calculation. Employment gains might stem from:

- increased employment in established businesses (note that these might be offset by destruction of employment in other businesses, either within or outside the intervention area);
- new business formation; and
- spill-over effects (separate from the multiplier effect of the construction of infrastructure).

The Voucher Scheme methodology quantifies just the first channel. The Cornwall study includes business formation and accounts for the spill-over effect.

Additionally, the Voucher Scheme study bases its estimate on just one survey question (counting just the firms that would not

upgrade connections otherwise), whereas the Cornwall study takes account of the counterfactual scenario in the absence of intervention. Therefore, the Cornwall methodology for estimating the employment growth is the more complete one and thus we consider it to be a better indication of potential benefits in Northern Ireland.

5.3 Increased teleworking

Of the three studies, this benefit is only evaluated in the UK Broadband Impact Study.

Methodology

SQW split their calculations by industry groups, in addition to the density deciles. They have also included assumptions about the evolution of the scale of teleworking until 2024. The key aspect of the analysis is the estimate of the relationship between days per year teleworked by each group as a function of average household connection speed. These estimates are then combined with duration of commutes in each density decile and the average GVA per hour worked.

Data and adjustments to methodology

There are several reasons why our methodology will differ substantially from the original one. First, the details of SQW's calculations are not publicly available. Second, the data on broadband speeds used in the original study is not publicly available. Third, we have made a number of modifications which either allow us to transfer the estimates obtained on English and Welsh data to Northern Ireland or improve the credibility of the estimates.

Specifically, in order to estimate the impact of speed increases on teleworking, we have used data from the 2011 Census, the 2001 Census and Ofcom's postcode-level speed data from 2013.

In our main regression, we use the difference between the proportion of people working from home in 2011 and 2001 in each output area as our dependent variable. We regress it on the average fixed broadband speeds in each output area in 2013, taken from Ofcom's Infrastructure report 2013. It is the earliest publicly available data for areas smaller than Local Authority Areas.

In measuring the effect of broadband speeds on teleworking, one has to account for the fact that rural areas experienced greater declines in teleworking over the period from 2001 to 2011 relative

to urban areas. Such declines cannot be explained by the change in speeds, as teleworking can only get easier with progress in speeds. Rural areas are also the ones where broadband speeds are smallest. As a result, this confounding effect will cause the relationship between connection speeds and teleworking to be exaggerated if it is not included in the analysis.

The original study evaluated their regression in each density decile. We believe that this is not the best approach, as within each decile densities still vary to some extent. Instead, we include in our regression a separate variable, the population density of the given output area (evaluated using data from the 2011 census). We found that this reduces the reported coefficient and implied benefits. However, we believe that it improves the reliability of our estimates.

We combine the resulting estimate with data on average commute time in Northern Ireland to obtain the time savings for each worker who starts working from home as a result of faster broadband. This likely contributes to an underestimation, as those who start working from home are likely to be those whose commute is the longest.

We evaluate all of the time savings using figures for output per head and average working hours in Northern Ireland. This may be either an under- or over-estimate.

On one hand, some of the time may be spent on leisure. There are grounds to believe that compensation, which is typically smaller than output, is the value a worker puts on an increase in leisure. This would be a logical conclusion from how workers are assumed to behave in the labour market. However, this is not entirely accurate as employees face many constraints when choosing their working time.

On the other hand, leisure may prove to have a benefit for the employee's wellbeing and their output. SQW, using guidelines from the Department for Transport, find that the increases in leisure time, even though smaller than increases in working time, will produce greater value for the economy and society.

Results

The benefit is projected to accumulate to £39.5 million by 2033, equivalent to £0.26 per pound spent by the government.

5.4 External benefits

5.4.1 UK Broadband Impact Study

Methodology

The UK Broadband Impact Study proposes a detailed methodology to calculate some of the environmental benefits resulting from faster broadband. Specifically, it outlines three routes to carbon abatement:

- increased teleworking;
- reduced business travel; and
- increased use of cloud computing.

Data and adjustments to methodology

Of the three routes mentioned above we have replicated just the teleworking benefit because the latter two use scarcely available data, less precise assumptions and turn out to be smaller in magnitude than the teleworking one.

The Travel Survey for Northern Ireland contains information about the modes of transport used for commutes in Northern Ireland. We learn that 81% of commuters use a car or a van, with around 1.27 in one vehicle on average, and 11% cycle or walk. The rest, which accounts just for 8%, is split between several modes of transport with varying and uncertain carbon footprint. We therefore calculate the carbon abatement associated with the use of cars and vans.

We use the carbon footprint figure that assigned by UK Government guidelines to an average sized car, 0.29 kg CO_2 per mile, as the amount saved by forgone car or van commutes by newly enabled teleworkers in Northern Ireland.

Results

We estimate that almost a thousand more workers will be working from home as a result of the new connections after the full take-up is reached. This will result in over 500 tonnes of CO_2 abatement each year. In total, it will amount to 6160 tonnes until 2033.

5.4.2 Superfast Cornwall evaluation

Methodology

Although it does not attempt to calculate environmental benefits in monetary terms, the Cornwall evaluation does give estimates of carbon abatement as a result of SFBB. This is based on a complimentary evaluation of the scheme, the 'Superfast Cornwall Environmental Monitoring' report by Graham Seabrook, and also BT's 3:1 carbon abatement methodology (published by the Carbon Trust).

The study considers five key routes to decreased carbon usage as a result of SFBB and bases the methodology to quantify these benefits on a combination of other studies' reports with some adjustments. They are as follows:

- **De-materialisation** – access to services enabled by high-speed broadband replace physically manufactured goods such as DVDs and printed documents;
- **Teleworking –** the ability to work from home means that individuals are less required to commute to work, therefore cutting total car/transport emissions;
- **eCommerce -** the reduction in commercial, retail and wholesale space required by businesses due to superfast broadband, which enables more remote working and online shopping;
- **Business travel -** the ability to participate in video-conferences reduces the need for face-to-face meetings, and thus associated travel; and
- **SME Cloud Services –** the reduction in carbon use arising from the ability to replace on-site hosted services with cloud-based services.

For most of these benefits, these lead to a 'per line' or 'per business' figure for carbon abatement.

Data and adjustments to methodology

The study also presents a total estimate of carbon abatement per type of subscriber. However, this is based on several assumptions that are likely invalid for Northern Ireland and therefore we attempt to break down the total estimate into its five channels. We are able to do so for three of the five benefits, with the insufficient information in the report to replicate business travel and SME benefits. We therefore present the lower bound estimate based on these three benefits as well. In addition, we report the carbon abatement based on total estimates from the Cornwall report as a comparative reference.

De-materialisation and eCommerce

Several of the channels allow for straightforward application of the Cornwall parameters. For example, the estimate of de-materialisation per annum is a straightforward application of their result to the assumed number of connected lines. Calculating the eCommerce-related abatement is also relatively straightforward – the report gives benefits dependant on the speed of the broadband connection. We assume that all households reach 100 Mb/s or more and apply this benefit per connected household.

In terms of changing behaviour in response to high-speed broadband access, such as moving towards de-materialisation, cloud services and e-commerce, it is difficult to gauge how different these effects might be between Cornwall and Northern Ireland. One way to assess this may be through digital literacy – which has been found to be relatively low in Northern Ireland. However, we cannot find information on digital literacy for Cornwall at this time, we assume that Cornwall and Northern Ireland are sufficiently similar to respond to the high-speed broadband in similar ways. This is likely a fair assumption given that the Cornwall intervention began in 2011, and that digital literacy has been rising in general.

Teleworking

The teleworking benefit is calculated per worker who has been enabled to telework as a result of the project. We assume that every household has one working individual (which will likely lead to an underestimate of benefits if more than one member of the household works).

We have found that distances travelled for commutes are broadly similar to the UK, although a much smaller percentage of individuals in Northern Ireland telework compared with the rest of the UK (6% compared with approximately 13%); whether this is due to choice or infeasibility is unclear.

We use the Northern Ireland travel survey to assess other features of NI teleworking: although the number of miles travelled per commute are somewhat smaller in Northern Ireland than that assumed in the Cornwall study, the number of days spent teleworking is high (2.6 in the study vs 2.9 in Northern Ireland[46]) and so these differences may, to some extent, balance each other out.

We assume that 6% of individuals who are enabled by SFBB to telework do so, based on NI-wide figures of teleworking. This is again likely to underestimate the full effect that broadband will bring, as some people will not telework at present because they are not able to do so due to poor internet connection. Furthermore, teleworking is more likely in rural areas than urban areas (as shown

[46] From Northern Ireland Travel Survey

by the Northern Ireland travel survey) and therefore the NI-wide estimate will be smaller than for rural areas.

Business travel and SME cloud computing

The exact model used for the business travel and SME cloud computing are unclear. Rather than attempt to quantify these independently we consider it more prudent to exclude these from our calculations. Therefore, our estimate should be taken as a strictly lower bound figure.

Table 8: Carbon abatement as a result of broadband connection

Benefit type	Abatement (per annum)	Application	Total abatement for Northern Ireland as a result of new network per annum[47]
Super-fast broadband enabled dematerialisation	0.197 tCO_2e per residential fibre broadband connection	60% of passed households	15,378
Teleworking	0.95 tCO_2e per telecommuter enabled by BT	6% (proportion of telecommuters in NI) of 60% of passed households	4,450
eCommerce	0.5 tCO_2e / business connection / per year when bandwidth range exceed 100 Mb/s and above	60% of passed business premises	3,242
Business travel	-	-	-
SMEs moving to Cloud	-	-	-

Source: Superfast Cornwall Environmental Monitoring, BT's 3:1 carbon abatement methodology

Results

Considering just the channels that we were able to replicate for Cornwall, we find a yearly carbon abatement of approximately

[47] Once 60% take up has been reached; for our final benefit calculations

230,000 tCO_2e over 15 years. Applying the Cornwall evaluation's estimate directly leads to a total carbon abatement figure of 751,000.

5.4.3 Summary of external benefits results

Table 9: External environmental benefits

Base study	Carbon abated ($tC0_2e$)
UK Broadband Impact Study	6160
Superfast Cornwall Evaluation	230,000

Whereas we have only focused on the carbon abatement from teleworking for the UK Broadband Impact study, we have also included de-materialisation and eCommerce for the Cornwall-based estimate. Although this estimate is therefore more complete than the Broadband Impact-based figure, it is nevertheless a lower bound as it still excludes carbon abatement from SMEs moving to Cloud and business travel.

5.5 Summary

Table 10 below provides an overall summary of how the various studies have been used to provide estimates of benefits. We indicate our preferred approach for estimating each category of benefit.

Table 10: Benefits by category and methodology for estimation

Source study	Productivity gain	Employment gain	Teleworking	Environmental
UK Broadband Impact Study	£270m Application of national level estimate of elasticity of productivity w.r.t. broadband speed	Not robust – issues with applying methodology and sensitivity of results to level of geographical disaggregation of data	£40m Re-estimated using our own model following broadly similar approach	6160 tCO_2e Reduced commuting only, so an underestimate
Connection voucher scheme impact study	£50m Clear underestimate as does not identify productivity increases that will be competed away and benefit consumers, rather than being taken as additional profit by firms	£290m Only impact on existing business considered, not creation of new businesses, so an underestimate		
Superfast Cornwall Final Evaluation	£407m Small sample issues	£890m Includes effects of business creation		230,000 tCO_2e Commuting, dematerialisation and eCommerce included

Notes: Preferred methodologies shaded. All benefits on a discounted 15-year basis.

6 Overall results

The summary of the results for each category of benefit is given in the Table 11 below.

Table 11: Summary of benefits

Benefit category	Absolute benefit	Benefit multiple (relative to cost)
Productivity growth	£50m - £407m	0.33 - 2.71
Employment benefits	£290m – £885m	1.93-5.9
Teleworking	£39m	0.26

We consider that the UK Broadband Impact Study-based estimates provide our central projections of the productivity and teleworking benefits. We use the Superfast Cornwall methodology as our main methodology for employment growth estimates.

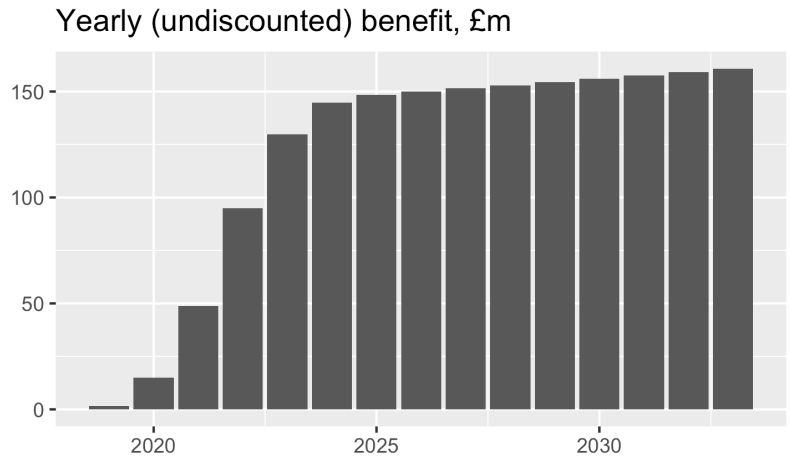
£8 of benefit for every £1 spent

This gives a central estimate of **£1190 million in benefits in discounted terms up to 2033**. This is equivalent to **£7.90 per pound spent by the government**. As the previous studies argued, this is a reasonable estimate considering that the Internet is a general-purpose technology that impacts businesses and the wider population on multiple levels of their functioning.

Steady state flow benefits in the order of £150m per annum

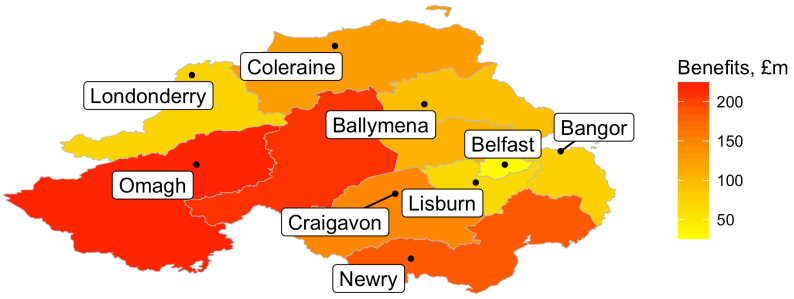
Figure 4 shows the evolution of these benefits over time. This reflects the phased take-up and adoption assumptions.

Figure 4: Time profile of benefits



The yearly benefit rises quickly until 2024, when we assume the full take-up will be reached. Thereafter, increases are due to underlying economic growth, which we conservatively assume continues at 1% per annum.

Figure 5: Geographical distribution of benefits



Benefits concentrated where productivity is currently relatively low

Figure 5 illustrates the regional distribution of the benefits. Benefits are concentrated in the west, especially Fermanagh and Omagh - £221 million – and Mid-Ulster - £208 million. Belfast, despite being the most populous out of the eleven Local Government districts, will only receive £27 million in benefits both as (i) roll-out here is limited and (ii) those premises that would be passed are disproportionately receiving speeds above 30 Mb/s already and so we do not count them as receiving benefits.

The intervention is thus directed towards the western part of the country, which is poorer than either Belfast or the eastern regions outside of Belfast (considering the five NUTS3 regions of Northern Ireland that have been in place before 2018 and 2016 GVA figures, West and South of Northern Ireland had a GVA per capita of just £17,553, while Belfast – £37,220).

Employment impact relatively important

Finally, the balance of benefits created through specific impact channels is somewhat different than in previous studies. In the UK Broadband Impact Study, the productivity growth benefit accounted for almost 80% of the projected benefits, with the rest explained mostly by the employment benefit. In the Voucher Scheme study, the employment benefit turned out to be 5.4 times higher than the profit increase for affected firms, even though the profit benefit was defined more broadly – and the employment one more narrowly – than in other studies.

In our central case, the employment gain is 3.3 times higher than the productivity gain and the teleworking benefit makes up 3.3% of the overall impact.

These differences in the ratio of the employment benefit to the productivity benefit are partly due to the significantly different nature of the interventions corresponding to each study. The intervention here is focussed on rural areas where there is potential for employment creation, but relatively less current economic activity to benefit from productivity gains.

Potential underestimation bias

Finally, the estimates of all benefits except for the teleworking one have a downward bias associated with the fact that we have not been able to identify all businesses featuring in the roll-out plan. Some businesses may be based on residential premises or use residential broadband plans and may not be identified as businesses in the data provided to us.

Annex A Data sources

Variables	Dataset	Web link
Average number of commute trips, average commute distance, means of transport used for commuting	UK Government, Department for Infrastructure (Northern Ireland): Travel Survey for Northern Ireland	https://www.infrastructure-ni.gov.uk/articles/travel-survey-northern-ireland
Average commute time	Office for National Statistics: Travel to work methods and the time it takes to commute from home to work, Labour Force Survey, 2007 to 2016	https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/adhocs/008005traveltoworkmethodsandthetimeittakestocommutefromhometoworklabourforcesurvey2007to2016
Average working hours	Statista: Average actual weekly hours of work in Northern Ireland from 2013 to 2017	https://www.statista.com/statistics/384055/average-actual-weekly-hours-northern-ireland-time-series-uk/
Carbon abatement per mile of forgone journey	UK Government, Department for Business, Energy & Industrial Strategy: Government emission conversion factors for greenhouse gas company reporting	https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
GVA (incl. GVA per head) split by NUTS3 regions	Office for National Statistics: Regional gross value added (income approach)	https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach
Number of businesses by size and NUTS3 region	Office for National Statistics: UK Business – activity, size and location	https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/datasets/ukbusinessactivitysizeandlocation
Number of households by NUTS3 region in 2011	Northern Ireland Statistics & research Agency: Census 2011	https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/2011-census-results-population-estimates-local-government-district-report-19-september-2012.pdf
Number of households in Northern Ireland in 2017	Office for National Statistics:	https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/adhocs/

	Total number of households by region and country of the UK, 1996 to 2017	005374totalnumberofhouseholds byregionandcountryoftheuk1996t o2015
Social value of carbon abatement	UK Government, Department for Business, Energy & Industrial Strategy: Carbon valuation	https://www.gov.uk/government/collections/carbon-valuation—2
Average speeds by area in 2013 in England and Wales	Ofcom: Infrastructure report 2013, Fixed broadband postcode level data 2013	https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research
Population density, number of workers and proportion of those working mainly at or from home, by Output Area in 2011	Nomis: 2011 Census Bulk Data Download	https://www.nomisweb.co.uk/census/2011/bulk/r2_2
Number of workers and proportion of those working mainly at or from home, by Output Area in 2001	Nomis: Census 2001	Query wizard available at: https://www.nomisweb.co.uk/home/census2001.asp
Local Enterprise Partnership GVA	Office for National Statistics: GVA for Local Enterprise Partnerships, February 2017	https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/gvaforlocalenterprisepartnerships
Gross Value Added by industry	Office for National Statistics: Nominal and real regional gross value added (balanced) by industry	https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/nominalandrealregionalgrossvalueaddedbalancedbyindustry
Workforce jobs by industry	Office for National Statistics: JOBS05: Workforce jobs by region and industry	https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/workforcejobsbyregionandindustryjobs05
Businesses by industry	NISRA: Interdepartmental Business Register January 2018	https://www.nisra.gov.uk/publications/current-publication-and-idbr-tables-0