

# Upgrading the UK: The Digital Connectivity Opportunity



Oxford  
Analytica

PART OF **FiscalNote**

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# 01. Foreword

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At Virgin Media O2 we are on a mission to upgrade the UK.

Our services played a vital role in connecting our customers to the people and things they love during the pandemic, and kept the country working, learning, informed and entertained at a time when it mattered most.

And now, as we look to the future, our purpose as a combined company has never been clearer. We're investing to expand and upgrade our fixed and mobile networks, living up to our role as a national challenger that will accelerate growth, get the UK back on its feet and help it become a connectivity champion.

To better understand the opportunity ahead, we have worked with some of Britain's leading economic analysts on a pioneering new way to measure digital connectivity.

Our new Digital Connectivity Index uses thousands of datapoints to measure how individuals and organisations can connect with one another and the rest of the world through high-quality internet access.

The Index, the first of its kind, assesses the quality of connectivity infrastructure across developed countries and finds the UK is currently ranked joint 8th out of 24 OECD countries publishing complete digital connectivity datasets – well into the top half of countries scored and just ahead of Germany, Portugal and Ireland.

It also reveals that upgrading mobile and broadband networks can support economic growth and help the country to level up. By becoming an international leader, in just five years the UK could boost GDP by £70 billion, unlock more than 500,000 new jobs and enable consistently higher economic growth rates every year.

However, this future is not guaranteed. To realise these benefits, we need to work across industry with the support of Government and regulators to build the digital infrastructure the UK needs.

As Virgin Media O2, we are committed to playing a leading role in helping the UK become a connected digital leader and are investing at least £10bn over the next 5 years to rollout gigabit speeds, expand our network and bring 5G to more parts of the country.

This investment will help provide those high-quality connections between people that are essential to modern life.

With a huge opportunity ahead of us, we're focused on our goal of upgrading the UK and reimagining connectivity. Our investment is turning up the dial on the national recovery, helping the country to climb up the international connectivity league tables and creating a brighter, more prosperous future for every corner of the UK.

CEO Lutz Schüler



# 02. The central role of digital connectivity to the UK's post-Covid future

## About us

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Virgin Media O2 is a **customer-first organisation** that brings a **range of connectivity services together in one place with a clear mission: to upgrade the UK.**

In our launch on 1 June 2021, we combined the UK's largest and most reliable mobile network with a broadband network offering the fastest widely available broadband speeds.

We currently have **47 million UK connections** across broadband, mobile, TV and home phone. Our own fixed network currently passes **15.5 million premises** alongside a mobile network that **covers 99% of the nation's population** with 4G, and almost 200 towns and cities with 5G services.

As we push ahead with this mission, we are committed to using the power of connectivity to super-charge communities across the UK, taking action to close the digital divide and helping to build an inclusive, resilient, and low carbon economy.

**We commit to playing a central role in the UK's recovery following the Coronavirus pandemic.**

We will connect more people to the things they love, support communities across the country, help businesses to grow, and help power the UK economy.

## A first-of-its-kind measurement of digital connectivity

***Our research shows the huge opportunities the UK can unlock through leadership in digital connectivity.***

This study – based on economic modelling, advanced analytics and survey data from households and businesses – measures the role that digital connectivity will play in the UK post-Covid-19. It offers new evidence of the central importance of digital connectivity to the UK's future.



## Launching: 'The Digital Connectivity Index'

The centrepiece of this research is a new way of measuring the ability of individuals and firms in a country to connect with one another and the rest of the world through high-quality internet access.

The **Digital Connectivity Index** brings together Organisation for Economic Co-operation and Development (OECD) datasets on broadband speed<sup>1</sup>, and the use of fixed broadband and mobile broadband.

Using advanced analytics<sup>2</sup>, the Index brings together thousands of national data points from across the OECD countries into a single, comparable score.

### Key findings – the Index reveals that:

**The UK currently ranks joint 8th<sup>3</sup>** out of 24 OECD countries publishing complete digital connectivity datasets – well into the top half of countries scored.

Between 2011 and 2019, **the UK improved its level of digital connectivity well above the OECD average**, in the top third of OECD countries.

Other countries, from the Netherlands to Norway, have made giant leaps in the Index since 2011. **With other countries making significant improvements in the Index, the UK too can increase its momentum to become an international leader.**

Economic modelling reveals a strong link between increased performance on The Digital Connectivity Index and **economic performance**.

If the UK was to become the OECD leader by 2026, not only would it unlock **£69.78 billion in additional GDP** but it would also create **510,000 new jobs**.

1. All of the OECD digital connectivity data used is publicly available and accessible [HERE](#).

The full methodology is available in the methodological appendix.

2. A Principal Component Analysis model, Oxford Analytica, August 2021, the full methodology is available in the methodological appendix.

3. When index scores are rounded to the nearest integer.

## The potential benefits to the UK becoming a digital connectivity leader.

If the UK were to build on its strong position, and become the OECD leader by 2026, it would unlock:

- **£69.78 billion** in additional GDP between now and 2026<sup>4</sup>.
- **510,000 new jobs** between now and 2026.
- **Consistently higher economic growth rates every year:** The UK's GDP growth rate would be almost a full percentage point higher (0.88) by 2026.

This demonstrates that between now and 2026, better digital connectivity has the potential to **unlock growth in the UK's economy** which could help build a better and fairer society across regions throughout the UK.

Ultimately, these benefits would be shared by both households and businesses and enable them to reach their own potential.

## In the UK, digital connectivity is now a top public priority

*The central role of digital connectivity to households and businesses is being increasingly recognised by the UK public.*

The Covid-19 pandemic has resulted in more of people's daily lives taking place virtually. With all aspects of life becoming increasingly digital, internet traffic has surged in the past 18 months. In June 2020, Ofcom estimated that UK adults were spending more than a quarter of their waking day online – this is the highest amount ever recorded<sup>5</sup>.

Not only has the pandemic resulted in new forms of virtual entertainment and leisure activities, but it has also meant that a large proportion of the UK public has had to adapt to working remotely. For instance, already in April 2020 almost half (47%) of people in the UK did some form of work from home, with more than 86% doing so because of the pandemic<sup>6</sup>. This **shift into new ways of working** has not only increased the importance of the telecoms industry and of digital connectivity to businesses but also to the UK public, who have become more reliant on connectivity in their day-to-day activities.

In recent nationally representative surveys (August 2021<sup>7</sup>), when asked how important the industry was to them personally, as many **as two thirds** (67%) say that **telecoms is important**. The Covid-19 pandemic is clearly making the role of the industry even more important to them – almost **a third** (31%) of the UK public say that **telecoms** has become **more important** to them **since the pandemic** – a sentiment held by all regardless of demographic or region.

In fact, nationally representative surveys conducted at the height of the Covid-19 pandemic in March 2021<sup>8</sup> also shows that over **80% of the UK** public thought that **Mobile Network Operators** (80%) and **broadband companies** (82%) had taken their **responsibility to society** seriously during the pandemic – ranked third and fourth, behind food (86%) and retailers (85%).

This research also showed widespread acknowledgement of the broader benefits of connectivity: for instance, telecoms companies are expected to help in **allowing children to learn effectively at home**, tackle **loneliness**

4. These calculations have been converted to British pounds from US dollars on 22nd October 2021.

5. Ofcom, *UK's internet use surges to record levels*, June 2020.

6. ONS, *Labour Market Study*, April 2020.

7. Online survey of 1,002 UK adults and 1,008 Business Leaders by Portland Communications, August 2021.

8. Online survey of 1,106 UK General Population by Portland Communications, March 2021.

**and isolation**, provide access to **mental health** and wellbeing support as well as pose potential **environmental opportunities**. Recent polling also reveals that the public feels the **top priorities for mobile phone and broadband companies** should be **supporting Britain recover from Covid-19** (42% and 38% respectively), **supporting small and medium sized businesses** (38% and 36%) and **providing good customer service** throughout the UK (39% and 42%).<sup>9</sup>

Covid-19 has highlighted the vital importance of digital connectivity to our everyday lives but has also underscored problems with digital poverty and inequality. In the report, *Adults' Media Use and Attitudes*<sup>10</sup> published in March 2021, Ofcom estimates that there are still **1.5 million families who remain offline in the United Kingdom**.

To highlight the continued need for reliable and improved connectivity across the UK, the same Ofcom study found that more than 4 in 5 (83%) of the public believe the **impact of Covid-19 has made digital connectivity more important** to the UK than before.

Furthermore, business leaders – as well as the public – are recognising the importance of digital connectivity to their success, particularly as a result of the pandemic. In recent proprietary polling<sup>11</sup> 4 in 5 (79%) of UK business leaders say the impact of Covid-19 has made digital connectivity more important to the UK than before. This is a view which is held across the UK regardless of business demographic. Data from the ONS from September 2021<sup>12</sup> predicts that only 12% of businesses expect their workforce to return to their normal place of work within the next 6 months, indicating that **digital connectivity will continue to be crucial to their success** as businesses continue to rely on digital connectivity in the coming months and years.

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9. Online survey of 1,004 UK General Population by Portland Communications, October 2021.

10. Ofcom, *Adults' Media Use and Attitudes*, March 2021.

11. Online survey of 1,002 UK adults and 1,008 Business Leaders by Portland Communications, August 2021.

12. ONS, *Business Insights and Conditions Survey*, September 2021.

# 03. The Index of Digital Connectivity: measuring the impact of digital connectivity

Using economic modelling and advanced analytics we have produced a **new calculation of the impact of digital connectivity on the UK's economy and society**. This calculation reveals the immense potential of digital connectivity to contribute across the UK but also the benefits for all countries looking to improve their digital connectivity.

The Digital Connectivity Index is a representation of the ability of individuals and companies to connect with one another and with the rest of the world using high-quality internet access. The variables underlying the Index represent three key dimensions of high-quality connectivity: 1) Broadband speed, 2) Fixed broadband and 3) Mobile broadband<sup>13</sup>.

## Key findings:

The UK has a strong position on the Index and has improved significantly since 2011, ranking **2nd across the OECD on percentage of households with fixed broadband internet access at home**.

There is a **strong** and statistically significant **relationship between** rates of economic growth (**GDP growth**) and performance on the Index of **Digital Connectivity**.

If the UK were to overtake other countries, and become the leader on the index, by 2026 it would unlock:

- **£69.78 billion** in extra GDP between now and 2026.
- **510,000** new jobs between now and 2026.
- Consistently higher **economic growth every year: a 0.88 percentage point** higher GDP growth rate by 2026.

13. For more information about the Digital Connectivity Index, please see page 28 in the appendix.



## Methodology in brief

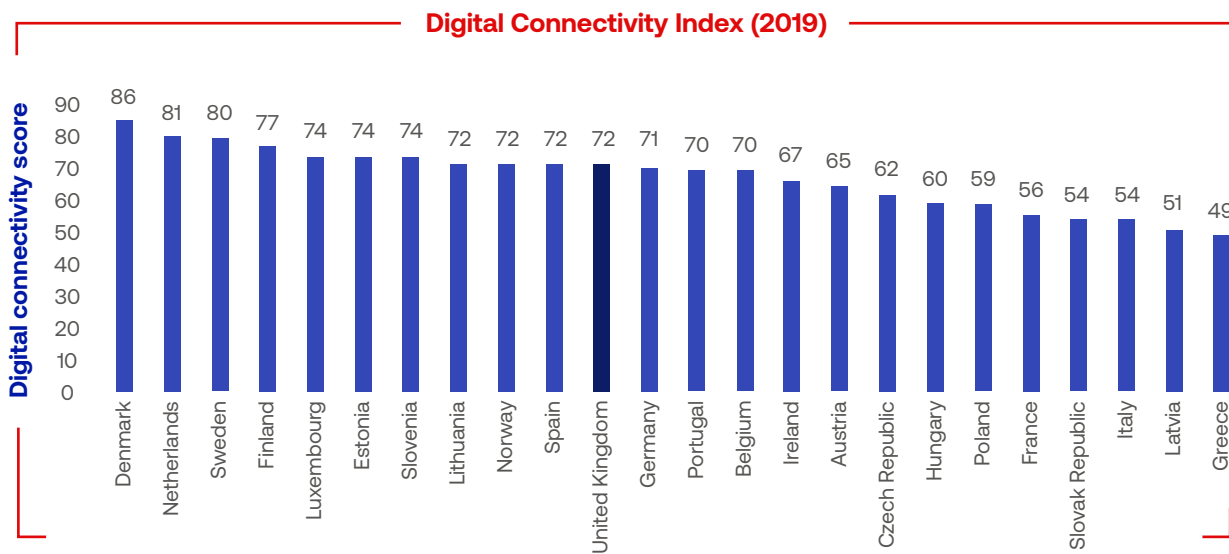
The Index brings together **OECD datasets on broadband speed<sup>14</sup>**, and the **use of fixed broadband and mobile broadband services**. Using a Principal Component Analysis (PCA) model, the Index combines these datasets into a single Index score. For further details of the methodology, please see the detailed appendix.<sup>15</sup>

## The Index of Digital Connectivity: performance

The Index – scored out of 100 – reveals that in its latest data from 2019, the UK ranks joint **8th<sup>16</sup>** across comparable OECD countries, **in the top half of countries scored**.

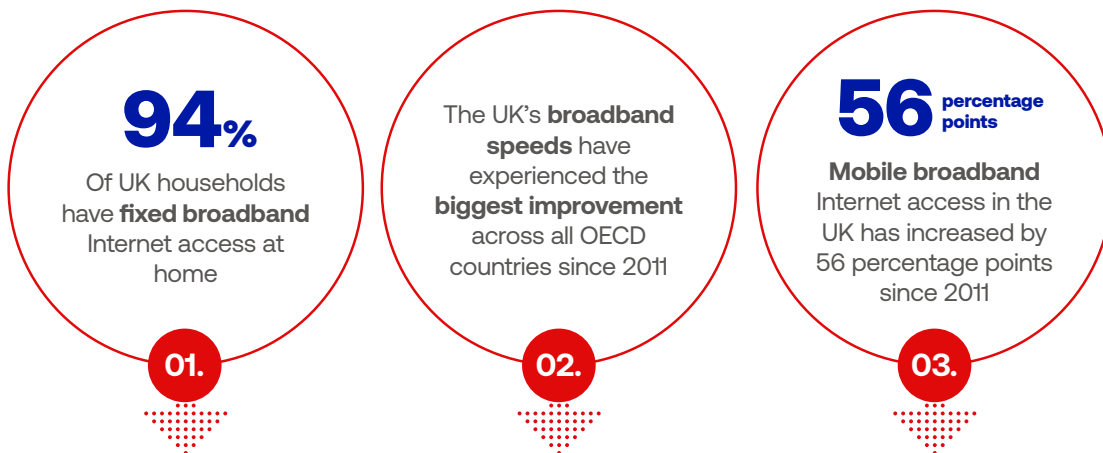
Figure 1. Digital Connectivity Index, 2019 scores (latest data)

Key: 100 is the highest possible score, 0 is the lowest possible score.



The UK has a fairly strong position on the Index and has improved significantly since 2011.

Across OECD datasets, the **three key moves explaining the UK's success** are:



14. All of the OECD digital connectivity data used is publicly available and accessible [HERE](#). The full methodology is available in the methodological appendix.

15. A Principal Component Analysis model, Oxford Analytica, August 2021, the full methodology is available in the methodological appendix.

16. When the index scores are rounded to the nearest integer as in Figure 1, the UK ranks joint 8th with Spain, Norway and Lithuania.

## 01.

At 94%, **the UK ranks 2nd across the OECD on percentage of households with fixed broadband internet access at home**. Only the Netherlands has a higher score at 98%.

- This contrasts with Finland (57%), Italy (61%) and Poland (62%).
- OECD leaders, alongside the UK and the Netherlands, are Norway (93%), Luxembourg (91%) and Germany (88%).

## 02.

The UK has experienced the **biggest improvement across all OECD countries studied on businesses with access to good broadband speeds**<sup>17</sup>.

In 2019, 35% of businesses had access to these speeds compared with 5% in 2011. At 30 percentage points, this is almost **double the average OECD improvement** of 16 percentage points over the same period.

## 03.

**The UK has jumped 57 percentage points**, from 7% in 2011 to 64% in 2019, on the percentage of households with mobile broadband internet access at home. This is **significantly above the average OECD improvement** across the same period at 40 percentage points.

- Only Estonia (+75 percentage point improvement), Spain (+69 percentage points), Slovenia (+62 percentage points) and Hungary (+63 percentage points) enjoyed larger increases in household access.
- This means that the UK has enjoyed the **fifth best** increase across OECD countries studied.

**These improvements explain why the UK has performed better than the OECD average between 2011 and 2019.**

Between 2011 and 2019, the UK ranks in the **top third of improvers** in the Index of Digital Connectivity across the OECD.

- The UK improved its overall score from 36 to 72, a **36-point increase** in the Index.
- This is a **24% larger** increase in performance than the average OECD improvement of **29 points**.

17. This is defined as a download speed of at minimum of 30 Mbit/s but less than 100 Mbit/s.

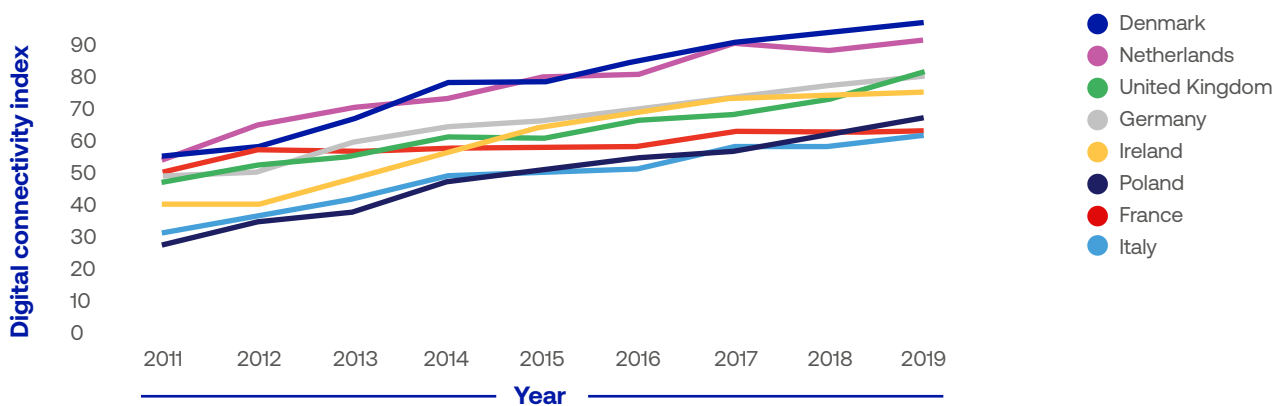
Figure 2. Highest improvements in Index of Digital Connectivity (2011 to 2019)

Rank of improvement	Country	Change in Index score (2011 to 2019)
1st Improvement	Norway	+ 54.3
2nd	Sweden	+ 46.9
3rd	Germany	+ 43.5
4th	Denmark	+ 42.2
5th	Netherlands	+ 40.1
6th	Spain	+ 39.2
7th	Portugal	+ 39.1
8th	United Kingdom	+ 36.4

Figure 3. Lowest improvements in Index of Digital Connectivity (2011 to 2019)

Rank of improvement	Country	Change in Index score (2011 to 2019)
28th improvement	Latvia	- 4.2
27th	Greece	+ 7.5
26th	Slovak Republic	+ 11.9
25th	Italy	+ 15.5
24th	Czech Republic	+ 17.6
23rd	Austria	+ 17.8
22nd	Estonia	+ 19.5
21st	Poland	+ 26.1

Figure 4. Digital Connectivity Index for selected countries, 2011-2019



# 04. The benefits of digital connectivity to OECD countries

Regression analysis reveals that better performance on digital connectivity is **strongly associated** with higher rates of **economic growth** and **employment growth**.

## Regression analysis: GDP growth



There is a **strong** and statistically significant **relationship between** rates of economic growth (**GDP growth**) and performance on the **Index of Digital Connectivity**.

Our regression analysis found that, on average, for European countries, a thirteen-point increase in index points is consistent with raising the GDP growth rate from 2.0% to 2.45%. **For the UK, an economy of 2.0 trillion pounds, this is worth approximately 9.14 billion pounds<sup>18</sup> in extra GDP.**

In recent experience, the average annual score increase across all countries is around 3.5 points. Yet countries have been able to raise their Digital Connectivity Index score by as much as 15 points in a single year (Luxembourg in 2014). The UK was 14 points behind the leader in our Connectivity Index, Denmark, in 2019. By raising its connectivity to become the leader of the index, our analysis suggests the UK could see its GDP growth rate increase by 0.88 percentage points, which is worth £69.78 billion pounds in extra GDP.



Leadership in digital connectivity will **boost GDP** in all regions across the UK

When looking at further **investment in digital connectivity in boosting GDP on a regional level, we see the potential for wide positive impacts across the UK.**

Our analysis reveals that if the UK became the digital connectivity leader, this could bring £16.00 billion GBP growth in the London region alone<sup>19</sup>. However, regions throughout the country could benefit from the additional GDP. **The North West of England, for instance, which is one of the more deprived regions of the UK, could see GDP growth as large as £6.81 billion.**

When looking at potential benefits at a more granular city level rather than looking at the Greater London region, the Greater London Authority could see an additional benefit as large as £1.56 billion. This is followed by Greater Manchester Combined Authority (£1.93 billion) and West Midlands Combined Authority (£1.80 billion), with smaller city regions benefitting also.

When broken down regionally based on current estimates, we would see the following additional GDP boost across the country<sup>20</sup>:

18. These calculations have been converted to British pounds from US dollars on 22nd October 2021.

19. These calculations of potential regional benefits have been done by assuming proportionate distribution based on existing GDP levels.

20. ONS, Labour Force Survey, June 2021.

Figure 5. Potential GDP benefits: regions across the UK

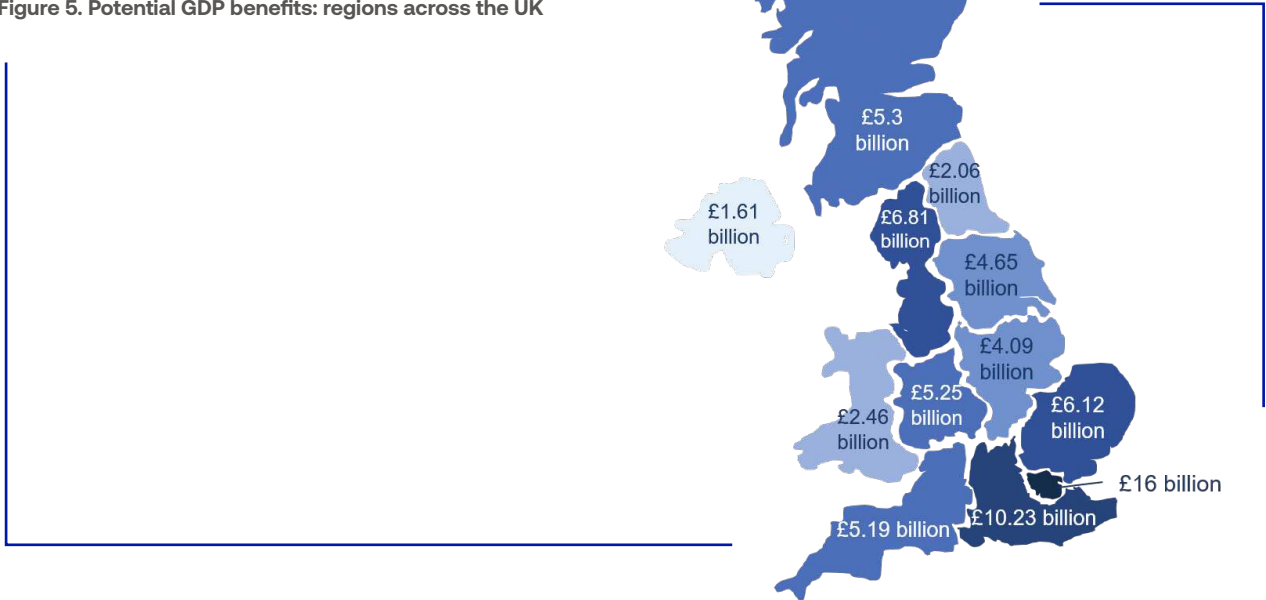


Figure 6. Potential GDP benefits by region in the UK

Region	Potential GDP benefit by 2026 of digital connectivity leadership
London	£16.00 billion
South East	£10.23 billion
North West	£6.81 billion
East of England	£6.12 billion
Scotland	£5.30 billion
West Midlands	£5.25 billion
South West	£5.19 billion
Yorkshire and the Humber	£4.65 billion
East Midlands	£4.09 billion
Wales	£2.46 billion
North East	£2.06 billion
Northern Ireland	£1.61 billion

Figure 7. Potential GDP benefits: city regions across the UK

City Region in the UK	Potential GDP benefit by 2026 of digital connectivity leadership
Greater London Authority	£11.56 billion
Greater Manchester Combined Authority	£1.93 billion
West Midlands Combined Authority	£1.80 billion
West Yorkshire Combined Authority	£1.50 billion
Glasgow City Region	£1.24 billion
Edinburgh and South East Scotland City Region	£1.08 billion
Cardiff Capital Region	£896 million
Liverpool City Region Combined Authority	£889 million
West of England Combined Authority	£813 million
Sheffield City Region	£743 million
Belfast City Region	£712 million
Cambridgeshire and Peterborough Combined Authority	£689 million
North East Combined Authority	£600 million
North of Tyne Combined Authority	£505 million
Tay Cities Region	£463 million
Aberdeen City Region	£440 million
North Wales Economic Ambition Board	£407 million
Swansea Bay City Region	£378 million
Tees Valley Combined Authority	£369 million
Ayrshires	£182 million
South of Scotland	£161 million
Growing Mid Wales	£98 million
Stirling and Clackmannanshire City Region	£95 million
Derry-Londonderry City Region	£80 million
Scottish Island Councils	£48 million

### Regression analysis: employment growth

Looking at the impact on employment, after isolating the effect of connectivity from the effect of GDP growth, there is a strong and statistically significant relationship between rates of employment growth and performance on the Digital Connectivity Index<sup>21</sup>. A 13-point increase in the Index is associated with a **0.21-percentage-point increase in the employment growth rate**. This translates to 510,000 **new high connectivity** jobs that would be created if the UK became a digital connectivity leader **by 2026**.



**510,000**

**New high connectivity jobs that digital connectivity will contribute to the UK economy by 2026**

When thinking about the types of jobs and sectors that would be particularly likely to benefit from this increase, **small and medium businesses could stand to be potential winners**. In polling conducted in August<sup>22</sup>, as many as 4 in 5 (81%) business leaders across the UK think small and medium-sized businesses would benefit from better connectivity.

21. After controlling for the rate of GDP growth and per-capita level of GDP.

22. Online survey of 1,002 UK adults and 1,008 Business Leaders by Portland Communications, August 2021.

While the positive impact of improved digital connectivity is highlighted by business leaders in a number of different sectors, **those in the environment and agriculture sector are the most likely to see potential benefits**. In total, as many as 88% of them think that better connectivity would make it easier for them to run their business. Around 4 in 5 of those in the energy and utilities sector (81%) and in creative arts and design (79%) also think better connectivity would make it easier for them to run their business, ahead of an average of 69% who thought the same.

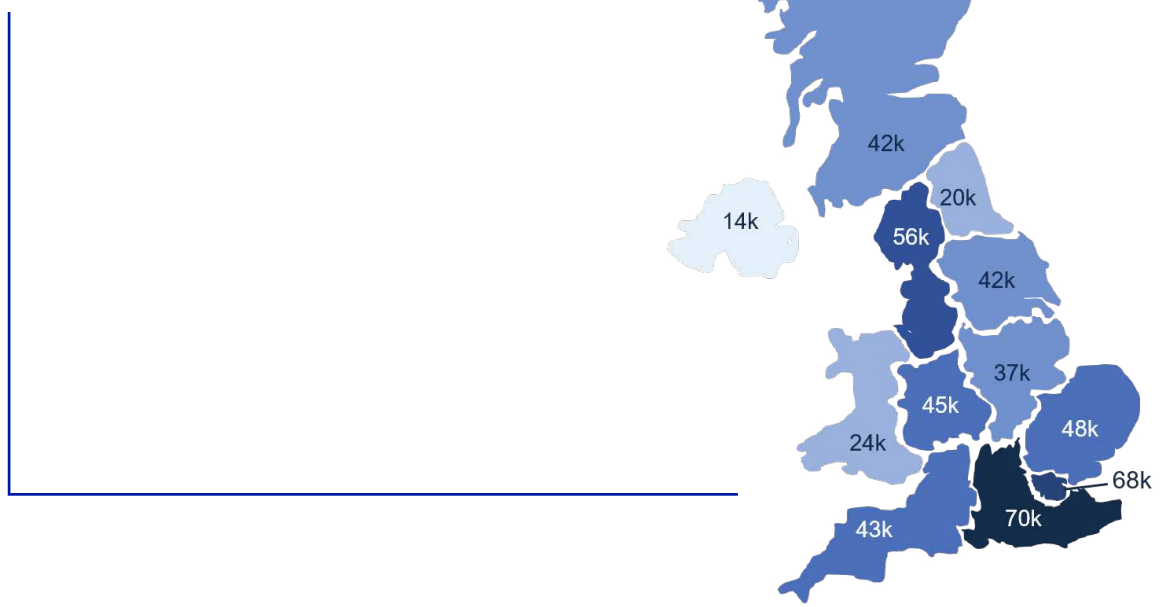
Better connectivity would also likely have a positive impact on local communities and the digital skills gap. Polling shows how 63% of business leaders agree that better connectivity would enable their business to support local communities – those working in healthcare were particularly likely to think so (67%), highlighting **the potential that improvements in digital connectivity would have on the healthcare sector**.

Improved connectivity could also positively impact the digital skills gap, particularly in areas outside of London. Surveying of businesses by World Skills UK found that almost one quarter (23%) of employers feel **their current workforce lacks the digital skills they need**, with 76% saying that a lack of digital skills actually affects profitability<sup>23</sup>. Improved connectivity could also increase access to skill sharing, such as digital training, and allow businesses to recruit those with digital skills from other regions, combatting geographical skill disparities.

In turn, this will bring many benefits to households and businesses across the UK. Across the country, it will **connect more people to the things they love, support local communities, help businesses grow, and power the UK economy in every region**.

It is clear that the benefits of increased digital connectivity will be felt across the UK, with potential new jobs being created in all regions across the country. Our analysis reveals if the UK became the digital connectivity leader, this could bring around 70,000 jobs in both the South East of England (70,115 new jobs) and London (68,384 new jobs). The North West of England could also see as many as around 55,979 new jobs created, based on current ONS estimates. When broken down regionally based on current estimates<sup>24</sup>, we could see the following additional jobs created across the country<sup>25</sup>:

**Figure 8. Potential employment benefits by regions across the UK**



23. World Skills UK, *Disconnected? Exploring the Digital Skills Gap*, March 2021.

24. These calculations of potential regional benefits have been done by assuming proportionate distribution based on the number of working aged people in each region.

25. ONS, Labour Force Survey, June 2021.

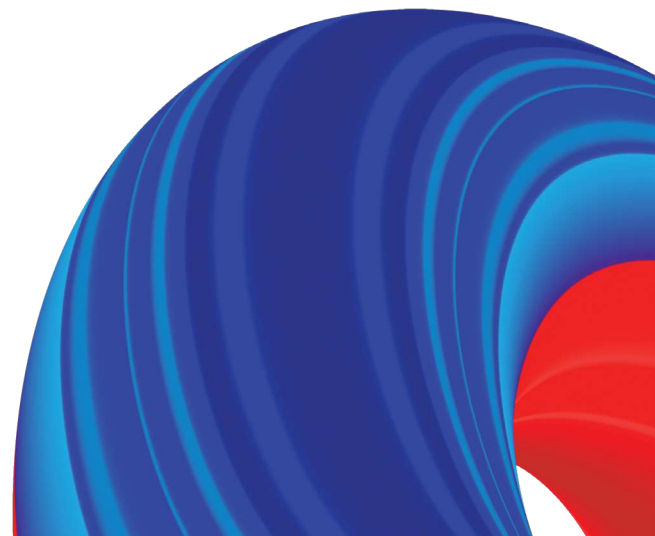
Figure 9. Potential additional employment by 2026 generated by digital connectivity leadership in the UK

Region	Additional employment by 2026 generated by digital connectivity leadership
South East	70,115
London	68,384
North West	55,979
East of England	47,604
West Midlands	45,298
South West	42,987
Yorkshire and the Humber	42,065
Scotland	41,746
East Midlands	36,880
Wales	24,094
North East	20,404
Northern Ireland	14,445

### Unlocking economic growth: the potential of digital connectivity in the UK

Our analysis reveals that if the UK were to steadily build on its strong position, and become the OECD leader, it would unlock:

- **£69.78 billion** in extra GDP between now and 2026.
- **510,000** new jobs between now and 2026.
- Consistently higher economic growth every year: a **0.88** percentage point higher annual GDP growth rate by 2026.





# 05. Closing the digital divide

The Index of Digital Connectivity, and the UK's position among global leaders, demonstrate the impact of critical steps already taken towards equality in digital connectivity in the UK. Despite this, research shows that the **digital divide in the UK is still apparent**.

Those living in more deprived areas of the country, those based in rural areas, lower income households and minority ethnic groups are experiencing the impact of inequality in digital connectivity the hardest. This disparity reinforces the importance of our commitments to a more connected Britain.

By understanding and outlining where these big gaps of inequality exist, we can predict where the positive impact of improved digital connectivity can be felt the strongest. In fact, making improvements in digital connectivity and taking leadership in this area will **disproportionately benefit these higher-need communities**.

## A digital divide: urban and rural connectivity

*Despite recent progress made, analysis of data from Ofcom's annual Connected Nations Report shows that geography remains a key factor when it comes to the digital divide<sup>26</sup>.*



Our research has found that the UK currently has a strong performance on digital connectivity, **but 190,000 premises are still without access to decent broadband**



There is a clear disparity in connectivity: **98% of urban areas** have access to superfast broadband compared to **81% of rural areas**



**7 in 10 (71%)** of the UK public **agree** that some areas of the UK **don't have fast and reliable internet**

At a broad level, the majority of the UK has access to decent broadband and mobile phone coverage. However, when comparing connectivity in rural and urban areas across the country, there are some clear gaps. According to the same Ofcom data, whilst 99.4% of the UK has access to decent broadband, as many as **190,000 premises are without** this. Most of these – 119,000 – are in England; 34,000 are in Scotland, 19,000 are in Northern Ireland, and 18,000 are in Wales.

When looking at superfast broadband<sup>27</sup> across the UK, there is **a clear gap when comparing urban and rural areas in all four nations**. Ofcom estimates<sup>28</sup> show that at least 98% of urban areas across the nations have access to superfast broadband, but when looking at rural areas, the greatest gaps can be seen in Northern Ireland and Scotland. In Northern Ireland, only 2 in 3 (66%) of rural areas have access to superfast broadband, while in Scotland this figure is at 72%.

Improved connectivity would help ensure that this seemingly small, but significant number of households and businesses, are not left behind. Virgin Media O2 is making an important contribution to this specific government initiative; 13 million homes can already access gigabit speeds and its entire network will be gigabit ready by the end of the year.

26. Ofcom, *Connected Nations 2020: UK report*, December 2020.

27. A connection allowing for a minimum of 30 Mbit/s download.

28. Ofcom, *Connected Nations 2020: UK report*, December 2020.

Figure 10. Access to Superfast Broadband % of Premises in the UK – Urban and Rural

	England	Scotland	Wales	Northern Ireland	UK
Urban	98%	98%	98%	99%	98%
Rural	84%	72%	78%	66%	81%
Total	96%	94%	94%	89%	96%

Regarding coverage of mobile network operators, Ofcom estimates<sup>28</sup> show that access to 4G outside is available for between 98–99% of the UK, while for coverage indoors the estimated figure is clearly lower at 90–95%. These numbers significantly differ when looking at the number of Mobile Network Operators with reach and when comparing urban and rural areas, with the **indoor coverage for 4G data connection in the latter being significantly lower** than elsewhere in the country.

For instance, when looking at coverage from all network operators, **only 46% of rural premises are estimated to have indoor 4G data coverage**, with this figure rising to 86% for urban areas. As many as 98% of premises in urban areas and 80% of those in rural areas have indoor 4G coverage by at least one MNO<sup>29</sup>.

These Ofcom estimates of digital connectivity between urban and rural areas are further supported by recent polling conducted in August by Portland Communications<sup>30</sup>. Results from nationally representative surveys show that those living in rural areas in the UK indeed report experiencing worse internet connection compared to **those based in urban areas**. In total, 13% of those living in a rural area report having a bad internet connection, which is more than twice as many as those living in urban areas who say they experience this (6%).

Some initiatives are already in place to tackle this divide, but more is needed. For instance, in 2020, a new Government-backed initiative called **Shared Rural Network (SRN)** was launched. This initiative, backed by the UK’s four leading MNOs, aims to address geographic problems in connectivity and improve rural coverage for the UK. This was deemed particularly crucial as a result of new digital ways of working, educating children more from home and accessing critical services online.

### The Covid-19 pandemic has highlighted the digital divide further

As noted previously, there has been a clear shift into new digital ways of working as a result of the Covid-19 pandemic, both among businesses and the UK public who have become more reliant on digital connectivity in their daily activities. It is also clear that this shift has exacerbated the digital divide and highlighted the gaps that exist in connectivity among different groups within the country.

A nationally representative survey conducted by Portland Communications in August 2021<sup>31</sup>, demonstrates that this digital divide is well recognised by the UK public. Findings indicate that a staggering 7 in 10 (71%) of the UK public agree that some areas of the UK don’t have fast and reliable internet connection; only 4% disagree with this statement and a quarter of the UK public are neutral or don’t know. Furthermore, **a clear majority (62%) consider access to the internet in the UK as being unequal**; with only 7% in disagreement with this statement, it is clear that there is room for improvement in making access to digital connectivity more equal.

29. Ofcom, Connected Nations 2020: UK report, December 2020.

30. Online survey of 1,002 UK adults and 1,008 Business Leaders by Portland Communications, August 2021.

31. Online survey of 1,308 UK General Population by Portland Communications, August 2021.

The impact of Covid-19 on the digital divide is clear to the public with just under 3 in 5 (57%) saying that **the pandemic has highlighted the divide** when it comes to digital connectivity. This shows that even though proportionally the number of households who don't currently have access to 'decent' or 'superfast' broadband or 4G connectivity is fairly small, this is a 'top of mind' issue for the public who notice the inequalities it creates.

Polling further shows that **addressing these gaps is clearly an area that the public expect to see improvements in**. Almost three quarters (65%) of the UK public believe that digital connectivity inequality should be an easy thing to fix, especially for a digitally advanced nation like Great Britain. Only 5% of the UK public disagree with this statement, which highlights the expectations of digital connectivity as an area that can be resolved.

Figure 11. Question: *To what extent do you agree or disagree with the following statements?* <sup>32</sup>

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	Don't know
Some regions of the UK don't have fast and reliable internet connection	29%	42%	18%	3%	1%	7%
There is unequal access to internet connection in the UK	23%	39%	23%	4%	2%	8%
The Covid-19 pandemic highlighted inequality in digital connectivity in the UK	20%	37%	26%	5%	3%	10%
Digital connectivity inequality should be an easy thing to fix, especially for a digitally advanced nation like Great Britain	25%	39%	22%	4%	1%	8%

32. Online survey of 1,308 UK General Population by Portland Communications, August 2021.

# 06. The digital divide: economic and social deprivation

Our research shows that in addition to differences in urban and rural connectivity, the digital divide runs along lines of existing economic and social deprivation. Here too, it is crucial to outline the differences currently experienced in detail as this helps us identify where improvements are most needed and where improved digital connectivity will have the most positive impact. Some of the differences experienced between those in the most affluent and most deprived areas of the UK include:



In the most **deprived quartiles**, fewer individuals can work from home (54% compared to 60% amongst the most affluent areas).



41% of those in the **more deprived** half of the country say the **speed** of their internet is a **barrier** to working remotely, compared to 35% of those in the most affluent quartile.



38% of those in the most deprived areas reported that **broadband quality** was a **barrier** to working remotely, compared to 34% of the most affluent areas in the UK.

We used the **Index of Multiple Deprivations** to look at differences in digital connectivity across different areas of the UK in order to understand the impact that digital connectivity (or lack of it) is having on different regions.

This index is widely-used in the UK to classify the relative deprivation of small areas and allows us to compare areas to one another. Multiple components of deprivation are weighted with different strengths and compiled into a single score of deprivation, which then allows for segments to be created using different thresholds.

A postcode analysis and local authority deprivation scores allows us to group survey responses into the following quartiles:

- 1st quartile – the top 25% **most deprived regions** in the UK
- 2nd quartile
- 3rd quartile
- 4th quartile – the 25% **least deprived regions** in the UK

By looking at findings from this analysis, we see some statistically significant differences when it comes to the most and least deprived regions of the UK<sup>33</sup>:

- In the **most deprived quartile of the UK, fewer individuals are able to work from home**. Only 54% say they use their broadband at home to work compared to 60% of those living in the most affluent quartile of the UK who do so.
- This is likely **linked to unreliable broadband speed**, as 41% of those people living in the more deprived half of the country say that the speed of their internet connection is a barrier to working remotely. Only 35% of those in the most affluent quartile in the UK name this as a barrier.
- Furthermore, 38% of those living in the most deprived quartile of the UK said that their **broadband quality is a barrier to working remotely**. This is slightly higher than for those living in the most affluent quartile with 34% identifying the quality of the internet connection as a barrier.

With the most deprived areas of the UK currently experiencing the most negative impacts from a lack of digital connectivity, we believe that upgrading the UK – and becoming a digital connectivity leader – is likely to considerably benefit these deprived areas of the UK.

Figure 12. Postcode deprivation analysis broken by quartiles

	Are you able to work from home using your home broadband?	Currently, is the speed of your internet connection a barrier to working remotely?		Currently, is the quality of your internet connection a barrier to working remotely?	
	Yes	Yes	No	Yes	No
1st quartile (most deprived regions in the UK)	54%	39%	55%	38%	57%
2nd quartile	62%	43%	54%	39%	57%
3rd quartile	55%	38%	58%	37%	59%
4th quartile (least deprived regions)	60%	35%	61%	34%	62%

33. Online survey of 4,107 UK General Population by Portland Communications, August 2021. Correlated with [Index of Multiple Deprivations](#)

# 07. The digital divide: systematic norms of inequality

Our research also shows **clear divides across regions and different socio-economic groups**. In addition to the aforementioned differences between rural and urban areas as well as levels of deprivation, the key systems of inequality that have become institutionalised in the UK: region, income, and ethnicity, also apply to the digital divide.

By understanding where the largest gaps in equality exist within these areas, we are able to clearly identify which groups in society are the ones that will feel the positive impact of improved digital connectivity the strongest. If the UK becomes a global digital connectivity leader, this will **disproportionately benefit these higher-need communities** which are currently lacking in digital connectivity. Some key highlights based on systemic norms include:



**Wales** has the highest proportion of individuals with **no basic digital skills at 19% of the population**, followed by the North East at around 12%.



Those **earning over £40,000** are the **most likely** to have an **internet connection at home** and those earning £10,000 and under are the least likely.



More people from **ethnic minority groups** say they were **unable to carry out important administrative tasks** and **stay in contact with family** because of poor internet.

## Regional factors

**Some regions in the UK, particularly Wales and the North East of England, are clearly worse affected by the digital divide than other areas of the country – improvements in digital connectivity would therefore have a particularly strong positive impact on these regions.**

When it comes to access to both **broadband and mobile connectivity, there are clear differences between different regions of the UK**. As can be seen in the charts below, where dark green represents higher levels of connectivity and light green lower levels of connectivity, Wales and the North East of England are some of the worst connected areas of the country.

In addition to this data from Ofcom<sup>34</sup> from 2020, recent nationally representative polling<sup>35</sup> further highlights the impact of low digital connectivity on these specific regions. Results show that those living in the **North East of England and Wales indeed feel like they have the lowest access to a decent internet connection in the UK**. For instance, 14% of those in the North East and 12% who live in Wales say their internet is 'bad', which compares to just 8% among the average British population.

34. Ofcom, Connected Nations 2020: UK report, December 2020.

35. Online survey of 1,308 UK General Population by Portland Communications, August 2021.

Figure 13. Broadband (left) and mobile (right) connectivity across the UK by local government authority

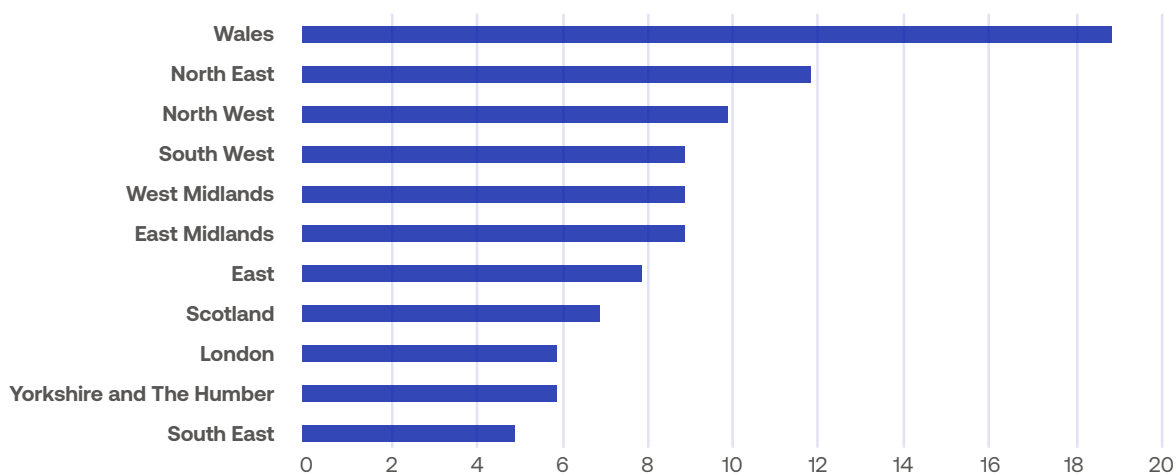


Not only do we see a divide across regions existing in terms of access, but ONS<sup>36</sup> estimates also show that there are major differences across the country when it comes to digital skills, this meaning the skills needed to use the internet competently, confidently, and safely. The regions that report **lower levels of access to fast and reliable internet tend to be the same areas that have higher proportions of the population with zero basic digital skills.**

In Wales, as many as 1-in-5 (19%) of people have no digital skills, representing the highest proportion in the UK. This figure is more than twice as high than most other regions, and four times higher than in the South East. Wales is followed by the North East of England, which has the second highest proportion of those with zero digital skills (12%). It is therefore clear that the regions with lowest access to connectivity are also those where digital literacy is the lowest.

Improved digital connectivity would level up different regions of the country, **with particular benefits to those areas currently lacking the access and means to help build their digital skills.**

Figure 14. Regional variation in proportion of population with zero basic digital skills



36. ONS, *Exploring the UK's Digital Divide*, March 2019

## Income factors

**Existing data also shows that the digital divide is driven by the disparity in income - those living in the lowest income households are most likely to be living in digital poverty.**

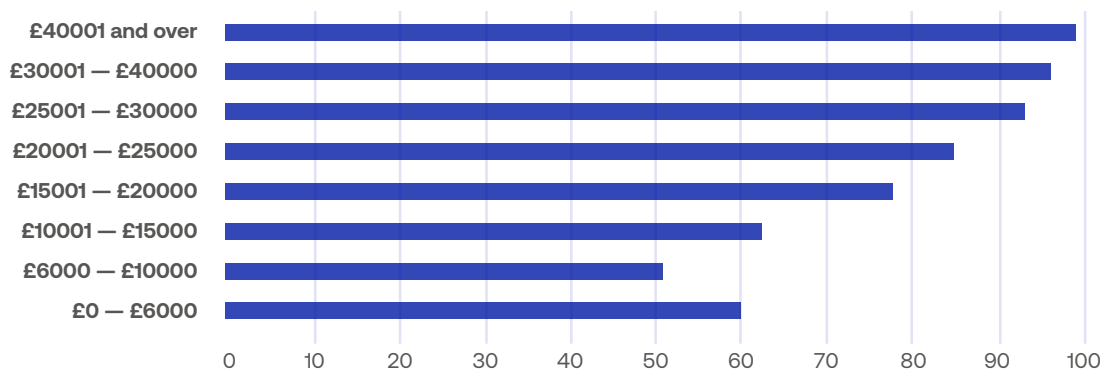
Proprietary research<sup>37</sup> from Portland Communications shows that those **living on the lowest incomes in the UK are the people most likely to be living in digital poverty**. There are clear statistically significant differences when it comes to both having access to the internet in the first place and the quality of internet connection when you have it.

Firstly, as many as 1 in 10 (10%) of those with a household income of £15,000 a year or less do not even have internet connection at home. This is significantly higher than the UK average, since only 1% of households on average do not have an internet connection at all. Additionally, as many as 10% of those with a household income of £15,000 a year or less report having bad internet connection, compared to only 2% of those with an income of over £75,000 a year who say they experience a bad connection.

ONS data gives further evidence as to how the **digital divide is driven by disparity in income**. Data focused specifically on Scotland highlights how the percentage of households with an internet connection increases with income<sup>38</sup>. Nearly all of those who earn over £40,000 have an internet connection at home (99%), while fewer than 3 in 5 of those earning £10,000 and under have an internet connection at home.

These clear differences based on income, which particularly highlight the disadvantageous position of those with lower incomes, indicate that **the benefits of improved digital connectivity would be felt most acutely among the lowest income groups** who currently have low quality access, or none at all.

Figure 15. The percentage of households in Scotland with an internet connection increases with income



## Ethnicity factors

**Improvements in digital connectivity would disproportionately benefit those from minority ethnic backgrounds.**

Similar to region and income, the digital divide is also impacting people from different ethnic backgrounds in different ways. Those from **minority ethnic backgrounds are currently more likely to have higher levels of internet usage but often experience poor connection**, which is clearly having an impact on their daily lives.

This could in part be explained by the fact that minority ethnic groups are more likely than white people to live in the most deprived areas of the UK<sup>39</sup>. Although research on the digital divide for minority ethnic

37. Online survey of 1,002 UK adults and 1,008 Business Leaders by Portland Communications, August 2021.

38. ONS, *Exploring the UK's Digital Divide*, March 2019.

39. Gov UK, *People Living in Deprived Neighbourhoods*, June 2020.



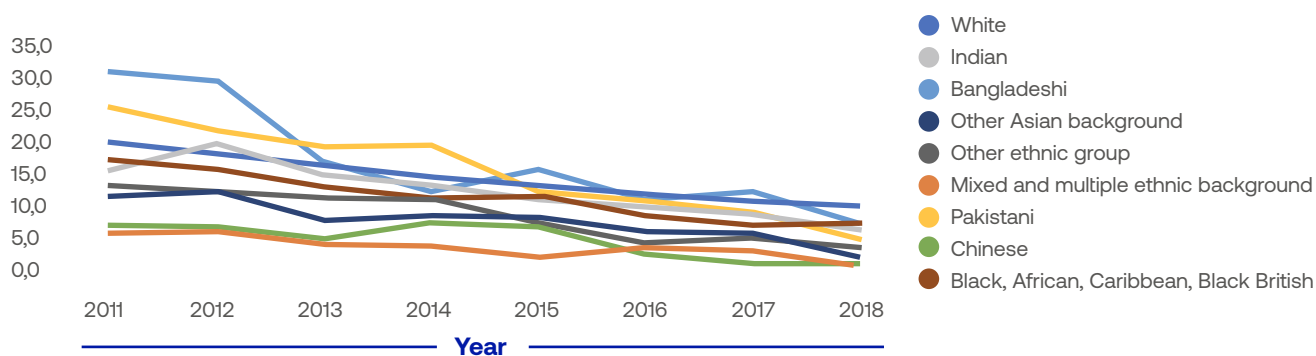
groups is currently limited, studies also note that even when controlling for socio-economic variables, such as income, ethnicity might play a role in technology ownership and digital access.<sup>40</sup>

Recent nationally representative polling<sup>41</sup> shows that **people who belong to a minority ethnic group are somewhat more likely to report having a slow internet connection** than white people in the UK (11% and 8% respectively). This is particularly concerning as minority ethnic groups in the UK currently say they use their home broadband more than white people for various activities, such as working from home (31% vs 24%), video calls (34% vs 17%) and listening to music (22% vs 16%).

According to the Office for National Statistics<sup>42</sup>, **levels of internet usage among the UK public has clearly increased over the last decade, regardless of ethnicity**. In support of the survey findings, this data also shows how the amount of people who do not use the Internet has steadily decreased since 2011.

This being said, according to latest data from 2018, white people have higher amounts of non-usage than other ethnic groups in the UK. In fact, Pakistani and Bangladeshi groups have seen the largest decreases in the amount of people who have not used the internet between 2011 and 2018.

Figure 16. Internet Non-users by ethnicity 2011-2018



Recent polling further highlights the impact that poor internet connectivity is having on various aspects of the daily lives of minority ethnic groups in the UK. For instance, as many as 36% of those belonging to a minority ethnic group say they are **unable to carry out important administrative tasks** due to poor internet connectivity, with only 20% of white people in the UK saying so<sup>43</sup>.

Similarly, as many as one third of those belonging to minority ethnic groups (30%) say they **haven't been able to stay in contact with family** in other parts of the UK or overseas because of poor internet connection. This is more than double the proportion of white people (14%) who report experiencing this issue.

It is clear from our research that minority ethnic groups are experiencing more disruptions in their daily lives as a result of poor internet connectivity than white people in the UK. Therefore, **the positive impact of improved digital connectivity would be particularly strong for those belonging to a minority ethnic group** -further highlighting the importance of digital connectivity in levelling up throughout the UK.

40. Cumberland Lodge, *Digital Inclusion: Bridging Divides*, 2020.

41. Online survey of 1,127 UK General Population by Portland Communications, August 2021.

42. ONS, *Exploring the UK's Digital Divide*, March 2019.

43. Online survey of 1,127 UK General Population by Portland Communications, August 2021.

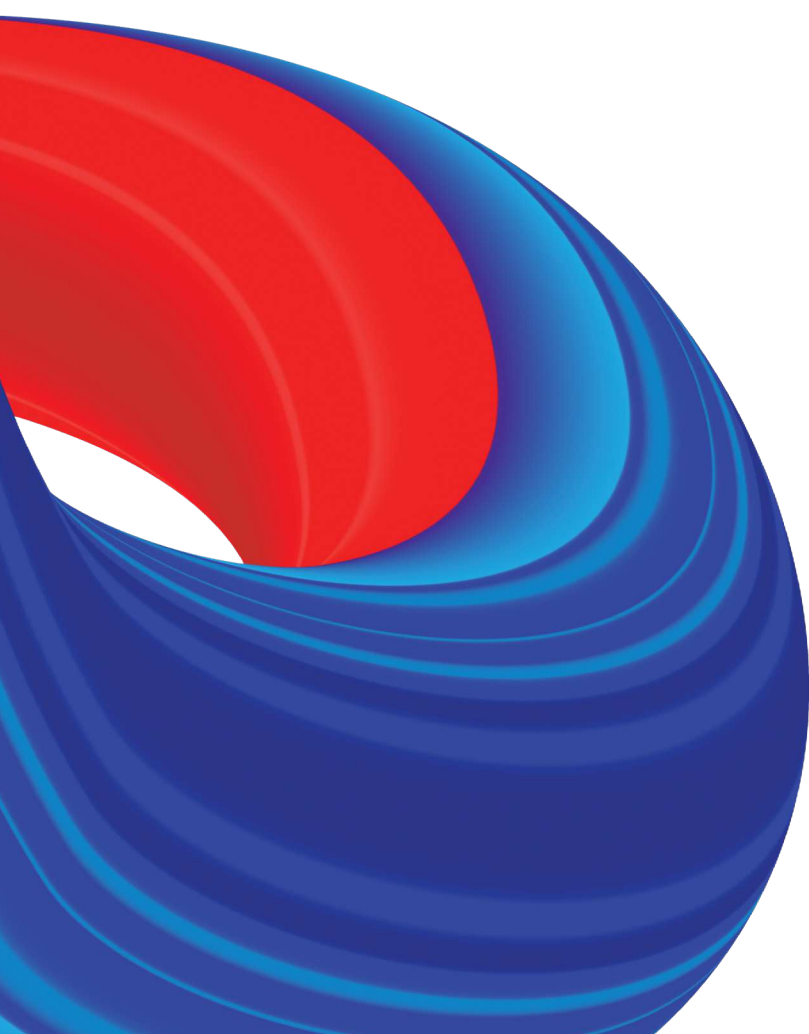
## 08. Conclusion

The Coronavirus pandemic and shift to new ways of working has showed us how critical digital connectivity is to the UK. It is **a key enabler of both economic and social growth** and has the potential boost productivity, jobs and levelling up across the country.

In this report, through economic modelling, advanced analytics and polling data, we have examined the role that digital connectivity can play in a post-Covid UK and the potential benefits we see are widespread. The additional GDP and employment opportunities that would be created if the UK was to become a digital connectivity leader by 2026 truly highlight the potential of digital connectivity in the UK's economy. Not only would the UK see as many as **510,000 new jobs** created across the country, but it would also benefit from an additional **£69.78 billion in GDP**.

Between now and 2026, better digital connectivity would help **build a better and fairer society across regions throughout the UK**. Despite some steps already taken towards equality in digital connectivity in the UK, it is apparent that there is still a clear digital divide in the country that has only been exacerbated by the pandemic. As making improvements in digital connectivity will disproportionately benefit these higher-need communities, **this disparity further reinforces the importance of commitments to a more connected Britain**.

At Virgin Media O2, we want to upgrade the UK as we believe our new company provides the opportunity for us to accelerate our leadership in digital connectivity. However, for the UK to fulfil a greater ambition and become the digital connectivity leader, **collaboration from Government, the regulator and the industry is needed**. This is a key opportunity to boost economic and social growth and to make the UK one of the world's most digitally connected countries.



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# 10. Methodological appendix: The index of digital connectivity and analysis

## Measuring digital connectivity

The Digital Connectivity Index is a new representation of the ability of individuals and firms to connect with one another and with the rest of the world using high-quality internet access.

### Index constituents

The variables underlying the Index represent three key dimensions of high-quality connectivity:

1. **Broadband speed.** Fast and ultrafast broadband services are together 1/3 of the index variables. Specifically, these measure businesses' use of fast and ultrafast broadband services.
2. **Fixed broadband.** High-quality, fixed-broadband services are 1/3 of the index variables. These measure households and businesses' use of fixed broadband services separately.
3. **Mobile broadband.** High-quality, mobile-broadband services are 1/3 of the index variables. These measure households and businesses' use of mobile broadband services separately.

The specific variables used in the Index are reported in Table A.

Table A: Constituent variables in Digital Connectivity Index

Geography	Indicator name	Unit
Total	Households with fixed broadband internet access at home	% of households
Total	Households with mobile broadband internet access at home	% of households
Total	Businesses with a wired or fixed wireless broadband connection	% of all businesses employing 10 or more people
Total	Businesses with a mobile broadband connection	% of all businesses employing 10 or more people
Total	Businesses with a broadband download speed at least 30 Mbit/s but less than 100 Mbit/s	% of all businesses employing 10 or more people
Total	Businesses with a broadband download speed at least 100 Mbit/s	% of all businesses employing 10 or more people

Source for all variables: OECD Statistics.

## Index construction

The need to represent a concept with a number will, in most settings, give rise to an index. The index-compiler will typically draw upon a variety of good but individually imperfect variables to jointly represent the concept. Each will have a bearing on a separate aspect of the concept, as discussed immediately previous.

The challenge is in distilling these variables into a single variable – in this case, a Digital Connectivity Index. We use a statistical technique called principal component analysis (PCA). The aim of this technique is to ask,

**Are there a discrete (and hopefully small) number of underlying properties in the data represented in all of these variables?** If the answer is “Yes”, PCA’s job is to find those underlying “components” (hence “principal component analysis”). Once found, it produces those components in new, bespoke variables.

## Digital connectivity rankings

PCA on our underlying connectivity variables shows that 60% of the information contained in them can be distilled into one distinct number (one variable). This is the “first principal component” in the PCA. This new, “synthetic”, variable is the Digital Connectivity Index.

## Regression analysis: the impact of digital connectivity

Regression analysis suggests that better connectivity is associated with higher rates of economic growth and employment growth.

### GDP growth

A standard-deviation increase in the Digital Connectivity Index is associated with roughly 0.45 of a percentage-point higher rate of GDP growth. To put that into context, one standard deviation in the index is approximately thirteen index points. On average, for European countries, a thirteen-point increase in index points is consistent with raising the GDP growth rate from 2.0% to 2.45%. For the UK, an economy of 2.8 trillion dollars, this is worth 12.6 billion dollars in extra GDP.

In recent experience, the average annual score increase is around 3 and a half points. But countries have been able to raise their Digital Connectivity Index score by as much as 15 points in a single year (Luxembourg in 2014). The UK was 14 points behind the leader in our Connectivity Index, Denmark, in 2019. By raising its connectivity to Denmark’s level and becoming a digital connectivity leader, our analysis suggests the UK could see its GDP growth rate increase by 0.88 percentage points, which is worth 18.0 billion pounds in extra GDP.

### Employment growth

After controlling for the rate of GDP growth and per-capita level of GDP, the Connectivity Index exhibits a statistically significant association with employment growth. Specifically, a 13-point (or one standard deviation) increase in the Index is associated with a 0.21-percentage-point increase in the employment growth rate. For the UK, this translates to around 67,580 jobs based on current employment of 32.18 million people. Moreover, by raising its connectivity to Denmark’s level and becoming the digital connectivity leader, the UK’s employment growth rate could increase by 0.42 percentage points, which amounts to around 135,000 jobs.

Table B: Impact on UK GDP and employment if it increased its connectivity to Denmark’s level

Variable name	Variable values in the UK in 2019	Values if UK connectivity increased to Denmark’s level	Gain
GDP growth rate	1.46 %	2.34%	24.64 billion dollars
Employment growth rate	1.11%	1.53%	135,000 jobs

## 01. Additional GDP

### Methodology

To estimate how much additional GDP the UK would create between 2021 and 2026 by gradually increasing its Connectivity Index score to Denmark's level, we compare:

- The UK's GDP when its Index score remains constant between 2021 and 2026 (the 'Business-As-Usual' scenario).
- The UK's GDP when its Index score gradually increases to Denmark's level between 2021 and 2026 (the 'Better Connectivity' scenario).

In the 'Business-As-Usual' scenario, we estimate the UK's annual GDP growth rates between 2021 and 2026 using the parameters identified in our regression analysis and holding the UK's Connectivity Index score constant at its 2019 level. Next, we use these growth rates to estimate the level of UK GDP between 2021 and 2026 in the 'Business-As-Usual' scenario.

In the 'Better Connectivity' scenario, we assume that the UK's Index score increases evenly between 2021 and 2026 until reaching Denmark's level in 2026. Thus, because there were 14.06 Index points separating Denmark and the UK in 2019, we assume that the UK's Index score increases by 2.34 Index points ( $= 14.06/6$ ) each year between 2021 and 2026. Next, we estimate the UK's annual GDP growth rates between 2021 and 2026 using our regression parameters and the UK's gradually improving Index scores under this scenario. Finally, we use these growth rates to estimate the level of UK GDP between 2021 and 2026 in the 'Better Connectivity' scenario.

The UK's GDP growth rates and GDP under both the 'Business-As-Usual' and 'Better Connectivity' scenarios are detailed in Table C.

Table C. UK GDP and annual GDP growth rates under the 'Business-As-Usual' and 'Better Connectivity' scenarios.

Years	Annual GDP growth rate (%) -- 'Business-As-Usual' scenario	Annual GDP growth rate (%) -- 'Better Connectivity' scenario	GDP (USD trillion) -- 'Business-As-Usual' scenario	GDP (USD trillion) -- 'Better Connectivity' scenario
2021	2.136918	2.283020	2.859834	2.863925
2022	2.078291	2.370494	2.919269	2.931814
2023	2.068232	2.506537	2.979647	3.005301
2024	2.049289	2.633696	3.040708	3.084451
2025	2.027131	2.757639	3.102347	3.169509
2026	2.004691	2.881301	3.164540	3.260832

### Additional GDP between 2021 and 2026

The difference between UK GDP in 2026 under the 'Better Connectivity' and 'Business-As-Usual' scenarios is around \$96.29 billion. This is how much additional GDP the UK would create by gradually increasing its Connectivity Index score to Denmark's level between 2021 and 2026.

## 02. Additional employment

### Methodology

To estimate how much additional employment the UK would create between 2021 and 2026 by gradually increasing its Connectivity Index score to Denmark's level, we compare:

- The UK's employment when its Index score *remains constant* between 2021 and 2026 (the 'Business-As-Usual' scenario).
- The UK's employment when its Index score *gradually increases* to Denmark's level between 2021 and 2026 (the 'Better Connectivity' scenario).

In the 'Business-As-Usual' scenario, we estimate the UK's annual employment growth rates between 2021 and 2026 using the parameters identified in our regression analysis and holding the UK's Connectivity Index score constant at its 2019 level. Next, we use these growth rates to estimate the level of UK employment between 2021 and 2026 in the 'Business-As-Usual' scenario.

In the 'Better Connectivity' scenario, we again assume that the UK's Index score increases evenly between 2021 and 2026 until reaching Denmark's level in 2026. Thus, as explained in Part I of this report, we assume that the UK's Index score increases by 2.34 Index points each year between 2021 and 2026. Next, we estimate the UK's annual employment growth rates between 2021 and 2026 using our regression parameters and the UK's gradually improving Index scores under this scenario. Finally, we use these growth rates to estimate the level of UK employment between 2021 and 2026 in the 'Better Connectivity' scenario.

The UK's employment growth rates and employment under both the 'Business-As-Usual' and 'Better Connectivity' scenarios are detailed in Table D.

Table D. UK employment and annual employment growth rates under the 'Business-As-Usual' and 'Better Connectivity' scenarios.

Years	Annual employment growth rate (%) -- 'Business-As-Usual' scenario	Annual employment growth rate (%) -- 'Better Connectivity' scenario	Employment (million) -- 'Business-As-Usual' scenario	Employment (million) -- 'Better Connectivity' scenario
2021	1.461776	1.531584	32.650400	32.672864
2022	1.453454	1.593071	33.124958	33.193366
2023	1.451661	1.661086	33.605820	33.744736
2024	1.448741	1.727974	34.092681	34.327836
2025	1.445438	1.794480	34.585470	34.943843
2026	1.442119	1.860969	35.084234	35.594137

### Additional employment between 2021 and 2026

The difference between UK employment in 2026 under the 'Better Connectivity' and 'Business-As-Usual' scenarios is around 509903. This is how much additional employment the UK would create by gradually increasing its Connectivity Index score to Denmark's level between 2021 and 2026.



## Detailed breakdowns

### Principal component analysis

Here we report the number of principal components associated with the variables listed in Table A. The output shows that the first principal component (“PC1”) explains 58.11% of variation in the data. The second part of the output shows the loadings of each variable with each component. For example, “0.353” below PC1 and to the right of “B21A” reports that B21A has a correlation of 35.3% with PC1.

	PC1	PC2	PC3	PC4	PC5	PC6
Standard deviation	1.8673	0.9517	0.8403	0.6784	0.50956	0.42616
Proportion of Variance	0.5811	0.1510	0.1177	0.0767	0.04328	0.03027
Cumulative Proportion	0.5811	0.7321	0.8498	0.9265	0.96973	1.000
Households with fixed broadband internet access at home	0.353	-0.635	0.27	-0.485	0.375	-0.154
Households with mobile broadband internet access at home	0.391	0.561	0.23	-0.445	0.056	0.527
Businesses with a wired or fixed wireless broadband connection	0.351	-0.225	-0.845	-0.01	0.021	0.335
Businesses with a mobile broadband connection	0.46	0.367	-0.208	-0.153	-0.165	-0.75
Businesses with a broadband download speed at least 30 Mbit/s but less than 100 Mbit/s	0.443	-0.294	0.301	0.260	-0.732	0.15
Businesses with a broadband download speed at least 100 Mbit/s	0.44	0.104	0.166	0.69	0.540	0.014

Note: All variables were transformed to z-scores prior to PCA.

## Regression results

### GDP growth

The output below reports that a 1 standard-deviation increase in the Connectivity Index (“PC1” in the Coefficients table) is associated with a 0.44 percentage-point rise in the GDP growth rate in real terms (NGDP\_RPCH). The regression controls for real per-capita income, which is represented by the combination of log of GDP in constant-price US dollars (GDPDrln) and the log of population (LPln).

```
## Call:
## lm(formula = NGDP_RPCH ~ PC1 + GDPDrln + LPln, data = GDP)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -8.9005 -0.9515 -0.0667  0.8296  7.2325
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.18281    0.69346   7.474 2.05e-12 ***
## PC1          0.44158    0.07757   5.692 4.16e-08 ***
## GDPDrln     -0.90630    0.24362  -3.720 0.000255 ***
## LPln         0.54651    0.26627   2.052 0.041361 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.984 on 211 degrees of freedom
## Multiple R-squared:  0.1997, Adjusted R-squared:  0.1883
## F-statistic: 17.55 on 3 and 211 DF, p-value: 3.288e-10
```



## Employment growth

The output below reports that a 1 standard-deviation increase in the Connectivity Index (“PC1” in the Coefficients table) is associated with a 0.21 percentage-point rise in the employment growth rate (LEd). The regression controls for real per-capita income, which is represented by the combination of log of GDP in constant-price US dollars (GDPDrln) and the log of population (LPln), and for the growth of GDP in real terms (NGDP\_RPCH).

```
## Call:
## lm(formula = LEd ~ PC1 + GDPDrln + LPln + NGDP_RPCH, data = dv4)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.9191 -0.5811  0.0773  0.6233  3.8090
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.19848    0.48654  -0.408   0.684
## PC1          0.21099    0.05206   4.053 7.32e-05 ***
## GDPDrln      0.19810    0.16597   1.194   0.234
## LPln         -0.23323    0.18323  -1.273   0.205
## NGDP_RPCH    0.34980    0.03445  10.153 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.232 on 193 degrees of freedom
## (18 observations deleted due to missingness)
## Multiple R-squared:  0.48, Adjusted R-squared:  0.4692
## F-statistic: 44.54 on 4 and 193 DF, p-value: < 2.2e-16
```



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